

RESEARCH REPORT 1996 - 1997



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INTRODUCTION

The Max Planck Institute for the History of Science (MPIWG) in Berlin was established in 1994, and is part of the network of research institutes sponsored by the Max Planck Society for the Advancement of Science. The Max Planck Institute for the History of Science is dedicated to the development of a theoretically-oriented history of science, which studies the acquisition of knowledge in interaction with its cultural, technical, and social contexts. Although the history of the natural sciences and mathematics is the primary focus of its research program, the Institute also sponsors a number of projects devoted to the history of the human sciences. The research pursued at the Institute aims to develop a “historical epistemology” for the sciences: a historical understanding of the fundamental categories that shape scientific investigation, explanation, evidence, and proof.

The years 1996-97 continued to be years of steep growth for the Institute. By the end of 1997 the number of Research Scholars employed at the Institute had risen from 22 (1995) to 26; in the period 1996-97, 67 predoctoral and postdoctoral fellows and 36 Visiting Scholars from all corners of the learned world enlivened the Institute’s research projects, colloquia, and conferences. An increasing number of these visitors came with support from external research institutions, including the Danish Natural Science Research Council, the French Centre National de Recherche Scientifique, the Schweizer National Fonds, the German Alexander-von-Humboldt-Stiftung, the Deutsche Forschungsgemeinschaft (Heisenberg-Programm), and several universities. The Institute has also participated in research collaborations with the Biblioteca Nazionale Centrale, Florence; the Istituto e Museo di Storia della Scienza, Florence; and the Institut für Geschichte der Naturwissenschaften der Ludwig-Maximilians-Universität, Munich. The Institute library has attempted to keep pace with the increase of resident scholars: since 1995 its holdings have grown from 13,000 to 20,000 volumes; these are to be supplemented by several computer data bases compiled in connection with specific research projects and an ambitious scanning project of key manuscripts and primary sources in the history of science. Most significant of all for the Institute’s intellectual and institutional development was the addition of a third Department, under the directorship of Hans-Jörg Rheinberger, which officially began its work in January 1997.

Now that all three of the scholarly Departments originally planned for the

Institute are in place and, as the contents of this Report testify in detail, active, the next intellectual and institutional challenge will be one of integration. Although the research reports contained in this volume cover an extraordinary range of topics, from the workings of ancient balances, to scientific travel, to the construction of a virtual physiological laboratory, certain themes recur throughout. These include the historicity and variety of scientific experience, the role of material culture in science, and the historical processes, cognitive and cultural, that create new objects of scientific inquiry. The specific contexts in which these themes currently are being explored by researchers at the Institute span many disciplines and periods; all, however, aim at a more general level of reflection concerning the historical preconditions for the emergence and disappearance of fundamental epistemological categories like "experience" and "object." In 1996-97 several conferences were dedicated to aspects of these themes (see *WORKSHOPS AND CONFERENCES P. 245*), and in 1999 all three Departments will host an international conference on "Things that Are Good to Think with: Paradigmatic Objects in the Sciences."

In addition to these connecting research themes, four new research initiatives, all scheduled to begin in 1998, will also contribute to the intellectual life of the Institute as a whole. Two of these are five-year independent research groups to be led by outstanding junior scholars; the selection procedure, conducted by an international and interdisciplinary commission of scholars, is already under way. The third is an independent five-year commission established by the Max Planck Society to investigate the history of its predecessor organization, the Kaiser-Wilhelm-Gesellschaft, from 1998 to 2003, concentrating on the National Socialist period (1933-45). This project is the result of a joint initiative by the historically-oriented Max Planck Institutes and the Max Planck Society Archives, and will be located at the Max Planck Institute for the History of Science. Its scholarly advisors are Professor Reinhard Rürup (Technische Universität Berlin) and Professor Wolfgang Schieder (Universität zu Köln); PD Dr. Doris Kaufmann, Research Fellow at the Institute from 1995-97, has been appointed Research Director of the project. Fourth and finally, the Max Planck Institute for the History of Science was awarded one of ten five-year research professorships for junior women scholars of distinction in their fields. Dr. Emma Spary (University of Warwick, U.K.) will take up her professorship in July 1998.

Inquiries of a general nature concerning the Institute and its programs should be addressed to the Research Coordinator:

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Further information can be found at the Institute's website
<http://www.mpiwg-berlin.mpg.de>

The Sciences of the Body Die Wissenschaften vom Körper



Barbara Duden Universität Hannover

26.03.1998, Donnerstag, 19.00 Uhr

Entkörperung in der Moderne –
zur Geschichte
des erlebten (Frauen-) Körpers
zwischen 1950 und 1990

Max-Planck-Institut
für Wissenschaftsgeschichte

Michael Hagner

16.04.1998, Donnerstag, 19.00 Uhr

In der Grenzregion
von Körper und Seele.
Zur Geschichte des Schwindels
im 19. Jahrhundert

14.05.1998, Donnerstag, 19.00 Uhr

Emma Spary University of Warwick

A Taste for Learning:
Gastronomy and
the Sciences
in Post-Revolutionary
France

Heinrich von Staden Yale University

11.06.1998, Donnerstag, 19.00 Uhr

Reading the Agonal Body:
The Language of Conflict and
Competition in "Hippocrates"

RESEARCH SCHOLARS AND GUESTS

RESEARCH SCHOLARS

Beurton, Peter J. (Dipl. 1968 [biology], Dr. rer. nat. 1973 [biology], Dipl. 1977 [philosophy] Humboldt-Universität zu Berlin, habil. phil. 1987 [philosophy] Universität Potsdam); research scholar Akademie der Wissenschaften der DDR (1972-1991); research scholar Forschungsschwerpunkt Wissenschaftsgeschichte und Wissenschaftstheorie, Berlin (1991-1994); research strategies in biological evolutionary theory; modern Darwinism and the philosophy of science (E. Mayr, K. Popper, T. S. Kuhn); genetics, population genetics, the biological species, and reductionism.

Brentjes, Sonja (Dipl. 1973 [mathematics], Technische Universität Dresden, Dr. rer. nat. 1977, Technische Universität Dresden, Dipl. Arabic/Middle Eastern Studies, Martin-Luther-Universität Halle-Wittenberg, Dr. sc. nat. 1989, Dr. habil. rer. nat. 1991, Karl-Marx-Universität Leipzig); assistant professor, Karl Sudhoff Institute for the history of medicine and science, Karl-Marx-Universität Leipzig (1976-1990); fellowship CNRS, Université VIII, Paris, Saint-Denis (1991); Rockefeller fellowship, University of Oklahoma, Norman (1991/92); assistant professor, Karl Sudhoff Institute (1992/1993); “integration” fellowship, Humboldt Foundation, Institute for History of Science, Ludwig-Maximilians-Universität München (1993); Feodor Lynen fellowship, Humboldt Foundation, member of the Institute for Advanced Study, Princeton (1994/95); assistant professor, Privatdozentin, Karl Sudhoff Institute (1995/96), visiting professor, Institute for History of Science, Georg-August-Universität Göttingen (1995-96) European travelers to the Middle East (16th-17th centuries) and the sciences in Muslim societies.

Cadden, Joan (B.A. 1965 Vassar College, M.A. 1967 Columbia University, Ph.D. 1971 [history and philosophy of science] Indiana University); assistant professor Harvard University (1971-1976); assistant professor, associate professor, professor Kenyon College (1978-1996), professor University of California at Davis (1996-present): history of medieval scientific and medical ideas on sexuality; medieval scientific arguments in disciplinary, social and political contexts.

Castagnetti, Giuseppe ([philosophy and history] University of Milano), research scholar Max Planck Institute for Human Development and Education, working group Albert Einstein (1990-1995); research scholar Einstein Papers project, The Collected Papers of Albert Einstein, Boston (1989-1996): history of institutions of physics in the 20th century; political and social context of Albert Einstein's activities in Berlin.

Clark, William (Ph.D. [history of science] University of California at Los Angeles, 1986); lecturer, history, UCLA, 1987-88; Lecturer & Mellon Fellow, Bryn Mawr College, 1988-89; lecturer & Kenan Fellow, Columbia University, 1989-91; Akademischer Rat a.Z., Institut für Wissenschaftsgeschichte, Göttingen, 1991-97; early modern German science and academic institutions.

Damerow, Peter (Dr. 1977 [mathematics] Universität Bielefeld, habil. 1994 [philosophy] Universität Konstanz); Max Planck Institute for Human Development and Education: history of science and education, genesis of writing and arithmetic, individual and historical development of cognition, mathematical modelling in the sciences.

Daston, Lorraine (A.B. 1973 Harvard University, Dipl. 1974 University of Cambridge, Ph.D. 1979 [history of science] Harvard University); assistant professor Harvard University (1980-1983) and Princeton University (1983-1986); Dibner Associate Professor Brandeis University (1986-1989); professor Georg-August-Universität Göttingen (1990-1992); professor University of Chicago (1992-1995): history of probability and statistics (16th-19th centuries); history of forms of scientific evidence and objectivity (16th-20th centuries).

Dierig, Sven (Dipl. 1990 [biology], Dr. rer. nat 1995 [neurobiology] Universität Konstanz); postdoctoral fellow Universität Konstanz (1995-1997): history of laboratory physiology in connection with history of technology and urban history; virtual reconstruction of laboratory equipment and historical experiments.

Feldhay, Rivka (1967 B.A. [General History and English Literature] Haifa University; Hebrew University Jerusalem; 1980 Ph.D. [history of science]

Hebrew University, Jerusalem) 1973-80 teaching and research assistant, 1975 master of arts (history of science), 1981-82 instructor at the Department of History Hebrew University Jerusalem; 1984-87 instructor, 1987-89 lecturer and since 1990 senior lecturer at the Cohn Institute for the History and Philosophy of Science, Tel Aviv University. History of Science.

Gradmann, Christoph, (M.A. 1987 Universität Hannover, Dr. phil. Universität Hannover 1991 [history]), research scholar Universität Hannover 1991/1992 [history], research scholar Universität Heidelberg 1992-1995 [history of medicine], assistant professor Heidelberg 1995 - [history of medicine]: history of bacteriology, cultural history of science (19th century), medicine and war (19th-20th centuries), theory and history of historical biography.

Graßhoff, Gerd (M.A. 1983, Dr. rer. nat. 1986 [history of science], habil. 1995 [philosophy] Universität Hamburg); Oxford University 1980-81, member of the Institute for Advanced Study Princeton 1987-88, Minerva Associate at Tel-Aviv University 1990-91, Hochschulassistent Universität Hamburg 1988-95, guest professor for philosophy Universität Hamburg 1994-95, chair for the history of science at Georg-August University Göttingen 1997-98: modelling of scientific discovery processes; history of astronomy; methodology of sciences; natural philosophy late 19th and early 20th century.

Hagner, Michael, (Staatsexamen 1986 [medicine], Dr. med. 1987 Freie Universität Berlin, habil. 1994 [history of medicine] Georg-August-Universität Göttingen); research scholar and postdoctoral fellow Freie Universität Berlin (1986-1989); research scholar Medizinische Universität Lübeck (1989-1991) and Georg-August-Universität Göttingen (1991-1995); Heisenberg-fellow (1995-1996): history of epistemic objects in the neurosciences and in teratology (18th-20th centuries); history of experimental cultures (18th-20th centuries).

Hoffmann, Dieter (Dipl. 1972 [physics], Dr. phil. 1976 Humboldt-Universität zu Berlin, Dr. habil. 1989 [history of science] Humboldt-Universität zu Berlin); research scholar Akademie der Wissenschaften der DDR (1976-1991); research scholar Physikalisch-Technische Bundesanstalt (1991-1992); research scholar Forschungsschwerpunkt Wissen-

schaftsgeschichte und Wissenschaftstheorie, Berlin (1992-1995): Guest Professor Humboldt-Universität zu Berlin (WS 1996/97), history of physics in the 19th and 20th centuries, esp. institutional history of quantum theory and modern metrology; history of science in the GDR.

Kant, Horst (Dipl. 1969 [physics], Dr. rer. pol. 1973 [history & philosophy of science] Humboldt-Universität zu Berlin); research scholar Humboldt-Universität zu Berlin (1973-1978); research scholar Akademie der Wissenschaften der DDR (1978-1991); research scholar Forschungsschwerpunkt Wissenschaftsgeschichte und Wissenschaftstheorie, Berlin (1992-1995): history of physics in the 19th and 20th centuries (esp. institutional and social aspects); history of quantum theory and nuclear physics; development of physics in Berlin.

Kaufmann, Doris (Dr. phil. 1983, habil. 1993 [history] Technische Universität Berlin); visiting professor Freie Universität Berlin (1994); visiting professor Universität Tübingen (1994-95); visiting professor Universität Jena (1995); visiting professor Universität Bern (1995-96): modern social and cultural history, history of psychiatry and of cultural anthropology, religious and gender studies.

Klein, Ursula (Dr. phil 1993 [philosophy] Universität Konstanz); postdoctoral fellow Forschungsschwerpunkt Wissenschaftsgeschichte und Wissenschaftstheorie, Berlin (1993-1995): history and philosophy of laboratory sciences; history of early modern natural philosophy; history of 17th-19th-century chemistry in connection with historical epistemology.

Küttler, Wolfgang (Dipl. 1958 [history] Friedrich-Schiller-Universität Jena, Dr. phil. 1966 Universität Leipzig, Dr. sc. 1976, Professor 1978 [history] Akademie der Wissenschaften der DDR); research scholar (1958-1967) Friedrich-Schiller-Universität Jena and Universität Leipzig; research scholar (1967-1974), head of department (1974-1990), director (1990-1991) Zentralinstitut für Geschichte der Akademie der Wissenschaften der DDR; visiting professor Humboldt-Universität zu Berlin (1981-1990); research scholar Forschungsschwerpunkt für Wissenschaftsgeschichte und Wissenschaftstheorie, Berlin (1992-1995): theory, methodology and history of historical science, Marxist theory of history, Max Weber research.

Lefèvre, Wolfgang (Dr. phil. 1971 [philosophy], habil. 1977 [philosophy in connection with history of science] Freie Universität Berlin, apl. Professor Freie Universität Berlin [philosophy]): history of science in connection with history of philosophy on the basis of social history; sciences in Greek antiquity; early modern physics and chemistry; history of biology (15th-18th centuries).

Mendelsohn, John Andrew (A.B. 1989 Harvard University, M.A. 1991 Princeton University, Ph.D. 1996 Princeton University); Mellon fellow in the Humanities 1989-94; assistant in instruction Princeton University 1991-92; International Doctoral Research Fellow Social Science Research Council 1992-93; postdoctoral fellow Max Planck Institute for the History of Science 1995-96: life and medical sciences in social context since 1800.

Müller-Hoissen, Folkert, (Dipl. 1980, Dr. rer. nat. 1983, habil. 1993 [physics] Georg-August-Universität Göttingen): general relativity; development and application of modern geometric methods in theoretical physics, history of relativity theory.

Renn, Jürgen (Dipl. 1983 [physics] Freie Universität Berlin, Dr. rer. nat. 1987 [mathematics] Technische Universität Berlin); collaborator and co-editor of Collected Papers of Albert Einstein (1986-1992); assistant, since 1993, associate professor Boston University (1989-1993) [philosophy and history of science, physics]; Simon Silverman Visiting Professor Tel-Aviv University (1993) [history of science]; visiting professor ETH Zürich (1993-1994) [philosophy]; adjunct professor Boston University (since 1994); honorary professor Humboldt-Universität zu Berlin (since 1995) [history of science]; history of early modern mechanics, history of relativity theory; interaction between cognitive and contextual factors in the history of science.

Rheinberger, Hans-Jörg (M.A. 1973 [philosophy], Dipl. 1979 [biology], Dr. rer. nat. 1982, habil. 1987 [molecular biology] Freie Universität Berlin); research scholar Max Planck Institute for Molecular Genetics Berlin (1982-1990); honorary professor (history of biology) University of Salzburg (1989); lecturer (history of science and medicine) University of Lübeck (1990-1994); visiting professor University of Göttingen (1992-1993); Ao. Univ. Prof. (molecular biology and history of science) Univer-

sity of Salzburg (1994-1996): history and epistemology of experimentation, history of the life sciences.

Roux, Sophie (Agrég. 1987 [philosophy], Ph.D. 1996 [history of science] EHESS); fellow École Normale Supérieure (1984-1989); assistant in instruction Université de Paris I (1989-1992); fellow Fondation Thiers (1993-1995); postdoctoral fellow at the Max Planck Institute for the History of Science (1996-1997): early modern physics and its epistemology.

Sauer, Tilman (Dipl. 1990, Dr. rer. nat. 1994 [physics] Freie Universität Berlin, research scholar Max Planck Institute for Human Development and Education Berlin (1990-1995)): history of general relativity.

Schoepflin, Urs (Dipl. 1975 [sociology], Freie Universität Berlin); director of library); scientific information systems, scientific communication, sociology and history of science, scientometrics.

Schüller, Volkmar (Dr. rer. nat. 1972 [physics] Universität Greifswald): research assistant Universität Greifswald (1972-1976); research scholar Akademie der Wissenschaften der DDR (1979-1991); research scholar Forschungsschwerpunkt für Wissenschaftsgeschichte und Wissenschaftstheorie, Berlin (1992-1994): history of mathematics and physics (16th and 17th centuries).

Sibum, H. Otto, (Dr. rer. nat. 1989 [physics] Carl-von-Ossietzky-Universität Oldenburg) research scientist Department of Physics, Universität Oldenburg (1989-1990); research associate (1991-1993), senior research associate (1994-1995) and affiliated research scholar (since 1996) University of Cambridge, England: history of the physical sciences (18th-century electricity and magnetism, 19th-century electro- and thermodynamics), history of precision measurement and experimentation in relation to knowledge production.

Steinle, Friedrich (Dipl. 1982 [physics], Dr. rer. nat., 1990 [history of science], Universität Tübingen): history of physics (17th-19th centuries); philosophy of science; history and philosophy of experimentation.

Strickland, Stuart (A.B. 1984 [philosophy] Columbia University, A.M. 1989, Ph.D. 1992 [history of science] Harvard University); Walther Rathenau Fellow (1992-93); assistant professor of history, Northwestern University (since 1993); philosophical idealism and experimental science, philosophies of history, literature and science.

Thieffry, Denis (Dipl. 1988 [molecular biology and philosophy of science] and Ph.D. 1993 [theoretical biology] Université Libre de Bruxelles); post-doctoral fellow Université Libre de Bruxelles (1993-1995); assistant professor Universidad Nacional Autónoma de México (1995-1997); history of genetics, embryology and molecular biology (20th century).

Vogel, Klaus A. (Dipl. 1981 [nautical science] Hochschule für Nautik Bremen, Dr. phil. 1995 [history] Georg-August-Universität Göttingen); research scholar Max Planck Institute for History Göttingen (1991-1995); medieval and early modern history; central European humanism; history of cosmography; late medieval and early modern science; history of violence and empathy.

Vogt, Annette (Dipl. 1975 [mathematics] Karl-Marx-Universität Leipzig, Dr. rer. nat. 1986 Karl-Marx-Universität Leipzig); research scholar Akademie der Wissenschaften der DDR (1975-1991); coordinator Forschungsschwerpunkt Wissenschaftsgeschichte und Wissenschaftstheorie, Berlin (1992-1994); history of mathematics; history of mathematics in Germany in the 19th and 20th centuries; history of the relationships between Russia/Soviet-Union and Germany in the 19th and 20th centuries in mathematics; history of Jewish scientists in Germany; history of female scientists in the 19th and 20th centuries.

Wahsner, Renate (Dipl. 1961, Dr. phil. 1966 [philosophy] Humboldt-Universität zu Berlin, Dr. sc. 1978 [philosophy] Akademie der Wissenschaften der DDR, professor [history of science] Akademie der Wissenschaften der DDR (1987); research scholar Humboldt-Universität zu Berlin (1963-1970); research scholar Akademie der Wissenschaften der DDR (1974-1991); research scholar Forschungsschwerpunkt Wissenschaftsgeschichte und Wissenschaftstheorie, Berlin (1992-1995); professor Universität Potsdam: history of philosophy in connection with history of

science; epistemological fundamentals and problems of physics; German idealism; classical natural philosophy.

Weinig, Paul (Dr. phil., 1994 [German philology], Johann Wolfgang Goethe-Universität Frankfurt/M.); teacher at the Goethe-Institut Frankfurt/M. (1991-1995); history of medieval mechanics in Arabic and Latin sciences; history of humanism in Germany (1400 to 1600); science and history of medieval manuscript-writing; history and methodology of language teaching (DaF).

Wunderlich, Falk (M.A. 1995 [philosophy] Freie Universität Berlin); Kant's natural philosophy.

VISITING SCHOLARS AND RESEARCH FELLOWS

Prof. Dr. Mohamed Abattouy, University of Fez, visiting scholar (July 1, 1996 - October 25, 1996 and July 1 - December 31, 1997)

Hanne Andersen, Universität Konstanz, predoctoral research fellow (February 1, 1996 - August 15, 1996)

Prof. Dr. Mitchell G. Ash, University of Iowa, visiting scholar (May 13, 1996 - December 15, 1996 and June 1, 1997 - September 30, 1997)

Dr. Jutta Berger, Technische Universität Berlin, postdoctoral research fellow (October 1, 1996 - September 30, 1997)

Conevery Bolton, Harvard University, predoctoral research fellow (June 15, 1996 - July 1, 1996)

Dr. Christophe Bonneuil, Université de Paris 7, predoctoral research fellow (August 1, 1996 - February 28, 1997) and CNRS postdoctoral research fellow (March 1, 1997 - February 28, 1998)

Francesca Bordogna, University of Chicago, predoctoral research fellow (April 1, 1996 - December 15, 1996)

Prof. Dr. Marie-Noëlle Bourguet, Université de Paris 7, visiting scholar (September 22, 1995 - Januar 31, 1996 and September 20, 1996 - October 6, 1996)

Christina Brandt, Georg-August-Universität Göttingen, predoctoral research fellow (October 1, 1996 - December 31, 1998)

Dr. Stéphane Callens, Université de Lille 1, postdoctoral research fellow (October 1, 1996 - September 30, 1997)

Dr. Michele Camerota, Università di Cagliari, postdoctoral research fellow (November 16, 1995 - February 15, 1996 and July 8, 1996 - October 8, 1996)

Dr. Yoonsuhn Chung, Seoul, visiting scholar (May 1, 1996 - April 30, 1997 and October 1, 1997 - December 31, 1997)

Nani Clow, Harvard University, predoctoral research fellow (February 1, 1996 - August 31, 1996)

Alix Cooper, Harvard University, predoctoral research fellow (July 1, 1997 - August 31, 1997)

Dr. Serafina Cuomo, Christ's College, Cambridge, postdoctoral research fellow (October 1, 1996 - September 30, 1997)

Dr. Michael Dettelbach, Smith College, Northampton, Alexander von Humboldt fellow (January 1, 1997 - June 30, 1997)

Prof. Dr. Bruce S. Eastwood, University of Kentucky, visiting scholar (July 1, 1997 - September 30, 1997)

Dr. Berna Kılıç Eden, University of Chicago, predoctoral research fellow (September 1, 1995 - December 31, 1996), postdoctoral research fellow (September 1, 1997 - August 31, 1998)

Dr. Elisabeth Emter, Freie Universität Berlin, postdoctoral research fellow (October 1, 1996 - September 30, 1997)

Prof. Dr. Robert Englund, University of California at Los Angeles, visiting scholar (September 10, 1997 - September 24, 1997)

Prof. Dr. Raphael Falk, The Hebrew University of Jerusalem, visiting scholar (September 20, 1996 - October 20, 1996 and July 15, 1997 - September 15, 1997)

Dr. Raymond Fredette, Fitch Bay, Canada, visiting scholar (November 25, 1997 - December 5, 1997)

Prof. Dr. Gideon Freudenthal, Tel-Aviv University, visiting scholar (June 1, 1996 - July 7, 1996 and July 25, 1997 - August 25, 1997)

Dr. Ofer Gal, University of Pittsburgh, postdoctoral research fellow (October 1, 1996 - December 31, 1997)

Dr. Peter Geimer, Philipps-Universität Marburg, postdoctoral research fellow (June 1, 1997 - December 31, 1998)

Dr. Martin Gierl, Georg-August-Universität Göttingen and Max-Planck-Institut für Geschichte, Göttingen, postdoctoral research fellow (October 1, 1995 - October 31, 1996)

Prof. Dr. Hubert Goenner, Georg-August-Universität Göttingen, visiting scholar (November 1, 1995 - February 29, 1996 and August 7, 1996 - August 30, 1996)

Prof. Dr. Catherine Goldstein, Université de Paris Sud, visiting scholar, CNRS fellow (July 7, 1996 - September 30, 1996 and October 17, 1997 - November 9, 1997)

PD Dr. Michael Hagner, Georg-August-Universität Göttingen, visiting scholar, Heisenberg fellow (November 1, 1995 - December 31, 1996), research scholar since January 1, 1997 (see *p. 19*)

Dr. Ton van Helvoort, Maastricht University, postdoctoral research fellow (October 1, 1997 - November 30, 1997)

Prof. Dr. Frederic L. Holmes, Yale University, visiting scholar (June 15, 1996 - July 15, 1996)

Dr. Wallace Hooper, Bloomington, Indiana, visiting scholar (August 11, 1997 - August 31, 1997)

Prof. Dr. Blahoslav Hruška, Oriental Institute and the Charles University, Prague, visiting scholar (August 1, 1996 - August 31, 1996 and August 1, 1997 - September 30, 1997)

Dr. Sarah Jansen, predoctoral research fellow (January 1, 1997 - July 31, 1997) and postdoctoral research fellow (August 1, 1997 - September 30, 1999)

Dr. Edward Jurkowitz, University of Toronto, postdoctoral research fellow (December 1, 1995 - December 31, 1996 and June 1, 1997 - August 15, 1997)

Shaul Katzir, Tel-Aviv University, predoctoral research fellow (June 1, 1996 - July 31, 1996 and March 1, 1997 - April 30, 1997)

Prof. Dr. Lily Kay, Massachusetts Institute of Technology, visiting scholar (May 5, 1997 - August 5, 1997)

Dr. Alexei Kojevnikov, Institute for History of Science and Technology of the Russian Academy of Sciences, Moscow, postdoctoral research fellow (April 1, 1996 - September 30, 1996)

Cheryce Kramer, University of Chicago and Wellcome Institute London, predoctoral research fellow (September 1, 1995 - October 15, 1996)

Dr. Morgane Labbé, Laboratoire de Démographie Historique, École des Hautes Études en Sciences Sociales, Paris, CNRS postdoctoral research fellow (October 1, 1996 - December 31, 1997)

Dr. sc. Karlheinz Lüdtke, Friedrich-Schiller-Universität Jena, visiting scholar (July 1, 1997 - January 31, 1998)

Dr. Christoph Lüthy, Harvard University, postdoctoral research fellow (October 1, 1996 - September 30, 1997)

Dr. Alexandre Mallard, École Nationale Supérieure des Mines de Paris, Centre de Sociologie de l'Innovation, postdoctoral research fellow (October 1, 1995 - September 30, 1996)

Christopher Martin, University of Pittsburgh, predoctoral research fellow (June 23, 1997 - July 20, 1997)

Dr. Michael May, Universität Hamburg, postdoctoral research fellow (April 1, 1997 - March 31, 1998)

Dr. J. Andrew Mendelsohn, Princeton University, postdoctoral research fellow (October 15, 1995 - December 31, 1996), research scholar since January 1, 1997 (see *p. 21*)

Dr. Alexandre Métraux, Otto Selz Institut, Universität Mannheim, visiting scholar (September 1, 1997 - February 28, 1998)

Dr. Gabriele Metzler, Eberhard-Karls-Universität Tübingen, postdoctoral research fellow, (March 1, 1996 - April 30, 1996)

Prof. Dr. Helmut Müller-Sievers, Northwestern University Evanston, visiting scholar (June 19, 1997 - July 31, 1997)

Dr. Staffan Müller-Wille, Universität Bielefeld, predoctoral research fellow (May 1, 1996 - November 30, 1997), postdoctoral research fellow since December 1, 1997

Dr. Sybilla Nikolow, Centre de Recherche de l'Histoire Science et Technique, Paris, postdoctoral research fellow (September 15, 1995 - October 31, 1996)

Brian Ogilvie, University of Chicago, predoctoral research fellow (September 1, 1995 - July 31, 1996)

Prof. Dr. Dorinda Outram, University of Cambridge and University College Cork, visiting scholar (September 1, 1995 - August 31, 1996 and June 1, 1997 - September 30, 1997)

Prof. Dr. Katharine Park, Wellesley College, visiting scholar (September 11, 1995 - January 31, 1996 and June 10, 1996 - June 28, 1996)

Ohad Parnes, Tel-Aviv University, research scholar (until June 30, 1997), predoctoral research fellow (July 1, 1997 - June 30, 1998)

Prof. Dr. Trevor Pinch, Cornell University, visiting scholar (May 15, 1997 - August 31, 1997)

Prof. Dr. Gianna Pomata, University of Minnesota/Università di Bologna, visiting scholar, (January 1, 1997 - March 31, 1997)

Dr. Albert Presas i Puig, Technische Universität Berlin, Walther Rathenau postdoctoral research fellow (September 1, 1995 - August 31, 1996) postdoctoral research fellow (September 1, 1996 - August 31, 1997)

Dr. S. Ravi Rajan, University of California, Santa Cruz, Walther Rathenau postdoctoral research fellow (January 1, 1997 - September 30, 1997)

Dr. Annelore Rieke-Müller, Universität Oldenburg, postdoctoral research fellow (October 1, 1996 - September 30, 1997)

Prof. Dr. James Ritter, Université de Paris 8, visiting scholar (July 7, 1996 - September 30, 1996)

Dr. Sophie Roux, École des Hautes Études en Sciences Sociales, Paris, postdoctoral research fellow (October 1, 1996 - September 30, 1997), research scholar since October 1, 1997 (see *p. 22*)

Prof. Dr. Theodore R. Schatzki, University of Kentucky, visiting scholar (October 1, 1997 - December 31, 1997), Alexander von Humboldt Fellow (January 1, 1998 - March 31, 1998)

Dr. Britta Scheideler, Universität Bochum, postdoctoral research fellow (October 1, 1995 - September 30, 1997)

Dr. Jutta Schickore, postdoctoral research fellow (April 1, 1997 - March 31, 1999)

Dr. Arne Schirrmacher, University of California at Berkeley, postdoctoral research fellow (January 1, 1996 - August 31, 1996)

Dr. Henning Schmidgen, Freie Universität Berlin, postdoctoral research fellow (March 1, 1997 - February 28, 1999)

Dr. Libby Schweber, Princeton University, postdoctoral research fellow (October 1, 1996 - September 30, 1997)

Prof. Dr. Marcel Sigrist, École Biblique et Archéologique Française de Jérusalem, visiting scholar (June 1, 1997 - August 31, 1997)

Dr. Skúli Sigurdsson, Harvard University, research scholar (until December 31, 1996), postdoctoral research fellow (August 1, 1997 - July 31, 1998)

Christopher Smeenk, University of Pittsburgh, predoctoral research fellow (June 23, 1997 - July 20, 1997)

Prof. Dr. John Stachel, Boston University, visiting scholar (July 1, 1996 - July 31, 1996 and July 7, 1997 - July 13, 1997)

Dr. Richard Staley, University of Melbourne, postdoctoral research fellow (October 1, 1996 - September 30, 1997)

Prof. Dr. Zeno G. Swijtink, Indiana University Bloomington, visiting scholar (October 1, 1995 - September 30, 1996)

Prof. Dr. Ken'ichi Takahashi, Kyushu University, Fukuoka, visiting scholar (June 2, 1997 - June 20, 1997)

Dr. Bernhard Thöle, Freie Universität Berlin, Lorenz Krüger postdoctoral research fellow (November 1, 1995 - August 31, 1997) postdoctoral research fellow (September 1, 1997 - October 31, 1998)

Carsten Timmermann, University of Manchester, predoctoral research fellow (March 3, 1997 - May 31, 1997)

Prof. Dr. Sabetai Unguru, The Cohn Institute for the History and Philosophy of Science and Ideas, Tel-Aviv University, visiting scholar (September 1, 1997 - February 28, 1998)

R. André Wakefield, University of Chicago, predoctoral research fellow (April 1, 1996 - August 31, 1996)

Dr. Eric Watkins, Virginia Polytechnic Institute and State University, Lorenz Krüger postdoctoral research fellow (September 15, 1996 - December 15, 1996)

Dr. Gabriele Werner, Walther Rathenau postdoctoral research fellow (October 1, 1995 - September 30, 1996)

Prof. Dr. M. Norton Wise, Princeton University, visiting scholar (June 1, 1996 - June 30, 1996 and June 15, 1997 - July 15, 1997)

Michael Witmore, University of California at Berkeley, predoctoral research fellow (June 15, 1997 - August 15, 1997)

**PROJECTS OF THE RESEARCH GROUP HEADED BY JÜRGEN RENN
(DEPARTMENT I)**

The work of the research group headed by Jürgen Renn is primarily dedicated to the understanding of the historical processes of structural changes in systems of knowledge. This goal comprises the reconstruction of central cognitive structures of scientific thinking (both first-order structures such as those associated with the concept of force, and second-order structures such as those associated with the notions of experiment and theory, *e.g.* the concept of causality), the study of the dependence of these structures on their experiential basis and on their cultural conditions (in particular on instruments and external representations), and the study of the interaction between individual thinking and institutionalized systems of knowledge. Thus, the interaction of three major factors in the development of scientific thinking has to be reconstructed: (1) the experiential basis of scientific thinking in a given period (including technical practice as well as scientific experiments); (2) the scientific means and external representations employed (including language, graphical representations, and formalisms); and (3) the cognitive organization and social conditions of the structures of scientific knowledge and thinking. This theoretical program of an historical epistemology is the common core of the various investigations and research projects pursued and planned by the research group.

Historical epistemology in this sense requires an integration of cultural and cognitive studies of science. Methods and results of the cognitive sciences, of the structuralist tradition of psychology as well as of philosophical theories of concept development, can help to compensate for theoretical deficits in the history of science in a narrow sense, in particular when it comes to explaining thought processes. The history of science can, inversely, contribute to overcoming the limitations of theoretical approaches whose claims have not yet been systematically confronted with the results of historical research. However, such an historical epistemology would not only have to add the models and scientific means of the social and cognitive sciences to the traditional methodological arsenal of the history of science, but must also develop a theoretical coherency that goes beyond exploiting historical case studies to flesh out preconceived philosophical opinions.

In order to achieve a broad historical basis for dealing with these theoretical problems and to cover at least some of the major developmental steps in the history of science, research has been inaugurated or is planned in four dif-

ferent areas: the emergence of formal sciences such as mathematics; the emergence of empirical sciences such as physics, chemistry, and biology; structural changes in sciences with developed disciplinary structures and integrated theoretical foundations, such as the transition from classical to modern physics; and the role of reflective thinking and second-order concepts in science.

Present research in these areas focuses on two central projects: (1) the relation of practical experience and conceptual structures in the emergence of science, and (2) studies in the integration and disintegration of knowledge in modern science. Both projects cover several of the above mentioned research areas. The first project seeks to understand the emergence of fundamental concepts of empirical sciences as a result of reflecting practical experiences, prior to the period in which experiments became the dominating experiential basis of science. The second project studies transformation processes of knowledge organization, in particular in developed sciences, and the role of fundamental concepts (both of the first and second order) in such processes. The activities of the two main projects have been supplemented by a project dedicated to the reconstruction of the epistemic dimensions of discovery processes, with the aim of developing dynamic models for specific discoveries in the history of science. A further area of work is dedicated to developing advanced tools for an historical epistemology. In this area, new electronic media are used both to explore new ways of granting access to the empirical basis of the history of science (electronic archives) and to model processes of discovery in science.

PROJECT 1: THE RELATION OF PRACTICAL EXPERIENCE AND CONCEPTUAL STRUCTURES IN THE EMERGENCE OF SCIENCE - MENTAL MODELS IN THE HISTORY OF MECHANICS

Jürgen Renn (responsible), in cooperation with Mohamed Abattouy, Jochen Büttner, Peter Damerow, Ofer Gal, Wolfgang Lefèvre, Simone Rieger, Volkmar Schüller, Paul Weinig

General Goals of the Project

The goal of the project is to study long-term developments of scientific knowledge and their causes. The project is focused on mechanics as a part

of science with extraordinary significance for the development of science in general. More than other disciplines, mechanics has a continuous tradition from its origins in Antiquity to the elimination of fundamental categories of mechanics by modern physics. Presently, the scope of the project is restricted to the time period from Antiquity to the emergence of classical mechanics in early modern times. It is, however, intended to follow up the research questions of the project up to the twentieth century.

The history of mechanics illustrates that scientific knowledge long predates the emergence of an experimental tradition. Mechanics, or at least certain parts of it, had already achieved the status and the form of a science in Antiquity. Just as did astronomy and mathematics, it played the role of a model science in the Scientific Revolution. It provided basic concepts shared across all disciplines of science in the period of classical physics and chemistry. Eventually it was substituted in this function by generalized concepts of modern science such as the concepts of relativity and quantum theory. Mechanics in the traditional sense became instead a specific subdiscipline of science as we know it today.

The remarkable longevity of mechanics has given rise to speculations that the experiential basis of such scientific knowledge must be of a special kind, distinct from that of other sciences which emerged much later. It has been claimed, for instance, that knowledge in mechanics or in mathematics is rooted in an essentially universal everyday experience or even based on *a priori* structures of thinking. These and other speculations involve a very restrictive notion of experience, however. They exclude the by no means universal experience that human beings acquire in a historically specific material environment when dealing, for instance, with the technology of their times. Therefore, the project is particularly focused on the historical reconstruction of such collective, practical experiences and their influences on the structure and content of scientific knowledge. Its main goal is to study the role of practical experience for the emergence and development of fundamental scientific concepts of mechanics, such as those of space, matter, force, time, and motion, and to reconstruct the patterns of explanation for which they were used.

Theoretical Framework

Any investigation of long-term developments of structures of knowledge and thought in the history of cognition is compelled first to answer the questions of whether such long-term developments exist at all, and what kind of developments are considered to be relevant to the intended investigation.

Concerning the first question, historians of science are generally convinced that such developments do, indeed, exist, and can be identified. Science can be conceived of as the result of a coherent process beginning with its emergence in ancient Greek culture, showing some stagnation in the Middle Ages, being revived in the Renaissance and developed into modern, empirically based science by first the Copernican and later the Newtonian revolution. The nature of such long-term developments, however, remained widely obscure. From the point of view of traditional historiography, changes in the systems of scientific knowledge are reduced to individual achievements of the heroes of transitional periods such as that of the Copernican revolution. Long-term developments of systems of knowledge seem to be only marginal manifestations of the aggregation of such individual contributions and the transmission of these contributions by scientific texts. In spite of ground-breaking innovations in the historiography of science, long-term developments are still studied only rarely.

The present project is based on the assumption that long-term developments of scientific knowledge are central to the history of science. They are widely determined, first, by the entirety of the basic techniques which guarantee the continuity of a particular culture; second, by the means of representing the knowledge inherent in the invention, production, and use of these techniques. These means – and not only the representation of mechanical knowledge in theoretical texts – guarantee its historical transmission from one generation to the other. According to these assumptions, the study of long-term developments of structures of knowledge and thought cannot be restricted to the investigation of scientific discoveries. It rather must include a wider *range of knowledge systems*, a revised *historical definition* of mechanics, and *analytical categories* which make it possible to differentiate scientific concepts not only according to their intrinsic functions but also according to their roots in practical experiences.

As far as the range of knowledge is concerned, the goal of the project inevitably requires that the analysis include those inherited or newly invented

techniques and practices which may determine the stability and change of knowledge, under the circumstances of any particular culture at any particular time. While the general relevance of practical experiences for the emergence and development of knowledge systems is obvious, the detailed and systematic reconstruction of the role of practical experience for the development of cognitive structures in science has hardly begun.

Such a reconstruction is certain to encounter numerous difficulties. Practical knowledge is in part tacit knowledge, in the dual sense that it may involve non-verbal experiences such as acquired skills, as well as including experiences which can be verbally expressed but were only orally communicated. An additional difficulty arises from the way in which practical knowledge is usually transmitted. For instance, in spite of important innovations, the tradition of canonical solutions was a characteristic feature of practical mechanics at least until the fifteenth century. To the extent that continuity is achieved essentially by copying well-established model solutions, the practitioners' knowledge necessary to create such solutions often escapes historical reconstruction.

It is an essential characteristic of the research activities in this project that not only the *explicit* mechanical knowledge as it is represented in scientific theories and arguments is studied. The attempt is rather to reconstruct both explicit knowledge and the knowledge *implicit* in the productive use of technology, a common precondition of both science and technology.

The methodological instruments of traditional history of science, such as narrative descriptions, are, however, largely inadequate for the concise analysis of such cognitive implications of practical experiences. An alternative is provided by those methods and analytical tools of cognitive science and of developmental psychology which have been developed specifically for the description and explanation of subscientific and implicit knowledge structures. In particular, the methodology of reconstructing domain-specific mental models from the analysis of activities and of reconstructing default attributions from underdetermined inferences is employed in the project.

Mechanics is commonly understood as a structured system of propositions, in accordance with its definition as a subdiscipline of classical physics. According to this understanding, the historical development of mechanics essentially must be considered as an accumulation of knowledge of laws represented by concepts, propositions and general theorems. This view thus

complies with an important characteristic of developing knowledge systems in general, as well as with the body of mechanical knowledge in particular. Some laws, such as the law of the lever, have been used to explain mechanical phenomena since the early stages of the discipline's development and remain important laws in mechanics. As the discipline developed, the body of mechanical knowledge increasingly was supplemented by the discovery of such new laws as those of gravitation or conservation, as, for instance, the law of energy conservation.

This process of accumulation has to be studied in any case, but it represents only one aspect of the historical development of mechanics. Additional aspects which require investigation include changes in the structure of systems of mechanical knowledge, as well as changes in the relation of mechanical knowledge to the solutions of practical problems in technology and everyday life.

Because of such changes, universal definitions of mechanical knowledge have only limited validity when applied to long-term developments in the history of mechanics. The project is therefore based on a *historical definition* of mechanical knowledge that differentiates among partially incompatible systems of mechanical knowledge linked by structural transformations and changes of paradigmatic objects, objects which mediate between theorems and principles on the one hand, and practical experiences and technology on the other. Such paradigmatic objects play a crucial role in the transformation of knowledge structures. Objects such as the balance, the lever, simple machines and devices, the inclined plane, pneumatics, projectile motion, collisions of bodies, springs and oscillators dominated technical as well as theoretical efforts in certain periods, and led to the construction of general mental models which structured mechanical knowledge.

A basic structural transformation which fundamentally altered the meaning of a number of concepts and propositions was the transition from the Aristotelian distinction between mechanics and physics to the integration of mechanics and physics in the Middle Ages. Aristotelian physics dealt primarily with natural motions, whereas Aristotelian mechanics dealt with forced motions. Mechanics and physics were eventually integrated through the construction of a mental model of the interaction of moving bodies which was applicable to both types of motions. This model was essentially based on the assumption that moving forces (impetus) could be impressed into the movables and could be transferred from one to the other.

The relation between practical experiences and conceptual structures as it is assumed in the project requires consideration of a further theoretical dimension of mechanical knowledge, corresponding to different relations of concepts and propositions of mechanics to their origins. This, in turn, requires the introduction of *analytical categories* to classify the contents of knowledge systems according not to their internal functions but to the external conditions of their emergence. In particular, several concepts of mechanics used for the explanation of mechanical phenomena had anthropomorphic origins, concepts such as force, impetus, resistance, atoms, etc. The paradigmatic objects of the emerging mechanical knowledge, however, brought about a different type of concept which obviously played a crucial role in the development of mechanics, namely, instrumental concepts such as metric time, center of gravity, positional weight etc. Mental models based on such concepts explain nature not in terms of human action but rather in terms of machines and mechanical arrangements. The application of this type of categorical distinctions, relating concepts and propositions of mechanics to the conditions of their emergence, is used in the project to reconstruct the interaction of conceptual structures and practical experiences which finally led to the emergence of classical mechanics.

Project Design

As the sources relevant to the study vary widely in terms of type and time periods, many different methods of analysis and ways of drawing conclusions concerning long-term developments regarding the contents and structures of mechanical knowledge are required. Accordingly, research activities related to the project tend to be organized specifically for the case in question. Nevertheless, a general agenda of the project has been worked out in order to coordinate individual research activities and to serve as a general guide.

- *Data collection and electronic data acquisition*: In order to cover a substantial part of the historical sources related to the development of mechanics, a survey of these sources is being prepared. Relevant texts and images are described by abstracts, and texts transcribed and translated if necessary. The sources are being prepared through representation in electronic form for computer-assisted analyses.

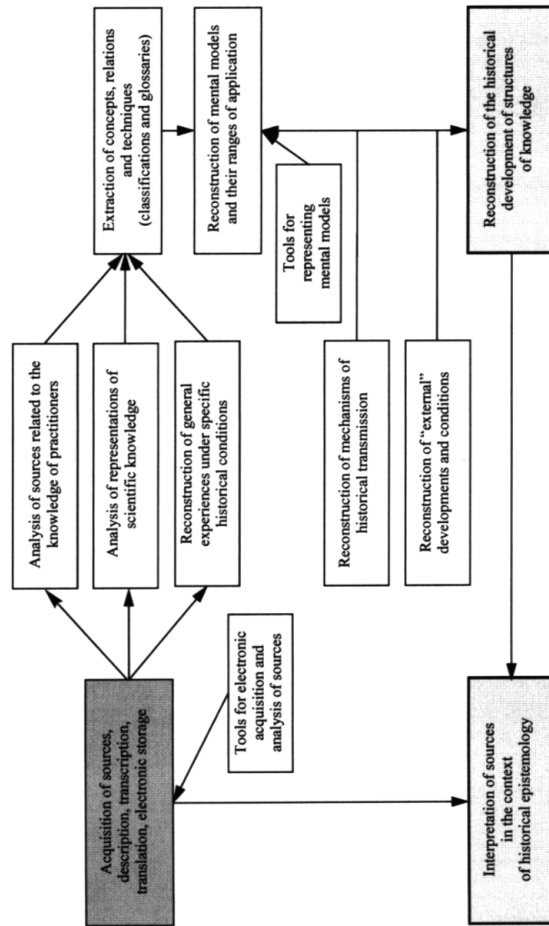
- *Data analysis*: Sources used in the project first are analyzed separately by reconstructing the contents and the structures of the mechanical knowledge they represent. Three types of reconstructions are employed. They aim first, at general assumptions on motion and mechanical causations of motion which represent *universal knowledge* in general or within a particular historical setting; second, at the *knowledge of practitioners*; and, third, at *scientific knowledge*. The identification of general assumptions is based primarily on the results of anthropological and psychological research, applied to particular contents and structures of mechanical knowledge. The identification of the knowledge of practitioners is based on the reconstruction of their professional activities and the transmission of their professional knowledge by participation and interaction. The identification of structures and contents of scientific knowledge is based on the analysis of texts applying philological, logical and mathematical methods. This analysis is facilitated by the fact that mechanical knowledge was represented as early as Antiquity by formally structured texts using technical terms and explicit principles and propositions, locally ordered by deductive arguments or even globally ordered by axiomatic theories.
- *Documentation*: The results of data analysis are documented using databases including classifications of concepts and relations between them (propositions, theorem, principles, etc.) as well as glossaries to provide context information.
- *Reconstruction of mental models*: Based on the results of the reconstruction of contents and the structures of mechanical knowledge, the mental models are identified which determine the apprehension of mechanical phenomena universally or in a specific way in different historical settings, and which structure the various systems of mechanical knowledge. This identification is based on an explicit definition of the concept of mental models and on the development of instruments for their theoretical representation.
- *Reconstruction of historical developments of knowledge structures*: Long-term developments of mechanical knowledge are described in terms of the stability and change of mental models in the course of history and their interaction with specific historical contexts. This reconstruction presupposes the identification of mechanisms of his-

torical transmission and the determination of the interaction of intrinsic with external conditions.

- *Reinterpretation of sources*: The validity of the results finally will be examined by reinterpreting the sources in the context of the long-term developments determined by the research in the course of the project.

For several steps of this research procedure, electronic tools are being developed which facilitate a computer-assisted analysis of text corpora in a reasonable time period. The development of these tools is described separately in the section "*DEVELOPMENT: ELECTRONIC RESEARCH TOOLS AND DATABASES*," p. 107.

Mental Models in History of Mechanics
 Longitudinal Study of the Historical Development of the Structures of Mechanical Knowledge
Project Overview



Present State of the Work

The project already was reported on in the Institute's Annual Report 1995. In the meantime, the project formally has been established according to the project design outlined above. It will become clear in the following sections that the initial activities described in the previous report have in part not been pursued further, and in part set the foundation for the established project and have been continued and expanded. In addition, several new activities will be reported for the first time.

A considerable part of the research and development activities planned has already been completed in part or to a large degree. The preparatory work of making texts electronically available for computer-assisted analyses, comparisons, and interpretations has progressed, although still focusing primarily on the theoretical texts on mechanics. The most important ancient and medieval sources for studying the development of mechanics have been scanned or typed into the computer in the original language and in English translation. The same is true for the most relevant sources related to the latest period investigated in the present project: the creation of a deductive system of mechanics by Galileo. The situation is, however, different for the historical period between these two periods. In particular, the rich sources from the sixteenth century are as yet electronically accessible only in small part.

Contrary to what was originally intended, sources from the Arabic text tradition are now also included. These sources are presently being transcribed and translated.

Various analyses and interpretations, as well as comparisons of the texts on mechanics, were performed as soon as the progress of the preparatory work allowed. The preliminary results of these activities will be the main content of the following sections of the report. Systematic work on general or universal cognitive preconditions of the structures of mechanical knowledge has been initiated only now and will not be included in the following report. The collection of sources on the knowledge of practitioners and their interpretation is also still in a rudimentary state. Some results on the construction and use of balances will be reported.

Current Research Activities Related to “The Relation of Practical Experience and Conceptual Structures in the Emergence of Science”

The Structure of Ancient Sources of Mechanics

Peter Damerow, Jürgen Renn and Paul Weinig

The Ancient Greek texts on mechanics are analyzed in order to reconstruct the emergence and developments of the first scientific representations of mechanical knowledge and the relation to mechanical knowledge in general available at that time. First, it is determined what contents of mechanics are represented and how these contents are conceptualized by technical terms. These contents are compared with the technological knowledge of the time. Second, the formal structures of the representations are analyzed and the cognitive operations which structure the mechanical knowledge are identified.

Greek texts on mechanics are among the oldest texts which document the application of the deductive method to what would later become an object of physics. Four of these texts date into the Hellenistic period or even earlier. The oldest is attributed to Aristoteles but was probably written by one of his disciples. Two texts are attributed to Euclid. One text was written by Archimedes. Aristoteles' *Physics* is also relevant since it serves as background for some of the other texts. Some more comprehensive treatises or commentaries date into Late Antiquity, in particular, treatises on mechanics by Heron and Pappos and a commentary by Eutocios.

The analysis of the oldest available sources nearly has been completed, but the Greek terminology must still be checked since none of the existing analyses translated this terminology consistently. It turns out that these texts document not only the early history of mechanics, but also stages of the development of the deductive method which later became characteristic of all disciplines of physics and a paradigm of scientific theory in general.

Further work will focus on the analysis of ancient technology in order to determine what knowledge is presupposed by this technology or emerges from its application. Moreover, the analysis of ancient sources of mechanics will be extended to the texts from Late Antiquity. In contrast to the early texts, these later texts deal more systematically with the contemporary technology.

Concerning the *contents* of the texts analyzed, the most important result so far is that all texts are centered on just one mechanical theorem, the law of the lever. (The Pseudo-Aristotelian text, which is with all likelihood the oldest, plays a special role since it deals only with a precursor of the law of the lever. This precursor, however, intuitively implies the law itself in the framework of Aristotelian physics.) Thus the early theoretical texts are extremely poor in comparison to the rich technological knowledge available at that time. The theoretical core of the texts depends exclusively on experiences with the balance, which provided an explanation for the mechanical principle according to which greater forces can be produced by smaller ones. The balance served as a mental model which was used in order to explain why and how various mechanical devices could be used for this purpose. Some applications of this model turned out to be rather sophisticated, as, for instance, an iterated application based on the idea that a balance may itself be attached to a balance as a weight. Sophisticated abstractions from this model emerged, in particular, the general concept of the center of gravity from the concept of the suspension of a balance.

The dominance of a mental model based on the balance in the ancient theoretical texts on mechanics raises two questions which remain open and must be addressed as the project continues. First, it must be investigated whether a corresponding pattern of explanation also dominated the much richer body of technological knowledge at that time. Second, analysis must investigate when and how a richer body of mechanical knowledge reached the level of theoretical reflection.

Concerning the *formal structure* of the representation of mechanical knowledge, according to our analysis, the texts of the oldest period show the full range from the origins of deductivity to sophisticated deductive systems. All four texts apply the deductive method, but only three of them already follow the Euclidian scheme, including the formal explication of axioms and propositions to be proven.

The Pseudo-Aristotelian text again is an exception here. It contains only one extensive proof of the main proposition: an *a priori* proof lacking any explicitly stated axioms or preconditions. Furthermore, it contains several one-step deductions resulting from the repeated application of the same mental model to several mechanical devices including balances, rudders, wedges, and beams.

The other texts, which exhibit a more developed deductive structure, reveal

yet another differentiation. On the one hand, deductivity is used to introduce Aristotelian physics as a foundation for proofs in mechanics. In this case, axioms can show a very sophisticated form due to technical reasons. Axioms are used, on the other hand, to justify mechanical knowledge by seemingly evident, simple experiences with the objects of the theory.

The Development of Balances and the Law of the Lever

Peter Damerow, Jürgen Renn and Paul Weinig

Balances are investigated in order to reconstruct what mechanical knowledge practitioners needed for their invention, production, and usage. In particular, it is being studied whether the invention of balances with unequal arms was a consequence of the discovery of the law of the lever, or whether, conversely, the discovery of the law of the lever was a consequence of the invention of the balance with unequal arms. For this purpose, all extant and accessible balances from the time of the emergence of ancient mechanics, in particular the rich findings in Pompeii and Herculaneum, are examined and analyzed with regard to cognitive prerequisites of the details of their construction.

Even an initial survey of the sources indicates that the long-term development of techniques related to the use of balances shows surprising peculiarities. The balance with equal arms is a very early achievement. It is attested both in Egypt and Babylonia as early as the middle of the third millennium B.C., it also existed in China, probably before the beginning of the first millennium B.C. In all cases the result was a developed metrology of weights, but nothing resembling the typical abstractions of mechanical concepts. In the middle of the second half of the first millennium, the first indications of the usage of balances with unequal arms, the so-called steelyards (with movable counter weight) and besmers (with movable suspension point) appear. These types of balance obviously require a deeper understanding of the relation between the construction of the balance and its function to determine weights. During exactly the same period, the first theoretical treatises on mechanics appeared (in Greece and probably also in China), focusing on the law of the lever (which should better be called the law of the steelyard).

Unfortunately, the archeological attestations of steelyards/besmers from this transitional period are very poor, with the exception of one extremely

rich source of artefacts (weights and balances) which survived as a consequence of the destruction of Pompeii and Herculaneum by the eruption of the Vesuvius in 79 A.D. While isolated findings of balances generally do not permit specific judgements about the knowledge of the persons who used them, a collection of balances which were used at the same place at the same time allows the individual attributes of single artefacts to be discriminated from the general patterns of their production and usage.

Work done so far therefore has concentrated on the analysis of balances and weights from these archaeological sites. In particular, all balances have been examined and the scales, markings and dimensions essential for their function have been measured and recorded (in total, 43 balances from the first century AD, including two balances from the Pergamon Museum in Berlin). Of these balances, 25 had equal arms, sixteen were steelyards, and two besmers. In addition, all objects which may have served as weights or counter weights have been measured (ca. 150 weights from the museums of Pompeij and Naples). Analysis of the data accumulated is still in progress.

Some preliminary conclusions can be drawn. A surprising finding was that, after cleaning and close inspection, all balances with equal arms were discovered to have a scale for an additional movable weight. Thus all balances examined seem to be dependent on knowledge of the law of the lever. The assumption seemed plausible that the steelyard was produced by calculating the scales according to the law of the lever. However, a survey of the steelyards data showed that this assumption must be wrong. Due to the complex construction of the steelyard, which is far from an ideal balance as a result of its production, the weight to be measured is, in fact, not simply related to the distance of the movable weight from the sponson point according to the law of the lever.

Instead, another remarkable characteristic of the construction of the balances was observed. For a set of twelve steelyards with a total of twenty scales, the original counterweights are preserved and could be identified. In spite of significant errors due to the state of conservation of the balances, it could be established that in all cases the following rule holds: the length of the short part of the beam divided by the length of the unit of scale equals the counterweight measured in the unit of weight.

A tentative explanation for these unexpected results is suggested by the reconstruction of a conceptual structure in later texts, which apparently incorporate remnants of the older traditions of practical knowledge:

weights have sometimes been identified with length. This leads to a weaker rule which may have been a precursor of the law of the lever in the context of the knowledge of practitioners. Adding a constant weight on one side of an arbitrarily formed balance always requires the counterweight to be moved a constant distance.

Based on the identification of this rule, it has been possible to reconstruct the production process of the steelyards. This reconstruction, in turn, made it possible to offer a plausible interpretation of the only known, somewhat obscure description of this process in the extant literature, in al-Khāzin's *Book of the Balance of Wisdom* from the twelfth century.

Two particular problems require further elaboration. In addition to the well-known metrology of Roman weights, a second system of weight measures has been found which could not yet be identified with any measures attested by literary sources. A further problem which could not yet be solved is the construction of the scales of the besmer and the determination of its historical role in the development of balances with unequal arms.

The Arabic Transformation of Mechanics

*Mohamed Abattouy and Paul Weinig in cooperation with Sonja Brentjes
(archival research in Indian archives and libraries)*

A survey of extant Arabic treatises on mechanics is compiled, at present focusing on texts related to the development of the balance, excepting the numerous treatises on mechanical engineering. The texts are transcribed into Arabic and Latin script and translated into English, in most cases for the first time. The technical terms are identified and translated consistently, and their relation to technical terms of the Greek and the Latin tradition is analyzed. A glossary is prepared containing the technical terms together with their Greek and Latin counterparts. The contents of the Arabic treatises are compared with the contents of the Ancient Greek and the medieval Latin mechanical traditions. Whenever possible, information about the social and technical context of the Arabic mechanics tradition is collected, in order to determine the relation of the treatises to the practical aspects of weighing and to the knowledge of practitioners focused on the construction and use of balances.

Beginning with the eighth century, Greek mechanics became known to the

Arab world and played an important role in the emerging development of the Arabic tradition of mechanics. Several Greek texts were translated into Arabic, and in some cases, these translations are the only extant versions of the original texts. These Arabic translations set the stage for the emergence of an original and self-contained tradition of Arabic treatises on the balance and weights which lasted for many centuries. The authors of this scientific and technical patrimony are known as scientists as well as artisans and masters of the art of weighing. Their treatises and other writings in Arabic literature (*e.g.*, the manuals of *'isba*) gave birth to a scientific tradition with theoretical and practical aspects, debating mathematical and physical problems, and involving questions relevant to both the construction of instruments and the social context of their use. Some of these Arabic treatises were translated into Latin in the twelfth century and influenced the medieval Latin tradition.

While it is clear in principle that this Arabic tradition represents ancient mechanical knowledge in part, but developed such knowledge to a great degree independently, it is still largely unclear precisely which ancient texts were known to Arabic scholars, which knowledge was their own contribution, and what part of this contribution was transmitted into the medieval Latin mechanics tradition. Only a survey of the extant Arabic texts and a careful comparison of their contents with the better known Greek and Latin traditions can provide new clues to answer these questions.

To date work has focused on establishing the corpus of extant manuscripts. Surprisingly, this corpus is much larger than usually assumed in history of science. Up to now about thirty different treatises dating from the ninth through the nineteenth centuries could be identified which deal with theoretical and practical aspects of balances and weights in the narrow sense. The majority of these treatises has never before been edited or studied, and only exists in one or more manuscript copies. Some important manuscripts have been discovered or rediscovered even in the course of the present research activities.

Texts dating from before the fifteenth century (about half of the corpus) have already been transcribed. These texts currently are being translated using a computer-assisted methodology which assures the identification and consistent translation of the technical terms (see *Edition of Sources Related to the Medieval Tradition of Mechanics p. 60*).

Although at present the analysis of the texts hardly has begun, due to the

laborious work necessary to make the Arabic treatises accessible, the importance of the Arabic tradition for the development of the body of mechanical knowledge already can be established. With regard to contents, the Arabic treatises on mechanics turned out to be much richer than what is known from the ancient tradition. Besides translations of Greek texts, the treatises contain foundations of deductive systems of mechanics different from those of extant Greek texts, as well as new propositions and theorems. In particular, the Arabic treatises also represent knowledge about practical aspects of the construction and the use of balances missing in ancient treatises.

The most influential text of the Arabic tradition of the balance is undoubtedly Thābit ibn Qurra's *Kitāb fī 'l-qarasān* (Book of the Steelyard), which presents a deductive theory of the steelyard implicitly based on Aristotelian assumptions. This text (possibly together with lost treatises on the *qarasān* by Banu Musa, Qustā ibn Luqā and al-Hasan ibn al-Haytham) established the theoretical foundation for the whole Arabic tradition in this field.

The attempt to provide a deductive Aristotelian foundation of the body of mechanical knowledge is one example of the productive assimilation and further development of ancient mechanics in the Arabic tradition, continuing the program of Pseudo-Aristotle's *Mechanical Questions*. That the Arabs knew this Greek text now could be firmly established. A passage of Pseudo-Aristotle's *Mechanical Questions* has been discovered in an Arabic manuscript dating from the twelfth century and extant in five copies. This discovery definitively closes the long debate among historians about whether or not Pseudo-Aristotle's treatise was known among Arab scholars.

Yet another finding illuminates the creative continuation of the Greek mechanical tradition by Arab scholars. The work of al-Isfizār (eleventh century) on the steelyard, entitled *Guiding the Learned Men in the Art of the Steelyard*, provides, among other topics, alternative geometrical demonstrations for the propositions of Pseudo-Euclid's treatise *On the Balance*.

As far as treatises on mechanics dealing with balances are concerned, the textual constituents of the Arabic tradition can be classified chronologically into three successive units. The theoretical basis of this scientific and technical production was defined quite early, in the ninth and tenth centuries, closely related to the Greek foundations (extant treatises of Thābit ibn Qurra, al-Ahwāzi, Qustā ibn Luqā, and Is'āq ibn Ūnayn). The second

period covers the eleventh through the thirteenth centuries (extant treatises of Ilyā al-Maṣrān, abū Óatim al-Isfizār, and al-Khāzin). The representative texts belonging to the third and last period, covering the thirteenth through the sixteenth centuries, are mainly practical text whose authors are known as mathematicians, astronomers and artisans (extant treatises of Najm al-Dīn ibn al-Rifā, Yaḡsh ibn Yaḡmak al-Amaw, Mu' ammad ibn abū al-Fat' al-Í Ḥf, and Ḥthmān b. Ḥlā al-Dīn ibn al-Malik al-Dimashq).

In all three periods numerous anonymous texts are found on different aspects of the theory and practice of balances and weights.

The Jordanian Revolution

Paul Weinig, Peter Damerow, and Jürgen Renn

A survey is compiled of extant manuscripts attributed to Jordanus Nemorarius, including a codicological analysis of the context of their transmission and their use. Attention is paid, in particular, to the role of these treatises in the tradition of medieval scholarship. For the transmission of mechanical knowledge, the medieval scholars seem to have played a role similar to that of the practitioners who formed the social background for the Arabic tradition of mechanics. The structure and content (deductive structure, terminology, reference body of theoretical and practical knowledge) of Jordanus' main texts on mechanics are analyzed in the same way as those of the ancient and Arabic traditions. The results of these analyses are compared in order to identify developments in the body of mechanical knowledge and its social context.

The medieval tradition of mechanics was initiated by the translation movement culminating in twelfth-century Spain. By the beginning of the thirteenth century, Latin scholars had access for the first time to a substantial collection of ancient and Arabic treatises on physics and mechanics by authors such as Aristotle, Archimedes, Euclid, and Thābit ibn Qurra.

This situation makes plausible the unique role of Jordanus Nemorarius, the focus of this study. The treatises on mechanics attributed to Jordanus or to his immediate followers constituted the core of medieval knowledge in mechanics. The study of his work has two main goals, the exploration of the extent to which the ancient traditions were adopted and modified, and the scope of the ancient traditions emulated, as well as the study of the

impact of these medieval treatises on the emergence of classical mechanics in the early modern era.

A survey covering almost 100 manuscripts has been completed, resulting in a systematic record of the corpus of the Jordanus codices. The codices have been extensively catalogued, described, and subjected to a codicological analysis. The manuscripts on mechanics listed in Thomson's catalog of manuscripts ascribed to Jordanus could be supplemented through the identification of a number of previously unknown Jordanus manuscripts. This systematic survey traced the origin of the majority of extant manuscripts and analyzed their context in the codices of other contemporary writings. The main treatises of the medieval tradition have been carefully studied; a comparison of the contents of the propositions and structures of the proofs with corresponding theorems from the ancient and Arabic text traditions has begun. A systematic documentation of the results in a database presently is being prepared.

The results concerning the diffusion and influence of treatises on mechanics written by or ascribed to Jordanus cannot be reported here in detail. They allow the conclusion that his achievements in mechanics became well known among medieval scholars throughout Latin Europe. This wide diffusion shows the extent to which Jordanus' treatises represent *the* medieval mechanics. Analysis of the context of transmission supports this result. Jordanus' texts not only were copied together with translations of older mechanical treatises but, as early as the thirteenth century he was himself considered to be an author worthy of dedicated collections, of the same caliber as the ancients; he was identified with Euclid, in particular. Furthermore it has become apparent that his mechanical writings were read together with the canon of the quadrivium.

The analysis of the contents of Jordanus' treatises is beyond the scope of this report, but the most important result deserves mention here: It has been possible to identify precisely the continuities of Jordanus' work with the ancient and Arabic body of mechanical knowledge. Against this background, the novelty of his writings could be judged, and an explanation sought for his unique contributions. Among these is Jordanus' solution to a problem which already was well known in ancient mechanics but could not be adequately solved by means of a direct application of the mental model of the balance (as attempted by Heron and Pappus): the determination of the reduction of the weight on an inclined plane. A detailed publication of this result is currently being prepared.

The distinct character of Jordanus' contribution, together with his overwhelming influence on medieval mechanics, the working group has dubbed "the Jordanian revolution." It irreversibly restructured the body of mechanical knowledge, creating necessary preconditions of later preclassical mechanics. The Jordanian revolution paved the way for the quantification of and innovations into Aristotelian physics by the calculatores of the fourteenth century. Moreover, it served as a necessary precondition of the dramatic conceptual changes in the physics of the fifteenth and sixteenth centuries, which eventually led to the deductive system of Galileo and the creation of classical physics.

Engineering and Mechanical Thinking

Wolfgang Lefèvre

The "Project 1" of the research group headed by Jürgen Renn is particularly focused on the historical reconstruction of collective, practical experiences and their influence on the structure and content of mechanical thinking. As a part of this program, research was launched recently to reconstruct structures and contents of mechanical thinking in connection with engineering in early modern times, and its significance for and within preclassical mechanics.

As is generally acknowledged, the preclassical mechanics of the early modern period (Leonardo to Galileo) acquired its distinctive form by merging theoretical traditions going back to Antiquity with a new wealth of practical experience. In order to reconstruct the role of practical experience in this process, several historical preconditions for the emergence of preclassical mechanics have to be examined. Of particular interest to this project are the rise of a "reflecting practical mechanics" and the emergence of instances of mediation between practical and theoretical knowledge.

1) Reflecting Practical Mechanics

Preclassical mechanics encompassed not only the work of those who more or less directly picked up ancient or medieval theoretical traditions, but also a specifically early modern "reflecting practical mechanics." This mechanics dealt with highly complex technical problems (rigidity of bodies, friction, etc.) which could not be addressed successfully with the means of theoretical mechanics then available. Typical examples of this reflecting

practical mechanics are the notebooks of Leonardo, Tartaglia's treatise on ballistics (*Nuova Scientia* 1537), and Galileo's "two new sciences" represented in the *Discorsi* (1638). The first of these "new sciences," dealing with the rigidity of bodies and almost entirely neglected by historians of science, shows in particular that the separation of this mechanics from theoretical mechanics is an artefact of the history of science. This separation of practical from theoretical mechanics, and the almost exclusive concentration on theory rather than practice, reflects the difficulty of reconstructing adequately the peculiar cognitive structures of practical mechanics.

As a result of initial investigations undertaken to investigate this reflecting practical mechanics, some general considerations on its significance for preclassical mechanics were outlined and submitted to *Science in Context* (W. Lefèvre: "Galileo Engineer - Art and Modern Science").

Technical innovations in the construction of machines in the fifteenth and sixteenth centuries are important aspects in this context and will be a main topic of further investigations. Their study does not aim at a history of technology, but at a comprehension of objects of experience which could have played a role in the reflections of both practical and theoretical mechanicians. These innovations consisted in new combinations of traditional elements of machines, such as lever and wheel, and in the introduction of new elements, such as flywheel and pendulum. New experiences constituted in any case the basis for an enlarged range of application of the traditional concepts of motion and force, which may have also had structural consequences for the meaning of these concepts.

2) Instances of Mediation between Practical and Theoretical Mechanics

Since Antiquity, practitioners have employed geometrical construction techniques as well as arithmetic algorithms for the solution of complex tasks. The application of mathematics, which spread in early modern times in the context of the use of perspective and the construction of scientific instruments, distinguished itself from this tradition of practical geometry by presupposing a more or less complete understanding of the theoretical foundations of geometrical techniques. Thus points of contact between practical and genuinely theoretical knowledge emerged, creating mediatory instances between practical and theoretical mechanics – between engineers and instrument makers, educated in mathematics and mechanics, on the one hand, and scientists familiar with practical problems on the other. A close study of the emergence and the actual function of these mediatory

instances will be a main task of the research activities with respect to engineering and mechanical thinking.

Documents which reveal the use of practical geometry in architecture, in the construction of certain machines and devices, and in geodesy are important indicators for the reconstruction of cognitive structures underlying challenging engineering tasks, and hence constitute an important focus of the research. Such documents are especially important because the reconstruction of such cognitive structures presents numerous serious difficulties. As generally known, for example, from the differences among historians of architecture regarding the pyramids of ancient Egypt or the Gothic cathedrals of the Middle Ages, it is not possible to deduce solely from preserved buildings or technical devices the knowledge applied by their creators. Without further evidence, any conclusions drawn from such objects remain highly speculative and uncertain. Furthermore, practical knowledge is in part “tacit knowledge,” in the dual sense that it may involve not only non-verbal experiences such as acquired skills, but also experiences which can be verbally expressed but were only orally communicated and transmitted. Often, however, such experiences and insights were not communicated at all since practitioners, and especially innovative ones, deliberately kept secret those parts of their professional knowledge which they regarded as decisive for their economic success. It is exactly these secrets that especially interest historians of their work.

Initial efforts are currently under way to better understand the graphical representations – sketches, drawings, plans – drawn or constructed by architects and engineers of that period. For what purpose were these images actually used by practitioners? Were they rhetorical means, means of communicating, means of reflection, means of designing, or means of manufacturing buildings or complex devices? How did those possible functions depend on the “syntax” of the images - on their being either pictures or plans? And most important in this context, did such graphical representations themselves constitute mediatory instances between practical and theoretical mechanics? First results achieved have been summarized in written form and will be submitted as a chapter of a book, edited by Jürgen Renn, on *The Emergence of the Scientific Image*.

Challenges to Preclassical Mechanics

Michele Camerota, Peter Damerow, Simone Rieger, and Jürgen Renn

New objects that raised the interest of “engineer-scientists” in the early modern period and challenged the methods of preclassical mechanics are studied in order to find out how they were assimilated into the existing body of mechanical knowledge, and how the contents and structure of this knowledge were changed by this assimilation.

The early modern period saw the creation of a preclassical mechanics which merged theoretical traditions going back to antiquity with a new wealth of practical experience. It is an inherent characteristic of early modern science that a variety of mechanical phenomena and arrangements, such as the trajectory of projectiles, the stability of constructions, the oscillation of a swinging body, or the curve of a hanging chain aroused the interest of scientists. Even though sixteenth- and seventeenth-century scientists did not necessarily address such phenomena in their publications, their extended scientific correspondence shows that they became at that time a perpetual concern of their investigations.

From today’s perspective, such objects represent a very particular subset of physical systems, one of whose distinct features turned out to be their tractability in terms of relatively simple differential equations. This fact alone suggests that the specific properties of these objects were an important factor in the development of early modern science, contributing to its contemporary form. Although this observation is straightforward, it tends to be neglected by historians of science even when the role of experience in the creation of classical mechanics is at issue, let alone where studies of the social and cultural conditions of scientific developments are concerned.

Adequate explanations of the mechanical devices and machines which were subjects of investigation in the sixteenth and seventeenth centuries were often provided only later by classical physics. The explanations based on the emerging modern mechanics were insufficient in various respects and notoriously confounded with theoretical assumptions of the ancient tradition which ultimately turned out to be incompatible with classical physics.

In the last year, the study focused on two outstanding objects of Galileo’s mechanics, the trajectory of projectiles and the catenary, that is, the curve of hanging chains. Galileo’s discovery and proof of the parabolic shape of

the trajectory is quite familiar and has much been studied; his attempts to provide a proof for the parabolic shape of the catenary, however, have been virtually neglected.

The question of when and how he discovered the parabolic shape of projectile motion has been the subject of over a century of intensive research by historians of science. Nevertheless, it is still an essentially open question. The dating of his discovery ranges anywhere from 1602 to 1632. Even more diverse are the assumptions about his sources. These cover the spectrum from pure empirical evidence achieved exclusively by means of careful experimentation and precise measurements, to predominantly theoretical speculation in direct continuation of scholastic traditions only scarcely supported by empirical demonstrations.

Based on new evidence attained by analyzing manuscripts of Galileo and Paolo Sarpi and from Galileo's correspondence, it could be shown that his famous discovery was based on a combination of simple experiments and obvious mathematical conclusions, achieved as early as 1592. It could further be demonstrated that Galileo confounded his discovery with his erroneous conviction, also based on theoretical and empirical evidence, that the shape of the projectile trajectory and the curve of a hanging chain are identical. Galileo planned to treat this relationship in a final chapter of his *Discorsi* which he was unable, however, to complete before his death in 1642.

On the basis of this new reconstruction of Galileo's discovery, the study has led to the conclusion that the qualitative experience with objects such as projectile motion or the hanging chain was crucial for his achievements in mechanics, even though these objects were, strictly speaking, neither experimentally nor theoretically accessible given the means of the time. The study thus provides evidence that neither the reliance on experiments, the continuity of theoretical traditions, nor the social context, taken by themselves, sufficiently account for the when and how of Galileo's discovery.

Not without a certain degree of contingency, objects which entered the intellectual horizon of the new engineer-scientists such as Galileo from outside the dominating academic traditions inevitably became a challenge for them. Although they generally were unable to meet this challenge adequately, these objects nevertheless triggered the development of scholastic physical concepts oriented toward classical mechanics. The origin of these

challenging objects in the accumulated knowledge of the practitioners and engineers of the time reveals their role as important and irreducible mediatory instances between early modern science and its social context.

The Development of Galileo's Deductive System of Mechanics

Jochen Büttner, Peter Damerow, Simone Rieger, and Jürgen Renn

The available sources (publications, manuscripts, notes) documenting the development of Galileo's deductive system of mechanics are investigated in order to find out what, after a long period of earlier developments of ancient and preclassical mechanics, finally brought about the transition to classical mechanics. Proofs are analyzed according to their implicit and explicit preconditions. Propositions and theorems are classified according to the preconditions needed for their proof, and according to the propositions with proofs assuming them as a precondition. The results will be used to reconstruct the role of deductivity in the development of Galileo's mechanics and to reconstruct the original order in which Galileo arrived at his propositions and proofs.

Galileo's early manuscripts show that he initially was close to the common Aristotelian way of conceptualizing mechanics. But at least by 1604, a letter documents that he already was deeply concerned with attempts to build a deductive theory on different foundations. The long process of developing this theory is documented in Galileo's surviving notes on mechanics (Ms. Gal. 72 of the National Library at Florence, see the report below on the development of an electronic representation of this manuscript *p. 108*). Finally, Galileo's *Discorsi*, first published in 1638, indicates the emergence of a new mechanics that soon afterwards developed into a core theory of classical physics. The "Second Day" of the *Discorsi* contains a deductive theory of the rigidity of bodies, while the "Third Day" and the "Fourth Day" are focused on a deductive theory of free fall, motion on inclined planes, and projectile motion. These theories fundamentally differ from the medieval tradition of mechanics. They deal with new contents, and they are built on axioms which no longer try to establish an Aristotelian underpinning of mechanics.

Research activities first have been concentrated on preparing the sources for a computer-assisted analysis and on analyzing the deductive structure of the final outcome, the deductive system of mechanical knowledge in the

Discorsi. A database has been established containing the full texts of the manuscripts, references to scholarly interpretations reported in the scientific literature, and the results of the research activities so far. In particular, the deductive structure of the *Discorsi* has been represented electronically and the notes and proofs of the manuscript pages of Ms. Gal. 72 have been linked to the theorems of the final publication to which they contributed. Currently these entries are being analyzed in order to determine which are closely related to the final proofs and which represent earlier stages of the development of the theory.

The analysis of the manuscript has provided evidence that the extant folio pages represent only part of the notes Galileo kept about his work. Yet the manuscript still contains notes on a substantial part of Galileo's final theory. For 85 percent of the propositions on accelerated motion, and for more than 50 percent of the propositions on projectile motion, at least some notes have been preserved.

The work on the deductive structure of the *Discorsi* itself has shown that the final theory has a peculiar structure deviating from what one can usually expect from a deductive theory. This is particularly evident in the case of the theory of accelerated motion. Eighty-seven percent of all propositions are not repeated in order to derive further propositions. In fact, most of the propositions are proven but *never* used in the proofs of other propositions (28 out of 38). A small number of further propositions (five), which also are not used repeatedly, only served to prove those immediately subsequent.

On the other hand, there is a very small group of propositions (four), which are the only ones used repeatedly in the proofs. These propositions are the law of fall, two basic propositions on motion along an inclined plane, and a scholium relating two fundamental concepts of Galileo to each other, the concept of velocity and the concept of the degree of velocity. These key propositions not only play a singular role in the deductive structure of the *Discorsi*, but are also well-known early achievements of Galileo's work on mechanics.

The analysis of the deductive structure thus reveals that Galileo's new system of mechanics is much less complex than the sophisticated mathematical structure of his arguments suggests. Essentially Galileo's *Discorsi* merely evolve inherent conclusions of his most prominent findings without adding anything to the physical content.

Associated Research Activities

Edition of Sources Related to the Medieval Tradition of Mechanics

Mohamed Abattouy, Thomas Berchtold, and Paul Weinig

The main treatises on the balance of the Arabic tradition and of its continuation in the medieval Latin tradition are prepared for critical editions (in the case of hitherto unedited texts), or for re-editions with consistent English translations, commentaries, and glossaries of technical terms. The edition covers works composed between the ninth and the sixteenth centuries. Arabic texts dating from the seventeenth through the nineteenth centuries are also taken into account as supplementary sources in order to reconstruct the older tradition.

By making accessible the Arabic tradition of mechanics, it is possible to give a comprehensive picture of the entire Greek-Arabic and Latin traditions for the first time. Work on such an edition started in fall 1996 and yielded important results, in particular, the rediscovery of two manuscripts by Thābit ibn Qurra, the *Kitāb fī 'l-qarasīn*, and his edition of Pseudo-Euclid's *On Heaviness and Lightness*, originally kept in Berlin, but lost during World War II. This discovery makes it possible to prepare for the first time a critical edition on the basis of all extant copies according to modern standards.

The entire codicological tradition of the Arabic works on the balance was surveyed and organized in a systematic overview. By now almost half of the corpus has been edited, transcribed and translated.

Contrary to the case of the Arabic sources, work on the medieval Latin tradition of mechanics can build on a considerable number of previous scholarly contributions comprising editions, English translations and commentaries. There is nevertheless occasion for further work on these sources as well. In the course of the research on the Jordanus text tradition, several new manuscript findings have made it necessary to update the existing editions. Furthermore, the available English translations are not always consistent in translating technical terms; a reworking of these translations has therefore turned out to be particularly important for a comparison with the Arab tradition.

The edition will include the following texts:

- The Book of Euclid on the balance,
- The Book of Euclid on heaviness and lightness and the measure of bodies by each other (both in the version edited by Thābit ibn Qurra and in the Latin version),
- The Book of Archimedes on heaviness and lightness (both in the Arabic and the Latin versions)
- Chapters 1 and 2 of Ps. Aristotle's *Mechanical Questions*
- Chapters 24-31 of Book I of Hero's *Mechanics* dealing with centers of gravity and balance of weight
- Al-Ahwazi: Treatise on the balance
- Thābit ibn Qurra's two works on the balance: Book of the steelyard and Book on the equilibrium and disequilibrium of weight
- Excerpts from Qustā ibn Luqā's Book on weighing and measuring and Is'āq ibn Ūnayn's Treatise on weights and measures
- Ilyā al-Matrān: Book of measures and weights
- Al-Isfizār: Guiding the learned men in the art of the steelyard
- Al-Khāzin's Kitāb mizān al-hikma, Book I, presenting an abridged version of al-Quhi and ibn al-Haytham's achievements on the theory of centers of gravity, the texts of which have not yet been found.
- Cause karastonis (by anonymus),
- Liber karastonis (translated by Gerard of Cremona),
- Liber de canonio (by anonymus), Elementa Jordani,
- Liber de ponderibus,
- *Liber de ratione ponderis*.
- Najm al-Dīn ibn al-Rif'a: The elucidation and the demonstration of the knowledge of the measure and the balance
- Ya'ash ibn Ya'mak al-Amawi: Problems related to the balance
- Mu'ammad ibn al-Fat' al-Īufi's three works on the steelyard: Guiding the weigher how to weigh with the steelyard, Treatise on repairing the defectuousity of the steelyard, Treatise on the division of the steelyard.

- ʿUthman ibn ʿAlaʿ al-Dīn ibn al-Malik: The Selected part of the art of the steelyard

Ink Analysis of Galileo's Notes on Mechanics Ms. Gal. 72 (joint project together with the Biblioteca Nazionale Centrale, Florence, the Istituto Nazionale di Fisica Nucleare, Sezione di Firenze, and the Istituto e Museo di Storia della Scienza in Florence)

Peter Damerow, Wallace Hooper, Simone Rieger, and Jürgen Renn (Max Planck Institute for the History of Science), Paola Pirolo and Isabella Truci (Biblioteca Nazionale Centrale), Piero del Carmine, Franco Lucarelli, and Pier Andrea Mandó (Istituto Nazionale di Fisica Nucleare), Paolo Galluzzi (Istituto e Museo di Storia della Scienza)

Galileo's notes on mechanics (Ms. Gal. 72) represent the most important source on the emergence of classical mechanics (see *p. 108* on the electronic edition of this manuscript). However, the understanding of these notes still is limited severely by the difficulties in arranging these notes (texts, drawings and calculations in partly chaotic arrangements) into the order they were written. Up to now, the entries have been dated primarily according to internal criteria (logical dependencies, type of handwriting, etc.) and the physical characteristics of the paper (watermarks).

Methods of the natural sciences offer opportunities to attain additional clues which could aid in the reconstruction of the original order of the entries. To exploit such opportunities, the Institute has established a joint project together with the library in which the manuscript is located, a nuclear physics institute, and a history of science research institute in Italy. The project aims at analyzing the compositions of inks used in the manuscript and comparing the results with ink compositions in letters and manuscripts for which the dates of origin are known. A method based on the analysis of the energy spectra of particle-induced X-ray emission (PIXE), which uses a low energy proton beam with a diameter of less than 0.1 mm, allows the determination of relative amounts of certain metallic elements (iron, copper, zinc, lead and nickel) within a spot smaller than the ink lines on the paper. Since the relative amounts of these metals vary considerably in the inks used at the time of Galileo, they can be used as indicators for the time when different entries on a folio page were written.

Following up promising measurements made previously by Wallace

Hooper and Pier Andrea Mandó, a pilot study has been launched in order to answer three questions.

- Is it possible to identify the different inks on a folio page?
- Is it possible to identify the same ink on different folio pages?
- Is it possible to increase the efficiency of the method so that it is possible to determine the inks in a substantial part of the manuscript within a reasonable amount of time?

During two beaming sessions of one week each (October and December 1996), about 370 ink spots on 13 folio pages were analyzed. First interpretations of the results were achieved in two workshops (November 1996 and August 1997). During the second workshop it was decided to include the data from the earlier measurements of Hooper and Mandó with the later work. This ultimately raised the number of measurements to 670 ink spots on 29 folio pages. Furthermore, the data included contain 124 ink spots on dated letters (Ms. Gal. 14) and 186 ink spots in a household book with dated entries (Ms. Gal. 26).

Concerning the research questions of the pilot study, the preliminary analysis of the data has provided the following answers.

- With some exceptions, different inks on a folio page could clearly be identified, provided that the number of measurements taken was sufficient to distinguish variations due to different inks from the rather high error variation.
- The identification of the same ink on different folio pages seems to be possible only under favorable circumstances (*e.g.*, closely related pages), because in general the variation of the ink is too high and the number of criteria distinguishing different inks too small for an identification of inks over long time periods.
- It is, unfortunately, impossible to investigate a substantial number of folio pages within a reasonable time frame. The strategies of choosing the spots for measurements could be improved by real-time analysis of the incoming data, but the time for one measurement could not be reduced below an average of ten minutes for each measurement.

When it became clear even during the measurements that only selected pages could be investigated due to the time-consuming procedure, the strategy of the pilot study was changed. Instead of including further pages

selected for testing the method, folio pages were selected for which the identification of the different entries is crucial for their interpretation. Thus, several results could be achieved which were significant for the interpretation of the folio pages. It turned out that the variety of entries on the folio pages is much smaller than generally assumed.

A first project report has been prepared documenting the measurements and the reconstruction of the different inks on the four folio pages investigated during the first beaming session. A second report will document the measurements of the second beaming session together with the earlier data from the measurements of Hooper and Mandó.

The results of the ink analysis are presently being analyzed by systematically relating them to the results of a thorough study of the contents of the manuscript pages. This combination of historical analysis with the results of the ink analysis has already yielded unexpected and promising outcomes. In the case of one manuscript page, for example, it seems possible to establish at least a partial internal time-line for Galileo's entries on this page. Such an achievement would be inconceivable without ink analysis and may have important consequences for the micro-reconstruction of Galileo's discoveries. In particular, the identification of entries related to an empirical check of the shape of the chain line (see *Challenges to Pre-classical Mechanics* p. 56) could be based on results of the ink analysis. In another case, it has been possible to reject a historical claim concerning an alleged discovery by Galileo of an essential error in his proof of the law of fall as late as 1618. This claim was based on cancellations of the erroneous ingredients in copies made by Galileo's disciples at that time. The ink analysis has revealed, however, that the cancellations were made at the time of copying by his disciples and thus did not constitute later additions. It should be stressed, however, that the evaluation of the bulk of the data is still in progress.

Edition of Galileo's Letters on Mechanics

Peter Damerow, Jutta Miller, Fiorenza Renn, and Jürgen Renn

An edition of a selection of Galileo's correspondence is prepared, containing the letters in original language and in English translation. The edition will contain all preserved letters from, to and in some cases about Galileo which can provide not only information about the development of his work

on mechanics, but also on the various intellectual contexts relevant to this development. Technical terms will be translated consistently. A glossary is prepared containing all technical terms used in the correspondence.

Although Galileo's correspondence represents a significant source for any reconstruction of his discoveries, there is no edition of this correspondence available in the English language. Only a small, eclectic selection of the letters has been translated to date, scattered across a number of publications of historians of science. The correspondence of Galileo has been taken into account systematically only in publications of Italian scholars.

Currently the relevant letters have been selected and scanned; more than 400 letters will be included in the planned edition (about half of them by Galileo). Almost all are found in the *Edizione Nazionale* prepared by Antonio Favaro around the turn of the century. Although this edition provides a virtually complete collection of Galileo's correspondence, additional contemporary letters relevant for understanding Galileo's science were sought with some initial successes. The translation of the letters is assisted by a specially-designed translation environment, supporting the consistent translation of technical terms in particular, and the creation of the glossary. Fifty letters have been translated so far, comprising Galileo's complete correspondence with Guidobaldo del Monte in particular, as well as several previously unpublished letters by Guidobaldo to other scientists which turned out to be relevant to his exchange with Galileo.

A New Translation of Newton's Principia

Volkmar Schüller

The transition from early modern physics to Isaac Newton's physics still is understood insufficiently. A proper understanding of the emergence of the modern Newtonian physics also requires intimate knowledge of Isaac Newton's physics. The major work of Newton's physics is his *Philosophia Naturalis Principia Mathematica*, which he wrote in Latin. Hence, a translation of this volume into a modern language which meets modern standards of science history is required and will be welcomed by philosophers and historians of science.

In 1729 the third edition of Newton's *Principia* was translated by Andrew Motte into English, and la Marquise du Chastellet published her French

version in 1756. In 1936 Florian Cajori revised Andrew Motte's English translation relying heavily on a German translation published by J. Ph. Wolfers in 1872. This German translation, however, introduces nineteenth-century terminology uncritically, thus falsifying Newton's intentions in many places, and, for instance, transforming a number of his propositions into mathematical equations. Moreover, this translation ignores the variant readings in Newton's manuscripts and differences between the first and second edition, as well as the annotations made by Newton in his own copies. These important additional textual elements were assembled by Koyré, Cohen and Whitman in their edition of Newton's *Principia*, which they published in 1972.

The present German language edition of Newton's *Principia* will be published by de Gruyter Verlag Berlin and contains the three versions of the *Principia* published by Newton in the years 1687, 1713 and 1726, respectively, and also Newton's manuscript for the 1687 edition. The annotations by Newton's hand in his copies of the two first editions and in a copy given to Locke are included. Furthermore, this new edition contains translations of the reviews published in *Acta Eruditorum*, *Philosophical Transactions*, *Bibliothèque Universelle et Historique*, *Journal des Scavans* and *Journal de Trevoux*. Some of Newton's manuscripts found in the bequest of David Gregory, which contain unique information pertaining to his *Principia*, are also added. In the second edition of 1713 Newton included the famous *Scholium generale* in which he defends himself against Leibniz' objections. Some important drafts of this *Scholium generale* found in Newton's bequest are also added. Moreover, the present edition gives a detailed account of the intricate genesis of Newton's *Principia* along with information about the sources used by Newton.

A Commentary on Newton's Principia

Volkmar Schüller

The significance of Newton's *Principia* as a unique intellectual achievement in the history of science calls for a comprehensive commentary. Such a commentary should deal with the problems considered by Newton from the perspective of his own time. The analysis should establish, whenever possible, precursors to Newton's own reasoning, in order to delineate more clearly Newton's own genuine, innovative contributions. It is also impor-

tant to explain Newton's suggestions in terms of the development of his own ideas, notions and mathematical tools.

In preparation for such a commentary, Schüller has written a study on Newton's calculation of the figure of earth. It is shown that Newton did not derive the earth-figure from the laws of motion, but by means of a hydrostatical model of the earth. In the case of the real earth, the centrifugal force of a particle and the force of gravity of the same particle are in equilibrium; from this condition Newton derived the ratio between the earth's major and minor axes. In this manner Newton convincingly demonstrated that the oblateness of the earth at the poles is due to the interplay of universal gravitation of all the earth's particles and the centrifugal force of these particles.

Currently Schüller has completed approximately one fourth of the commentary on Newton's theory of the tides, which derives from Newton's principle of universal gravitation. In addition to the commentary, he has been working on an important Newtonian manuscript which was published in the paper "Newton: The classical Scholia" by Paolo Casini (*History of Science* 22 (1984) 1 - 58). This manuscript was hitherto unknown. These manuscripts include important historical and philosophical explanations by Newton about the propositions IV - IX of Book III, in which Newton formulated his principle of universal gravitation. These manuscripts have not yet attracted much attention, probably for two reasons: they were written by Newton in Latin, and they were not translated into a modern language by Casini. Indeed, their translation will be a difficult undertaking, because the Latin in these texts is corrupt in numerous places. These corruptions must not be attributed to Newton, for the comparison of these texts with Newton's manuscripts reveals Casini as the source of these corruptions. Therefore Schüller is now working on a new edition of these texts. This edition will contain the authentic text together with a German translation, as well as a new compilation of sources to which Newton referred directly and indirectly. These texts are crucial to the understanding of Isaac Newton's physics and its genesis, because they prove incorrect the opinion held by many historians of physics: that Newton's ideas of universal gravitation derive from his investigations into alchemy. In fact, Newton refers only to the Ancients, and not to alchemical authors, in his justification of the universal gravitation.

A New Translation of Galileo's De Motu

Raymond Fredette

Galileo's earliest treatise on mechanics, the manuscript *De Motu*, which he never published, is the most important source documenting the starting point of his years of work on a new science of mechanics. An edition of the treatise is included in Volume I of the *Edizione Nazionale* of Galileo's Works, and an English translation has been published by Drabkin.

Nevertheless, various problems continue to make the role of this treatise for the development of Galileo's work on the foundations of classical mechanics difficult to understand. Several different versions of the manuscript have survived which can be dated only by internal criteria such as the use of specific technical terms.

This is the background for a recent initiative aiming at a new English and French translation and edition of the treatise. The emphasis will be on a consistent translation of the technical terms into both languages. This endeavor is supported by a working environment for computer-assisted translation developed at the Institute for this specific purpose.

Newton and Hooke

Ofer Gal

The study was dedicated to a historical-epistemological analysis of the work of Robert Hooke (1635-1703), organized around his most celebrated theoretical achievement: the proposal to "compoun[d] the celestial motions of the planets of a direct motion by the tangent & an attractive motion towards a central body." The suggestion that planetary orbits should be calculated solely on the basis of the parameters of rectilinear motions and rectilinear attractions, understood as the outcome of continuous deflection of a motion along their tangents by the attraction of the sun, has come to be known as Hooke's Programme. The traces of Hooke's construction of this Programme for celestial mechanics lead through his investigations in microscopy, practical optics and horology, and thus offer a survey of the epistemic operations of this central figure of late seventeenth-century science. Hooke's unique capacity to move freely between the theoretical, experimental and technological realms, as well as in and out of the circles

occupied by gentlemen-philosophers, instrument makers, servants and technicians, provides an opportunity to examine the social and epistemological boundaries, relations and hierarchies between them.

The chapter completed this year offers an analysis of Hooke's Programme through its influence on the work of Isaac Newton following their correspondence in 1679-80. It suggests a reading of the correspondence as one continuous text, written by both, analyzing the outcome as a common product for which both men's skills, tools and techniques were essential. It explicates the manner in which communication is established, common grounds for exchange are created, and new knowledge – Hooke's Programme as it came to function in Newton's Kepler Motion Papers and *De Motu* – is created by a combination of collaboration and careful positioning. One essential element of the Programme is crystallized: the notion that planetary motions are curved from original rectilinear paths into closed orbits by an external power (Hooke's term), itself operating along straight lines. This clear and simple depiction of planetary motion is compared to the formulations of the question employed by young Newton and Huygens, and its surprising originality is substantiated by short references to Kepler, Descartes and Borelli. Another, more subtle element of the Programme – a particular conception of the relations between power, motion and trajectories – arises from considering Newton's changing understanding of it. A comparison of the three versions of the Programme – the one gradually delivered in the correspondence; the one published at the end of Hooke's 1674 *Attempt to Prove the Motion of the Earth*, and the original version, delivered as an address to the Royal Society in 1666 – reveals that this conception, still vague in the earliest, 1666 version, is fully developed in the 1674 publication.

PROJECT 2: STUDIES IN THE INTEGRATION AND DISINTEGRATION OF KNOWLEDGE IN MODERN SCIENCE

Jürgen Renn (responsible), in cooperation with Peter J. Beurton and Ohad Parnes (biology), Gerd Graßhoff, Wolfgang Lefèvre, Renate Wahsner, and Falk Wunderlich (philosophy), Leo Corry, Hubert Goenner, Dieter Hoffmann, Michel Janssen, Edward Jurkowitz, Horst Kant, Alexei Kojévnikov, Folkert Müller-Hoissen, James Ritter, Tilman Sauer, Arne Schirmacher and John Stachel (modern physics), Giuseppe Castagnetti and Britta Scheideler (history)

General Goals of the Project

It is remarkable that in some fields and in some historical situations, a vast array of scientific knowledge is structured by only a handful of concepts. The concepts of space, time, force, motion, matter, and a few others played this role for classical Newtonian mechanics; together with the concepts of energy, entropy, and charge, they also played this role in developed classical physics. The concepts of field, energy-momentum, and space-time continuum structured modern relativistic theories; the concepts of species, gene, selection, variation, and adaptation for classical evolutionary biology; and the concepts of cell, bacterium, pure culture, and infection for classical microbiology. In retrospect, such core groups of concepts may appear to constitute the starting point for gaining scientific knowledge in their respective fields. A closer historical examination shows, however, that such core groups of concepts usually achieved their privileged position in the organization of knowledge only *after* a long process of knowledge integration, in a material, social, and cognitive sense. Knowledge integration, in turn, requires material embodiments, such as an experimental arrangement or a formalism which can be assimilated to the cognitive structures belonging to the different branches of knowledge to be integrated, and a social organization allowing scientists actually to bring the combined knowledge of the different branches to bear on such material embodiments. The emergence of a core group of foundational concepts in the course of or as the sequel to such integration processes therefore must be analyzed as a restructuring of the cognitive organization of previously acquired knowledge. Earlier studies of this process by participants of the project were dedicated to the reconstruction of the emergence of key concepts of evolutionary biology (Lefèvre) and of

classical mechanics (Renn). A case study pursued in the context of the project has complemented these earlier studies through a parallel analysis of the little-known case of the emergence of foundational concepts of microbiology (Parnes).

Reflective thinking plays an important, but not yet well understood role in such restructuring processes. This role is evident, for instance, in Newton's philosophical integration of physics and mechanics, which necessarily interacted with the creation of Newtonian mechanics. It is particularly evident in historical attempts to provide an explicit philosophical synthesis of scientific knowledge. An outstanding example of the role of reflective thinking in philosophical integrations is the long-lasting influence of Kant's natural philosophy on the self-understanding of classical science. It emerged from the reflective integration of key concepts of early modern science and remained the dominant philosophical background of the ever more specialized scientists, whatever changes of systems in philosophy took place. When classical science ultimately reached a crisis at the end of the nineteenth century, Kantianism saw a spectacular revival, not only in the modified form of Neo-Kantianism, but also in the emergence of a new type of philosophical integration by the "linguistic" turn of positivism (the Köhnke thesis). It was a common feature of earlier integration attempts that foundational, first-order concepts of a particular body of knowledge, such as the concept of force, were exploited in order to achieve such a philosophical integration. In the process, these then were assimilated into new second-order, reflective structures of knowledge. These new structures, such as a new concept of nature, in turn transformed and stabilized the meaning of the first-order concepts. The novel feature of philosophical integrations after the linguistic turn was, in contrast, that they were based on a reflection on the syntactic structures of the representation of scientific knowledge by language. As a consequence, the basic concepts of this integration no longer had any direct relation to first-order concepts, such that the integration was content-independent and formal.

Contrary to philosophical integrations, processes of integration and disintegration within disciplines always remained closely connected with first-order concepts. Two outstanding examples are the disintegration of neo-Darwinian evolutionary biology in the 1960's, and the disintegration of classical physics around the turn of the century and the subsequent partial reintegration into global theories such as general relativity and quantum mechanics. Both examples are examined in the context of this project.

Work on the second example has made particularly clear the complex structure of long-term developments of such processes of integration and disintegration.

The foundational concepts which emerged from the first ground-breaking periods of knowledge integration, such as those of space and time in the case of classical physics, proved to be extremely stable in the face of an enormous growth of knowledge in the course of the further development of science. In fact, on occasion they even were considered to have *a priori* status, not subject to any changes by the accumulation of knowledge. Nevertheless, most scientific disciplines have witnessed fundamental changes of precisely this core group of foundational concepts in the past century. These fundamental changes were preceded by more or less extended periods of knowledge disintegration, in which the established cognitive organization of knowledge became problematic. Paradoxically, it appears that the essential mechanisms at work in these periods of destabilization were of the same nature as those which functioned in the original processes of knowledge integration. For the case of the transition from classical to modern physics, this affirmation is supported by the crucial role of borderline problems for this transition.

By the end of the nineteenth century, physics had evolved by cumulative integration of magnetic, electrical and thermal phenomena into three major branches, each treating a set of interconnected physical problems on the basis of a relatively stable theoretical foundation. The oldest of the theoretical foundations of physics was classical mechanics. However, in the course of this process of integration, these three branches developed increasingly into independent theories of mechanics, electrodynamics (including optics) and thermodynamics. By creating new concepts such as charge and entropy, these theories became relatively independent with stable specific foundations for their respective ranges of phenomena.

Among the many concrete, unsolved problems studied by contemporary scientists, several were related to more than one such specific foundation, such as the problem of the electrodynamics of moving bodies, which requires the application of both the laws of electrodynamics and the laws of motion from mechanics. Heat radiation is another example of this class of borderline problems produced by a progressive integration of knowledge, which requires the application of both the laws of radiation – covered by those of electrodynamics – and those of thermodynamics. Since these problems fall under the range of application of two partially different theoretical

foundations, they represented not only a potential locus of conflict between different conceptual frameworks, but also points of departure for their integration into more developed theoretical frameworks. This in turn required a revision of fundamental concepts underlying all of classical physics, and hence a disintegration of traditional knowledge structures. Thus, the electrodynamics of moving bodies became the core of the later special theory of relativity, with its new concepts of space and time to which the rest of physical knowledge had to be adapted. Planck's law of heat radiation, another example, was later seen as the first decisive contribution to quantum theory, with its new concepts of matter and radiation which also required a reconceptualization of traditional physical knowledge.

Such processes of reconceptualization frequently lead to a new type of foundational problems of scientific theories. This is, for instance, the case for the reconceptualization of the entirety of classical physics on the basis of special relativity theory. In particular, the classical Newtonian concept of gravitation with its implication of instantaneous propagation was obviously incompatible with the limit-speed imposed on any physical interaction by special relativity. Any attempt to eliminate this problem by reconceptualizing gravitation within the theory of special relativity failed, so that fundamental assumptions of the theory ultimately had to be substituted by the assumptions of general relativity. The need to describe gravitation in terms of re-revised concepts of space and time led to an even more extensive disintegration of the knowledge structures of classical physics.

Several case studies are dedicated to examining the structural changes of physical knowledge associated with the introduction of these new theories, as well as the disintegration of classical evolutionary biology due to analogous challenges. In the case of relativity theory, the focus is on the emergence of the general theory of relativity, and in particular on the disintegration of knowledge structures of classical physics induced by the need to describe gravitation in terms of the new concepts of space and time resulting from the special theory of relativity. In the case of quantum theory, work is concentrated on reconstructing research policies relevant to the emergence of quantum mechanics, and in particular on analyzing the refocusing of traditional research activities induced by the discovery of a new common thread ("the quantum"), connecting hitherto separate problems. In the case of evolutionary biology, a case study analyzes attempts to reinterpret its fundamental concepts as a reaction to new insights, such as the increased knowledge about genes due to molecular biology, and the conse-

quences of such reinterpretations for the integrative role of these concepts. All these cases are characterized by an interaction of heuristic programs, which aim at knowledge integration, and traditional structures of knowledge, be they cognitive or social, which are disintegrating. The heuristic programs are comparable to the philosophical programs of an earlier period mentioned above, although they now usually are formulated from an inner-scientific perspective (which, of course, does not exclude effects from the field of philosophy), and although they may even take the form of a science policy. Thus, in spite of the diversity of the studies pursued in this project, they focus on the same crucial problem, the still insufficiently understood role played by reflective thinking in processes of restructuring scientific knowledge.

Current Research Activities Related to "Studies in the Integration and Disintegration of Knowledge in Modern Science"

Knowledge Integration and Concept Formation in Microbiology

Ohad Parnes

Ohad Parnes' research project looks at the origins of fundamental concepts of medical bacteriology and microbiology as a consequence of processes of knowledge integration in the nineteenth century.

The conceptual foundation of modern microbiology was established in the last quarter of the nineteenth century, and is commonly associated with the work of Louis Pasteur, Robert Koch, and their disciplines. But the emergence of its core concepts, such as "parasitism," "pure-culture," and "bacterial species," was merely a successful culmination of the gradual development of concepts and methods since the beginning of the nineteenth century. The aim of the project has been to trace the various strands of this knowledge integration and to reconstruct the processes of cognitive reorganization by which a seemingly self-evident conceptual foundation of this knowledge was created. During the period of the report, the work by Ohad Parnes has been integrated into the projects of the research group headed by Hans-Jörg Rheinberger, where it is now being pursued under a slightly different perspective. (For a detailed report, see *p. 215.*)

Newton's Synthesis of φυσικη and τεχνικη and its Reception in the Hegelian System

Renate Wahsner (responsible) partly in cooperation with Horst-Heino v. Borzeszkowski

In his work *Philosophiae Naturalis Principia Mathematica*, Newton discusses the relation of practical mechanics to universal mechanics, as determined by his theory. He shows the former to be the basis of geometry, which “is nothing but that part of universal mechanics which accurately proposes and demonstrates the art of measuring,” and is the precondition for and the core of the measurement-theoretical foundation of his theory. Under practical mechanics, Newton understands ancient mechanics or, more precisely, the theory of the so-called five simple machines: lever, wrench, pulley, wedge, and inclined plane. In his view, this mechanics treats the forces of the hand, while his own, *i. e.*, universal mechanics, treats the forces of nature. This means that Newton understands his classical mechanics as a theory of the forces of nature, including the forces of hand. To the extent that mechanics was not considered a theory of nature or a theory of φυσικη but of τεχνικη in classical Antiquity, a synthesis of φυσικη and τεχνικη inheres in this integration of the forces of nature and hand. Therefore, classical mechanics founds a new concept of nature, a concept that is characteristic of the thinking of the *Neuzeit*.

This project seeks to investigate the problem of how this new concept of nature, synthesizing nature as the objectively existing and the humanly acting, occurs as the subject of classical mechanics, as in its concept of motion, and how this synthesis is reflected by Hegel's natural philosophy. In this context, it will be clarified what role Hegel – in reference to Kant's idea of an organism – ascribes to teleology in his system.

As has been shown in previous investigations, Hegel's adoption of mechanics was determined considerably by the mechanistic concept of mechanics. This project intends to investigate the reasons for and manner in which the mechanization of mechanics was initiated by Voltaire.

The project includes the following activities: a German edition of Voltaire's work *Éléments de philosophie de Newton* (in cooperation with Horst-Heino v. Borzeszkowski); a discussion on the topic “Hegels Rezeption des neuzeitlichen Bewegungsbegriffs;” a paper on the reasons for the mechanization of mechanics (in cooperation with Horst-Heino v. Borzeszkowski);

and a paper on Hegel's natural philosophy.

The work on the German edition of Voltaire's works *Éléments de philosophie de Newton* and *Défense du Newtonianisme* was finished. The material was issued as a preprint of the Institute, and an expanded version was published in book form. The analysis of the intellectual circumstances under which Voltaire was writing shows that Voltaire, initiating the popularization of classical mechanics on the continent, simultaneously 1) founded a completely new type of popular literature on physics, 2) unified empiristic English Newtonianism with Cartesian rationalism in France, and 3) added fuel to the confrontation between Newtonianism and Leibnizian rationalism in Germany. As a consequence he made metaphysics aware of problems that hitherto were only considered by empirism. In so doing, Voltaire identified Newton's physical theory with the philosophical mechanistic conception of the world. This identification essentially molded the notion of mechanics, primarily that of German idealism.

The continuation of the work on Hegel's natural philosophy (publication of the book *Zur Kritik der Hegelschen Naturphilosophie. Über ihren Sinn im Lichte der heutigen Naturerkenntnis*, two seminars, a paper on Hegel's system and evolution concepts) demonstrates the lasting influence of this notion of mechanics. As was shown, this notion determines the way in which the evolution from Mechanics over Physics to Organics occurs in Hegel's natural philosophy, as well as what function for evolution is fulfilled by the concept of teleology.

The Philosophical Integration of Classical Science

Wolfgang Lefèvre and Falk Wunderlich

The classical modern sciences of the seventeenth and eighteenth century consisted not only of single theories – for instance, theories of motion in free fall, of percussion, of gravity, etc. – which reached a hitherto unknown level of intersubjective acceptance on the basis of experiments and methodically controlled observations. They were also characterized by attempts to construct overall theories of nature based on such single theories, which were to replace universal natural philosophy in the tradition of Aristotle. Examples are Kepler's "Weltharmonik," Descartes' mechanistic cosmology, Newton's speculations on "active principles," Leibniz' philosophy of "monads," Boscovic's and Kant's dynamism, and Le Sage's atomistic the-

ory. These theories failed, however, to achieve a status of being intersubjectively shared. In retrospect it seems clear that the contemporary level of modern sciences provided too small a basis for these ambitious enterprises. Except among historians of philosophy, these universalist theories are forgotten today or mentioned only as metaphysical embryos of this early stage of the modern sciences.

These theories do deserve attention, however, if one wants to reconstruct a full picture of the emergence of the modern sciences. In particular, these theories represent, despite their entirely obsolete scientific bases, outstanding examples of the role of reflective thinking in integrating disparate pieces of scientific knowledge. From the perspective of historical epistemology, it is especially interesting to study how first-order concepts of the scientific theories which were to be integrated interacted with second-order concepts in the construction of these global theories. Reflections based on first-order concepts from the whole range of science played a role in both integration and in concept formation in single fields of scientific knowledge.

These processes are being investigated through the example of Kant's natural philosophy. A detailed documentation of the scientific concepts in Kant's pre-critical writings, based on an electronic version of the entire body of writing involved, is nearly finished. This documentation comprises in particular a list of Kantian notions used in his writings until 1780. Most of these notions will be supplemented by glossary entries which clarify their meaning and show parallels to contemporary usage. References to Kant's writings which contain definitions or give particular insights into the Kantian use of a notion will also be provided, and these notions will be cross-referenced to create a net of interrelations among them. The system of cross-references is differentiated into the categories "Synonyms," "Antonyms," and "Related Notions." In order to show the diachronic dimension, each notion will be associated with a brief note about the work (represented by year of appearance) in which it occurs.

In 1996 and 1997 the main task of the project, the research for and the writing of the glossary entries, was continued. Explorations and preparations regarding the technical possibilities for eventually publicizing the documentation with all of the facilities of an electronic database were started in 1997.

The Disintegration of Nineteenth Century Physics and its Reflection in Wittgenstein's Philosophy

Gerd Graßhoff

The physics of the last decades of the nineteenth century was confronted with a striking conceptual heterogeneity among its major subfields. As a response to this heterogeneity, several attempts were made at a conceptual unification, mostly based on proclaiming the core concepts of one subfield to be the basis for the unification of all of physics, if not of all of science. Examples are the “mechanistic” and “electromagnetic” world views, and also the world view of “energetics,” based on fundamental concepts of thermodynamics. A unifying mechanical theory of all physical phenomena was pursued, in particular, by Kirchhoff, Helmholtz, Hertz, and Boltzmann. Such unifying programs lost their centrality due to the further progress of physics. Attempts to create a consistent, all-encompassing conceptual framework of physics were in fact pushed into the background, as were their claims to an integration of physical knowledge, by the conceptual incompatibilities that became visible with the borderline problems emerging at the boundaries of the competing theoretical frameworks.

In his investigation of late nineteenth-century natural philosophy, Gerd Graßhoff shows that these unificatory programs nevertheless had a lasting impact on the philosophy of science, which transformed some of the first-order concepts relevant to these programs into second-order reflective categories with a normative methodological character. This process is reconstructed for Wittgenstein's *Logisch-Philosophische Abhandlung*, which is shown to represent such a transformation, in this case of the program of natural philosophy laid out by Hertz's *Prinzipien der Mechanik*, Boltzmann's lectures in Vienna, and works on the theory of engineering in the tradition of F. Reuleaux. Details of Wittgenstein's studies of engineering in Berlin-Charlottenburg could be reconstructed and related to the project since new archival material from Wittgenstein's later friend Paul Engelmann has been found. New findings of documents from Heinrich Hertz draw a much more detailed picture of what was commonly referred to as “exact sciences” as a scientific research program, for which Wittgenstein believed his early philosophy to be a valuable contribution. It confirms that with a full grasp of its physical content, Wittgenstein used Hertz's *Prinzipien* as the foundation for the philosophical architecture built in close contention with the logical theory proposed by Russell and Frege.

The Relativity Crisis and the Reorganization of Classical Knowledge on Gravitation – the Reconstruction of Einstein’s Discovery Process

Jürgen Renn, Tilman Sauer, John Stachel (Max Planck Institute for the History of Science), Michel Janssen (Boston University), and John Norton (Pittsburgh University)

The study is devoted to a reconstruction of the emergence of the General Theory of Relativity. On the basis of an exhaustive examination of all available historical sources, comprising, in particular, published papers, correspondence and research notebooks, the development of Einstein’s thinking on gravitation is traced from his first publication on the subject in 1907 to the publication of the final version of the theory in 1915. The aim is to reach a systematic understanding of both the knowledge basis in classical physics for Einstein’s achievement, and of the nature of the developmental process by which his research overcame some of the conceptual foundations of classical physics. The results of the reconstruction are documented in the form of detailed commentaries on the historical sources and in the form of a new interpretation of the early history of General Relativity.

Einstein’s general theory of relativity emerged in reaction to a fundamental conceptual crisis of classical physics, characterized by foundational inconsistencies between classical mechanics, classical electrodynamics and special relativity. Even though the challenge of reconciling classical mechanics and classical, special-relativistic electrodynamics was recognized and taken up by many contemporaries, the conceptual breakthrough to the theory of general relativity was achieved largely by Einstein and his immediate collaborators in the years between 1907 and 1915. The theory he finally published in 1915 provides the successful revision of the classical theory of gravitation and eventually became part of the canonized knowledge of modern physics.

The emergence of the general theory of relativity has been the object of extensive joint research by a group of scholars associated with the Institute. This work was originally pursued in the context of the Arbeitsstelle Albert Einstein and since has been essentially completed at the Max Planck Institute for the History of Science. In particular, a meticulous line-by-line analysis of a key document from the period between 1912 and 1913, the so-called “Zurich Notebook,” has been completed by a joint effort of the mem-

bers of the research group. A preliminary discussion of the interplay between formalism and heuristics, based on the joint analysis of the Zurich Notebook, has been published. The subsequent work of the group focused on the question of how Einstein overcame the misconceptions of an intermediate version of his relativistic theory of gravitation, the so-called “Entwurf theory,” established by his efforts from 1907 to 1913. Several interpretative essays on this question have been written by members of the group. Furthermore, an extensive, line-by-line commentary on Einstein’s published papers on gravitation from 1907 to 1915, analogous to the commentary on the Zurich Notebook, has been completed in large part. Although the work of the group mainly focused on Einstein’s search for the gravitational field equations, the systematic efforts to analyze all available sources on his thinking on gravitation from the perspective of this study also have led to several conclusions concerning other aspects of the history of general relativity; these results have been published in papers by members of the group. It is planned to publish the cumulative results of the reconstruction of Einstein’s discovery process in a comprehensive monography which is currently in preparation.

On the basis of the results achieved to date, a comprehensive reassessment of the emergence of the theory of general relativity from the point of view of an historical epistemology has now become possible and will be the main topic of the planned monography. This reassessment cannot be discussed here in detail. However, the overall structure of the emergence of General Relativity resulting from our study, as well as some of the concepts we have used in order to describe this structure, deserve mention.

Einstein’s path to general relativity essentially began in the year 1907 with the formulation of the later “equivalence principle,” and ended in the fall of 1915 with the discovery of generally covariant field equations for gravitation. The equivalence principle, embodied by such mental devices as the freely falling elevator, served as a basic *mental model* for the relation between gravitation and inertia. By linking effects in accelerated frames of reference to gravitation, it provided an *integrative perspective* from which separate branches of classical physics could be related to each other, thus establishing connections, *e.g.*, between gravitational and optical phenomena. Searching for an understanding of gravitation with the help of this mental model, Einstein achieved striking qualitative insights into the empirical consequences which the new theory of gravitation should have, for instance, the deflection of light in a gravitational field. In the course of

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$$ds^2 = \sum g_{\mu\nu} dx^\mu dx^\nu$$

x^0	x^1	x^2	x^3
x^0	x^1	x^2	x^3
x^0	x^1	x^2	x^3
x^0	x^1	x^2	x^3

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will provide a forum for historians, philosophers and physicists to meet and discuss recent work in the history of General Relativity;

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- The Realm of Alternatives in its History
- Experimental and Theoretical Explorations
- National Contexts and its Vicissitudes
- Historical and Philosophical Contexts
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- The Problem of Model Building in Cosmology

4th International Conference on the History of General Relativity
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 - Vladimir Vitzth, Moscow

g_{00}	g_{01}	g_{02}	g_{03}
1	0	0	0
0	1	0	0
0	0	1	0
0	0	0	c^2

$$c^2 \left(\frac{\partial a}{\partial x} \right)^2 + 2c \frac{\partial a}{\partial x} \frac{\partial b}{\partial x} + \left(\frac{\partial b}{\partial x} \right)^2 = 2c \frac{\partial a}{\partial x} \frac{\partial b}{\partial x}$$

$$\frac{z^2}{2} = y$$

$$dy = \frac{1}{2} \frac{dz^2}{z} = \frac{1}{2} \frac{2z dz}{z^2} = \frac{dz}{z}$$

$$\frac{dz}{z} = \frac{dy}{y}$$



$$dy = \frac{z}{4} \frac{dz^2}{z}$$

this reconstruction it became clear that even as early as 1912 he elaborated this insight into a quantitative prediction of gravitational lensing.

Other fundamental structures of knowledge relevant to Einstein's search for a new theory of gravitation were those incorporated in the understanding of what an equation of motion and what a field equation mean in classical physics and the special theory of relativity. This understanding involves concepts such as those of force, energy, momentum, potential, field, source, and mass. In order to capture the role of these concepts as heuristic orientations for Einstein's search, beyond their role as elements of any specific physical theory, the project has used the concept of *frame*. With the help of this concept, those common properties which relate the understanding of the Poisson equation in classical physics to the Einstein equation of general relativity have been described, to substantiate the claim that these common features played an important role in the historical development linking the two equations.

In addition to the identification and systematic description of basic structures of knowledge relevant for Einstein's achievement, the role of mathematical representations for the evolution of his thinking has been studied. It has been possible, in particular, to provide a detailed account of the interaction between his exploration of these representations and the basic physical concepts used in his emerging theory of gravitation. Two distinct heuristic strategies have been identified in Einstein's research which mediate between the available mathematical representations and his physical understanding. One strategy was to take as the starting point physical considerations derived from classical physics, such as energy-momentum conservation and the recovery of Newton's gravitational theory in a suitable limit; the other strategy was to begin from mathematical considerations concerning the covariance group of candidate field equations and then to attempt to find a consistent physical meaning – from the point of view of classical physics – for the mathematical objects under consideration.

The reconstruction of the calculations in the Zurich Notebook led to the astonishing result that, following the mathematical strategy, Einstein had already considered the correct field equations of 1915 (albeit in linearized approximation) in 1912, and had thus come within a hair's breadth of the final general theory of relativity. He failed to recognize the physical meaning of these equations, however, and turned to the alternative, physical strategy. In the sequel he published the "erroneous" "Entwurf" field equations of 1913.

The work in the time covered by the report mainly focused on the question of how Einstein was nevertheless able, in the period between 1913 and 1915, to overcome those obstacles which prevented him from realizing that the correct field equations were the ones derived in his notebook and not the ones he published in 1913. The answer to this question found in the course of this project leads to the surprising insight that, contrary to what is commonly accepted, the long interval between the publication of the erroneous field equations and the dramatic return to the correct equations at the end of 1915 was not simply a period of stagnation. It was rather a period during which Einstein arrived at a number of insights creating those crucial preconditions which made the dramatic events of November 1915 possible. Paradoxically, this state of elaboration itself had to be reached under the guidance of the erroneous “Entwurf” theory. This result suggests that the establishment and stabilization of the new physical concepts that emerged with general relativity first required a degree of elaboration of the mathematical formalism which went considerably beyond finding the correct field equations.

A comparison with Hilbert’s contemporary work on gravitation, performed in the context of this study, has shown, on the other hand, that an exploration of the relevant mathematical formalism cannot have been the only process driving the conceptual changes associated with the emergence of General Relativity. In fact, it turned out that Hilbert, in spite of his superior mathematical competence and contrary to commonly held views, did not arrive independently at the field equations of general relativity (see also the *History of Alternative Approaches* below). Our study suggests rather that the reconceptualization of gravitation, space, and time brought about by General Relativity could only succeed under the guidance of Einstein’s peculiar heuristics which represented his integrative perspective on the knowledge of classical physics.

The Relativity Crisis and the Reorganization of Classical Knowledge on Gravitation – the History of Alternative Approaches

Leo Corry, Shaul Katzir, Christopher Martin, Jürgen Renn, Tilman Sauer, Matthias Schemmel, Christopher Smeenk, and John Stachel

Several research activities have been dedicated to the study of theories of gravitation before and after the advent of Special Relativity. The primary

aim is to reach an understanding of the “*horizon of possibilities*” of reacting to the crisis provoked by the conflict between the understanding of gravitation in classical physics and the challenge represented by the special theory of relativity. In this sense, the study also aims at providing a broader context to the reconstruction of Einstein’s singular achievement, thus contributing to an explanatory history of modern physics. It is being examined, in particular, which approaches to the problem of gravitation existed in late classical physics, on which intellectual resources the different approaches relied, the extent to which they were able to respond to the crisis of classical physics, what potential alternative scenarios to the one actually realized existed, and for which reasons Einstein’s General Relativity eventually came to be accepted as the resolution of the crisis.

As mentioned above, the crisis became apparent when it turned out that Newton’s gravitational force law was incompatible with the new concepts of space and time introduced by the special theory of relativity in 1905. Whereas the classical theory of gravitation postulated an instantaneous action at a distance, the concept of velocity in Einstein’s new kinematics excluded any physical action at speeds greater than that of light. It is therefore no surprise that not only Einstein but also several of his contemporaries addressed the problem of formulating a theory of gravitation which complied with the new kinematics of relativity theory. The analysis of these alternative approaches, as well as of earlier alternative approaches to gravitation within classical physics, helps to identify the necessities and contingencies in the actual historical development.

The history of alternative approaches to the problem of gravitation in late classical physics is still largely unexplored. A first step undertaken in this study was therefore the creation of a survey of primary sources, recorded in a database. In addition, several in-depth studies have been completed during the period covered by this report, each dealing with specific aspects of the historical development. Preparatory work has been done on a volume including three types of texts: selected original papers translated into English, editorial notes on the primary sources, and detailed studies of specific aspects, in particular those prepared at the Institute. The volume will be supplemented by a CD-ROM containing a broader selection of primary sources.

The volume will contain, in particular, the following contributions:

- a study by Jürgen Renn on the conceptual resources for solving the problem of a relativistic theory of gravitation in the traditions of mechanics and field theory;
- a study by John Norton on the elaboration of a special relativistic alternative to Einstein's approach by Gunnar Nordstrøm and others;
- a study by Julian Barbour on the role of the Machian tradition of mechanics on the development of General Relativity;
- a study by Leo Corry on David Hilbert's work on relativity in the context of his attempts to develop a unified axiomatic approach to the whole of physical science;
- a study by Jürgen Renn and John Stachel on the relation between physical interpretation and mathematical formalism in the evolution of Hilbert's thinking on gravitation;
- a study by John Stachel on the possible alternative scenario that a reformulation of Newton's theory of gravitation using the concept of an affine connection had been developed before Special Relativity.

In the period covered by the report new results have been found, in particular concerning Hilbert's role in the development of General Relativity. Earlier research on his role essentially followed the common view that Hilbert independently derived the field equations of General Relativity five days before Einstein on 20 November 1915 – after only half a year's work on the theory. The studies on which we have reported in the section on *The Reconstruction of Einstein's Discovery Process* have led to an essential correction of this view. Here we focus only on the peculiarities of Hilbert's contribution which recently have become clear. It was generally known that Hilbert's approach had two separate starting points, Mie's special relativistic electromagnetic theory of matter and Einstein's early attempts to base a theory of gravitation on the metric tensor. It has now turned out that not only his starting point but also his results were different from Einstein's. Hilbert's path did not, in fact, actually lead to General Relativity, but to a theory whose physical meaning was quite different from that of Einstein's final achievement and rather more closely related to both Mie's speculative theory of matter and to Einstein's earlier, non-covariant versions of a theory of gravitation. Only by adapting elements of Einstein's approach in the course of his work did Hilbert rederive results in General Relativity – and then, only at the price of inconsistencies with his own physical approach.

The Relativity Crisis and the Reorganization of Classical Knowledge on Gravitation – the Contexts of the Establishment of General Relativity

Giuseppe Castagnetti, Peter Damerow, Hubert Goenner, Folkert Müller-Hoissen, Jürgen Renn, and Britta Scheideler

The aim of the studies reported here is to analyze various contexts of the establishment of General Relativity as part of the canon of modern physics. One study is dedicated to the academic context of General Relativity, in particular to the integration of the theory into a teaching tradition. This study focuses on an edition of student lecture notes from Einstein's courses on General Relativity. Several other studies deal with the political contexts of the creation and reception of General Relativity. They are dedicated to Einstein's political engagement during and after World War I, to the evolution of his political thinking and its relation to his role as a scientist, and to the conflicts with his colleagues and with his institutional context, in particular with the Berlin Academy.

Teaching constitutes an essential intermediate step in the process of the social mediation of scientific research results. While the processes underlying the development of the physical theory, documented by research notes and publications in scientific journals, form one pole in the communication chain, the other pole comprises the mediation of research results in textbooks and popular expositions. The oral teaching tradition lies between these poles; in its early phase, the reflection on topical research problems and the constraints arising from the need to embed the new theory in the canon of scientific tradition are close to each other. Here one has the chance to study in detail the rise of a generally accepted "context of justification" from the individual "context of discovery" and to relate questions of the reconstruction of individual cognitive processes to questions of the social development of knowledge.

Einstein's early courses are a valuable source for the reconstruction of this academic context of the history of relativity theory. Tilman Sauer and Folkert Müller-Hoissen have concentrated on student lecture notes from Einstein's courses for which his original notes are not preserved. They worked, in particular, on a course on General Relativity probably held in the summer semester 1919 at the University of Berlin. For this course there are notes from Hans Reichenbach preserved in the Reichenbach archives in Pittsburgh. The aim was to edit a transcription of these notes, to be accom-

panied by extensive editorial and historical comments and by brief reviews from the perspective of modern physics of central topics addressed in the manuscript. Although work on transcription and commentary is well advanced, the edition project had to be suspended for the time being since both Tilman Sauer and Folkert Müller-Hoissen left the Institute in order to take up more permanent positions in other fields.

The analysis of Reichenbach's notes has turned out to be particularly valuable for an assessment of the relation of the early teaching tradition of General Relativity to Einstein's discovery process. Einstein did not give an axiomatic introduction to the theory of general relativity in these lectures, but followed a course which very much parallels the actual historical development. He started by pointing out deficiencies of both the theory of special relativity and of classical mechanics, and discussed in particular those elements which had played a major role in the heuristics and had guided his search for a general theory of relativity. The lectures end with a discussion of problems at the cutting edge of research at the time, namely the "cosmological problem" and a modification of the field equation in order to set up a theory of the electron, related to a paper he presented in April 1919 to the Prussian Academy of Science.

Einstein's fame after the confirmation of the bending of light in 1919, predicted by General Relativity and generally taken as a proof for the validity of this theory, was a central reason for the intense reaction to him as a political figure in the public sphere. Understanding and assessing Einstein's historical role as a prominent public figure, who simultaneously became a symbol of successful scientific creativity as well as of heated ideological dispute, was at the center of an investigation by Hubert Goenner and Giuseppe Castagnetti, based on earlier work in the context of the Arbeitsstelle Albert Einstein, as well as on further extensive archival research.

The results of this work since have been published. The paper by Castagnetti and Goenner discusses, among other issues, Einstein's radicalization, and clears up the circumstances of his public appearance during the revolution in November 1918. Einstein's role in the Bund Neues Vaterland and other pacifist organizations, as well as his interaction with other pacifists in Germany and abroad, could be exposed and analyzed in detail. In contrast to the generally accepted view, the study has led to a reappraisal of Einstein's pacifist activity. It shows that he only rarely applied social and political categories to the events during the war and that Einstein's pacifism

remained one more of creed than of deed.

The research on Einstein's political biography was complemented by a study by Hubert Goenner and Britta Scheideler on Einstein's political thinking and behavior in the context of the reaction of natural scientists to the cultural and social changes between 1914 and 1933. Due to Britta Scheideler's departure for a more permanent position at another institution, the study could, however, not be completed. First results were presented at an international colloquium on Einstein in Berlin, held in March 1997 in Boston and co-organized by the Center for History and Philosophy of Science at Boston University, the Collected Papers of Albert Einstein and the Max Planck Institute. The preliminary results will be published as a paper.

In particular it could be shown that, contrary to his scientific thinking and contrary also to a view that is widespread in the literature, Einstein's political thinking and behavior were not characterized by radical breaks with respect to his contemporaries' politics. Rather, his thinking and behavior were influenced by his self-image as a scientist. Einstein grew into the role of an involved intellectual whose political thinking was based on generalizing the model of the "true scientist" to that of an ideal individual, opposed to dominant values of the society. This role with its critical distance from the dominant social and political standards set him apart from the majority of both humanities professors and natural scientists. But Einstein's understanding of this role was largely structured by traditional ideas on the role of the individual, and in particular that of the elitist individual in society. In fact, as an intellectual, Einstein felt that he belonged to an "elite of values," a position that determined his understanding of democracy. Surprisingly, it turns out that his political thinking was *not* pluralistic, in the sense that he did not acknowledge competing social groups with conflicting interests. While witnessing the contemporary disarray of the social and political foundations, Einstein remained under the influence of rather old-fashioned and naive ideas about society, and essentially denied part of the social and political reality with which he was confronted in his Berlin years.

That Einstein's political attitudes and actions nevertheless brought him into conflict with his colleagues and with his institutional context is shown by a study of Giuseppe Castagnetti, Peter Damerow, and Jürgen Renn begun in the period covered by the report. Analyzing Einstein's relation to the Berlin Academy in the years between 1914 and 1933, the study indicates that his forced retreat from the Academy in 1933 was not only the result of increased external pressures by the rise to power of Nazism. It rather seems

that Einstein's ultimate conflict with the Academy was a consequence of the Academy's loyalty to the state, an effectively political role that was shunned by its apolitical self-understanding. The persistence of this role is illustrated by the position that the Academy had taken all long with regard to Einstein's political attitudes and actions since he assumed membership in 1914. Preliminary results of this study were presented at a colloquium of the Berlin-Brandenburg Academy in November 1996.

The Quantum Crisis and the Reorganization of Research Strategies in Classical Physics – the Cases of Einstein and Bohr

Giuseppe Castagnetti, Hubert Goenner, Dieter Hoffmann, Edward Jurkowitz, Horst Kant, Alexei Kojevnikov, Jürgen Renn, and Arne Schirmacher

The goal of the study was to undertake collaborative research with the intention to reconstruct the reorganization of physical research as a reaction to the emergence of "quantum problems" early in the twentieth century, meaning the problems which contributed to a disintegration of classical physics and which were eventually recognized as pertaining to the range of quantum theory. The study's central interest was the question of the extent to which such a reorganization took place as a result of explicit reflections on the disintegration of classical physics. It was planned to concentrate activities on four of the major sites of exploration of quantum theory, where some of the most powerful and successful physicists and organizers of the work toward the elucidation of quantum problems lived: Berlin, Munich, Göttingen and Copenhagen. For each of these locations, the various social and cognitive processes behind the shift that put the quantum at the *center* of research activities were to be investigated.

The problems later recognized as quantum problems pertained to such different areas of research in classical science as black body radiation, spectroscopy, or solid state physics. Typically they were "borderline problems," in the sense explained in the introduction to Project 2, that is, located at the frontier between partially distinct conceptual frameworks of classical physics. The incompatibility of these problems with the foundations of classical physics and their mutual interrelationships were only recognized gradually. This process extended over a quarter of a century, roughly between 1900 and 1925, and involved a considerable number of

physicists, chemists, and mathematicians from several countries. While the emergence of new theoretical concepts and new experimental results have been extensively studied by historians of science, the processes of knowledge integration underlying this development still require further study. The focus of research at the Institute concerned only one specific aspect of this integration: the effect of contemporary scientists' recognition of quantum problems and their interrelationships to the shifting of their research foci, reallocation of their resources, and reorganization of research structures and policies. In this way, the study has sought to answer the question of whether quantum theory was developed, like Einstein's theory of relativity, primarily by the individual contributions of a few distinguished scholars or, in contrast to Einstein's discovery, by the joint effort of a scientific community interacting according to principles also at work in modern research institutions. The study thus had the aim to bridge the gap between work on individual physicists' paths of discovery and research on the institutional history of science.

In the period covered by this report, however, the study could not be completed as originally planned for two main reasons: the departure of junior visiting scholars for more permanent positions, and other activities of research scholars of the Institute, in particular due to outside obligations partly incurred prior to their participation in the study. Archival work in the Sommerfeld Archive in Munich (Horst Kant) was temporarily suspended and has only recently been resumed with the aim to provide material for a future study of Sommerfeld's research policies. It is generously supported by the cooperation of the Sommerfeld project (Michael Schüring, Michael Eckert), with which transcriptions of primary documents are being exchanged. Work on the research policies of the Physikalisch-Technische Reichsanstalt (PTR) during the early history of quantum theory (Dieter Hoffmann) has also been pursued only on a reduced scale.

Although the major comparative study between different research centers could not be completed as originally envisaged, the more limited goal of performing a comparison between at least two institutions with different research policies and their impact on the development of quantum theory could nevertheless be reached, in particular due to contributions by visiting scholars of the Institute. Work has therefore been refocused on the cases of Einstein and Bohr and is, within this narrower scope, essentially finished. Two major studies, one on Einstein's role at the Kaiser-Wilhelm-Institut für Physik in Berlin (by Giuseppe Castagnetti and Hubert Goenner), the

other on Niels Bohr and his institute in Copenhagen (by Alexei Kojevnikov) have been completed. They have prepared the ground for a detailed comparison of the readjustments of research policies – in reaction to the quantum crisis – in one institution at the “center” (Berlin) and another institution rather more at the “periphery” (Copenhagen) of the academic world of the time. It is planned to publish the results of the joint work with an extensive introduction in a book edited by Jürgen Renn. A related study by Jürgen Renn, completed in the period covered by this report, was dedicated to the tension in late classical physics between specialization along traditional borderlines and the possibility of integrating knowledge accumulated in and spread over various disciplines and subdisciplines. The study has focused on the origin of statistical mechanics and its applications, including those to the early quantum problems.

The work on the research policies of the Kaiser-Wilhelm-Institut für Physik (Castagnetti and Goenner) has shown that the foundation of an institute under Einstein’s directorship, promoted by an influential group of Berlin physicists, administrators, and industrialists, was a reaction to the increased differentiation within physics and to the increasingly important role of Planck’s quantum as a germ of crystallization of a growing field of knowledge. The creation of the institute was a concrete reaction to this situation which attempted to take advantage of Einstein’s ability for conceptual integration for an organization of science. It turned out, however, that this attempt was essentially a failure. The integration of the knowledge from physics and chemistry that was required for the formulation of the later quantum mechanics could, it appears, neither be achieved by the intellectual work of a single outstanding individual such as Einstein nor by traditional types of intellectual cooperation. In particular, the failure of the Kaiser-Wilhelm-Institut to promote regular and lasting collaboration among scientists on a set of challenging research problems, across traditional disciplinary specializations, can be interpreted as a failure of the “academy model” of research policy and funding. (The role of the academy model is also the subject of a study on Einstein and the Berlin Academy by Giuseppe Castagnetti, Peter Damerow, and Jürgen Renn, see also *The Relativity Crisis and the Reorganization of Classical Knowledge on Gravitation – the Contexts of the Establishment of General Relativity* p. 87).

The study on the history of Niels Bohr’s research policies from 1913 to the advent of quantum mechanics in 1925 (Kojevnikov) is based on extensive archival research in the Niels Bohr Archive in Copenhagen and in other

archives. It not only shows that the political circumstances of the time provided a neutral country like Denmark with a special opportunity to play a new and more important role in the international scene. It also makes it clear that these circumstances, in particular after the First World War, weakened traditional scientific institutions and, at the same time, the traditional professional and intellectual loyalties fostered by them. As a consequence, the relatively small Bohr institute could create new, transnational bonds between scientists which were more flexible than the established ones. These new, less rigid connections also allowed for the integration of a variety of local scientific traditions, which were then brought to bear on specific problems of the emerging quantum theory. This development is exemplified by several case studies treated within the study. In the period covered by the study so far, Bohr's intellectual agenda evidently played an important role for the identification of research problems. The present study will be supplemented by a more detailed analysis of this agenda, possibly in comparison with that of Einstein.

The Disintegration of Evolutionary Biology

Peter J. Beurton

In the period extending roughly from the early 1930's to the 1960's, the neo-Darwinian paradigm, founded by scholars like R. A. Fisher, S. Wright, T. Dobzhansky, and E. Mayr, which also has become known as the "synthetic theory of evolution," seemed to provide an all-embracing, monolithic framework of evolutionary biological thought. By approximately 1970 this paradigm was replaced or complemented by a number of new evolutionary approaches which called even the most fundamental concepts of the previous period into question. There are no longer unequivocal definitions of "adaptation," "gene," "species," or, in fact, "Darwinism."

While evolutionary biology can no longer be viewed as a unified field of knowledge, its foundational concepts, such as the concept of the gene, nevertheless still play a role for knowledge integration in biology – relating insights in molecular biology to knowledge in population genetics, for example. We are thus confronted with a protracted, still open-ended period of scientific turmoil. Analyzing the implications of this integrative function of the foundational concepts of evolutionary biology is one of the central objectives of the studies pursued by Peter J. Beurton. His present research

project, which builds on his previous work on the history and structure of the synthetic theory of biological evolution as well as on his investigations into the biological species concept, concentrates on the concept of the gene.

Peter J. Beurton, Wolfgang Lefèvre, and Hans-Jörg Rheinberger have organized an international working group to investigate the historical development of this concept. A first workshop of this group was held two years ago (see the preprint no. 18 based on this workshop). A second workshop on this topic was held in the fall of 1996 and has been followed in the meantime by the preparation of a book manuscript by the participants of the workshop (see *p. 247*). Peter Beurton, Raphael Falk, and Hans-Jörg Rheinberger prepared written comments for the external reviewers and the authors, as well as an early draft of a “Commentary Overview” paper that should summarize the notions discussed in the workshop and in the submitted papers. A comprehensive literature list of all the papers also was compiled.

Moreover, Peter J. Beurton has worked to provide an outline towards a comprehensive view of the synthetic theory and has made a biographical sketch of two major figures (T. Dobzhansky and S. Wright) involved directly or indirectly in the synthesis. As a case study to elucidate the principles of the development of the evolutionary theoretical argument, he has submitted an essay on the development of the young Darwin’s thinking.

Peter J. Beurton has continued with the construction of a database for conceptual problems in evolutionary biology which builds on a core collection of 2500 papers deposited at the Institute (at present 4000 entries).

Associated Research Activities

History of Atomic and Nuclear Research

Horst Kant

In preparation for a project on the history of atomic and nuclear research (from radioactivity to nuclear fission), which will start in 1998, a number of single contributions were completed by Horst Kant. Many of these were also connected with some of the author’s previous projects, concerning among others the history of the German Uranium Project and the history of

the Kaiser-Wilhelm-Institut für Physik.

One group of papers concerned the early history of radioactivity, dealing with the contributions of A. H. Becquerel and the younger E. Rutherford in particular, and comprised the first steps of the new study.

Another set of papers dealt with issues subsequent to the above mentioned project. Among these was a lecture given on the German Uranium Project at an international conference on the History of the Soviet Atomic Project in Dubna in May 1996. Results of this conference were included in a lecture on the history of physics in the Soviet Union at the Freie Universität Berlin in January 1997; a publication will follow in 1998.

Aspects of Institutional History

Horst Kant

In connection with previous projects, a smaller-scale study on the history of physics at University of Strasbourg during the Second World War was carried out within the framework of an international project on the history of Strasbourg universities (the "HISA"), coordinated by GERSULP at the University of Strasbourg. For this subject, for which only a minimum of preliminary work has been performed, extensive archival studies were necessary, complemented by interviews with persons involved in the subject at that time. The result of this activity was a manuscript, completed in mid-1997, which will be included in a book of collected papers on this subject (to be published in 1998). An extended form of this manuscript appeared as preprint no. 73.

In addition, in early 1997 Kant completed the edition of a book with the title *Fixpunkte - Wissenschaft in der Stadt und der Region*, which dealt in a wider sense with science and urbanization. Included in this book is a paper by Kant on regional aspects of communication structures, concerning the development of physics in Berlin at the turn of the last century. In this connection, in-depth studies of the physicist Emil Warburg and his work, and of other scholars in Berlin, also were completed and published. Additional related studies were carried out on Helmholtz, presented at such fora as a conference of the Interdivisional Group on History of Physics of the European Physical Society in Bratislava in August 1996, and published in the proceedings of this conference.

*The Contribution of the Physikalisch-Technische Reichsanstalt
to Quantum Physics*

Dieter Hoffmann

Connected with the general approach of the quantum project, the aim of this study is to investigate the role of the Berlin Physical Institute (Physikalisch-Technische Reichsanstalt) in the early history of quantum physics. As a reaction to the challenges of the new quantum theory, the institute's scientific research program turned to related problems: photochemistry, lowtemperature physics, radioactivity. In these fields the PTR was able to contribute important solutions to special quantum problems and to establish a fruitful, but limited and traditionally oriented interaction between theory and experiment. These achievements made the PTR an important center in the early period of experimental quantum physics, and allowed it to become a leading power in a highly developed culture and long working tradition of precision measurement. Since the general approach to quantum problems was quite conservative and the contributions were focused on very special problems, the PTR's contribution to the history of quantum theory was both timely and of short endurance.

An Exhibition on Max Planck

Dieter Hoffmann

In 1997 Dieter Hoffmann organized an exhibition, "Max Planck – Leben, Werk, Persönlichkeit." The exhibition was co-sponsored by the German Physical Society and was held in the Magnus-Haus Berlin. The activities connected with this exhibition are a starting point for further research on Planck. This research will focus on two subjects. Firstly, research has shown that Planck's position in German society and his role as a scientific organizer and politician should be investigated in more detail and in a more general perspective. A comparative study of Planck and Harnack and their behavior at points of rupture (*Umbruchsituationen*), and their reaction to both political and scientific crises is under way (together with J. Renn and G. Castagnetti). This study will continue with a detailed documentation of Planck's role and behavior during the Third Reich. Already completed is a paper dealing with the myth and legends of Planck's personality during the

post-war period and its instrumentalization in the framework of the Cold War, especially in connection with the celebration of the Planck centenary in Berlin in 1958.

Secondly, as a continuation of the research on the role of the PTR in early quantum physics, the reception of Planck's radiation formula will be documented. While Planck's formula generally has been discussed in the framework of quantum history, this study will treat the formula as a problem of precision measurement, as only a few laboratories in the world had achieved the technical capabilities and the experimental tradition of the PTR which enabled it to carry out measurements in this field.

Science and Technology in the GDR

Dieter Hoffmann

A project on the history of science and technology in the former German Democratic Republic, which was started in 1993 under the direction of Dieter Hoffmann and Kristie Macrakis (Michigan State University) and sponsored by the Humboldt Foundation and its transcoop project, was completed during the period covered by the report. The edited volume of papers gives a representative overview of the development of specific areas and disciplines, ranging from studies on science policy and special scientific institutions, to the history of disciplines and professions as well as the biographies of scientists whose careers were typical for GDR society. Most of the studies had a comparative perspective – between East and West, among the socialist countries, and between Nazi Germany and the GDR.

Future research in this field should continue with additional biographical studies and with more general investigations into the conditions of scientific research in totalitarian societies.

PROJECT 3: DYNAMIC MODELS OF SCIENTIFIC DISCOVERIES

Gerd Graßhoff, Bruce Eastwood, and Michael May

General Goals of the Project

The project studies the development of scientific discoveries as a genesis of a network of scientific ideas, research practices, and their material preconditions in specific historical contexts. Historical explanations of discovery processes must identify the ingredients of concept formation processes and the generative steps by scientific actors who utilize those ingredients as means to create new hypotheses, instrumentation and research practices.

To investigate such processes, an explanatory framework is assumed. The set of cognitive components relevant for the discovery process forms an epistemic system, which can be described by a dynamic model of scientific discovery. Such a model should represent epistemic goals that direct the agent to the solution of his problem; propositional attitudes such as beliefs, assumptions, or considerations, regardless of their truth value; and heuristics, which are rules of action according to which either propositional attitudes (*e.g.*, belief in a causal hypothesis) are generated or physical actions (*e.g.*, experiments) are performed. Finally, epistemic actions realize the proposed steps in the discovery process.

Although discovery processes clearly have to do with scientific beliefs and their changes, it is strongly emphasized that models of the dynamics of beliefs alone are insufficient for a theory of scientific discovery. Instead, practical reasoning related to human action both for physical and mental acts provides the generative frame for a historical explanation of cognitive processes as they are exhibited in the development of science. Surprisingly few heuristic rules suffice to coordinate hypothesis creation processes and form the ‘motor’ of changes during a scientific discovery process.

The focus of the reconstructed historical events are cognitive states and their preconditions related to scientific discovery, among them:

- scientific hypothesis;
- goals to be pursued in the course of scientific activities;
- scientific practice, which rules scientific experimentation, creates observable effects or crafts computer programs that evaluate the

data obtained through scientific actions and their material preconditions;

- scientific objects (*e.g.*, objects of study), material devices for experimental and observational contraptions, and material tools of scientific reasoning (*e.g.*, computers or graphical representations).

The close connection between goals, actions and theoretical knowledge lies at the heart of the analysis of scientific discovery processes. This connection is far from obvious, since the link between scientific enterprises and actions is no more direct than that between actions and theoretical content. For example, the goal that a certain hypothesis should be empirically validated does not specify a particular action to pursue that goal. Hence, on the general level, this model focuses on those intentions which relate to scientific actions. Furthermore, the model does not differentiate principally between physical actions like performing an experiment, and mental acts like constructing a hypothesis.

The history of a scientific discovery process is manifest in the changes of the state of the epistemic system. These similarly affect goals, actions and beliefs, and the state of the material things relevant for the discovery. Models of historical processes are tested by comparing the sequence of the model's states with documents produced by the researcher throughout his work. These historical investigations cover both experimental scientific activities (the case study of the discovery of the urea cycle) and theoretical development (history of planetary theory). The experimental study will concentrate on a micro-study of one single discovery process of a team of just two researchers, while the long-range study examines the development of planetary theory by many participants.

Discovery of the Urea Cycle

Gerd Graßhoff, Michael May

This study focuses on hypothesis formation by experimental means. It investigates the discovery of the urea cycle, a major biochemical discovery made by Hans Krebs and his assistant Kurt Henseleit in the 1930's at Freiburg. Before Krebs and Henseleit, the synthesis of urea in mammals had been investigated for a long time, but without definitive results. In a long series of skillfully arranged experiments, Krebs and Henseleit were able to

establish the cyclic nature of this process. The laboratory notebooks of both researchers have survived and provide detailed historical data for studying the strategies of hypothesis formation based on experiment. The case is especially suited to this task since the theoretical background knowledge available to Krebs at that time was comparatively shallow. This forced him to perform much experimental work during hypothesis construction and testing, leading to a materialization of thought processes in a series of experimental setups. Since experimental setups and results are written down in lab books practically at the time of their conception, the danger of false recollections from memory is reduced significantly. Krebs and Henseleit executed more than two hundred experiments in all stages of their approximately ten-month investigation, producing data for most activities related to experimental research, such as the design of a measurement process, the search for a reproducible effect, the formulation of a hypothesis, or its final verification.

In contrast to a reconstruction by Frederic L. Holmes (Yale), it is assumed that the discovery process as documented in the laboratory notebooks can be explained up to a fair level of detail by assuming some very general principles of causal reasoning. To this end, the concept of a causal structure is given a precise meaning, and the close link between such a structure and strategies of experimentation is elucidated. These principles are embedded in a larger structure called an epistemic system, which, through computer simulation techniques, allows the explanation of a discovery process as a goal-oriented activity guided by heuristic principles. Thus the importance of cognitive factors in an explanatory framework is emphasized. That this framework proves to be fruitful for a historical study is shown by providing a detailed historical and methodological commentary to all of the more important experiments documented in the notebooks.

To make available to the public the primary data, including Krebs' and Henseleit's laboratory notebooks and the relevant literature, these have been collected in a database which will be made available in its final version on the Internet. Additionally, the database will contain the commentaries of the project group, and also the relevant parts of Holmes' previous reconstruction. Thus it will document ongoing discussions of the group with Holmes and Herbert A. Simon (Carnegie Mellon University) on the adequate reconstruction of this case, both historically and methodologically. Since the database provides immediate access to most of the relevant primary and secondary sources, it is also intended to invite other scholars to

participate in this discussion, possibly using the database itself as a discussion forum.

After completion of the database the project again will take up the task of providing a computer simulation of this discovery. A previous model provided a reproduction of the historical path leading to the discovery (Graßhoff & May 1995): based on the relevant knowledge available to Krebs and Henseleit at the time of their investigation and assumptions about their heuristics and reasoning strategies, the system simulates the history of the discovery. The next step will be to allow for counterfactual interferences at some crucial episodes. How will the model behave if relevant knowledge is removed or additional knowledge added? Does it prevent the epistemic system from attaining its goal? Does it take an interesting alternative path? Such counterfactual simulations do more than provide a test for the adequacy of a proposed model, since it should act reasonably under such variations. The tables can be turned by provisionally accepting the adequacy of the heuristical structure and starting from the diagnosis of what knowledge Krebs needed in order to be able to make his discovery. Alternatively, simulation can determine which items of knowledge were crucial and which were not, thereby addressing the question of why Krebs was able to make the discovery while his competitors were not.

Here interaction with the database becomes important. By giving access to the laboratory notebooks, literature, etc., the database allows to check efficiently which items were available at Krebs' time and which were not. When the simulation model is used as a heuristical device for generating historical hypotheses, as described in the last paragraph, such hypotheses can be validated or refuted with reference to the historical documents.

Associated Research Activities

The studies described in the following are complementary to the one on which the last section reported. Firstly, the formation of planetary theories from their early Babylonian origin to their transformation into a physical theory by Kepler is a paradigmatic case of theory formation not driven by experimental means. In fact, here experimentation plays no role at all. This allows an approach which counters potential objections that the theory of Epistemic Systems is built upon an empirical basis that is not varied enough. Secondly, the epistemic system under study is not confined to a

single person or single group of persons: it embodies a process of collective scientific model building with cooperative actions and the expansion of scientific knowledge, as later generations of researchers draw from the results of their predecessors and work with them under new context conditions. Therefore, social and macroscopic aspects of scientific theory formation are in focus. Thirdly, it does not deal with a process which takes place in a short period of time, but covers several historical periods. Taken together, both sub-projects provide support for the viability of the assumed explanatory framework, by systematically varying important historical and methodological dimensions of science. The development of early astronomy will be studied in close connection with the simultaneous development of mechanics. Manifest knowledge transfer is evident between these fields, culminating in the sixteenth century with a theory change induced by Copernicus' method of using mechanical models of epicyclic motion. Throughout the history of astronomy, one can see the development of calculatory devices that enable even laymen to conduct astronomical calculations from standard tables. With this shift in thinking, the possibilities of mechanical motion then reflect the motion of heavenly bodies – the mechanics of the world. This development reaches its apex in Kepler's work and the inclusion of the law of the lever as the basic theorem of motion. Such close interrelations between astronomy and mechanics will be analyzed more closely by the two respective research projects.

Early Babylonian Observational Diaries

Gerd Graßhoff

In recent studies, N. M. Swerdlow, L. Brack-Bernsen and J. Britton developed new accounts of the rise of Babylonian planetary theory. The type of planetary models developed by Babylonian astronomers and successive changes to these models are fairly well known today. Lacking is a better understanding of their constructive goals, their means and aims for improvement and change of models – a reconstruction within the dynamic framework of epistemic system. A basic requirement for such an attempt is a reconstruction of the observational data employed, the quality of Babylonian astronomical practices, and the stability of observational practice over six hundred years in Mesopotamia. This study established for the first time what kind of observations were recorded consistently in ancient

observational sites and kept well documented by the Royal Palace. On that basis, future studies of changes of observational practice will be undertaken, and finally brought together with the history of Babylonian astronomical theories.

Several types of astronomical texts attest to the earliest elaborate form of astronomy, which flourished in the first millennium B.C. in Ancient Mesopotamia.

Early astronomy dealt with events such as eclipses and the observation of the first and last visibility of the moon, planets and stars after (or before) their close proximity to the sun prevented them from being seen. The Babylonian theories could predict these events accurately. Their basic parameters are of such good quality that they merged into Greek astronomy and continued to comprise the backbone of astronomical knowledge up to the time of Kepler. Although we have a clear picture of the precision and predictive scope of Babylonian astronomical theories, their empirical basis has remained unclear. Which types of observations provided the information necessary to construe those theories? All information points to a different epistemological relation between observation and theory in prehistoric astronomy.

The recently published *Astronomical Diaries* are a collection of astronomical cuneiform texts in Akkadian, which was the language used for Babylonian astronomy during the first millennium. These texts report a variety of astronomical events over a certain period, including eclipses and the visibility phenomena of the moon and planets. Despite a careful analysis of possibly false assumptions, all previous reconstructions failed to provide a consistent interpretation of the *Diaries* as observational reports.

New forms of computer representations of the Akkadian texts and a systematic hermeneutic search for a consistent interpretation have been developed, and all texts are now represented as linguistic Akkadian tokens. According to a trial interpretation of the astronomical language, these sentences can be translated automatically into corresponding observational scenarios. A highly accurate recalculation of the historical sky over Babylon then allows a comprehensive test of the validity of numerous interpretation models in reference to all known cuneiform tablets of that type. With these methods, it could be established that the observational reports of the *Diaries* are indeed coordinate measurements suitable to found Babylonian theoretical astronomy and to play a specific role in the

formation of one of the earliest scientific theories. With these findings, the earliest routine observational practice could be established – a practice that is very stable over at least six hundred years despite drastic political and social changes through Babylonian, Persian, and Greek rule in Mesopotamia. The observational practices were taught, archived carefully and evaluated systematically through generations of early astronomers. Only this stable set of observations allowed the construction of the accurate planetary theories as they are known today.

Diagrams in Medieval Planetary Astronomy

Gerd Graßhoff and Bruce Eastwood

While the Ptolemaic planetary theory is well known, the transmission of planetary theory to Early Medieval Europe has been widely neglected. In a comprehensive study, a major portion of all available manuscript material from the ninth to the twelfth centuries on planetary astronomy is evaluated and it is shown that the process of theory formation which takes place during this period differs from those occurring before or after. The analysis demonstrates that these results have an impact as late as the sixteenth century.

The generally received opinion among historians of science and even among historians of astronomy is that there existed no planetary theory and virtually no astronomy in medieval Europe before the twelfth century, when Greco/Arabic astronomical texts were translated into Latin. Contrary to this opinion, materials reveal the essential concepts of Hellenistic astronomy in the Latin West from the early ninth century onwards. The traditional opinion may be motivated by a concept of theory formation which assumes mathematical or natural language as a necessary medium. It is shown however, that the most important evidence is provided by planetary diagrams. From the early ninth century onwards, scholars invented diagrams for three essential purposes: teaching, textual study, and theory construction.

Scholars during the ninth through the early twelfth centuries had certain foundations upon which to build. Lacking any mathematical astronomical texts, the medievals had a group of four Roman works with relevant materials: the *Natural History* of Pliny the Elder, the commentary of Calcidius on Plato's *Timaeus*, Macrobius' *Commentary on the Dream of Scipio*, and

the astronomical textbook in the survey of the liberal arts composed by Martianus Capella, *The Marriage of Philology and Mercury*. Of these, only Calcidius' work originally contained diagrams with materials for planetary theory, and some of these had become severely corrupted by the ninth century, providing more confusion than instruction.

Beginning almost anew in the Carolingian revival of the ninth century, students of astronomy clarified the texts, invented diagrams, corrected corruptions in earlier diagrams, extracted especially relevant parts of the texts for further study, employed diagrams to apply planetary models to new texts, and showed, in their planetary diagrams most fully, both a willingness to interpret old texts in new ways and an ability to construct complex planetary theories. Teaching, textual study, and theory construction come to light through this research into early medieval planetary diagrams.

Theory formation in this context has a close proximity to hermeneutic problems of text understanding. The medieval commentators did not undertake astronomical observations of significance for the purpose of planetary theory. Their primary goal was text understanding, as can be shown by the fact that unclear or difficult passages of the ancient authors were those most commented upon, especially with the help of diagrams. There are also instances, however, when diagrams clearly function as more than just commentaries of the text and develop a life of their own, extending beyond the geometrical information expressed by the medieval commentator. Commented manuscripts circulated further and were copied again by others, who themselves changed diagrams according to their understanding of the cosmological order. The epistemic goal of this period was refined to the search for qualitative, two-dimensional representations of planetary motion that could account for a standard set of qualitative planetary phenomena for planetary positions without predictive power. Based on a large collection of more than eight hundred diagrams from manuscripts of the early medieval period, the theory of epistemic systems can be tested for its ability to explain these changes in diagrams.

Kepler's Physical Astronomy

Gerd Graßhoff

As a continuation of Neugebauer's and Swerdlow's work on Copernicus, Kepler's heuristic techniques in his reform of traditional mathematical

astronomy are analyzed in the last case study.

In his *Astronomia Nova*, Kepler describes his extensive struggle to base a physical theory of the motions of the planets on Tycho Brahe's observational data. While the impact of those laws of planetary motion he eventually discovered on the further development of mechanics and, in particular, on the development of Newtonian dynamics, is well known, Kepler's own dynamics and its heuristic role for his research are still insufficiently understood.

Continuing earlier unpublished work by Otto Neugebauer, and using special software to construct computer models of geometric and kinematic relations, Gerd Graßhoff analyzes Kepler's numerical calculations, both in the *Astronomia Nova* and in his manuscripts. His aim is to reconstruct Kepler's intermediary models of planetary motion and the heuristics motivating these models within the framework of epistemic systems. Research goals are the causal requirements of a planetary theory which Kepler tried to realize with traditional means of epicyclic astronomy. These goals allowed him to abandon both the Copernican and the Ptolemaic models and seek his own solution. Construction steps are well documented by a variety of intermediary planetary models, some of which left their only traces in peculiar numerical parameters used in the context of other problems. The strength of determining epistemic goals and sequences of model construction steps becomes apparent when the impact of famous physical models is assessed, like those of the magnetic forces and boat models described by Kepler in the *Astronomia Nova*. It is argued that these aspects were only introduced into the model construction process after Kepler reached the stage of attempting a physical explanation. However, they also were abandoned quickly whenever further geometrical exploration showed a need for a modification of geometry. Kepler's criteria of model evaluation are indeed causal and of the same sort of causal reasoning established in the experimental study on the formation of the urea hypothesis. These findings indicate that Kepler's research can be described as 'preclassical astronomy,' analogous to the 'preclassical' character of contemporary mechanics: close familiarity with the ancient and medieval traditions of theoretical astronomy; extensive and flexible use of their techniques in order to reflect new empirical knowledge; the treatment of astronomical problems in the context of other aspects of natural philosophy, including applications of mechanics to these problems; and the elaboration of new consequences of traditional means of deduction, such as the construction of an elliptic orbit

by means of an epicyclic model. Similar to preclassical mechanics, Kepler's research in preclassical astronomy also involved mastery of techniques familiar from practical experience, in particular, the determination of orbital positions in his models by a method of triangulation, not common in traditional theoretical astronomy.

DEVELOPMENT: ELECTRONIC RESEARCH TOOLS AND DATABASES

Jürgen Renn (responsible), in cooperation with Michele Camerota, Peter Damerow, Gerd Graßhoff, Simone Rieger, Bernd Wischnewski, Michael Schüring, Marcel Sigrist, Mohamed Abattouy, and Paul Weinig

General Goals of the Developments

Recent developments in electronic data processing have changed fundamentally the potential of research in the history of science, as in other historical disciplines. Although the new possibilities are still realized only to a limited extent, they already offer important new research methods.

On the one hand, the electronic storage of historical sources improves their accessibility and makes new and powerful methods of the retrieval of information possible. In the past, documenting, interpreting, and publishing of new sources was a major focus of the work of historians. The electronic storage of sources offers improved methods of searching and combining information to such an extent that problems of integrating historical details into coherent models of historical developments turn out to become increasingly important. In the special case of the history of science, electronic data storage and retrieval challenges the traditional picture of the history of science as a history of accumulating knowledge, and potentially offers for the first time an opportunity to reconstruct not only the history of representations of knowledge, but also the development of knowledge structures themselves. On the other hand, electronic data processing also provides new methods for constructing models of mental structures and activities. Thus, by means of computer models, the traditional methods of history of science for reconstructing discovery processes can be complemented by computer simulations of such processes under different conditions and compared to the results of historical case studies.

Even though preparing electronic editions of historical sources and con-

structuring computer models of mental processes are not at the center of activities at the Institute, the new opportunities offered by electronic data processing are used as much as possible with the available resources:

- scanning and optical character recognition techniques are being used to build an electronic archive containing sources important for the research at the Institute
- databases and working environments are being developed to assist research and editorial activities
- software tools are being developed which are suitable for the presentation of sources in formats compatible with a variety of different computer platforms
- mental processes involved in scientific thinking are being modeled and computer simulations of research processes applied to case studies of major scientific discoveries.

Current Work Related to “Electronic Research Tools and Databases”

Electronic Edition and Representation of Galileo’s Notes on Mechanics Ms. Gal. 72 (joint project together with the Istituto e Museo di Storia della Scienza and with the Biblioteca Nazionale Centrale in Florence)

Michele Camerota, Peter Damerow, Simone Rieger, Jürgen Renn, and Bernd Wischnewski (Max Planck Institute for the History of Science), Paolo Galluzzi (Istituto e Museo di Storia della Scienza, Florence), Isabella Truci (Biblioteca Nazionale Centrale, Florence)

An electronic edition of Galileo’s notes on motion and mechanics, kept as Ms. Gal. 72 in the Galilean collection of the Biblioteca Nazionale Centrale in Florence, is prepared. The edition will make the manuscript accessible from CD ROM or through the internet. The part of the manuscript containing Galileo’s notes (folios 33-194) is represented by digital images of the folio pages, transcribed texts, reconstructed calculations, and redrawn figures and diagrams. The images of the folio pages are related to the transcriptions and interpretations by electronic links. Additional information about the manuscript, including a description of the history of the manuscript, data about the physical characteristics of the folio pages, references

to interpretations of pages of the folio published by historians of sciences, is also provided. A navigation system is developed according to the requirements of scholarly work on the manuscript. Indices are created for Latin words, Italian words, numbers in the text, numbers in the calculations, variables in the texts and variables in the calculations, with direct links to the locations in the manuscript where the items occur. The edition uses a HTML format so that it can be used with standard Internet retrieval software on any computer platform.

Galileo's notes on motion and mechanics document his work on mechanical problems over a period of more than forty years. The manuscript consists of more than 300 pages. They contain numerous short texts in Latin and Italian, representing sketches of proofs, but also extended drafts intended for publication, calculations, tables of calculated numbers, diagrams, and even some documents pertaining to experiments performed by Galileo. The manuscript is considered the essential source of information on the intellectual route followed by Galileo in achieving the insights he submitted in the *Discorsi* (see the sections above on *Challenges to Preclassical Mechanics* p. 56 and on *The Development of Galileo's Deductive System of Mechanics* p. 58).

Making this manuscript accessible is a joint endeavor of the Institute together with the Biblioteca Nazionale Centrale and the Istituto e Museo di Storia della Scienza in Florence. In February 1997 a first complete version officially was presented by the three institutions in Florence to historians of science. In the meantime, the edition has been improved technically and by further work on its content. Presently, the access through the World Wide Web is under preparation. The intention is to update the edition from time to time by integrating results of the research of Galileo scholars working on the manuscript.

Database of Proto-Cuneiform Texts from Archaic Babylonia (joint project together with the Seminar of Near Eastern Archaeology of the Freie Universität Berlin, with the Vorderasiatisches Museum der Staatlichen Museen zu Berlin, and with the Computer Center of the Universität Lüneburg)

Peter Damerow and Michael Schüiring (Max Planck Institute for the History of Science), Robert Englund (University of California at Los Angeles), Hans Nissen (Freie Universität Berlin), Martin Schreiber (Universität Lüneburg)

In cooperation with the editors of the proto-cuneiform tablets of ancient Mesopotamia (3200-3000 B.C.), an electronic representation of these tablets is prepared in order to make them accessible through the Internet. The tablets are represented by images and transcriptions. Access is provided through a catalog and through sign glossaries.

Documents that give evidence of the development of mathematical thinking in ancient civilizations provide an important source for studying the emergence of formal thinking. The corpus of proto-cuneiform texts contains some 5800 tablets and fragments. Eighty-five percent of these texts are administrative documents; the others are "lexical lists," a special type of school texts. This text corpus represents not only the first step to literacy, but also the transition from proto-arithmetic control devices to the use of measures and numbers.

The catalog of the texts contains detailed archaeological information as well as information about the present owner of each text, related publications, and interpretations. The texts themselves are represented by photos and by drawings, both in natural size and enlarged four times. Furthermore, transcriptions are provided for each text. The texts are accessible both from an alphabetically arranged list of excavation numbers and from a sign list via a glossary with references to all texts containing the signs in question. Programs have been developed to automatically generate systems in HTML format to make the image and text data thus accessible through the Internet.

At present, the project essentially is completed and the result is being tested in the Intranet of the Institute. Final corrections are being made, and the layout will be improved before the text corpus is presented to the public. Later updates are possible and intended. In particular, a classification of the

texts according to their contents will be added later.

Electronic Research Environment

Gerd Graßhoff, Michael May

In this project a comprehensive electronic environment is developed to support research activities of the type described in the project on the discovery of the urea cycle. It is designed to assist the researcher in various phases of research: accessing data, data collection, transcription, interpretation and electronic publication. It includes a database containing bibliographical data, scanned images of laboratory notebooks, articles, books and drawings, as well as various kinds of transcriptions. Extensive search capabilities are included to allow the efficient exploration of historical data. Also provided are graphical tools for commenting historical documents: whole documents, individual pages, or parts of pages. Comments on these documents are also saved in a database. These comments are indexed by information such as commentator, type of comment or the date the comment was written. Also, different levels of keywords (which can be defined by the user) can be attached to a comment and accessed in graphical form. All of this information is searchable.

Special attention has been paid to the choice of technology. The system runs on several platforms and is based on a Java client accessing a relational database (SQL) server via TCP/IP. The relative hardware independence and the use of standard technologies which are SQL or prospected to be ISO-certified (Java) offer some security against tapping into technological dead ends, especially for long-term projects and data that need to be stored for long periods of time. In order to integrate an electronic source of historical data with the simulation tool for the discovery of the urea cycle, high-level internet technology using Java was required. This computer language supports the development of modular software components which easily can be maintained and extended for future applications. The modularity of the software components allows their simple integration into the other electronic tools developed at the Institute. The electronic research environment can be mixed with HTML environments for Internet presentations, and configured with ease for the specific requirements of each project.

Since the data can be accessed over the Internet, they are available regard-

less of a researcher's location. Data may be distributed over several places and yet can be accessed by the user as if they were stored together. Thus a research team composed of scholars working in different countries and cities can work on a joint historical commentary without the problem of inconsistencies arising from having different versions of a text or other data.

Medieval Scientific Manuscripts

Gerhard Brey, Gerd Graßhoff, Michael May

A version of the International Computer Catalog of Medieval Scientific Manuscripts (ICCMSM), assembled by Prof. Folkerts and his research group at the University of Munich, was developed for complex search inquiries via the intranet of the MPIWG. The catalog contains comprehensive information of the huge Munich collection of Medieval mathematical manuscripts. The Munich research group kindly supplied a copy of the catalog's raw data, from which a subset for a relational database (SQL) was derived. Two technological versions were developed in order to test the following objective: it should allow multiple user search of the catalog from all different computer platforms of the MPIWG's local computer network. One version was based on an LINUX implementation of a very fast database SQL (MYSQL) that can be accessed via HTML and CGI-Perl scripts. The advantage of that implementation is its high speed, robust operation and easy accessibility through standard WWW-browsers. Its disadvantage is its limitation of the complexity of search requests (it lacks outer join commands) and lack of integration into other tools currently under development at the institute for the display of graphical images such as microfilm scans. Since an extension of the catalog in that direction is possible, a second version of the catalog interface has been developed on the basis of an Oracle database and a JAVA user interface.

Mesopotamian Year Names

Marcel Sigrist and Peter Damerow

A list of Babylonian year names, compiled as a tool for the dating of cuneiform tablets as well as for supporting historical studies on early bookkeep-

ing techniques, is made accessible through the Internet. The tool essentially consists of a collection of date formulae in administrative documents as they were used by the scribes in ancient Mesopotamia, of computer-generated indices for a quick identification of incomplete date formulae on damaged cuneiform tablets, and of issues and events mentioned in these formulae. Access is provided through a list of cities and kings, a list of words, and a list of words in English translation.

The basic list currently contains more than 2,000 year names. The compilation covers the time period from the time of the empire of Sargon to the end of the Babylon dynasty. Its preparation is an outcome of a cooperation over a period of over ten years.

Originally it was intended to prepare a computer-generated publication of the data and suitable indices. Some seven years ago a preprint of this publication was made available to interested scholars, at that time including only the year names of the Ur III period and Old Babylonian period. It turned out, however, that an electronic representation is more suited to the intended purpose, since it facilitates the continuous improvement of the list by the correction and further addition of year names and variants known from newly published texts.

The data are stored in a database from which a representation in HTML format is automatically generated. A first version recently was made available for scholarly use on the Web server of the Institute. A complementary bibliography is currently in preparation.

Cuneiform Texts of the Third Millennium B.C. in the Vorderasiatisches Museum, Berlin (joint project together with the Vorderasiatisches Museum, Berlin, and scholars of universities in Berlin, Wien, and Los Angeles)

Peter Damerow and Michael Schüring (Max Planck Institute for the History of Science), Joachim Marzahn (Vorderasiatisches Museum), Hans Nissen (Freie Universität Berlin), Robert Englund (University of California at Los Angeles), and Gebhard Selz (University of Wien)

An electronic representation of the Babylonian cuneiform texts from the third millennium B.C. which are kept in the Vorderasiatisches Museum der Staatlichen Museen zu Berlin, is prepared. For the first time, a substantial

collection of cuneiform texts kept in a museum will be made completely accessible through the Internet.

The documents derive from the following periods of the third millennium.

- Uruk IV/II, ca. 3200/2700 B.C. (ca. 1900 tablets)
- Fara period, ca. 2600/2500 B.C. (ca. 400 tablets)
- Old Sumerian period, ca. 2500/2350 B.C. (ca. 400 tablets)
- Old Akkadian period, ca. 2350/2200 B.C. (ca. 100 tablets)
- Neo-Sumerian period, ca. 2100/2000 B.C. (ca. 800 tablets)

With their wide range of chronological distribution, these texts constitute the most important collection in the world currently available for the study of the third millennium. The scientific value of this collection lies in its unique importance not only for the study of the early development of writing, but also for the history of household economies, of administration and of science during the early period of state formation.

The project to make this collection accessible through the Internet is a joint endeavor together with the museum and scholars specialized in the archaeology and philology of the third millennium B.C. The methods of electronic representation applied have been developed at the Institute. The clay tablets are directly scanned using a suitable flatbed scanner. Data for the catalog are administered by means of a database. The HTML system, including the catalog and the digital images, is generated with software tools developed at the Institute for such purposes.

At present, the texts of the Neo-Sumerian period are being scanned. The scanning of the other texts already has been completed. Work on the compiling of the catalog data has commenced.

The Archimedes Project: Electronic Resources in the History of Mechanics (joint project together with the Perseus Project at Tufts University, Boston)

Mohamed Abattouy, Peter Damerow, Jürgen Renn, Paul Weinig (Max Planck Institute for the History of Science), Gregory Crane (Tufts University)

As a result of a workshop at Tufts University in December 1997, a joint

project has been initiated in order to combine the efforts of both institutions to make sources in the history of science electronically accessible. It is the goal of this project to make available on the Internet ancient, medieval and early modern texts relevant for the study of the origins of mechanics and its development into classical mechanics, to provide tools that facilitate the translation of the texts, and eventually to provide translations if necessary.

**PROJECTS OF THE RESEARCH GROUP HEADED BY LORRAINE DASTON
(DEPARTMENT II)**

The work of the research group of Lorraine Daston for 1996-1997 addresses three major topics: the varieties of scientific experience, the history of demonstration, proof, and test in the sciences, and the history of scientific objectivity. All three projects aim to historicize, by means of specific examples taken from several periods and scientific disciplines, categories of analysis long taken for granted by historians, philosophers, and sociologists of science. These projects take as their departure point that experience, demonstration, and objectivity themselves have histories, which can be reconstructed on the basis of key examples.

PROJECT 1: THE VARIETIES OF SCIENTIFIC EXPERIENCE

Lorraine Daston (responsible), in cooperation with Sonja Brentjes, Rivka Feldhay, Doris Kaufmann, Ursula Klein, H. Otto Sibum, Stuart Strickland

General Goals of the Project

Both the natural and human sciences have been extremely fertile in new forms of experience: clinical observations, laboratory experiments, legal indices, statistical tables, anatomical dissection, field work in natural history and anthropology, introspection, instrumental probes, ideal types, and computer simulations. Some of these forms of experience are as old as Hippocrates; others have emerged within living memory. Each has its characteristic objects of study, canons of evidence and proof, and conventions of literary presentation. All have, until very recently, been lumped together under the rubric “empiricism” by philosophers, and mostly ignored by historians. The project “The Varieties of Scientific Experience,” begun fall 1996 in Department II, has three goals: (1) to construct a refined taxonomy of the forms of scientific experience across a varied sample of disciplines and periods; (2) to trace the history of each of these forms, with special attention to the conditions under which they emerge or disappear; and (3) to investigate the relationships between different forms of experience and corresponding standards of evidence, proof, and description within the sample.

Although the center of gravity for the sample lies within the natural sciences since the seventeenth century, for several reasons it has been considered essential to include some examples both from the human sciences and from earlier periods. First, some forms, like the clinical observation, have a long and continuous, though not static, history that stretches back to antiquity. Second, the current classifications of knowledge that divide the natural from the human sciences diverge sharply from earlier classifications. For example, in the medieval university curriculum, music theory was the near neighbor of astronomy, and astronomy and physics were remote from one another. Third, there are historical affinities and genealogies among forms of experience that cut across even contemporary classifications. It is, for example, difficult to understand seventeenth-century notions of what constituted a scientific fact without careful study of the legal doctrines of evidence drawn from things and witnesses from the early modern period. Throughout the project, the importance of comparisons has been emphasized – between disciplines, periods, and intellectual and cultural contexts.

The study of forms of scientific experience sheds light on two other fundamental issues in the history of science: how certain kinds of objects (and not others) come to qualify as objects of scientific inquiry; and what can and cannot be communicated in the presentation of scientific experience to a community dispersed in time and space. In the first case, there is an intimate connection between what can become a scientific object and what are considered to be legitimate forms of scientific experience. For example, the controversy in psychology at the turn of this century over the legitimacy of introspection as a form of scientific experience – it was empirical but not public knowledge – threatened to eliminate the will and consciousness itself as objects of scientific inquiry. In the second case, there are very special conditions placed upon communications intended for audiences scattered across the globe and even across centuries as opposed to those for an audience addressed face to face, as in the classroom. Certain crucial aspects of scientific experience, for example the elements of bodily skill required to get a capricious experiment to work, may become invisible because they cannot be communicated in words, though they might be learned by example.

In the early phases of the project effort was made to limit cases of scientific experience, specifically, to cases that stretch some aspect of the current conceptions of the empirical almost to the breaking point. These limiting cases unsettle the self-evidence of currently accepted forms of scientific

experience by providing concrete alternatives to the choices of what to investigate and how. They also throw into relief the otherwise hidden criteria by which certain forms of experience and description are judged to be legitimate. If, for example, the late eighteenth-century *Seelenforscher* attempted to develop an empirical science of dreams, but psychologists of the early twentieth century rejected the possibility of a science even of waking consciousness, a crucial shift in these criteria may explain the change in attitudes. Similarly, if mid-eighteenth-century physicists discard reports of luminescent phenomena that their seventeenth-century predecessors deemed key to understanding the nature of light, the explanation for this probably lies in a change in criteria of evidence, significance, and even of facticity. Special attention has been paid to hybrid kinds of scientific experience, which usually emerge in contexts of application: for example, the standardization of scientific units and procedures through the creation of an electrification network, the extraordinary pressures on psychiatry to classify and cure war-time mental disorders, or the “paper tools” of tables and formulas manipulated by organic chemists suspended between the laboratory and the factory.

Current Research Activities Related to “The Varieties of Scientific Experience”:

Wonders and the Order of Nature

Lorraine Daston (in cooperation with Katharine Park, Wellesley College)

Final revisions on the book manuscript *Wonders and the Order of Nature*, which traces the responses of European naturalists from the high Middle Ages through the Enlightenment to marvels and anomalies in nature, were completed in the summer of 1996. The book will be published by Zone Books. Chapter headings are as follows:

Introduction: Nature at the Limit

Chapter 1: The Topography of Wonder

Chapter 2: The Properties of Things

Chapter 3: Wonder among the Philosophers

Chapter 4: Marvelous Particulars

Chapter 5: Monsters: A Case Study
Chapter 6: Strange Facts
Chapter 7: Wonders of Art, Wonders of Nature
Chapter 8: The Passions of Inquiry
Chapter 9: The Enlightenment and the Anti-Marvelous
Epilogue: Wonders Now

European-Muslim Scientific Encounters Between the Sixteenth and the Eighteenth Centuries

Sonja Brentjes

The project aims to revise another misconception regarding the history of early modern science both in Europe and in the Muslim world. This subject emerged from a large-scale survey of reports about the Ottoman, Safavid, and Mogul empires written by European gentlemen travelers, diplomats, merchants, and missionaries between the sixteenth and eighteenth centuries. They not only demonstrate that, contrary to current standard historiography, there were scientific communities at work in the different Muslim societies during the period of investigation, but they also illustrate that European scientific endeavors were significantly linked with the Muslim societies of their times. On the European side, this concerns the endowment and enrichment of cabinets of curiosity, botanical gardens, and royal and other libraries. It also applies to astronomical and geographical observations, historical investigations, comparisons of measures, sales of instruments, the composition of general and specialized dictionaries, professional careers, and patterns of patronage. On the side of the Muslim societies, the connection is evident in the acquisition of European books and instruments, including telescopes and microscopes, and in the translation and discussion of geographical, mathematical, astronomical, or medical books by Italian, French, German, Dutch, and other European authors of the sixteenth, seventeenth, and eighteenth centuries. Also relevant were efforts to introduce different types of European mechanical devices in mining, printing, military techniques, or the usage of water as energy.

The project surveys a broad range of sources to establish the scope and types of these European-Muslim collaborative encounters in the sciences.

Its major methodological foundation is the analysis of the cultural patterns which warranted and shaped these encounters.

The Use and Abuse of Mathematical Entities and the Emergence of Early Modern Science

Rivka Feldhay

Departing from the debates on the certitude and scientificity of the mathematical disciplines which erupted in the context of a commentary on the pseudo-Aristotelian *Mechanical Questions*, this book identifies and characterizes two different types of mathematical physical discourses on motion in the sixteenth and seventeenth centuries and follows the development of an ontology of mathematical entities, which was used for purposes of legitimization by one discourse and rejected by the other. Themes of this book were developed in a contribution on Galileo and the Jesuits to the volume *Companion to Galileo*. A paper on “The Cultural Field of Jesuit Science” was written for the conference “The Jesuits: Culture, Learning and the Arts,” which took place in Boston in May 1997. Another version was presented at the department seminar in the Max Planck Institute for the History of Science. Feldhay also wrote a paper (“On the Agony of Knowing”) for a workshop held at the Einstein Forum in June, and participated in the conference, “The Varieties of Scientific Experience,” where she commented on two papers.

The Emergence of Scientific Psychiatry: From Clinical Observation to Social Field Work

Doris Kaufmann

Following up on studies of the relationship between psychiatric discourse, its social context, and cultural representation from the 1850's to the turn of the century – a period which saw the establishment of a scientific psychiatry emphasizing the physiological basis of psychic phenomena in general and the somatic causes of hysteria in particular – the current project focuses on the disappearance of the latter as a central object of psychiatric interest at the beginning of the twentieth century. Following Emil Kraepelin's new system of classification of nervous and mental diseases, the psychiatric dis-

course began to abandon the concept of hysteria as a disease entity by assigning hysterical symptoms to psychosis, which were defined on the basis of cerebral disfunctions. When the First World War presented the mass phenomenon of soldiers answering to the previously unknown experience of technical warfare in the language of hysteria, the psychiatric community once again was forced to address the conceptual and therapeutical question of hysteria. This project analyses the importance of the First World War as a new space for psychiatric experience and the development of new psychiatric definitions for the normal and the pathological. As a result of the First World War, the key question of the psychiatric discourse, namely whether external and social or internal and endogenous causes were responsible for psychic and mental disorders, was presumed to have been resolved. A further consequence was the beginning of the divergence of the disciplines of psychiatry and neurology on the one hand from psychoanalysis and psychotherapy on the other. This process in the 1920's is investigated on different levels: the clinic, the courts, the psychiatric discussion of the new "key" disease schizophrenia, and the non-scientific public language or discourse on the self. A primary focus concerns the distinctions and the common ground between psychiatric and public cultural practice, their impact, and the exchange between these spheres.

Formulas and the Production of Order in Nineteenth-Century Organic Chemistry

Ursula Klein

This project is concerned with the introduction of chemical formulas into nineteenth-century chemistry, the different functions of formulas as models and paper tools in organic chemistry, and, intimately connected to the latter, the transformation of vegetable and animal chemistry into organic chemistry during the first half of the nineteenth century. Chemical formulas in their still familiar algebraic form were introduced by Jacob Berzelius in 1813, but not even Berzelius applied them in the subsequent ten years. This changed starting in the late 1820's, when French and German chemists working in the emerging subdiscipline of organic chemistry began to use formulas. Within a few decades, chemical formulas not only became reified as paper tools accepted by all chemists, but also created a new "paper world" that thoroughly altered the image of chemistry. The widespread

opinion on chemical formulas among scientists, philosophers and historians of science is that formulas were a convenient means of representing existing knowledge, mere abbreviations and means of communication. No historian or philosopher of science has considered with sufficient care the manipulative aspects of formula techniques and the power of chemical formulas to produce knowledge when applied as paper tools in chemical research. Although scholars have recognized the link between the fate of chemical formulas and the transformation of vegetable and animal chemistry into organic chemistry, the question as to why this link exists has not been investigated. This conjunction of two different research traditions and their following co-evolution demand explanation.

Detailed analysis of a series of experiments performed from the beginning of the nineteenth century through the 1850's – experiments which may be regarded as “paradigmatic” for organic chemistry – and study of the different functions of chemical formulas within this experimental practice, confirmed the conviction that chemical formulas were indispensable “paper tools” in the transformation of vegetable and animal chemistry into organic chemistry. This part of the project, which includes the analysis of the qualitative and quantitative meaning and of the representational form of chemical formulas is nearly finished. It is based on research reports published in various French and German scientific journals. The second part of the project, currently in progress, embeds this detailed analysis of the interaction of experiments and chemical formulas into the broader cultural changes that occurred in the transformation of vegetable and animal chemistry into organic chemistry. Compared with “vegetable chemistry” and “animal chemistry,” “organic chemistry” meant a thoroughly different research culture. The epistemic objects of eighteenth-century vegetable and animal chemistry were natural bodies and natural transformations; the experiments done in these fields were intended to leave the natural state of the bodies as untouched as possible; the classification to a large extent followed the principles of natural history; theories were exclusively articulated in natural language; and conceptions were not based on quantification. In contrast, organic chemistry investigated chemical reactions which did not exist in “nature” outside the laboratory, created a new realm of artificial organic substances, introduced a new taxonomic system based on chemical formulas, and linked conceptions and theories articulated in natural language to chemical formulas which embodied measured quantities of chemical substances. This latter part of the project is based

more strongly on the analysis of chemical textbooks, letters, and popular writings than on research reports.

The study addresses epistemological questions about the uses of experiments, and about the interaction of experimentation with symbolic representations, models, and conceptions and theories based on quantification in nineteenth-century sciences. A particular focus is the category of the model and techniques of modeling. The project's approach to "models" investigates their functions rather than their structure, thus embedding them in historically specific epistemic systems. The transformation of vegetable and animal chemistry into organic chemistry sheds some light on another epistemological question: what distinctions did nineteenth-century experimental scientists make between nature and art, and how did they draw the boundary between the natural and artificial? Both kinds of epistemological issues are linked to another large question. Modern science in its current epistemological forms, its specialization, and its abstinence from ethical and social issues was shaped in the nineteenth century. This project is a contribution to historical-epistemological studies which attempt to analyze the particular kind of knowledge and style of reasoning which became prevalent in nineteenth-century sciences, particularly in the physical sciences (including chemistry). It studies prerequisites for the transformation of nineteenth-century physical sciences such as quantification and mathematization, the pragmatic application of non-verbal paper tools, the marginalization of natural language, and links to industrial application.

Experiment, Sensuous Experience and Knowledge Production

H. Otto Sibum

Recent historical research has shown that the practices and representation of experiment differ greatly. This has led to a variety of methods of identifying and interpreting the traces produced by historical actors. Reworking experiments by performing them with replicas of historical objects is a technique developed to enrich our knowledge of historical laboratory events. This performative historiography demonstrates that working knowledge in the laboratory is embodied in human actions and cannot be expressed fully in literary form. These hidden dimensions of knowledge production generally are called skills or tacit knowledge, depending on the kind of scientific inquiry involved. As outlined in the Annual Report 1995,

in order to study these neglected dimensions of experimentation and its historical meaning for the development of nineteenth-century physics, this methodological approach is the basis of a broader study of the history of a scientific fact, *i.e.*, the mechanical equivalent of heat. At the time, this was seen both as one of the most important “constants of nature” and as the “golden number of the nineteenth century.”

Pursuing this course of research raised another question as to the impact of sensuous experience on the formation of knowledge, and whether this can be reconstructed historically. This project addressed these issues in a two-step approach. Firstly, reworking Joule’s paddle-wheel experiment by means of a replica provided insight into the use of both the instruments and the senses of the experimenter. Thermometrical skills were identified as particularly crucial for the performance of the experiment, although these were neither noted in Joule’s literary renditions nor existent in the early Victorian scientific community. But it is reasonable to argue that such skills were part of the working knowledge of the historical experimenter. The project argues that instruments in action speak their own “language” and that the “eloquence” of the experiment is given through the actors’ performance. This emphasis on the performative led to the notion of gestural knowledge in order to account for the embodiment of knowledge in human actions. Sensuous experience is certainly a constitutive part of the gestural knowledge of the experimenter, according to this dynamic perspective of knowledge production. Notebook entries and publications were important, but they were not sufficient representations of the gestural knowledge which was required to carry out experiments.

Secondly, in order to see how sensuous experience had an effect on the formation of scientific knowledge, the historical context in which this experiment was performed and the necessary gestural knowledge was acquired must be reconstructed. Previous historical accounts of Joule’s thermometric experience point to his extraordinary skills, but leave open the question of where they were acquired. The reconstruction of apparently unrelated sites of knowledge production, such as the brewing culture to which Joule also belonged, show that only through his continuous work in the laboratory and at the brewing site was he able to develop the gestural knowledge necessary to perform the experiment. More recent results indicate that this brewers “world of sense” was formative even for Joule’s knowledge of the dynamic nature of heat, far from accepted in the scientific community of his time. The results thus far have shown that it is possible to reconstruct

the historical process of how changing sensory experiences are formative in the production of scientific knowledge. What conventionally has been called “tacit knowledge,” and has often obscured the process of major scientific changes, is not tacit at all, but just those forms of expression of gestural knowledge of the historical actor or research collective which can become explicit only through their performance or partly through the objects themselves.

Ideologies of Self-Knowledge and Dilemmas of Personal Experience

Stuart Strickland

This project is an historical examination of the privileged, yet precarious, position of personal experience within the empirical sciences and of the ideological frameworks within which knowledge of nature became linked with knowledge of the self. While assertions of a perfect fit between an external natural environment and an internal self became increasingly common towards the end of the eighteenth century, these formulations consistently obscured at least two difficulties to which this project is addressed. On the one hand, by portraying nature as a living creature whose visible history corresponded to the life-history of an individual, this ideology conflated knowledge of the body and knowledge of the self. On the other, it tended to exclude an essential third term: the communities within which self-knowledge and knowledge of nature each sought their place. The claim that knowledge of nature led directly to knowledge of the self, and vice versa, must be read in the face of an awareness that the two held radically different status within contemporary scientific communities and within a communally shared body of knowledge.

This project thus is embedded at once in a history of modern subjectivity and in an analysis of how concerns about personal knowledge came to define the parameters of a distinctively scientific public sphere. To put it another way, the project investigates why, at this critical moment in the “structural transformation of the public sphere,” the self became an issue within science – and how, within a discourse ostensibly devoted to nature, attention to the self of the scientist helped shape a new conception of individuality.

By focusing on the self-experimentation of Alexander von Humboldt, Johann Wilhelm Ritter, and Jan Purkyne, the study has begun to unpack an

early moment in the formation of the ideology of self-knowledge by considering the peculiarities of locating the self within the body of the investigator, a body conceived at once as a laboratory instrument, a metaphor for nature, and a sign of the investigator's individual identity. Historicizing the relationship between the self and the body of the natural philosopher also requires scrutiny of the tensions between solitude and community at the turn of the last century. Those who experimented on their own bodies did so at great personal expense and often under intensely private conditions. Their withdrawal into an internal world of personal and perhaps even idiosyncratic experience may appear to have been an attempt to escape from the political and intellectual turmoil that accompanied the Napoleonic Wars and the demands of an emergent public sphere; but these retreats also presupposed an eventual return to a historically specific community whose reservations about personal knowledge were well known to and often ambivalently shared by those who fled. It is thus essential that this study of self-knowledge attend to the difficulties anticipated and encountered in trying to convey experiences rooted in a particular body to a scientific community that was, for ideological reasons of its own, increasingly coming to esteem general over particular truths.

Related Projects of Visiting Scholars and Research Fellows

Jutta Berger, "Georg Ernst Stahl's Concept of Chemical Processes"; Christophe Bonneuil, "Plant Science in the French Empire, 1870-1940"; Alix Cooper, "Local Knowledge and Natural History in the Early Modern German Territories"; Michael Dettelbach, "Surveying Techniques and Nature-Physiognomy in Humboldtian Science"; Elisabeth Emter, "The Human Corpse and Personal Identity in Germany in the 17th and 18th Centuries"; Martin Gierl, "Eighteenth-Century Numismatics and Scientific Rationalization"; Cheryce Kramer, "The Psychiatry of Gemüth in a Biedermaier Asylum"; Christoph Lüthy, "Atomist Iconography"; Alexandre Mallard, "The Role of Scientific Instrument-Makers Between Science and the Market"; Brian Ogilvie, "Observation and Experience in Early Modern History"; Dorinda Outram, "Scientific Voyages in the Eighteenth Century"; Gianna Pomata, "From Recipe to 'Historia' in Early Modern Medicine"; Annelore Rieke-Müller, "German Research Travels and Travelers in the Eighteenth Century"; Sophie Roux, "Rational Mechanics and Corpuscular Theories of Matter"; Richard Staley, "Inferometers, Experiment, and

the Early History of Relativity Theory”; R. André Wakefield, “Camerarism and Useful Knowledge in Germany”; M. Norton Wise, “Muscles and Engines: Hermann Helmholtz in Industrializing Berlin”; Michael Witmore, “Accidents: Unexpected Knowledges in Early Modern England” (see *ACTIVITIES OF THE VISITING SCHOLARS AND RESEARCH FELLOWS P. 182*).

PROJECT 2: THE HISTORY OF SCIENTIFIC OBJECTIVITY

Lorraine Daston (responsible) in cooperation with Wolfgang Küttler and Annette Vogt

General Goals of the Project

When did objectivity begin? With the first gropings towards a philosophy of nature in the fragments of the pre-Socratics? With the strivings of ancient historians like Thucydides and Tacitus to render an impartial account of the past? With the meditations of Descartes on the possibility of certain knowledge? With the cult of facts established by seventeenth-century scientific societies such as the Accademia del Cimento, the Royal Society of London, and the Paris Académie des Sciences? With the attempts of Enlightenment savants to replicate each other’s experiments on electricity, pneumatics, or animal magnetism? With scientific illustrations made by camera obscura – or by photography? With the emergence of techniques and instruments of precision measurement in the nineteenth century? With the invention of statistical techniques of data reduction and inference?

Each of these historical moments, which arc from the sixth century B.C. to the 1940’s, reflects a facet of our current notion of objectivity. Truth, certainty, impartiality, facticity, publicity, authenticity, impersonality – these concepts all cluster tightly around objectivity as we know it, as do the practices of photography and statistical data analysis. But a mere inventory of the components and close neighbors of objectivity will tell us little about the meaning of the whole, and still less about its history. Both meaning and history depend not only on the components and associations but also on their interrelationships: how did these elements come to cohere together? The corresponding historical question is not, how and when did each element emerge, but rather, how and when did these components and associ-

ations crystallize into a whole?

This project seeks to answer this question by studying both the concrete practices (photography, statistical data analysis, etc.) and the reflective ideals (publicity, impersonality, etc.) of objectivity in historical context. Although seventeenth- and eighteenth-century case studies provide instructive antecedents and contrasts, the focus of the study lies in the period 1820-1950, when the very word “objectivity” and its cognates reappeared within major European languages, and when objectivity replaced truth as the primary goal of the sciences. This transformation of ideals and practices stretched across many disciplines in the natural sciences, from anatomy to geology, and also encompassed human sciences such as history and sociology. Hence, although the project emphasizes the specific cultural and intellectual contexts which made this transformation possible, it aims ultimately at a global account of a global phenomenon that affected many diverse disciplinary and national traditions.

At present, the project consists of three complementary studies, each concentrating on a different aspect of the history of objectivity: techniques of visualization in the natural sciences; the careers of women scientists and mathematicians at Berlin universities and within the Kaiser-Wilhelm-Gesellschaft during the first decades of higher education for women in Prussia; and the role of history within the social sciences at the turn of the twentieth century, emphasizing the work of Max Weber. Each of these studies emphasizes a different moment of scientific objectivity. New ways of making images, particularly photography and global mapping, at once symbolized and constituted new forms of scientific objectivity in the middle decades of the nineteenth century. These images were attempted solutions of epistemological and moral problems at the heart of objectivity. The career possibilities for women scientists in early twentieth-century Berlin shed light on another aspect of the practices of objectivity: to what extent were contemporary ideals of a science blind to personal traits realized in institutions and biographies? Although objectivity may have originated in the natural sciences, social scientists confronted with challenge of political relevance on the one hand and with the threat of political ideology on the other provided some of the most acute and far-reaching reflections on the possibility and limits of objectivity.

Current Research Activities Related to “The History of Scientific Objectivity”

The Images of Objectivity

Lorraine Daston (in cooperation with Peter Galison, Harvard University)

The photograph and the global map: these images were at the core of two new and distinct forms of scientific objectivity which emerged in the middle decades of the nineteenth century, which might be called mechanical objectivity and communitarian objectivity. Mechanical objectivity countered the subjectivity of projection onto nature, including judgment and aesthetic idealization. It was nominalist in its metaphysics, mechanical in its methods, and self-restrained in its morals. Scientific images produced in the service of this brand of objectivity were neither types nor ideals nor averages – all time-honored modes of scientific illustration – but rather representations of concrete individuals. Wherever possible, image-making and observation were mechanized, through photographs, self-registering instruments, and statistical data reduction. In a moral vein, scientists upholding the ideals of mechanical objectivity exhorted themselves and their colleagues to refrain from intervention in and interpretation of phenomena. The unretouched photograph became both the emblem and the substance of mechanical objectivity.

Communitarian objectivity, in contrast, countered the subjectivity of idiosyncrasy and parochialism, not only of individuals but also of local research groups. Proponents of mechanical objectivity worried that human intervention might distort natural phenomena; proponents of communitarian objectivity fretted about how anthropocentric scales of time and space might fail to register certain phenomena altogether – the path of a storm system, the shape of an isotherm, the distribution of a species. Communitarian objectivity preferred composites of many observations to representations of individuals, and standardized to mechanical techniques. Whereas mechanical objectivity called for self-restraint in judgment and interpretation in the name of authenticity, communitarian objectivity demanded the equally severe curtailment of individual and/or local autonomy in choice of instruments, methods, and even research topics in the name of solidarity. Its most characteristic visual technique was the global map – of the whole earth or the entire dome of the heavens – composed like a mosaic by a net-

work of farflung observers, each contributing a fragment.

This study traces the emergence and development of both forms of objectivity through atlases of scientific objects, from nebulae to fossils, and through the records of the scientific collaborative projects, such as the Internationales Gradmessungsprojekt and the Carte du Ciel, launched in the mid-nineteenth century. Close attention to the choice of practices, such as choice of instrument or mode of illustration, described and debated in these sources reveals how both forms of objectivity fused methods, morals, and metaphysics into new ways of investigating and understanding nature.

In 1996-97 research was extended in two directions from its nineteenth-century focus: backwards into the eighteenth century and forward into the twentieth century, in order to highlight contrasts with the characteristic forms of objectivity that emerged in the nineteenth-century sciences. A study of eighteenth-century scientific illustration, particularly in botany and anatomy, reveals a different epistemic ideal, that of “truth to nature,” which strived for accuracy while permitting idealization, interpretation, and abstraction in depictions of natural objects. In the twentieth century, scientific imaging techniques are increasingly accompanied by calls for judgment by an expert eye – not the genial interpreter of nature of the eighteenth century, still less the mechanical observer of the nineteenth, but rather the trained professional. Close comparison of preliminary sketches of objects – plants, insects, fossils, dissected animals – annotated by both artists and naturalists with published versions shows how scientific objects come into being: an initial rendition, often highly idiosyncratic with respect both to the object portrayed and to the style of portrayal, becomes a type specimen, which stands in for a whole class of objects and serves as a reference for a community of naturalists and artists.

History as a Problem for the Sciences. Changing Approaches Towards History in the Social Sciences and the Humanities in Germany After 1900

Wolfgang Küttler

Activities in the context of the present project focused on two major points. First the project investigated the relation between history, science, and objectivity in Max Weber’s work. With respect to all three items, Weber’s work and its reception reveal an internal tension between structural and evolutionary issues (*i.e.*, social questions) as well as overarching elemen-

tary explanations of cultural motivations of action and systems of values and norms (*i.e.*, general problems of culture).

The issues addressed in this project apply to the peculiarities of empirical research and concept formation in all historically oriented disciplines. An analysis of Weber's concept of value-relation and value-freedom of empirical research on history, of his ideal types, and of his concept of modernization as rationalization and disenchantment will be concluded in spring 1998 and will be published as a monograph. Another important contribution of Weber's approach is his perception of the historicity of nature and of human culture. Therefore Weber's approach to history has particular relevance for the role of science in modern rationalization. This process is seen by Weber not only as technical progress in civilization, but also as an irresolvable contradiction between the technical-bureaucratic increase of *Zweckrationalität* and the internal qualities of lifestyle (*Lebensführung*).

From this context, the interdisciplinary question of cultural history emerged: how are historicity, a cognitive function of science, and cultural value systems interrelated? This issue demands a comprehensive treatment of the basic typology of historical knowledge (involving structure, development, progress, events, actions, and historical alternatives). Weber's investigation of the relationship between religious structures of motivation in different cultures (which also function as formative elements of social structures) and of the ethics of lifestyle, especially of economic ethics (*Wirtschaftsethiken*) provides also a framework for assaying the different conceptions of knowledge, of life practice, and of historical change in these cultures.

In view of the changes to the concept of science and objectivity since the turn of the last century and subsequent decades, further studies have been initiated to investigate Weber's sources in the natural sciences and humanities of the nineteenth century, as well as to examine the reception of his innovative approaches. The hitherto conducted studies will be expanded in a wider framework of comparative studies embracing social and natural scientists in Germany at the turn of the nineteenth and twentieth centuries.

The second set of activities closely linked to the research of the work of Max Weber, now partially completed, focuses on Marx's theory and method and on the Marxist tradition in the historical sciences. Like the Weber study, it addresses the issue of history as a form of knowledge on the one hand, and history as a means of orientation of practical life in modern

societies on the other. Marx focuses on how scientific objectivity is linked to the knowledge of internal “objective” coherence in history and how this serves simultaneously both as a basis for theory formation and as a strategy for socio-cultural change. Marx brings together the traditional ideal of developing the historical and cultural disciplines towards the standards developed for the classical natural sciences with very concrete social perspectives. At the same time, he proposes a new concept tailored to the peculiarities of the subject matter of the social and historical sciences. The roots of this innovation lie in the development of the sciences since the end of the eighteenth century. Marx’s innovation had lasting but contradictory effects on the disciplines in question, their interdisciplinary relations and, particularly, their political engagement.

Two major studies which related Marx’s approach to the development of the sciences in the nineteenth century as well as to the reception of his work in the twentieth century were finished in 1996 and 1997.

Women Scientists at the Berlin University and at the Institutes of the “Kaiser-Wilhelm-Gesellschaft” in Berlin/Germany between 1898 and 1945

Annette Vogt

Work continued on the project of a comprehensive survey of women who graduated from the Friedrich-Wilhelms-Universität Berlin from 1898/1899 to 1945 and of women scientists who worked at different institutes of the Kaiser-Wilhelm-Gesellschaft (KWG) (see the Annual Reports of 1994 and 1995). Initial results were published and further results were reported in various lectures.

In addition to establishing the identities and biographies of this surprisingly large group of women researchers, the study aims to uncover:

- (1) What were the reasons for women gravitating to certain institutions and specialities within the natural sciences and mathematics? For what reasons did women find opportunities in some Institutes of the KWG? Where did women have better chances, in the KWG or at the University? When and why did the situation change?
- (2) What ideals and practices of early twentieth-century scientific research, particularly those of objectivity, helped or hindered the recruitment and the

participation of women?

(3) What role did changing cultural views of femininity during this period in Germany play in the careers of these women scientists? What were the reasons for changing possibilities for employment of women? Why did the situation for female scientists, especially those working in industrial laboratories, change so rapidly after 1933?

As in 1994/95, archival research in 1996 and in 1997 was concentrated in the archive of the Max-Planck-Gesellschaft, the archive of the University of Berlin and the Archive of the Berlin-Brandenburgische Academy of Science in Berlin. Furthermore, in 1996, the papers of Lise Meitner in the Churchill Archives Centre in Cambridge (UK) were studied and other archives were consulted.

1. The study of the documents about the dissertations of women at the Berlin University from 1899 to 1945 has been finished. A surprisingly large number of 368 theses on natural sciences by women were studied. From 1899 to 1936, all 617 dissertations by women were done at the Philosophical Faculty; among them, 346 dealt with topics in the humanities and social sciences, whereas 271 covered topics in mathematics and natural sciences. From 1936 to April 1945 only 97 theses were submitted by women at the Mathematical-Science Faculty, while 310 theses were completed by women at the Philosophical Faculty.

Careful attention was given to the dissertations based on research performed at the laboratories of Institutes of the KWG. Between 1919 and 1936, at least 32 theses were based on research done at the laboratories of several Institutes of the KWG: fourteen in chemistry, fourteen in biology, two in medicine and two in physics. Between 1936 and 1945 only eleven theses were based on research done at the laboratories of Institutes of the KWG: three in chemistry, seven in biology and only one in physics.

Furthermore, all documents of those women who had completed a *Habilitation* at the Philosophical Faculty (twelve between 1919 and 1932 and four between 1937 and 1945) and at the Mathematical-Science Faculty (only two in 1939 and in 1943) were also studied.

A directory of all archival documents related to dissertations and *Habilitationen* by women, with a brief introduction to the theme and with preliminary results, was prepared for print and published as preprint no. 57 of the Institute (in April 1997).

To answer the questions mentioned above, further studies about the possibilities of the employment of women with a doctoral degree are necessary. Biographical research on women scientists who achieved a *Habilitation* at the University was begun in 1996 and continued in 1997. Furthermore, all documents of those women who worked as an assistant in the Institutes of the Philosophical Faculty and the Mathematical-Science Faculty were studied in 1997.

2. The biographical research on women scientists who worked in several Institutes of the KWG continued in 1996 and in 1997. In 1996, records of more than 150 women scientists working for the KWG during the period between 1912 and 1945 have been uncovered, to date, a total of over 192 women scientists. It has become apparent that women scientists headed at least eleven departments in Institutes of the KWG. There were large differences between the institutes, with some institutes employing no female scientists and others employing many. The reconstruction of the scientific careers of the eleven department heads at the KWIs, who have been omitted from the official history of the KWG until the present, continues. Initial results about the different places of the women scientists in the different KWIs and the explanations for these differences were published as preprint no. 67 of the Institute (in July 1997).

Expanding the level at this study from biography to prosography, the project next must reconstruct the sociological backgrounds of these women, the intellectual affinities governing their choice of a certain discipline or sub-discipline, and the culture of gender relations at the leading scientific institutions of Berlin during this period. In expanding the comprehensive survey of women at the University of Berlin and at the Institutes of the KWG, a special comparison must be drawn between the assistants at the University and the scientific workers at the KWIs on the one hand, and the female *Privatdozenten* at the University and the female leaders of departments at the Institutes of the KWG on the other.

Related Projects of Visiting Scholars and Research Fellows

Francesca Bordogna, "Objectivity and Psychical Research, 1880-1910"; Stéphane Callens, "History of Measure - History of Risk"; Berna Eden, "Psychology versus Logic in 19th-Century Probability Theory"; Morgane Labbé, "History of the Concept of Nationality in Statistics"; Sybilla Niko-

low, “The Visual Representation of Statistics”; Libby Schweber, “Statistical Entities and the Creation of New Disciplines in 19th-Century France and Britain”; Zeno G. Swijtinks, “Early Visual Representations of Experimental and Observational Data” (see *ACTIVITIES OF THE VISITING SCHOLARS AND RESEARCH FELLOWS* P. 182).

PROJECT 3: DEMONSTRATION, PROOF, TEST (1997-98)

Lorraine Daston (responsible) in cooperation with Joan Cadden, William Clark, and Sophie Roux

General Goals of the Project

Epistemology studies how we know and how secure our knowledge is. Historical epistemology studies, *inter alia*, the history of the specific ways devised to make knowledge secure, from the mathematical demonstration to the judicial proof to the empirical test. Although the words “demonstration,” “proof,” and “test” in their narrow senses refer to very different aims and procedures – contrast, for example, the demonstration, which seeks to circumvent an induction over cases, with the eminently inductive test of a hypothesis or a machine – their histories and current usages are closely intertwined in the major European languages. This project is dedicated to posing philosophical questions about how knowledge, both theoretical and practical, becomes trustworthy in a concrete, historical vein: what are the forms of argument, the techniques, the procedures that guarantee various kinds of knowledge, and how did they emerge and become authoritative? Although the project takes mathematical and scientific knowledge as its departure point, it follows the broader disciplinary and practical traditions of the words “demonstration,” “test,” and “proof” in including theological, medical, legal, and technological cases as well. Particularly revealing are examples which treat (1) prototypical forms of argument that become models for all other forms of secure knowledge (*e.g.*, Euclidean geometry, or scholastic arguments for the existence of God); (2) procedures and standards that migrate from one disciplinary context to another (*e.g.*, the application of legal standards of evidence to early modern civil and natural history, or the adaptation of proofing techniques to assess the gold content of coins for chemical analysis); (3) the introduction of novel methods to

prove or test (*e.g.*, the polygraph in the cross-examination of witnesses, or double-blind trials in medical research); and (4) the convergence and conflict of different methods for securing knowledge about the same objects (*e.g.*, bodily tact versus instruments, or computer simulations versus physical experiments).

UPCOMING PROJECTS:

1998-99: "Scientific Personae"

1999-2000: "The Moral Authority of Nature"

**PROJECTS OF THE RESEARCH GROUP HEADED BY HANS-JÖRG
RHEINBERGER (DEPARTMENT III)**

The work of Hans-Jörg Rheinberger's research group is divided into three overlapping areas of investigation: (1) the history and epistemology of experimental practices; (2) the history of objects and spaces of knowledge; (3) the historical pragmatics of concept formation and the uses of theory in the life sciences. Most of the individual projects are situated in the context of the biological and the medical sciences from the eighteenth to the twentieth century. The overarching historical question is: What are the conditions conducive to scientific innovation?

Each of these three areas of investigation will be the subject of a major international conference, the first of which will be held in 1999.

I: HISTORY AND EPISTEMOLOGY OF EXPERIMENTATION

General Goals

Over the past three centuries, the study of living beings has changed from a classificatory *historia naturalis*, an anatomy of visible structures, and a physiology of apparent body functions, to a highly stratified investigative endeavor adapted to its similarly diverse research objects. These objects range in scale from biodiversity through the social behavior of organisms to macromolecules. Each of these levels of organization and investigation has developed a corresponding phenomenology, set of analytical approaches, and methods of determining its object. In history of science 'from the top down,' these developments are often seen as a social process through which scientific disciplines became differentiated, or as a succession – evolutionary or revolutionary – of theoretical paradigms. Complementary to the history of disciplines and the history of ideas, and in accordance with the recent 'practical turn' in the history of science, the perspective of this investigation is 'from the bottom up.' It inquires how fields of research, and ultimately disciplines, aggregate around a cluster of practices and technologies, methods, concepts, and theoretical conjectures to become relatively stable configurations. Such aggregation appears to be socially as well as theoretically underdetermined.

Serious consideration of this empirical horizon of the life sciences demands that historical assessment start not with the reconstruction of the development of biological theory according to a perceived immanent logic, but rather with the reconstruction of the practical contexts in which particular theories gained momentum. Here, the importance of experimental arrangements for the genesis of concepts and generalizations in the modern biological sciences moves center stage. Our analyses proceed from the assumption that experiment itself is a historically variable practice that has undergone decisive shifts of structure and content. These shifts can be illuminated best through broadly conceived comparative studies. As early as the seventeenth century natural philosophers experimented with living things; but in what sense? The demonstrative experiment of the seventeenth century differs significantly from the eighteenth-century idea of an experiment as a more or less systematic extension of observation. In the nineteenth century, conversely, observation itself becomes dependent on experimental exploration in many areas of science. In accordance with these changes, the practice of experimentation has taken on different forms and has become greatly diversified. These forms of experiment deserve systematic assessment.

Of particular relevance to the life sciences of the nineteenth and the twentieth centuries is a close examination of what we call 'experimental systems.' On the one hand, experimental systems can be viewed as comparatively robust, if transient, embodiments of concepts. On the other hand, they represent the most basic, integral, social realizations of scientific activity. As François Jacob once put it: "In biology, any study [begins] with the choice of a 'system'."

This state of affairs, synchronically and diachronically, calls for an epistemology of experimentation. A comparative study of the forms of experimentation is an important element of a historical epistemology of the sciences. Such an epistemology of experimentation lies beyond those modes of philosophy of science that have relegated to the experiment the trivial function of testing hypotheses. The case studies that are needed to realize this project require new methodologies. In addition to the analysis of published texts, they include the systematic evaluation of laboratory notebooks and of oral history documents, the study of historical laboratory structures and of other microstructures of scientific practice, and, finally, the virtual reconstruction of historical experiments.

Current Research Activities Related to “History and Epistemology of Experimentation”

Experimental Systems in Molecular Biology

Hans-Jörg Rheinberger

Hans-Jörg Rheinberger's recent book *Toward a History of Epistemic Things: Synthesizing Proteins in the Test Tube* (Stanford University Press, 1997) contains a detailed investigation of the history of protein biosynthesis research between 1945 and 1965. Central to the story is an 'in vitro system' for the incorporation of radioactive amino acids into proteins. The establishment of this system is followed closely and its various elements are analyzed. This historical case study in experimental systems concomitantly elucidates the roles and functions played by cancer research and biochemistry in the development of molecular biology. On the basis of this historical material, several epistemological concepts are developed both in order to understand experimentation in twentieth-century life sciences and to contribute to a general epistemology of experimentation. These include 'experimental system,' 'epistemic thing,' 'representation,' and 'conjuncture.'

A Virtual Laboratory for Physiology (VLP)

Sven Dierig (in cooperation with Jörg Kantel)

Based on digitized illustrations, texts, and other historical records taken from scientific journals and handbooks, catalogues of scientific instruments, administrative documents, correspondence, and laboratory notebooks, the goal of the Virtual Laboratory for Physiology is to provide an electronic research tool for historical studies on the development of instrumentation and experimentation in nineteenth-century life sciences. The database aspires to a complete collection, classification, and integration (through hyperlinked documents) of representations of experimental practices, instruments, and technical tools used in the production of knowledge and in teaching in the nineteenth-century physiology laboratory. The Virtual Laboratory for Physiology will be presented on the World Wide Web. It will include a virtual library with all relevant journals, allowing visitors

to conduct online literature searches and to evaluate statistical and geographical distributions (landscapes of experimentation). Newsgroups and other Internet-related forms of communication will be established to provide a forum for discussion and information exchange.

Related Projects of Visiting Scholars and Research Fellows

Sarah Jansen, "'Population' as an Object of Experimental Systems: Ecology and Related Fields in Germany, 1850-1950"; Ohad Parnes, "The Origins of Microscopical Biology, 1760-1850"; Henning Schmidgen, "Pendula, Noematographs, and Chronoscopes: The Origins of the Reaction Time Paradigm in Nineteenth Century Psychology" (see *ACTIVITIES OF THE VISITING SCHOLARS AND RESEARCH FELLOWS P. 182*).

2: HISTORY OF OBJECTS AND SPACES OF KNOWLEDGE

General Goals

This area of investigation is based on the assumption that a decisive aspect of scientific innovation lies in choosing, shaping, reshaping, and sometimes in abandoning certain objects of study. The mere examination of the history of these objects presupposes that they take on various forms in the different research contexts in which they acquire their epistemic value. Embryos, brains, mice, and bacteria are not epistemic things by themselves; they are things that become epistemic insofar as they locate monsters, memory, oncogenes, and messengers in a cluster of practical and theoretical relations. The projects in this area of investigation focus on three central aspects of the history of scientific objects in the life sciences: first, the choice of organism, or of part of an organism; second, the spaces in which these organisms or parts function as objects of epistemic interest; and third, the 'mental culture' of the scientist who lives in these spaces and investigates these objects.

The choice of organisms has always played and continues to play a decisive role in the life sciences. Since the end of the eighteenth century, the meaning of key biological concepts has been shaped by the availability of particular model organisms. Late eighteenth-century vitalism, for example,

was by no means a purely speculative endeavor; it is unthinkable without the frog as a model and emblem of bioelectricity. Similarly, the eighteenth-century conception of epigenesis relied on the polyp as a model of organic regeneration. The history of genetics, to take another example, can be portrayed as a succession of model organisms: from humans to peas to flies to molds, bacteria, viruses, and back to higher organisms. Alternatively, experimental medicine has been characterized since its beginnings by a debate as to what animal models are best suited for the study of human diseases and the testing of pharmacological substances. A closer analysis of such examples shows that the uses and scientific 'careers' of certain organisms are bounded by a complex set of conditions. These include technical specifications such as utility, disposability, suitability for laboratory work, and ease of manipulation; ethical and financial considerations; forms of everyday life; and theoretical presuppositions. These conditions may include the natural and cultural histories of organisms, of diseases, or even of entire environments. Here the cultural, social and epistemological aspects of the investigative enterprise are tightly interwoven.

A natural object can become interesting for many reasons, but it only becomes epistemically relevant if it fits into real and symbolic spaces that have taken different forms in history. Such spaces of knowledge include natural cabinets, botanical gardens, agricultural experiment stations, laboratories, the 'field' of the anthropologist or the naturalist, and computer simulations. Every space of knowledge is characterized by its own particular material culture. Spaces of knowledge mark the boundaries of epistemic objects and connect them to larger cultural settings, forms of everyday life, forms of art and architecture, and especially forms of scientific communication. In turn, these spaces receive their particular shapes from the chosen objects of study. Such mutual dependence of objects and spaces is characteristic not only of the microworld of experimental systems, but also of natural histories, anthropological and clinical classifications, and multidimensional scientific accounts of mass phenomena such as epidemics.

Finally, to any particular material culture there corresponds the scientist's 'mental culture.' In fact, 'the scientist' is itself a figure displaying historically conjugant configurations of explicit and tacit knowledge, skills, bodily and mental discipline, and gestural repertoires. These include such elements as the mastering of instruments in a given experimental situation and the training of the senses in subjective sensory physiology. The concept

of mental culture encompasses not only the above aspects, but also the virtues, passions, mentalities, and idiosyncrasies of the researcher. Thus the scope of mental culture ranges from the importance of sensibility in late eighteenth-century life sciences and the role of heroism in romantic self-experimentation to attempts to include or exclude the participating observer in twentieth-century anthropology. The assumption is that such mental culture, in combination with material cultures, helps to explain the relationship between scientific activity and more general cultural and social ideas, practices and values. Notions such as epistemic objects, spaces of knowledge, and mental cultures will allow the development of a framework to overcome the traditional dichotomies of internal *vs.* external factors of scientific development, of experiment *vs.* observation, of basic *vs.* applied research, and of scientific method *vs.* bricolage.

Current Research Activities Related to “History of Objects and Spaces of Knowledge”

From the Organ of the Soul to the Brain

Michael Hagner

Michael Hagner’s recent book *Homo cerebrealis. Der Wandel vom Seelenorgan zum Gehirn* (Berlin Verlag, 1997) describes the transformation of brain research in the years around 1800, from ‘the organ of the soul’ to the brain. In the early modern period, the organ of the soul served as a material medium between the body and the soul. It permitted an understanding of man which combined metaphysical and religious aspects with medical and natural historical approaches. The reconceptualization of the brain as an organ, in which various mental qualities were housed equivalently among each other, marked an epistemic rupture. The previous conception allowed for the categorical differentiation between body and the soul, and between reason and passions, in accordance with an enlightened, yet strictly hierarchical view of man. The new development of brain research represented a science of man, whereby the former categorical differences were now localized in the brain. The brain emerged as the epistemic field for various attributes and differentiations that became fundamental for modernity – such as man/woman, madness/genius, wilderness/civilization, and sense/

sensibility.

The study covers the period from the late Enlightenment to the 1870's, when the foundations of modern experimental brain localization were established. A major focus of the book is the new role of the brain in early nineteenth-century phrenology and romantic *Naturphilosophie*. Although these movements often were regarded as obstacles to scientific progress, both were essential in establishing this new approach, providing a number of assumptions, models, and practices which became central to modern localization research in anatomy, experimental physiology, and clinical research.

Mental Cultures

Michael Hagner

In the context of collaboration with Lorraine Daston, Dorinda Outram, and H. Otto Sibum on the conference project "*Varieties of Scientific Experience*," (see p. 258) Michael Hagner has started a book-length study of the history of 'mental cultures.' To this end, he has focused on the histories of vertigo and of attention as an element of self-experimentation. Scientists' understanding of attention underwent a fundamental transformation in the course of the eighteenth and nineteenth centuries. These conceptualizations were linked to the role of the scientist as subject and as object in self-experiments, as well as to the establishment of attention as a fundamental virtue. The ambiguous character of attention lay in the dual role which it occupied as both an experimental tool and object of investigation. Similarly, until the eighteenth century, vertigo was regarded as a merely pathological phenomenon and thus a subject of interest only to physicians. In the late eighteenth century, however, empirical psychologists came to regard vertigo as a disturbance of the regular activity of the soul and thus began investigating it more closely. Henceforth the concepts of vertigo and attention became polarized. While the latter was defined as a state of orientation, vertigo was understood as disorientation. As a consequence, the history of these two phenomena became inseparably intertwined. This connection will be illustrated through three examples: late enlightenment self-observation, Romantic self-experimentation, and psychophysical research in the 1860's. These case studies may well show that the formation and the transformation of categories such as attention and vertigo became crucial for estab-

lishing new criteria of scientific experience. As a consequence, these categories were seen as essential for understanding and investigating the self as a 'mind-body' unity.

Urbanization, Industrialization, and the Place of Experiment in Nineteenth-Century Physiology

Sven Dierig

Laboratories, along with the researchers, organisms, instruments, and experiments associated with these places of investigation, are not isolated from the world beyond their physical and institutional boundaries. Both laboratories and cities in which they are embedded are subject to change, as was most dramatically apparent in their dynamic and far-reaching transformation during the Industrial Revolution of the nineteenth century. Using the example of Berlin and the institutionalization of experimental physiology by Emil Du Bois-Reymond (1818-1896), this project analyzes the interrelations between urban transformation and the laboratory revolution in physiology during the second half of the nineteenth century. The fundamental aim of the project is to understand how cities and laboratories form spaces of knowledge and cooperate in the production of scientific novelty. A main emphasis is to demonstrate how ongoing changes in urban life and society, industry, economy and technology entered Du Bois-Reymond's workplace and became part of the social and material culture of experimental physiology in Berlin. Rather than following a strict chronology, the study focuses on several themes which illustrate the effects of urbanization on laboratory life. These include (1) the networked city: the connected laboratory and the increasing dependence of experimental work on urban technological systems (water, gas, electricity); (2) city building and the establishment of scientific working places; (3) the city as a disruptive factor: public transportation and precision work in the laboratory; (4) the industrial city and labor: scientific instruments, the power of machines, and the evolution from manual work to mass production in the laboratory; (5) the nervous city and changes in public values: utilitarianism, the American spirit, and the end of Biedermeier science; (6) the iron city and urban life style: sports, art, and the aesthetics of human bodies, machines, and experiments.

History of the 'Epidemic' as a Scientific Object

Andrew Mendelsohn

Epidemiology is among the oldest fields of scientific inquiry. Yet while much has been written about the history of public health and the social history of disease, relatively little attention has been paid to epidemics as objects of knowledge. Epidemiology is rich in traditions: historico-geographical, environmental, statistical, bacteriological, mathematical. Yet the focus of this project is less on these traditions as such, or on epidemiology as a discipline, than on the history of the 'epidemic' as a scientific object at the intersection of myriad nineteenth and early twentieth-century institutions, technical practices, and fields of knowledge. The project asks in particular how the ancient entity 'epidemic' was transformed by the rise of bureaucratic states, statistics, and that new object, population; and how epidemiology figured in the emergence of population sciences (ecology, genetics, evolution) after 1900. A paper completed in 1997 as part of the project (see bibliography) suggests that quantitative understanding and graphical analysis of the dynamics of epidemics preceded such an understanding and analysis of other biological mass phenomena. The late nineteenth-century epidemiologists' construction of population as a thing of changing densities and rates of interaction would appear to bridge the social statistics of the nineteenth century and the population sciences of the twentieth. A second focus of the project is on the way in which politics and culture shaped methods of investigating epidemics and theories of causation, and, conversely, how the subsequent development of those very techniques of inquiry into mass phenomena of health, disease, and death helped give such categories as the 'social' and the 'environmental' their modern form.

Robert Koch and the Genesis of Bacteriology in Germany

Christoph Gradmann

This project focuses on the 'founder' of medical bacteriology, Robert Koch. Questions concern both the development of German bacteriology in the late nineteenth century and the biography of its central figure. One problem addressed is the extent and nature of medical research on bacteria

prior to Koch's identification of the anthrax bacillus in 1875-76. Another issue concerns triangular relations between the Prussian Ministry of Culture, the pharmaceutical industries, and bacteriological laboratories, and the significance of these relations for Koch's career and for the early development of German bacteriology. One of the principal builders of the microcosm of bacteriology displayed a distinct desire for the macrocosm: among Koch's most notable biographic features is his enthusiasm for world travel. Another subject is the impact of bacteriology, apart from the etiological content emphasized in most studies, on contemporary pathological thinking. The project relies on source materials located in many archives, libraries, and other institutions in Berlin.

The project will result in a series of biographical studies of Koch. One aim is to confront the standard biographies of Koch with a more open concept of a historical personality which should not be treated as a given unity, but as an assembly of differing roles that vary in their degree of individuality.

Related Projects of Visiting Scholars and Research Fellows

Berna Eden, "The Mind as an Epistemic Object, or Why Did Psychology and Anthropology Become Dangerous to Logic?"; Peter Geimer, "The Photography of Invisible Phenomena around 1900"; Karlheinz Lüdtke, "Virus Research from the End of the Nineteenth Century to the 1960's"; Jutta Schickore, "Investigating the Constitution of the Retina in Nineteenth Century Sensory Physiology" (see *ACTIVITIES OF THE VISITING SCHOLARS AND RESEARCH FELLOWS* P. 182).

3: PRAGMATICS OF CONCEPT FORMATION AND THE USES OF THEORY IN THE LIFE AND MEDICAL SCIENCES

General Goals

The general aim of this incipient study, outlined only tentatively here, is to assess the specificity and role of the 'theoretical' in the investigation of living things. Concept formation and the function of generalizations in biology will be analyzed from a number of different perspectives: the relation between physical and life sciences; the organizing function of concepts,

especially over the *longue durée*; the heterogeneity of biological discourses; and the historicization of analytical categories such as reductionism, holism, and mechanism. Special emphasis will be placed on the pragmatic aspect of how concepts and generalizations work as tools in various historical contexts and on how they become embodied. Examples are the concept of species, from taxonomy to evolutionary biology to genetic engineering; the concept of information in the history of molecular biology; the concept of hereditary units in the convoluted history of genetics (see the book project of Peter Beurton in the research group of Jürgen Renn, p. 93). It is the recent 'practical turn' in the history of science itself that makes the question of the theoretical once again interesting and investigable from a new perspective.

The relation between physical and life sciences has been a crucial problem since at least the seventeenth century. In each epoch the boundary between the realm of the living and that of the non-living was drawn differently, as the result of a negotiation that in itself is a first order problem for the history of science. Natural history and physiology in the eighteenth century drew this boundary in a distinctly different manner than romantic biology around 1800, or the biological disciplines of the nineteenth century such as cytology, sensory physiology, and evolutionary biology. Today, the realm of the organic is conceived as being the unique product of an evolutionary process and therefore irrevocably shaped by history. This may be an underlying reason for the fact that the history of bioscience since the late nineteenth century has not allotted as significant a role for 'theoretical biology' and 'theoretical medicine' as the history of physics has for theoretical physics.

Within this general framework, the role of organizing concepts is addressed, paying special attention to their stabilities and instabilities, and to their long-term appropriations and transformations. Two examples will be given in the projects listed below. One deals with the notion of 'regulation' and its impact on the formation of molecular biology. The other traces such concepts as complexity, equilibrium, whole, system, and the 'biological' itself as they came to pervade twentieth-century interwar scientific medicine. Such concepts appear to work without being firmly embedded in an overall theoretical framework, and their fruitfulness often appears to be bound to a lack of strict definition.

Another perspective on the problem of the theoretical derives from the complexity of the living as it has emerged fitfully in different fields since the creation of biology in the nineteenth century. As a consequence of this

complexity, conceptualization of the living takes place on many different levels of organization. Access to, and therefore definition of, such levels has depended to a great degree on technologies which generally developed independently of the biological sciences. This adds a further dimension to the question as to how these levels of epistemic activity are connected. We suspect that the connections are largely *ad hoc*, due to historical contingencies. Heterogeneity of discourses results. Instead of joining the perennial quarrel over reducibility – of biology to physics at large, and of one level of analysis to another – projects in this field offer an investigation of the historical dynamics of such heterogeneity in its own right.

Current Research Activities Related to “Pragmatics of Concept Formation and the Uses of Theory in the Life Sciences”

The Complexity of the Body, 1900-1940

Andrew Mendelsohn

This project identifies a ‘biological transformation of Western medicine’ in the overshadowed, allegedly stagnant period before molecular biology. In this transformation, simpler ‘medical’ understandings of immunity, hereditary disease, infection, allergy, deficiency, cancer, and perhaps other concepts and entities gave way to what contemporaries called ‘complex’ biological, ecological, populational, quantitative ones. The aim is to produce a narrative of scientific medicine in the first half of this century complementary to the story of the path to the double helix. In so doing, the project should help to answer the question as to how, after the Second World War, certain fields of medical science were so suddenly reconstructed – for example, when immunology, which had been dominated by a narrow immunochemistry, yielded the ‘immune system.’ The participation of ‘narrow medical men’ in those interwar trends which historians of biology have tended to call holistic also points to a wide context of change in the culture of life science – a change which perhaps has less to do with holism and organic metaphors *per se* than with quantitative conceptual structures (although often expressed in qualitative form: “equilibrium”) and styles of causal explanation developed in the physical, social, and biological sciences alike. Three papers written in 1996-97 (see bibliography

and list of lectures) confirm that contemporaries were at least as concerned with complexity – a concept whose own history will have to be charted – as with unity. The papers suggest, moreover, that standard categories of analysis, such as holism, mechanism and reductionism, fail to capture what changed conceptually during this period. Moreover, their definition, use, and applicability to particular domains of knowledge deserve investigation as a historical problem.

A History of the Notion of Genetic Regulation

Denis Thieffry

The project endeavors to trace some of the main conceptual shifts that occurred in the transition from experimental embryology at the beginning of the twentieth century to contemporary developmental biology. The focus is on the roles of the notions of ‘regulation’ and ‘regulatory network.’

The notion of regulation occupies a central position in most fields of contemporary biology. Accordingly, several authors have addressed its history, especially with respect to the development of the concept of ‘regulatory gene’ in the context of the rise of molecular genetics in the 1950’s. However, the notion of regulation is clearly of much older origin and involves a wide variety of disciplines, including chemistry, physiology, and embryology.

Accordingly, one focus of the present project is on the notion of regulation in the work of experimental biologists in the first half of this century, such as Hans Driesch, T.H. Morgan, Hans Spemann, C.H. Waddington. Versions of the concept are then elucidated in conjunction with related embryological concepts such as ‘induction,’ ‘field,’ ‘epigenesis,’ ‘canalization,’ up to recent interpretations of embryonic development in terms of a spatio-temporal control of gene expression.

In the shadow of the new molecular biology, most of these embryological concepts went through a partial eclipse in the 1960’s and 1970’s, all but disappearing from embryological textbooks and mainstream publications. However, some of them (‘gradient,’ for example) continued to inspire the research of such theoretically inclined biologists as Lewis Wolpert and Hans Meinhardt as well as the research of some experimentalists working on regeneration (Alfred Gierer) and insect development (Klaus Sander).

More recently, some of these concepts, notably ‘gradient’ and ‘epigenesis’, were redefined in molecular terms and reintroduced into the description of cell differentiation and embryonic development, while others, such as ‘canalization,’ remained marginal.

Aiming to understand how the uses and successes of these concepts relate to specific experimental settings, model organisms, disciplines, and local cultures, this study emphasizes polysemy and shifts of meaning. The historical reconstruction will highlight the ways in which the study of embryogenesis was redefined and became integrated into the molecular framework.

Related Project

Christina Brandt, “Linguistic and Informational Metaphors in the History of Molecular Biology” (see *ACTIVITIES OF THE VISITING SCHOLARS AND RESEARCH FELLOWS P. 182*).

OTHER RESEARCH ACTIVITIES

OTHER ACTIVITIES OF THE RESEARCH SCHOLARS

Peter J. Beurton

Participation in the annual meeting of the “Deutsche Gesellschaft für Theorie und Geschichte der Biologie,” Vienna, June 27-30, 1996.

Lecture “Was ist (oder war) die Synthetische Theorie?,” during the workshop “Gab es eine Moderne Synthese in der deutschen Evolutionsbiologie?” organized by the Fakultät für Biologie of the Eberhard-Karls Universität Tübingen, December 6-7, 1996.

Introductory lecture “Reductionism and the present evolutionary landscape” and lecture “Organismic form gives rise to genes; not the other way around!”, both held at the 7. International Symposium of the Senckenbergische Naturforschende Gesellschaft, “Organisms, Genes, and Evolution; Evolutionary Theory at the Crossroads,” Frankfurt, October 9-12, 1996.

Participation in the annual meeting of the “Deutsche Gesellschaft für Theorie und Geschichte der Biologie,” Tübingen, June 27-29, 1997

Lecture “What was wrong about Richard Dawkin’s gene concept?” Participation in a symposium “100 Years of Species Concepts in Zoology” in Dresden, held by the Staatliches Museum für Tierkunde Dresden, November 15-16, 1997

Participation in a workshop on “Evolutionary Biology from Darwin to Today,” organized by the Institute for the History of Science of the Georg-August-Universität Göttingen; December 5-6, 1997.

Sonja Brentjes

Lecture “Orthodoxy, Science, Power, and the Madrasa (‘college’) in the Middle East (13th-14th centuries),” workshop “Experience and Knowledge Structures in Arabic and Latin Sciences,” Max Planck Institute for the History of Science, Berlin, December 16-17, 1996.

Lecture “European travellers to the Middle east during the 16th and 17th centuries and their descriptions of the sciences in Muslim societies,” con-

ference "European travellers to Egypt and the Middle East," University of Oxford, Oxford, July 9-12, 1997.

International Congress for the History of Science, July, 20-26 1997, Université de Liège, Liège, Belgium: Organization and chairing of the symposium: Crossing boundaries - new approaches towards the history of pre-modern sciences and technology, together with Nathan Sivin, University of Pennsylvania, Philadelphia.

Lecture "The 'scientific revolution' and the Middle East," International Congress for the History of Science, Université de Liège, Liège, July 20-26, 1997

Lecture "Die 'wissenschaftliche Revolution' und der Nahe Osten," Festkolloquium zum 70. Geburtstag von Hans Wußing, Sächsische Akademie der Wissenschaften and Karl-Sudhoff-Institut der Universität Leipzig, October 16, 1997.

Lecture "The 'scientific revolution' and the Middle East," Max Planck Institute for the History of Science, seminar of Department II, November 26, 1997.

Peter Damerow

Lecture: "Die Entstehung des Zahlbegriffs," Friedrich-Schiller-Universität Jena, April 23, 1996

Lecture "La Rappresentazione Elettronica del Codice Ms. Gal. 72," (together with Jürgen Renn), Florence, February 14, 1997

Lecture "Archival Electronic Publication: The Galileo Archive in Florence," (together with Jürgen Renn), Tufts University, Boston (Mass.) December 14, 1997

Editor of the series Materialien zu den frühen Schriftzeugnissen des Vorderen Orients (MSVO), together with R. M. Boehmer, R. K. Englund und H. J. Nissen.

Teaching Activities:

Aristotelische Physik. Universität Konstanz. (Kompaktseminar, 30 hours per semester).

Galileis Discorsi. Universität Konstanz. (Kompaktseminar, 30 hours per semester).

Die Theoretisierung der Waage: ausgewählte Texte zur antiken und mittelalterlichen Mechanik (Kompaktseminar, 30 hours per semester, together with Paul Weinig).

Lorraine Daston

Lecture "Description by Omission: Nature Obscured and Enlightened," delivered at conference on "Regimes of Description: In the Archive of the Eighteenth Century," Stanford, January 1-14, 1996.

Lecture "Wonders of Nature, Wonders of Art," delivered at Bar-Hillel Colloquium for the History and Philosophy of Science, Tel Aviv, May 14-20, 1996.

Lecture "Enlightenment Fears, Fears of the Enlightenment," delivered at conference on "The Career of the Enlightenment," Clark Library, Los Angeles, June 7-8, 1996.

Lecture "Mechanical and Communitarian Objectivity," delivered at Bologna/Berkeley/Uppsala Summer School for the History of Science, "The Ends of the Scientific Revolution," Bologna, September 15-21, 1996.

Lecture "Die Angst vor dem Fortschritt: Die Wissenschaften um 1900," Karl-Sudhoff-Gedächtnisvortrag, Berlin, September 29, 1996.

Lecture "Fear and Loathing of the Imagination in Science," delivered at conference Science in Culture: In Honor of Gerald Holton, American Academy of Arts and Sciences, Cambridge, October 12, 1996.

Lecture "The Enlightenment and the Anti-Marvelous," delivered at the Department of the History of Science, Harvard University, October 15, 1996.

Lecture "The Nature of Nature in Early Modern Europe," delivered at conference on The Scientific Revolution as Narrative: Local Knowledges or Global Frameworks?, Brandeis University/Harvard University, Boston, October 18-20, 1996.

Lecture "What Does Gender Matter to Objectivity?" delivered at Zentrum für interdisziplinäre Frauen- und Geschlechterforschung, Technische Universität Berlin, October 30, 1996.

Lecture "What Does It Mean to Be Irrational? Historical Perspectives," delivered to Mind/Brain/Behavior Faculty Seminar, Harvard University,

December 2, 1996.

Lecture “Scientific Objectivity as Epistemic Ideal,” delivered at invitation of Ministry of Science and Technology, Lisbon, Portugal, January 31, 1997.

Lecture “Die Kultur der wissenschaftlichen Objektivität,” delivered at Max-Planck-Institut für Geschichte, Göttingen, March 5, 1997.

Lecture “What Kind of Culture is Science?” delivered at Duke University, Durham, March 8, 1997.

Lecture “Recherches en l’*épistémologie* historique des sciences: Empirisme et objectivité,” delivered at Centre Alexandre Koyré, Paris, March 24, 1997.

Lecture “Can Rationality Have a History?” delivered at History of Science Society Annual Meeting, San Diego, November 6-9, 1997.

Lecture “Objectivity versus Truth,” delivered at Max-Planck-Institut für Geschichte, Göttingen, November 12-14, 1997.

Lecture “Die Akademien und die Klassifizierung der Wissenschaften: Die Disziplinierung der Disziplinen,” delivered at Berlin-Brandenburgische Akademie der Wissenschaften, Berlin, November 28, 1997.

Lecture “Die Quantifizierung des Risikos im 18. Jahrhundert,” delivered at Eidgenössische Technische Hochschule, Zürich, December 2, 1997.

Advisory Editor, Ideas in Context series, Cambridge University Press (1991-).

Advisory Boards: Einstein Forum, Potsdam (1992-), Internationales Forschungszentrum Kulturwissenschaften, Wien (1993-), Forschungszentrum für Europäische Aufklärung, Potsdam (1996-).

Honorary Professor, Seminar für Kulturwissenschaften, Humboldt-Universität zu Berlin.

Organizing Committee for “Nature” conferences, Project on “Concepts and Symbols in Eighteenth-Century Europe,” European Science Foundation.

Christoph Gradmann

Lecture “Hermann von Helmholtz als Mediziner und Physiologe,” Braunschweigisches Landesmuseum/PTB, Braunschweig, July 6, 1997.

Lecture “Biographien und Medizingeschichte,” Humboldt-Universität zu Berlin, Lehrstuhl für Wissenschaftsgeschichte, October 23, 1997.

Lecture “Robert Koch, das Tuberkulin und die Gründung des Instituts für Infektionskrankheiten,” Institut für Geschichte der Medizin, Freie Universität Berlin, November 13, 1997.

Lecture “Tuberculosis and Tuberculin,” Max Planck Institute for the History of Science, Colloquium Department III, Berlin, November 18, 1997.

Lecture “Das Problem der Tuberkulose. Ätiologie und Pathogenese der Infektionskrankheiten bei Robert Koch,” Infektiologischer Arbeitskreis, Hygieneinstitut der Universität Heidelberg, November 25, 1997.

Gerd Graßhoff

Lecture “Wittgenstein’s Tractatus,” Duisburg, June 24, 1997.

Lecture “‘Über die Erhaltung der Kraft’ von Hermann Helmholtz: Der Energiesatz und das vereinheitlichte Weltbild der Mechanik bei Heinrich Hertz.” Kolloquium zum 150. Jahrestag des Vortrages, Berlin, June 16, 1997.

Lecture “Von der Steinplatte zur Sonnenuhr. Über den Umgang mit gegenständlichen Quellen in der Wissenschaftsgeschichte,” Regensburg, September 29, 1997.

Lecture “Die sprachphilosophische Wende der Metaphysik,” Hamburg, December 10, 1997.

Teaching Activities: (Georg-August-Universität Göttingen)

- WS 97/98: Vorlesung: Die Kopernikanische Revolution
- WS 97/98: Seminar: Begleitseminar zur Vorlesung
- WS 97/98: Seminar: Experimentelle Forschungsmethoden am Beispiel der Anfänge der Biochemie
- WS 97/98: Wissenschaftshistorisches Kolloquium

Michael Hagner

Lecture “Monstrositäten im Kabinett. Zur Geschichte der Repräsentation körperlicher Deformitäten,” Medizinhistorisches Kolloquium, Institut für

- Geschichte der Medizin, Freie Universität Berlin, January 11, 1996.
- Lecture "Zur Physiognomik bei Alexander von Humboldt," Max-Planck-Institut für Wissenschaftsgeschichte, Berlin, February 14, 1996.
- Lecture "The frog as a stabilizing system in Müller's and Helmholtz's physiology," Workshop on Bedeutung und Vielfalt des Experiments, Zentrum für interdisziplinäre Forschung, Universität Bielefeld, March 29, 1996.
- Lecture "Monstrositäten im Naturalienkabinett. Zur Repräsentation körperlicher Fehlbildungen im 18. Jahrhundert," 5. Jahrestagung der Deutschen Gesellschaft für Geschichte und Theorie der Biologie, Wien, June 29, 1996.
- Lecture "Reil's Natural Philosophy of the Brain," 3rd Triennial Conference of the European Association for the History of Psychiatry, Munich, September 13, 1996.
- Lecture "Hirnforschung um 1900," 1. Wissenschaftshistorikertag, Berlin, September 28, 1996.
- Lecture "Aufmerksamkeit als Ausnahmezustand," Liechtensteiner Exkurse III: Aufmerksamkeit. Schaan, Liechtenstein, October 2, 1996.
- Lecture "Monstrosities in the Age of Enlightenment between Natural Cabinets and Theories of Generation," Science Museum, London, October 23, 1996.
- Lecture "Enlightened Monsters," The Wellcome Unit for the History of Medicine, University of Cambridge, October 25, 1996.
- Lecture "The Emergence of Brain Localisation and the Modern Understanding of Man in the Nineteenth and Twentieth Centuries," Symposium on Mind and Brain in Historical Perspective, 25. Göttinger Neurobiologentagung, May 25, 1997.
- Lecture "A short history of attention and vertigo," Conference on "The Varieties of Scientific Experience," Max Planck Institute for the History of Science, Berlin, June 21, 1997.
- Lecture "Eine kurze Geschichte der Aufmerksamkeit," Wissenschaftshistorisches und wissenschaftsphilosophisches Kolloquium, Universität Leipzig, July 2, 1997.
- Lecture "Radical Brains. Geniuses and criminals in nineteenth century brain research." XXth International Congress of History of Science, Liège,

July 22, 1997.

Lecture "Towards a History of Attention and Vertigo," Department for History of Science, Princeton University, October 4, 1997.

Lecture "Selbstbeobachtung und Drehstuhl. Überlegungen zur Geschichte des Schwindels," Zentrum für Literaturforschung, Berlin, October 9, 1997.

Lecture "The Representation of Monstrosities in Enlightenment between Natural Cabinets and Embryology," Department for the History of Science, Harvard University, October 28, 1997.

Lecture "The 1874 Debate on the History of Aphasia in Berlin," Department for the History of Science, Harvard University, October 29, 1997.

Lecture "Between Neurophysiology and Neuro-poetry: Natural-philosophical approaches to the brain around 1800," Annual Meeting of the History of Science Society, San Diego, November 7, 1997.

Lecture "Geniuses, Brains and the Transformation of Nineteenth-century Anthropology," Conference on Science as Cultural Practice, 1750-1900, Max-Planck-Institut für Geschichte, Göttingen, November 15, 1997.

Lecture "Zur Bedeutung der experimentellen Praxis bei Viktor von Weizsäcker," Jahrestagung der Viktor von Weizsäcker Gesellschaft, Heidelberg, November 21, 1997.

Co-organizer of the conference "Varieties of Scientific Experience," (with Lorraine Daston, Dorinda Outram and H. Otto Sibum), Max Planck Institute for the History of Science, Berlin, June 19-22, 1997.

Dieter Hoffmann

Lecture "Operation Epsilon: Die Protokolle von Farm Hall oder von der 'Stunde Null' deutscher Atomphysik(er)," colloquium of the Institut für Theoretische Physik der Ruprecht-Karls-Universität, Heidelberg, January 29, 1996.

Lecture "Operation Epsilon oder die Angst der Alliierten vor einer deutschen Atombombe," Soiree at the Staatstheater Hannover, February 8, 1996.

Lecture "Hermann von Helmholtz als 'Reichskanzler der Wissenschaften,'" colloquium of the Medizinhistorisches Institut der Universität Bonn, February 9, 1996.

Lecture "Normung von Maß, Zeit und Gewicht. Vom deutschen Zollverein bis zur Physikalisch-Technischen Bundesanstalt," 6. Dortmunder Symposium zur Vermessungsgeschichte "Europa wächst zusammen," Dortmund, February 12, 1996.

Lecture "Wissenschaft, Technik und Industrie in Berlin - historische Reminiszenzen," annual meeting of the Arbeitskreis Unternehmensführung der Schmalenbach-Gesellschaft, Berlin, March 14, 1996.

Lecture "Die Atombombe und ihre Erfinder," colloquium Fachschaft Physik der Humboldt-Universität zu Berlin, May 5, 1996.

Lecture "Zuflucht am Bosphorus. Deutsche Wissenschaftleremigration in die Türkei nach 1933," Deutsch-Türkischer Club, Berlin, May 14, 1996.

Lecture "Die Physikalische Gesellschaft (in) der DDR. Zur Anatomie einer wissenschaftlichen Gesellschaft im Sozialismus," Tagung Wissenschaft und Macht, Halle, May 15, 1996.

Lecture "Walther Nordsack and the Quantum Theory," Symposium "Discovery of Elements," Leuven, September 18-20, 1996.

Lecture "Wandlungen der Berliner Wissenschaftslandschaft im Spiegel der Entwicklung von Naturwissenschaft und Technik um 1900," Berlin, September 28, 1996.

Lecture "Friedrich Herneck (1909-1993): Über Schwierigkeiten beim Schreiben von Wahrheit" auf der Karl-Sudhoff-Gedächtnissitzung der Gesellschaft für Geschichte der Medizin, Naturwissenschaften und Technik, Berlin, September 29, 1996.

Lecture "The Nazis and the Physicists" at the colloquium "La Scienza di Fronte ai Conflitti Etnici," Dipartimento di Fisica, Università Genova, Genua, November 12, 1996.

Lecture "Hans Geiger in Manchester und James Chadwick in Berlin - zum Forschungsnetzwerk in der Frühgeschichte der Radioaktivität," VII. Physikhistorische Tagung des Fachverbandes Geschichte der Physik der DPG, Munich, March 19, 1997.

Lecture "Friedrich Möglich (1902-1957): Mann ohne Schatten. Zur Vorgeschichte und den Rahmenbedingungen einer Wissenschaftlerkarriere im Sozialismus," Ernst-Alban-Gesellschaft Rostock, May 22, 1997.

Lecture "The 'Radioactive Triangle' Manchester, Berlin, Vienna: Cooperation and Competition in the Early History of Radioactive Research," XXth

International Congress of History of Science, Liège, July 22, 1997.

Lecture “Die Kultur der Präzisionsmessung und die Rolle der Berliner Physikalisch-Technischen Reichsanstalt in der Frühgeschichte der Quantentheorie,” 80. Jahreshaupttagung der Deutschen Gesellschaft für Geschichte der Medizin, Naturwissenschaft und Technik, Regensburg, September 28, 1997.

Lecture “Tieftemperaturphysik an der Berliner Physikalisch-Technischen Reichsanstalt,” Abschiedskolloquium for Prof. Dr. H. Lübbig at the Physikalisch-Technische Bundesanstalt, Berlin, November 7, 1997.

Conception, book and illustration of the exhibition “Hermann von Helmholtz. Klassiker an der Epochenwende” (together with H. Laitko), organized by the Hermann von Helmholtz-Gemeinschaft Deutscher Forschungszentren, the Deutsche Museum Bonn and the Physikalisch-Technische Bundesanstalt Braunschweig/Berlin, Bonn, November/December, 1996.

Conception and organization of the exhibition “Max Planck - Leben, Werk, Persönlichkeit” of the German Physical Society and the Max Planck Society at the Magnus House in Berlin, October 3-30, 1997.

Co-Editor of the Planck-Issue of the “Physikalische Blätter” (10/1997).

Co-Editor of “Max Planck (1858-1947). Vorträge und Ausstellung zum 50. Todestag, München 1997.”

Member of the scientific board of the Symposium “Discovery of Elements,” Leuven September 18-20, 1996.

Co-organizer of the symposium “Physik im Umbruch 1900 - Neue Grenzüberschreitungen” auf dem Deutschen Wissenschaftshistorikertag, Berlin September 28, 1996.

Head of the Organizing Committee of the VII. Conference for History of Science of the German Physical Society at the Annual Meeting of Deutsche Physikalische Gesellschaft, Munich March 19-21, 1997.

Co-organizer of the symposium “150. Jahrestag des Vortrags ‘Über die Erhaltung der Kraft’ von Hermann Helmholtz,” Magnus-Haus Berlin, June 16, 1997.

Member of the Scientific Committee of the conference “Radioactivity: History and Culture (1896-1930’s),” Paris, July 8-10, 1997.

Co-organizer of the symposium “Science and Technology in the GDR”

(SM 27) at the XXth International Congress of History of Science, Liège July 26, 1997.

Head of the commission “Geschichte der Physik” of the Deutsche Physikalische Gesellschaft.

Member of the Board of the commission “History of Physics” of the European Physical Society.

Secretary of the commission “History of Modern Physics” of the International Union for History and Philosophy of Science/ Division History of Science.

Member of the Board of the Deutsche Gesellschaft für Geschichte der Medizin, Naturwissenschaft und Technik e.V.

Advisor for history of science matters to the Physikalisch-Technische Bundesanstalt Braunschweig/Berlin.

Member of the scientific board (wissenschaftlicher Beirat) of the Robert-Havemann-Gesellschaft, Berlin.

Referee for scientific journals and Volkswagen-Stiftung.

Teaching Activities

- Quantentheorie und Weimarer Republik, Humboldt-Universität zu Berlin, Institut für Geschichtswissenschaften, seminar (2 hours per week), summer semester 1996.
- Visiting professor, Humboldt-Universität zu Berlin, Institut für Geschichtswissenschaften (Lehrstuhlvertretung Prof. Rüdiger vom Bruch), winter semester 1996/97.
- Vom Kabinett und Seminar zu den Großforschungseinrichtungen der Moderne (lecture).
- Physiker- und Chemiker-Biographie des 19. und 20. Jahrhunderts (seminar).
- Von Helmholtz bis Einstein. Der Umbruch von Physik und Naturwissenschaften im 19./20. Jahrhundert. (seminar)

Research Colloquium

- Zur Geschichte des Energieerhaltungssatzes, seminar (2 hours per week), summer semester 1997.

- Max Planck (1858-1947) - ein Gelehrtenleben im wissenschafts- und zeithistorischen Spiegel, seminar (2 hours per week), winter semester 1997/98.

Horst Kant

Lecture “Hermann von Helmholtz, der Reichskanzler der Wissenschaft,” Kepler-Gesellschaft, Stuttgart, January 17, 1996.

Lecture “Wechselbeziehungen zwischen Physik und Technik in Berlin – das Beispiel Elektrotechnik um 1900,” Conference Wissenschaft - Innovation - Unternehmertum der Gesellschaft für Wissenschaftsforschung, Deutsches Patentamt Berlin, March 22-23, 1996.

Lecture “The German Uranium Project and the Kaiser-Wilhelm-Institute for Physics,” International symposium History of the Soviet Atomic Project in Dubna (Russia), May 13-19, 1996.

Lecture “The Establishment of Theoretical Physics as a Separate Field of Investigation and Teaching at the End of the Nineteenth Century,” 7th Biennial Conference of the European Physical Society’s Interdivisional Group on History of Physics, “History and Philosophy of Physics in Education,” Bratislava, August 21-24, 1996.

Lecture “Die Frühgeschichte des Kaiser-Wilhelm-Instituts für Physik - Physik und Wissenschaftspolitik,” Deutscher Wissenschaftshistorikertag Berlin, September 26-29, 1996.

Lecture “Emil Warburg und die Physik in Berlin,” Dahlemer Archivgespräche, Archiv der Max-Planck-Gesellschaft in Berlin-Dahlem, December 2, 1996.

Lecture “Andrej Sacharov und das sowjetische Atomwaffenprojekt - Physik und Verantwortung,” Ernst-Alban-Gesellschaft für Mecklenburg-Pommersche Wissenschafts- und Technikgeschichte, Rostock, January 23, 1997.

Lecture “Die Entstehung wissenschaftsbasierter Industriezweige: das Beispiel Elektroindustrie,” Conference Wissenschaft – Innovation – Unternehmertum II; Gesellschaft für Wissenschaftsforschung, Berlin, April 4, 1997.

Teaching Activities 1996/97

- Wissenschafts- und Hochschulpolitik in der Weimarer Republik, required lecture for the major in history of science and technology, Universität Stuttgart, January 18, 1996.
- Grenzüberschreitungen - Leben, Werk und Wirkungen Werner Heisenbergs, lecture and seminar course, Bischöfliche Akademie des Bistums Aachen, September 21-22, 1996.
- Frühgeschichte der Atom- und Quantenphysik, Pädagogisches Landesinstitut Potsdam, November 8, 1996.
- Der Weg zu Stalins Bombe - Die physikalischen Wissenschaften von der Oktoberrevolution bis zum Ende der 40er Jahre, lecture on January 29, 1997 as part of the lecture series "Wissenschaftsgeschichte in Osteuropa," Osteuropainstitut of the Freie Universität Berlin.
- Zur Physik im 19. Jahrhundert - Hermann von Helmholtz als 'Reichskanzler der Physik,' lecture on December 12, 1997 as part of the lecture series "19. Jahrhundert," Brandenburgische Technische Universität Cottbus.

Doris Kaufmann

Lecture "Verletzung des Körpers als Heilung der Seele. Heroische Kuren in der Frühzeit der Psychiatrie," Colloquium der Arbeitsstelle für historische Kulturforschung Universität des Saarlandes on "Der verletzte Körper. Schmerzerfahrung in der Frühen Neuzeit," Saarbrücken, March 2, 1996.

Lecture "Aufklärerische Öffentlichkeit: Identität und Devianz," Kulturwissenschaftliches Institut der Universität Leipzig, April 22, 1996.

Lecture "'Widerstandsfähige Gehirne' und 'kampfunlustige Seelen'. Psychiatrie im I. Weltkrieg," Historisches Institut der Universität Bielefeld, June 26, 1996.

Lecture "Johann Christian Reil's Natural Philosophy of Pain," Third Triennial Conference of the European Association for the History of Psychiatry, München, September 13, 1996.

Lecture "Die psychiatrische Hysteriediskussion 1880-1920: Vom Aufstieg und Niedergang einer Krankheitsdiagnose," 1. Wissenschaftshistorikertag, Berlin, September 28, 1996.

Lecture “Zwang zur Vernunft? Zur Frühgeschichte der ‘Reformirrenanstalten’,” lecture series of the Institut für Geschichte der Medizin und der Psychiatrischen Universitätsklinik Erlangen-Nürnberg, November 26, 1996.

Lecture “Wissenschaft als kulturelle Praxis. Psychiatrie im I. Weltkrieg und in der Weimarer Republik,” Sozial- und kulturgeschichtliches Colloquium des Soziologischen und Historischen Instituts der Universität Hannover, December 9, 1996.

Lecture “Wissenschaft als kulturelle Praxis. Psychiatrie im I. Weltkrieg,” Historisches Institut der Universität Gießen, January 20, 1997.

Lecture “Männliche Hysterie im ärztlichen Diskurs des I. Weltkriegs,” Forschungscolloquium des Zentrums für Interdisziplinäre Frauen- und Geschlechterforschung der Technischen Universität Berlin, February 5, 1997.

Lecture “Traum und Selbstbewußtsein. Zur Kartographie der Seele im 18. und frühen 19. Jahrhundert,” Institut für Geschichte der Medizin der Universität Bonn, June 23, 1997.

Lecture “Männliche Hysterie im I. Weltkrieg und in der Weimarer Republik. Neue Forschungsergebnisse in der Diskussion,” public discussion event with Paul Lerner (New York), Institut für Geschichte der Medizin, Freie Universität Berlin, June 26, 1997.

Lecture “Die heroischen Kuren in der Psychiatrie des 19. Jahrhunderts,” Workshop Körper-Macht-Geschichte of the Bielefelder Graduiertenkolleg at the Fakultät für Geschichtswissenschaft, June 28, 1997.

Lecture “Psychiatrie als kulturelle Praxis,” Workshop “Trauma-Zeit-Geschichte. Das Ereignis in der Epoche der Medien,” Zentrum für Literaturforschung Berlin, July 2, 1997.

Lecture “Wissenschaft als kulturelle Praxis. Die Psychiatrie im I. Weltkrieg und in der Weimarer Republik” at the history department of the University of Basel/Switzerland, December 9, 1997.

Teaching Activities:

- Max Weber als Historiker und Wissenschaftstheoretiker. Technische Universität Berlin, Department of History, Hauptseminar (2 hours per week) summer semester 1996.

- Neuere Ansätze in der Kulturgeschichte und in den Kulturwissenschaften. Technische Universität Berlin, Department of History, Übung (2 hours per week) summer semester 1997.

Ursula Klein

Lecture "The Production of Paper Orders - Two Case Studies from the History of Chemistry," Max Planck Institute for the History of Science, Berlin, February 21, 1996.

Lecture "Paving a Way through the Jungle of Organic Chemistry," conference "Bedeutung und Vielfalt des Experiments," Bielefeld, March 27-31, 1996.

Lecture "Do We Need a Philosophy of Chemistry?" conference "Philosophy of Chemistry," Athens, April 4-7, 1996.

Lecture "Nature and Art in 17th-Century French Chemical Textbooks," Sixteenth Century Studies Conference, St. Louis, Oct. 24-27, 1996.

Lecture "Chemical Formulas as Paper-Tools in 19th-Century Chemistry," annual meeting of the American History of Science Society, Atlanta, November 7-10, 1996.

Lecture "Paper-Tools and Techniques of Modelling in 19th-Century Chemistry," Harvard University, Department of the History of Science, Physical Sciences Working Group, November 22, 1996.

Lecture "Alchemy and Early Modern Chemistry - A Comparison of Patterns of Knowledge and Experimentation." Harvard University, Department of the History of Science, Early Science Working Group, December 12, 1996.

Teaching Activities:

- Konzepte des Experiments in neueren Theorien der Wissenschaftsgeschichte. Freie Universität Berlin, Institute for Philosophy, Hauptseminar (2 hours per week, together with W. Lefèvre).

Wolfgang Küttler

Conference leader (together with Jörn Rüsen and Ernst Schulin) "Geschichtsdiskurs IV Krisenbewußtsein und Innovation 1880-1945," Universität Bielefeld. Zentrum für Interdisziplinäre Forschung. February,

22.-24, 1996.

Lecture "Die DDR-Historiographie in der Ökumene der Historiker. Selbstverständnis und Praxis als Wissenschaftsdisziplin," Göttingen, conference Geschichtswissenschaft in der DDR, Zentrum für Zeithistorische Studien Potsdam/Zentrum für höhere Studien Leipzig/ Max-Planck-Institut für Geschichte, May 30- June 1, 1996.

Lecture "Formationstheorie als Basis der DDR-Gesellschaftswissenschaften. Dogma und heuristische Bedeutung," Leipzig, Zentrum für höhere Studien / Zentrum für Zeithistorische Studien Potsdam, June, 14-15, 1996.

Lecture "Hat die marxistische Geschichtswissenschaft noch eine Zukunft?" Vilnius, Lithuania, Conference "Geschichtswissenschaft und offene Gesellschaft," University of Vilnius, Department of History/George Soros Foundation Lithuania/ Kulturwissenschaftliches Institut Essen/ Georg-Eckert-Institut für internationale Schulbuchforschung Braunschweig, September, 24-29, 1996.

Lecture "Frühbürgerliche Revolution im Geschichtsdenken der DDR," colloquium on the occasion of the 65th birthday of Gerhard Brendler, Kulturwissenschaftliche Fakultät of the Europa-University, Viadrina, Frankfurt/Oder, January 21, 1997.

Lecture "Formationstheorie und Geschichte - zwanzig Jahre danach betrachtet," colloquium on the occasion of the 70th birthday of Georg Iggers, Zentrum für Höhere Studien, University of Leipzig, March 15, 1997.

Lecture "Ranke's lectures on the Epochs of Modern History" with commentary to the text, delivered to the working group "Varieties in scientific experience," MPIWG, Department II, March 17, 1997.

Commentary "Problems of Periodization of Universal History," conference of the International Commission of the History of Historiography: "Periodization in History and Historiography," Budapest, July 4-6, 1997.

Conference leader (together with Jörn Rüsen, Essen, and Ernst Schulin, Freiburg), lecture: "Systemdenken - Denkstil einer Epoche? 'Marxistisch-leninistische' Geschichtswissenschaften in der Systemkonfrontation" and chair of the 5th session: Geschichtsphilosophie, conference Geschichtsdiskurs V, "Globale Konflikte, Erinnerungsarbeit und Neuorientierungen seit 1945," Zentrum für Interdisziplinäre Forschung at the University of Biele-

feld, July 10-12, 1997.

Lecture "Geschichte als Entwurf gesellschaftlicher Veränderung. Karl Marx im Geschichtsdiskurs der Moderne" and (together with Ludger Heidbrink (Lüneburg), Hermann Lübke (Zürich) and Jörn Rüsen (Essen) round table: "Weltgesellschaft und Nation. Stiftet die Geschichte Identität?". 129th conference of the Evangelische Akademie Iserlohn: "Zukunft und Geschichte. Vor der Jahrtausendwende: Perspektiven gegenwärtiger Geschichtsphilosophie," November 21-23, 1997.

Member of the advising counsel of the journal *Comparativ*, Leipzig.

Member of the editorial board of the *Sitzungsberichte der Leibniz-Sozietät Berlin*.

Member of the Internationale Kommission zur Erforschung der Geschichte des Deutschen Ordens.

Coeditor (with Jörn Rüsen and Ernst Schulin) of the series *Geschichtsdiskurs* (Vol. III -IV).

Wolfgang Iser

Chair of session at the workshop "Gene Concepts in Development and Evolution II," Max Planck Institute for the History of Science Berlin, October 17-19, 1996.

Lecture "Hegels Geschichte der Philosophie aus wissenschaftsgeschichtlicher Perspektive," XXI. Internationaler Hegelkongreß "Hegels Geschichte der Philosophie," San Sebastian, October 1-4, 1996.

Lecture "The Limits of Pictures," ESF Workshop "The Emergence of the Scientific Image, 1500-1700," Berlin, September 19-21, 1997.

Member of the Board of the "Internationale Hegel-Gesellschaft".

APL Professor for philosophy at Freie Universität Berlin.

Visiting Scholar at the Department of History of Science, Harvard University, Cambridge (MA), Fall 1997 - Spring 1998.

Guest Editor of issue IX/3 - "Fundamental Concepts of Early Modern Chemistry" - of *Science in Context*.

Teaching Activities (1996 and Spring Term 1997):

- Konzepte des Experiments in neueren Theorien der Wissenschaftsgeschichte, Freie Universität Berlin, Institute for Philosophy - Hauptseminar (2 hours per week, together with U. Klein).
- Philosophie - Wissenschaft - Gesellschaft, Freie Universität Berlin, Institute for Philosophy - research colloquium (3 hours per week, together with A. Arndt).

Andrew Mendelsohn

Lecture "The Model of War and the Problem of Peace in the Making of Immunology," Department of the History of Science, Medicine, and Technology, Johns Hopkins University, February 13, 1997; Princeton Workshop in the History of Science, Princeton University, February 15, 1997.

Lecture "Infection without Disease: The Crisis of Etiology, 1890-1910," Berlin-Brandenburgische Akademie der Wissenschaften, April 9, 1997.

Referee: *Medical History*

Book Project: *The Making of Bacteriology*, supported by a grant from the Alfred P. Sloan Foundation, to be published by Princeton University Press in 1998-99.

Folkert Müller-Hoissen

Lecture "Integrable models and noncommutative geometry," Universidade Federal da Bahia, Salvador, Brasil, February 14, 1996.

Lecture "Konzepte und Methoden nichtkommutativer Geometrie und deren Anwendungen in der Physik," Technische Universität Braunschweig, May 3, 1996.

Jürgen Renn

Lecture "Galilei und die klassische Physik," workshop "Neue Entwicklungen in der Galileo-Forschung," Zürich, January 22, 1996.

Lecture "Living with Diversity and Unification in Science," interdisciplinary workshop "The Changing Metaphysics of Science," Vienna, March 14, 1996

Lecture "Towards an Historical Epistemology of Space, Time, Matter, and

Force,” symposium on “Epistemology as Genetic History of Science” at the international conference “The Growing Mind,” Geneva, September 17, 1996.

Lecture “Von der klassischen Trägheit zur dynamischen Raumzeit,” conference “1. Deutscher Wissenschaftshistorikertag,” Berlin, September 28, 1996.

Lecture “La Rappresentazione Elettronica del Codice Ms. Gal. 72” (together with Peter Damerow), Florence, February 14, 1997

Lecture “The Rediscovery of General Relativity in Berlin” (together with Tilman Sauer), at “Boston Colloquium for Philosophy of Science,” Boston, March 3, 1997

Lecture “The Birth of General Relativity: Mathematical Formalism and Physical Interpretation,” at “Primo Congresso della S.I.F.F.,” Trieste, April 7, 1997.

Lecture “The Parabola in Galileo’s Research: a Curve and its Context” (together with Peter Damerow), workshop “The Emergence of the Scientific Image, 1500-1700,” Berlin, September 19, 1997.

Lecture “Albert Einstein: Alte und neue Kontexte in Berlin,” colloquium “Die Preußische Akademie der Wissenschaften zu Berlin im Kaiserreich,” Berlin, November 29, 1997.

Lecture “Archival Electronic Publication: The Galileo Archive in Florence” (together with Peter Damerow), Tufts University, Boston (Mass.) December 14, 1997

Editor of *Science in Context* (together with G. Freudenthal).

Editor of *Boston Studies in the Philosophy of Science* (together with Kostas Gavroglu).

Member of the Editorial Boards of *Archimedes*, *New Studies in the History and Philosophy of Science and Technology* and of *Studies in History and Philosophy of Modern Physics*.

Member of the Scientific Committees of the “Centro Interuniversitario di Ricerca in Filosofia e Fondamenti della Fisica” of the universities Bologna and Urbino, and of the Conference Series of the European Science Foundation “Science and the Visual Image 1500-1800.”

Head of commission “MPG im World-Wide-Web” of the Max-Planck-Gesellschaft.

Member of the MPG commissions: “Vorbereitung des 50jährigen Jubiläums der Max-Planck-Gesellschaft,” “Beratender Ausschuß für EDV-Anlagen in der Max-Planck-Gesellschaft,” “MPIWG für psychologische Forschung,” “Bibliotheca Hertziana,” “MPG/DFG-China-Koordinierungsausschuß,” “Geschichte der Kaiser-Wilhelm-Gesellschaft im Nationalsozialismus.”

Vice-Chair of the “Verbund für Wissenschaftsgeschichte,” Berlin.

Adjunct Professor for history of science at Boston University.

Honorary Professor for history of science at Humboldt-Universität zu Berlin.

Teaching Activities:

- Geschichte der aristotelischen Physik von der Antike bis zur Neuzeit. Humboldt-Universität zu Berlin, Institute for History - research colloquium (2 hours per week).
- Galileis “Discorsi,” Humboldt-Universität zu Berlin, Institute for History - research colloquium (2 hours per week).

Hans-Jörg Rheinberger

Lecture “Augenmerk,” Liechtensteiner Exkurse III: “Aufmerksamkeit,” Schaan, October 3, 1996.

Lecture “Experimental Systems, Generators of Epistemic Things” and comment on A. Pickering: The Mangle of Practice, “Signatures of Knowledge Societies,” Joint Meeting of the Society for Social Studies of Science and the European Association for the Study of Science and Technology, Bielefeld, October 12, 1996.

Lecture “Gene Concepts: A Fragmented View From the Perspective of Molecular Biology,” Workshop on “Gene Concepts in Development and Evolution II,” Max Planck Institute for the History of Science, Berlin, October 19, 1996

Lecture “Über den Stellenwert der Wissenschaftsgeschichte für die Philosophie der Wissenschaften,” Philosophisches Institut der Universität Salzburg, October 24, 1996.

Lecture “Experimental Complexity in Biology: Epistemological and Historical Remarks,” Philosophy of Science Association, Fifteenth Biennial

Meeting, Cleveland, November 2, 1996.

Lecture "Experimental Complexity," Mark M. Horblit Colloquium in the History of Science, Harvard University, Cambridge (USA), November 5, 1996.

Lecture "Experimental Complexity in Biology: Historical and Epistemological Remarks," Instituto de Investigaciones Filosóficas, UNAM, Mexico City, November 8, 1996.

Lecture "Experimental Systems and the History of Molecular Biology," Laboratorio de Historia de la Biología y Evolución de la Facultad de Ciencias, UNAM, Mexico City, November 13, 1996.

Lecture "Experimentelle Komplexität am Beispiel der Molekularbiologie," Institut für Wissenschaftsgeschichte, Göttingen, November 19, 1996.

Lecture "Experimentalsysteme, Experimentalkulturen, Wissenschaftsgeschichte," Kolloquium Spezielle Zoologie, Prof. W. Maier, Tübingen, December 5, 1996.

Lecture "Überlegungen zur Geschichte der Molekularbiologie," Workshop "Gab es eine moderne Synthese in der deutschen Evolutionsbiologie?," Lehrstuhl für Ethik in den Biowissenschaften, Tübingen, December 6, 1996.

Lecture "Medizinische Grundlagenforschung und Molekularbiologie: Zur Geschichte der Proteinbiosynthese," Sächsische Akademie der Wissenschaften, Leipzig, May 22, 1997.

Lecture "Wie verändert sich die Biologie? Der Einzug der Molekulargenetik," conference "Was wissen Biologen schon vom Leben," Evangelische Akademie, Loccum, May 23, 1997.

Lecture "Research-Enabling Technologies: Lyle Packard's Liquid Scintillation Counter," Workshop on Instrumentation for Science, Industry and the State: Research-Technology Dynamics, Paris, June 6, 1997.

Lecture "Experimentalsysteme," Kolloquium Berlin-Brandenburgische Akademie der Wissenschaften, Berlin, June 11, 1997.

Lecture "Ephestia: The Experimental Design of Alfred Kühn's Physiological Genetics," XXth International Congress of History of Science, Liège, July 25, 1997.

Lecture "Zwischen Ultrazentrifuge und Eiswanne - Zum Verhältnis von Präzision und Basterei in der Geschichte molekularbiologischer Labor-

praxis,” 80. Jahrestagung der DGGMNT, Regensburg, September 27, 1997.

Lecture “The Changing Fate of the ‘Gene’ in Molecular Biology,” Historical-Philosophical Faculty, University of Oslo, October 24, 1997.

Lecture “Strukturen experimenteller Praxis,” Wissenschaft als kulturelle Praxis, 1750-1900, Max-Planck-Institut für Geschichte, Göttingen, November 13, 1997.

Lecture “Conceptual Entities and Biological Processes,” Sloan Workshop on “The Knowability of Scientific Entities - Genes and Genetic Programs,” Oxnard (USA), December 5, 1997.

Lecture “Materiekonzeptionen in der Geschichte der Biologie,” Colloquium, Institut für Philosophie, Wissenschaftstheorie, Wissenschafts- und Technikgeschichte, Technische Universität Berlin, December 9, 1997.

Member of the Advisory and Editorial Boards: *Journal for the History of Biology*, *Studies in History and Philosophy of Biological and Biomedical Sciences*, *Sociology of the Sciences Yearbook*.

Editor, *Jahrbuch für Geschichte und Theorie der Biologie* and its supplement series (together with Michael Weingarten).

President (until June 1997), Deutsche Gesellschaft für Geschichte und Theorie der Biologie.

Member of the MPG commission: “Geschichte der Kaiser-Wilhelm-Gesellschaft im Nationalsozialismus.”

Tilman Sauer

Lecture “Path Integral Monte Carlo Simulations of Quantum Chains,” 5th International Conference on “Path Integrals from meV to MeV,” Dubna, May 27-31, 1996.

Lecture “Staging versus Multigrid Algorithms in Path Integral Monte Carlo,” workshop on “Algorithms for dynamical critical phenomena,” Lyon, June 20-22, 1996.

Urs Schoepflin

Lecture “Zum Neuaufbau von Bibliotheken in den neugegründeten Institu-

ten in den Neuen Bundesländern,” XIX. Fortbildungstagung für Bibliotheksleiter/innen der Max-Planck-Institute und Arbeitsgruppen, Tübingen, May 7-10 1996.

Section chair of “Neuaufbau von Bibliotheken in den neugegründeten Instituten in den Neuen Bundesländern,” XIX. Fortbildungstagung für Bibliotheksleiter/innen der Max-Planck-Institute und Arbeitsgruppen, Tübingen, May 7-10 1996.

Lecture “A bibliometric study of reference literature in the sciences and social sciences” (jointly with Wolfgang Glänzel) at the joint EASST/4S Conference on Signatures of Knowledge Societies, Bielefeld, October 9-12, 1996.

Lecture “Job enrichment und job enlargement - Integration von Tätigkeiten” at Round Table Neue Organisationsstrukturen in Bibliotheken, Göttingen, October 13 1997.

Lecture “Ganzheitliche Arbeitsplätze und BAT - Zur Arbeitsorganisation in der Bibliothek des Max-Planck-Instituts für Wissenschaftsgeschichte” at Herbsttagung der Bibliotheksleiter der GW-Sektion der MPG, Hamburg, November 6-7 1997.

Member of the program committee of the 6th Biannual Conference of the International Society for Scientometrics and Informetrics 1997 in Jerusalem.

Chairperson of the Committee on Scientometrics of the Deutsche Gesellschaft für Dokumentation.

Vice-chair of the Research Association for Science Communication and Information (RASCI).

Volkmar Schüller

Lecture “Leibniz versus Newton - Über die Polemik zwischen Leibniz und dem Newton Schüler Samuel Clarke,” Institut für Theoretische Physik der Universität Greifswald, December 12, 1996.

Lecture “Die Streitschriften zwischen Leibniz und Newtons Schüler Samuel Clarke,” workshop of 61. Physikertagung München, March 19, 1997.

H. Otto Sibum

Lecture "James Clerk Maxwell and the Education Value of Experiment," delivered at workshop on "Bedeutung und Vielfalt des Experiments," Zentrum für interdisziplinäre Forschung, Universität Bielefeld, March 28-30, 1996.

Lecture "Experimental Performance and Limits of Representation," delivered at the Internal Colloquium of the Institute, Berlin August 28, 1996.

Lecture "Instrumente der Wissenschaftsgeschichte," delivered at workshop on "Perspektiven der Instrumentengeschichte in Deutschland," Forschungsinstitut des Deutschen Museums München, December 6, 1996.

Lecture "Experimentalkulturen im Wandel: Entstehungsgeschichte eines modernen physikalischen Standards," delivered at Universität Hamburg, Institut für Geschichte der Naturwissenschaften, Mathematik und Technik, February 17, 1997.

Lecture "Vermessene Gesten," La Villette, Centre de recherche en histoire des sciences et des techniques, Paris, April 22, 1997.

Lecture "Experimentalkulturen im Wandel. Zur Entstehungsgeschichte des Energiebegriffs," delivered at conference in commemoration of Hermann von Helmholtz's publication of "Die Erhaltung der Kraft," Magnus Haus, Berlin, June 16, 1997.

Lecture "Shifting Scales," delivered at the conference on Varieties of Scientific Experience at the Max Planck Institute for the History of Science, Berlin, June 19-22, 1997.

Lecture "Experimentalkulturen im Wandel" delivered at workshop Geschichtsdiskurse V: Globale Konflikte, Erinnerungsarbeit und Neuorientierung seit 1945 at the Zentrum für interdisziplinäre Forschung, Universität Bielefeld, July 10-12, 1997.

Plenary lecture "Experimentelle Wissenschaftsgeschichte," on historiographical and methodological perspectives on the history of experiment and instrumentation, delivered at 80th annual meeting of the Deutsche Gesellschaft für Geschichte der Medizin, Naturwissenschaft und Technik, Regensburg, September 26 -29, 1997.

Delta Lecture (a joint programme of Universities of Cambridge and Oxford and the South Kensington Institute, London) "Shifting Scales. The material culture of microstudies in early Victorian Britain," delivered at the Science

Museum, London, November 19, 1997.

Director of research project “Innovation, Historical Replication and Training in Classical Experimental Physics,” British German Academic Research Collaboration Programme (British Council and German Academic Exchange Service), 1993 - March 1996.

Member of Board of the Interdivisional Group on “History of Physics” in the European Physical Society.

Affiliated Research Scholar, Department of History and Philosophy of Science, University of Cambridge, England, since 1996.

Referee for scientific journals, *Studies in History and Philosophy of Science*, *Science in Context*, *NTM*.

Teaching Activities:

Department of History and Philosophy of Science, University of Cambridge, England:

- “Working Experiments and Gestural Knowledge,” three lectures each in Lent Term 1995/96 and Lent Term 1996/97.
- “Working Experiments. Machines and Gestural Knowledge in 18th- and 19th-Century Physical Sciences,” three lectures Michaelmas Term 1997/98.

Stuart Strickland

Lecture “The Knowing Body in German Romanticism,” annual meeting of the American Society for Eighteenth-Century Studies, Austin, Texas, March 29, 1996.

Lecture “Self-Knowledge and Self-Experimentation in the Romantic Era,” Chicago-Wide Eighteenth-Century Studies Colloquium, Northwestern University, May 21, 1996.

Lecture “Die Suche nach ‘objektiven Ursachen’ und der Verdacht der Selbsttäuschung in der Physik des romantischen Zeitalters,” Institut für Geschichte der Naturwissenschaften, Mathematik und Technik der Universität Hamburg, November 25, 1996.

Lecture “Zur Geschichte der Erfahrungswissenschaften um 1800,” colloquium, MPIWG, Department II, November 27, 1996”

Denis Thieffry

Lecture "La modélisation du développement embryonnaire: de l'organisme au gène et vice versa," XXth International Congress of History of Science. Liège, Belgium, July 24, 1997.

Editor of the *Bulletin of the Canadian Society for Theoretical Biology*.

Referee for the *Journal of Theoretical Biology*.

Klaus A. Vogel

Lecture "La révolution cosmographique de la Renaissance a-t-elle eu lieu dans la cartographie grande échelle?" Université de Lille, March 21, 1996.

Chair of session at the international conference "Die humanistischen Sodalitäten im 15. und 16. Jahrhundert - Stowarzyszenia humanistyczne w XV i XVI wieku," Krakau, Collegium Maius, May 15-19, 1996.

Chair of founding session of the "Arbeitskreis interdisziplinäre Gewaltforschung," Max-Planck-Institut für Geschichte, Göttingen, July 1, 1996 (together with Prof. Dr. med. Manfred Cierpka, Leiter des Schwerpunkts Familientherapie der Universität Göttingen).

Member of the Board of the "Willibald-Pirckheimer-Gesellschaft für die Erforschung von Renaissance und Humanismus."

Editor of the "Pirckheimer-Jahrbuch" (1996 ff).

Annette Vogt

Lecture "Female Scientists at the Berlin University and at the Institutes of the Kaiser-Wilhelm-Gesellschaft in Berlin between 1898 and 1945 - First approach," Berlin, colloquium of Department II, Max Planck Institute for the History of Science, January 9, 1996.

Lecture "'Wissenschaftlerinnen in der KWG' Vortrag über das Projekt und erste Ergebnisse," Berlin, colloquium of the research group of Prof. Dr. Beate Kraus, Max Planck Institute for Human Development and Education, Berlin, January 16, 1996.

Lecture "Die Berliner Gelehrtenfamilie Remak - Aufstieg und Niedergang einer deutsch-jüdischen Familie," Berlin, Jewish-Cultur-Club, in the series "Jewish scientists in Berlin," March 19, 1996.

Lecture "Die Fräulein Doctores der Philosophischen Fakultät der Berliner Universität - Eine Längsschnittanalyse zur Entwicklung der Promotionen von Frauen zwischen 1898 und 1936," Berlin, colloquium of the chair of the History of Science at the Humboldt-Universität zu Berlin, May 7, 1996.

Lecture "Die ersten Karriereschritte - Biologinnen als Promovendinnen an der Philosophischen Fakultät und als Wissenschaftlerinnen in einigen Kaiser-Wilhelm-Instituten (1900-1945)," Berlin, colloquium "41. Medizinhistorischer Nachmittag" of the Institut für Medizingeschichte at the Humboldt-Universität zu Berlin, May 21, 1996.

Lecture "Die Kaiser-Wilhelm-Institute wagten es: Frauen als Abteilungsleiterinnen," Kaiserslautern, Lecture-Program "Frauen in Mathematik und Naturwissenschaften," Mathematische Fakultät of Universität Kaiserslautern, June 3, 1996.

Lecture "Die vergessenen Kolleginnen von Lise Meitner - Naturwissenschaftlerinnen an der Berliner Universität und in den Kaiser-Wilhelm-Instituten zwischen 1911 und 1945," Darmstadt, conference "Frauen in der Wissenschaft," Technische Hochschule Darmstadt, June 20, 1996.

Lecture "Archivakten erzählen: Frauenpromotionen an der Philosophischen Fakultät der Berliner Universität zwischen 1899 und 1936 im Fach Mathematik," Göttingen, workshop for the history of mathematics, July 16, 1996.

Lecture "Die Spielregeln der Objektivität. Die ersten Promotionen und Promotionsversuche von Frauen an der Philosophischen Fakultät der Berliner Universität 1898-1908," Berlin, Wissenschaftshistorikertag, September 28, 1996.

Lecture "Karl Weierstraß Verbindungen zu Rußland," Berlin, Wissenschaftshistorikertag, September 28, 1996.

Lecture "Und es gab sie doch - Physikerinnen in den Kaiser-Wilhelm-Instituten in Berlin-Dahlem," Berlin, opening talk for the exhibition "Von der Antike bis zur Neuzeit - der verleugnerte Anteil der Frauen an der Physik?" at the department of physics at Freie Universität Berlin, October 22, 1996.

Lecture "Lise Meitner und ihre Kolleginnen in den Instituten der Kaiser-Wilhelm-Gesellschaft zwischen 1911 und 1945," interdisciplinary research colloquium "Wissenschaftsforschung als Geschlechterforschung," Technische Universität Berlin, November 6, 1996.

Lecture "Brüche und Verschiebungen bei den Promotionen von Frauen

1900 bis 1945 am Beispiel der Universität Berlin,” Göttingen, colloquium “Frauenforschung” in the sociological seminar of the Georg-August-Universität Göttingen, November 11, 1996.

Lecture “Die Physikerin Lise Meitner - Briefe erzählen aus ihrem Leben,” Berlin, Jewish-Cultur-Club, in the series “Jewish scientists in Berlin,” November 12, 1996.

Comment “The History of Measure, the History of Risk” of Stéphane Calens, Berlin, colloquium of Department II, Max Planck Institute for the History of Science, November 13, 1996.

Lecture “Emil Julius Gumbel (1891-1966) - Mathematiker und Publizist, Zeitzeuge und Emigrant,” colloquium of the research group “Mathematikgeschichte,” Bergische Universität/Gesamthochschule Wuppertal, November 29, 1996.

Lecture “Naturwissenschaftlerinnen in der Kaiser-Wilhelm-Gesellschaft,” Berlin, colloquia “Sparkurs in der Wissenschaft - Einsparung von Frauen?” conference of the Deutsche Hochschullehrerinnenbund e.V., December 6, 1996.

Lecture “Von Petersburg nach Moskau: Zur Geschichte der russisch-sowjetischen Mathematik (1850-1975),” Lecture-Program “Wissenschaftsgeschichte in Osteuropa,” Osteuropa-Institut of the Freie Universität Berlin, December 18, 1996.

Lecture “Die ersten Karriereschritte - Physikerinnen als Promovendinnen an der Berliner Universität und als Mitarbeiterinnen in Instituten der Kaiser-Wilhelm-Gesellschaft,” lecture at the conference “100 Jahre Frauen in der Wissenschaft,” Bremen, February 18, 1997.

Lecture “Von Elisabeth Schiemann bis Hildegard Strübing - Die Promotionen von Frauen im Fach Biologie an der Friedrich-Wilhelms-Universität Berlin von 1899 (1905) bis April 1945,” lecture at the Institutskolloquium, Naturkundemuseum, Humboldt-Universität zu Berlin, February 26, 1997.

Lecture “Sonja Kovalevskajas Nachfolgerinnen - Promotionen von Frauen in der Mathematik an der Berliner Universität zwischen 1899 und April 1945,” lecture in the seminar “History of Mathematics” at the Technische Universität Wien, March 13, 1997.

Lecture “Ilse Schneider-Rosenthal - eine Frau interpretiert Albert Einstein,” lecture in the series “Jewish scientists in Berlin,” Jewish-Cultur-Club Berlin, April 8, 1997.

Lecture “Vom Hintereingang zum Hauptportal - Wissenschaftlerinnen in der Kaiser-Wilhelm-Gesellschaft,” lecture in the series “Dahlemer Archivgespräche,” Berlin, April 21, 1997.

Lecture “Frauen an der Friedrich-Wilhelms-Universität zu Berlin,” lecture in the seminar “Rekonstruktion von historischen Biographien der Humboldt-Universität,” Kulturwissenschaftliches Seminar, Frau Prof. Marlis Dürkop, Berlin, May 7, 1997.

Lecture “Scientific Experience - a report on a new effect to a learned society. Gerda Laski and her research on the infrared radiation - an example of a scientific experience. Introduction,” lecture in the Scientific Experience Group, Department II, Max Planck Institute for the History of Science, Berlin, May 12, 1997.

Lecture “Frauenpromotionen in Mathematik an der Mathematisch-Naturwissenschaftlichen Fakultät der Berliner Universität von April 1936 bis Februar 1945,” lecture at the conference, Deutsche Mathematiker-Vereinigung, Fachsektion Geschichte der Mathematik, Sektionstagung in Calw vom May 28 - June 1, 1997.

Lecture “Es gab überraschend viele Naturwissenschaftlerinnen in den Kaiser-Wilhelm-Instituten,” lecture in the Gymnasium in Osterholz (bei Bremen), Abiturstufe, June 4, 1997 (“Schulvortrag” on the occasion of the MPG-Jahreshauptversammlung).

Lecture “The Kaiser-Wilhelm-Gesellschaft and the career chances for female scientists between 1911 and 1945,” Symposium (SU 13) “Gender issues in scientific, technical and medical communities,” XXth International Congress of History of Science, Liège, July 23, 1997.

Teaching Activities:

- Lectures in the series “Jewish scientists in Berlin” in the Jewish-Cultur-Club Berlin, 1996 and in 1997.
- Seminar about the history of women scientists at the Berlin University from 1899 to 1945 cross-listed for the Historical Faculty and “gender studies,” Humboldt-Universität zu Berlin, winter semester 1997/1998.

Renate Wahsner

Lecture “Der Anfang der Naturphilosophie. Die Begriffsentwicklung von Raum über Zeit zu Materie und Bewegung in den §§ 254-261 der *Enzyklopädie*,” Universität Kaiserslautern, Sitzung des Arbeitskreises zu Hegels Naturphilosophie, February 17-18, 1996.

Lecture “Philosophie als System und Ungeschichtlichkeit der Natur – ein antiquiertes Konzept?,” San Sebastian/ Donostia, XXIth International Hegel Congress, October 1-4, 1996.

Lecture “Ernst Machs Lob der Erfahrung” (together with H.-H. v. Borzeszkowski), Institut für Philosophie der Johann Wolfgang Goethe Universität Frankfurt/Main, May 8, 1996.

Lecture “Messung als Begründung oder Vermittlung. Ein Briefwechsel mit Paul Lorenzen über Protophysik und ein paar andere Dinge” (together with H.-H. v. Borzeszkowski), Institut für Philosophie der Philipps-Universität Marburg, June 5, 1996.

Lecture “Die Suche nach der objektiven Sinnlichkeit. Über den Zusammenhang von Feuerbachs Sensualismus und Helmholtzens Programm einer empirischen Geometrie,” International Institute Schloß Reisenburg/Günzburg, Conference “Materialismus und Spiritualismus. Zwischen Philosophie und Wissenschaft nach 1848,” February 26 - March 1, 1997.

Teaching Activities:

- Hegels Naturphilosophie I. Mechanik. Freie Universität Berlin, Institute for Philosophy, Hauptseminar (2 hours per week) winter semester 1995/96.
- Hegels Naturphilosophie II. Physik und Organik. Freie Universität Berlin, Institute for Philosophy, Hauptseminar (2 hours per week) summer semester 1996.

Paul Weinig

Chair of session at the workshop “Experience and Knowledge Structures in Arabic and Latin Sciences,” Berlin, December, 16-17, 1996.

Lecture “Latin Medieval Tradition of Mechanics: Aspects of the Textual Tradition,” workshop on “Experience and Knowledge Structures in Arabic and Latin Sciences,” Berlin, December 17, 1996.

Lecture “Tradition and Context: Types of Transmission in the Medieval Science of Weights,” XXth International congress for the History of Science, Liège, July 26, 1997.

Organization of the international workshop “Experience and Knowledge Structures in Arabic and Latin Sciences” (together with Mohamed Abattouy), Max Planck Institute for the History of Science, Berlin, December 16-17, 1996.

Teaching Activities:

- Einführung in das Fach Deutsch als Fremdsprache. Humboldt Universität zu Berlin, Institut für Deutsche Sprache und Linguistik, seminar (2 hours per week), summer semester 1996.
- Landeskunde im Deutsch als Fremdsprache-Unterricht. Freie Universität Berlin, Fachbereich Germanistik, seminar (2 hours per week), summer semester 1997.
- Die Theoretisierung der Waage (together with Peter Damerow). Universität Konstanz, Kompaktseminar (30 hours a week), summer semester 1997.

ACTIVITIES OF THE VISITING SCHOLARS AND RESEARCH FELLOWS

Mohamed Abattouy (University of Fez)

stayed from July 1, 1996 - October 25, 1996 and July 1 - December 31, 1997 as a visiting scholar at the Institute and contributed to the project 1 of Department I (see *p. 34, p. 48, p. 60, p. 107 and p. 114*).

Hanne Andersen (Universität Konstanz)

stayed from February 1, 1996 - August 15, 1996 as a predoctoral research fellow at the Institute, funded by the Danish Natural Science Research Council. Her general research topic is conceptual change in conceptual revolutions. A central point of this work is to account for the dynamic of conceptual change, and especially the role played by anomalies in triggering such changes. During her stay at the Institute, Hanne Andersen worked on two case studies to illustrate these points: the discovery of nuclear fission, and the development of the theory of special relativity. On the discovery of

nuclear fission she presented some results in the Institute's internal colloquium, and finished the paper "Noddack Neglected – the 1934 Suggestion of Nuclear Fission," presented at the conference "Discovery of Elements" in Leuven/Belgium, September 17-20, 1996. On the development of the theory of special relativity she has focused on analyzing the anomaly which Einstein saw in the asymmetric description of electromagnetic induction. She contributed to the research activities of the Institute on the development of relativity theory through her analysis of students' notes from Einstein's lectures on electromagnetism and relativity in Zürich during winter semester 1913/14. Together with Klaus Vogel she initiated the internal workshop "Revolutions in Science." For the South Scandinavian Consortium for Science Studies, together with Prof. Thomas Söderqvist, University of Roskilde, she organized the summer school "The Relation Between History of Science and Philosophy of Science" which was held at the Mols Laboratory in Aarhus/Denmark, July 26-31, 1996.

Mitchell G. Ash (University of Iowa, now Institute of History, University of Vienna)

stayed from May 13, 1996 - December 15, 1996, and from June 1, 1997 - September 30, 1997 as a visiting scholar at the Institute, with support from the National Science Foundation (USA). His research concerned the following topics: forced migration and scientific change – emigré German scientists after 1933; scientific changes in Germany following political upheavals in 1933, 1945 and 1989; and psychological twin research under Nazism and after 1945. During his two stays he presented *inter alia* a paper on psychology in Germany at the turn of the century at the Schiller National Archive in Marbach, as well as a keynote address to a conference on the history of the psychological institute at the Universität Würzburg, and accepted an invitation to address to the first national conference of historians of science (*Wissenschaftshistorikertag*) in Berlin. At the Institute he presented a department colloquium paper entitled "From 'Positive' Eugenics to Behavioral Genetics: Psychological Twin Research under Nazism and Since," and an Institute colloquium paper entitled "Scientific Changes in Germany after 1933, 1945 and 1989: Toward a Comparison."

Jutta Berger (Technische Universität Berlin)

stayed from October 1, 1996 - September 30, 1997 as a postdoctoral research fellow at the Institute. She started work on a research project "Georg Ernst Stahl's Concept of the Chemical Processes." Stahl's research question, how the change of substances occurs, remains not only one of the central theoretical problems of chemistry as a natural science, but also one of the classical themes of natural philosophy, where it is generally known as "the problem of mixtio."

Today Georg Ernst Stahl (1659-1734) is best known for his phlogiston theory of combustion, which is usually regarded as the first generally accepted theory of eighteenth-century chemistry. Most historiographical research on Stahl has been done from this perspective, and thus classifies his research primarily as prehistory to the chemical revolution achieved by Lavoisier. Furthermore, his historiographical characterization appears to be rather ambivalent. On the one hand, he is thought of as one of the most important theorists of eighteenth-century chemistry; on the other hand he is described as obscure, mysterious and outdated. Starting from this contradiction, Berger attempted to look at Stahl's theory of matter and his ideas on chemical change from the reverse perspective of seventeenth-century chemistry. She focused her study on the works of the chemical practitioners Glauber, Kunkel, and Becher. In contrasting their notions of substantial change with those of the alchemists represented by the works of Geber Latinus and even Paracelsus, she demonstrated that the seventeenth century can be seen as a transitional period in chemistry, as the concept of "reaction" was just emerging.

"Reaction" means that changes in substances are interpreted as a naturally occurring process resulting from an interaction of different chemical substances to form a new combination. This idea must be distinguished from alchemical transmutation, which was interpreted as the qualitative change of a body effected by an alchemical operation.

Berger's study of ideas about chemical change focused on two problems: 1) the relationship between corpuscular notions and the use of the traditional concepts of qualities in explaining chemical change and, 2) the use, significance and development of the term "affinity" as the cause of a specific chemical behavior.

Additional activities:

Lecture "Zeit in der Chemie: Reaktionszeit und Affinität," research collo-

quium of the Institut für Philosophie, Wissenschafts- und Technikgeschichte, Technische Universität Berlin, January 7, 1997

Lecture “Chemische Mechanik und Kinetik,” Fachgruppe Geschichte der Chemie of the Gesellschaft Deutscher Chemiker at Marburg, March 13, 1997.

Conevery Bolton (Harvard University)

stayed from June 15 - July 1, 1997 as a predoctoral research fellow at the institute. She was working on her dissertation “The Health of the Country: Environment, Health, and Sense of Place in the Making of the American West, 1800-1850.” Her advisor is Professor Allan M. Brandt of the Department of the History of Science, Harvard University Faculty of Arts and Sciences, and the Department of Social Medicine, Harvard Medical School.

This project connects Arkansas and Missouri settlers’ perceptions of body and environment with concerns of early nineteenth-century American culture, the quotidian experiences of immigration and agricultural work, and long-standing ideas about both health and the natural world. Documenting a pervasive and powerful set of beliefs, it asserts the centrality of health to Western immigration and American national expansion in the first half of the nineteenth century.

This project traces the perceived relationships between environment and health in the early histories of Arkansas and Missouri, setting those specific regions in a broader context of U.S. expansion into the trans-Mississippi West. Charting the interactions between popular writings and medical and scientific reports, it explores a world-view in which the human body was in thrall to forces both powerful and all-pervasive. The dissertation’s six main chapters address, respectively: health concerns in the context of American Western immigration; the concept of bodily well-being and the multiple meanings of environmental miasma; relations between agricultural ideas and medico-scientific understandings of the body; the literature of medical geography and its utility in establishing a professional role for the physician/scientist in borderland regions; anxieties about the instability of race as revealed in discussions about acclimatization; and the interactions between perceptions of the health of Western environments and emerging conceptions of region and regionalism.

Christophe Bonneuil (Université de Paris 7)

stayed from August 1, 1996 - February 28, 1997 as a predoctoral research fellow, and is staying from March 1, 1997 to February 28, 1998 as a CNRS postdoctoral research fellow at the Institute. In May 1997 he completed his dissertation on "Crafting and Disciplining the Tropics: Plant Science in the French Empire, 1870-1940," which straddled the disciplines of the cultural history of French colonialism, environmental history and the history of science. More specifically, he explored scientific practices in some spaces of knowledge – herbariums, botanical gardens, agricultural experimental stations, plantations – to elucidate the constitution of the tropical space as a field of investigation, intervention and control, as well as the production of visions of tropical nature and societies. The main issues addressed in this dissertation include: 1) the establishment of the Paris Muséum National d'Histoire Naturelle as an imperial institution of the Third Republic and the colonial culture of curiosity in the wake of exploration and conquest; 2) plant transfers, colonial botanical gardens and the creation of a Western/cosmopolitan/urban tropicality in colonial cities (case study on Conakry, French Guinea); 3) the plantation as laboratory: the organization of space, agricultural research, and scientific management of workers in order to achieve the three goals of (contested) social order, higher yields and increased agronomical knowledge (case study of the rubber industry in Indochina); 4) the colonial monitoring of African agriculture: patterns of scientific research and forms of intervention which placed rural societies under experimentation and rendered them more receptive to the practices and objects of the experimental station as well as more amenable to administrative action (case study on peanut breeding in Senegal).

His present research interests are concentrated on the two following themes:

1. An archeology of "Development" – understood as a coherent nexus of discourses, knowledge, and modes of intervention in the peasantries in tropical regions – from the perspective of the experimentalization of agrarian societies. His previous work revealed a shift in the culture of French colonialism from a posture of "unveiler" to a posture of experimenter and demiurge transforming "less advanced" societies. The project explores how African agrarian societies were turned into objects of "development" in the period 1930-1970 both under French and British rule as well as by the new independent States, through a comparative study of some of the sites of experimentation that flourished during this period: irrigation projects

(the Office du Niger in Mali), units of mechanization (Groundnut Scheme in British Tanganyika), or units of technology transfer like the “Paysan-nats” in the Belgian Congo. Hybrids between a village and an experimental system, these sites were crucial for experimenting with “development,” *i.e.*, for the production of both scientific knowledge on farming in Africa and expert knowledge on adequate ways to monitor agrarian communities. Bonneuil studies how space, land use, social relations and work were configured by experts, bureaucrats and researchers in order to render these transformed villages amenable to the production of such knowledge, and discusses how farmers reacted to these interventions.

2. The practices of classifying and naming in botany in the second half of the nineteenth century. Intense controversies erupted about the breadth and criteria of circumscription of species (not to mention more ontological questions) and about rules of nomenclature, which only can be fully understood in two contemporary contexts: the increasing flood of specimens collected at the periphery of expanding colonial empires, and the growing hegemony of huge public herbaria, such as those of Kew, Berlin and Paris. These major imperial centers trained botanists and instructed travelers’ eyes and hands. They edited colonial floras, monographs and other unprecedented compilatory works, preparing the ground for a division of labor among botanists, and served as tools for controlling the production of new names and for standardizing classification practices. Bonneuil investigates the competing metrological activities of these herbaria and their relations to travelers, traders and indigenous botanical knowledge.

This second research theme is part of Department II’s research project on “Science, Travel and Instrument,” coordinated by Otto Sibum.

Additional activities:

Lecture “The Right Seeds in a Cleared Field: Peasants and Colonial Experts in Senegal (1900-1950),” at Berlin Summer Academy “Nature’s Histories, August 18-29, 1997, MPIWG.

Francesca Bordogna (University of Chicago)

stayed from April 1, 1996 - December 15, 1996 as a predoctoral research fellow at the Institute. She worked on two different projects.

The first dealt with epistemological problems posited by psychical phenomena – *e.g.*, telepathy, clairvoyance, levitation of tables, etc. Based on

material collected in the archive of the Society for Psychical Research in Cambridge, UK in July 1996, she wrote a conference paper, "Objectivity and Psychical Research, 1880-1910," for the History of Science Society Meeting held in Atlanta in November 1996. This paper traced the change in psychical researchers' approach to the issue of objectivity over the period considered. Their increasing appeals to the apparatus and notion of mechanical objectivity suggest growing concerns with the introduction of epistemological distortions by the unconscious mind of the investigator. Bordogna also wrote one chapter of her dissertation, "The Scientist and the Ghost: The Epistemology and Method of Pragmatism in Context," presented at the Department II Colloquium on December 11, 1996. This chapter deals with evidential problems raised by psychical phenomena, and argues that James's pragmatist conception of evidence relates in complex ways to his investigation of such phenomena.

She also completed a long-term project on the history of algebraic number theory, writing a paper on the perception and conceptualization of ideal numbers in the second half of the nineteenth century.

Preprint: "Interpreting the Ideal: Embedding Ideal Numbers in the Mathematical Programs of Kummer, Dedekind, and Klein," preprint no. 47.

Additional Activities:

Conference paper "Objectivity and Psychical Research, 1880-1910," Atlanta, History of Science Society Meeting, November 9, 1996

Christina Brandt (Georg-August-Universität Göttingen)

is staying from October 1, 1996 - December 31, 1998 as a predoctoral research fellow at the Institute.

She is working on her dissertation on metaphors in the history of molecular biology. Her project deals with the emergence and development of language as a metaphor ('DNA as language' or tropes of reading and writing) and its connections to the 'information' metaphor in molecular biology throughout the 1950's and 1960's. She examines both the scientific literature of this period as well as the dissemination of 'language' tropes in the textbooks of the 1960's. Combining theories of metaphor with historical research, her work focuses on the constitutive role and the transformational power of metaphors. On the basis of case studies, she analyzes how linguistic metaphors were used and developed in different research contexts, how

they interacted with scientific practice, and how shifts of meaning took place through these processes. To this end, she is concentrating on two case studies: the development of tobacco mosaic virus research in Berkeley and Tübingen in the 1950's and the early 1960's, and the research on genetic fine structure by Seymour Benzer during the same period.

Stéphane Callens (Université de Lille 1)

stayed from October 1, 1996 - September 30, 1997 as a postdoctoral research fellow at the Institute. He completed a study of the history of measure and probability theories in the nineteenth century. He currently is working on the topic of risks, specifically, on the relationship between economic theories of risk and public debates on economics in the twentieth century.

During the last trimester of 1996 he prepared the draft of his book *Les maîtres de l'erreur*, and wrote two research reports. The report "On se trompe toujours" concerns the local governance of risks; "Economie de la précaution" deals with the role of the *Vorsorgeprinzip* in the history of prudence and in the history of economic theories.

During this period, he participated in an internal colloquium on November 13, 1996 with the discussion paper "The History of Measure, The History of Risk." He also edited an issue of the review, *Clés*, on "Les économies de l'extrême," published by the University of Lille.

Michele Camerota (Università di Cagliari)

stayed from November 16, 1995 - February 15, 1996 and July 8, 1996 - October 8, 1996 as a postdoctoral research fellow at the Institute and contributed to the project 1 of Department I (see p. 56 and p. 108).

Yoonsuhn Chung (Seoul)

stayed from May 1, 1996 - April 30, 1997 and October 1 - December 31, 1997 as a visiting scholar at the Institute. Her work focuses mainly on the historical investigation of the epistemological structure of the basic concepts and categories of physics. Tracing the shift of the basic categories from space and matter into field and vacuum in modern physics is one of its central questions.

During her stay she finished a paper with the title “Die Entwicklung des Kraftbegriffes im 18. und 19. Jahrhundert und die Entstehung des Feldbegriffes als einer Entität zwischen Raum und Materie” (MPIWG preprint, no. 68), in which the epistemological structure of the classical field concept and the influences of earlier ideas about space and matter are investigated. This work will be published in a book with the working title: *The Epistemological Structure of Michael Faraday’s Field Concept*.

In her paper it is shown that the concept of force was first treated as a mathematical quantity in natural philosophy in early modern times and then “materialized” through Faraday’s concept of lines of force in the nineteenth century. A part from the development of the mathematical formalism in the eighteenth century, the crucial role in the process of this conceptualization was played by the concepts of force in the monadological theories of Giordano Bruno and Leibniz, which were transformed through the writings of Rudjer Boscovich and of Immanuel Kant. This classical concept of field, which arose as an entity between (substantialized) space and matter, was expanded to provide the basis for the development of the modern concept of the quantum field.

The latest step in the “materialization” of the concept of force is achieved by the so-called second quantization of the fields in quantum field theory. The vacuum, now considered to be the ground state of the field (not an empty space), is thereby structured. Whether the concepts of field and vacuum build the basic categories of modern physics requires further investigation.

Nani Clow (Harvard University)

stayed from February 1, 1996 - August 31, 1996 as a predoctoral research fellow at the Institute. She worked on her dissertation project titled “The Laboratory of Victorian Culture: Experiments, Technicians, and Industry in Oliver Lodge’s Liverpool Laboratory, 1881-1900.” Using Oliver Lodge’s (1851-1940) University College Liverpool Laboratory as a focal point, the dissertation examines the interplay of experimental physics with educational, technological, and industrial concerns in the late nineteenth century. The experimental physics laboratory became a site not only for education, but also for research, calibration, and metrology for both industry and academic physics. In general, the project examines how the requirements for expertise in both experiment and theory manifested themselves

in the physical spaces, instruments, practice and pedagogical tools of the laboratory.

Alix Cooper (Harvard University)

stayed from July 1, 1997 - August 31, 1997 as a predoctoral research fellow at the Institute. She is currently in the final stages of researching and writing her dissertation, "Inventing the Indigenous: Local Knowledge and Natural History in the Early Modern German Territories," which explores the emergence of the local flora and similar genres in the seventeenth century as ways of taking inventory of 'natural riches.' While at the Institute, she made use of Berlin's rich library resources to locate several sources she had not been able to find during her previous stay in Göttingen. She also took advantage of the opportunity to take part in the Institute's 1997 International Summer Academy, "Nature's Histories." Other research interests include the development of concepts of 'natural resources;' the environmental history of early modern Europe; the history of medicine and the body, in particular occupational and environmental medicine and the 'diseases of scholars;' and local, national and international divisions of labor in science.

Serafina Cuomo (Christ's College, Cambridge, GB)

stayed from October 1, 1996 - September 30, 1997 as a post-doctoral research fellow at the Institute. She completed a book on *The Faces of Mathematics in Late Antiquity: Pappus of Alexandria's Collectio Mathematica*. By combining an analysis of the text with a study of contemporary mathematical practices and a survey of their cultural and social background, she argued that Pappus (ca. 4th century A.D.) had a mathematical agenda which featured a strong interest in problem-solving and geometrical constructions, in generalizations and analysis of particular cases, and in applications of general statements to particular instances, carried out by numerical calculations. Moreover, Pappus used and, to a certain extent, created previous mathematical traditions as a means to assert his own expertise and authority, and to convey an image of the good mathematician which included ethical and social virtues, as well as knowledge of the subject and intellectual skills.

She also wrote a section on Roman engineering for the *Enciclopedia della*

storia della scienza and a paper on Roman land surveying for the conference “Mathematics in the Ancient World” in Oxford, September 20-21, 1997. This latter, which could become a larger project on surveying in the Roman Empire, focuses on Frontinus (1st century AD) and explores the meanings of land division, which was at the same time a way to facilitate the administration of a territory, a way of making a landscape into an object of knowledge, and a way to occupy and control space.

In the seminar of the Department II she contributed a paper, “The Machine and the City: Hero of Alexandria’s War Engines.” She is currently working on an article about rules for multiplication in antiquity, as well as on a general history of mathematics in antiquity (forthcoming in the Routledge series, *Sciences in Antiquity*, 1999).

Michael Dettelbach (Smith College, Northampton)

stayed at the Institute from January 1, 1997 - June 30, 1997 as an Alexander von Humboldt fellow at the Institute. As planned, much of his stay in Berlin was spent working at the Preussisches Geheimes Staatsarchiv in Dahlem and with the correspondence collections of the Humboldt-Forschungsstelle in the Berlin-Brandenburgische Akademie der Wissenschaften, collecting evidence of Humboldt’s participation in Prussian political, economic, and cultural reform between the Revolutions of 1789 and 1848. He discovered traces of such activity in three areas – railroads and banking liberalization; mining (including an important memorandum on Prussia’s acquisition of the Rhineland in 1815); military education and army reform – and presented his findings to the Akademie’s Arbeitskolloquium in the history of the sciences (April 29, 1997). These findings will form the basis for an article on Humboldt as mediator between court, bureaucracy, and *Wissenschaft* in the interrevolutionary Prussian monarchy, intended for a forum such as the *Journal of Modern History*.

Unplanned, but no less important, were the colloquia and daily interactions with scholars at the Max Planck Institute, which drew him back towards statistics and mapping as expressions of political economy, and to Humboldt’s role as an innovator in these fields, especially in the graphic display and manipulation of data and in the creation of new forms of topographical surveying. A presentation on this topic to the Institute’s working group on scientific experience (April 21, 1997) yielded an essay, tentatively titled “Making the Face of Nature: Surveying Techniques and Nature-Physiog-

onomy in Humboldtian Science,” forthcoming in *Studies in the History and Philosophy of Science*.

Bruce S. Eastwood (University of Kentucky)

stayed from July 1, 1997 - September 30, 1997 as a visiting scholar at the Institute and contributed to the project 3 of Department I (see *p. 104*).

Berna Kılıç Eden (University of Chicago)

stayed from September 1, 1995 - December 31, 1996 as a predoctoral research fellow at the Institute. Her project searches the roots of antipsychologism within philosophies of probability, by examining the development of empirical psychology, focusing mainly on the British intellectual scene.

During the middle decades of the nineteenth century, a central divide in the modern accounts of probability emerged, tending to polarize statisticians and philosophers of probability into objectivists and subjectivists. A new philosophy of probability, frequentism, appeared at this time, opening the received opinions on the subject to criticism, and emphasizing the objective nature of probability judgments. Why did this bifurcation take place during this period? Why were savants of the caliber of Jacob Bernoulli or Pierre-Simon de Laplace, whose mathematical insights were venerated by the frequentists Robert Leslie Ellis and John Venn, accused of subjectivism by the same? Not because Ellis or Venn thought the classical approach, formulated in the works of Bernoulli or Laplace, was only a descriptive enterprise, registering personal evaluations of uncertainties. The problem, as they saw it, was that classical probability could not live up to its normative aspirations. But, on the other hand, why did Bernoulli or Laplace fail to perceive any such gap between the descriptive and the normative features of probability theory?

The dismissive attitudes towards psychology found among the writers on logic and probability in this period hint at the answers to these questions. Psychology was accepted as a field of investigation, but only as long as it was bracketed out from the philosophies of logic and probability. The thesis of this project is that the studies in empirical psychology flourishing at the time revealed not only deviants, but also, and more importantly, variants to the classical ideal of rationality. Significant support for this devel-

opment was provided by the phrenological doctrines so popular in Britain in the first half of the nineteenth century. Charting out the mind directly from the shape of the brain, phrenology not only made minds transparent through the cranium, but implied that they were as infinitely variable as the bumps on an individual's head. An investigation of the impact of the phrenological movement on writers on logic or probability, such as William Hamilton, John Stuart Mill, Alexander Bain and Herbert Spencer, provides an explanation of the rise of this concern with objectivity. Psychology, as long as it continued to locate irrationality in the mutant as it had in previous centuries, posed no threat to those normative claims of probability theory which at the same time professed to be descriptive. But could a psychology which undermined the very substratum of rationality, the sacrosanct monolithic mind, by establishing the variability of minds, still be of service to a philosophy of probability?

In this context, the project seeks insights into a wider inquiry pertaining to the reasons for the rise of anti-psychologism within philosophies of logic at the turn of the twentieth century. Anti-psychologism, a persistent feature of the twentieth-century scientific world view that sought to eliminate forms of personal or communal knowledge as viable epistemological units, first became conceivable in the nineteenth century. Rather than construing anti-psychologism as a sudden realization by philosophers like Gottlob Frege and Edmund Husserl that logic had nothing to do with psychological considerations, further expansion and elaboration of this research will demonstrate that logic and psychology became incompatible because of the new orientation of empirical psychology.

As part of this research project, Eden has examined the archives in several locations in the U.K. A short article on the history of probability is forthcoming in *The Scientific Revolution: An Encyclopedia*, edited by W. Applebaum.

Eden is staying at the Institute for a second time from September 1, 1997 - August 31, 1998 as a postdoctoral research fellow. Her current research focuses on the scientific context of the rise of anti-psychologism and anti-anthropologism among German logicians at the end of the nineteenth century. The reasons for this hostility towards psychology and anthropology, most prominently exhibited in the works of Edmund Husserl and Gottlob Frege, are sought in the flourishing life and human sciences of the nineteenth century, particularly in the biological, psychological and anthropological conceptions of the mental individual which these sciences

promulgated. The study aims to ascertain whether the human and life sciences of the nineteenth century posed a challenge to logic through their articulation of a more detailed and complex picture of the mental individual than that of Enlightenment studies of human nature.

Elisabeth Emter (Freie Universität Berlin)

stayed from October 1, 1996 - September 30, 1997 as a postdoctoral research fellow at the Institute. Her scientific interests center on the relation between perceptions of the human corpse and concepts of personal identity in Germany in the seventeenth and eighteenth centuries. This research, which contributes to a growing literature on changing constructs of the human body, rests on the premise that to historicize the body one must also historicize the corpse. Instead of limiting her analysis to representations of the dead human body, Emter focuses on the elaboration of the corpse in the context of various scientific and philosophical projects. She is currently using medical and anatomical texts to investigate how seventeenth- and eighteenth-century anatomists created their objects of observation. This work includes an examination of the terms used for the dead human being and of the historical context to which these terms belonged.

During her time at the Institute, Emter's interest led her to focus on the following research questions: How did the ancient idea of the separation of the consciousness and the body at death shape anatomists' view of the corpse? How were scientific perceptions of the corpse shaped by the introduction of new instruments and methods of anatomical examination? How was the unimportant individual reconciled with the important universal? How were others persuaded to accept dissection? How were the physical signs of death determined and described? How did the scientific treatment of the corpse differ from popular attitudes towards death? In a subsequent phase of this research, Emter related her analysis of explicitly scientific and medical texts with the portrayal of anatomy and corpses in seventeenth- and eighteenth-century literature and art, analyzing a novel published by the physician Johann Christoph Ettner in 1697 which focused on the role of anatomical practice in Ettner's concept of an ideal doctor.

Over the course of the year she also finished an article on the relation between modern physics and twentieth-century literature and completed a paper on the influence of Søren Kierkegaard on Max Bense's concept of *Augenblick*. In addition, she wrote the introduction for the second volume

of the collected papers of the philosopher Max Bense. She also participated in the workshop *Constructing and Deconstructing the Body. Art and Anatomy XVth-XXth Century*, held in Annecy, May 8-11, 1997.

Robert Englund (University of California at Los Angeles)

stayed from September 10, 1997 - September 24, 1997 as a visiting scholar at the Institute and contributed to the *Database of Proto-Cuneiform Texts from Archaic Babylonia* (see p. 110) and the *Cuneiform Texts of the Third Millennium B.C. in the Vorderasiatisches Museum, Berlin* (see p. 113).

Raphael Falk (The Hebrew University of Jerusalem)

stayed from September 20, 1996 - October 20, 1996 and July 15, 1997 - September 19, 1997 as a visiting scholar at the Institute. The stay in 1996 was devoted to the preparation of the workshop on "*Gene Concepts in Development and Evolution II*" (see p. 247).

The two months in 1997 were devoted to editing fourteen papers submitted for the volume on "The Gene Concept in Evolution and Development" following the Workshop held on the subject in the fall of 1996.

All papers were intensively annotated and written comments were prepared for external reviewers and the authors, after consultation with the other two editors, Peter Beurton and Hans-Jörg Rheinberger.

Detailed notes were prepared, along with an early draft of a "Commentary Overview" paper which summarizes the ideas discussed at the Workshop and in the submitted papers. A comprehensive literature list of all the papers also was compiled. The remaining preparatory work should allow the publication of the volume within the next year.

July 22-26, 1997 Falk traveled to Liège, Belgium, to participate in the 20th International Congress of History of Science. He participated in the discussions and contributed a paper on "Muller on Development" to the session on developmental genetics.

Raymond Fredette (Fitch Bay, Canada)

stayed from November 25, 1997 - December 5, 1997 as a visiting scholar at the Institute and contributed to the project 1 of Department I (see p. 68).

Gideon Freudenthal (Tel-Aviv University)

stayed from June 1, 1996 - July 7, 1996, and from July 25, 1997 - August 25, 1997 as a visiting scholar at the Institute. During his first stay, he worked on the epistemological status of conservation principles in Leibniz's philosophy and on the concept "Scientific Controversy." He completed the paper "Leibniz als Transzendental philosoph malgré lui" which he presented to the conference "Labora diligenter," July 4-6, 1996, at the Einstein Forum in Potsdam. The paper will be published in a supplementary issue of *Studia Leibnitiana*.

In addition, he prepared a commentary on a paper of Prof. Alan Gross on scientific controversies. This commentary was read at the École des Hautes Études en Sciences Sociales, Paris.

During his second stay, he worked on the Leibniz-Papin controversy over the concept of "force" in physics. He translated most papers and letters from Latin and French into English and worked on the interpretation of the controversy. When completed, this work will be published accompanied by the relevant texts in a Volume *Leibniz the Polemicist*, to be edited together with Marcelo Dascal and Quintin Racionero.

Ofer Gal (University of Pittsburgh)

stayed from October 1, 1996 - December 31, 1997 as a postdoctoral research fellow at the Institute and contributed to the project 1 of Department I (see *p. 34* and *p. 68*).

Peter Geimer (Philipps-Universität Marburg)

is staying from June 1, 1997 - December 31, 1998 as a postdoctoral research fellow at the Institute. His research project concerns the photography of invisible phenomena around 1900. It deals with cases in which photographs functioned as visible (and often the only) proof of the existence of certain phenomena. The study aims at a description and analysis of this extra value of photography and its epistemological status. A comparative study of significant cases (photography of rays, forces and phantoms) will show the extent to which a common structure of these different kinds of photographic visualization of invisibility existed.

A special interest derives from the fact that photography was regarded both

as a means and a subject of scientific research. “La photographie est une des branches de la chimie et de la physique,” declared Albert Londe in 1889. Photography, then, could produce representations of chemical and physical processes by means of chemical and physical processes. Therefore scientific critics of spirit photography argued that photographs of supernatural and invisible phenomena were mere visualizations of chemical accidents deriving from the photographic process itself, products which normally would be treated as deficiency, failure and waste. Thus the project deals with a space of knowledge in which the interpretation of one and the same visual document balanced between worthless waste product and serious epistemological object, between technical fault and technically revealed truth.

Additional Activities:

Lecture “Die Blendung. Vom Trauma der Blitzlichtphotographie,” at the conference Trauma/Zeit. Das Ereignis im Zeitalter der Medien, Zentrum für Literaturforschung Berlin, July 9-10, 1997.

Martin Gierl (Georg-August-Universität Göttingen and Max-Planck-Institut für Geschichte, Göttingen)

stayed from October 1, 1995 - October 31, 1996 as a postdoctoral research fellow at the Institute. The history of coin collecting, *i.e.*, numismatics, in the eighteenth century was at the focus of his research interests. His project encompassed two parts. First, through an intensive study of the practice of eighteenth-century numismatics it became possible to understand the process of scientific rationalization in a novel fashion. This process may also be described as the co-evolution of numismatics and a “rationalized” society. The second part analyzed the interconnections between coin collecting and the emergence of modern historiography.

The eighteenth-century fashion of numismatics extracted coins of old vintage out of general circulation and had the startling effect of minting a uniform coinage. In response to the demands of numismatists, coin-descriptions were for the first time gathered and published in a comprehensive manner. By exhaustively describing all coins which were known to have existed, the field of numismatics became a central domain in the emergence of the “new” historiography. Numismatists determined the historical importance of events: Remarkable is what was minted on a coin. Thus numismatics contributed to the emergence of a new historical sensi-

bility – history which claimed to be universal. Instead of telling single stories about single events, historians began to investigate history in its all-embracing, singular form.

This two-pronged investigation traced the paths of numismatists from the contemplation of individual coins to economics and finance, an ambitious project whose completion they envisioned at the end of the century. Gierl's study illustrated the intentions of changing numismatics into finance and its correlation to a new form of a historic thinking: History no longer was seen as a store of past events, but as a continuous process. Production, rather than collecting, became the goal in this new epoch.

Additional activities:

Lecture "Pietismus im Streit. Theologischer Wahrheitsschutz und die Genese des Pietismus" at the Internationales Pietismussymposium in Spiez, March 4 - 6, 1996, organized by the Historischen Kommission zur Erforschung des Pietismus.

Lecture "Theologischer Wahrheitsschutz und die Geburt der Frühaufklärung" at the Friedrich-Meinecke-Institut der Freien Universität Berlin, May 15, 1996

Lecture "Die Reform der Gelehrsamkeit am Ende des 17. Jahrhunderts," October 21, 1996 as part of the Berliner Seminar für Wissenschaftsgeschichte, organized by the Berliner Verbund für Wissenschaftsgeschichte and the MPIWG.

Hubert Goenner (Georg-August-Universität Göttingen)

stayed from November 1, 1995 - February 29, 1996 and August 7, 1996 - August 30, 1996 as a visiting scholar at the Institute and contributed to the project 2 of Department I (see *p. 87* and *p. 90*).

Catherine Goldstein (CNRS/Université de Paris Sud)

stayed from July 7, 1996 - October 7, 1996 as a visiting scholar at the Institute. She is a researcher at the Centre National de la Recherche Scientifique (URA D-752) and worked at the Institute within the framework of a joint program between the CNRS and the Max Planck Society, on the theme of the transmission of scientific knowledge.

Her research focuses on numbers and number theory in the perspective of a social history of mathematical tools, results and practices. During her stay at the Institute she worked on the relations between German (especially Berlin) and French number theory between 1870 and 1914, adopting a strategy of textual 'micro'-history. More specifically, by taking into account all the articles published during this period and exploring their relationships at a variety of levels (references, tools, comments, contents) it was possible to delineate groups of texts where extensive exchanges (sometimes of an oppositional nature, sometimes based on explicit or implicit collaboration) are revealed and others which are specifically characteristic of one subgroup of a center. This approach also allowed a redefinition of the position and work of such important figures as Hermite: his training and mathematical interests relate him closely to German mathematicians, among other things through his attention to a unity of mathematics. Hermite sought this unity through the revelation of unexpected connections among various areas in opposition to other positions, where the stress is put on the purity of method and the necessity to maintain homogeneity of results, mathematical objects and tools. To this end Goldstein also used extensively the Berlin Archives, particularly those at the Academy of Sciences. She also began a similar work (in order to explore the potentiality of the approach) on unified field theory in the 1920's, in collaboration with another visiting scholar at the Institute, James Ritter.

Ton van Helvoort (Maastricht University)

is staying from October 1, 1997 - November 30, 1997 as a postdoctoral research fellow at the Institute.

Having published on the history of virology and the history of the concept of virus in particular, Helvoort's interest is now moving to cancer research in the first half of this century. His project is on the history of the Institut für Krebsforschung of the Charité in Berlin in general, and on the favourable reception of two experimental cancer models - one in chicken and one in plants - at this institute in the 1920's in particular. In these cancer models a virus and a bacterium, respectively, were claimed to be the aetiological agents.

The establishment of the Institut für Krebsforschung in 1903 was an initiative of Ernst von Leyden, who adhered to the hypothesis of an "Infectious Origin of Cancer." In the 1910's this hypothesis fell into disgrace and,

therefore, many clinical pathologists were more than skeptical about the validity of the models mentioned above. Aims of the study are to analyze 1) how the institute gained authority in its competition with neighboring clinical departments, *e.g.*, surgery, gynecology, and dermatology; and 2) how the aforementioned cancer models were given credibility in this clinically oriented institute.

Frederic L. Holmes (Yale University)

stayed from June 15 - July 15, 1996 as visiting scholar at the Institute. He began a project to study the origins of physiological chemistry as an example of the formation of scientific disciplines in nineteenth-century Germany. The example is chosen as representative of the type of subfield which arises, not by the subdivision of an existing field, but by the recombination of portions of previously existing fields. One of the questions asked is whether physiological chemistry acquired an autonomous disciplinary structure of knowledge, or whether it remained a boundary field between chemistry and physiology. For a preliminary exploration of the evolving structure of the discipline, he examined four textbooks of physiological chemistry spanning the period 1850 to 1900. To assess the results of this first phase in the project, he wrote an informal position paper which formed the basis for an internal workshop convened at the end of his visit (see also *Discovery of the Urea Cycle* p. 99).

Wallace Hooper (Bloomington, Indiana)

stayed from August 11, 1997 - August 31, 1997 as a visiting scholar at the Institute and contributed to the project 1 of Department I (see p. 62).

Blahoslav Hruška (The Oriental Institute, Prague)

stayed from August 1, 1996 - August 31, 1996 and August 1, 1997 - September 30, 1997 as a visiting scholar at the Institute. Hruška investigated systems of knowledge in Ancient Mesopotamia during the third through first millennia B.C., particularly the bilingual Sumerian-Akkadian cuneiform lexical lists. Ancient Mesopotamian knowledge is still incorrectly called a "science of lists" (*Listenwissenschaft*), although the thematically ordered lists already contain the first signs of a reflexive and associative

structuring of knowledge. Nor did these lexical lists serve only for the conservation of Sumerian – already a dead language by the second millennium B.C. Their authors and users – even in the educational system – possessed specific traditions and constituted socially differentiated groups of experts. List entries were memoranda, directed at people who already understood their use and were informed about their conceptual history. Hruška sought in the bilingual lists the competence which the individual list entries assumed from their users, in order to illuminate the relation between students and scholars. The problem of ancient Mesopotamian knowledge brings together three questions: How did someone name and describe an object (concept formation)? How did he come to know and understand the object (concept content)? How did he transmit knowledge of the object (concept development and change)?

In order to achieve a broad basis for dealing with these theoretical problems, research has been pursued in three different areas: (1) the reflexions of the list entries in the Sumerian “dialogues,” (2) the role of reflective thinking in the Sumerian mythological texts, and (3) the instructional texts and their didactic functions (proverbs, riddles, instructions and precepts, essays concerned with the Mesopotamian scribe and school).

Sarah Jansen

is staying as a postdoctoral research fellow from August 1, 1997 - September 30, 1999, and stayed before as a predoctoral research fellow from January 1, 1997 - July 31, 1997. In her dissertation on the history of pest control in Germany she provided a history of the mathematical, experimental, technical, economic, semantic and social-administrative construction of a scientific-technological object, the ‘pests.’ Her postdoctoral research project “Population as an Object of Experimental-Mathematical Systems: Ecology and Related Fields in Germany, 1850-1950,” will use the example of animal population ecology and its forerunners to develop a historical-epistemological case study about mathematization in biology.

Additional Activities:

Lecture “‘Sozialparasiten’ und ‘Tödlichkeitszahlen’: Zu Repräsentationsformen der Schädlingsbekämpfung in Deutschland, 1900-1920,” presented in Bielefeld, Institut für Wissenschafts- und Technikforschung, at the conference Faktizität, Kontext, Diskurs, Diskursanalyse in den Geschichts-, Kultur- und Sozialwissenschaften, February 1, 1997 and at the Berlin Sum-

mer Academy “Nature’s Histories, August 18-29, 1997, MPIWG.

Instructed seminar, “Geschichte der Geschlechterverhältnisse in Naturwissenschaft und Technik,” at the Technische Universität Braunschweig, Abteilung für Geschichte der Pharmazie und der Naturwissenschaften, winter semester 1996/1997.

Assistant docent and co-organizer at the Berlin Summer Academy “Nature’s Histories,” August 18-29, 1997, MPIWG.

Edward Jurkowitz (University of Toronto)

stayed from December 1, 1995 - December 31, 1996 and June 1, 1997 - August 15, 1997 as a postdoctoral research fellow at the Institute and contributed to the project 2 of Department I (see p. 90).

Shaul Katzir (Tel-Aviv University)

stayed from June 1, 1996 - July 31, 1996 and March 1, 1997 - April 30, 1997 as a predoctoral research fellow at the Institute and contributed to the project 2 of Department I (see p. 84).

Lily Kay (Massachusetts Institute of Technology)

stayed from May 5, 1997 - August 5, 1997 as a visiting scholar at the Institute. During her stay she completed the final chapter, “In the Beginning was the Word?” of her book, *Who Wrote the Book of Life? A History of the Genetic Code* (Stanford University Press, forthcoming). This chapter – dealing with language as/and the origin of life – is a culmination of the book’s thesis: The representation of gene-directed protein synthesis as a code of genetic information transfer, as primal writing and scriptural technology, is an historically and culturally situated technoepistemology – the rise of cybernetic, information, and computer sciences in the Cold War period.

The book traces the production of the information discourse in biology in the early 1950’s, and how the genetic code was constituted as a scientific object within those new discursive formations. It examines the first, theoretical-mathematical phase of the code work (1953-1961) during which time researchers, predominantly physical scientists, transported the infor-

mation discourse into the problem of gene expression. This discursive structure, in turn, shaped the biochemical work on the genetic code in the second phase, beginning in 1961 with the groundbreaking experiments of Marshall Nirenberg and Heinrich Matthaei at the National Institute of Health (USA) and completed in 1967. By that time the iconology of a genomic book of life was circulating widely, both in scientific circles and popular culture, and it continues to shape the discourse and practices of human genome projects as information technosciences.

Another goal was to work on the conference entitled Postgenomics? Historical, Techno-epistemic, and Cultural Aspects of Genome Projects, organized by Hans-Jörg Rheinberger with her collaboration and planned for July 8-11, 1998. Collaborative follow-up steps and other organizational aspects of the conference will continue throughout the academic year.

She has also had the opportunity to present various aspects of her work in various lectures and seminars:

“A Book of Life? How the Genome Became an Information System,” Max Planck Institute for the History of Science, Berlin, May 20, 1997

“Biopower: Molecularizing and Disciplining the Body in the Twentieth Century,” Universität Salzburg, May 23, 1997

“Writing the Book of Life: Information and the Emergence of Molecular Medicine,” University of Athens and Athens Technical University, June 6, 1997

“Military Code? How the Genome Became an Information System,” Hamburger Institut für Sozialforschung, June 17, 1997

“Writing the Book of Life: Information and the Emergence of Molecular Medicine,” Humboldt-Universität zu Berlin, July 15, 1997

“The Curious Fate of Information Theory in Biology in the 1950’s,” International Congress of History of Science, Liège, Belgium, July 22, 1997

In August she began her research on the history of neural nets (1940’s-1950’s). During her stay at the MPIWG she has benefitted from the expertise of Michael Hagner and has compiled a preliminary bibliography on modern neuroscience.

Alexei Kojevnikov (Institute for History of Science and Technology of the Russian Academy of Sciences, Moscow)

stayed from April 1, 1996 - September 30, 1996 as a postdoctoral research fellow at the Institute and contributed to the project 2 of Department I (see p. 90).

Cheryce Kramer (University of Chicago/Wellcome Institute London)

stayed from September 1, 1995 - October 15, 1996 as a predoctoral research fellow at the Institute. She spent her stay writing a dissertation on the institutional culture of Illenau, one of the first purpose-built psychiatric asylums in Germany. This doctoral thesis, entitled "A Fool's Paradise – the Psychiatry of Gemueth in a Biedermeier Asylum," was supervised by Lorraine Daston and successfully defended at the University of Chicago in November 1997. It examines the Biedermeier conception of Gemueth, a "soul-organ" which was taken by those who believed in its influence to be both mental and physical as well as individual and collective. The conceptual and phenomenal framework which structured experiences of Gemueth is unearthed from the history of psychiatric practice, specifically, in the southern German asylum Illenau during the period 1842-1889, whose practitioners held mental illnesses to be, literally "illnesses of the Gemueth." Illenau's therapeutic approach is reconstructed from the organization of space, through the landscape and architecture, and of time, through the use of music and gymnastics. The last chapter explores the relationship between Gemueth and sexuality by comparing the sexual content of Illenau patient records to Richard von Krafft-Ebing's *Psychopathia Sexualis* (1877), a text informed by, yet at odds with, the culture of Gemueth at Illenau in which its author trained for five years, 1864-1869.

This research is being continued now during a two-year research fellowship at the Wellcome Institute London by comparative studies on Russian and German psychiatry in the nineteenth century based on a comparison of the therapeutic regimes at Illenau and an asylum in Kazan.

Morgane Labbé (Laboratoire de Démographie Historique, École des Hautes Études en Sciences Sociales, Paris)

is staying from October 1, 1996 - December 31, 1998 as a CNRS postdoctoral research fellow at the Institute. Her research deals with the history of

the concept of nationality in statistics. She had previously studied the case of the ethnic classifications used in the census of the Balkan states, emphasizing the process of objectivation of ethnic ascriptions through these statistical representations. Her present research focuses on the emergence of the project of ethnographic statistics as a part of population statistics collected by the census, which was proposed and discussed at the International Statistical Congress in the nineteenth century. The study of the proceedings led her to underline the reservations this project raised among statisticians, whose definitions of nationality inevitably remained linked with their political representations of a nation (differences which took acute expression in the opposition of French and German statisticians), which played a role in the defeat of the project.

During her stay at the Institute she is working on the national form of this project, focusing on the German case, and revealing that, contrary to the cohesiveness of their opinion at the international level, German statisticians held various conceptions of an ethnic statistic. She examines the effects of these differences on the questions of the census, working in the archives of the reports of the Statistical Office. From their discussions on the relevant criteria of nationality for the statistics, she concentrates on the distinction between what was considered as an objective criterium, or indirect indicator of nationality (such as the mother tongue), and a subjective, or direct, criterium, *i.e.*, self-declaration. This discussion is linked to a broader discussion of the validity of an individual answer insofar it is a self-assessment. In the particular case of nationality this will be examined in relation to the notion of "individual consciousness" or "national feeling" that the statisticians referred to in their definition.

Labbé also examines the effects of disciplinary claims on the definition of nationality as a scientific object, and in particular how these led statisticians to stress a distinction from the concept of race.

Karlheinz Lüdtke (Friedrich-Schiller-Universität Jena)

is staying from July 1, 1997 - January 31, 1998 as a visiting scholar at the Institute. The object of his work is the history of understanding of the "virus" from the end of the nineteenth century through the 1960's (including the history of phage research). His project conceives of this history as a complex bridging process linking virus research with the various scientific areas engaged by virus researchers, including genetics, biochemistry,

biophysics, and macromolecular chemistry, in order to elucidate the puzzling nature of this filterable, invisible and uncultivable agent. To this end he is especially interested in investigating the development of interdisciplinary interactions which made possible the change from a bacteriological to a molecular-genetic understanding of viruses. After appropriating different vocabularies to define the virus, referring to concepts like “gene,” “macromolecule,” “nucleoprotein,” etc. – based on “similarities” assumed by researchers – methods and procedures were borrowed from the aforementioned disciplines. As a consequence, the identity of the virus as an object of research was altered, allowing it to function also as an object for genetical, biochemical and other studies.

The results of this research project are intended to provide empirical support to reflections on the sociology of science. In particular, this concerns the still controversial discourses about interdisciplinarity, about the correlation of empirical to theoretical knowledge, and about the emergence of scientific innovations understood as processes of social construction.

Christoph Lüthy (Harvard University)

stayed from October 1, 1996 - September 30, 1997 as a postdoctoral research fellow at the Institute. During this time, he worked primarily on a book manuscript on the development of atomist imagery in the early modern period. Various articles written during his stay deal with questions related to the fundamental transformations undergone by early modern natural philosophy between 1400 and 1750. The most general treatment of this theme will be found in the essay “Renaissance Natural Philosophy,” written for the Enciclopedia Italiana’s forthcoming nine-volume *History of Science*. A special issue of “Early Science and Medicine,” co-edited with William R. Newman, specifically examines the transformation of the Aristotelian key concepts of “form” and “matter” between 1580 and 1720. Historical studies on the life and work of Sébastien Basson, the author of what is often regarded as the earliest atomist textbook (1621), on Giordano Bruno’s atomist iconography, and on the fruitful conflation of four *Democriti* in early seventeenth-century literature (*i.e.*, the authentic atomist of Abdera, the laughing moralist, the alchemist, and the anatomist, the latter three being pseudonymous) were the fruit of further specific historical investigations. The results of these studies were presented in a number of lectures presented in Germany and abroad.

Alexandre Mallard (École Nationale Supérieure des Mines de Paris, Centre de Sociologie de l'Innovation)

stayed from October 1, 1995 - September 30, 1996 as a postdoctoral research fellow at the Institute. He worked in the field of sociology of science and technology, focusing on the way in which instruments contribute to the framing of practice. He investigated various aspects related to the use of instruments in modern societies: the transformation of know-how and technical competencies into ordinary activity, the role of visualizing and measuring devices in scientific experiments, and the construction of networks of metrology and standardization associated with the diffusion of instruments. This project considers the perspective developed on instruments in the sociological tradition (sociology of innovation and technical change) as well as in the historical disciplines (history of measuring practices, history of precision).

His research focused on the role of instrument makers in the construction and diffusion of instruments, at the interface between science and the market. A qualitative survey was conducted in the Berlin area, based on interviews with engineers and researchers working in instrumentation firms. It will lead to a first classification of innovation patterns in this domain, and to the identification of relevant criteria for further research on instrument makers: patterns of technology transfer from the university to industry, the role of the mobility of researchers, the structure of market for innovative products, the creation of enterprise, the activity of the users in the stimulation of innovation, the role of the economic and political context (in the case of Berlin, reunification, and various transformations in local networks of research and development).

Additional activities:

Lecture "De la philosophie à la sociologie des sciences," professional training Médiation artistique et culturelle of the Agence Rhone-Alpes de Services aux Entreprises Culturelles, Le Havre, March 21, 1996.

Lecture "The Observatory of Twentieth-Century Experiment. Ethnographical Account of the Relations Between Laboratory and Place of Knowledge in Air Quality Control Research," Berliner Seminar für Wissenschaftsgeschichte, July 8, 1996.

Lecture "Instruments, Inscriptions and the Construction of the Scientific Laboratory," Hamburger Institut für Sozialgeschichte, September 9, 1996.

Christopher Martin (University of Pittsburgh)

stayed from June 23, 1997 - July 20, 1997 as a predoctoral research fellow at the Institute and contributed to the project 2 of the Department I (see p. 84).

Michael May (Universität Hamburg)

is staying from April 1, 1997 - March 31, 1998 as a postdoctoral research fellow at the Institute and contributing to the project 3 of the Department I (see p. 99, p. 111 and p. 112).

Alexandre Métraux (Otto Selz Institut, Universität Mannheim)

is staying from September 1, 1997 - February 28, 1998 as a visiting scholar. His project focuses on the various discursive (experimental, linguistic, metaphorical, pictorial, logico-inferential, etc.) resources by means of which Sigmund Exner, Sigmund Freud, and Charles Sherrington outlined the integrative action of the human nervous system before and after the turn of the century. Two aspects are of special relevance: the physical coordination of elementary, or simple, peripheral and/or cerebral reflexes on the one hand, and the integration of lower level physiological processes into conscious, purposeful behavior, on the other.

Additional Activities:

Lecture "Biography and memory" at the Institut für Psychologie of the Universität Erlangen, November 5, 1997

Gabriele Metzler (Eberhard-Karls-Universität Tübingen)

stayed from March 1, 1996 - April 30, 1996 as a postdoctoral research fellow at the Institute. Her research concentrated on a project dealing with the tensions between internationalism and nationalism among German physicists in the twentieth century. During her stay she gave a talk on this subject at the internal colloquium. She is now completing a book, *Science as Culture. German Physicists as Members of the International Community, c. 1900-1960*, which she prepared during her time at the Institute.

Helmut Müller-Sievers (Northwestern University Evanston)

stayed from June 19, 1997 - July, 31, 1997 as a visiting scholar at the Institute. His activities included the presentation of a paper at the international conference "Varieties of Scientific Experience" (June 18 - 22, 1997, Max Planck Institute for the History of Science). He also worked on a paper entitled "Skullduggery. Goethe and Oken, Natural Philosophy and Freedom of the Press," to be published in *Modern Language Quarterly*. The first draft of a new book with the working title *Disorientation. Georg Büchner, Science and Literature* was completed. This manuscript will be submitted for publication early next year. Müller-Sievers collaborated with Wolfgang Schäffner to rewrite for publication a short essay, "On Punctuation and Points in Philosophy and Mathematics."

Staffan Müller-Wille (University of Bielefeld, Institute for Science and Technology Studies)

stayed from May 1, 1996 - November 30, 1997 as a predoctoral fellow and since December 1, 1997 as a postdoctoral research fellow at the Institute. His work at the Institute was concerned with the completion of a dissertation on Carolus Linnaeus's theory of plant classification. While the historiography of biology has traditionally viewed Linnaeus's innovations in this field - epitomized in the introduction of binomial nomenclature - as innovations of a self-evident, purely practical value, his dissertation views these innovations as dependent on certain theoretical convictions about the structure of the "natural order" among organisms which are highly peculiar for modern biology. The overall thesis of his dissertation is that Linnaeus's "System" of plants (*i.e.*, the hierarchic order of genealogical-morphological relations among plant genera and species due to "natural laws" governing plant reproduction) can be understood as the theoretical result of an abstraction from the "Economy" of plants (*i.e.*, the complex seasonal and topographical distribution of plants due to their specific requirements towards their local habitat), which was realized by accumulating plant samples gathered on worldwide natural history travels in botanical gardens, and by reproducing and exchanging this material in and among these botanical gardens.

The dissertation was submitted to the University of Bielefeld on July 1, 1996 under the title "Varietäten auf ihre Arten zurückführen. Zur Begründung eines natürlichen Systems der Pflanzen durch Carl von Linné (1707-

1778).” The promotion procedure was completed in November 1997.

The facilities at the Institute offered Müller-Wille the opportunity to gain access to some additional, rare material and to work on the final text of the dissertation. Furthermore, the stay at the Institute allowed for fruitful contact with scholars working on related topics, and for the presentation of partial results of his work to the internal colloquium of the Institute and to a wider audience by:

- presenting the paper “Form und Funktion der Repräsentationsmittel in Linnés Botanik” at the Jahrestagung der Deutschen Gesellschaft für Geschichte und Theorie der Biologie in Vienna, June 28-30, 1996.
- presenting the paper “Form and Function of Means of Representation in Linnaeus’s Botany” at the session “Practices of Experience in Early Modern Natural History” organized by B. Ogilvie for the History of Science Society 1996 Annual Meeting in Atlanta, November 6-10, 1996.
- presenting the paper “The Disappearance of the Exotic in Linnaeus’s *Genera plantarum*, published in Leyden 1737” at the conference “Looking through the Habsburg’s glasses” organized by the “Internationales Forschungszentrum Kulturwissenschaften” in Vienna, November 29-30, 1996. This paper will be published in the proceedings of the conference under the title “Collating Plants of the Old and the New World in the Heart of Flourishing Holland,” presumably due to appear in 1998.
- presenting the paper “Pehr Kalm’s travels in North America” at the 11th International Conference of The Society for the History of Natural History in Charlottesville, Virginia, April 27-29, 1997.

He also prepared a preprint version of a paper (“‘Varietäten auf ihre Arten zurückführen’. Zu Carl von Linnés Stellung in der Vorgeschichte der Genetik”, preprint no. 49). Finally, since September 1997, he has taken initial preparatory steps to collaborate with the Institute’s library and computer staff, the Linnean Society at London, and Tomas Anfält at Uppsala University (currently working on an edition of Linnaeus’s letters) to provide an electronic edition of Linnaeus’s main taxonomic works on the Institute’s Computer Aided Source Collection.

Sybilla Nikolow (Centre de Recherche de l’Histoire Science et Technique, Paris)

stayed from September 15, 1995 - October 31, 1996 as a postdoctoral research fellow at the Institute, contributing to research activities on the

history of scientific objectivity. Her particular focus is the history of visual and graphical representations in the sciences and their bearing on the question of objectivity. The focus of this work is how graphical techniques developed between the late eighteenth and early twentieth centuries, and how they were to be employed to visualize statistical data and facts. At that time, graphs and diagrams were no longer used merely to illustrate scientific facts, but also to reduce, analyze and interpret data, and thus to produce new scientific facts and arguments. The politics of the modern use of graphical representation consisted of making the objectivity of the data immediately visible.

Nikolow's visual-graphic project, entitled "Die anschauliche Sprache der Daten," investigates the visual rhetoric utilized by advocates of the graphical representation in three case studies. At the center of the rhetorical analysis are questions of how statistical data and fact achieve visual credibility and persuasive force. In exploring these two questions, it became clear that credibility resulted from the use of objectified algorithms, which yield scientific objectivity as if produced mechanically by symbolic machines. The force of persuasion is derived from the graphs and diagrams semantically enriched with notions and images in order to link them to intuition (*Anschauung*) and make them understandable and communicable.

The first case study examines the relational graphs of the German cameralist August Friedrich Wilhelm Crome around 1800. Like Playfair in England, he employed regular forms like circles and rectangles to visualize the extent of surface, population and other public resources of different states in order to compare them. This practice took place at the intersection of geography instruction according to philanthropic Enlightenment educational practice and ideas, comparable methods of the strength of the states in cameralism and in the science of the state (*Kameralismus und Staatswissenschaften*) and novel techniques in mapping the social and economical activities. She reported on this work in the colloquium of Department II of the Institute on May 31, 1996.

The second case study investigates the International Hygiene Exhibition in Dresden in 1911, where more than 4,000 graphical representations of many varieties were employed. The graphic riches of the Dresden Exhibition are a striking example of the visual culture of modernity mixing pedagogy, called *Volksaufklärung mit Bildern*, as well as of the advertising skills of the organizer of this exhibition, the producer of the mouthwash Odol, Karl August Lingner. The purpose of using graphical representations in this case

was to objectify popular and scientific discussion about the recent results of social hygiene, concerning, for instance, the social conditions of diseases, the effects from the control of diseases for the mortality rates and the decline in birth rates. She reported on this work in the lecture “Graphisch-statistische Repräsentationsformen in der sozialen Hygiene” at the Fifth Annual Conference of the “Deutsche Gesellschaft für Geschichte und Theorie der Biologie” in June 27-30 in Vienna, and in the lecture “Die anschauliche Sprache der sozialen Hygiene. Graphisch-statistische Darstellungen in der Internationalen Hygiene-Ausstellung in Dresden 1911” in the research colloquium of the Institut für Wirtschafts- und Sozialgeschichte of the Ludwig-Maximilians-Universität München on July 11, 1996.

The third case study deals with the picture statistics (*Bildstatistik*) of Otto Neurath, a universal visual language developed in the 1920's and 1930's for public education and exhibitions.

Nikolow also contributed to planning an exhibition at the Jüdisches Museum Wien, entitled “Der Shejne Yidd. The beautiful Jew: Jewish Bodies, Culture and Hygiene.” The study explores the meaning and use of statistics in the construction of the social and biological body of the Jew. It deals with the discourse of German Jewish scientists around 1900. The analysis focuses on concepts of Jews as a race, supported by evidence of biological differences in rates of illness and mortality.

Brian Ogilvie (University of Chicago)

stayed from September 1, 1995 - July 31, 1996 as a predoctoral research fellow at the Institute. During this period he completed much of the research and writing for his dissertation on “Observation and Experience in Early Modern Natural History.” In contrast to older historiography, his dissertation examines the structure of experience and the practices of observation, rather than taking these as primitive, unproblematic categories whose meaning is always and everywhere the same. It fits into the broad framework of recent literature on the culture of early modern natural history, but stresses the careful investigation of European plants and animals rather than introductions from the New World and Asia, and the close attention which naturalists devoted to ordinary, common objects as well as to the strange, marvelous, and foreign. He presented a chapter, “Travel and Natural History in the Sixteenth Century,” to the Department II colloquium. In

addition, during his stay he researched and wrote a paper on “Encyclopedism in Renaissance Botany,” which he presented at the International Congress on Pre-Modern Encyclopedic Texts, Rijksuniversiteit Groningen, July 1996.

Dorinda Outram (University of Cambridge and University College Cork) stayed from September 1, 1995 - August 31, 1996 and from June 1, 1997 - September 30, 1997 as a visiting scholar at the Institute. Her major research area falls within the field of the Enlightenment. She focused on the relationship between Enlightenment and the new scientific knowledge produced by exploration of the non-European world in the eighteenth century, by such men as Alexander von Humboldt, Johann Reinholdt Forster, or Cook and Bougainville. Exploration science contributes to project 1 of Department II, because it explores a great variety of scientific experience within the confines of a particular activity. Direct observation under field conditions, and the making of large-scale series of instrumental readings, are both part of the exploration experience. The collection of specimens of plants and animals to send back to metropolitan institutions also contributes greatly to the institutional development of science in Europe, and enables much broader claims about taxonomy and distribution to be made than before. Equally, the correlation of large-scale series of instrumental readings gained within exploration enables a new understanding of climate and geophysics. Exploration science also raises broader questions concerning historical epistemology, questions such as the reasons for the acceptance of exploration knowledge as real and legitimate knowledge. How do explorers persuade others to accept as true experiences and observations which no one at home has seen as they occur? What beliefs about facticity, observation and generalization in the society at large, and in its scientific culture in particular, do they mobilize in order to do so?

Additional activities:

Seminar on the Career of the Enlightenment, William Andrews Clark Memorial Library, University of California, Los Angeles, June 1996

Coorganizer of the workshop “Varieties in Scientific Experience,” MPIWG, Berlin, June 18-23, 1997

Lectures at Berlin Summer Academy “Nature’s Histories,” August 18-29, 1997, MPIWG.

Ohad Parnes (Tel-Aviv University)

stayed as a research scholar at the Institute until June, 1997. From July 1, 1997 - June 30, 1998 he continues to stay as a predoctoral research fellow.

In his project Ohad Parnes looks at the origins of fundamental concepts of microscopical biology and medical bacteriology in the period 1760-1850. Contrary to the prevailing historiography of microscopy, evidence has been gathered that microscopy already had been taken up systematically by investigators in the last part of the eighteenth century. Of special importance is the relation between epigenetic theories of generation and microscopy. The importance of C. F. Wolff's new theory of generation lay not only in its re-statement of epigenesis, but also in the constitutive role played by microscopy and the microscopical in his theory.

Moreover, a major problem in this pre-cellular period was the nature of organic substances, namely of the most fundamental units of organized structures. Here the task was to make sense of the amorphous, semi-solid substances which seemed to constitute living bodies and be present in a whole series of physiological phenomena – the pus of suppurating wounds, the mucus accompanying putrefaction, the slime secreted from many plants and so on. No unifying scheme for the life science would have been conceivable without reference to this very central problem – the Schleim problem.

In the last year special emphasis has been placed on careful scrutiny of the laboratory notebooks of Theodor Schwann for the years 1835-1838. During those years, while working as an assistant of Johannes Müller in Berlin, Schwann developed his cell theory, which was published shortly thereafter and remains a unifying scheme for the life sciences today. Careful study of these notebooks has corroborated the assumption that Schwann arrived at his cell theory less through a systematic, cumulative series of microscopical inspections of animal tissues than via other investigations into stomach digestion, spontaneous generation and fermentation, during the years 1835-1837. It was through this seemingly unrelated work that Schwann was able to conceive and explicate physiological processes as the manifestation of specific and genuine organic agents. This scheme of specific agency was at the heart of the cell theory and also of its remarkable impact. This demanded resolution of the Schleim problem as well. Many historians have stumbled over Schwann's erroneous theory of free cell formation, which was rejected in the 1850's in favor of the theory of cell division. It is usually

claimed that Schwann had the wrong theory for the right observation. But it can be shown that this “erroneous” theory was the key for his observations, and that it provided the solution to the long-standing problem of organic substances – by proposing a new order of causality between a specific agent (the cell or cell nucleus) and its environment (the “Cytoblastem,” Schwann’s designation for the amorphous fundamental organic substance). Moreover, Schwann arrived at an experimental demonstration of such causality in his work on fermentation and putrefaction.

Further research is envisaged on the impact of Schwann’s cell theory and on the role of the idea of specific aetiology in the years 1840-1870, *i.e.*, in the period preceding the “bacteriological revolution” of Robert Koch and Louis Pasteur.

Additional Activities:

Lecture “Agents and Cells: Theodor Schwann’s work in Berlin (1835-1838)” at the XXth International Congress of History of Science in Liège, Belgium, July 20-26, 1997

Trevor Pinch (Cornell University)

stayed from May 15, 1997 - August 31, 1997 as a visiting scholar at the Institute. He continued his research into the sociology of experimentation. His focus was on large-scale solar-neutrino detection experiments. During his time at the Institute he and Harry Collins completed the second volume in their Golem series entitled *The Golem at Large: What You Should Know about Technology*, Cambridge University Press: forthcoming, 1998. Pinch also completed a chapter, “The Social Construction of Technologies and Markets,” to appear in J. Porac and M. Ventresca (eds.) *Constructing Industries and Markets*, Pergamon Elsevier, 1998. Pinch completed an article with Frank Trocco, “The Social Construction of the Early Electronic Music Synthesizer” to appear in *Icon: Journal of the International Committee for the History of Technology*, Volume 4, 1998. During his stay Pinch presented papers at the Gender, Science and Technology workshop and doctoral course in Trondheim, Norway; at the Institute for Science and Technology Studies, University of Bielefeld, Germany, and at the Science Peace Workshop, Southampton University, England. Pinch was also interviewed by the *Frankfurter Allgemeine Zeitung* for an article on the “science wars.”

Gianna Pomata (University of Minnesota/Università di Bologna)

stayed from January 1, 1997 - March 31, 1997 as a visiting scholar at the Institute.

In this period she worked on revisions of several chapters of her new book *Similitudo Dissimilis. The Search for Sexual Difference in Early Modern Medicine*. She also finished revising the English translation of her book *La promessa di guarigione: malati e curatori in antico regime* (forthcoming from Johns Hopkins University Press). In addition, she wrote a paper that is part of a new research project on the use of "historia" in early modern medical observation. She reported on this work in an internal colloquium at the Institute on February 19, presenting a paper called "A New Way of Saving the Phenomena: From Recipe to 'Historia' in Early Modern Medicine." During her visit at the Institute, Pomata also gave lectures at the Freie Universität Berlin, and at the Institut Romand d'Histoire de la Médecine et de la Santé at Geneva and Lausanne. She participated in a colloquium on the history of the body organized by the Zentrum für interdisziplinäre Frauen- und Geschlechtergeschichte at the Technische Universität Berlin, presenting a paper entitled: "A Sexual Utopia of the Renaissance: Elena Duglioli Dall'Olio's Spiritual and Physical Motherhood, ca. 1510-1520." Her major research interest focuses on the cultural and social history of early modern medicine.

Albert Presas i Puig (Technische Universität Berlin)

stayed from September 1, 1995 - August 31, 1997 as a postdoctoral research fellow (1995/96: Walther Rathenau Fellow) at the Institute.

In the exploration of the origins of the Scientific Revolution, he studied the technical education and the transmission of practical knowledge in the early Italian modern period, in particular of the Accademia del Disegno, (Florence in 1563). The Accademia was the first known attempt to systematize and objectivize the common experience of engineers, architects, sculptors and painters. It is therefore an example which can aid in understanding the environment in which the new renaissance science originated and developed. As part of the analysis of the sources, he is preparing modern editions of the "Summa aritmetica..." (geometrical part) by Luca Pacioli and the Catalan translation of *La Nova Scientia* by Nicolò Tartaglia.

On December 13-15, 1996, he attended the Fourth Symposium on History

of Science and Technology at Alcoi, Comunitat Valenciana, Spain.

S. Ravi Rajan (University of California, Santa Cruz)

stayed from January 1, 1997 - September 30, 1997 as a Walther Rathenau postdoctoral research fellow at the Institute. He completed work on three edited volumes and journal special issues. The first of these, a special issue, "Ecological Visionaries, Ecologized Visions," appeared in the journal *Environment and History* (Volume 3, Number 2, 1997). The second volume, *Colonized Ecologies: Readings in the Environmental History of South Asia and Southern Africa*, is currently under review with the University of Wisconsin Press, and the third, a special issue on "Science, Democracy and Development," is about to be submitted for review to the journal *Science As Culture*. In addition, Rajan continued work on his forthcoming edited book based on the unpublished work of the historical geographer Clarence Glacken, entitled *Genealogies of Environmentalism, Clarence Glacken on Nature, Culture and History in the Nineteenth and Twentieth Centuries*, to be published by University of California Press. Rajan also had two articles accepted for publication during his tenure as Walther Rathenau Fellow: "Foresters and the Politics of Colonial Agroecology: the Case of Shifting Cultivation and Soil Erosion, 1920 - 1950," in the journal *Studies in History*; and "Bhopal and Beyond: An Anthropology of Relief and Rehabilitation Efforts and Prospects for a Socially Relevant Political Ecology of Disaster Management," in Anthony Oliver-Smith and Susanna Hoffman (eds.) *The Angry Earth: An Anthropology of Disasters* (Routledge, forthcoming).

Additional Activities:

Assistant docent and co-organizer at the Berlin Summer Academy "Nature's Histories," August 18-29, 1997, MPIWG.

Annelore Rieke-Müller (Universität Oldenburg)

stayed from October 1, 1996 - September 30, 1997 as a postdoctoral research fellow at the Institute. She began her research on exoticism and its impact on science, on cultural development and on national identity in eighteenth-century Germany. Her topic centered initially on German scientific overseas experience in the eighteenth century, specifically on travels and travelers financed or organized by monarchical support, scientific

associations or by private funds. This work contributed to the project “The Varieties of Scientific Experience” of Department II. She was especially interested in the different approaches to undertaking scientific travels, taking the *Lebenswelt* concept as a framework. She analyzed the educational background of travelers and their professional lives both before traveling and after returning from overseas, examining not only well-known travelers like Georg Forster and Alexander von Humboldt, but also relatively little-known individuals like Friedrich Hornemann and Ulrich Jasper Seetzen. Initial results were presented in an internal colloquium at the Institute, German Research Travels and Travelers in the Eighteenth Century: A Cultural History, on May 28, 1997. In the second half of her stay her interests focused on the connection of exoticism and historicism in eighteenth-century Germany, interpreting historicism as a comprehensive paradigm in science.

She presented the paper “Von der lebenden Kunstkammer zur privaten Liebhaberei: Fürstliche Menagerien im deutschsprachigen Raum während des 18. Jahrhunderts” at the workshop The Display of Nature in Eighteenth-Century Europe, organized by P.H. Reill and L. Daston as part of the European Science Foundation’s program “Concepts and Symbols of the Eighteenth Century in Europe.” The revised version of this paper was published as preprint no. 74.

James Ritter (Université de Paris 8)

stayed from July 7, 1996 - September 30, 1996 as a visiting scholar at the Institute and contributed to the project 2 of the Department I (see p. 70).

Sophie Roux (École des Hautes Études en Sciences Sociales, Paris)

stayed from October 1, 1996 - September 30, 1997 as a postdoctoral research fellow, and is staying at the Institute as a research scholar since October 1, 1997.

Her dissertation, “La philosophie mécanique. 1630-1690,” led her to further inquiries into the epistemological conceptions of science and into the science of mechanics in the seventeenth century; she is generally concerned with texts by Gassendi, Galileo, Descartes, Hobbes, Glanvill, Charleton, Hooke, Boyle, Rohault, Régis, Mariotte or Huygens. First, she explores the epistemological differentiation between mathematical and physical truths,

and, more specifically, the emergence of new standards to evaluate physical hypotheses. She also examines the fundamental notions of classical mechanics (such as relativity of motion, principle of inertia, concept of force, law of action and reaction, etc.). Her goal is to clarify the relationships, if there are any, between these notions and the corpuscularian theories of matter flourishing at the time.

During her stay at the Institute she gave three lectures: “Descartes a-t-il formulé le principe d’inertie?” delivered at the conference Descartes Savant, in Paris, December 6-7, 1996; “La catégorie de scepticisme modéré et l’histoire des sciences,” delivered at the conference Richard Popkin in Paris, January 11, 1997 and “Descartes atomiste?” delivered at the conference Atomism and Continuum in the Seventeenth Century in Naples, April 27-30, 1997.

Theodore R. Schatzki (University of Kentucky)

is staying from October 1, 1997 - December 31, 1997 as a visiting scholar and from January 1, 1998 - March 31, 1998 as a Alexander von Humboldt Fellow at the Institute. He worked primarily on a social theoretical book about the ordering of social life. The book’s main thesis is that the social field, the site where social life transpires, is a net of interwoven practices and orders, where practices are organized human activities and orders are arrangements of people, artifacts, and things. In elucidating this thesis the book examines, *inter alia*, contextualist versus nominalist accounts of human coexistence, the role and prefiguration of human and non-human agency in the transformation of practices and orders, and the “divide” between society and nature. The work’s theoretical contentions are developed through analysis of the mid-nineteenth-century American Shaker medicinal herb business at New Lebanon, NY, which pioneered the American pharmaceutical industry. While at the Institute he also continued work on an anthology he is editing on practice theory, which collects essays from philosophers, sociologists, and science studies scholars, such as Andrew Pickering, Joe Rouse, Hubert Dreyfus, Karin Knorr-Cetina, and Barry Barnes.

Britta Scheideler (Universität Bochum)

stayed from October 1, 1995 - September 30, 1997 as a postdoctoral research fellow at the Institute and contributed to the project 2 of Department I (see *p. 87*).

Jutta Schickore

is staying from April 1, 1997 - March 31, 1999 as a postdoctoral research fellow at the Institute. Her project in the history of microscopic anatomy focuses on studies of the retina carried out by G. R. Treviranus, J. Henle, G.G. Valentin and others during the first half of the nineteenth century. In examining the manner in which this research was performed, she seeks to trace the transformation of the retina into an object of microscopic research, and thereby to explore the way in which anatomists sought to understand its micro-structure and function. The explanatory framework for their findings was provided primarily by contemporaneous investigations into the nature of the peripheral ends of the nerves. The project deals with the question why and how that framework lost its binding force, and how it was replaced by new explanatory approaches.

Furthermore, the study attempts to determine the extent to which the microscopic findings influenced and modified the theories of sense-perception and vision of that period. The more general aim of the project is to assess the significance of anatomical studies of the sense organs as intermediaries in the transition from J. E. Purkyne's and J. Müller's subjective sense-physiology to the project of Helmholtzian experimental physiology.

Arne Schirrmacher (University of California at Berkeley)

stayed from January 1, 1996 - August 31, 1996 as a postdoctoral research fellow at the Institute and contributed to the project 2 of Department I (see *p. 90*).

Henning Schmidgen (Freie Universität Berlin)

is staying from March 1, 1997 - February 28, 1999 as a postdoctoral research fellow at the Institute. His main interest is in the discursive and non-discursive practices that connect modern psychological knowledge to technology. Currently, he is working on the history of the psychological

laboratory founded by Wilhelm Wundt at Leipzig University in the 1870's. The focus of his research is on the history of the "Hipp chronoscope," a precision time-measurement device that served to determine human reaction times. In the late nineteenth century, the chronoscope was the instrumental center around which psychological research activities were organized. Reaction experiments with the chronoscope, which offered a wide range of possible combinations and variations, became the *Fundamentalversuch* of the New Psychology. However, before entering into the practices and discourses of psychology, the chronoscope was used to assess the personal equation in astronomy and to measure the velocity of projectiles in ballistics. The chronoscope also played an important role in teaching physics: combined with a so-called *Fall-Apparat*, a device for producing the free fall of bodies (e.g., balls), the chronoscope served as a means to verify, by demonstration, the laws of gravitation. In Wundtian psychology, the arrangement "chronoscope/fall-apparatus" was adopted up with only minor modifications. Thus the laboratory work in Leipzig had from the beginning not only a strong modernist, i.e., technological appeal, but was also characterized by a dimension of staging and representing. The goal of the research project is to reconstruct the various scientific contexts in which the chronoscope was embedded. It is only against the background of these material cultures that the emergence of experimental practices specific to the New Psychology can be understood adequately.

Libby Schweber (Princeton University/École des Hautes Études en Sciences Sociales, Paris)

stayed from October 1, 1996 - September 30, 1997 as a postdoctoral research fellow at the Institute. Her research examines the relation between the elaboration of "statistical entities" and the creation of new disciplines in nineteenth-century France and Britain. Her work explores the hypothesis that the division of moral science into distinct disciplines corresponded with the introduction of new concepts of "population" and "society." Relevant disciplines include public health, epidemiology, demography, sociology and administrative statistics.

During her time at the Institute, Libby Schweber completed a manuscript on the development of demography in France and vital statistics in England. She also began a comparative study on the reception of mortality tables in the course of the nineteenth century in France and England. The

interest of mortality tables lies in their role as carriers of a particular project for social statistics – one which combined statistics, probabilistic modes of reasoning and social reform; in their representation of population as an abstract statistical entity; and in differences in their reception in the two countries.

In the course of the year, she presented this work at conferences at Princeton University, Princeton, NJ, at the REHSEIS, CNRS in Paris, and at the SHADYC, CNRS/EHESS in Marseille, and authored two articles for *Enquête* and *Genèse*.

Marcel Sigrist (École Biblique et Archéologique Française de Jérusalem)
stayed from June 1, 1997 - August 31, 1997 as a visiting scholar at the Institute and contributed to the *Mesopotamian Year Names* (p. 112).

Skúli Sigurdsson (Harvard University)

stayed as a research scholar at the Institute until December 31, 1996. From August 1, 1997 - July 31, 1998 he is staying as a postdoctoral research fellow. The history of electrification presents a paradox. People expect electric power to be cheap, fast and reliable. Yet they do not consider carefully that pollution results from producing electricity and fulfilling these demands. Electric power production and consumption entails reconstructing waterways, building dams, cluttering the countryside with high voltage transmission lines, burning fossil fuel and accumulating radioactive waste. The light switch on the wall is emblematic of the modern technological order; it yields instant satisfaction, is shaped by people and in turn shapes them. The light switch was immortalized by Claes Oldenburg in the 1960's and 1970's in the form of large sculptures.

A focus on the small things which control or make large technological systems operational (bolts, cables, dials, fuses, light switches, norms, plugs, push buttons, rivets, screws, sockets, technical terms) enables the historian of electrification to take a fresh look at worldwide systems of electric power and consumption. This underscores the labor underlying modern technology, and the complex chain of events unleashed by flicking a light switch. In Sigurdsson's current investigation of the history of the electrification of Iceland, these are not idle concerns. From a slow start around 1910, the course of Iceland's electrification until the 1960's was largely

driven by domestic consumption in fishing villages and towns. The light switch highlights the centrality of domestic life in the history of the electrification of Iceland, and questions the importance currently ascribed to large-scale projects in its power saga. During the Cold War, hopes of modernizing the agricultural and fishing economy with energy-intensive industries was a charged political issue. Eventually, aluminium, cement, ferrosilicon and fertilizer plants were built. In order to supply them and the population with electric power, the downlands and the arctic hinterland were transformed, and the domestic/gendered nature of the electrifying early history passed into oblivion.

Sigurdsson is a member of the International Commission on the History of Mathematics.

Additional Activities:

“The Electrification of Icelandic Existence,” [Rafvæding íslenskrar tilveru] Icelandic Historian Congress, Reykjavík, May, 1997.

“C is for Controversy,” [K wie Kontroverse] Physikgeschichte Section at the Annual Meeting of the Deutsche Physikgesellschaft, Munich, March 1997.

“Problems in Writing a National History of Electrification,” seminar on New Directions in the Social and Historical Study of Science and Technology, Copenhagen, December 1996.

“Mathematics, Exhibitions, Modernity,” Seventh Annual Conference on the History of Mathematics, Heidelberg, November 1996.

“In Memory of Thomas S. Kuhn,” 4S/EASST Conference, Bielefeld, October 1996.

“Technology and the World,” [Technologische Weltkonstruktionen] seminar: Institute for History of Science and Technology, Universität Stuttgart, July 1996.

“Angst, Transcendence, Unity: Hermann Weyl and Spacetime Stories,” workshop on the Historical and Philosophical Interpretation of the Work of Hermann Weyl, Universität Mainz, June 1996.

“From Infinitesimal Parts to the External World: Hermann Weyl, Mathematics and Physics ca. 1920,” conference on History and Philosophy of Modern Mathematics, Roskilde University Center, April 1996.

“Weyl,” conference and workshop on Geometry and Physics, 1900-1930,

Open University, Milton Keynes, March 1996.

Christopher Smeenk (University of Pittsburgh)

stayed from June 23, 1997 - July 20, 1997 as a predoctoral research fellow at the Institute and contributed to the project 2 of the Department I (see *p. 84*).

John Stachel (Boston University)

stayed from July 1, 1996 - July 31, 1996 and July 7, 1997 - July 13, 1997 as a visiting scholar at the Institute and contributed to project 2 of the Department I (see *p. 70, p. 79, p. 84 and p. 70*).

Richard Staley (University of Melbourne)

stayed from October 1, 1996 - September 31, 1997 as a postdoctoral research fellow at the Institute. His research on interferometers and their uses contributes to the project on the relations among instruments, science and travel. The apparatus Albert Michelson first developed in 1881 has often been celebrated for its role in the now famous ether drift experiment which played such an important part in the development of relativity. Approaching the interferometer as an instrument – rather than as an experiment alone – provides a new perspective both on Michelson's activities and on the development of physics and its relations to high precision industry around the turn of the century. This change of optic prompts us to pay attention to major features of Michelson's work commonly neglected by historians. Here the project investigates the role of travel in the conceptual formation and material realization of different forms of the instrument. How did the different institutions and people with whom Michelson worked enable a most delicate experiment to become a robust and versatile tool capable of use in a wide variety of contexts? Conversely, what role did Michelson's travel play in the ability of others to take up the new instrument? Answering these questions involves both a new approach to previous scholarship on the ether drift apparatus, and archival work exploring, in particular, Michelson's activities in the Bureau of Weights and Measures (establishing light as a standard of length), and his relations with important spectroscopists and astronomers (where the interferometer promised a new

precision of observation). A second means of approaching the interferometer as an instrument is provided through a study of the work of instrument makers. How did firms such as Adam Hilger propagate the new instrument, and how did their engagement with the instrument differ from that of Michelson himself? Here both published catalogs and company archives, with their ledger books and customer lists, constitute important resources. This research thus provides an opportunity to investigate what it means for apparatus to count as an experiment or an instrument – and how perception of it in one field may effect claims made for it in another field. It also complements previous studies of the important theoretical programs of the period by bringing into the picture communities of instrument makers and experimentalists, and by exploring the means by which these communities worked for a unity of methods and instrumentation.

Zeno G. Swijtink (Indiana University Bloomington)

stayed from October 1, 1995 - September 30, 1996 as a visiting scholar at the Institute. His project was on the changing relation between sensibility and reason in the late Enlightenment, exemplified in the early visual representations of experimental and observational data in the physical sciences, especially in the work of the polymath Johann Lambert; and on the consequences of this change for the natural sciences of the early nineteenth century, particularly in the work of Alexander von Humboldt.

These new graphical techniques were studied on the intersection of a number of distinct developments: 1) the use of construction diagrams within Euclidean geometry, the extension of these diagrams to include mechanical or curved lines in the new calculus of eighteenth century, and the purging of diagrams from analysis in the early nineteenth century; 2) the visual and manual culture of practical geometry and map making (with its use of the plane table, or *mensula praetoriana*, and its use and discussion of *Augenmaß*, or *coup d'oeil*, and free hand drawing - *proprio Marte*); 3) the development of the theory of errors, in which the earlier deterministic theory of errors, part of what we now call experimental design (Cotes, Marinoni, Lambert, Kästner, J. Mayer, Späth), turned probabilistic in Lambert, and algebraic in Gauss, Legendre, and Laplace; 4) the re-evaluation of sensibility in the late Enlightenment and early Romanticism (Schiller, Goethe, and the von Humboldt brothers).

Additional Activities:

Lecture “Two ways of looking: *coup d’oeil* and *point de vue* – From Johann Lambert to Alexander von Humboldt,” Colloquium at the Institut für Wissenschaftsgeschichte, Universität Göttingen, April 30, 1996

Lecture “The disunity of data analysis,” Dis/unity of Physics Conference, Technische Universität Berlin, June 7, 1996.

Lecture “In praise of unity,” seminar on Revolutions in Science, Max Planck Institute for the History of Science, June 24, 1996.

Colloquium paper “The instrumental life of Alexander von Humboldt,” Institute-wide colloquium at the Max Planck Institute for the History of Science, July 3, 1996.

Lecture “Das Individuum denkt nicht, die Gemeinschaft denkt,” Seminar of the working group: Revolutions in Science, Max Planck Institute for the History of Science, July 5, 1996.

Ken’ichi Takahashi (Kyushu University, Fukuoka)

stayed from June 2, 1997 - June 20, 1997 as a visiting scholar at the Institute. His scientific interests are focused on both the historical reconstruction of Galileo’s theory of motion and the medieval Latin tradition of Euclid’s *De speculis*. As for the former topics, he benefited from an electronic edition of Galileo’s manuscript 72 being prepared by the Institute and also from useful discussions with some members of the Institute including Jürgen Renn and Peter Damerow. As for the latter, he prepared an English draft of ‘Euclid’s *De speculis*: Its Textual Tradition Reconsidered’ presented at the XXth International Congress of History of Science in Liège, and received useful information from Paul Weinig about some Euclidian medieval manuscripts whose locations were unknown to him.

Bernhard Thöle (Freie Universität Berlin)

is staying from November 1, 1995 - October 31, 1998 as a postdoctoral research fellow (1995/97: Lorenz Krüger Fellow) at the Institute.

His current research interests lie at the intersection of epistemology, philosophy of mind and the philosophical foundations of science in early modern thought. The first draft of a book on *Subjectivity in an Objective World*

has been completed. This work focuses on the project of physicalism as it relates to mental phenomena. Physicalism is the thesis that all phenomena are at their basis physical. The first chapter of the book provides a critical account of the physicalist program, its motives and meaning. The remaining chapters investigate to what extent the physicalist program allows for a satisfactory integration of mental phenomena into its ontology. The discussion focuses on four main topics: qualitative experience, consciousness, self-knowledge and mental causation. It is argued that an adequate solution of the problem of integration presupposes an improved conception of scientific objectivity.

Related to this work are two papers presented at a conference on naturalism at the Humboldt University (Berlin) in February 1997 and at a congress on Rationality, Realism and Revision at the University of Munich in September 1997.

The problem of the relation between the scientific and the manifest image of the world as it appears in perception forms the background of a second main research project which might be seen as a historical counterpart to the first. This project continues work which originated as a joint research project with Lorenz Krüger on primary and secondary qualities. With the establishment of the mechanical world view, the distinction between primary and secondary qualities and the corresponding thesis about the subjectivity of sensory qualities became a central topic in philosophical reflection about the foundations of the scientific image. The project focuses on the interrelation between science and metaphysics with an emphasis on the "rationalist" tradition - especially concentrating on those philosophers who, like Descartes and Leibniz, contributed significantly to the development of modern science.

Kant's natural philosophy constitutes a third research topic. A commentary on Kant's Analogies of Experience, which will appear as part of a cooperative commentary of *Kant's Critique of Pure Reason*, has been completed. In addition, two papers on Kant's views about systematicity have been completed. The first, "The Unity of Experience in Kant" was presented at the meeting of the Engere Kreis der Allgemeinen Gesellschaft für Philosophie at the University of Halle in September 1997. The second, "Kant's Conception of a Philosophical System," was presented at a conference on Architectonic and System in the Philosophy of Kant in Vienna. This work is linked with a seminar on Kant's Metaphysical Foundations of Natural Science held at the Institute.

Carsten Timmermann (University of Manchester)

stayed from March 3, 1997 - May 31, 1997 as a predoctoral research fellow at the Institute. During his stay he did research for his doctoral dissertation on the 1920's debate over a "crisis in medicine" and its consequences for medical science and practice.

The main symptoms of the crisis were the increasingly difficult economic situations of doctors, medical scientists and students, and a tendency on the side of the public towards consulting and trusting unorthodox practitioners rather than medical science. Miracle healers, homeopaths, chiropractics and osteopaths prospered. While professional organizations blamed the Weimar state and the health insurance funds, other critics suggested that medicine itself was corrupted by too much science and a lack of spirit and soul: mechanization and specialization had allegedly replaced intuition and creativity. Many claimed that medicine, after all, could not be reduced to the laws of physics and chemistry. They were attracted by neovitalism and holistic ideas and appealed to early heroes like Hippocrates and Paracelsus.

Carsten Timmermann took advantage of his stay at the Institute to exchange ideas with other scholars working on related subjects.

Sabetai Unguru (Tel-Aviv University)

is staying from September 1, 1997 - February 28, 1998 as a visiting scholar at the Institute. He continues his work on a new interpretation of Apollonius's *Conica*, concentrating now on the analysis of the three books of the treatise preserved only in Arabic and recently translated into English by G. J. Toomer. His plan is to publish in due time a monographic study of the *Conica* and of its historical background, intended as a historically more acceptable substitute to H. G. Zeuthen's pathbreaking study *Die Lehre von den Kegelschnitten im Altertum*. This alternative interpretation will refrain from the use of analytical techniques and modern symbolical notation in explaining the Apollonian achievement. It will appeal only to available contemporary Greek techniques when unpacking Apollonius's assumptions, craftsmanship, and methods, attempting to place the *Conica* squarely within its appropriate historical context.

He has also completed an essay review for the *Annals of Science* and is in the process of writing another review for *Speculum*. In December he has been invited to give a talk on Alhazen's problem within the framework of

the research seminar of the Cohn Institute, and in April he will comment on a paper presented at the Bar-Hillel Colloquium on the History, Philosophy and Sociology of Science. At the Institute, he is organizing an international workshop on work in progress in the history of Greek mathematics, scheduled to take place from 3-6 February, 1998.

R. André Wakefield (University of Chicago)

stayed from April 1, 1996 - August 31, 1996 as a predoctoral research fellow at the Institute. His research during this period examined the institutionalization and formalization of useful knowledge in the universities and academies of *Aufklärung* Germany. More specifically, he focused on the importance of cameralism – a peculiarly German academic discipline of the eighteenth century – as the nexus of a debate concerning the proper place of productive and practical knowledge within the German lands of the *Aufklärung*. Currently, the main archival sites of his research, which correspond to competing sites of useful knowledge in the eighteenth century, include the archives of the Bergakademie and the Oberbergamt in Freiberg (Sachsen), the archives of the Akademie der Wissenschaften and the Georg-August-Universität in Göttingen, and the archival sources of the Hohe-Kameral-Schule in Lautern.

Eric Watkins (Virginia Polytechnic Institute and State University)

stayed from August 15, 1996 - December 15, 1996 as a Lorenz Krüger postdoctoral research fellow at the Institute. His research project was entitled “Kant’s Justification of Newtonian Science.” His research at the Institute focused on the reception of Newton’s *Principia* in Eighteenth Century Germany, taking into consideration metaphysics textbooks (*e.g.*, in rational cosmology), the Berlin Academy of Sciences, and physics textbooks.

While at the Institute, he gave a series of informal presentations entitled “The Argumentative Structure of Kant’s Metaphysical Foundations of Natural Science” and “Kant’s Justification of the Laws of Mechanics.” During his stay he worked on a preliminary draft of “The Laws of Motion from Newton to Kant.” He also researched various Prize Essay questions given by the Berlin Academy of Sciences.

Gabriele Werner

stayed from October 1, 1995 - September 30, 1996 as a Walther Rathenau postdoctoral research fellow at the Institute. Her studies relate to the images and constructions of the body in art and science in the seventeenth century. Three works of early modern art form the basis of her investigation: Jan Saendredam's engraving "Allegorie auf die sinnliche und ideelle Erkenntnis/Der Maler und sein Modell" (1616), and David Teniers' "Der zwölfjährige Jesus unter den Schriftgelehrten" (1651/56) and "Der Alchemist" (1651/56). Saendredam's engraving contrasts two kinds of bodies: the effective and sensual body of the *nuda veritas*/the model and the rationalized body of the artist surrounded by a geometer, a chemist and an astronomer. Moreover, the painting draws attention to the relationship between the artist and the scientist. Examination of Teniers' paintings offers a better understanding of this relationship. In both paintings, the same Jew is reading a book is portrayed in the foreground. The paintings depict different kinds of knowledge, alchemy and elements of the Jewish Kabbala tradition, and link them together. Thus they elucidate what was at stake in seventeenth-century disputes about knowledge in the same way Saendredam's engraving does. Moreover, the body with its multiple connotations highlights different kinds of experience and sites of knowledge production. If the body is presumed to be crucial for experience and knowledge, then it is reasonable to analyze the function of body images in historical processes, in particular, the way in which they illuminate changing forms of experiences and knowledge. This approach does not subordinate art to science but investigates the cultural representation of science in art.

Additional Activities:

Instruction of a seminar at the Institut für Kunstwissenschaft at the Humboldt Universität zu Berlin (October 1995 - February 1996): "Vom Golem zum Cyborg. Über die Faszination an künstlichen Wesen"

M. Norton Wise (Princeton University)

stayed from June 1, 1996 - June 30, 1996 and June 15, 1997 - July 15, 1997 as a visiting scholar at the Institute. The short work, "Muscles and Engines: Hermann Helmholtz in Industrializing Berlin," that emerges from this project will integrate Helmholtz's activities in the 1840's thoroughly into the culture of Berlin: educationally, economically, militarily, and aesthetically. Most narrowly, it shows how his muscle physiology and energy phy-

sics were tied together by the concept and practical measurement of “work,” as realized in the indicator diagrams employed by engineers to measure the work done by steam engines. More generally, however, work had come to be seen as the real measure of value of all commodities in the political economy. The study explores how the value thereby vested in quantitative measurements of work, and of associated “modernizing” technologies, permeated those parts of Berlin culture within which Helmholtz and his circle of young friends located themselves. A key organization in the modernization campaign was the Verein zur Beförderung des Gewerbelebens, organized by P.C.W. Beuth, the head of the Technical Deputation of the Ministry of Trade and Industry, who sought to unite art with industry in an aestheticized version of British accomplishments. The membership of the Verein included high-ranking government administrators, entrepreneurs, professors, state architects, and master mechanics. Closely associated with them was a network of institutions for technical education, linked in part by their shared professors, including most of those with whom Helmholtz studied during his training as a military doctor. It was the sons and students of these promoters of Prussia’s industrial future, including considerable numbers of military engineers and instrument makers, who constituted themselves in the Berlin Physical Society in 1845, setting out to advance science in Berlin through the use of rigorous means of physical analysis. And it was as a member of this group of second-generation progressives that Helmholtz had access to the theoretical and instrumental means with which he carried out his remarkable efforts to unite energy physics with muscle physiology. In this light his research projects – mathematically, philosophically, and experimentally – take on a meaning quite different from their standard interpretations.

During a month at the MPIWG in June/July 1997 it was possible to draw up a detailed outline of the essay that will result from this project and to firm up its main arguments. Nearly all of the members of the Berlin Physical Society and their activities could be identified. This accomplishment alone opened up our cultural perspective in unforeseen ways. Important elements remaining include more research on technological modernization in the artillery, engineering, and medical corps, and on the specific ways in which aesthetic values always stood in intimate relation with the technical.

Michael Witmore (University of California at Berkeley)

stayed from 15 June, 1997 - 15 August, 1997 as a predoctoral research fellow at the Institute. During his stay he completed his dissertation, "Culture of Accidents: Unexpected Knowledges in Early Modern England," a project that analyzes tensions among theological, philosophical, and aesthetic modes of interpreting "accidental events" in England during the late sixteenth and early seventeenth centuries. Situating these events in the context of a learned philosophical and theological tradition which held that accidents could neither reveal natural processes nor give explicit insights into God's providential plan, the dissertation demonstrates the unprecedented degree to which accidental events began to function as moments of revelation in Bacon's natural philosophy, Shakespearean drama, and the English interpretation of Calvin's doctrine of special providence.

Numerous exchanges with colleagues and researchers from other institutions (the Wissenschaftskolleg) allowed him to produce a conclusion to the dissertation as well as substantial revisions of three chapters. He also attended the Varieties of Scientific Experience conference in June and served as a commentator on a presentation by Stéphane Callens to the Berlin Seminar for the History of Science concerning "precaution" and environmental risk.

COMPLETED DOCTORAL DISSERTATIONS

Christophe Bonneuil, Francesca Bordogna, Berna Kılıç Eden, Sarah Jansen, Cheryce Kramer, Staffan Müller-Wille, and Brian Ogilvie.

SERVICE UNITS

LIBRARY AND DOCUMENTATION UNIT

headed by Urs Schoepflin

Introduction. The Library is the central information unit of the Max Planck Institute for the History of Science. Its task is to assist research by providing literature, reference and modern information services in any form. This includes the acquisition and delivery of traditional printed sources like books or journals, microfiche and microfilms, bibliographic reference files, and extends to electronic documentation and electronic archives. Along with electronic documentation, the Library supplies not only reference information and sources in history of science, but also the appropriate tools to search and handle the wealth of electronic information available in-house and worldwide.

Library Developments. In late 1995 the Library moved to its new quarters. An official opening took place on January 18, 1996, with a ceremony in the presence of the President of the Max Planck Gesellschaft and a speech by Lorraine Daston on “Die Naturwissenschaften als eine neue, andere Kultur.”

The book and journal collections are presented for open access and arranged systematically according to the Dewey Decimal Classification to meet user requirements for browsing. The Library offers a reading area with Intranet and Internet connections as well as a casual reading corner for newspapers. These areas can be configured for discussion groups and receptions. Local and Internet electronic resources are made available through the Library’s homepage. The Library is permanently accessible for members of the Institute, including evening hours and weekends.

The development of the collections was continued and concentrated on reference works, major source works, and critical standard editions along with a selection of secondary literature. The Library benefitted from the acquisition of the private library of Robert P. Multhauf with valuable items in history of science, chemistry, and technology. The collection of printed books – current holdings of over 20,000 volumes – is arranged in the following divisions:

- Reference collection
- Lorenz Krüger collection
- Source works
- Secondary literature
- Rare books

As a further information resource, 120 current journals belonging to the core literature in the research areas of the Institute are available. These include a selection of current newsletters of the major learned societies and institutions in our field.

The Library's microform collection (*e.g.*, Landmarks of Science, Newton's Manuscripts and Papers and Einstein's Collected Works) was further expanded and now holds some 10,000 historical works and manuscripts. Microfilm readers, reader-printers and reader-scanners are provided to take full advantage of this strategic resource for research at the Institute (see *Project "Computer-Aided Source Collection in History of Science" p. 237*).

The Inter Library Loan (ILL), another service priority to support research at the Institute, has been expanded to the third research group and has gained a high level of acceptance. It provides bibliographic reference and document delivery from the major research libraries in Berlin, Germany and abroad. ILL also provides copies of journal articles as well as microfilms of books and other documents. Provisions are made for receiving remote documents in digitized form. Catalogs of the lending libraries can be consulted on microfiche, electronic files, and through the Internet as a part of the Library's reference service.

Electronic resources. The Library's electronic resources include references like the catalog of holdings, bibliographic reference and full-text databases, encyclopedias, and electronic library catalogs. Catalog information on all the Library's collections and holdings is provided via an internal Online Public Access Catalog (OPAC) available through the Intranet. Databases on CD-ROM can be searched on individual workstations.

A selection of remote bibliographic databases are made available for direct searches. These include table of contents files (Current Contents, Online Contents, Uncover) as well as subject databases (History of Science and Technology, Medline, Biosis, Inspec). For mediated searches in a wide

range of other databases (*e.g.* Science Citation Index, Philosopher's Index, Historical Abstracts or Dissertation Abstracts) the Library has access to the networks of Dialog, STN, Questel, and to the German Library Service Center (DBI, Berlin).

All local and remote electronic services are integrated in the Library's World Wide Web homepage providing a unified access to the various electronic resources. This page lists links to the Institute's library resources (catalog of holdings, new acquisitions lists, current journals), as well as to major library catalogs in Germany and abroad, to bibliographic information, to text archives, or to relevant sites in the history of science field.

Besides continuous support in library, archive, and bibliography matters, the Library periodically offers structured introductions to the collections and services. Special courses are taught for the use of remote bibliographic databases, library catalogs on the Internet, and for the use of personal bibliography makers (EndNote). Support is also provided for problems with reformatting various bibliographic software.

Hand in hand with the expansion of the services in 1996 and 1997, permanent library staff was raised to six, including one systems librarian. This team is currently supported by auxiliary staff.

Staff development was accompanied by training schedules covering systems administration, search techniques in bibliographic databases, Internet training, and language courses. Staff members were also delegates at conferences and exhibitions; one member joined a four weeks' visiting program at the Médiathèque Histoire des Sciences, La Villette, Paris, arranged by the German Library Service Center (DBI, Berlin).

Project "Computer-Aided Source Collection in History of Science". Since the institute is not endowed with an old library of gradually expanded holdings, many of the historical sources had to be acquired in the form of microfilm. To date, these microfilm archives store over 10,000 works and manuscripts. To offer state-of-the-art access to this resource, a digital library was conceived. This digital library includes tools for the management and access of electronic facsimile documents, as well as a digitization unit with paper and large-scale microfilm scanners. The *Computer-Aided Source Collection in History of Science* is a joint project of members of the research groups, the Computing service unit, and of the Library.

So far a pilot of the document server has been developed, making some 60

documents available. Care was taken to use widely available standard software for access and browsing (Web browser), both to immunize against dedicated and platform-dependent software solutions and to guarantee flexibility for future developments.

The digitization unit consists of a heavy-duty paper scanner for documents on paper and a recently installed SunRise microfilm scanner. It is planned to scan the core documents of the microfilm archive to make them available on the Intranet. The films will be digitized to gray-scale images in order to give the most detailed reproduction of the original possible. Production will be supported by assistant staff.

Integration into professional networks. Particular attention was paid to the integration of the Library's concepts and developments into professional networks. Besides participating in national and international conferences, the head of the Library regularly attended the librarians' meetings of the Max Planck Society to discuss policy and technical issues. The Library has become a member of Pica, one of Germany's major library networks with extensive activities in electronic text management. Urs Schoepflin discussed developments in this area with members of the Center for Electronic Texts in the Humanities while visiting the Rutgers and Princeton University Libraries. Legal and technical issues related to the digitization of Landmarks of Science microfilms were raised at the University of Oklahoma, Norman (Department of History of Science, host site of the original Landmarks of Science Library Collection).

Other foci were new concepts of information provision and service development. Urs Schoepflin investigated advanced concepts of information provision with bibliographic databases at the Research Libraries Group and at Dialog Inc. To this end he also studied the organization of information services at the Stanford University Library, the University Libraries of UC at Berkeley and San Francisco, at the Harvard University Library, and at the Dibner Institute (MIT).

In Europe he extended contacts to the Library of the Federal Institute of Technology, Zurich, to the new Bibliothèque Nationale de France, Paris, and to the Médiathèque Histoire des Sciences, La Villette, Paris, to discuss novel information service concepts.

Finally, the Library has become involved with the Institute of Library Science at the Humboldt University, Berlin, where concepts, services, and the organization of the Library are regularly presented at seminars.

Scholarly activities at the Library. In addition to his duties as head of the Library, Urs Schoepflin has also carried out scientometric research in the areas of scientific communication structures and reception processes of scientific literature.

In an ongoing study (in cooperation with Wolfgang Glänzel, Information Science and Informetrics Research Unit at the Library of the Hungarian Academy of Sciences, Budapest) the differences in reception between fields of science were investigated. Previous studies of the project focused on the differences in the aging of journal literature in science and the social sciences. It was shown that bibliometric standard indicators based on journal articles need to be modified for several fields and topics in order to yield valid results. In fields where monographs, books or reports are the central means of scientific information, science communication is not reflected in an adequate manner by journal literature alone. To extend this approach to subjects where the role of non-serial literature is considerable or critical in terms of bibliometric standard methods, the totality of the bibliographic citations indexed in the 1993 annual cumulation of the SCI and SSCI databases have been processed. The analysis is based on three indicators, the *percentage of references to serials*, the *mean references age*, and the *mean reference rate*. Applications of these measures at different levels of aggregation (*i.e.*, to journals in selected science and social science fields) lead to the following conclusions: The percentage of references to serials proved to be a sensitive measure for characterizing typical differences in the communication behavior between the sciences and the social sciences. However, there is an overlap zone which includes fields like mathematics, technologically-oriented science, and social science areas. In certain social science areas, part of the information seems to originate to some extent in non-scientific sources: references to non-serials do not always represent monographs, pre-prints or reports. Consequently, the model of information transfer from scientific literature to scientific (journal) literature assumed by standard bibliometrics requires substantial revision before valid results can be expected through its application to social science areas.

COMPUTING SERVICE UNIT

headed by Jörg Kantel

Introduction. The Computing Service Unit plays an important role within the scientific activities of the Institute. Its main task is to assist research by providing an electronic environment that ranges from standard computer applications like word processing and e-mail, up to highly sophisticated facilities for scanning historical documents, preparing them for Optical Character Recognition, publishing within the World Wide Web, etc. Additional tasks include:

- planning and acquisition of the computing equipment necessary for the Institute's research projects, administration, and the Library
- establishing and supporting the Institute's Internet connection
- providing training and support services
- planning, establishing, supporting, and expanding the Institute's Local Area Network
- designing future computing facilities for the Institute
- providing direct support to the research projects
- participating in the design of the computing facilities of the Library and Documentation Unit of the Institute, as well as supporting the computing facilities of the Administration Unit (SAP).

The personnel capacity of the computing service unit is very small, comprising only two members. To keep pace with the expansion of the Institute over the last two years, the unit is currently supported by two part-time student assistants.

Hardware. In order to preserve a homogeneous and comfortable working environment for the Institute's staff and visitors, Apple Macintosh computers were chosen as the standard equipment for each workplace. However, other machines and operating systems (Windows NT/95 as well as UNIX-based Linux boxes) are needed for special tasks. Besides these, additional workplaces have been equipped with high-end computers suitable for special tasks requiring more powerful computing facilities. Most of these computers are also UNIX based (Linux, Solaris), but due to developments in the computer technology, within the last year a number of Windows NT serv-

ers were also installed for such purposes.

The Institute's hardware capabilities again were expanded greatly during the last two years. Different services are distributed among different servers to avoid the "one-point-of-failure" problem. At the moment three database servers are in operation, one server is responsible for the Institute's calendar, and another handles the internal electronic-mail facilities. In addition there is a central backup server, as well as different servers providing external modem connections. Although most of these machines are Apple Macintosh, a Linux machine is used for the Internet connection, and the central server for the Institute's administration unit is SINIX. Finally, a Silicon Graphics Computer with the Irix operating system works as a RIP (Raster Image Processor) between the local network of the Institute and a Xerox color printer-scanner.

Outside the research workplaces, the administrative unit uses normal Windows 3.1 systems to work with the SAP applications.

The network. Like the Institute's central hardware, the network and the workplaces also have expanded greatly over the last two years. At the moment, the Local Area Network covers nearly 200 workplaces at the Institute. As mentioned in the Annual Report 1995, the LAN was designed with a 100-MBit FDDI backbone from the ground floor to the sixth floor. From here the backbone was extended last year to the newly occupied rooms in the west wing of the sixth floor. At strategically planned locations, six routers have been installed to connect the users to the Institute's LAN over 10-MBit Ethernet lines. In the near future, the Computing Service Unit plans to upgrade to a 100-MBit Ethernet, first for the high-end workplaces mentioned above, then subsequently for the rest of the desktop computers at the Institute. Due to security concerns, an additional isolated LAN was installed to separate the administration unit from the research network.

Through a CISCO router the Institute maintains a 64-kBit permanent ISDN link to the Fritz Haber Institute in Berlin-Dahlem, which connects the Institute via a 2-MBit line to the Internet.

The same CISCO router also connects the administration unit with a separate link to the SAP server of the administration unit located at the Fritz Haber Institute in Berlin-Dahlem.

Like all the other electronic facilities, the World Wide Web capabilities of the Institute also underwent great expansion. An external WWW server, an

internal WWW server and an internal document server were installed. (For more on the document server, a collaborative project with the library, see the library unit's report.) The external WWW server can be visited at <http://www.mpiwg-berlin.mpg.de/>.

Support of research activities. Despite the small capacity of the Computing Service Unit, it has been able to support Institute research activities such as

- consulting for several projects on the facilities of publishing and providing their research results through the World Wide Web
- programming and scripting support for several Internet projects of the Institute
- support of the scanning and OCR activities
- consulting and supporting the activities of the Library Unit to install a document server, as well as establishing a Microfilm/Microfiche scanner which will make these scans available electronically throughout the Institute
- electronic support for audio-visual presentations at workshops and conferences.

In addition, a weekly informal Computer Task Force session was initiated to offer a forum for the Computing Service Unit and the Institute's computer users to discuss computer problems and issues.

The Computing Service Unit also held several training sessions for users, including

- Internet for Beginners
- How to Use the Electronic Mail and Database Facilities of the Institute
- Working within the World Wide Web
- Scanning Images and Working with Optical Character Recognition
- HTML, Java and CGI – The Languages of the Web.

Besides these activities, the Computing Service Unit is expanding its competence to take advantage of the new possibilities provided by the growth of the World Wide Web. This includes HTML and Java programming, as well as the programming of client-server applications with CGI and database connection tools. To this end, the staff of the unit has participated in

several workshops and exhibitions on the technology and potential of the Web.

EVENTS AND PUBLICATIONS

WORKSHOPS AND CONFERENCES

Workshop "Revolutions in Science," August 13, 1996

Organized by Hanne Andersen and Klaus A. Vogel

Since the publication of Thomas S. Kuhn's pioneering study on "The Structure of Scientific Revolutions" (1962) there has been an ongoing debate on the usefulness and analytic distinctness of the concept of "revolution(s)" in the context of a processual analysis within the history of science. In a recent historiographic overview on "Revolution in Science" (1985), Bernard Cohen reconstructed the use of the term over the last two centuries both in general history and in the history of science, thereby pointing to a close interrelation of its political and scientific career. The last few years, however, have shown a remarkable reluctance in the use of the concept of "revolution(s)" in science, giving way to other processual terms like "transformation," "integration/disintegration," etc. Does this mean that "revolution" as descriptive and/or analytic term, combining notions of speed, intensity, discontinuity, transgression, incommensurability and "gestalt-switch," is altogether superseded? Or, on the contrary, has "revolution" as a concept in the historiography of science reached an already unquestionable status, only to be pinpointed anew in its range and specific qualities?

A number of preparatory working group sessions were devoted to successors and precursors of Kuhn's concept of scientific revolutions, for example Ludwik Fleck's "Entstehung und Entwicklung einer wissenschaftlichen Tatsache" (1935). Speakers for these sessions were Hanne Andersen, Peter Barker (University of Oklahoma), Gerd Graßhoff, Wolfgang Küttler, Andrew Mendelsohn, Staffan Müller-Wille, Ohad Parnes, Skúli Sigurdsson, Zeno Swijtink, and Klaus Vogel from the Institute.

The workshop itself concentrated on historical case studies, each trying to evaluate from a specific empirical background the usefulness of the concept of a "scientific revolution" as a descriptive and/or analytic category. After an historical introduction to the notion of scientific revolutions by

Klaus Vogel and an analytical introduction by Skúli Sigurdsson, the following case studies were presented: “The Cosmographic Revolution” (Klaus Vogel), “Kepler’s Revolution” (Gerd Graßhoff), “Linné” (Staffan Müller-Wille), “Cell Theory” (Ohad Parnes), “The Bacteriological Revolution” (Andrew Mendelsohn), “Faraday’s Field Concept” (Yoonsuhn Chung), “The General Theory of Relativity” (Tilman Sauer), and “Max Weber” (Wolfgang Küttler).

The concluding debate (chair: Hanne Andersen) comprised a confrontation of the different approaches. There was consensus among the speakers that the use of the term “revolution” presupposes a spectacular reorganization of a subdiscipline or a field of knowledge, leading to a transgression of its boundaries. As the perspectives on this process vary among the actors and change through time, the term “scientific revolution,” although useful for a general qualification, requires a number of specifications provided by historical description. Some of these specifications, like “discontinuity,” “incommensurability,” and “gestalt-switch,” qualify particular aspects of the process, but do not delimit the possibilities of its reconstruction.

Workshop “Fundamental Categories of Prescientific and Scientific Cognition (Number, Space, Time, Matter, etc.) in Human Action,” September 9-11, 1996

Organized by Peter Damerow and Jürgen Renn

In genetic epistemology it has been claimed that there are close connections between the development of fundamental structures of cognition in ontogenesis and the development of basic concepts in the history of science. Until now, this challenging claim had, however, scarcely an impact on theory formation in psychology and was almost completely neglected in the history of science.

The workshop brought together psychologists and historians of science in order to initiate a closer cooperation on epistemological questions. Basic results of psychological research concerning conceptual universals in the development of prescientific thought and conceptual changes in the individual development of cognition resembling conceptual changes in the history of science have been confronted with investigations concerning the sweeping changes of the concepts of number, time and space in the development from primitive societies and early civilizations to modern mathe-

matics and physics.

Discussions at the workshop centered on two questions: How do psychological and historical research account for the development of basic structures of cognition? And how can psychological and historical research be based on common epistemological assumptions in order to provide explanations for this development that do not contradict each other?

The following presentations were given at the workshop: Jonas Langer (University of California, Berkeley, Department of Psychology): "Conceptual Universals in Prescientific Thought Development," Helmut Reich (Pädagogisches Institut of the University of Freiburg): "Empirical Evidence for Parallelisms between the Scientific Developments from their Origins to Galileo and the Development of the World View of Children," Peter Dame-row (MPIWG): "Historical Epistemology of the Number Concept," Jürgen Renn (MPIWG): "Historical Epistemology of the Concepts of Time, Space and Matter," Gerd Graßhoff (MPIWG): "The Concept of Time Developing with Instrumental Capabilities and Theoretical Requirements."

The workshop was organized in honor of Wolfgang Edelstein on the occasion of his retirement. The intention is to continue the work initiated at the workshop through a series of further workshops on different aspects of the relation between action and cognition.

Workshop "Gene Concepts in Development and Evolution II," October 17-19, 1996

Organized by Peter J. Beurton and Wolfgang Lefèvre

The gene concept and its present crisis provided the subject matter for the workshop "Gene Concepts and Evolution" held in 1995 with participants from America, Israel, France, Germany and Switzerland (see that year's Annual Report and the preprint no. 18 that arose from the workshop). The results of this workshop attest to the fact that research on "the gene" at present provides a unique intersection of historical, methodological, and empirical problems in the life sciences. It also became clear that different approaches to the conceptual problems of the gene affect a number of related subjects in unforeseen ways, *e.g.*, the nature – nurture debate, questions of the origin of life, or even questions of health care. In view of these promising beginnings, work on the subject was intensified, and after a

period of intensive communication, a second workshop on the subject was held in the fall of 1996. The theme of the workshop was slightly broadened into "Gene Concepts in Development and Evolution," to do justice to the most recent trends in concept formation.

The month before the workshop Raphael Falk (The Hebrew University of Jerusalem) joined the preparation group as a visiting scholar. Together with Peter J. Beurton and Wolfgang Lefèvre he finalized the program for the workshop and arranged the discussions during the plenary sessions and the outlines for round-table sessions. Special attention was paid to the policy and the procedures of editing the papers submitted for the conference into a publishable volume.

An "overview" draft was prepared in which major aspects of the different papers were summarized and commented. This was distributed to all participants before the conference convened. On the basis of the submitted manuscripts and the overview-intensive preliminary discussions, the possibility of integrating the workshop into a cohesive enterprise was considered, an enterprise that would provide not only historical-conceptual insights but may also be of some prospective value.

The workshop was attended by: Peter J. Beurton (Max Planck Institute for the History of Science), "The end of reductionism or a unified view of the gene from the perspective of population genetics;" Raphael Falk (The Hebrew University), "An overview" (based on all other participants' contributions); Thomas Fogle (Saint Mary's College), "The dissolution of protein coding genes in molecular biology;" Michael Dietrich (University of California, Davis), "From gene to genetic hierarchy: Richard Goldschmidt and the problem of the gene;" Fred Gifford (Michigan State University), "Gene concepts and genetic concepts;" Scott F. Gilbert (Swarthmore College), "Bearing crosses: the historiography of genetics and embryology;" James R. Griesemer (University of California, Davis), "Reproduction and the reduction of genetics to development;" Evelyn Fox Keller (MIT), "Decoding the genetic program;" Wolfgang Lefèvre (Max Planck Institute for the History of Science); Michel Morange (École Normale Supérieure), "The developmental gene concept: history and limits;" Hans-Jörg Rheinberger (Universität Salzburg/Max Planck Institute for the History of Science), "Gene concepts: a fragmented view from the perspective of molecular biology;" Sara Schwartz (The Hebrew University), "The differential concept of the gene: past and present;" Marga Vicedo (Arizona State University West), "Unit-characters, factors, and genes: E.M. East's views

on the nature of hereditary units;" Marcel Weber (University of Minnesota), "Representing genes: co-linearity and the logic of genetic mapping;" Sahotra Sarkar (McGill University). Jean Gayon (Université de Bourgogne) and Frederic Holmes (Yale University), though unable to attend, remain "full members" of the project.

This second workshop was convened in the understanding that it forms an immediate stepping stone towards a book manuscript and that the papers presented at the workshop are drafts of the contributions to the volume. The papers covered historical, empirical, conceptual, and also linguistic and social aspects related to the question, "What is a gene?"

The volume, however, will not simply contain workshop proceedings, but is supposed to become a well-edited volume of interrelating contributions on the topic. To this end, most of the workshop activities centered on discussions of organized comments on each participant's paper by one other participant. These comments, in edited form, will become an integral part of the volume.

As already noted in the 1995 report, no final definition of the gene will emerge from the volume, but rather a diversity of concepts reflecting the background of the individual contributors (*e.g.*, developmental versus corpuscular gene, referential gene versus ontological gene, etc.).

The editorial work was and will be assisted especially by Raphael Falk during a second stay at the Institute in 1997 (see *p. 196*).

Workshop "The Display of Nature in Eighteenth-Century Europe"
December 12-14, 1996

Organizer: Lorraine Daston

Workshop held under the auspices of the European Science Foundation project, "Concepts and Symbols in Eighteenth-Century Europe"

A workshop on "The Display of Nature in Eighteenth-Century Europe" (organized by Lorraine Daston) was held at the Max Planck Institute for the History of Science in Berlin, 12-14 December 1996, as the second of the five planned workshops under the rubric "Nature," organized as part of the European Science Foundation project, "Concepts and Symbols in Eighteenth Century Europe." All five of the workshops were conceived as

attempts to anchor traditional themes of eighteenth-century studies in the context of practices, representations, and values, as well as of concepts. In attempting to understand how the eighteenth-century aesthetics and metaphysics of nature was translated into the classifications of naturalists, the experimental demonstrations of physicists, the landscape paintings of artists, and the administrative units of statesmen, participants in the workshop paid close attention both to philosophical and scientific sources, such as treatises on the sublime and theories of electricity, and also to concrete objects, such as estate maps, collecting boxes, barometers, opera sets, and menagerie animals. The methodological aim of the workshop was to unite forms of evidence – texts, paintings, maps, scores, blueprints – as well as disciplines – the histories of philosophy, science, music, art, and geography – in order to reveal eighteenth-century nature as it was conceptualized, depicted, and experienced.

“Display” was the key organizing concept for all of the papers, echoing the peculiarly eighteenth-century tendency to imagine nature as a spectacle, as staged, framed, boxed, or otherwise demonstrated in the root sense of the word. It was not enough to observe and admire nature; nature must be presented from a carefully selected point of view, artfully designed to evince certain effects (in the case of the scientific experiment) or to cultivate a certain sensibility (in the case of landscape gardening or panoramic paintings) or to enforce certain norms of decorum (in the case of literary or theatrical allegories). The aesthetic appreciation of nature is at least as old as Pliny’s rhapsodies on the beauty of flowers and seashells, and the sixteenth- and seventeenth-century *Wunderkammern* embodied a striking natural aesthetic of plenitude and variety. What was novel about the eighteenth-century European portrayal of nature in a wide range of milieux was its deliberate selectivity and theatricality.

Four major themes ran through the nine papers presented at the workshop: the blurred boundary between the natural and the artificial, the normative uses of nature, the material apparatus for the study of nature, and the shaping of sensibilities towards nature. In the brief account of each of these themes that follows, papers will be referred to by author in abbreviated form; please see the list of authors and titles at the end of the report for full references.

All of the papers emphasized that “nature” in eighteenth-century usage almost always referred to an ersatz nature, a representation of nature through a mathematical model, a map, a natural history collection, a paint-

ing, an allegorical figure, or a landscaped garden. In this sense, all of nature might be said to be artificial. Some of the papers, however, invoked the boundary between the natural and the artificial in a more specific context. For example, a 1778 painting of the Rhône glacier ordered what had earlier been perceived as a hideous chaos along strict geometrical principles (Klonk); the Viennese menagerie at Schönbrunn (est. 1752) was planned in concentric circles around a breakfast pavilion at the center, symbolizing imperial power and perhaps alchemical and emblematic associations with exotic animal species (Rieke-Müller); reforming British landowners called for a nature “improved” by human cultivation and engineering (Porter); the Museum d’Histoire Naturelle rejected offers by artists to paint decorative friezes on the grounds that works of nature were superior to those of art (Spary). The fact that almost all eighteenth-century examples of the “natural,” from the menagerie to the exhibitions at natural history museums, partook of the artificial makes the struggle over labels all the more revealing of the meanings and values of nature for eighteenth-century Europeans. It is against this background that canonical texts like Denis Diderot’s *Supplément au voyage de Bougainville* and Jean-Jacques Rousseau’s *Rêveries* must be reread.

In the Latin West there exists a long tradition of moralizing nature since at least the thirteenth century, but invocations of nature’s authority were generally restricted to the domain of familial relationships and sexuality. In eighteenth-century Europe, the moral authority of nature expanded dramatically; nature became the final court of appeal to which the legitimacy of governments, of religions, of specific laws, and even of weights and measures was submitted. Viewed against this background, the displays of nature could serve as implicit or explicit justifications for the distribution of power and prestige. The princely menageries of eighteenth-century Germany symbolized the far-flung dominion and commercial networks of their owners (Rieke-Müller); the portrayal of nature as reasonable and decorous at the ducal opera house in Parma exacted corresponding conduct from the Duke’s formerly boisterous subjects (Feldman); the paternalistic land policies propounded by English gentry dovetailed neatly with paternalistic social policies (Porter). The marvelous, a staple of early modern poetry, drama, and art, was banished in the name of seemliness and verisimilitude. Nature, formerly so copious and varied, was held up as the standard of orderly uniformity, the underwriter of natural law’s jurisprudence, and later, of the *Droits de l’Homme*. Each of the antonyms to the natural – arti-

ficial, preternatural, unnatural – was tainted either morally, aesthetically, or (more) both simultaneously.

During the eighteenth century, particularly but not exclusively in the natural sciences, an elaborate apparatus emerged with which to study and demonstrate nature. Leyden jars, static electricity machines, thermometers, barometers, specially designed boxes for collecting natural history specimens, vitrines and cabinets for displaying natural objects – all of these tools filtered observations of nature. Indeed, it is not too much to claim that they created a new nature. Electricians like the Abbé Nollet and Benjamin Franklin produced novel and wondrous phenomena before both expert and lay audiences (Licoppe); traveling naturalists brought home to their studies and museums specimens which were not only new to Europeans but also classified and arranged in an order that obliterated connections to their environments of origin (te Heesen). The savants-voyageurs who scaled first the peaks of the Alps and the Pyrenees in Europe and then the mountains of South America learned to cast an imaginary worldwide net of instrument measurements over objects widely separated in space; geologists came to understand glimpses into the depths of a ravine also as glimpses into depths of time from which the earth's history might be read (Bourguet).

“Sensibility” is a notoriously dense word in eighteenth-century parlance, referring simultaneously to perception, emotion, and judgment. The displays of nature at once formed and were formed by these collective ways of seeing, feeling, and discerning. Celebrated landscapes of alpine scenery or Vesuvian explosions colored perceptions of tourists who summed up sublime vistas in their journals by the name of the appropriate artist of that genre (Klonk, Porter). Estate maps commissioned for the prosaic purposes of tax collection became framed ornaments for English gentry, singling out those features of the terrain made meaningful by tradition and taste (Bendall). To possess a particular sensibility for nature became the badge of the learned or the lay observer: amateurs preferred their shells polished, while naturalists insisted upon having them “bruts” (Spary); Parisians who flocked to popular lectures in experimental physics gasped over artificial lightning, while electricians strained to catch barely visible effects (Licoppe). Alexander von Humboldt and other explorer-naturalists wrote paeans to the Olympian perspectives and contemplative solitude they enjoyed on mountain peaks (Bourguet). Strict attention to different sensibilities of nature divides spectators to nature's display into several different audiences, even for the same objects. Sensibility also calls attention to the

plurality of the senses, beyond vision, and the cultivation of synesthesia. The displays of nature in eighteenth-century Europe were schools of sensibility, disciplining the senses at the same time they instructed the mind.

List of Participants and Papers:

Sarah Bendall (Merton College, Oxford, UK), "Mapping and Displaying an English Marsh Landscape in the Mid-Eighteenth Century"

Marie-Noëlle Bourguet (Université de Paris VII), "Voyage et montagne au XVIIIe siècle: Le spectacle de la nature"

Martha Feldman (University of Chicago, USA), "Personifying Nature and Remaking Stage and Spectator in Eighteenth-Century Parma"

Anke te Heesen (Forschungszentrum Europäische Aufklärung, Potsdam), "Boxes in Siberia: Daniel Gottlob Messerschmidt's Ordering System on his Travels 1720-1727"

Charlotte Klonk (University of Warwick, UK), "The Art of Nature: The Depiction of Nature in Geological Publications"

Christian Licoppe (Paris, France), "Nollet's Electrical Show vs. the Devious Ways of Franklin's Electrical Atmospheres: A French Mid-Eighteenth-Century Crisis in the Legitimation of Experimental Philosophy through Experimental Display"

Roy Porter (Wellcome Institute, London, UK), "The Environment and the English Enlightenment"

Annelore Rieke-Müller (Oldenburg, Germany), "Von der lebenden Kunst-kammer zur privaten Liebhaberei: Fürstliche Menagerien im deutschsprachigen Raum während des 18. Jahrhunderts"

Emma Spary (University of Warwick, UK), "Forging Nature: The Boundaries of Artificiality at the Republican Museum"

Workshop "Instruments, Travel and Science," December 15-16, 1996

Organized by H. Otto Sibum, Marie-Noëlle Bourguet, and Christian Licoppe

During the last year a number of scholars at the MPIWG have been working on different aspects of the history of travel and the history of experimentation and precision measurement. They have identified the study of

instruments, travel and science – and their relations – as an important theme for understanding historically the complex process of producing and communicating scientific knowledge. In order to explore the potentials of such a research project they invited a small group of scholars working in related fields for a first one-day meeting on December 15 and 16, 1996.

Participants of the workshop were Jim Bennett (University of Oxford), Christophe Bonneuil (MPIWG, Berlin), Marie-Noëlle Bourguet (Université VII-Denis Diderot, Paris), Lorraine Daston (MPIWG, Berlin), Christian Licoppe (CNET/CNRS, Paris), Guiliano Pancaldi (University of Bologna), Kapil Raj (CNRS/URA 1743, Paris), Simon Schaffer (University of Cambridge, U.K.), H. Otto Sibum (MPIWG, Berlin), Richard Staley (MPIWG, Berlin) and David Turnbull (Deakin University, Australia).

The workshop identified two main issues to examine more closely: 1) the uses of instruments, or the notion of local knowledge traditions, and 2) encounters, or the meaning of travel for the acquisition and transmission of scientific knowledge.

The first question picks up on historical studies about spaces of knowledge. Most of the recent work on the material culture of science, and especially that on experimentation, emphasizes the need for more fine-grained description of the places, people and practices surrounding the instruments scientists use in their investigations. The project of reworking experiments and the notion of gestural knowledge provide further methodological grounds to examine more closely those knowledge spaces, and emphasize the importance of working out how locales are coordinated with each other. The problem of coordination applies both to the linkages made by scientists and to the ways historians working on specific case studies can collaborate to achieve a more general portrayal of the sciences' development. Thus the tools and techniques explicitly designed for travel seem an excellent focus for our study.

A second major discussion concerned the notion of encounter. Historical accounts about encounters, explorations, and *Wanderjahre* support the assumption that a variety of spaces of knowledge or local knowledge traditions exist which are by no means the prerogative of traveling scientists, but rather are developed by a great number of different cultures. This discussion raises important questions, such as: What are the mechanisms of transmitting knowledge? What can travel? What cannot? How do these encounters effect a transformation of knowledge claims? What role do

instruments play in this transfer of knowledge? Is the distinction of center and periphery helpful in this analysis? Do we have to distinguish between images of uniformity and practices which make uniformity? How do we differentiate between precision, practice of measurement, and standardization?

The organizers and the participants agreed to continue work on this subject and will meet again in September 1998 in order to discuss first results of the participants' research.

Workshop "Experience and Knowledge Structures in Arabic and Latin Sciences," December 16-17, 1996

Organized by Paul Weinig and Muhammad Abattouy (Fez University)

The international workshop was the Institute's first effort in the field of History of Arabic Science. Its primary aim was to attain a general view of selected disciplines of Arabic sciences (philosophy, mathematics, astronomy, cartography, cosmography, medicine). The workshop also offered opportunities to receive first-hand information from specialists and allowed insight into the actual state of the art in each field portrayed. Problems of transmission or transmission processes and the relationship between experience and knowledge structures in the selected disciplines comprised the core of the discussions.

Another function of the workshop was to present to the scientific community of Arabists a research initiative on medieval Arabic mechanics. Connected with the framework of a current project on the emergence of preclassical mechanics directed by Jürgen Renn, it was designed and is being conducted in cooperation with Muhammad Abattouy (Fez University) and Paul Weinig (MPIWG Berlin). They are collaborating to edit and translate into English numerous Arabic treatises on balances and weights from the ninth through the sixteenth centuries. Many of these texts have escaped previous notice or have yet to be sufficiently studied, and thus constitute a field that deserves urgent exploration. Work was prompted by the recent rediscovery of two manuscripts of the most important texts by Thābit ibn Qurra: a copy of the Arabic version of his famous *Kitāb fī 'l-qarastān*, and a copy of his edition of a text ascribed to Euclid, *On Heaviness and lightness*. Originally preserved in the Staatsbibliothek in Berlin, the two manuscripts were reported lost after World War II. Fortunately

project scholars were able to locate them in Krakov and present them to the specialists during the workshop.

The workshop was held in four sessions and included lectures given by twelve scholars from seven countries. In the first session, aspects of the “Transmission of Knowledge from Antiquity to the Middle Ages” were the main topics discussed. Papers were presented by Richard Lorch (Ludwig-Maximilians-Universität, Munich): “Transmission of Greek Mathematical Works through Arabic into Latin: Theodosius’ *Sphaerica* as Example,” Matthias Schramm (Universität Tübingen): “Theoretical and Practical in Antiquity and Middle Ages,” and Charles Burnett (Warburg Institute, London): “The Coherence of the Arabic-Latin Translation Programme in Toledo in the Twelfth Century.”

Speakers in the second session on “Social Structures of Knowledge Production and Transmission” were Françoise Micheau (Université de Paris I): “Production des traités médicaux au Proche-Orient arabe (VIIIe-XIIIe siècles), étude quantitative sur les conditions et les rythmes de l’activité scientifique,” Sonja Brentjes (MPIWG Berlin): “Orthodoxy, Science, Power and the *Madrasa* (‘college’) in the Middle East (13th-14th centuries),” and Jens Høyrup (Roskilde University): “Integration/Non-integration of Theory and Practice in Ancient, Islamic and Medieval Latin Contexts.”

“Practical Experience and Scientific Knowledge, the Cases of Mathematics, Geography, Astronomy and Cosmography” was the topic of the third session. Papers were presented by Menso Folkerts (Ludwig-Maximilians-Universität, Munich): “Early Texts on Hindu-Arabic Calculation,” David A. King (Johann Wolfgang Goethe-Universität Frankfurt/M.): “The Culmination of Medieval Islamic Mathematical Cartography, World-Maps for Finding the Direction and Distance of Mecca,” Julio Samsó (Barcelona University): “Andalusian and Maghrebian Traditions of *zijas*,” and Jamil Ragep (American Research Institute, Istanbul): “Scientific Cosmography in Islamic Civilization: Social and Intellectual Context of *hay’a*, Readership, Ownership Lines of Transmission.”

In the final session “Comparison studies and their Problems in Arabic and Latin Sciences (the case of Mechanics)” the speakers were Muhammad Abattouy (Fez University): “Arabic Tradition of Mechanics and Engineering,” and Paul Weinig (MPIWG Berlin): “Latin Medieval Tradition of Mechanics, Aspects of the Textual Tradition.” Additionally this session included a brief presentation of a paper submitted by the late Wilbur R.

Knorr (Stanford University): "On Heiberg's Euklid."

The papers of this workshop were edited as preprints of the Institute and will be published in a special issue of "Science in Context" edited by Muhammad Abattouy and Paul Weinig.

Colloquium "Einstein in Berlin: The First Ten Years," March 3-4, 1997

A joint colloquium by the Center for Philosophy and History of Science at Boston University, the Collected Papers of Albert Einstein, and the Max Planck Institute for the History of Science

The colloquium was dedicated to Einstein's scientific achievements in Berlin and their intellectual, institutional, and cultural contexts. The Institute contributed to the colloquium three presentations, "Albert Einstein in Politics – a Comparative Approach" (Britta Scheideler and Hubert Goenner), "The Rediscovery of General Relativity in Berlin" (Jürgen Renn and Tilman Sauer), and "Directing a Kaiser Wilhelm Institute: Einstein, Organizer of Science?" (Giuseppe Castagnetti and Hubert Goenner). All three presentations interpreted Einstein's activities as a choice among a range of possible reactions to external challenges, be they the political crisis of the First World War, the intellectual crisis of classical physics, or the demands of a new institutional organization of science. A further common perspective of the three contributions was that the intellectual resources upon which Einstein drew in these reactions were deeply rooted in various nineteenth-century traditions. These traditions shaped, in particular, his image of science as the lonely search for a conceptually unified understanding of nature by members of an elitist *république des savants*. In spite of Einstein's classical understanding of science, its protagonists, and its place in society, when faced with the challenges of the early twentieth century, he responded quite differently in the scientific, institutional, and political realms. The texts of the three presentations appeared as a preprint of the Institute under the title "Foundations in Disarray: Essays on Einstein's Science and Politics in the Berlin Years."

Symposium "The Varieties of Scientific Experience" June 19-22, 1997

Organizers: Lorraine Daston, Michael Hagner, Dorinda Outram, and Otto Sibum

The physician feels a pulse, the chemist tastes an unidentified compound, the naturalist dries an exotic plant, the physicist reads an instrument scale, the anthropologist notes down a myth, the physiologist severs an artery, the sociologist compiles a statistical survey. However multifarious these points of contact between inquirer and object of inquiry, they do not begin to exhaust the variety of what we summarily call "experience" in the sciences. One word must be stretched to cover the most immediate and obtrusive of sensations, and the most delicate laboratory manipulations mediated by an arsenal of instruments. Although we sometimes distinguish between "observation" and "experiment," we have no special terms for the sensory observation of an explorer who registers degrees of bodily cold and the instrumental observation of the astronomer who deciphers the signals collected by a radio telescope. In principle, "experience" can be made to span the zoological observations made by Aristotle on the island of Lesbos as much as the computer simulations that now count as experiments in certain areas of physics and cognitive sciences. This symposium posed philosophical questions about the nature of scientific experience – its multiplicity, mutability, and entrenchment – in a historical vein.

Building on the recent work of the history, philosophy, and sociology of experiment and fieldwork, the symposium invited a broader exploration and more refined taxonomy of scientific experience from the late sixteenth through the early twentieth centuries, in the human as well as in the natural sciences. An inquiry into the multiplicity and history of scientific experience inevitably expands into an inquiry into the sources of scientific authority, the shifting boundary between the public and the private in science, and the establishment of scientific discipline and disciplines. Who may presume to interpret the dictates of nature, from the reader of auguries to the reader of instrument dials? When and how do certain forms of experience, such as manual skill or introspection, sink below the level of what officially counts as public knowledge, although they remain communicable by word or deed? How are novices initiated into the experiential regimens that will ultimately qualify them as practitioners of a discipline, in every sense of the word? These are questions that can be posed only if one pries experience apart from nature, and relinquishes the assumption that experi-

ence, like nature, is the same everywhere and always.

The symposium consisted of six sessions:

Session 1: Towards a History of Experience

Where do the categories – “observation,” “experiment,” “phenomenon,” “data,” “fact” – into which we parse scientific experience come from? Although these structures may come to seem like the very model of the self-evident (*e.g.* “facts”), they must not only be invented; they must also be continually modified in light of new scientific ideals and practices. This session delves beneath the apparent immediacy and transparency of experience to uncover its structures and histories.

Session 2: Constituting Means of Experience in Science

Historians who describe science as practice concern themselves primarily with the silent representatives of the past, the instruments, but neglect the productivity of the human actors. This session examines the complex relations between material technologies and human performance in the production of scientific knowledge.

Session 3: Location and Dislocation of Experience

Locality as both a category of scientific experience and of its evaluation has become increasingly important due to the rise of fieldwork science of global scope since the eighteenth century. At the same time, science lays claim to universal truths, independent of time and space contexts. This session aims to delineate both the historical roots of these tensions and their conceptual and cultural consequences.

Session 4: Constructions of Self-Experience

What is the identity of the self, both body and mind, who undergoes scientific experience and discipline? This session explores both the abstract philosophical construction of the self through categories like self-reflexivity, and the concrete physiological construction of the self through categories like spatial orientation and vestibular balance.

Session 5: The Personal Authority of Experience

Historians of science have tended to concentrate on the authority of research programs, institutions, and techniques, at the expense of that commanded by individual practitioners. This session aims to ask how the definition of the authority of the scientific practitioner has changed, and with what consequences. New approaches may be found in anthropology and

other human sciences concerned with how other cultures construct authoritative persons who intervene in nature.

Session 6: Experience without an Experiencing Subject

Scientific experience can be heroically subjective, as in self-experimentation or introspection, or heroically objective, as in the recourse to photography and self-registering instruments. This session inquires into the origins and functions of objectified experience within both science and art, and into the creation of collective subjects of experience.

List of Speakers:

Robert Brain (Harvard University, USA), "Instrumental Currencies of Experience."

Michael Bravo (University of Manchester/University of Cambridge, UK), "Historioloquy and Hospitality in the Field."

Peter Dear (Cornell University, USA), "Experience, Authority, Expertise, Skill: How Can We See with the Eyes of Others?"

Michael Harbsmeier (Odense Universitet, Denmark), "Location, Dislocation and the Creation of Knowledge: Continuity and Change in Inuit-Danish Constellations."

Dorinda Outram (University of Cork, Ireland/ MPIWG), "The Explorer and Mimesis: Some Considerations on Personal Authority, and Translocation in the Enlightenment."

Simon Schaffer (University of Cambridge, UK), "On Astronomical Drawing."

H. Otto Sibum (MPIWG), "Shifting Scales."

Bonnie Smith (Rutgers University, USA), "Amateur and Professional Experiences of History in the Nineteenth-Century West."

Stuart Strickland (Northwestern University, USA, MPIWG), "The Ideology of Self-Knowledge and the Practice of Self-Experimentation."

Piers Vitebsky (University of Cambridge, UK), "Shamans, Patients and the Authenticity of Experience: The Sora of Tribal India."

List of commentators:

Rivka Feldhay (University of Tel Aviv, Israel/ MPIWG)

Peter Galison (Harvard University, USA)

Ian Hacking (University of Toronto, Canada/ Eidgenössische Technische Hochschule, Switzerland)

Dorinda Outram (University of Cork, Ireland/MPIWG)

Krzysztof Pomian (École des Hautes Études en Sciences Sociales, France)

M. Norton Wise (Princeton University, USA)

Rivka Feldhay (University of Tel Aviv, Israel/ MPIWG)

Berlin Summer Academy 1997, "Nature's Histories," August 18-29, 1997

Organizer: Simon Schaffer (University of Cambridge)

Who writes nature's histories? In the past twenty years two groups of scholars have attempted to write the history of human interactions with nature. One group, historians of the natural sciences, have been preoccupied with how human knowledge about nature has been painstakingly achieved on the basis of voyages of exploration, collections, classifications, measurements, and theoretical frameworks for understanding the figure and history of the earth. These historians have concentrated their attention on naturalists – their tools, their travels, their practices, their ideas. The assumption which informs their work is that insofar as we know anything about nature, it is only through the lens of a natural knowledge firmly embedded in cultural and intellectual context. The other group, historians of the environment, have investigated how nature and human activity have mutually shaped one another. Mountains, rivers, and forests are as likely to figure as agents in their narratives as the humans who attempt to master, understand, protect, or eradicate these parts of nature. For these historians, scientific knowledge of nature is largely taken to be unproblematic, a transparent window onto nature itself. Instead of focusing on human knowledge about nature and its validity, they chart human impact upon nature, and nature's impact upon humans. Two sharply contrasting histories of nature emerge, written in almost complete isolation from one another: historians of science write about nature as a mosaic composed of selected specimens, instrument readings, taxonomies, and theories; environmental historians write about nature as the brutest of facts, which makes, and is made by, human culture in the concrete form of settlement patterns, deforestation, climatic change, and pollution. Perhaps the most striking contrast between the histories of nature written by historians of science and environmental historians is that

between narrative styles. For historians of science, naturalists carry the action of the story; nature is revealed (or occluded) through their investigations. For environmental historians, nature commands center stage; the story unfolds through nature's actions, and even interests and purposes. The aim of the Berlin Summer Academy 1997 was to bring these two groups of historians together in a forum that would promote exchange and reflection.

Following the format from previous Summer Academies, this eighth Berlin Summer Academy began with an intensive preparatory seminar for junior participants, led by senior docents Everett Mendelsohn (Harvard University, USA) and Dorinda Outram (University of Cork, Ireland and University of Cambridge, UK), assisted by Sarah Jansen (MPIWG) and S. Ravi Rajan (MPIWG). In addition to discussing key works at the intersection of the history of science and environmental history, seminar participants prepared commentaries on the papers presented during the second week of the Summer Academy by senior scholars:

List of speakers:

Dr. Christophe Bonneuil (MPIWG), "The right seeds in a cleared field": Peasants and colonial experts in Senegal (1900-1950)"

Prof. Robert Brain (University of Cambridge, UK), "The Geographical Vision and the Popular Order of Disciplines, 1848-1870"

Dr. Michael Bravo (University of Manchester, UK), "The Accuracy of Ethnoscience: a Study of Inuit Cartography and Cross-Cultural Commensurability"

Prof. Dr. Franz Brüggemeier (University of Hannover), "Eine Kränkung des Rechtsgefühls?"

Prof. Mark Cioc (University of California, Santa Cruz, USA), "The Rhine as Kunstwerk: The Geo-Politics of Engineering in the 19th Century."

Prof. Michael Dettelbach (Harvard University, USA), "The Face of Nature: precise measurement, sensibility, and physiognomy in Humboldtian Science"

Dr. Richard Drayton (Lincoln College, Oxford, UK), "Environmental History as a Just so Story?: Alfred Crosby's Ecological Imperialism and the Margins of Nature and History"

Prof. Peter Galison (Harvard University, USA), "Wastelands of the Weap-

ons Complex”

Prof. Dr. Gert Groening (Hochschule der Künste, Berlin), “The idea of land embellishment”

Dr. Susanne Hauser (Berlin), “Images of Nature in Reconstructions of Industrial Sites”

Dr. Sarah Jansen (MPIWG), “‘Sozialparasiten’ und ‘Tödlichkeitszahlen’ - Zu Repräsentationsformen der Schädlingsbekämpfung in Deutschland, 1900-1925”

Prof. Gregg Mitman (University of Oklahoma, USA), “High Over the Borders: Visions of International Conservation from Pan Americanism to the Arusha Conference”

Prof. Robert Proctor (The Pennsylvania State University, USA), “The Natural and Political History of Radon”

Dr. Ravi Rajan (University of California, Santa Cruz, USA), “Sylvan Technics: German Forestry and the Politics of Monocultures in Colonial India, 1870-1900”

Dr. James A. Secord (Cambridge University, UK), “Narrative Landscapes: Interpreting the Scottish Highlands.”

Prof. Dr. Ludwig Trepl (Technische Universität München), “Gefühlte Theorien: Innerstädtische Brachflächen und ihr Erlebniswert”

Seminar Participants:

Niti Anand (New Delhi, India)

Peder Anker (Harvard University, USA)

Beatrix Bäumer (Hopsten, Germany)

Conevery Bolton (Harvard University, USA)

Christina Brandt (MPIWG)

Sabine Brauckmann (Münster, Germany)

Tobias Cheung (Technische Universität München)

Alix Cooper (Harvard University, USA)

Helen Denham (Wolfson College, Oxford, UK)

Kerstin Dressel (Lancaster University, UK)

Patricia Faasse (Amsterdam, Netherlands)

Palmira Fontes da Costa (Darwin College, Cambridge, UK)
Michael Gordin (Harvard University, USA)
Nina S. Hinke Schultze (Wellcome Institute, London, UK)
Martina Kaup (Göttingen, Germany)
Susanne Köstering (Berlin, Germany)
Julia Lajus (Russian Academy of Science, St. Petersburg, Russia)
Angela Mayer-Deutsch (Frankfurt/Main, Germany)
Gerhard Mener (Deutsches Museum, Munich)
Karen Oslund (Institute for Archaeology and Ethnology, Copenhagen, Denmark)
Thomas Potthast (Universität Tübingen)
Sara B. Pritchard (Stanford University, USA)
Eugenia Roldan-Vera (Darwin College, Cambridge, UK)
Jutta Schickore (Berlin, Germany)
Friedemann Schmoll (Tübingen, Germany)
Frank Uekötter (Bielefeld, Germany)
Thomas Zeller (Deutsches Museum, Munich)

The next Berlin Summer Academy will take place in August 1999 on the theme "Science, Technology, and the Law." Organizers are: Lorraine Daston (MPIWG), Peter Galison (Harvard University), Everett Mendelsohn (Harvard University), Hans-Jörg Rheinberger (MPIWG), Simon Schaffer (University of Cambridge), and M. Norton Wise (Princeton University). Senior docents will be Michael Hagner (MPIWG) and Robert Proctor (The Pennsylvania State University).

Workshop "The Emergence of Scientific Image 1500 - 1700," September 19-21, 1997

Organized by Jürgen Renn in the context of the ESF Network on Science and the Visual Image 1500-1800

This workshop was funded by the European Science Foundation in the context of a "Network on Science and the Visual Image 1500-1800," initiated

The Emergence of the Scientific Image 1500-1700

hosted by the Max Planck Institute for the History of Science

Berlin, September 19-21, 1997



Organizing Committee

André Aeschlimann, Bern
Steven de Clercq, Utrecht
Gérard Darden, Strasbourg
Tora Frängemyr, Uppsala
Paolo Galluzzi, Firenze
Robert Halleux, Liège
Martin Kemp, Oxford
Jürgen Renn, Berlin
William Shea, Strasbourg
Walter Tega, Bologna

Participants

Annerita Angelini (Université di Bologna)
Michael Blay (Département des Sciences de l'Homme et de la Société, Paris)
Horst Bredekamp (Humboldt-Universität zu Berlin)
Anne-Françoise Cannella, Robert Halleux (Université de Liège)
Alan Cook (University of Cambridge)
Peter Damerow, Lorraine Daston, Gerd Graßhoff, Wolfgang Lefèvre,
Christoph Lüthy, Jürgen Renn (Max-Planck-Institut für Wissenschaftsgeschichte, Berlin)
Bruce Eastwood (University of Kentucky, Lexington)
Allen Ellenius (Uppsala University)
David Freedberg (National Gallery in Washington)
Howard Gruber (Columbia University, New York)
Albert van Helden (Rice University, Houston)
Klaus Mauerberger (Technische Universität Dresden)
Renato Mezzolini (Università di Trento)
Brian Ogilvie (University of Chicago)
Klaus A. Vogel (Max-Planck-Institut für Geschichte, Göttingen)
Matthias Winner (Biblioteca Apostolica, Rome)

by William Shea, Strasbourg University. The aim of the workshop was to bring together historians of science and historians of art in order to discuss the role of visual representations in the emergence of early modern science.

The title of the workshop may be somewhat misleading: The use of images as representations of scientific thinking was, of course, by no means new in the period to which the workshop was dedicated, as becomes particularly clear in the case of astronomy. Precisely because of the relation of early modern imagery to such older traditions, the first session of the workshop was dedicated to "Astronomy between Geometry and Imagery: the Transformation of Visual Traditions." Astronomy was considered here as a testing ground for pursuing the question of what the early modern period changed in a visual tradition with a very long history, in particular with respect to the relationship between geometrical representations and other kinds of visual representations such as images of celestial phenomena.

In a study of the role of images in science, the question of their role in scientific thinking is central and was discussed in several sessions. The session "Images and the Architecture of Knowledge" addressed, in particular, the relation between images and other representations of scientific thinking, such as texts or symbolic representations, and pursued the question of how the relation between image and other media changed in the early modern period. The session also addressed the role of images in the early modern period as metaphors and models for the organization of knowledge.

As is particularly clear in the case of the illustrations of the life sciences, images were used in the early modern period as tools of research, a topic to which the session "Images in the Process of Research" was dedicated. These tools, which were shaped by literary, mythological, artistic, philosophical as well as scientific traditions, profoundly affected the way in which knowledge about nature was acquired, elaborated and communicated. In this session these processes were discussed not only for the life-sciences but, in a comparative spirit, for other fields of knowledge as well. A central question was, how imagery shaped the understanding of fundamental scientific problems of the early modern time, such as the laws of optics and the laws of dynamics.

A further question extensively discussed at the workshop was the mediatory function of images between different cultural traditions, such as those between art and science or geometry and natural philosophy, but also between scientific and public culture. This question of the mediatory role of

images was the focus of the session “Imagery as Link between Science and its Context.” Here the iconographical traditions that shaped the scientific imagery of the early modern period were discussed, including, for instance, the sources of the imagery employed for representing the abstract entities of early modern science such as atoms. In the session “Images between Art and Science,” art historians contributed their views of the role of images as mediatory instances between art and science and of the relation between the transformations which images undergo in both spheres at this time.

Finally, the central topic of the session “Visual Representation and New Experience” was the function of visual representations for reflecting on the new experiences of the early modern period, from the new worlds of machines to the new worlds beyond the ocean. It was studied, for instance, how the new experiences were assimilated to traditional imagery, such as that used in Aristotelian natural philosophy. With regard to the social history of early modern science, it was discussed which special role visual representations played as a medium of reflection for the protagonists of the new experience, the non-academic practitioners.

An edited book is planned, based partly on the workshop but also including contributions from other authors. The next workshop administered in the context of the ESF Network will take place in Strasbourg, and be organized by William Shea.

Speakers were:

Annarita Angelini, Università di Bologna

Michel Blay, CNRS, Paris

Horst Bredekamp, Humboldt-Universität zu Berlin

Anne-Françoise Canella, Université de Liège

Alan Cook, Selwyn College, Cambridge UK

Peter Damerow, MPIWG, Berlin

Bruce Eastwood, University of Kentucky

Allan Ellenius, Universitet Uppsala

David Freedberg, National Gallery of Art, Washington

Gerd Graßhoff, MPIWG, Berlin

Robert Halleux, Université de Liège

Albert van Helden, Rice University, Houston
Wolfgang Lefèvre, MPIWG, Berlin
Christoph Lüthy, MPIWG, Berlin
Klaus Mauersberger, Technische Universität Dresden
Renato Mazzolini, Università degli Studi di Trento
Brian W. Ogilvie, University of Massachusetts at Amherst
Jürgen Renn, MPIWG für Wissenschaftsgeschichte, Berlin
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Matthias Winner, Bibliotheca Hertziana, Rom

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André Aeschlimann, Bern
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Tore Frängsmyr, Uppsala
Paolo Galluzzi, Firenze
Mirko Grmek, Paris
Robert Halleux, Liège
Martin Kemp, Oxford
Jürgen Renn, Berlin
William Shea, Strasbourg
Walter Teg, Bologna

PLANNED WORKSHOPS AND CONFERENCES

Workshop "Greek Mathematics - Work in Progress," February 2-5, 1998

Workshop "QED: Mathematical Demonstration in Historical and Cross-Cultural Context," May 28-30, 1998.

Organizer: Lorraine Daston (MPIWG)

The aim of the workshop is to explore the ideals and practices of demonstration – primarily in mathematics, but also in natural philosophy, logic, and other fields which have at one time or another aspired to this standard of argument and proof – from a comparative perspective, both historical and cultural. Although demonstrative arguments (*i.e.*, ones which attempt to show that their conclusions are necessarily, not just contingently true) are statistically rare in the history of argument viewed worldwide, they have nonetheless exercised a vast influence in the sciences, philosophy, theology, and even practical fields like law and medicine. The workshop addresses three principal themes:

- 1) What kind of intellectual traditions demand demonstration (as opposed to other forms of argument, such as rhetoric, and proof, such as empirical test), and when, why, and for what do they demand it?*
- 2) How do the strategies and techniques of demonstrative argument change over time, and what are the conditions for the acceptance and rejection of innovation?*
- 3) How are demonstrations translated, transmitted, and re-interpreted among different intellectual and cultural traditions?*

Workshop in Honor of John Stachel "Space-Time, Quantum Entanglement and Critical Epistemology," June 5-6, 1998

Symposium "Demonstration, Proof, Test." June 25-28, 1998

Organizers: Lorraine Daston (MPIWG) and Arnold Davidson (University of Chicago)

Epistemology studies how we know and how secure our knowledge is. Historical epistemology studies, *inter alia*, the history of the specific ways devised to make knowledge secure, from the mathematical demonstration to the judicial proof to the empirical test. Although the words "demonstration," "proof," and "test" in their narrow senses refer to very different aims and procedures – contrast, for example, the demonstration, which seeks to circumvent an induction over cases, with the eminently inductive test of a hypothesis or a machine – their histories and current usages are closely intertwined in the major European languages. This conference is dedicated to posing philosophical questions about how knowledge, both theoretical and practical, becomes trustworthy in a concrete, historical vein: what are the forms of argument, the techniques, the procedures that guarantee various kinds of knowledge, and how did they emerge and become authoritative? Although the conference takes mathematical and scientific knowledge as its departure point, it follows the broader disciplinary and practical traditions of the words "demonstration," "test," and "proof" in including theological, medical, legal, and technological cases as well. Particularly revealing are examples which treat 1) prototypical forms of argument that become models for all other forms of secure knowledge (*e.g.*, Euclidean geometry, or scholastic arguments for the existence of God); 2) procedures and standards that migrate from one disciplinary context to another (*e.g.*, the application of legal standards of evidence to early modern civil and natural history, or the adaptation of proofing techniques to assess the gold content of coins for chemical analysis); 3) the introduction of novel methods to prove or test (*e.g.*, the polygraph in the cross-examination of witnesses, or double-blind trials in medical research); and 4) the convergence and conflict of different methods for securing knowledge about the same objects (*e.g.*, bodily tact versus instruments, or computer simulations versus physical experiments).

Conference "Postgenomics? Historical, Techno-Epistemic, and Cultural Aspects of Genome Projects," July 8-11, 1998

Organized by Hans-Jörg Rheinberger and Lily Kay (Harvard University)

The agenda of this conference will be somewhat unusual. Although the ethical, social, political, economical, and judicial aspects of human and other genome research loom large throughout, the focus of this workshop lies elsewhere. Its predominant aim is to explore, in a discussion among scientists, historians, and scholars in science studies, the epistemic, technical, and cultural challenges of genome research – especially the human genome – and to set them in an historical context. The intention is to assess how this type of research has developed: What visions have guided it, what kind of structures it has taken, what interactions and networks it has created, which challenges it poses, and, eventually, to what sort of biology and society it might be leading. Genome research as it has been practiced during the last decade is increasingly seen – not only by critics but also by participants – as an historically transient episode on the way to a postgenomic biology that is, by now, still largely conjectural; developmental biology, evolutionary biotechnology and rational drug design might be elements of this distant vision.

A first issue addressed is "Re-Visions of Genetics." Major punctuations have marked the genetic discourse of the twentieth century. The field has come a long way from viewing the genes as the formal units of preclassical and classical genetics to their conception as the material/informational units of molecular biology, with all their attendant historico-cultural valences; from the genome as the book of life to commercial genomes in the age of gene technology and bioinformatics; and now to the prospects of postgenomics in its various aspects of epigenetics, and to a reevaluation of genotypic as well as phenotypic complexity. To assess where science and society stand with respect to genome research these visions need to be re-evaluated. Of special interest in this context is the troubling discrepancy between a growing appreciation of organismic complexity and an ever more sophisticated scientific gene discourse, on the one hand, and a rising trend of naive genetic determinism in the public and economic sphere on the other.

The workshop's second issue concerns the question: "Whose Genome?" Since its inception, and to some extent contrary to its original impetus,

genome research has become a variegated enterprise. Besides the human genome program itself with its focus on some “standard” genome, the assessment of human diversity has entered the arena, as have diverse programs to sequence several model organisms (including several bacteria, yeast, *Arabidopsis*, *Caenorhabditis elegans*, and mouse). Among these genome projects, the European yeast program, successfully completed in 1996, represents the first eukaryotic organism to be genetically sequenced in its entirety. Participants will not only survey their underlying assumptions and how these different projects are realized, but also ask the question of how scholars in science studies can and should study such enterprises.

This leads to a third array of concerns about the techno-epistemic dimensions of genome research. What does the recent explosion of sequencing efforts amount to? What kind of questions – biological and other – does it evoke? What kinds and modes of data and representations of the body will it lead to? What kind of challenges does it pose to biocomputing? What kind of organization do such collaborative and globally distributed efforts necessitate, involving many different research groups entrenched in widely different local research contexts and research traditions? What spaces of knowledge/power would genome sequencing open? Contrary to early critical voices, the assumption is that such massive sequencing will not result merely in dull repetition, but will give rise to unprecedented scientific and social prospects.

In the wake of a new effort to promote human genome research in Germany, it is deemed necessary not only to assess the ethical, social, and judicial aspects of incumbent new forms of human genetics, but to make an effort to contemplate and rethink the techno-epistemic and cultural dimensions of these developments, which have led to remarkable new constellations of basic and applied biological research. As an opportunity to concentrate on these aspects, an interdisciplinary and international conference will be organized. It is understood that this conference should bring together prominent as well as junior scientists and scholars from Europe and the United States to represent national and global perspectives. They will explore the historical, epistemic, and sociocultural dimensions of molecular biology and gene technology in an effort to assess the achievements that have been made in this field over the past 15 years and to address the perspectives and practices that flow from these achievements.

This conference has been initiated by Jürgen Renn and is generously supported by the Bundesministerium für Bildung, Wissenschaft, Forschung

und Technologie (BMBF) as part of the Deutsche Humangenomprojekt (DGHP).

Workshop "Instruments, Travel and Science," September 3-6, 1998

Organizers: H. Otto Sibum (MPIWG), Marie-Noëlle Bourguet (Université de Paris VII) and Christian Licoppe (Centre National d'Études des Télécommunications)

The historical focus of this workshop is the new instrumental and measuring culture with its changing cognitive practices emerging in Europe between the mid-eighteenth and the twentieth centuries. The diversity of local knowledge traditions in this period raises the question of how these locales became coordinated with each other. The papers to be discussed will analyze particularly the increasing use of quantifying practices and the voyages of instruments and skilled individuals during this period. With a view toward identifying the long-term historical processes which gave rise to this instrumental culture, the participants will discuss French, German, and British initiatives, as well as the relationship between these initiatives and the knowledge and techniques of travelers in other cultural spaces (India, Africa, Polynesia, Southeast Asia and North America).

Workshop "Reworking the Bench. On Research Notebooks in the History of Science," November 12-15, 1998

Organizers: Frederic L. Holmes (Yale University), Jürgen Renn and Hans-Jörg Rheinberger (MPIWG)

Until recently seldom exploited by historians, research notebooks now are studied as valuable sources for understanding the investigative processes that lie behind public claims for discoveries and other novel findings. The growing interest in scientific practice among historians and other students of science is opening up a field of scholarly questions for which notebook records offer tools for fertile research.

Those who have worked with such documents have found them rewarding but challenging. Problems ranging from illegible handwriting to extreme compression and unexplained gaps pose obstacles to interpretation.

Research notebooks often cannot be read directly like other types of unpublished documents, requiring instead special techniques of analysis.

The intent of the workshop is to bring together scholars who have used such notebooks in their studies of past scientists to share their experiences with each other and with other historians who are beginning to use them, or plan to do so.

INTERNAL COLLOQUIUM OF THE INSTITUTE 1996/1997

January 17, 1996 - Bernhard Thöle: "Das klare und deutliche Bild der Welt"

January 31, 1996 - Hubert Goenner (Universität Göttingen): "The Quest for Ultimate Explanation in Physics, or Reductionism on the March"

February 28, 1996 - Klaus Vogel: "Kolumbus und Kopernikus. Die kosmographische Revolution und die Entwicklung der Wissenschaften"

March 13, 1996 - Gabriele Metzler: "Zwischen Nationalismus und Internationalismus. Deutsche Physiker in der internationalen community, ca. 1900-1960"

March 27, 1996 - Mohamed Abattouy : "The Evolution of Galileo's Theory of Motion between 1600 and 1609: Analysis of some Manuscripts (vol. 72) and a Historical Reconstruction"

April 10, 1996 - Hanne Andersen: "From Transuranic Elements to Nuclear Fission: How Anomalies in Categorization Led to a Revolution"

May 22, 1996 - Doris Kaufmann: "Ein Experiment größten Stils an unserer psychischen Volksgesundheit - Psychiatrie im 1. Weltkrieg"

June 5, 1996 - Skúli Sigurdsson: "Mosaic of Language & History"

July 3, 1996 - Zeno Swijtink: "The Instrumental Life of Alexander von Humboldt"

July 17, 1996 - Dorinda Outram: "Passion and Interest: Patronage, Science and Gender in the Age of Absolutism"

July 31, 1996 - Cheryce Kramer: "Rhapsodien über die Anwendung von Kant, Reil und Moritz auf Geisteszerrüttungen"

August 14, 1996 - Edward Jurkowitz: "Phenomenological Physics: Phenomenological Theory as a Mediator of the Boundary Between Theory and Experiment in Superconductivity Research"

August 21, 1996 - Herbert Mehrrens (Universität Braunschweig): "Perspectives on 20th Century Mathematical Culture"

August 28, 1996 - H. Otto Sibum: "Experimental Performance and Limits of Representation"

September 11, 1996 - Gabriele Werner: "Männliche Weiblichkeit als Kreativitätsmodell - Künstlermythen im Surrealismus"

October 23, 1996 - Arne Schirmacher: "Der Formalismus ist sowieso schlauer als wir... – Bemerkungen zur Philosophie der Naturwissenschaftler im 20. Jahrhundert"

November 6, 1996 - Staffan Müller-Wille: "Form and Function of Means of Representation in Linnaeus' Botany"

November 20, 1996 - Mitchell Ash: "Scientific Changes in Germany after 1933, 1945, and 1990 – Steps Toward a Comparison"

January 29, 1997 - Mordechai Feingold: "Mathematicians and Naturalists: Isaac Newton and the Nature of the Early Royal Society"

May 21, 1997 - Sahotra Sarkar: "J.B.S. Haldane and evolutionary biology"

December 3, 1997 - John Ziman: "Evolutionary Reasoning in Science and Technology Studies"

December 17, 1997 - Henry P. Krips: "Catachresis, Quantum Mechanics and the Letter of Lacan"

PUBLICATIONS AND PREPRINTS

Publications

Abattouy, Mohamed. "Galileo Galilei (1564-1642) et la naissance de la physique moderne." In *Histoire des Sciences et Epistémologie. Etudes*, 3-11. Rabat: University Mohamed V, Faculty of Letters Press, 1996.

Abattouy, Mohamed. "Genèse et développement de la théorie physique chez Galilée : aperçu sur les manuscrits dynamiques du Volume 72." In *Comment écrit-on l'histoire des sciences?*, Ed. Salem Yafout. 25-47. Rabat: University Mohamed V, Faculty of Letters Press, 1996.

Abattouy, Mohamed. "Le concept de force chez Newton : explication mécanique ou interprétation alchimique?" In *Workshop on the Concept of "Explanation" in the Sciences in Marrakesh*, University Mohamed V, Faculty of Letters Press, 3-29, 1996.

Abattouy, Mohamed. "Sur la tradition arabe de la balance : Thabit ibn Qurra et al-Khazini." In *Colloquium on the Philosophy and the Sciences in the Antiquity and in the Middle Ages in Marrakesh*, University Mohamed V, Faculty of Letters Press 1997.

Abattouy, Mohamed. "Au-dessus ou au-dessous du Soleil : prolégomènes sur la position de Mercure et de Vénus dans la tradition astronomique andalouse médiévale." In *Proceedings of the First Moroccan-Spanish Colloquium of History of Science (Chefchaouen, May 23-26, 1996)*, Chefcha-

ouen (Morocco): The Center of Andalusian Studies in Chefchaouen, in press.

Abattouy, Mohamed. "Le *Mss. Gal. 72* : une bibliographie générale." *Revue d'histoire des sciences*, in press.

Abattouy, Mohamed. "Le Style galiléen : 1. Galilée et la découverte de la loi de la chute des corps." *Linguistica communicatio (Fez, Morocco)*, in press.

Abattouy, Mohamed. "Les Mathématiques de l'isochronisme chez Galilée." In *Philosophical and Sociological Studies Dedicated to the Memory of Jamal-Eddine Alaoui*, Fez: Faculty of Letters Press, in press.

Abattouy, Mohamed and E. Mazet. "Les *De motu antiquiora* de Galilée : leur structure et leur classement chronologique." *Revue d'histoire des sciences*, in press.

Albani, Matthias, Uwe Glessmer, and Gerd Graßhoff. "Deutung eines wissenschaftlichen Instrumentes aus Qumran." In *Cahiers de la Revue Biblique*, Ed. Ecole Biblique. Paris: Gabalda, in press.

Andersen, Hanne. "Noddack Neglected - the 1934 Suggestion of Nuclear Fission." In *Proceedings of the Conference "Discovery of Elements" (Leuven, September 17-20, 1996)*, in press.

Ash, Mitchell G. "Denazifying Scientists and Science." In *Technology Transfer out of Germany after 1945*, Eds. M. Judt and B. Ciesla. 61-80. Amsterdam: Harwood Academic Publ., 1996.

Ash, Mitchell G. "Die Goldhagen-Diskussion im Internet." *die tageszeitung*, 17.07.1996.

Ash, Mitchell G. "Emigre Psychologists after 1933 : the Cultural Coding of Scientific and Professional Practices." In *Forced Migration and Scientific Change. Emigre German-Speaking Scientists and Scholars after 1933*,

Eds. Mitchell G. Ash and Alfons Söllner. 117-138. Cambridge: Cambridge Univ. Press, 1996.

Ash, Mitchell G. "Wissenschaft - Krieg - Modernität : einführende Bemerkungen (zum 32. Symposium der Gesellschaft für Wissenschaftsgeschichte)." *Berichte zur Wissenschaftsgeschichte* 19 (1996): 69-75.

Ash, Mitchell G. "American and German Perspectives on the Goldhagen Debate : History, Identity and the Media." *Holocaust and Genocide Studies* 11 (1997): 396-412.

Ash, Mitchell G., Ed. *German Universities Past and Future : Crisis or Renewal?* Providence, RI: Berghahn Books, 1997.

Ash, Mitchell G. "Higher Education in the New German States : 'Renewal' or the Importation of Crisis?" In *German Universities Past and Future. Crisis or Renewal?*, Ed. Mitchell G. Ash. 84-109. Providence, RI: Berghahn Books, 1997.

Ash, Mitchell G. "Kurt Gottschaldt und die psychologische Forschung vom Nationalsozialismus zur DDR : konstruierte Kontinuitäten." In *Naturwissenschaft und Technik in der DDR*, Eds. D. Hoffmann and K. Macrakis. Berlin: Akademie-Verlag, 1997.

Ash, Mitchell G. "Wissenschaft, Politik und Modernität in der DDR : Ansätze zu einer Neubetrachtung." In *Wissenschaft und Politik. Genetik und Humangenetik in der DDR (1949-1989)*, Eds. K. Weisemann, P. Kroener, and R. Toellner. 1-26. Münster: LTI-Verl., 1997.

Ash, Mitchell G. "From 'Positive' Eugenics to Behavioral Genetics : Psychological Twin Research under Nazism and Since." *Historia Paedagogica* (Special Issue), in press.

Ash, Mitchell G. "Psychologie in Deutschland um 1900 : Reflexiver Diskurs des Bildungsbürgertums, Teilgebiet der Philosophie, akademische Disziplin." In *Fächergrenzen. Deutsche Philologien und Kulturwissen-*

schaften um 1900, Eds. C. König and et al. Frankfurt a.M.: Fischer, in press.

Ash, Mitchell G. and Alfons Soellner, Eds. *Forced Migration and Scientific Change : Emigre German-Speaking Scientists and Scholars after 1933*. Cambridge: Cambridge Univ. Press, 1996.

Berger, Jutta. "Chemische Mechanik und Kinetik : die Bedeutung der mechanischen Wärmetheorie für die Theorie chemischer Reaktionen." *Annals of Science* 54 (1997): 567-584.

Berger, Jutta. *Affinität und Reaktion : über die Entstehung der Reaktionskinetik*. Studien und Quellen zur Geschichte der Chemie. Bd. 9, Berlin: Verl. für Wissenschafts- und Regionalgeschichte Engel, in press.

Berger, Jutta. "Review of: Kritsman, V.A.; Zaikov, G.E.; Emanuel, N.M.: *Chemical Kinetics and Chain Reactions : Historical Aspects*. New York: Nova Science Publ. 1995." *NTM (Neue Serie)*, in press.

Beurton, Peter John. "Darwins Notebooks." *Jahrbuch für Geschichte und Theorie der Biologie* 5, in press.

Beurton, Peter John. "Sewall Wright." In *Klassiker der Biologie*, Eds. I. Jahn and M. Schmitt. München: Verlag C.H. Beck, in press.

Beurton, Peter John. "Theodosius Dobzhansky." In *Klassiker der Biologie*, Eds. I. Jahn and M. Schmitt. München: Verlag C.H. Beck, in press.

Beurton, Peter John. "Was ist die 'synthetische Theorie'?" *Jahrbuch für Geschichte und Theorie der Biologie*, Suppl. Vol., in press.

Beurton, Peter John. "Was sind Gene heute?" *Senckenbergische Reden und Aufsätze*, in press.

Bleker, Johanna and Annette Vogt. "Bericht: Deutscher Wissenschaftshistorikertag 1996 : der Eintritt der Frauen in die Gelehrtenrepublik - eine Zeitenwende?" *NTM (Neue Serie)* 5 (4 1997): 269-270.

Bonneuil, Christophe. "Conakry : le jardin où s'inventent les tropiques." *La Recherche* 28 (300 1997): 76-80.

Bonneuil, Christophe. "Crafting and Disciplining the Tropics : Plant Science in the French Colonies." In *Science in the Twentieth Century*, Ed. J. Krige & D. Pestre. 77-96. London: Harwood, 1997.

Bonneuil, Christophe. *Mettre en ordre et discipliner les tropiques : les sciences du végétal dans l'empire français, 1870-1940*. Paris: Ed. des Archives Contemporaines, in press.

Bonneuil, Christophe and Patrick Petitjean. "French Scientific Research and Colonial Policy : the Creation of ORSTOM 1936-1945." In *Science and Technology in a Developing World*, Ed. T. Shinn and V.V. Krishna. 129-178. Dordrecht: Kluwer Academic Publishers, 1997.

Borzeszkowski, Horst-Heino v. and Renate Wahsner. "Leonhard Euler (1707-1783) und Joseph Louis Lagrange (1736-1803)." In *Die großen Physiker, Bd. 1*, Ed. Karl v. Meyenn. 229-242. München: C. H. Beck, 1997.

Borzeszkowski, Horst-Heino v. and Renate Wahsner. "Not Even Classical Mechanics is Mechanistic." In *Einstein Meets Magritte. An Interdisciplinary Conference on Science and Society*, Ed. Diederik Aerts. Yellow Book. Worldviews and the Problem of Synthesis. Dordrecht: Kluwer, in press.

Bourguet, Marie-Noëlle. "L'explorateur." In *L'homme des Lumières*, Ed. Michel Vovelle. 285-346. Paris: Editions du Seuil, 1996.

Bourguet, Marie-Noëlle. "De la Méditerranée." In *L'invention scientifique de la Méditerranée. Egypte, Morée, Algérie*, Eds. Marie-Noëlle Bourguet, Bernard Lepetit, Daniel Nordman, and Maroula Sinarellis. Paris: Editions de L'Ecole des hautes études en sciences sociales, in press.

Bourguet, Marie-Noëlle. "La collecte du monde: grands voyages et expéditions scientifiques au XVIIIe siècle." In *Le Muséum au premier siècle de son histoire*, Eds. Claude Blanckaert, Roger Chartier, Claudine Cohen, and Pietro Corsi. Paris: Editions du Muséum, in press.

Bourguet, Marie-Noëlle. "Voyages et voyageurs." In *Dictionnaire européen des lumières*, Ed. Michel Delon. Paris: P.U.F., in press.

Bourguet, Marie-Noëlle and Bernard Lepetit. "La Méditerranée existe-t-elle? Remarques sur les images de la Méditerranée, 1750-1850." In *L'invention scientifique de la Méditerranée. Egypte, Morée, Algérie*, Eds. Marie-Noëlle Bourguet, Bernard Lepetit, Daniel Nordman, and Maroula Sinarellis. Paris: Editions de L'Ecole des hautes études en sciences sociales, in press.

Brentjes, Sonja. "The Relevance of Non-Primary Sources for the Recovery of the Primary Transmission of Euclid's Elements into Arabic." In *Tradition, Transmission, Transformation. Proceedings of Two Conferences on Pre-Modern Science Held at the University of Oklahoma*, Eds. F. Jamil Ragep, Sally P. Ragep, and Steve Livesey. 201-225. Leiden: Brill, 1996.

Brentjes, Sonja. "Remarks about the Proof Sketches in Euclid's Elements, Book I as Transmitted by Ms Paris, B.N., Fonds Latin 10257." In *Mathematische Probleme im Mittelalter. Der lateinische und arabische Sprachbereich*, Ed. Menso Folkerts. 115-137. Wiesbaden: Harrassowitz, 1996.

Brentjes, Sonja. "The Persian Transmission of Euclid's Elements." In *Proceedings of the Conference on 'Persian Scientific Texts'*, Teheran: Institut Français en Iran, in press.

Brentjes, Sonja. "Additions to Book I in the Arabic Traditions of Euclid's Elements." *Journal for the History of Medicine and Science* in press.

Brentjes, Sonja. "Alchemie in China." In *Kulturgeschichte der Chemie*, Ed. Horst Remane. Seculum-Verlag, in press.

Brentjes, Sonja. "Observations on Hermann of Carinthia's Version of the Elements and its Relation to the Arabic Transmission. Colloquium in Honor of B. A. Rozenfeld, August 27-28, 1994." Ames, IN: Modern Logic Publishing, in press.

Brentjes, Sonja. "Uqlidis." In *Encyclopedia of Islam*, Leiden: Brill, in press.

Burian, Richard and Denis Thieffry, Eds. *Research Programs of the 'Rouge-Cloître Group'*. Vol. 19. History and Philosophy of Life Sciences (Special Issue), 1997.

Callens, Stéphane. *Economie de la précaution : report for the DRAST of the MELTT*. 1996.

Callens, Stéphane. "Erreurs fatales." *Alliage* (1996): 80-84.

Callens, Stéphane. "L'économie de la précaution." *Clés* (2 1996): 29-40.

Callens, Stéphane. "La mesure du risque : une histoire récente." *Revue Française des Affaires Sociales* (2 1996): 73-83.

Callens, Stéphane. "Les âges de la sécurité routière." *Cahiers de la sécurité intérieure* (25 1996): 107-117.

Camerota, Michele. "Un aristotelico bolognese corrispondente e oppositore di Galileo : Flaminio Papazzoni." *Annali della Facoltà di Scienze della formazione dell'Università di Cagliari, Nuova serie* 19 (3 1996): 111-139.

Camerota, Michele. "Una ristampa del 'Saggiatore' con le correzioni di Galileo." *Giornale critico della filosofia italiana, Sesta serie* 16 (1996): 125-127.

Camerota, Michele. "Galileo e l'Accademico Incognito." In *Atti del convegno di studi su Galileo nella cultura italiana e tedesca (November 10-13, 1994, Berlin)*, Ed. Michael Segre, in press.

Camerota, Michele. "Review of: Giornata Galileiana : 16 giugno 1994. Interventi di Mario D'Addio, Ugo Baldini, Sergio Pagano, Vincenzo Cappelletti. Presentazione di Paul card. Poupard, Commentarii, Vol. III, n. 34, 1996." *Archives Internationales d'Histoire des Sciences*, in press.

Castagnetti, Giuseppe and Hubert Goenner. "Albert Einstein as Pacifist and Democrat during World War I." *Science in Context* 9 (4 1996): 325-386.

Christlieb, Norbert, Gerd Graßhoff, Andreas Nelke, and Andreas Schlemminger. "How to Exploit an Astronomical Gold Mine : Automatic Classification of Hamburg/ESO Survey Spectra." In *Proceedings of ADASS '97*, Ed. R. Albrecht et al., in press.

Christlieb, Norbert, Gerd Graßhoff, Andreas Nelke, Andreas Schlemminger, and Lutz Wisotzki. "Automatic Spectral Classification." In *Data Highways and Information Flooding, a Challenge for Classification and Data Analysis*, Eds. I. Balderjahn, R. Mathar, and M. Schader. New York, Berlin: Springer, 1997.

Christlieb, Norbert, Gerd Graßhoff, Andreas Nelke, and Lutz Wisotzki. "Automatic Classification of Digitized Objective Prism Spectra." In *Wide-Field Spectroscopy*, Eds. E. Kontizas, M. Kontizas, D.H. Morgan, and G. Vettolani. 109-113. Dordrecht: Kluwer, 1997.

Corry, Leo, Jürgen Renn, and John Stachel. "Belated Decision in the Hilbert-Einstein Priority Dispute." *Science* 278 (5341 1997): 1270-1273.

Damerow, Peter. "Food Production and Social Status as Documented in Proto-Cuneiform Texts." In *Food and the Status Quest. An Interdisciplinary Perspective*, Eds. Polly Wiessner and Wulf Schiefenhövel. 149-169. Providence RI: Berghahn Books, 1996.

Damerow, Peter. "Number as a Second-Order Concept." *Science in Context* 9 (2 1996): 139-149.

Damerow, Peter. "Prehistory and Cognitive Development." In *Piaget, Evolution, and Development*, Eds. Jonas Langer and Melanie Killen. Hillsdale: Erlbaum, in press.

Damerow, Peter, Gideon Freudenthal, Peter McLaughlin, and Jürgen Renn. *Exploring the Limits of Preclassical Mechanics*. 2nd ed., Galileo and the Genesis of Conceptual Novelty, New York: Springer-Verlag, in press.

Damerow, Peter and Wolfgang Lefèvre. "Wissenssysteme im geschichtlichen Wandel." In *Enzyklopädie der Psychologie. Themenbereich C: Theorie und Forschung, Serie II: Kognition, Band 6: Wissen*, Eds. Friedhart Klix and Hans Spada. Göttingen: Hogrefe, in press.

Damerow, Peter see also: Høyrup and Damerow

Daston, Lorraine. "Die Naturwissenschaften als eine neue, andere Kultur." *MPG-Spiegel* (3 1996): 51-56.

Daston, Lorraine. "Nice Work : Essay Review of: Norton Wise (Ed.): The Values of Precision." *ISIS* 87 (3 1996): 517-519.

Daston, Lorraine. "Strange Facts, Plain Facts, and the Texture of Scientific Experience in the Enlightenment." In *Proof and Persuasion. Essays on Authority, Objectivity, and Evidence*, Eds. Elizabeth Lunbeck and Suzanne Marchand. 42-59. Turnhout: Brepols, 1996.

Daston, Lorraine. "The Cold Light of Facts and the Facts of Cold Light : Luminescence and the Transformation of the Scientific Fact, 1600-1750." In *Signs of the Early Modern II. 17th Century and Beyond*, Ed. David Lee Rubin. 17-45. 3. Charlottesville: Rockwood Press, 1997.

Daston, Lorraine. "Die Quantifizierung der weiblichen Intelligenz." In *Aller Männerkultur zum Trotz*, Ed. Renate Tobies. 69-82. Frankfurt a.M./ New York: Campus Verlag, 1997.

Daston, Lorraine. "Possible Histories of Scientific Experience." *Quaderni Storici*, in press.

Daston, Lorraine. "Probability in the Seventeenth Century." In *Cambridge History of Philosophy*, Eds. Michael Ayers and Daniel Garber. 17th-Century Volume. Cambridge: Cambridge University Press, 1997.

Daston, Lorraine and Katharine Park. *Wonders and the Order of Nature, 1150-1750*. New York: Zone Books, in press.

Emter, Elisabeth. "Augenblick : eine Zeitschrift wider die metaphysische Behaglichkeit." In *signum um signum*, Eds. Udo Bayer, Karl Gfesser, and Juliane Hansen. 52-59. Baden-Baden: Agis-Verl., 1997.

Emter, Elisabeth. "Einleitung: Von Hause aus Physiker und Mathematiker: der Philosoph Max Bense." In *Max Bense: Ausgewählte Schriften, Bd. 2 : Mathematik, Natur und Technik*, Ed. Elisabeth Walter. 1-18. Berlin: Metzler, 1997.

Emter, Elisabeth. "Man entgeht nicht der Technik, indem man die Physik verlernt : ein Plädoyer für interdisziplinäres Denken in der Literaturwissenschaft." *LiLi* 27 (106 1997): 130-138.

Engel, Edwin, Klaus Richter, Gerhard Obermeyer, Peter Briza, Andreas J. Kungl, Birgit Simon, Manfred Auer, Christof Ebner, Hans-Jörg Rheinberger, Michael Breitenbach, and Fátima Ferreira. "Immunological and Biological Properties of Bet v 4, a Novel Birch Pollen Allergen with Two EF-Hand Calcium-binding Domains." *Journal of Biological Chemistry* 272 (45 1997): 28630-28637.

Feldhay, Rivka. "The Cultural Field of Jesuit Science." In *The Jesuits. Culture, Learning and the Arts*, Ed. J. O. Malley. Toronto: Toronto Univ. Press, in press.

Feldhay, Rivka. "The Use and Abuse of Mathematical Entities : Galileo and the Jesuits Revisited." In *Companion to Galileo*, Ed. P. Machamer. Cambridge: Cambridge Univ. Press, in press.

Ferreira, Fátima, Christof Ebner, Bettina Kramer, Georg Casari, Peter Briza, Andreas J. Kungl, Rudolf Grimm, Beatrice Jahn-Schmid, Heimo Breiteneder, Dietrich Kraft, Michael Breitenbach, Hans-Jörg Rheinberger, and Otto Scheiner. "Modulation of IgE Reactivity of Allergens by Site-Directed Mutagenesis: Potential Use of Hypoallergenic Variants for Immunotherapy." *FASEB Journal*, in press.

Ferreira, Fatima, Kora Hirtenlehner, Alexander Jilek, Jasminka Godnik-Cvar, Heimo Breiteneder, Rudolf Grimm, Karin Hoffmann-Sommergruber, Otto Scheiner, Dietrich Kraft, Michael Breitenbach, Hans-Jörg Rheinberger, and Christof Ebner. "Dissection of Immunoglobulin E and T Lymphocyte Reactivity of Isoforms of the Major Birch Pollen Allergen Bet v 1: Potential Use of Hypoallergenic Isoforms for Immunotherapy." *Journal of Experimental Medicine* 183 (1996): 599-609.

Geimer, Peter. "Das Haus der Inkohärenz : Capriccio und Sammlung im 18. Jahrhundert." In *Kunstform Capriccio. Von der Groteske bis zur Spieltheorie*, Ed. Joachim Rees. 120-134. Köln: König, 1997.

Gierl, Martin. "Gesicherte Polemik : zur polemischen Natur geschichtswissenschaftlicher Wahrheit und zu Anthony Graftons 'Die tragischen Ursprünge der deutschen Fußnote'." *Historische Anthropologie* 4 (1966): 267-279.

Gierl, Martin. "Dal libello al giornale : la difesa della verità da parte degli intellettuali e le prime forme di recensione in Germania." *Revista di Storia della Storiografia Moderna*, in press.

Glänzel, Wolfgang. "A Bibliometric Approach to Social Sciences : National Research Performances in 6 Selected Social Science Areas." *Scientometrics* 35 (3 1996): 291-307.

Glänzel, Wolfgang, Ed. *Proceedings of the Workshop on "Bibliometric Standards"* (June 11, 1995, Rosary College, River Forest). *Scientometrics*, Vol. 35, No. 2. Amsterdam: Elsevier, 1996.

Glänzel, Wolfgang and Hans-Jürgen Czerwon. "A New Methodological Approach to Bibliographic Coupling and its Application to the National, Regional and Institutional Level." *Scientometrics* 37 (2 1996): 195-222.

Glänzel, Wolfgang, E. J. Rinia, and M. G. M. Brocken. "A Bibliometric Study on Highly-Cited European Physics Papers in the 80s Based on 'Physics Briefs' Source Publications and 'SCI' Citation Data." In *Proceedings of the Fourth International Conference on Science and Technology Indicators* (October 4-7, 1995, Antwerp), in press.

Glänzel, Wolfgang and Urs Schoepflin. "A Bibliometric Study of Reference Literature in the Sciences and Social Sciences." *Information Processing & Management*, in press.

Goenner, Hubert, Jürgen Renn, James Ritter, and Tilman Sauer, Eds. *The Advancement of General Relativity and its Contexts*. Basel: Birkhäuser, in press.

Goenner, Hubert see also: Castagnetti and Goenner

Gradmann, Christoph. "Rezension zu Bettina Hey'l: Geschichtsdenken und literarische Moderne : zum historischen Roman der Weimarer Republik." *Internationales Archiv für Sozialgeschichte der deutschen Literatur (IASL)* 21 (1996): 218-223.

Gradmann, Christoph. "Koch, Heinrich Hermann Robert." In *Deutsche Biographische Enzyklopädie, Bd. 5*, Ed. Walter Killy. 643. München: 1997.

Gradmann, Christoph. "Ein Fehlschlag und seine Folgen : Robert Kochs Tuberkulin und die Gründung des Instituts für Infektionskrankheiten in Berlin 1891." In *Strategien der Kausalität. Modelle und Institutionen ätio-*

logischen Denkens in Medizin und Naturwissenschaft im 19. und 20. Jahrhundert, Eds. Christoph Gradmann and Thomas Schlich. Pfaffenweiler: Centaurus, in press.

Gradmann, Christoph. "Hermann von Helmholtz : Historiography and Biography 100 Years Later." *History and Philosophy of the Life Sciences* 19, in press.

Gradmann, Christoph. "Hermann von Helmholtz als Physiologe und Mediziner." In *PTB-Texte*, in press.

Gradmann, Christoph. "Koch, Robert." In *Reader's Guide to the History of Science*, Ed. Arne Hessenbruch. London: Routledge, in press.

Gradmann, Christoph. "Money, Microbes, and More : Robert Koch, Tuberculin and the Foundation of the Institute for Infectious Diseases in Berlin in 1891." In *Pasteur, Germs and the Bacteriological Laboratory*, Ed. Bernardino Fantini. Chicago: Chicago University Press, in press.

Gradmann, Christoph. "Review of: Heinz-Peter Schmiedebach: Robert Remak (1815-1865) : ein jüdischer Arzt im Spannungsfeld von Wissenschaft und Politik." *Berichte zur Wissenschaftsgeschichte*, in press.

Gradmann, Christoph and Thomas Schlich, Eds. *Strategien der Kausalität: Modelle und Institutionen ätiologischen Denkens in Medizin und Naturwissenschaft im 19. und 20. Jahrhundert*. Pfaffenweiler: Centaurus, in press.

Graßhoff, Gerd. "4 Entries: Russels Paradox; Boolesche Algebra; Logizismus; Operation, logische." In *Handbuch der Kognitionswissenschaft*, Ed. Gerhard Strube. Stuttgart: Klett, 1996.

Graßhoff, Gerd. "Cognitive Modelling of Scientific Discovery Processes." In *First European Workshop on Cognitive Modeling*, Eds. U. Schmid, J. Krems, and F. Wysotzki. 1996.

Graßhoff, Gerd. "Michael Heidelberger: Die innere Seite der Natur : Gustav Theodor Fechners wissenschaftlich-philosophische Weltauffassung." *Archiv für Geschichte der Philosophie* 78 (3 1996): 347-351.

Graßhoff, Gerd. "Hertz's Philosophy of Nature in Wittgenstein's *Tractatus*." In *Hertz Centennial*, Eds. John Hughes and Alfred Nordmann. Dordrecht: Kluwer, 1997.

Graßhoff, Gerd. "Wittgenstein's *Metaphysical Tractatus*." *The British Journal for the History of Philosophy* 5 (1 1997): 87-120.

Graßhoff, Gerd. "Discovery of the Urea Cycle : Computer Models of Scientific Discovery." In *Computer Simulations in Science and Technology Studies*, Eds. Petra Ahrweiler and Nigel Gilbert. Berlin: Springer, in press.

Graßhoff, Gerd. "Late Babylonian Astronomical Diaries." In *Ancient Astronomy and Divination*, Ed. Noel Swerdlow. Chicago: Chicago University Press, in press.

Graßhoff, Gerd. "The Methodology of Modeling the Astrophysical Object SS 433." *Philosophia Naturalis* (in press):

Graßhoff, Gerd. "Von der Steinplatte zur Sonnenuhr." In *Tagungsband der 80. Jahrestagung der DGGMNT, "Instrument-Experiment"*, Ed. Christoph Meinel. Stuttgart: GNT Verlag, in press.

Graßhoff, Gerd and Timm Lampert. "Paul Engelmanns Psychologie graphisch dargestellt." *Grazer Philosophische Studien*, in press.

Graßhoff, Gerd see also: Albani, Glessmer and Graßhoff

Graßhoff, Gerd see also: Christlieb, Graßhoff, Nelke and Schlemminger

Haas, Norbert, Rainer Nägele, and Hans-Jörg Rheinberger, Eds. *Liechtensteiner Exkurse III: Aufmerksamkeit*. Eggingen: Edition Isele, in press.

Hagner, Michael. "Das Gehirn als Schlüssel zur Wissenschaft vom Menschen : die Schädellehre von Franz Joseph Gall und die Folgen." In *Meilensteine der Medizin*, Ed. Heinz Schott. 276-283. Dortmund: Harenberg Kommunikation, 1996.

Hagner, Michael. "Der Geist bei der Arbeit : Überlegungen zur Visualisierung cerebraler Prozesse." In *Anatomien medizinischen Wissens. Medizin, Macht, Moleküle*, Ed. Cornelius Borck. 259-286. Frankfurt am Main: Fischer, 1996.

Hagner, Michael. "Review of: Herbert Hörz: Physiologie und Kultur in der zweiten Hälfte des 19. Jahrhunderts : Briefe an Hermann von Helmholtz ; Ed. Klaus Wenig : Rudolf Virchow und Emil du Bois-Reymond : Briefe 1864-1894." *NTM (Neue Serie)* 4 (1996): 198-200.

Hagner, Michael. "Review of: Luigi Marino: Praeceptores Germaniae. Göttingen 1770-1820." *Gesnerus* 53 (1996): 261-262.

Hagner, Michael. "Review of: Sigmund Freud - Ludwig Binswanger : Briefwechsel 1908-1938." *Sudhoffs Archiv* 80 (1996): 237-238.

Hagner, Michael. "Zur Geschichte und Vorgeschichte der Neuropsychologie." In *Enzyklopädie der Neuropsychologie, Bd. 1*, Ed. Hans J. Markowitsch. 1-101. Göttingen: Hogrefe, 1996.

Hagner, Michael. "Zur Physiognomik bei Alexander von Humboldt." In *Geschichten der Physiognomik. Text, Bild, Wissen*, Eds. Rüdiger Campe and Manfred Schneider. 431-452. Freiburg: Rombach, 1996.

Hagner, Michael. *Homo cereбрalis : der Wandel vom Seelenorgan zum Gehirn*. Berlin: Berlin Verlag, 1997.

Hagner, Michael. "Johannes Peter Müller." In *Deutsche Biographische Enzyklopädie, Bd. 7*, Eds. Walther Killy and Rudolf Vierhaus. 271. Darmstadt: Wiss. Buchges., 1997.

Hagner, Michael. "Monstrositäten in gelehrten Räumen." In *Alexander Polzin : Abgetrieben*, Ed. S. Gilman. 11-30. Göttingen: Wallstein Verlag, 1997.

Hagner, Michael. "Zwei Anmerkungen zur Repräsentation in der Wissenschaftsgeschichte." In *Räume des Wissens. Repräsentation, Codierung, Spur*, Eds. Hans-Jörg Rheinberger, Michael Hagner, and Bettina Wahrig-Schmidt. 339-355. Berlin: Akademie Verlag, 1997.

Hagner, Michael. "Aufmerksamkeit als Ausnahmezustand." In *Liechtensteiner Exkurse III. Aufmerksamkeit*, Eds. Norbert Haas, Rainer Nägele, and Hans-Jörg Rheinberger. Eggingen: Edition Isele, in press.

Hagner, Michael and Hans-Jörg Rheinberger. "From Theories to Experimental Systems, Objects of Investigation, and Modes of Representation." In *Experimental Essays : Versuche zum Experiment*, Eds. Michael Heidelberger and Friedrich Steinle. Baden-Baden: Nomos Verlag, in press.

Hagner, Michael see also: Rheinberger, Hagner and Wahrig-Schmidt

Heidelberger, Michael and Friedrich Steinle, Eds. *Experimental Essays : Versuche zum Experiment*. Interdisziplinäre Studien ; 3. Baden-Baden: Nomos Verlag, in press.

Helbing, Mario and Ottavio Besomi. *Galileo Galilei. Dialogo sopra i due massimi sistemi de mondo. Nuova edizione critica e comentata*. Miscellanea Medievale e Umanistica, Ed. G. Billanovich. Padova: Antenore, in press.

Hoffmann, Dieter. "Walther Nernst." In *Deutsche Biographische Enzyklopädie, Bd. 7*, Eds. Walther Killy and Rudolf Vierhaus. 364-365. Darmstadt: Wiss. Buchges., 1997.

Hoffmann, Dieter. "Friedrich Herneck (1909-1993) : über Schwierigkeiten beim Schreiben von Wahrheit." *Nachrichtenblatt der Deutschen*

Gesellschaft für Geschichte der Medizin, Naturwissenschaft und Technik e.V. 46 (3 1996): 116-126.

Hoffmann, Dieter. "Genauigkeit und Präzision und die Symbiose von Metrologie und moderner Physik." In *Genauigkeit und Präzision in der Geschichte der Wissenschaften und des Alltags*, Eds. Dieter Hoffmann and Harald Witthöft. 53-72. Bremerhaven: Wirtschaftsverlag NW, 1996.

Hoffmann, Dieter. "Hans Bethe - ein Interview zum 90. Geburtstag." *Physik in unserer Zeit* 27 (5 1996): 214-217.

Hoffmann, Dieter. "Heinrich Hertz und Berlin." In *Fixpunkte. Wissenschaft in der Stadt und der Region. Festschrift für H. Laitko*, Ed. Horst Kant. 257-273. Berlin: Verlag für Wissenschafts- und Regionalgeschichte M. Engel, 1996.

Hoffmann, Dieter and Hubert Laitko. *Hermann von Helmholtz : Klassiker an der Epochenwende ; Jubiläumsausstellung zum 175. Geburtstag des Universalgelehrten ; Katalog* . Bonn: Deutsches Museum, 1996.

Hoffmann, Dieter. "Reaktionen der in Farm Hall internierten deutschen Kernphysiker auf die amerikanische Atombombe : öffentliche Podiumsdiskussion, XXXII ; Symposium der Gesellschaft für Wissenschaftsgeschichte, 26.5.1995 Greifswald." *Berichte zur Wissenschaftsgeschichte* 19 (2-3 1996): 169-172.

Hoffmann, Dieter. "Wider die geistige Trennung : die Max-Planck-Feier(n) in Berlin 1958." *Deutschland-Archiv* 29 (4 1996): 525-534.

Hoffmann, Dieter. "'Das zu wissen, wäre mir von hohem Werte' : über das Schicksal der Bibliothek von Max Planck." *Physikalische Blätter* 53 (10 1997): 21-23.

Hoffmann, Dieter. "Der Physiker Friedrich Möglich (1902-1957) - ein Antifaschist?" In *Naturwissenschaft und Technik in der DDR*, Eds. D. Hoffmann and K. Macrakis. 361-382. Berlin: Akademie-Verlag, 1997.

Hoffmann, Dieter. "Der Physikochemiker Robert Havemann (1910-1982) - eine deutsche Biographie." In *Naturwissenschaft und Technik in der DDR*, Eds. D. Hoffmann and K. Macrakis. 319-336. Berlin: Akademie-Verlag, 1997.

Hoffmann, Dieter. "Ernst Mach." In *Macmillan Encyclopedia of Physics; Vol. 3*, Ed. John S. Rigden. 891-892. New York: 1997.

Hoffmann, Dieter. "Ernst Mach." In *Deutsche Biographische Enzyklopädie, Bd. 6*, Eds. W. Killy and R. Vierhaus. 549-550. München: 1997.

Hoffmann, Dieter. "Ernst Mach (1838-1916)." In *Die grossen Physiker, Bd. 2*, Ed. Karl von Meyenn. 24-36. München: C.H. Beck, 1997.

Hoffmann, Dieter. "Max Planck (1858-1947) : Leben-Werk-Persönlichkeit; Ausstellung im Magnus-Haus Berlin, Oktober 1997." In *Max Planck. Vorträge und Ausstellung zum 50. Todestag*, Ed. Max-Planck-Gesellschaft zur Förderung der Wissenschaften. 53-90. München: Max-Planck-Gesellschaft, 1997.

Hoffmann, Dieter. "Naturwissenschaft und Technik und die Berliner Wissenschaftslandschaft um 1900." In *Technikgeschichte als Vorbild moderner Technik*, Ed. G. Kroker. 57-72. Bochum: 1997.

Hoffmann, Dieter. "Normung von Maß, Zeit und Gewicht : vom deutschen Zollverein bis zur Physikalisch-technischen Bundesanstalt." In *Europa wächst zusammen*, Ed. K. Kröger H. Junius. 7-29. Stuttgart: 1997.

Hoffmann, Dieter. "Robert Rompe (1905-1993)." In *Das Müggelheim Buch. Landschaft-Geschichte-Personen*, Ed. Herbert Pieper. 168-170. Berlin: 1997.

Hoffmann, Dieter, Fabio Bevilacqua, and Roger H. Stuewer, Eds. *The Emergence of Modern Physics : Proceedings of a Conference Commemorating a Century of Physics, Berlin 22-24 March 1995*. Pavia: Università degli Studi di Pavia, 1997.

Hoffmann, Dieter and Hubert Laitko. "Kompetenz, Autorität und Verantwortung : Helmholtz und die Wissenschaftspolitik im Wilhelminischen Deutschland." In *Hermann von Helmholtz (1821 bis 1894). Berliner Kolloquium zum 100. Todestag*, Eds. Dieter Hoffmann and Heinz Lübbig. 115-136. Braunschweig: Physikalisch-Technische Bundesanstalt, 1996.

Hoffmann, Dieter and Heinz Lübbig, Eds. *Hermann von Helmholtz (1821 bis 1894) : Berliner Kolloquium zum 100. Todestag*. PTB-Texte, Bd. 5. Braunschweig: Physikalisch-Technische Bundesanstalt, 1996.

Hoffmann, Dieter and Kristie Macrakis, Eds. *Naturwissenschaft und Technik in der DDR*. Berlin: Akademie-Verlag, 1997.

Hoffmann, Dieter and Thomas Stange. "East Germany's Physic(ist)s in the Light of the 'Physikalische Blätter'." In *The Emergence of Modern Physics. Proceedings of a Conference Commemorating a Century of Physics, Berlin 22-24 March 1995*, Eds. Dieter Hoffmann, Fabio Bevilacqua, and Roger H. Stuewer. 521-530. Università degli Studi di Pavia, 1996.

Hoffmann, Dieter and Harald Witthöft, Eds. *Genauigkeit und Präzision in der Geschichte der Wissenschaften und des Alltags*. PTB-Texte, Bd. 4. Bremerhaven: Wirtschaftsverlag NW, 1996.

Hoffmann, Dieter see also: Renn and Hoffmann

Høyrup, Jens and Peter Damerow, Eds. *Changing Views on Ancient Near Eastern Mathematics*. Berlin: Reimer, in press.

Hruška, Blahoslav. "Der Heilige Hügel in der altmesopotamischen Religion und Mythologie." In *Festschrift zum 65. Geburtstag von Hans Hirsch*, Eds. Michael Jursa et al. Wien: Institut für Orientalistik der Universität Wien, in press.

Hruška, Blahoslav. "Die Sumerer und ihr Heiliges : das profane und sakrale Wissen." In *Assyriologica et Semitica (Festschrift für Joachim Oelsner)*,

Eds. Hans Neumann and Joachim Marzahn. Münster: Ugarit Verlag, in press.

Huerta, Araceli M., Heladia Salgado, Denis Thieffry, and Julio Collado-Vides. "RegulonDB : a Database on Transcription Regulation in *Escherichia coli*." *Nucleic Acid Research*, in press.

Janke, Wolfhard and Tilman Sauer. "Computer Simulations of Quantum Chains." In *Dubna Joint Meeting of International Seminar "Path Integrals: Theory and Applications" and 5th International Conference on "Path Integrals from meV to MeV", May 27-31, 1996 in Dubna, Russia*, edited by Vladimir S. Yarunin and Mikhail A. Smondyrev, Joint Institute for Nuclear Research, 139-143, 1996.

Janke, Wolfhard and Tilman Sauer. "Multigrid Method versus Staging Algorithm." *Chemical Physics Letters* 263 (13 December 1996): 488-494.

Jansen, Sarah. "'Sozialparasiten' und 'Tödlichkeitszahlen' : zu Repräsentationsformen der Schädlingsbekämpfung in Deutschland, 1900-1920." *Aufsätze und Reden der Senckenbergischen naturforschenden Gesellschaft*, in press.

Kant, Horst. "17 Biographien (Arons, Foucault, Frölich, Graftio, Kerr, Klasson, Krzhizhanowskij, Langen, Millikan, Naglo, Papaleksi, Poincaré, Slawjanow, Stefan, Stoletov, Van de Graaff, Wehnelt)." In *Lexikon der Elektrotechniker*, Ed. Kurt Jäger. Berlin, Offenbach: VDE-Verlag, 1996.

Kant, Horst. "Albert Einstein, Max von Laue, Peter Debye und das Kaiser-Wilhelm-Institut für Physik in Berlin (1917-1939)." In *Die Kaiser-Wilhelm-/Max-Planck-Gesellschaft und ihre Institute. Studien zu ihrer Geschichte. Das Harnack-Prinzip*, Eds. Bernhard vom Brocke and Hubert Laitko. 227-243. Berlin: Walter de Gruyter, 1996.

Kant, Horst. "Andrej Sacharov - Physik und Verantwortung." In *Wissenschaftsforschung Jahrbuch 1994/95*, Eds. Hubert Laitko, Heinrich Parthey, and Jutta Petersdorf. 259-290. Marburg: Verlag des Bundes demokratischer Wissenschaftlerinnen und Wissenschaftler, 1996.

Kant, Horst. "Betrachtungen zur Frühgeschichte der Kernphysik : vor hundert Jahren wurde die Radioaktivität entdeckt." *Physikalische Blätter* 52 (3 1996): 233-236.

Kant, Horst. "Die Bedeutung Hermann von Helmholtz' für die theoretische Physik des 19. Jahrhunderts." In *Hermann von Helmholtz. Vorträge eines Heidelberger Symposiums anlässlich des einhundertsten Todestages*, Eds. Wolfgang U. Eckart and Klaus Volkert. 207-239. Pfaffenweiler: Centaurus-Verlagsgesellschaft, 1996.

Kant, Horst. "Ein Pionier der Quantenmechanik wird 100 - Friedrich Hund zum Geburtstag." *Physik in der Schule* 34 (2 1996): 74.

Kant, Horst, Ed. *Fixpunkte : Wissenschaft in der Stadt und der Region ; Festschrift für Hubert Laitko*. Berlin: Verlag für Wissenschafts und Regionalgeschichte M. Engel, 1996.

Kant, Horst. "Kalendarium zu ausgewählten Daten der Naturwissenschafts- und Technikgeschichte (Schwerpunkt Physikgeschichte) für 1996." *Physik in der Schule* 34 (1 1996): 38-39.

Kant, Horst. "Peter Debye und die Deutsche Physikalische Gesellschaft." In *The Emergence of Modern Physics. Proceedings of a Conference Commemorating a Century of Physics, Berlin 22-24 March 1995*, Eds. Dieter Hoffmann, Fabio Bevilacqua, and Roger H. Stuewer. 505-521. Pavia: Università degli Studi di Pavia, 1996.

Kant, Horst. "Physik in Berlin vor der Jahrhundertwende im Kontext ihrer kommunikativen Strukturen : eine Betrachtung zu möglichen Untersuchungsfeldern." In *Fixpunkte. Wissenschaft in der Stadt und der Region*, Ed. Horst Kant. 135-159. Berlin: Verlag für Wissenschafts- und Regionalgeschichte M. Engel, 1996.

Kant, Horst. "Rezension zu K. Hoffmann : J. Robert Oppenheimer : Schöpfer der ersten Atombombe (Berlin, Heidelberg, New York 1995)." *Physikalische Blätter* 52 (9 1996): 904.

Kant, Horst. "Rutherford und die ersten Dezennien der Erforschung der Radioaktivität." *Physik in der Schule* 34 (10 1996): 366-371.

Kant, Horst. "Emil Warburg und die Berliner Physik." *Dahlemer Archivgespräche* 2 (1997): 64-100.

Kant, Horst. "Kalendarium zu ausgewählten Daten der Naturwissenschafts- und Technikgeschichte (Schwerpunkt Physikgeschichte) für 1997." *Physik in der Schule* 35 (1 1997): 38-39.

Kant, Horst. "Peter Debye (1884-1966)." In *Die großen Physiker, Bd. 2*, Ed. Karl von Meyenn. 262-275. München: Beck, 1997.

Kant, Horst. "Review of: Lin Qing : Zur Frühgeschichte des Elektronenmikroskops. Stuttgart: GNT-Verl., 1995." *NTM (Neue Serie)* 5 (3 1997): 199-200.

Kant, Horst. "The Establishment of Theoretical Physics as a Separate Field of Investigation and Teaching at the End of 19th Century." In *Proceedings of the International Conference on History and Philosophy of Physics in Education, August 21 - 24, 1996, Bratislava*, 123-133. Bratislava: 1997.

Kaufmann, Doris. "Wahnsinn und Geschlecht : eine erfahrungsseelenkundliche Fallgeschichte aus der Entstehungszeit der bürgerlichen Gesellschaft in Deutschland." In *Was sind Frauen? Was sind Männer? Geschlechterkonstruktionen im historischen Wandel*, Ed. Christiane Eifert et al. 176-195. Frankfurt a.M.: Suhrkamp, 1996.

Kaufmann, Doris. "Ethnologie et rapports entre les sexes : le compte rendu de Georg Forster sur son voyage autour du monde (1772-1775)." *Gradhiva. Revue semestrielle d'histoire et d'archives de l'anthropologie*, in press.

Kaufmann, Doris. "Eugenik-Rassenhygiene-Humangenetik : Wissenschaft von der Verbesserung des menschlichen Erbguts." In *Schöpfungsträume und Körperbilder 1500 - 2000*, Ed. Richard van Dülmen. Köln, Weimar, Wien: Böhlau, in press.

Kaufmann, Doris. "Schmerz zur Heilung des Selbst : heroische Kuren in der Psychiatrie des frühen 19. Jahrhunderts." In *Medizin, Gesellschaft und Geschichte. Jahrbuch des Instituts für Geschichte der Medizin der Robert Bosch Stiftung, Bd. 15*, 101-116. Ed. Robert Jütte. Stuttgart: Franz Steiner, 1997.

Kaufmann, Doris. "Science as Culture : Psychiatry in the First World War and Weimar Germany." *Journal of Contemporary History*, in press.

Klein, Ursula. "The Chemical Workshop Tradition and the Experimental Practice : Discontinuities within Continuities." *Science in Context* 9 (3 1996): 251-287.

Klein, Ursula. "Chemiker-Virtuosi und chemisch-technologische Literatur im 17. Jahrhundert." In *Dilettanten und Wissenschaft. Zur Geschichte und Aktualität eines wechselvollen Verhältnisses*, Ed. Elisabeth Strauß. 49-68. Amsterdam: Rodopi-Editions, 1996.

Klein, Ursula. "Experiment, Spiritus und okkulte Qualitäten in der Philosophie Francis Bacons." *Philosophia Naturalis* 33 (2 1996): 288-315.

Klein, Ursula. "Review of: Michael Hagner, Hans-Jörg Rheinberger, Bettina Wahrig-Schmidt : Objekte, Differenzen und Konjunkturen : Experimentalsysteme im historischen Kontext. Berlin: Akademie-Verlag 1994." *NTM (Neue Serie)* 4 (2 1996): 125-126.

Klein, Ursula. "4 Entries: Elements; Glauber, Johann Rudolf; Lemery, Nicolas; Libavius, Andreas." In *The Scientific Revolution. An Encyclopedia*, Ed. Wilbur Applebaum. New York: Garland, in press.

Klein, Ursula. "Do we need a philosophy of chemistry ?" In *Philosophy of chemistry*, Ed. Nikolaus Psarros. Würzburg: Königshausen & Neumann, in press.

Klein, Ursula. "Nature and Art in 17th-Century French Chemical Textbooks." In *Special issue of the Sixteenth Century Journal*, Eds. Allen G. Debus and Michael T. Walton, in press.

Klein, Ursula. "Paper-Tools and Techniques of Modelling in Classical Chemistry." In *Models as Mediating Instruments*, Eds. Mary S. Morgan and Margret C. Morrison. Cambridge: Cambridge Univ. Press, in press.

Klein, Ursula. "Paving a Way through the Jungle of Organic Chemistry : Experimenting within Changing Systems of Order." In *Experimental Essays : Versuche zum Experiment*, Eds. Michael Heidelberger and Friedrich Steinle. Baden-Baden: Nomos Verlag, in press.

Klein, Ursula. "Review of: 'Laws and Order in Eighteenth-Century Chemistry' by Alistair Duncan. Oxford: Clarendon Press, 1996." *Ambix*, in press.

Klein, Ursula see also: Mendelsohn and Klein

Kojevnikov, Alexei. "Das sowjetische Atomprojekt vor und nach Hiroshima." *Berichte zur Wissenschaftsgeschichte* 19 (2-3 1996): 165-167 und 173-178.

Kojevnikov, Alexei. "President of Stalin's Academy : the Mask and Responsibility of Sergei Vavilov." *ISIS* 87 (1 1996): 18-50.

Küttler, Wolfgang. "Das Historismusproblem in der Geschichtswissenschaft der DDR." In *Historismus in den Kulturwissenschaften. Geschichtskonzepte, historische Einschätzungen, Grundlagenprobleme*, Eds. Gerhard Otto Oexle and Jörn Rüsen. 239-262. Köln: Böhlau, 1996.

Küttler, Wolfgang. "Formationstheorie und Moderne." *Sitzungsberichte der Leibniz-Sozietät, Berlin* 8 (Heft 8/9 1996): 17-56.

Küttler, Wolfgang. "Formationstheorie zwischen Dogma und Wissenschaft." *Utopie kreativ* 73/74 (November/December 1996): 65-80.

Küttler, Wolfgang. "Probleme des Geschichtsdiskurses im vereinigten Deutschland : historisches Denken und Geschichtswissenschaft im Übergang." In *Mauern der Geschichte. Historiographie in Europa zwischen Diktatur und Demokratie*, Eds. Gustavo Corni and Martin Sabrow. 159-186. Leipzig: Akademische Verlagsanstalt, 1996.

Küttler, Wolfgang. "Theorie und Geschichte : Perspektiven eines Diskurses." *Potsdamer Bulletin für zeithistorische Studien* (8 1996): 29-32.

Küttler, Wolfgang. "Wie offen ist die Geschichte?" In *Gibt es erledigte Fragen an die Geschichte?. Beiträge eines wissenschaftlichen Kolloquiums aus Anlaß des 65. Geburtstages von Walter Schmidt am 1. Juli 1995*, Eds. Wolfgang Küttler and Helmut Maier. 11-20. Berlin: Trafo Verlag Weist, 1996.

Küttler, Wolfgang. "Gesellschaftstheorie, Ökonomie und Geschichte : Karl Marx im gesellschaftlichen und wissenschaftsgeschichtlichen Kontext der Modernisierung des Geschichtsdenkens." In *Die Epoche der Historisierung, Bd. 3*, Eds. Wolfgang Küttler, Jörn Rüsen, and Ernst Schulin. 377-395. Frankfurt/Main: Fischer Taschenbuch Verlag, 1997.

Küttler, Wolfgang. "Marxismus." In *Handbuch der Geschichtsdidaktik*, Eds. Klaus Bergmann, Klaus Fröhlich, Annette Kuhn, Jörn Rüsen, and Gerhard Schneider. 181-187. 5. überarb. Aufl. ed., Vol. Seelze-Velber: Kallmeyer'sche Verlagsbuchhandlung, 1997.

Küttler, Wolfgang. "Perspektiven der Moderne im Werk Max Webers : Gesellschafts- und Sozialwissenschaften am Scheideweg." *Utopie kreativ* (77 1997): 11-17.

Küttler, Wolfgang and Helmut Maier, Eds. *Gibt es erledigte Fragen an die Geschichte? : Beiträge eines wissenschaftlichen Kolloquiums aus Anlaß des 65. Geburtstages von Walter Schmidt am 1. Juli 1995*. Schriftenreihe des Vereins "Gesellschaftswissenschaftliches Forum" e.V., Vol. 5. Berlin: Trafo Verlag Weist, 1996.

Küttler, Wolfgang, Jörn Rüsen, and Ernst Schulin, Eds. *Die Epoche der Historisierung*. Vol. 3. Geschichtsdiskurs in fünf Bänden. Frankfurt/Main: Fischer Taschenbuch Verlag, 1997.

Küttler, Wolfgang, Jörn Rüsen, and Ernst Schulin, Eds. *Krisenbewußtsein, Katastrophenerfahrungen und Innovationen 1880-1945*. Vol. 4. Geschichtsdiskurs in fünf Bänden. Frankfurt/Main: Fischer Taschenbuch Verlag, 1997.

Küttler, Wolfgang and Walter Schmidt. "Walter Markov : 5.10.1909 - 3.7.1993." *Sächsische Akademie der Wissenschaften. Jahrbuch 1993-1994* (1996): 377-380.

Labbé, Morgane. "Dénombrer les minorités: enjeux politiques et jeux des catégories dans les recensements grecs." In *Anciennes et nouvelles minorités*, Eds. Alain Bidault, Jacques Magaud, and Jean Louis Rallu. Paris: P.U.F., 1997.

Labbé, Morgane. "Les nationalités dans les Balkans : de l'usage des recensements." *L'Espace géographique*, in press.

Lefèvre, Wolfgang, Ed. *Fundamental Concepts of Early Modern Chemistry*. Science in Context, Vol. 9, No. 3. Cambridge (U.K.): Cambridge University Press, 1996.

Lefèvre, Wolfgang. "Galileo Engineer - Art and Modern Science." *Science in Context*, in press.

Lefèvre, Wolfgang. "Hegels Geschichte der Philosophie aus wissenschaftsgeschichtlicher Perspektive." *Hegel Jahrbuch 1997*, in press.

Lefèvre, Wolfgang. "J. B. Lamarck." In *Klassiker der Biologie, Bd. 1*, Eds. Ilse Jahn and Michael Schmitt. München: C.H. Beck, in press.

Lüttke, Karlheinz. "Das öffentliche Wissenschaftsverständnis in Ost und West." In *Deutsch-deutsche Sprachspiele. Tagungsband zur 9. Tagung*

Friedenspsychologie Jena 1996, Ed. Wolfgang Frindte. Münster: LIT-Verlag, in press.

Lüdtke, Karlheinz. "Entstehung und Entwicklung wissenschaftlich-technischer Neuerungen in soziologischer Sicht." In *Wissenschaftsforschung Berlin-Brandenburg. Jahrbuch 1996/1997*, Eds. Hubert Laitko, Heinrich Parthey, and Siegfried Greif. Marburg: BdWi-Verlag, in press.

Lüdtke, Karlheinz. "Entwicklungen auf dem Gebiet der Biotechnologie im Prozess sozialer Interaktionen von Grundlagenforschern und Akteuren des biotechnologischen Ingenieurwesens : Projektskizze." *Jenaer Beiträge zur Soziologie*, in press.

Lüdtke, Karlheinz. "Wissenschaftsentwicklung und der Wandel disziplinärer Strukturen." *Ethik und Sozialwissenschaften*, in press.

Lüthy, Christoph. "Die glücklichen Fische : Stephen Toulmins Entwurf einer nachmodernen Wissenschaft." *Frankfurter Allgemeine Zeitung*, 04.12.1996.

Lüthy, Christoph. "Kosmos aus Kügelchen : zur Entstehung des atomistischen Weltbildes." *Frankfurter Allgemeine Zeitung, Beilage Geisteswissenschaften*, 11.09.1996.

Lüthy, Christoph. "The Life of '8K' : a Vagrant Microscope Objective." *Gesnerus* 53 (1996): 49-66.

Lüthy, Christoph. "Sébastien Basson, philosophe atomiste et régent au Collège de Die (1611-1625)." *Revue Drômoise* 90 (481 1996): 118-126.

Lüthy, Christoph. "Letzte Garde der Rationalität : Der 'Golem' tobt: In Amerika wird zwischen den Disziplinen ein Wissenschaftskrieg geführt." *Frankfurter Allgemeine Zeitung*, 09.07.1997, Geisteswissenschaften.

Lüthy, Christoph. "Parabeln der Entdeckung : Neues zur Genese von Galileo Galileis Gesetzen." *Frankfurter Allgemeine Zeitung*, 17.09.1997.

Lüthy, Christoph. "Thoughts and Circumstances of Sébastien Basson : Analysis, Micro-History, Questions." *Early Science and Medicine* 2 (1997): 1-73.

Lüthy, Christoph. "Bruno's 'Area Democriti' and the Origins of Atomist Theory." *Bruniana & Campanelliana*, in press.

Lüthy, Christoph. "Renaissance Natural Philosophy, 1400-1600." In *Storia della Scienza*, Ed. E. Knobloch B. Copenhaver, N. Siraisi, C. Vasoli. § 11.b. 4. Rome: Enciclopedia Italiana, in press.

Lüthy, Christoph. "Review of: Marian Fournier, *The Fabric of Life : Microscopy in the Seventeenth Century*. Baltimore and London: The Johns Hopkins University Press, 1996." *Technology & Culture* 38 (in press):

Lüthy, Christoph. "Review of: Peter Dear, *Discipline & Experience : The Mathematical Way in the Scientific Revolution*. Chicago: University of Chicago Press, 1995." *British Journal of the History of Science*, in press.

Lüthy, Christoph and William R. Newman, Eds. *The Fate of Hylomorphism : "Matter" and "Form" in Early Modern Science*. *Early Science and Medicine*, Special Issue ed., Leiden: Brill, 1997.

Lüthy, Christoph and William R. Newman. "'Matter' and 'Form': By Way of a Preface." *Early Science and Medicine* 2 (3 1997): 215-226.

Mallard, Alexandre. "Approches philosophiques et socio-culturelle de l'activité scientifique." In *Projets d'Action Educative à Caractère Scientifique et Technologique. Expériences et bilan 1994-1995*, 95-103. Dijon: ENESAD, 1996.

Mallard, Alexandre. "Des instruments à leur usage : aperçus sur la coordination par la mesure." In *Représenter, Hybrider, Cordonner. Actes du Colloque du CSI 9 et 10 mai 1996*, Eds. C. Méadel and V. Rabeharisoa. Paris: Ecole des Mines de Paris, 1996.

Mallard, Alexandre. "L'interprétation collective des résultats d'une expérience : le cas de l'intercomparaison des instruments scientifiques." *Sociologie du travail* 38 (3 1996): 293-310.

Mallard, Alexandre. "Les réseaux de pratique instrumentées." In *Actes du Colloque Emprunts et Innovation, Porquerolles, septembre 1995*, in press.

Mallard, Alexandre. "The Pictures of Comparison." In *Actes of the Symposium on Pictures in Communication, Roskilde Universitetscenter Copenhagen, 1-3 december 1994*, in press.

May, Michael. "Causation and Discovery." In *Computer Simulations in Science and Technology Studies*, Eds. Petra Ahrweiler and Nigel Gilbert. Berlin: Springer, in press.

Mendelsohn, J. Andrew. "Abel Strikes Back : Review of Frank J. Sullo-way, 'Born to Rebel: Birth Order, Family Dynamics, and Creative Lives'." *The Wilson Quarterly* 21 (Winter 1996): 88-89.

Mendelsohn, J. Andrew. "The Body between Infection and Disease : Heredity, Etiology, and Constitution in European Scientific Medicine, 1890-1940." In *Transmission. Human Pathologies between Heredity and Infection*, Eds. Ilana Löwy and Jean-Paul Gaudillière. Harwood Academic Publ., in press.

Mendelsohn, J. Andrew. "From Eradication to Equilibrium : How Epidemics Became Complex after World War I." In *Greater than the Parts. Holism in Biomedicine, 1920 - 1950*, Eds. Christopher Lawrence and George Weisz. Oxford: Oxford University Press, in press.

Mendelsohn, J. Andrew. "Von der Ausrottung zum Gleichgewicht : Das Ende der Gewißheit in der Epidemiologie nach dem ersten Weltkrieg." In *Strategien der Kausalität. Modelle und Institutionen aetiologischen Denkens in Medizin und Naturwissenschaft im 19. und 20. Jahrhundert*, Eds. Christoph Gradmann and Thomas Schlich. Pfaffenweiler: Centaurus Verlag, in press.

Mendelsohn, J. Andrew and Ursula Klein. "Translation of Etienne-François Geoffroy, 'Table of the Different Relations Observed in Chemistry between Different Substances, 27 August 1718'." *Science in Context* 9 (1996): 313-320.

Métraux, Alexandre. "Psychologie." In *Au jardin des malentendus. Le commerce franco-allemand des idées*, Eds. Jacques Leenhardt and Robert Picht. 475-480. Arles: Actes Sud, 1997.

Montada, Leo, Urs Schoepflin, and Paul B. Baltes. "Erwiderung auf die Kommentare von Hans. J. Markowitsch, Fritz Strack und Dieter Wolke." *Psychologische Rundschau* 47 (1 1996): 40-41.

Müller-Wille, Staffan. "Collating Plants from the Old and the New World in the Heart of Flourishing Holland." In *Looking Through the Habsburg's Glasses*, Ed. Ineke Phaf-Rheinberger. Stanford: Stanford Univ. Press, in press.

Nikolow, Sybilla. "Die Mathematizität von Blut und Urin : statistische Methoden in der Medizin. Kommentar." In *Die Normierung von Gesundheit : Messende Verfahren der Medizin als kulturelle Praktik um 1900*, Ed. Volker Hess. 33-37. Husum: Matthiesen, 1997.

Nikolow, Sybilla. "Report to: Die Normierung von Gesundheit : Messende Verfahren der Medizin als kulturelle Praxis. Workshop auf dem Wissenschaftshistorikertag in Berlin 1996." *NTM : Internationale Zeitschrift für Geschichte und Ethik der Naturwissenschaften, Technik und Medizin (Neue Serie)* 5 (1997): 179-180.

Park, Katharine. "Impressed Images: Generation and Perception in Late Medieval Italy." In *Histories of Art/Histories of Science*, Eds. Caroline Jones and Peter Galison, in press.

Park, Katharine see also: Daston and Park

Presas i Puig, Albert. "Der Zirkel und das Weltbild." In *Der "mathematicus". Zur Entwicklung und Bedeutung einer neuen Berufsgruppe in der Zeit Gerhard Mercators*, Ed. Irmgard Hantsche. 41-72. Bochum: Brockmeyer, 1996.

Presas i Puig, Albert. "Luca Pacioli i De Divina Proportione : matemàtica i experiència a principis del Renaixement." In *IV Trobades d'Història de la Ciència i de la Tècnica, Alcoi, 13.-15. de desembre de 1996*, in press.

Presas i Puig, Albert. *Praktische Geometrie und Kosmologie am Beispiel der Architektur*. Stuttgart: Steiner, in press.

Renn, Jürgen. "Zum Strukturwandel der wissenschaftlichen Öffentlichkeit durch elektronische Medien." *MPG-Spiegel* (1 1996): 2-4.

Renn, Jürgen. "Absturz bei einer schwierigen Gratwanderung." *Tagesspiegel*, 02.06.1997.

Renn, Jürgen. "Die Geburt der Statistischen Mechanik aus dem Geist der Elektronentheorie der Metalle." *Physikalische Blätter* 53 (9 1997): 860-862.

Renn, Jürgen. "Von der klassischen Trägheit zur dynamischen Raumzeit : Albert Einstein und Ernst Mach." *Berichte zur Wissenschaftsgeschichte* 20 (2-3 1997): 189-198. (Also published in: *Naturwissenschaften und Industrie um 1900*, Ed. Werner Kroker. 25-38. Bochum: Georg-Agricola-Gesellschaft, Bochum, 1997)

Renn, Jürgen. "Einstein's Controversy with Drude and the Origin of Statistical Mechanics in his Atomism : A New Glimpse from the 'Love Letters'." *Archive for History of Exact Science*, in press.

Renn, Jürgen and Dieter Hoffmann. "Lexikon Eintrag zu Albert Einstein." In *Physik-Lexikon*, Spektrum Akademischer Verlag, in press.

Renn, Jürgen and Tilman Sauer. "Einsteins Züricher Notizbuch : die Entdeckung der Feldgleichungen der Gravitation im Jahre 1912." *Physikalische Blätter* 52 (9 1996): 865-872.

Renn, Jürgen and Tilman Sauer. "Einstein zögerte lange." *Schweizerische Technische Zeitschrift* 10 (1997): 6.

Renn, Jürgen and Tilman Sauer. "Einsteins Entdeckung des Gravitationslinseneffekts." *Physikalische Blätter* 53 (3 1997): 198.

Renn, Jürgen and Tilman Sauer. "Heuristics and Deductivity in Einstein's Discovery of the Gravitational Field Equations." In *The Advancement of General Relativity and its Contexts*, Eds. Hubert Goenner, Jürgen Renn, James Ritter, and Tilman Sauer. Basel: Birkhäuser, in press.

Renn, Jürgen, Tilman Sauer, and John Stachel. "The Origin of Gravitational Lensing : a Postscript to Einstein's 1936 *Science* Paper." *Science* 275 (5297 1997): 184-186.

Renn, Jürgen see also: Corry, Renn and Stachel

Renn, Jürgen see also: Damerow, Freudenthal, McLaughlin and Renn

Renn, Jürgen see also: Goenner, Renn, Ritter and Sauer

Rheinberger, Hans-Jörg. "Comparing Experimental Systems : Protein Synthesis in Microbes and in Animal Tissue at Cambridge (Ernest F. Gale) and at the Massachusetts General Hospital (Paul C. Zamecnik), 1945-1960." *Journal of the History of Biology* 29 (1996): 387-416.

Rheinberger, Hans-Jörg. "Jenseits von Natur und Kultur : Anmerkungen zur Medizin im Zeitalter der Molekularbiologie." In *Anatomien medizinischen Wissens*, Ed. Cornelius Borck. 287-306. Frankfurt am Main: Fischer, 1996.

Rheinberger, Hans-Jörg. "Molekulare Medizin als Paradigma? : Gentechnologie im Blick von Wissenschaftstheorie und medizinischer Ethik." In *Meilensteine der Medizin*, Ed. Heinz Schott. 555-561. Dortmund: Harenberg, 1996.

Rheinberger, Hans-Jörg. "Between Biological Chemistry and Molecular Biology : Ernest F. Gale on Protein Synthesis, 1946-1958." In *Qu'est-ce que la physiologie? Achèvement et renaissance*, Ed. Claude Debru. 147-160. Paris: Vrin, 1997.

Rheinberger, Hans-Jörg. "Cytoplasmic particles in Brussels (Jean Brachet, Hubert Chantrenne, Raymond Jeener) and at Rockefeller (Albert Claude), 1935-1955." *History and Philosophy of the Life Sciences* 19 (1997): 47-67.

Rheinberger, Hans-Jörg. "Review of: Deichmann, Ute: Biologen unter Hitler." *Berichte zur Wissenschaftsgeschichte* 20 (1997): 251-252.

Rheinberger, Hans-Jörg. "Review of: Latour, Bruno: Wir sind nie modern gewesen. Versuch einer symmetrischen Anthropologie." *Berichte zur Wissenschaftsgeschichte* 20 (1997): 285-286.

Rheinberger, Hans-Jörg. "Stichwort 'Experimentalsysteme'." *Information Philosophie* 25 (4 1997): 36-39.

Rheinberger, Hans-Jörg. *Toward a History of Epistemic Things : Synthesizing Proteins in the Test Tube*. Stanford: Stanford University Press, 1997.

Rheinberger, Hans-Jörg. "Von der Zelle zum Gen : Repräsentationen der Molekularbiologie." In *Räume des Wissens. Repräsentation, Codierung, Spur*, Eds. Hans-Jörg Rheinberger, Michael Hagner, and Bettina Wahrig-Schmidt. 265-279. Berlin: Akademie-Verlag, 1997.

Rheinberger, Hans-Jörg. "Alles, was überhaupt zu einer Inskription führen kann." In *Formen der Wissensvermittlung*, Berlin: Akademie Verlag, in press.

Rheinberger, Hans-Jörg. "Augenmerk." In *Liechtensteiner Exkurse III. Aufmerksamkeit*, Eds. Norbert Haas, Rainer Nägele, and Hans-Jörg Rheinberger. Eggingen: Verlag Klaus Isele, in press.

Rheinberger, Hans-Jörg. "Bemerkungen zur Geschichte der Molekularbiologie." In *Katalog Gen-Welten, Kunst- und Ausstellungshalle der Bundesrepublik Deutschland*, in press.

Rheinberger, Hans-Jörg. "Experimental Complexity in Biology : Epistemological and Historical Remarks." *Philosophy of Science*, in press.

Rheinberger, Hans-Jörg. "Experimental Systems - Graphematic Spaces." In *Writing Science*, Ed. Timothy Lenoir. Stanford: Stanford University Press, in press.

Rheinberger, Hans-Jörg. "Geschichte der Molekularbiologie." In *Geschichte der Biologie*, Ed. Ilse Jahn et. al. Jena: Fischer, in press.

Rheinberger, Hans-Jörg. "Review of: Kay, Lily: The Molecular Vision of Life. Caltech, the Rockefeller Foundation, and the Rise of the New Biology." *History and Philosophy of the Life Sciences*, in press.

Rheinberger, Hans-Jörg. "Review of: Nyhart, Lynn: Biology Takes Form." *Berichte zur Wissenschaftsgeschichte*, in press.

Rheinberger, Hans-Jörg. "Symbols, Icons, Indices : Commentary to Lily Kay: A Book of Life? How a Genetic Code Became a Language." In *Controlling our Destinies*, Ed. Phillip Sloan. Notre Dame: Notre Dame University Press, in press.

Rheinberger, Hans-Jörg and Michael Hagner. "Plädoyer für eine Wissenschaftsgeschichte des Experiments." *Theory in Bioscience (Biologisches Zentralblatt)* 116 (1997): 11-31.

Rheinberger, Hans-Jörg, Michael Hagner, and Bettina Wahrig-Schmidt, Eds. *Räume des Wissens : Repräsentation, Codierung, Spur*. Berlin: Akademie Verlag, 1997.

Rheinberger, Hans-Jörg, Bettina Wahrig-Schmidt, and Michael Hagner. "Räume des Wissens : Repräsentation, Codierung, Spur." In *Räume des Wissens. Repräsentation, Codierung, Spur*, Eds. Hans-Jörg Rheinberger, Michael Hagner, and Bettina Wahrig-Schmidt. 7-21. Berlin: Akademie Verlag, 1997.

Rheinberger, Hans-Jörg and Michael Weingarten, Eds. *Jahrbuch für Geschichte und Theorie der Biologie 3*. Berlin: Verlag für Bildung und Wissenschaft, 1996.

Rheinberger, Hans-Jörg and Michael Weingarten, Eds. *Jahrbuch für Geschichte und Theorie der Biologie 4*. Berlin: Verlag für Bildung und Wissenschaft, 1997.

Rheinberger, Hans-Jörg see also: Engel, Richter, Obermeyer and Rheinberger

Rheinberger, Hans-Jörg see also: Ferreira, Ebner, Kramer and Rheinberger

Rheinberger, Hans-Jörg see also: Ferreira, Hirtenlehner, Jilek and Rheinberger

Rheinberger, Hans-Jörg see also: Haas, Nägele and Rheinberger

Rheinberger, Hans-Jörg see also: Hagner and Rheinberger

Rieke-Müller, Annelore. "'Ein Kerl mit wilden Thieren...': zur sozialen Stellung von Tierführern im 18. Jahrhundert." *Das achtzehnte Jahrhundert*, in press.

Ritter, James. "Third Millenium Egyptian Metrology." In *Ancient Mathematics*, Eds. Jens Høyrup et al., in press.

Ritter, James see also: Goenner, Renn, Ritter and Sauer

Roux, Sophie. "Les explications de la philosophie mécanique." *Lettre de la Maison Française d'Oxford* (4 1996): 125-136.

Roux, Sophie. "Descartes atomiste?" In *Atomism and Continuum in the Seventeenth Century in Napoli*, Ed. Egidio Festa, Istituto Italiano per gli Studi Filosofici, 1997.

Roux, Sophie. "La nature de la lumière selon Descartes." In *Le siècle de la lumière*, Eds. Christian Biet and Vincent Jullien. Paris: Presses de l'École Normale Supérieure de Fontenay Saint-Cloud, 1997.

Roux, Sophie. "Review of: Thomas M. Lennon : The Battle of the Gods and Giants. The Legacies of Descartes and Gassendi, 1615-1755. Princeton: Princeton University Press, 1993." *Physis* 33 (1-3 1997): 367-372.

Roux, Sophie. "Le scepticisme et les hypothèses de la physique." *Revue de synthèse*, in press.

Roux, Sophie. "Review of: Margaret J. Osler, Divine Will and the Mechanical Philosophy. Gassendi and Descartes on Contingency and Necessity in the Created World. Cambridge: Cambridge University Press 1994." *Physis*, in press.

Roux, Sophie. "Force." In *Dictionnaire d'histoire et de philosophie des sciences*, Ed. Dominique Lecourt. Paris: Presses Universitaires de France, in press.

Sánchez, Lucas, Jacques van Helden, and Denis Thieffry. "Establishment of the Dorso-Ventral Pattern during the Embryonic Development of *Drosophila Melanogaster* : a Logical Analysis." *Journal of Theoretical Biology*, in press.

Sauer, Tilman see also: Goenner, Renn, Ritter and Sauer

Sauer, Tilman see also: Janke and Sauer

Sauer, Tilman see also: Renn, Sauer and Stachel

Scheideler, Britta. *Zwischen Beruf und Berufung : zur Sozialgeschichte der deutschen Schriftsteller von 1880 bis 1933*. Vol. 46. Archiv für Geschichte des Buchwesens, Frankfurt am Main: Buchhändler-Vereinigung, 1997.

Schirrmacher, Arne. "Emigrationsphysik." *Physikalische Blätter* 52 (1996): 449-452.

Schmidgen, Henning. *Das Unbewußte der Maschinen. Konzeptionen des Psychischen bei Guattari, Deleuze und Lacan*. München: Fink, 1997.

Schoepflin, Urs. "Zum Neuaufbau von Bibliotheken in den neugegründeten Instituten in den Neuen Bundesländern." In *XIX. Fortbildungstagung für Bibliotheksleiter/innen der Max-Planck-Institute und Arbeitsgruppen in Tübingen, Germany*, in press.

Schoepflin, Urs see also: Glänzel and Schoepflin

Schoepflin, Urs see also: Montada, Schoepflin and Baltes

Schüller, Volkmar. "Metaphysik als Wurzel der Physik : zum 400. Geburtstag von René Descartes." *Physikalische Blätter* 52 (1996): 563-566.

Schüller, Volkmar. "Review of: R. S. Westfall: Isaac Newton : eine Biographie. Heidelberg : Spektrum-Verlag 1996." *Physikalische Blätter* 53 (5 1997): 454.

Schüller, Volkmar. "Christiaan Huygens." In *Die großen Physiker, Bd. 1*, Ed. Karl von Meyenn. 185-193. München: Beck, 1997.

Schüller, Volkmar. "René Descartes." In *Die großen Physiker, Bd. 1*, Ed. Karl von Meyenn. 170-184. München: Beck, 1997.

Schüller, Volkmar. "'Unsere Welt ist die beste aller möglichen Welten' : zur 350. Wiederkehr von Leibniz' Geburtstag." *Physikalische Blätter* 53 (3 1997): 235-238.

Schüller, Volkmar, Ed. *Isaac Newton : die mathematischen Prinzipien der Physik*. Berlin: de Gruyter, in press.

Schweber, Libby. "L'histoire de la statistique, laboratoire pour la théorie sociale." *Revue Française de Sociologie* 37 (1996): 107-128.

Schweber, Libby. "Controverses et styles de raisonnements : débats sur la statistique de population au 19e siècle en France et en Angleterre." *Enquête* 5 (1997): 83-108.

Schweber, Libby. "L'échec de la démographie en France au XIX siècle." *Genèse*, in press.

Sibum, H. Otto. "Charles Augustin Coulomb : einfache Maschinen in Theorie und Praxis." In *Die großen Physiker, Bd. 1*, Ed. Karl von Meyenn. 243-262. München: C.H. Beck, 1997.

Sibum, H. Otto. "Die Sprache der Instrumente : eine Studie zur Praxis und Repräsentation des Experimentierens." In *Experimental Essays. Versuche zum Experiment*, Eds. Michael Heidelberger and Friedrich Steinle. 141-156. Baden-Baden: Nomos Verlag, in press.

Sibum, H. Otto. "Les gestes de la mesure : Joule, les pratiques de la brasserie et la science." *Annales : Histoire, Science Sociale*, in press.

Sibum, H. Otto. "Mechanical Equivalent of Heat Apparatus." In *Instruments of Science. A Historical Encyclopaedia, Vol. 1*, Eds. Robert Bud and Deborah Warner. 375-377. Hamden: Garland Publishing, in press.

Sibum, H. Otto. "An Old Hand in a New System." In *The Invisible Industrialist. Manufactures and the Production of Scientific Knowledge*, Eds. Jean-Paul Gaudillière and Ilana Löwy. 23-57. London: Macmillan, in press.

Sibum, H. Otto. "Vosproizvedenije mehaničeskogo ekvivalenta teploty : točnye instrumenty i metody strogosti v ranneviktorskoj Anglii." *Voprosy istorii estestvoznanija tehniki*, in press.

Sigurdsson, Skúli. "Physics, Life, and Contingency : Born, Schrödinger and Weyl in Exile." In *Forced Migration and Scientific Change. Emigre German-Speaking Scientists and Scholars after 1933*, Eds. Mitchell G. Ash and Alfons Söllner. 48-70. Cambridge: Cambridge Univ. Press, 1996.

Sigurdsson, Skúli. "Sublime and Worldly Crystals : Essay Review of D. W. J. Cruickshank, Hellmut J. Juretschke, and Norio Kato (Eds.) : P. P. Ewald and his Dynamical Theory of X-ray Diffraction. Oxford: Oxford University Press 1992." *Annals of Science* 53 (1 1996): 85-88.

Sigurdsson, Skúli. "Electric Memories and Progressive Forgetting." In *The Historiography of Contemporary Science and Technology*, Ed. Thomas Söderqvist. 129-149. Amsterdam: Harwood Academic Publishers, 1997.

Sigurdsson, Skúli. "Journals and the Passage of Time." *hochschule ost. politisch-akademisches journal aus ostdeutschland* 6 (3-4 1997): 9-20.

Staley, Richard. "Albert Einstein." In *Reader's Guide to the History of Science*, Ed. Arne Hessenbruch. London: Fitzroy Dearborn, in press.

Staley, Richard. "Born, Max (1882-1970)." In *The New Dictionary of National Biography*, Ed. Colin Matthew. Oxford: Oxford University Press, in press.

Staley, Richard. "On the Histories of Relativity." *Isis*, in press.

Staley, Richard. "Quantum Physics I: Quantum Theory." In *The Reader's Guide to the History of Science*, Ed. Arne Hessenbruch. London: Fitzroy Dearborn, in press.

Staley, Richard. "Quantum Physics II: Quantum Mechanics." In *The Reader's Guide to the History of Science*, Ed. Arne Hessenbruch. London: Fitzroy Dearborn, in press.

Staley, Richard. "Relativity, Theory of." In *Reader's Guide to the History of Science*, Ed. Arne Hessenbruch. London: Fitzroy Dearborn, in press.

Steinle, Friedrich. "Work, Finish, Publish? : The Formation of the Second Series of Faraday's 'Experimental Researches in Electricity'." *Physis* 33 (1-3 1996): 141-220.

Steinle, Friedrich. "Exploratives vs. theoriebestimmtes Experimentieren : Ampères frühe Arbeiten zum Elektromagnetismus." In *Experimental Essays : Versuche zum Experiment*, Eds. Michael Heidelberger and Friedrich Steinle. Baden-Baden: Nomos Verlag, in press.

Steinle, Friedrich. "Review of: Christine Blondel/Matthias Dörries (Eds): Restaging Coulomb. Usages, controverses et répliques autour de la balance de torsion. Firenze: Olschki 1994." *Archives Internationales d'Histoire des Sciences*, in press.

Steinle, Friedrich. "Review of: Lorenz Krüger (Ed.): Universalgenie Helmholtz : ein Rückblick nach 100 Jahren. Berlin: Akademie-Verlag 1994." *NTM : Internationale Zeitschrift für Geschichte und Ethik der Naturwissenschaften, Technik und Medizin (Neue Serie)* 5 (1997): 125-126.

Steinle, Friedrich see also: Heidelberger and Steinle

Strickland, Stuart. "The Ideology of Self-Knowledge and the Practice of Self-Experimentation." *Eighteenth-Century Studies*, in press.

Swijtink, Zeno G. "6 Entries: Beth Definability Theorem; Categorical Theory; Craig's Interpolation Theorem; Model Theory; Satisfiable; Standard Model." In *The Cambridge Dictionary of Philosophy*, Ed. Robert Audi. New York: Cambridge University Press, 1996.

Swijtink, Zeno G. "2 Entries: Beth's Definition Theorem; Craig's Interpolation Theorem." In *Routledge Encyclopedia of Philosophy*, Ed. Michael Detlefsen (Sub-Editor). London: Routledge, in press.

Swijtink, Zeno G. "2 Entries: Error Theory; Probability." In *Reader's Guide to the History of Science*, Ed. Arne Hessenbruch. London: Fitzroy Dearborn, in press.

Swijtink, Zeno G. "The Disunity of Data-Analysis." *Philosophia Naturalis* Special issue : Brigitte Falkenburg and Wolfgang Muschik (Eds.) : Models, Theories and Disunity in Physics, in press.

Swijtink, Zeno G. "The Romantic Conception of Knowledge in Alexander von Humboldt." *Perspectives on Science*, in press.

Thieffry, Denis. "Contributions of the 'Rouge-Cloître Group' to the Notion of mRNA." *History and Philosophy of Life Sciences* 19 (1 1997): 89-111.

Thieffry, Denis. "From Experimental Embryology to Developmental Biology : the metamorphoses of the gradient concept." In *XXth International Congress of History of Science in Liège, Belgium, 1997*.

Thieffry, Denis and René Thomas. "Qualitative analysis of gene networks." In *Pacific Symposium on Biocomputing '98 in Maui, Hawaii*, World Scientific, Singapor, in press.

Thieffry, Denis see also: Burian and Thieffry

Thieffry, Denis see also: Huerta, Salgado and Thieffry

Thieffry, Denis see also: Sánchez, van Helden and Thieffry

Thöle, Bernhard. "Die Analogien der Erfahrung." In *Kommentar zu Kants "Kritik der reinen Vernunft"*, Eds. Georg Mohr and Marcus Willaschek. Berlin: Akademie-Verlag, in press.

Thöle, Bernhard. "Die Einheit der Erfahrung." In *Erfahrung und Urteilskraft*, Ed. Rainer Enskat. Würzburg: Königshausen & Neumann, in press.

Thöle, Bernhard. "Kants Systemidee." In *Architektur und System in der Philosophie Kants*, Eds. Hans-Friedrich Fulda, Hans-Dieter Klein, and Jürgen Stolzenberg. Hamburg: Meiner, in press.

Thöle, Bernhard. "Naturalismus, Reduktion und Qualia." In *Fragen des Naturalismus*, Eds. Geert Keil and Herbert Schnädelbach. Frankfurt am Main: Suhrkamp, in press.

Vogel, Klaus A. "Plus ultra? : Grenzbewußtsein und Raumbewältigung im Prozeß der Rezeption der überseeischen Entdeckungen des 15. und 16. Jahrhunderts." In *Grenzen und Raumvorstellungen (11.-20. Jahrhundert) = Frontières et conceptions de l'espace (11e-20e siècle)*, Ed. Guy P. Marchal. 123-133. Zürich: Chronos, 1996.

Vogel, Klaus A. "Wo Sprache endet : der Bericht des Anton Prätorius über die Folter und das Problem der selektiven Empathie." In *Ein Schauplatz herber Angst. Wahrnehmung und Darstellung von Gewalt im 17. Jahrhundert*, Eds. Markus Meumann and Dirk Niefanger. 188-204. Göttingen: Wallstein, 1997.

Vogel, Klaus A. "1492 - Europa und die Entdeckung neuer Welten : Literaturbericht." *Geschichte in Wissenschaft und Unterricht*, in press.

Vogel, Klaus A. "From Columbus and Copernicus : The Cosmographical Revolution and the Beginnings of Early Modern Science." *Science in Context*, in press.

Vogel, Klaus A. *Sphaera terrae : das mittelalterliche Bild der Erde und die kosmographische Revolution*. Göttingen: Vandenhoeck und Ruprecht, in press.

Vogel, Klaus A. and Thomas Haye. "Die Bibliothek Konrad Peutingers : Überlegungen zu ihrer Rekonstruktion, Erschließung und Analyse." In *Bücher und Bibliotheken im Zeitalter der Renaissance*, Ed. Werner Arnold. 113-128. Wiesbaden: Harrassowitz, 1997.

Vogt, Annette. "'Auch Damen möchten den Doktorhut' : Promotionen von Frauen an der Philosophischen Fakultät der Berliner Universität zwischen 1898 und 1945." In *Geschlechterverhältnisse in Medizin, Naturwissenschaft und Technik*, Eds. Christoph Meinel and Monika Renneberg. 288-296. Bassum, Stuttgart: Verlag für Geschichte der Naturwissenschaften und der Technik, 1996.

Vogt, Annette. "Bericht: 100 Jahre Frauen in der Wissenschaft : ein Tagungsbericht." *IWK (Internationale wissenschaftliche Korrespondenz zur Geschichte der deutschen Arbeiterbewegung)* 32 (4 1996): 552-558.

Vogt, Annette. "Emil Julius Gumbel : der erste Herausgeber der mathematischen Manuskripte von Marx." In *MEGA-Studien 2/1995*, 26-41. Berlin: Dietz, 1996.

Vogt, Annette. "Friedrich II. und der Mathematiker Leonhard Euler." *Berlinische Monatsschrift* 2 (1996): 86-90.

Vogt, Annette. "Heinrich Grell und Karl Schröter in Ost-Berlin - ein falsches Leben?" In *Fixpunkte. Wissenschaft in der Stadt und Region*, Ed. Horst Kant. 291-311. Berlin: Verlag für Wissenschafts- und Regionalgeschichte M. Engel, 1996.

Vogt, Annette. "Karl Weierstraß wird berufen." *Berlinische Monatsschrift* 6 (1996): 72-74.

Vogt, Annette. "Zu den naturwissenschaftlichen Promotionen von Frauen an der Philosophischen Fakultät der Berliner Universität zwischen 1898 und 1945 : Überblick und Einzelbeispiele." In *Zur Geschichte des Frauenstudiums und weiblicher Berufskarrieren an der Berliner Universität*, 34-57. Berlin: Humboldt-Universität, 1996.

Vogt, Annette. "Zum Gedenken an Boris Vladimirovic Gnedenko : (Nachruf)." *NTM (Neue Serie)* 4 (1996): 182-184.

Vogt, Annette. "Bericht: Deutscher Wissenschaftshistorikertag 1996. Wissenstransfer Osteuropa - Westeuropa." *NTM (Neue Serie)* 5 (3 1997): 181-182.

Vogt, Annette. "Berlins erste Professorin : der 'Milch-Skandal' machte sie berühmt. Lydia Rabinowitsch-Kempner - die erste vom Kaiser ernannte Professorin in Berlin." *Berlinische Monatsschrift* 7 (1997): 32-36.

Vogt, Annette. "Das 'cum laude' gelang erst im zweiten Anlauf. Alice Salomon." *Berlinische Monatsschrift* (9 1997): 34-38.

Vogt, Annette. "Die Kaiser-Wilhelm-Gesellschaft wagte es : Frauen als Abteilungsleiterinnen." In *'Aller Männerkultur zum Trotz'. Frauen in Mathematik und Naturwissenschaften*, Ed. Renate Tobies. 203-219. Frankfurt/Main und New York: Campus Verlag, 1997.

Vogt, Annette. "Elsa Neumann - erste Promovendin an der Berliner Uni." *Berlinische Monatsschrift* 8 (1997): 27-32.

Vogt, Annette. "'In Ausnahmefällen ja' - Max Planck als Förderer seiner Kolleginnen. Zum 50.Todestag von Max Planck." *Max-Planck-Spiegel* (4 1997): 48-53.

Vogt, Annette. "Naturwissenschaftlerinnen in der Kaiser-Wilhelm-Gesellschaft." In *Sparkurs in der Wissenschaft - Einsparung von Frauen? Tagungsbeiträge*, Ed. Vorstand des Deutschen Hochschullehrerinnenbundes. 3-28. Berlin: Humboldt-Universität zu Berlin, 1997.

Vogt, Annette. "Review: Petra Werner/Angelika Irmscher (Hrsg.) Fritz Haber. Briefe an Richard Willstätter. 1910-1934. Berlin 1995." *Berlinische Monatsschrift* (6 1997): 135-136.

Vogt, Annette. "Vom Hintereingang zum Hauptportal - Wissenschaftlerinnen in der Kasier-Wilhelm-Gesellschaft." *Dahlemer Archivgespräche* (2 1997): 115-139.

Vogt, Annette. "Vom Hintereingang zum Hauptportal : Forscherinnen in der KWG." *Max-Planck-Spiegel* (4 1997): 62-64.

Vogt, Annette. "Die Berliner Familie Remak - eine deutsch-jüdische Geschichte im 19. und 20. Jahrhundert." In *Tagungsband Geschichte der Mathematik*, Ed. Michael Toepell. Heidelberg: Spektrum, in press.

Vogt, Annette. "Die Spielregeln der Objektivität : die ersten Promotionen und Promotionsversuche von Frauen an der Philosophischen Fakultät der Berliner Friedrich-Wilhelms-Universität 1898-1909." In *Der Eintritt der Frauen in die Gelehrtenrepublik. Zur Geschlechterfrage im akademischen Selbstverständnis und in der wissenschaftlichen Praxis am Anfang des 20. Jahrhunderts*, Ed. Johanna Bleker. 31-48. Husum: Matthiesen Verlag, in press.

Vogt, Annette. "Issai Schur - vertrieben, aber nicht vergessen." In *Menora. Deutsch-Jüdisches Jahrbuch*, Ed. Julius Schöps. Bodenheim: Philo Verlag, in press.

Vogt, Annette. "'Mit ihr habe ich nicht geredet, nur mit ihrem Mann' - die Wissenschaftlerin Elena Aleksandrovna Timoféeff-Ressovskaja und ihr Verhältnis zu Deutschland." In *Ring-Vorlesung 1995/1996, "Bilder und Selbstbilder im östlichen Europa"*, Ed. Osteuropa-Institut der Freien Universität. Berlin: in press.

Vogt, Annette see also: Bleker and Vogt

Wahsner, Renate. "Neobchotimoto treto." *Filosofia* 5 (5-6 1996): 61-68.

Wahsner, Renate. "Review of: Christoph Friedrich v. Pfleiderer : Naturlehre nach Klügel. Nachschrift einer Tübinger Vorlesung von 1804. Hrsg. und eingel. von Paul Ziche, Stuttgart-Bad Cannstatt: Frommann-Holzboog 1994." *Deutsche Zeitschrift für Philosophie* 44 (6 1996): 1056-1057.

Wahsner, Renate. "Review of: Wolfgang Neuser : Natur und Begriff. Zur Theorienkonstitution und Begriffsgeschichte von Newton bis Hegel, Stuttgart/Weimar: Metzler 1995." *Deutsche Zeitschrift für Philosophie* 44 (2 1996): 317-318.

Wahsner, Renate. "Totalität und Totalitarismus. Verschiedene Begriffe des Allgemeinen." In *Hegel-Jahrbuch 1996*, Eds. Andreas Arndt, Karol Bal, and Henning Ottmann. 236-242. Berlin: Akademie Verlag, 1996.

Wahsner, Renate. *Zur Kritik der Hegelschen Naturphilosophie. Über ihren Sinn im Lichte der heutigen Naturerkenntnis*. Hegeliana : Studien und Quellen zu Hegel und zum Hegelianismus, Bd. 7, Ed. Helmut Schneider. Frankfurt a. M.: Lang, 1996.

Wahsner, Renate. "Über die Berechtigung des analytischen Vorgehens in der Philosophie." In *Analyomen 2. Proceedings of the 2nd Conference "Perspectives in Analytic Philosophy", Vol. 1: Logic, Epistemology, Philosophy of Science*, Ed. Georg Meggle. 322-328. Berlin, New York: de Gruyter, 1997.

Wahsner, Renate. "Demokrit und die Quantenmechanik oder Erwin Schrödingers Rezeption des antiken Atomismus." *Wiener Beiträge zur Geschichte der Neuzeit* 23 (in press):

Wahsner, Renate. "Die Suche nach der objektiven Sinnlichkeit : über den Zusammenhang von Feuerbachs Sensualismus und Helmholtzens Programm einer empirischen Geometrie." In *Materialismus und Spiritualismus. Zwischen Philosophie und Wissenschaften nach 1848*. Ed. Walter Jaeschke. Berlin: Akademie Verlag, in press.

Wahsner, Renate. "Ein Brief über die Philosophie in der DDR." *TOPOS* 10 (Menschenbild), in press, 18.

Wahsner, Renate. "Hegels spekulativer Geozentrismus." In *Hegels Jenaer Naturphilosophie*, Ed. Klaus Vieweg. 299-308. München: Wilhelm Fink Verlag, in press.

Wahsner, Renate. "Naturphilosophie im deutschen Idealismus und alternative Konzepte. Review of: Bernd-Olaf Küppers: *Natur als Organismus. Schellings frühe Naturphilosophie und ihre Bedeutung für die moderne Biologie* (Philosophische Abhandlungen Bd. 58), Frankfurt a. M.: Vittorio Klostermann 1992, 138 S. ; Wolfdietrich Schmied-Kowarzik: 'Von der wirklichen, von der seyenden Natur'. Schellings Ringen um eine Naturphilosophie in Auseinandersetzung mit Kant, Fichte und Hegel. (Schellingiana. Herausgegeben von Walter E. Ehrhardt im Auftrag der Internationalen Schelling-Gesellschaft. Bd. 8), Stuttgart-Bad Cannstatt: Frommann-Holzboog 1996, 234 S. ; Karen Gloy und Paul Burger (Hg.): *Die Naturphilosophie im Deutschen Idealismus (Spekulation und Erfahrung. Texte und Untersuchungen zum Deutschen Idealismus. Abteilung II, Bd. 33)*, Stuttgart-Bad Cannstatt: Frommann-Holzboog 1993, XIV 399 S.; Wolfgang Bonsiepen: *Die Begründung einer Naturphilosophie bei Kant, Schelling, Fries und Hegel. Mathematische versus spekulative Naturphilosophie* (Philosophische Abhandlungen Bd. 70. Frankfurt a. M.: Vittorio Klostermann 1997, 651 S." *Philosophische Rundschau*, 44 (4 1997): 288-303.

Wahsner, Renate. "Philosophie als System und Ungeschichtlichkeit der Natur – ein antiquiertes Konzept?" In *Hegel-Jahrbuch 1997*, Eds. Andreas Arndt, Karol Bal, and Henning Ottmann. Berlin: Akademie Verlag, in press.

Wahsner, Renate and Horst-Heino v. Borzeszkowski, Eds. *Voltaire: Elemente der Philosophie Newtons. Verteidigung des Newtonianismus. Die Metaphysik des Neuton*. Berlin, New York: Walter de Gruyter, 1997.

Wahsner, Renate and Horst-Heino v. Borzeszkowski. "Zur Editions-geschichte. Zeitgenössische Polemik gegen Voltaires 'Metaphysik des Neuton'. Voltaires Weg vom Literaten zum Philosophen. Die Mechanisierung der Mechanik (Einleitung zum edierten Titel)." In *Voltaire. Elemente der Philosophie Newtons. Verteidigung des Newtonianismus. Die Metaphysik*

des Neuton, Eds. Renate Wahsner and Horst-Heino v. Borzeszkowski. 1-77. Berlin, New York: de Gruyter, 1997.

Wahsner, Renate see also: Borzeszkowski and Wahsner

Weinig, Paul. "Aeneas Silvius Piccolomini und sein Publikum." In *Humanismus und früher Buchdruck. Akten des Interdisziplinären Symposiums vom 5./6. Mai 1995*, Eds. Stephan Füssel and Volker Honemann. 71-82. Nürnberg: Carl, 1996.

Weinig, Paul. *Aeneam suscipite, Pium recipite! Aeneas Silvius Piccolomini - Die Rezeption eines humanistischen Schriftstellers im Deutschland des 15. und 16. Jahrhunderts*. Gratia 33 : Bamberger Schriften zur Renaissanceforschung, Ed. Dieter Wuttke. Wiesbaden: Harrassowitz, in press.

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