RESEARCH REPORT 1998—1999

MAX-PLANCK-INSTITUT FÜR WISSENSCHAFTSGESCHICHTE

Max Planck Institute for the History of Science

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Structure and Organization of the Institute

Scientific Advisory Board

Prof. Dr. Roger Chartier, Centre de Recherches Historiques, CNRS, École des Hautes Études en Sciences Sociales, Paris, France
Prof. Dr. Rivka Feldhay, The Cohn Institute for the History and Philosophy of Science and Ideas, Faculty of Humanities, Tel Aviv University, Israel
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Prof. Dr. Rüdiger Wehner, Philosophische Fakultät-II, Zoologisches Institut, Universität Zürich, Switzerland

Departments and Research Groups

Jürgen Renn

Department I

Director: *Prof. Dr. Jürgen Renn*
Research Scholars: *Dr. Peter Beurton, Dipl. Phys. Jochen Büttner, Giuseppe Castagnetti, PD Dr. Peter Damerow, Prof. Dr. Gerd Graßhoff (until March 31, 1999), PD Dr. Dieter Hoffmann, Dr. Horst Kant, Prof. Dr. Wolfgang Lefèvre, Simone Rieger, Dipl. Phys. Matthias Schemmel, Dr. Volkmar Schüller, Prof. Dr. Renate Wahsner, Dr. Paul Weinig, Falk Wunderlich* (until December 31, 1998, now predoctoral research fellow)

Lorraine Daston

Department II

Director: *Prof. Dr. Lorraine Daston*
Research Scholars: *PD Dr. Sonja Brentjes* (until July 1999), *Prof. Dr. Joan Cadden* (until July 1998), *Dr. William Clark* (until September 1998), *PD Dr. Matthias Dörries, Dr. Anke te Heesen, Prof. Dr. Doris Kaufmann* (until March 1998), *Prof. Dr. Wolfgang Küttler, Dr. Antoinette Roesler-Friedenthal, Dr. Sophie Roux,* (until August 1998), *Dr. H. Otto Sibum* (until September 1998, now director of the independent research group II), *Dr. Friedrich Steinle* (until March 1998 and since August 1999), *Prof. Dr. Irmline Veit-Brause* (October 1998 to July 1999), *Dr. Annette Vogt, Dr. Michael Wintroub* (September 1998 to August 1999)

Hans-Jörg Rheinberger

Department III

Director: *Prof. Dr. Hans-Jörg Rheinberger*
Research Scholars: *Dr. Sven Dierig, PD Dr. Michael Hagner, Dr. Sarah Jansen, Dr. Andrew Mendelsohn, Dr. Thomas Potthast, Dr. Denis Thieffry* (until December 1998)

Independent Research Group I

Established January 1999 for five years.
Director: *PD Dr. Ursula Klein*
Research Scholar: *Dr. Peter Ramberg*

Independent Research Group II

Established April 1999 for five years.
Director: *Dr. H. Otto Sibum*
Research Scholar: *Annik Pietsch*

Max Planck Society Research Fellowship for Outstanding Woman Scholars

Established July 1998 for five years.
Dr. Emma Spary

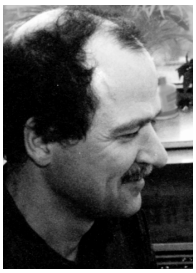


Ursula Klein
H. Otto Sibum
Emma Spary

Service units

Administration headed by *Claudia Paaß*
Library headed by *Urs Schoepflin*
Computing Service Unit headed by *Jörg Kantel*
Research Coordination: *Jochen Schneider*



Claudia Paaß,
Urs Schoepflin,
Jörg Kantel,
Jochen Schneider

The Institute's 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. Held lectures at universities and other academic institutions in Bornheim, Blacksburg, Cambridge (USA), Chicago, Göttingen, Jerusalem, Knoxville, New Haven, and Tel Aviv. At the Institute since September 1994.

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-Dénis (1991); Rockefeller Fellowship, University of Oklahoma, Norman (1991–1992); 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 (1994–1995); PD, Karl Sudhoff Institute (1995–1996); visiting professor, Institute for History of Science, Georg-August-Universität Göttingen (1995–1996): European travelers to the Middle East (16th–17th centuries) and the sciences in Muslim societies.
Held lectures at the *International Congress on Learning and Education in the Ottoman World* in Istanbul, and at the University of Essen. At the Institute from December 1996 to July 1999.

Büttner, Jochen (Dipl. 1997 [physics] Freie Universität Berlin): history of early modern mechanics. At the Institute since January 1998.

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. At the Institute from July 1997 to July 1998.

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. At the Institute since october 1997.

Clark, William (Ph.D. [history of science] University of California at Los Angeles, 1986); lecturer, history, University of California at Los Angeles (1987–1988); lecturer & Mellon Fellow, Bryn Mawr College (1988–89); lecturer & Kenan Fellow, Columbia University (1989–1991); Akademischer Rat a. Z., Institut für Wissenschaftsgeschichte, Göttingen (1991–1997); lecturer, University of Cambridge (1998–present): early modern German science and academic institutions. At the Institute from October 1997 to September 1998.

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 modeling in the sciences.
Held lectures at the ITEM-CNRS conference *Genèse* in Paris, at the *Hauptversammlung der Max-Planck-Gesellschaft* in Weimar (together with *Jürgen Renn)*, at the Institute's public lecture series

Media of thinking, and further lectures at universities and other academic institutions in Cambridge (USA), Florence, Paderborn, and Philadelphia. At the Institute since January 1997.

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).

Held plenary lecture at the annual meeting of the *History of Science Society* in San Diego and further lectures at universities and other academic institutions in Berlin, Braunschweig, Cambridge (UK), Cambridge (USA), Chicago, Heidelberg, London, Los Angeles, Lyon, New York, Potsdam, Princeton, Providence, San Diego, and Vienna. At the Institute since July 1995.

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.

Held a lecture at the Institute's workshop *Physiological and Psychological Practices in the 19th Century* and further lectures (partly with *Jörg Kantel* and *Henning Schmidgen*) at universities and other academic institutions in Berlin, Düsseldorf, Göttingen, Jena, and Lüneburg. At the Institute since July 1997.

Dörries, Matthias (Dr. rer. nat. 1989 (Freie Universität Berlin); habil. 1998 [history of science] Ludwigs-Maximilians-Universität, München); research scholar, Office for the History of Science and Technology, University of California at Berkeley (1989–1990); research scholar, Centre de recherche en histoire des sciences et des techniques, Paris (1991–1993); research scholar, Forschungsinstitut für Technik- und Wissenschaftsgeschichte, München (1993–1998); associate professor, Université Louis Pasteur (Strasbourg I) (1999–): history of the physical sciences (18th to 20th centuries); history of science in France (18th to 20th centuries).

Held a lecture at the *Deutscher Historikertag* in Frankfurt/M, and further lectures at universities and other academic institutions in Chicago, Montpellier, München, Regensburg Strasbourg, and Tarragona. At the Institute since January 1999.

Graßhoff, Gerd (M.A. 1983, Dr. rer. nat. 1986 [history of science], habil. 1995 [philosophy] Universität Hamburg); Oxford University (1980–1981); member of the Institute for Advanced Study Princeton (1987–1988); Minerva Associate at Tel Aviv University (1990–1991), Hochschulassistent Universität Hamburg (1988–1995); guest professor for philosophy Universität Hamburg (1994–1995); chair for the history of science at Georg-August-Universität Göttingen (1997–1998): modeling of scientific discovery processes; history of astronomy; methodology of sciences; natural philosophy late 19th and early 20th century. Held lectures at universities and other academic institutions in Bern, Bielefeld, Duisburg, Göttingen, Hamburg, and Köln. At the Institute from April 1995 to March 1999.

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); visiting professsor University of Salzburg (1998); Simon Silverman Visiting Professor Tel Aviv University (1999): history of epistemic objects in the neurosciences and in teratology (18th-20th centuries); history of experimental cultures (18th-20th centuries).

Held lectures at the conferences *Aufmerksamkeit* in Wien, and *Das Gesicht der Weimarer Republik* in Potsdam, the *Liechtensteiner Exkurse* in Schaan, at the Institute's public lecture series *The Sciences of the Body*, at the Institute' conference *The organisation of visibility*, and further lectures at universities and other academic institutions in Basel, Berlin, Beer-Sheva, Bielefeld, Cottbus,

Düsseldorf, Florenz, Heidelberg, Jena, Los Angeles, Lübeck, Münster, Tel Aviv and Zürich. At the Institute since January 1997.

Heesen, Anke te (Dipl. 1990 [cult. pedagogy], Universität Hildesheim; Dr. phil. 1995 (aesthetics und communication) Universität Oldenburg; Walther Rathenau Fellowship for the History of Science (1994–1995); research scholar at the Forschungszentrum Europäische Aufklärung (1996–1997); research scholar at the Deutsche Hygiene-Museum Dresden (1998–1999): history of visualization and education (18th century); material representation of knowledge (18th–19th centuries). At the Institute since October 1999.

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 Wissenschaftsgeschichte und Wissenschaftstheorie, Berlin (1992–1995): Guest Professor Humboldt-Universität zu Berlin (WS 1996/97), since 1997 there Privatdozent. History of physics in the 19th and 20th centuries, esp. institutional and experimental history of quantum theory and modern metrology; history of science in the GDR.

Held lectures at the conferences *Wissenschaft und Kalter Krieg* in Halle and *Die Deutsche Akademie der Wissenschaften 1914 –1945* in Berlin, the *XVII. International Scientific Instrument Symposium* in Soro, the *VIII. Physikhistorische Tagung der Deutschen Physikalischen Gesellschaft* in Heidelberg, the fourth *Symposium zur Geschichte der Kaiser-Wilhelm-/Max-Planck-Gesellschaft* in Bad Homburg, and further lectures at universities and other academic institutions in Berkeley, Berlin, Boston, Halle, Lübeck, and Stuttgart. At the Institute since December 1995.

Jansen, Sarah (B.Sc. 1981 [biology] McGill University, Dr. phil. 1997 [history] Technische Universität Braunschweig); researcher Deutscher Bundestag (1983–1985); free-lance writer and independent scholar (1986–1991); instructor at the Universities of Giessen, Kassel, Braunschweig and Paderborn (1990–1997); visiting scholar Harvard University (1995); postdoctoral fellow Max-Planck-Institute for the History of Science 1997–1998: history of biology, biomedicine and the environmental sciences; history of population sciences; gender studies; history of scientific objects in science and politics since 1800.

Held lectures at the meeting of the *International Society of History, Philosophy, and Social Studies of Biology in Oaxaca*, the *Jahrestagung der Deutschen Gesellschaft für Geschichte und Theorie der Biologie* in Rostock, the *Liechtensteiner Exkurse* in Schaan, the workshop *Räume und Weisen der Normalisierung um 1900* in Braunschweig, the annual meeting of the *History of Science Society in Kansas City*, and further lectures at universities in Berlin, Braunschweig, and Cambridge (USA). At the Institute since January 1999.

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 radioactivity and nuclear physics; development of physics in Berlin.

Held a lecture at the *International Conference HISAP 1999* in Wien and further lectures at universities and other academic institutions in Berlin. At the Institute since October 1995.

Kaufmann, Doris (Dr. phil. 1983, habil. 1993 [history] Technische Universität Berlin); visiting professor Freie Universität Berlin (1994); visiting professor Universität Tübingen (1994–1995); visiting professor Universität Jena (1995); visiting professor Universität Bern (1995–1996): modern social and cultural history, history of psychiatry and of cultural anthropology, religious and gender studies; since April 1998 research director of the project of the Max Planck Society: "History of the Kaiser-Wilhelm-Gesellschaft during the National Socialist period (1933–1945)". At the Institute from October 1995 to March 1998.

Klein, Ursula (Dr. phil. 1993, habil. 2000 [philosophy] Universität Konstanz). Postdoctoral fellow Forschungsschwerpunkt Wissenschaftsgeschichte und Wissenschaftstheorie Berlin (1993–95); research scholar Max Planck Institute for the History of Science (1995–97); visiting scholar Harvard University (1996–98); visiting scholar Dibner Institute (1997–98). Philosophy of science; history of laboratory sciences; the history of chemistry.
Held lectures at the annual meetings of the *American Chemical Society* in Dallas and the *History of Science Society* in Pittburgh and further lectures at universities and other academic institutions in Cambridge (USA), Columbia, New York, and Princeton. At the Institute as director of an independent research group since July 1998.

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.
Held lectures at universities and other academic institutions in Berlin, Bochum, Dresden, and Leipzig. At the Institute since October 1995.

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).
Held lectures at the Institute's workshops *Space-Time, Quantum Entanglement and Critical Epistemology* and *Between Leibniz, Newton, and Kant* and further lectures at universities and other academic institutions in Blacksburg, Braunschweig, and Cambridge (USA). At the Institute since July 1994.

Mendelsohn, John Andrew (A.B. 1989 [history & science] Harvard University, M.A. 1991 Princeton University, Ph.D. 1996 [history] Princeton University); Mellon Fellow in the Humanities (1989–1994); assistant in instruction Princeton University (1991–1992); international doctoral research fellow Social Science Research Council (1992–1993); postdoctoral research fellow Max Planck Institute for the History of Science Berlin (1995–1996); Simon Silverman Visiting Professor Tel Aviv University (1998): life and medical sciences in social context since 1800.
Held lectures at the annual meeting of the *History of Science Society* in Pittsburgh, at the annual conference of the *Society for the Social History of Medicine* in Glasgow, at the Institute's conferences and workshops *The Brain and its Sciences in the Twentieth Century*, *Scientific Personae*, and *Gehirn und Kultur*, and further lectures at the Universities of Heidelberg and Tel Aviv. At the Institute as research scholar since January 1997.

Pietsch, Annik (Diplom [biochemistry] Freie Universität Berlin, 1988; B.A. [history of art] Technische Universität Berlin, 1990); collaborator CNRS, Centre de Recherches sur la Conservation des Documents Graphiques (1990), collaborator Louvre, Laboratoire de Recherche des Musées de France (1990–91); Leader of the conservation analytical laboratory in the central restauration workshops of the Westfälisches Museumsamt (1992–99); Ph. D. student [art history], Freie Universtiät Berlin: Binding Media. Painting Techniques in Art, Science, and Industry in 18th and 19th Century Germany.
Held lectures at the Fachhochschule Hildesheim/ Holzminden and Fachhochschule Erfurt. At the Institute since July 1999.

Potthast, Thomas (Dipl. 1993 [biology] Universität Freiburg, Dr. rer. nat. 1998 [biology] Universität Tübingen); postgraduate fellow and research scholar Zentrum für Ethik in den Wissenschaften der Universität Tübingen 1994–1998; history, epistemology, and ethics of evolutionary biology, ecology, and nature conservation.

Held lectures at the *Jahrestagung der Gesellschaft für Ökologie* in Ulm (together with *Uta Eser*), the conference *Konfliktpartnerschaft: Gentechnologie als Herausforderung zu einer neuen Diskussionskultur?* in Mannheim, the annual meeting of the *Deutsche Gesellschaft für Geschichte und Theorie der Biologie* in Rostock, the annual meeting of the *History of Science Society* in Pittsburgh, the workshop *Rassenforschung im Nationalsozialismus. Konzepte und wissenschaftliche Praxis unter dem Dach der Kaiser-Wilhelm-Gesellschaft* in Berlin and further lectures at universities and other academic institutions in Berlin, Blaubeuren, Cambridge (USA), Cottbus, Greifswald, and Tübingen. At the Institute since September 1998.

Ramberg, Peter J. (B. Chem., 1984, University of Minnesota, M.S. [organic chemistry], M.A. [history and philosophy of science], PhD., 1993 [history of science], Indiana University). Visiting Professor (1993–95) and Senior Lecturer (chemistry, 1997–99), Johns Hopkins University; visiting professor (chemistry), Ohio University (1996–97); visiting professor (chemistry), North Dakota State University (1995–96). 19th century organic chemistry and stereochemistry; history and philosophy of chemistry. At the Institute since September 1999.

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.
Held lectures at the conferences *Volta and the History of Electricity* and *Science as a Culture* in Como-Pavia, at the *Fifth International Conference on the History and Foundations of General Relativity* in Notre Dame (USA), at the conference *The Transformation of Science – Research between Printed Information and the Challenges of Electronic Networks* in Elmau, at the colloquium *Adolf von Harnack (1851-1930)* in Ringberg, at the *Hauptversammlung der Max-Planck-Gesellschaft* in Weimar (together with Peter Damerow), and further lectures at universities and other academic institutions in Berlin, Dortmund, Florence, Göttingen, Köln, München, Potsdam, Stuttgart and Tübingen. At the Institute since March 1994.

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 Georg-August-Universität Göttingen (1992–1993); Ao. Univ. Prof. (molecular biology and history of science) University of Salzburg (1994–1996); honorary professor for history of science and technology at the Technische Universität Berlin (since 1998): history and epistemology of experimentation, history of the life sciences.
Held lectures at the workshop *Ein Moment und seine epistemische Dauer* in Frankfurt/Oder, at the Institute's conference *Reworking the Bench - Research Notebooks in the History of Science*, the workshop *Geschichte der Kaiser-Wilhelm-Gesellschaft im Nationalsozialismus – Bestandsaufnahme und Perspektiven der Forschung* in Berlin, the commission meeting of the *IUHPS/DDHS* in München, the meeting of the *International Society of History, Philosophy, and Social Studies of Biology in Oaxaca*, the workshop *American Foundations and the Development of Modern Biomedicine in Europe* in Pocantino Hills, the *Liechtensteiner Exkurse* in Schaan, the annual meeting of the *History of Science Society* in Pittsburgh, and further lectures at universities and other academic institutions in Athens, Austin, Berlin, Bielefeld, Blacksburg, Buffalo, Gamprin, Hamburg, Lexington, Leipzig, München, Roskilde, Stanford, Wien, and Zürich. At the Institute since January 1997.

Rieger, Simone (M.A. 1998 [linguistics and philosophy] Technische Universität Berlin): research project about optical chinese character recognition (Technische Universität Berlin), research project about technical terminology and its pragmatics in engineering sciences (Technische

Universität Berlin); history of early modern mechanics, linguistics and semiotics; genesis of technical terminology. At the Institute since February 1999.

Roesler-Friedenthal, Antoinette (M.A. 1994 Freie Universität Berlin, Dr. phil. 1999 Freie Universität Berlin [Art History]); research assistant British Museum London 1990–1991; research fellow Bibliotheca Hertziana (Max Planck Institute) Rome 1994–1999; research fellow Max Planck Institute for the History of Science, 1999–2001: Self-portraits and Images of the Artist in the Italian Renaissance; interactions between the art market and academic art history; time-related questions in the perception of works of art.

Held a lecture at the *30th International Congress of the History of Art* in Sussex and at the Freie Universität Berlin. At the Institute since March 1999.

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 (1996–1997) and research fellow (1997–1998) at the Max Planck Institute for the History of Science Berlin; Centre A. Koyré Paris (1998–present): early modern physics and its epistemology. At the Institute from October 1997 to August 1998.

Schemmel, Matthias (Dipl. 1997 [physics] Universität Hamburg): history of general relativity, history of early modern mechanics. At the Institute since January 1998.

Schoepflin, Urs (Dipl. 1975 [sociology], Freie Universität Berlin); director of library: scientific information systems, scientific communication, sociology and history of science, scientometrics. Held lectures at the 21st and 22nd *Fortbildungstagung für Bibliotheksleiter/innen der Max-Planck-Institute und Arbeitsgruppen*, at the workshop *Das digitale Archiv Duderstadt im Kontext der Diskussion um die Digitalisierung* in Göttingen, at the *Seventh International Conference of the International Society for Scientometrics and Informetrics* in Colíma, Mexico (together with *Wolfgang Glänzel)*, and at the workshop *Dokumentenmangement* in Nijmegen, Netherlands. At the Institute since September 1994.

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). Held a lecture at the *International Symposium on the History of Mathematics* in Göttingen. At the Institute since September 1994.

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; research scholar (1995–1998) and director of an independent research unit (since October 1998) at the Max Planck Institute for the History of Science Berlin: history of physical sciences (17th – 20th centuries), history of experimentation and non-literal knowledge traditions.

Held lectures at the workshop *Historische Anthropologie der Wissenschaft* in Potsdam, at the Institute's workshops *Instruments, Travel and Science* and *Reworking the Bench*, at the conference *History of Precision Measurement* in Utrecht, at the Nobel Symposium *Museums of Modern Science*, at the Institut's conference *Scientific Personae*, and further lectures at universities and other academic institutions in Antwerpen, Braunschweig, Cambridge (USA), Princeton, and Oldenburg.

Spary, Emma (B.A. 1988 [natural sciences] University of Cambridge, Ph. D. 1993 University of Cambridge); Research Fellow, Girton College, Cambridge (1992–1995); Warwick Research Fellow, University of Warwick (1995–1998): history of natural history (late 17th – early 19th centuries); history of agriculture (18th century); history of the sciences of food (18th – early 19th centuries).

Held a lecture at the conference *Science and Medicine in the Enlightenment* in Edinburgh, at the workshop *Exercising Taste: Luxury and the Education of the Senses* in Coventry, and further lectures

at universities and other academic institutions in Amsterdam, Cambridge (UK), and Paris. At the Institute since July 1998.

Steinle, Friedrich (Dipl. 1982 [physics], Dr. rer. nat. 1990 [history of science], Universität Tübingen); research scholar Georg-August Universität Göttingen (1990–1995), research fellow Maison des Sciences, Paris (1994–95), research grant Deutsche Forschungsgemeinschaft (1996–1997), research fellow Dibner Institute for History of Science and Technology (MIT), Cambridge, USA (1998–1999): Early modern natural philosophy, history of physics (17th–19th centuries), philosophy of science, history and philosophy of experimentation.

Held lectures at the *Jahrestagung der Deutschen Gesellschaft für Geschichte der Medizin, Naturwissenschaft und Technik* in Leipzig, the *Seven Pines Symposium* in Lewis, the Conference "*Volta and the History of Electricity*" of the European Physical Society in Como, and further lectures at universities and other academic institutions in Bielefeld, Cambridge (USA), and Kassel. At the Institute from October 1997 to March 1998 and since August 1999.

Thieffry, Denis (Dipl. 1988 [molecular biology and philosophy of science] and Ph.D. 1993 [theoretical biology] Université Libre de Bruxelles); postdoctoral fellow Université Libre de Bruxelles (1993–1995); assistant professor Universitad Nacional Autónoma de México (1995–1997; research fellow at the Max Planck Institute for the History of Science Berlin (1997–1998); (since 1999–) Laboratory of Genetics, Department of Molecular Biology, Université Libre de Bruxelles: history of genetics, embryology and molecular biology (20th century).

Held lectures at the *Pacific Symposium on Biocomputing 1*998in Maui, at the Institute's conference *Postgenomics? Historical, Techno-Epistemic and Cultural Aspects of Genome Projects,* at the *Fifth International Conference on Mathematical Population Dynamics* in Zakopane (together with Lucas Sánchez), the *First International Conference on Bioinformatics of Genome Regulation and Structure* in Novosibirsk (together with *Luis Mendoza* and *Elena R. Alvarez-Buylla)* and at the University of Copenhagen. At the Institute from July 1997 to December 1998.

Veit-Brause, Irmline (Ph.D. 1967 [history] University of Cologne); tutor (history) Monash University (1968–1973); research associate, University of Cologne, (1973–1974); senior tutor, Monash University (1973–1977); lecturer (1977–1984); senior lecturer (1984–1988) and associate professor (since 1989); Deakin University (Philosophical Studies); visiting professor, Freie Universität Berlin (1991–1992): modes of rationality in the human sciences (19th century).

Held a lecture at the *Swedish Colloquium for the Advanced Study of Social Science* in Uppsala, and further lectures at universities and other academic institutions in Berlin and Göttingen. At the Institute from October 1998 to August 1999.

Vogt, Annette (Dipl. 1975, Dr. rer. nat. 1986 [mathematics] Karl-Marx-Universität Leipzig); research scholar Akademie der Wissenschaften der DDR (1975–1991); research scholar and 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.

Held lectures at the third and forth *Symposium zur Geschichte der Kaiser-Wilhelm-/Max-Planck-Gesellschaft* in Bad Homburg, the *ICM '98* workshop on history of mathematics in Göttingen, the *Königsberger Symposium der Österreichischen Gesellschaft für Wissenschaftsgeschichte,* the workshop *Frauen(t)raum Technik - Ingenieurinnen zwischen Geschichte und Zukunftsberuf* in Berlin, the workshop of the DHS/IUHS *Women in Science* in Cambridge (UK) and further lectures at universities and other academic institutions in Berlin Bremen, Marseille, and Lindau. At the Institute since September 1994.

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 (1995): history of philosophy in connection with history of science; systematical relations between philosophy and natural science; epistemological fundamentals and problems of physics; German idealism; classical natural philosophy.
Held lectures (partly together with *H.-H. v. Borzeszkowski)* at the *Gesamttagung der Internationalen Gesellschaft "System der Philosophie"* in Wien, the *XXII. Internationaler Hegel-Congress* in Utrecht, the conferences *Physical Interpretation of Relativity Theory* in London, *Classical and Quantum Nonlocality* in Erice, *Experiment und Technik bei Hegel* in Kaiserslautern, the *Internationale wissenschaftliche Tagung aus Anlaß des 300. Geburtstages von Pierre Louis Moreau de Maupertuis* in Berlin, and further lectures at universities and other academic institutions in Berlin and Bern. At the Institute since October 1995.

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). At the Institute since November 1995.

Wintroub, Michael (A.B. 1981 University of California at Berkeley, M.Sc. 1984 London School of Economics, M.A. 1990 University of California at Los Angeles, Ph.D. 1995 [European History] University of California at Los Angeles); research associate University of Cambridge (1994–1996); assistant professor University of Michigan, Ann Arbor (1996–present): ritual, identity formation, alterity and the history of objectivity in early modern Europe. At the Institute from September 1998 to August 1999.

Wunderlich, Falk (M.A. 1995 [philosophy] Freie Universität Berlin): Kant's natural philosophy. Held lectures at the Institute's workshop *Between Leibniz, Newton, and Kant* and at the Virginia Tech. University, Blacksburg. At the Institute as research scholar from September 1995 to December 1998.

The Research Program of the Institute, its Departments and Research Groups

Introduction

The Max Planck Institute for the History of Science was founded in 1994, and since then has grown from one scholar balancing a telephone on his lap to circa seventy-five scholars (including visitors), a support staff of 45, and a library of some 35,000 volumes. The numerous research projects described in this report are divided among three permanent departments (directed by *Jürgen Renn, Lorraine Daston,* and *Hans-Jörg Rheinberger*) and two five-year independent research groups (led by *Ursula Klein* and *H. Otto Sibum)*. The range of these projects is extremely broad, spanning ancient Babylonian mathematics to contemporary debates over the human genome, and the diversity of themes correspondingly great, addressing topics in the history of almost every scientific discipline. These projects are documented in their considerable variety in these pages. All of the projects aim, however, to contribute to a theoretically informed understanding of the historical development of scientific knowledge: a "historical epistemology" that investigates the conceptual and material structures – patterns of argument, architectural spaces, regimens of experience, techniques of visualization, mental models – that have made the sciences in their present and past forms possible. Taken together, the research projects conducted at the Institute share three premises: first, that even the most deeply entrenched aspects of scientific thought and practice have a history; second, that comparative investigations are essential to understanding major changes in the history of science; and third, that the sources for a historical epistemology of science should be expanded to include images, objects, spaces, and gestures as well as texts. A few words about each of these premises, with illustrative reference to one or two research projects that attempt to apply them, will serve as a brief introduction to this report and to the common mission of the Institute.

History: Historical epistemology assumes that the most fundamental categories of contemporary scientific experience and reasoning have a history. Objectivity and experiment have been two longterm foci of historical research at the Institute. In both cases, core ideals and practices of science originate in specific intellectual and cultural contexts, and then gradually spread by means of new techniques and institutions. In the case of objectivity, new techniques of image-making (e.g. photography) and data analysis (e.g. inference statistics) were the concrete expression of scientific worries, new to the nineteenth century, about the distorting effects of the self on the investigation of nature (see p. 49). Experiment as a form of scientific experience emerged in the seventeenth century, and its history is still ongoing. Several research projects study how practical knowledge from industry and crafts was slowly integrated into the corpus of science in the late eighteenth and nineteenth centuries, how the "tacit" knowledge of the workshop was given a voice in the laboratory (see p. 90). Another cluster of projects addresses the diversification of "experimental systems", with special attention to modes of representation as diverse as electroencephalography or chronoscopy (see p. 58).

Comparison: Most recent research in the history of science has taken the form of detailed studies of specific episodes situated within a restricted disciplinary and chronological context. While recognizing the necessity of such contextual studies as the basis for reliable historical work, the Institute encourages research projects that examine problems comparatively, across historical, cultural, and disciplinary contexts – hence the prominence of collaborative work at the Institute. Research projects on "Mental Models in the History of Mechanics" (see p. 18). "Demonstration-Test-Proof" (see p. 32), and "History and Epistemology of Experimentation" (see p. 55) chart developments over several centuries, in different cultures and disciplines. The goal of such comparisons is in the first instance taxonomic: to identify and classify variations. The utility of comparisons does not, however, end there: although extremely fruitful, the last decade of fine-grained contextual studies in the history of science has left open the question of how certain forms of knowledge overcome their local origins to become global. Comparisons should also lead to an

understanding of long-term developments in science in dependence on varying cultural conditions such as e.g. those of the Latin and Arabic traditions in mechanics.

Beyond Texts: Although the close study of scientific texts remains essential to almost all branches of the history of science, a leitmotif of research projects at the Institute has been the use of further kinds of historical documents, including images, instruments, buildings, and other material artefacts. The layout of botanical gardens, the idiosyncrasies of early thermometers, and the molecular models of chemists have their own hermeneutics that historians are learning to read as they have long read texts (see pp. 83, 90). These new sources have stimulated several research groups to develop innovative ways of documenting and analyzing everything from ancient balances to physiological laboratories, drawing heavily on the possibilities of computer technology (see pp. 28, 63).

The following chapters describe the projects currently pursued at the Institute in more detail. In addition to this Research Report, specific and up-to-date information about the Institute and its activities is available at http://www.mpiwg-berlin.mpg.de.

Department I (Director: Jürgen Renn)

The work of the research group headed by *Jürgen Renn* is mainly 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, the study of the dependence of these structures on their experiential basis and on their cultural conditions, and the study of the interaction between individual thinking and institutionalized systems of knowledge. This theoretical program of an historical epistemology is the common core of the different investigations and research projects pursued and planned by the research group.

In order to cover at least some of the major developmental steps in the history of science, research is pursued in four different 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. The first project seeks to understand the emergence of fundamental concepts of empirical science arising from the reflection of 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. A further area of work is dedicated to developing advanced tools for an historical epistemology. In this area, new electronic media are used for exploring new ways of creating access to the empirical basis of the history of science.

A detailed account of the design and methodology of the major projects of the department has been given in the Institute's Research Report 1996–1997. The present report concentrates on the state of the work and on recent activities not covered by the previous report.

Meanwhile, one of the central research projects of the department, as well as some other undertakings, had to be suspended. The project "Dynamic Models of Scientific Discoveries" had to be given up because one of the senior scientists of the department *(Gerd Graßhoff)* accepted the call to the chair of history and philosophy of science at the University of Bern. As a consequence, several associated research activities at the Institute were also terminated and some of his closer collaborators left the Institute. The departure of the group affected the Institute all the more as its technical competence in the field of UNIX technology compensated for deficits due to the understaffed computer department of the Institute. For similar reasons, the research on the crisis of classical physics leading to the relativity and quantum revolutions had to be refocused, suspending research activities depending on the special qualifications of temporary collaborators who left the Institute for more permanent positions *(Edward Jurkowitz, Tilman Sauer, Britta Scheideler, Arne Schirrmacher)*.

Some other reorientations with regard to the direction of research pursued in the department are the result of decisions that have become possible because individual activities, partly begun before the Institute was founded, have meanwhile been completed. Compared with the situation previously reported, the research could hence to a greater extent be focused on the main goals of the major projects. The advancement of these projects makes it possible to identify perspectives of future research based on their results. In particular, it is intended to more intensively study the rise of the analytical method as a result of early modern mechanics which revolutionized physics and became the most important prerequisite of the disintegration of classical science which has been one of the foci of research so far. This will be a first step towards bridging the historical interval between the emergence of classical physics and its decline and hence to learn more

about another kind of epistemological shift, the functioning of the mental models responsible for the rise and decline of the mechanical world view.

Another upcoming project draws on the extensive studies of the relativity revolution, as well as on the studies of the reorganization of research strategies in response to the quantum crisis investigated in recent years. Just as the emergence of General Relativity has been analyzed as a consequence of the reorganization of the classical knowledge on gravitation, it is planned to pursue a detailed analysis of the birth of quantum theory as a result of the reorganization of the classical knowledge on matter and radiation.

In addition to these plans, which to a certain extent emerge from the work done during the first five years of the Institute, partnerships with other institutions have made it now possible to tackle issues requiring an even more extensive interdisciplinary cooperation. In particular, a cooperation with the Max Planck Institute for Psycholinguistics in Nijmegen will make it possible to explore the roots of scientific theories of space and time in cognitive and linguistic preconditions of spatial orientation, and of the temporal structure of human activities. A recently launched joint research project with the Bibliotheca Hertziana (Max Planck Institute) in Rome is dedicated to an epistemological history of architecture. It aims at documenting and analyzing the long-term history of the unwritten knowledge that has made the great architectural achievements of mankind possible. This knowledge emerged long before the advent of science and was repeatedly subjected to transformations which explain the fascinating interplay of utility, rationality, and art that is the hallmark of architecture.

Project 1: The Relation of Practical Experience and Conceptual Structures in the Emergence of Science: Mental Models in the History of Mechanics

General goals of the project

The goal of the project is to study the causes and long-term developments of scientific knowledge. The project is focused on mechanics as a part of science with an extraordinary significance to the development of science in general. In particular, 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 until the twentieth century.

The peculiar 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 every-day 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 that they were used for.

Volkmar Schüller

Completed research activities

Translation of Newton's Principia:
A new edition in German translation of the principal source of classical mechanics has been completed and published *(Volkmar Schüller).* This edition contains a translation of the variants of the

three editions of the *Principia* edited by Newton in the years 1687, 1713 and 1726 and of Newton's manuscript for the edition in 1687. Moreover, translations of all contemporary reviews of the *Principia* are included.

Current research activities

Katja Bödeker

Intuitive Mechanics:
Mechanical knowledge predates considerably any systematic theoretical treatment of mechanics. The most basic knowledge presupposed by mechanics is based on experiences acquired almost universally in any culture by human activities. It includes the perception of material bodies and their relative permanence, their impenetrability, their mechanical qualities, and their physical behavior. The outcome is an "intuitive mechanical knowledge" embedded in a qualitative physics, which is built up in ontogenesis and guides human activities related to our physical environment. A dissertation project *(Katja Bödeker)* provides a survey of relevant research in psychology, linguistics, and cognitive science and evaluates methods and results with the aim to integrate them into an analysis of mechanical thinking from the viewpoint of historical epistemology.
Professional knowledge of practitioners:
A second kind of mechanical knowledge which predates any systematic theoretical treatment of mechanics is the knowledge achieved by the use of mechanical tools. In contrast to intuitive mechanical knowledge, this type of knowledge is closely linked to the production and use of tools by professionalized groups of people and it consequently develops in history. The professional knowledge of practitioners is historically transmitted by immediate participation in practices such as the processes of labor and production in which such tools are applied and by oral explanation that accompanies their application.

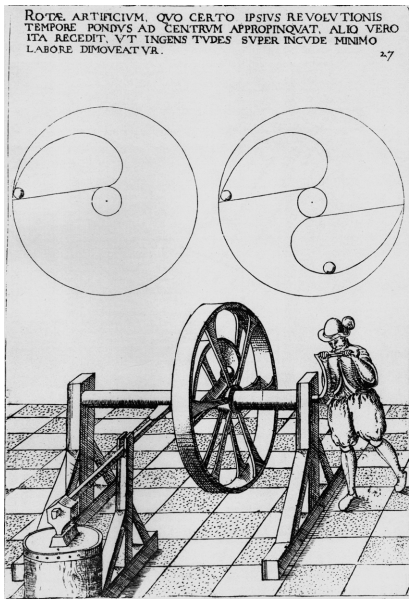
Steelyard, still traditionally manufactured in China. Which mechanical knowledge is employed?

Research on professional knowledge related to mechanics including extensive field work aiming at documentation of still-existing traditional technologies is being performed predominantly in two areas: artisanal knowledge related to the law of the lever going back to antiquity and engineering knowledge inherent in the invention and use of machines with particular emphasis on the early modern period. The relation between practical knowledge and the origin of mechanics as a science, which was for a long time based mainly on the law of the lever, is studied by reconstructing the knowledge needed for the invention, production, and usage of balances with unequal arms *(Peter Damerow, Jürgen Renn, Simone Rieger, Matthias Schemmel, Paul Weinig)*. In the course of this study, the mechanical knowledge of ancient cultures (Greek, Roman, Chinese, Inca) is being investigated, based on the analysis of archeological finds and surviving traditional practices.

Marcus Popplow

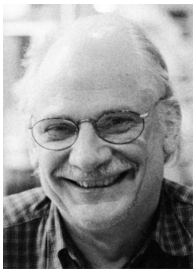
The tradition of engineering knowledge since antiquity is studied with particular attention to forms of representation that are not predominantly shaped by the theoretical tradition such as drawings and models *(Wolfgang Lefèvre, David McGee, Marcus Popplow)*. In the early modern period, these representations formed the core of a specific "reflecting practical mechanics," dealing with highly complex technical problems (rigidity of bodies, friction, etc.) which could not be addressed successfully with the theoretical mechanics then available. In particular, the body of mechanical knowledge was then confronted with "challenging objects," such as the trajectory of projectiles, the stability of constructions, the oscillation of a swinging body, or the curve of a hanging chain. As becomes clear from the outstanding example of Galileo's "Two New Sciences," these objects enriched the traditional knowledge but also induced fundamental revisions of its structure, eventually leading to classical mechanics. A dissertation project on Galileo as an engineer *(Matteo Valleriani)* investigates conditions of this change (see also expansion of theoretical mechanics in the early modern period, p.21).

Preliminary results of these studies on the professional knowledge of practitioners have been presented at an international conference on ancient science and technology and are being prepared for publication. The video documentation of the field work on traditional practices in Italy and China will be made accessible both in the form of a research database and a documentary film *(Jürgen Renn, Richard Röseler, Matthias Schemmel, Zhang Baichun)*.



A study of the mechanical properties of a flywheel in a engineer book from the 16th century

Origins of theoretical mechanics:



Peter Damerow

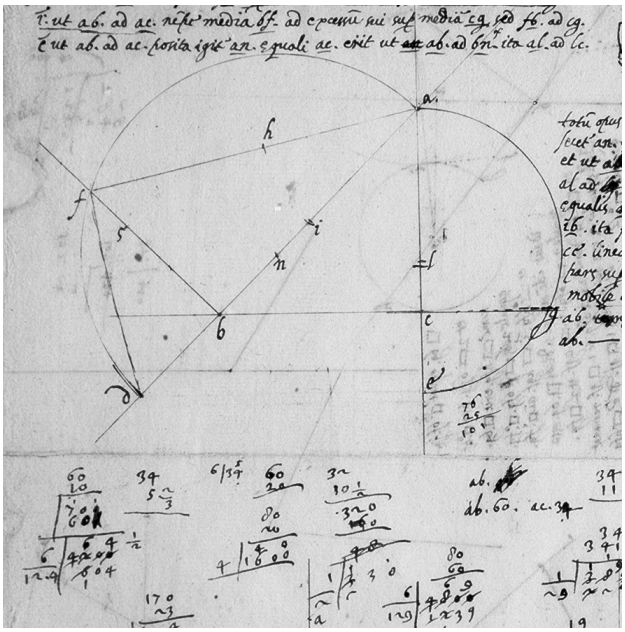
Ancient Greek and Latin texts on mechanics are analyzed in order to reconstruct the emergence and developments of the first scientific representations of mechanical knowledge and the relation to mechanical knowledge in general available at that time *(Peter Damerow, Jürgen Renn, Paul Weinig)*. First, 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 cognitive operations are identified which structure the mechanical knowledge. In addition to the Greek and Latin sources, this investigation includes Arabic sources as well. During a workshop at Konstanz University the technical terminology used in these sources has been examined across the various languages with the help of a computer-assisted analysis. The language-technology developed by the Perseus Project, and in particular automated morphological analysis, is being implemented to

Paul Weinig

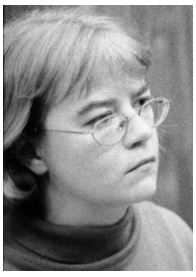
support this study (see development, p. 28) which presently focuses on what probably represents the first text of theoretical mechanics, the "Mechanical Problems" of Pseudo-Aristotle *(Markus Asper, Istvan Bodnar, Peter Damerow, Brian Fuchs, Elke Kazemi, Peter McLaughlin, Jürgen Renn, Paul Weinig).*

Expansion of theoretical mechanics in the early modern period:

The new objects that raised the interest of "engineer-scientists" in the early modern period challenged the methods of preclassical mechanics. These challenging objects 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 was changed by this assimilation. An exemplary study showing how Galileo's discoveries were triggered by such objects and constrained by the limits of preclassical mechanics *(Peter Damerow, Jürgen Renn, Simone Rieger)* is being published in a volume dedicated to the context of these discoveries, together with other studies also pursued in part at the Institute, in particular on the historiography of Galileo's discoveries *(Giuseppe Castagnetti)* and on their roots in practical knowledge *(Wolfgang Lefèvre)*.



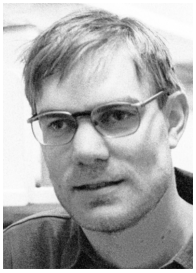
Page from Galileo's notes on motion and mechanics



Simone Rieger

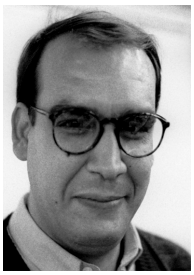
Jochen Büttner

Present work focuses on the branching of theoretical alternatives made possible by the enrichment of theoretical mechanics in the early modern period. This potential becomes visible, in particular, in sources which did not enter the heroic narratives of the birth of classical mechanics. Among these are unpublished materials (research notebooks, correspondence, unpublished manuscripts) and the works of scientists who are less well known because they did not, from the anachronistic perspective of classical physics, contribute to its emergence. In the sequel of the extensive work invested into making Galileo's manuscripts accessible (see development, completed work, p. 29) his notes on mechanics have now become the subject of a dissertation project *(Jochen Büttner)*. Another dissertation project is dedicated to similar research notes by Thomas Harriot, one of the most important contemporaries of Galileo who worked with different methods on the same subjects with similar results *(Matthias Schemmel)*. A third dissertation project explores long-range effects of the objects challenging preclassical mechanics, which result from the fact that many of them could not be adequately handled with the simple theoretical means of classical mechanics developed in the period of its foundation; this dissertation deals with the roots of Euler's reformulation of basic concepts of mechanics in such long-range effects *(Dirk Wintergrün)*.



Matthias Schemmel

Edition and translation into English of sources related to the tradition of mechanics:
Work on the contents and contexts of sources on mechanical thinking is accompanied by the development of electronic tools for their computer-assisted analysis (see below) and the preparation of editions and translations. In view of the importance of the "Mechanical Questions" of Pseudo-Aristotle, a new translation with consistent rendering of technical terms is being prepared *(Elke Kazemi)*, serving at the same time as a test bed for the prototype of a working environment for computer-assisted translation. The main treatises on the balance from the Arabic tradition and of its continuation in the medieval Latin tradition are prepared for critical editions or reeditions with consistent English translations, commentaries, and glossaries of technical terms *(Mohamed Abattouy, Thomas Berchtold, Paul Weinig)*. Two further projects have been pursued in the framework of the Programme International de Coopération Scientifique (PICS): A new consistent translation into English and French of Galileo's first treatise on motion "De Motu Antiquiora" has been all but completed *(Raymond Fredette, Mark Schiefsky)*. The translation of Galileo's correspondence dealing with mechanics and engineering problems is being continued *(Matteo Valleriani)*.



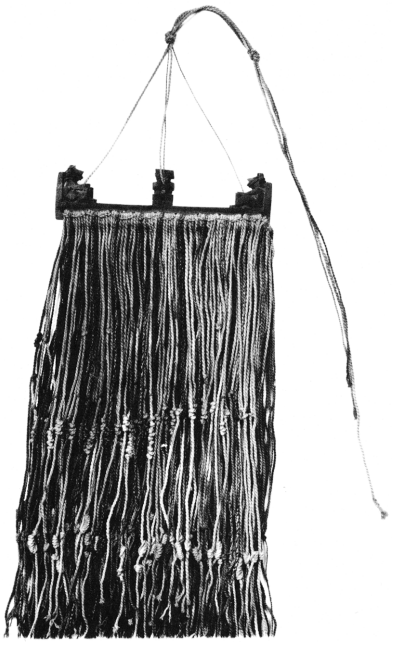
Mohamed Abattouy

Associated research activities

Commentary on Newton's Principia:
Following up the publication of a new German translation of Newton's "Principia," the work on a commentary is being continued *(Volkmar Schüller)*. A commentary on Newton's theory of tides has been completed and is now being complemented by a commentary on Newton's solution of the problem to relate gravitational forces to the orbits they generate. The commentary will also include a documentation of the contemporary reception of Newton's "Principia," in particular taking into account the "Notae in Newtoni Principia Mathematical Philosophia Naturalis" by David Gregory.

Matteo Valleriani

Various activities on the early development of mathematical thinking:
The emergence of mathematical thinking in the third millennium B.C., conceived as a reflection of the professional knowledge of Babylonian administrators, is the subject of an edited volume which is presently being prepared for publication *(Peter Damerow, Jens Høyrup)*. A documentation of the quipus preserved from the Inca culture in various European and American museums is being pur-



Quipu, a counting device of the Inca culture

sued in cooperation with the Berlin Museum of Ethnology; in addition ancient Spanish sources are being studied which provide information about the function of the quipus in the accounting system both under the Inca administration and after their adoption by the Spanish colonial administration *(Carmen Loza)*. Algorithmic operations in Babylonian and Egyptian mathematical problem texts have been compared with divinatori and juridical texts from a structural point of view *(James Ritter)*. Further research activities have been pursued on deductive structures in the works of Appollonius *(Sabetai Unguru)* and, by the Lorenz-Krüger fellow of the Institute, on the relation of the medieval composition of music and the ancient theory of proportions *(Oscar Joao Abdounur)*.

Various other activities related to the goals of the project:

Gerd Graßhoff

In the context of work on basic structures of scientific thinking, an authorized edition of the collected works of the psychologist Howard Gruber is being prepared *(Katja Bödeker)*. An analysis of the historical genesis and scientific function of astronomical diagrams illustrating the text of Martianus Capella has been completed and is being prepared for publication *(Christoph Lies)*. This study was part of a systematic survey of diagrams in medieval planetary astronomy pursued in the context of the former project on "Dynamic Models of Scientific Discoveries" *(Bruce Eastwood, Michael May, Gerd Graßhoff)* which is no longer continued at the Institute due to the call of the responsible senior scientist to the University of Bern. Arabic mechanics and technology in cultural contexts has been studied *(Abdelhamid I. Sabra)*. The history of the relation between mechanisms, organisms, and society and the socio-biological implications of this relation have been the theoretical focus of studies dedicated to the fourteenth century islamic scholar Ibn Khaldun and to the German chemist Georg Ernst Stahl *(Alfred Gierer)*. Furthermore, the establishment of networks of communication by Henry Oldenburg has been investigated *(Mara Beller)*, and extensive studies on a controversy between Leibniz and Papin, and also on the philosophical foundation of Newton's physics by Salomon Maimon have been pursued *(Gideon Freudenthal)*. Finally, intersections between epistemology, philosophy of mind, and the history of science were in the focus of various research activities whose results have been prepared for publication *(Bernhard Thöle, Gabriel Motzkin)*.

Project 2: Studies in the Integration and Disintegration of Knowledge in Modern Science

General goals of the project

The goal of the project is the study of the emergence and dissolution of core groups of concepts structuring vast arrays of scientific knowledge as a result of processes of knowledge integration and disintegration. In the context of the project, the emergence of such a core group of foundational concepts is conceived of as a restructuring of the cognitive organization of previously-acquired knowledge. Core concepts of scientific disciplines such as space, time, force, motion, and matter in the case of mechanics or species, gene, selection, variation, and adaptation in the case of evolutionary biology 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. Such concepts proved to be extremely stable in the face of an enormous growth of knowledge in the course of the further development of science. Nevertheless, most scientific disciplines have also witnessed fundamental changes of precisely such core groups 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. Processes of integration and disintegration of knowledge are studied in the project in close connection since it has turned out that the essential mechanisms at work in periods of destabilization were of the same nature as those in the original processes of the emergence of core concepts of a discipline.

Completed research activities

The Philosophical Integration of Classical Science:

Wolfgang Lefèvre

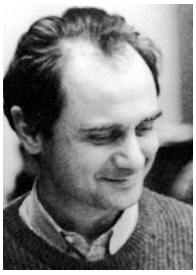
From the perspective of historical epistemology it has been studied how first-order concepts of the classical scientific theories of the seventeenth and eighteenth centuries interacted with second-order concepts of global theories such Kepler's Weltharmonik, Kant's dynamism, or Le Sage's atomistic theory *(Wolfgang Lefèvre, Falk Wunderlich)*. This interaction has been investigated through the example of Kant's natural philosophy of his pre-critical period (1747–1780). A database rendering of Kant's concepts and their interrelations, based on an electronic version of the entire body of writing involved, was finished and published as a CD ROM.

Newton's Synthesis of τέχνη and φύσις and its Reception in the Hegelian System:

This work has been completed and has resulted in approximately 20 papers *(Renate Wahsner)*. The undertaking centered around two main topics: (1) the synthesis of τέχνη and φύσις that was achieved through the foundation of Newtonian mechanics, and (2) Hegel's investigation of differential calculus which he conducted in terms of the conceptual-logical interdependence of quality and quantity.

The concept of the gene in development and evolution:

In modern biology, there are no longer unequivocal definitions of "adaptation," "gene," "species," or, in fact, "Darwinism" *(Peter Beurton, Raphael Falk, Hans-Jörg Rheinberger)*. For this reason, a research initiative was launched shortly after the foundation of the Institute, bringing together historians and philosophers of biology as well as active research biologists, in order to study and discuss what amounts to a protracted, still open-ended period of scientific turmoil. They have met at workshops held at the Institute and during working stays of guest scientists and have continuously exchanged their views and results in the past years. As an outcome of this intense interaction, a joint book project has been completed.



Giuseppe Castagnetti

The Contexts of the Establishment of General Relativity:

As mentioned above, several research activities pertaining to this theme had to be discontinued since the responsible scholars left the Institute for more permanent positions at other institutions. In the case of the work on Einstein's political biography results of this work could nevertheless be completed and have been published (*Britta Scheideler*); the political context of Planck's work has been a subject of further study, resulting in several publications *(Giuseppe Castagnetti, Peter Damerow, Dieter Hoffmann, Jürgen Renn, Simone Rieger)*.

Alexei Kojevnikov

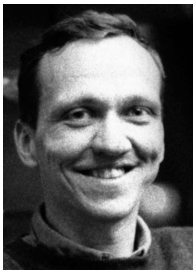
The Quantum Crisis and the Reorganization of Research Strategies in Classical Physics – the Cases of Einstein and Bohr:

The study's central interest was the question to what extent the reorganization of physical research early in the twentieth century, reacting to the emergence of "quantum problems," took place as a result of explicit reflections on the disintegration of classical physics. Two major studies, one on Einstein's role at the Kaiser-Wilhelm-Institut für Physik in Berlin *(Giuseppe Castagnetti, Hubert Goenner)*, the other on Niels Bohr and his institute in Copenhagen *(Alexei Kojevnikov)* have been completed and are being prepared for publication.

Current research activities

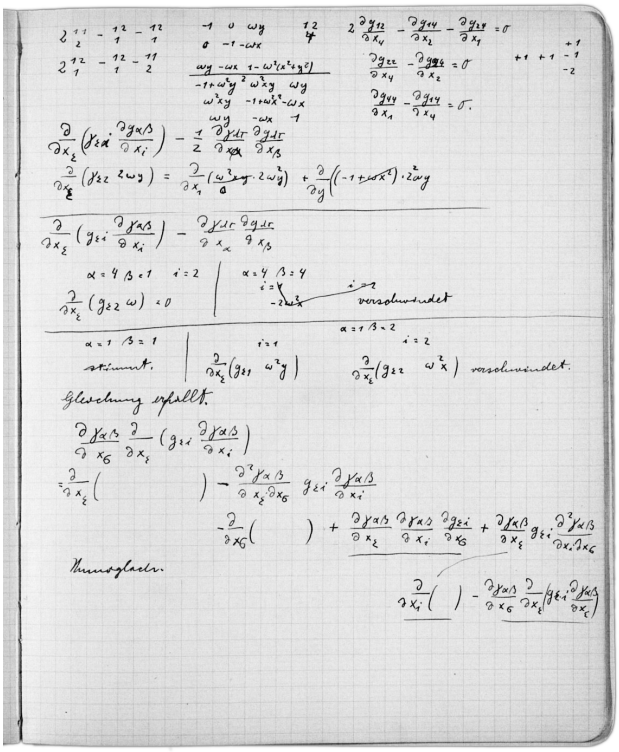
The reorganization of classical knowledge on gravitation:

The emergence of the General Theory of Relativity is studied, focussing, first, on the work of Albert Einstein and, second, on the largely unexplored history of alternative approaches to the problem of gravitation in late classical physics *(Julian Barbour, Dieter Brill, Giuseppe Castagnetti, Leo Corry, Hubert Goenner, Stefan Hajduk, Michel Janssen, Christopher Martin, John Norton, Jürgen Renn, Tilman Sauer, Matthias Schemmel, Scott Walter, Christopher Smeenk, John Stachel)*. The aim is to reach a systematic account of the structure of the knowledge basis in classical physics which made a reconstruction of its core concepts unavoidable. A further aim is to understand the nature



Tilman Sauer

of the developmental process by which Einstein and his contemporaries overcame the obstacles impeding the development of new conceptual foundations, obstacles which prevented Einstein even from realizing that he had already found the correct field equations three years before he finally recognized them as such. The starting point of the investigation was a meticulous reconstruction of the interplay of physical and mathematical knowledge which constituted the successful heuristics of Einstein's discovery process in the period between 1907 and 1915 *(Michel Janssen, John Norton, Jürgen Renn, Tilman Sauer, John Stachel)*. The scientific context of Einstein's search for a new theory of gravitation has been systematically studied by analyzing a broad range of sources related to the work on alternative approaches, including also the work of less well-known authors, in order to identify knowledge traditions that contributed to the emergence of General Relativity *(Julian Barbour, Dieter Brill, Giuseppe Castagnetti, Leo Corry, Hubert Goenner, Stefan Hajduk, Christopher Martin, John Norton, Jürgen Renn, James Ritter, Matthias Schemmel, Scott Walter, Christopher Smeenk, John Stachel, Yoonsuhn Chung)*. The comprehensive results of the



Page from Einstein's Zurich notebook showing his last desperate attempt to formulate field equations that are invariant under rotation

reconstruction of the genesis of General Relativity in its context are documented in the form of detailed commentaries on the historical sources and in the form of a new interpretation of the transition from the core concepts of classical physics to those of modern relativistic physics. A series of volumes is presently being prepared, including an edition of key sources pertaining to both the creation of the theory and to less successful approaches.

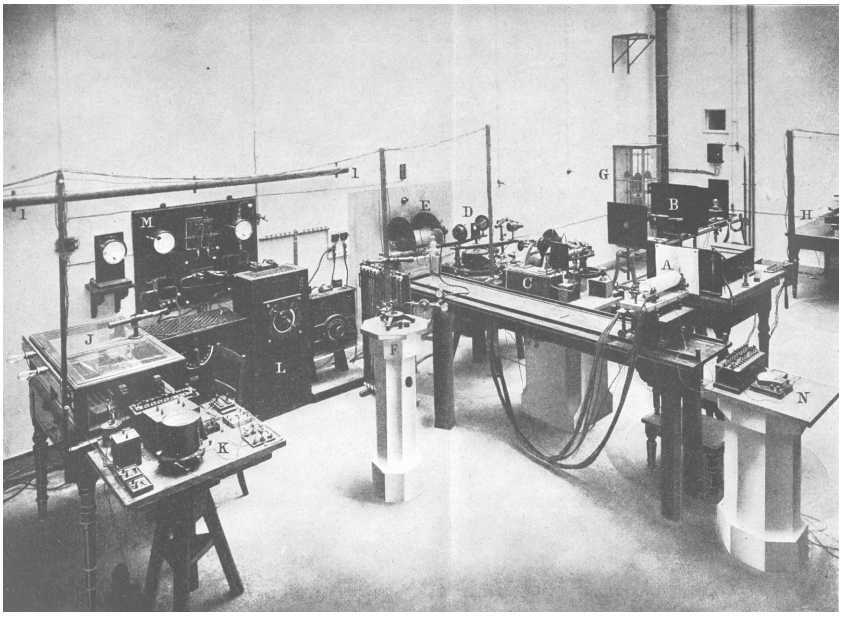
A failed attempt to unify electrodynamics and gravitation:

The difficulties which forced scientists at the beginning of the twentieth century to fundamentally change the conceptual basis of physics resulted from incompatibilities between its three main subdisciplines, mechanics, thermodynamics and electromagnetism, when applied to "borderline problems" such as the explanation of the photoelectric effect, the electrodynamics of moving bodies, or the thermal equilibrium of electromagnetic radiation. Analyzed within the epistemic framework of the crisis which emerged from these incompatibilities, the widely accepted historiographic interpretation of the competing approaches of Hilbert and Einstein, allegedly ending in a race with Hilbert as the winner, had to be given up. A more thorough analysis of this competition in a

broader context turned out to be necessary when archival research produced the puzzling result that Hilbert did not find the field equations of General Relativity independently, but took them from Einstein's publication and inserted them afterwards into the proofs of his own publication *(Leo Corry, Jürgen Renn, John Stachel)*. As a result of this analysis, Einstein's and Hilbert's struggles with a new theory of gravitation have been interpreted, in an extensive study, as alternative attempts to integrate the knowledge of the diverging subdisciplines of modern physics into one coherent framework, exploiting different resources which account for the different fates of the two approaches in the further restructuring of the whole body of physical knowledge *(Jürgen Renn, John Stachel)*. In fact, Einstein's approach, striving to encompass the knowledge of mechanics as well as that of electrodynamics, became the basis of modern cosmology while Hilbert's approach, essentially founded in Mie's attempt to reduce mechanics to an electrodynamic conception of matter, became the first of a series of still more or less unsuccessful attempts to find a common mathematical framework of the two classical field theories, electromagnetism and gravitation theory.

The crisis of specialization in astronomy:

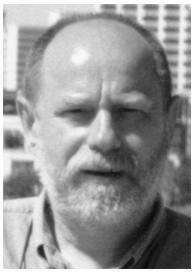
Due to the high degree of specialization of the sciences in the early twentieth century, only with delay did the consequences of the conceptual restructuration of physical knowledge enter the intellectual horizon of experts dealing with subjects for which, in fact, the new theory was relevant, in particular, the attention of astronomers. Several meetings and preliminary investigations have been devoted to the study of the emergence of modern cosmology in cooperations with an international group of scholars *(Giuseppe Castagnetti, Jean Eisenstaedt, Hubert Goenner, Jürgen Renn)*. Moreover, the conditions of the hesitant integration of the theory of General Relativity into astronomy are studied using the exceptional example of the work of Schwarzschild *(Matthias Schemmel)*. As one of the founders of astrophysics, Schwarzschild had already in the nineteenth century realized the artificial character of the constraints imposed by specialization. He tackled some of the fundamental questions at the borderlines between theoretical physics and astronomical observation which were eventually answered within the framework of General Relativity. Schwarzschild was hence prepared to immediately recognize that astronomy and its extension to scientific cosmology would become the touchstone of the new theory and contribute to overcoming the disciplinary separation between physics and astronomy.



The Laboratory in Berlin which provided the experimental prerequisites for Planck's radiation formula and thus for the first decisive contribution to quantum theory

The emergence of contradictions between thermodynamics and radiation theory:
A further borderline problem produced by a progressive integration of knowledge which is intensively studied in the framework of the project is the problem of heat radiation. It requires the application of both the laws of radiation – covered by those of electrodynamics – and those of thermodynamics. Since such 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. For example, 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.

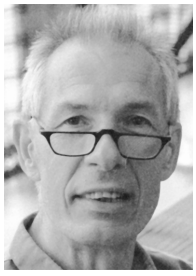
The earlier research on conceptual transformations in the emergence of relativity theory has recently been extended to include the origins of quantum theory, integrating earlier attempts to study the institutional conditions of the quantum revolution *(Jochen Büttner, Dieter Hoffmann, Michel Janssen, Jürgen Renn, Matthias Schemmel).* Planck's law of heat radiation of 1900 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. Another step is undoubtedly Einstein's proposal of the light quantum hypothesis in his 1905 paper. This step was taken on the basis of the development of statistical mechanics, which allowed conclusions to be drawn about the microscopical constitution of physical properties from their macroscopical properties; this background was the subject of a specific investigation *(Olivier Darrigol, Jürgen Renn).*



Dieter Hoffmann

An analysis of the interaction between Planck and Einstein and the comparison of their different approaches on the basis of the new evidence provided by Einstein's early letters has made it clear that, contrary to what is commonly believed, the origins of quantum mechanics can be adequately understood only in the framework of the integration problems raised by Einstein's models built from radiation, resonators, gas molecules, solid bodies, mirrors, and heat absorbers – components which represent knowledge areas incompatible at that time. Within this framework, Kuhn's controversial claim that the quantum discontinuity was established only after 1900 and by Einstein rather than by Planck thus turned out to be a fruitful starting point for the investigations now being pursued. Their goal is the reconstruction of the history of the interaction of the emerging quantum theory with the developing techniques of precision measurements in state institutions such as the Physikalisch-Technische Reichsanstalt from the viewpoint of historical epistemology.

The disintegration of evolutionary biology:
In the framework of the present project, processes of integration and disintegration are not exclusively studied in the field of physics but also for the protracted conceptual transformation affecting biology to this day *(Peter Beurton).* 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. From the point of view of the present project, applied to a subject quite different from physics, the concept of the gene can be more adequately understood as resulting from and developing in consequence of an ongoing knowledge integration which will eventually make genes understandable as products of the evolutionary process rather than as fundamental particles. In the sequel of publishing a volume of essays on the issue of the gene as an outcome of the project (see completed research activities, p. 24), work within the project has recently been concentrated on the impact of the historical analysis on questions of modern biology, because this approach to the gene also opens new opportunities of interpretation of the history and structure of the Synthetic Theory of biological evolution.



Peter Beurton

Associated research activities

Mechanism and organism:
Building on the completed research activities on Newton's Synthesis of τέχνη and φύσις and its reception in the Hegelian system (see above, completed research activities), the role played by the conflict between mechanism and organism in the epistemological foundation and reflection of modern natural science is being investigated *(Renate Wahsner)*. A beginning has been made with the conception of organism as introduced by Kant as a thought principle and with his attempt to understand this principle in terms of a completion, not replacement, of mechanism.

Horst Kant

Deduction of universal categories: A dissertation project is dealing with the historical background of Kant's transcendental deduction of the categories in his "Critique of Pure Reason" *(Falk Wunderlich)*. Kant's argument is reconstructed within the context of contemporary questions, debates and terminology, in particular with regard to the concept of mind in eighteenth century metaphysics.
Studies on the history of atomic and nuclear research – from radioactivity to nuclear fission:
Preliminary research has been completed with the aim to give a comprehensive survey of the research activities of the Hahn/Meitner-group up to 1932, as well as on the international connections of this group *(Horst Kant)*.

Ulf von Rauchhaupt

Various other activities related to the goals of the project:
Preconditions of the reassessment of the Darwinian gradualist and selectionist theory of evolution have been investigated, which was suggested by population genetics on the base of a theory of change in gene frequencies within populations *(Staffan Müller-Wille)*. As part of a study on the history of the Max Planck Institute for Extraterrestrial Physics, the foundation of this institute in the context of space research after the launch of the Sputnik has been investigated by the Reimar Lüst fellow of the Institute *(Ulf von Rauchhaupt)*. Another, still ongoing study concerns the transformation of the concept of vacuum from classical physics to modern quantum physics *(Yoonsuhn Chung)*, and preparatory work has been done in order to investigate the interrelations of mathematics and physics in the period of the creation of relativity and quantum theory *(Erhard Scholz)*.

Development: Electronic Research Tools and Databases

General goals of the developments

Recent developments in electronic data processing have fundamentally changed the potential of research in the history of science as well as in other disciplines. The electronic storage of historical sources improves their accessibility and makes new and powerful methods of the retrieval of information possible. Scanning and optical character recognition techniques are being used to build electronic archives of historical sources, and databases and software tools are being developed to assist research and editorial activities. These activities aim at the creation of working environments that make it possible to integrate historical details into coherent models of historical developments. They are based on both the availability of a wide range of sources accessible to the scientific community as a whole, within the framework of open digital research libraries, and on scholarly cooperations extending well beyond a single institution. These cooperations, characterized by a novel unity of research and dissemination, are by their very nature international and interdisciplinary. They draw on the potential of the Internet to cut across the traditional distinctions of research institutions, universities and libraries.

The process of restructuring scientific work in the history of science is part of a larger process of restructuring scientific research and dissemination presently discussed in the Max Planck Society. Although the preparation of electronic editions of historical sources and the development of new working environments is not at the center of activities at the Institute and cannot be adequately pursued with its resources, they are unavoidable as long as the time-lag in exploiting the potential of the new information technologies in the humanities has not been overcome. The

activities reported here follow proposals for the development of information management techniques which were envisioned at a conference at Elmau Castle, coorganized by *Jürgen Renn* on behalf of the "Beratende Ausschuß für EDV-Anlagen" (BAR) about future perspectives of information management in the Max Planck Society. At this conference it became clear that the consequences of the information revolution for research institutes make it necessary to provide the institutes with coordinated support for their information management. In particular, the time-lag of the humanities with regard to the ongoing information revolution will not be overcome as long as digital library projects such as those reported here do not receive the kind of support which is expected from the planned Center for Information Management (CIM) of the Max Planck Society proposed at the Elmau conference.

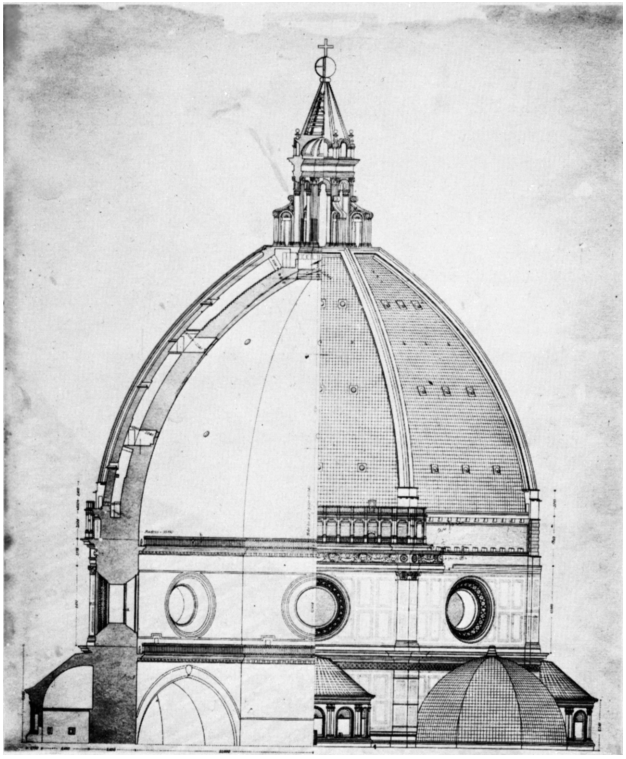
Completed work

Model working environment for manuscripts:
An electronic representation of Galileo's notes on motion and mechanics, kept as Ms. Gal. 72 in the Galilean collection of the Biblioteca Nazionale Centrale in Florence, has been prepared. It provides a working environment for scholarly work which is extensively used through the intranet of the Institute and has moreover been made freely available through the Internet (http:// www.mpiwg- berlin.mpg.de/Galileo_Prototype/MAIN.HTM). The electronic representation is a joint pilot project of the Biblioteca Nazionale Centrale in Florence *(Isabella Truci)*, the Institute and Museum for the History of Science in Florence *(Paolo Galluzzi)*, and the Max Planck Institute for the History of Science in Berlin *(Peter Damerow, Jürgen Renn)*. It was realized at the Institute by a team of scholars and staff *(Jochen Büttner, Michele Camerota, Giuseppe Castagnetti, Peter Damerow, Jörg Kantel, Jürgen Renn, Simone Rieger, Martin Warnke, Carmen Wedemeyer, Berndt Wischnewski)*. The electronic representation has received the Pirelli INTERNETional Award 1998.
Medieval Manuscripts:
An "International Computer Catalog of Medieval Scientific Manuscripts" (ICCMSM) compiled over a number of years at the University of Munich *(Gerhard Brey, Menso Folkerts)* has been restructured and upgraded to modern database technology *(Gerhard Brey, Jochen Büttner, Peter Damerow, Paul Weinig)*. It has been made accessible through the intranet of the Institute and is presently being prepared to be made freely available through the Internet (http://archimedes.mpiwg-berlin.mpg.de/ cgi-bin/iccmsm.pl)
Cuneiform texts of the third millennium B.C.:
In a joint project of the Institute *(Peter Damerow)* together with the Seminar of Near Eastern Archaeology of the Freie Universität Berlin *(Hans Nissen)*, with the Department of Near Eastern Languages and Cultures of the University of California at Los Angeles *(Robert K. Englund)*, and with the Computer Center of the Universität Lüneburg *(Martin Schreiber, Martin Warnke)*, an electronic representation of the proto-cuneiform tablets of ancient Mesopotamia (3200–3000 B.C.) has been prepared, based on the sources collected, edited and deciphered by the Uruk Project. This pioneering endeavor to introduce advanced techniques of electronic information management into scholarly work on archaic writing was subsequently extended to the development of techniques to virtually rejoin and analyze cuneiform archives now scattered in numerous museum collections. A first major activity in this direction, performed together with the Vorderasiatisches Museum der Staatlichen Museen zu Berlin *(Joachim Marzahn, Beate Salje)*, concerns the cuneiform texts from the 3rd millennium B.C. kept in this museum; they have been scanned and made electronically accessible together with results of scholarly work on them *(Peter Damerow, Robert K. Englund, Michael Schüring)*. The outcomes of both undertakings are presently being prepared to be made available through the Internet (http://cdli.ucla.edu or http:// cdli.mpiwg-berlin.mpg.de). They have served as pilot projects for a larger venture, the Cuneiform Digital Library Initiative (CDLI) in which the Institute takes part (see below).

Current work

Mark Schiefsky

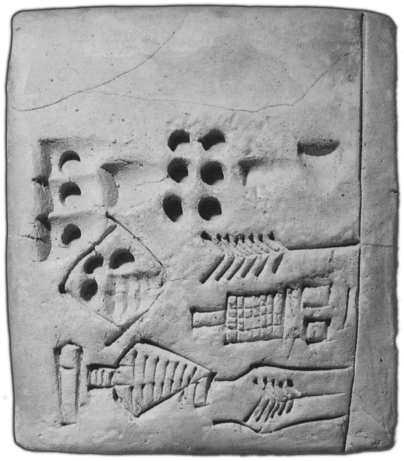
An open digital research library for the history of mechanics (Archimedes Project):
This project is a proof-of-concept project for an open digital research library for the history of science which integrates research and dissemination in a new way. It is a joint endeavor of the Max Planck Institute for the History of Science *(Jürgen Renn)*, the Classics Department at Harvard University *(Mark Schiefsky)*, and the Perseus Project at Tufts University *(Gregory Crane)*, the English Department at the University of Missouri at Kansas City *(Jeffrey Rydberg-Cox)*, realized within a wider network of scholarly cooperation supported in particular by "Project International de Coopération Scientifique" (PICS) *(Pierre Souffrin)*. The Archimedes Project has designed a three-phase "production line" for digitizing printed texts and other source materials and structuring the outcome according to scholarly analysis of their content. So far in the first phase of text acquisition, primary data of the majority of text sources have been entered (approximately 10,000 pages of source texts). As for the next phase, the implementation of dedicated language technology, two seventeenth-century dictionaries have been made electronically available and the basic programming of the morphological analysis of Italian has been completed. Regarding the computer-assisted interpretation of the sources, working environments for metadata production have been developed and implemented. In particular, a working environment for the conformal translation of Greek and Latin sources using morphological analysis and automatic linking to dictionaries and prior translations of terms has been created to support the current research. The cooperation between the American and German partners engaged in the Archimedes Project includes the qualification and technical training of junior scholars, in particular in the context of a specially created Archimedes fellowship program.



Brunelleschi's cupola of the Cathedral of Florence

The Administrative Archives of the Cathedral of Florence:
In cooperation with a research group of the Opera del Duomo *(Margret Haines)*, i.e. the board of works of the Cathedral of Florence, an electronic representation of the administrative documents from the time when the cupola of the Cathedral was built is being developed *(Jochen Büttner,*

Peter Damerow, Jürgen Renn, Berndt Wischnewski). The data to be represented and the results of their analysis will provide unique information about the structures of planning and the organization of knowledge at the most prominent construction site of the early Renaissance period. It is the major aim of work being pursued by the group of the Institute to secure the longevity of this unique set of data and to make it freely accessible through the internet.



Mesopotamian bookkeeping record from the 3rd millennium BC

The Cuneiform Digital Library Initiative (CDLI):
Based on the experience gained in Berlin from the digitization of the archive of the Uruk project and of cuneiform tablets in the collection of the Vorderasiatisches Museum (see above, completed works), an international initiative has been inaugurated aimed at integrating major collections of cuneiform texts from the third millennium B.C. and making these collections, together with the results of scholarly work on them, freely accessible through the internet *(Peter Damerow, Robert K. Englund, Hans Nissen).* Beginning in July 2000, the initiative will be supported by the NSF. At present, five museums (Vorderasiatisches Museum, Berlin; British Museum, London; Louvre, Paris; Hermitage, St. Petersburg) and scholars from several countries have joined the initiative. The work on the collection in the Vorderasiatisches Museum has been completed *(Peter Damerow, Robert K. Englund, Joachim Marzahn, Michael Schüring, Berndt Wischnewski),* and scanning of the cuneiform collection in the Hermitage is in progress and will be finished in the first half of the year 2000 *(Markus Schnöpf).* A preliminary SGML format for cuneiform texts has been developed as a tool for integrating transcriptions provided by different scholars and for transliterating texts from scanned images *(Mark Schiefsky).* As a test bed for the unification of transcriptions and the application of electronic tools, a group of 12,000 transcriptions of texts from the Ur-III period has been reformatted; an electronic representation including automatically generated word lists is being prepared to make them accessible through the internet *(Peter Damerow, Berndt Wischnewski).* As a test bed for transliterating cuneiform texts in a validating SGML working environment, the texts from the Fara period kept in the Vorderasiatisches Museum are being transliterated *(Blahoslav Hruška).*

Blahoslav Hruška

Department II (Director: Lorraine Daston)

Since its inception in 1995, the work of Department II has been principally organized around thematic research groups: "The Emergence of Scientific Objects" (1995–96), "Varieties of Scientific Experience" (1996–97), "Demonstration-Test-Proof" (1997–98), "The Scientific Persona" (1998–99), and "The Moral Authority of Nature" (1999–2001), as well as an ongoing project on "The History of Scientific Objectivity". These themes are chosen to open up fundamental categories of scientific thought and practice to detailed historical investigation: how do some domains of phenomena (microbes, centers of gravity, monsters) become objects of scientific inquiry? how do new forms of scientific experience such as the experiment or the clinical trial establish themselves? under what circumstances do novel patterns of argument, e.g. mathematical demonstration or computer simulation, emerge? when and why does the intellectual and cultural identity of the scientist diverge from that of the sage or scholar? why is the conflation of the normative and the natural apparently so irresistible? The aim of questions like these is to create a historical epistemology, which examines the emergence and development of the categories – object, experience, proof – that have come to undergird rational inquiry, both theoretical and empirical. Historical epistemology attempts to root the abstract and immutable concepts of epistemology in the concrete, changing contexts of history. It addresses the specificities of scientific practices as well as the generalities of concepts and ideals: for example, the techniques of photography and statistical inference are as constitutive of scientific objectivity as the philosophical reflections of Kant or Helmholtz.

Each research group consists of a mix of junior and senior scholars, most of whom spend at least an academic year at the Institute working on individual topics within the framework of that year's research theme. In addition to Institute funding, individual scholars have also been supported by fellowships from the Alexander von Humboldt Foundation, the USA Fulbright Commission, the French CNRS, the German Academic Exchange Service, the Swiss National Fund, and their home institutions. Because of the importance of comparative studies for historical epistemology, groups are composed with an eye toward diversity of disciplinary (history of natural history, mathematics, anthropology, chemistry, etc.), period (ancient to contemporary), and methodological (history, history of science, history of art, philosophy, sociology, anthropology) perspectives. Members of the group present works-in-progress to one another at biweekly departmental colloquia; moreover, each research project has included at least one international conference devoted to that year's theme. (Publications relating to projects are listed under the author's name in the Bibliography.)

Demonstration-Test-Proof (1997–98)

Christophe Bonneuil, Sonja Brentjes, Joan Cadden, Jordi Cat, Giovanna Cifoletti, William Clark, Lorraine Daston, Catherine Goldstein, Alain Herreman, Sally Humphreys, Evelyn Fox Keller, Morgane Labbé, Carmen Loza, Javier Moscoso, Marc Ratcliff, Joan Richards, Sophie Roux, Friedrich Steinle. Short-term Visiting Scholars: *Daniel Garber, Niccolò Guicciardini, Deepak Kumar*
Demonstrations, proofs, and tests seek not only to increase knowledge, but to make knowledge secure. 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 machine – their histories and current usages are nonetheless closely intertwined in the major European languages. The research group addressed the question of how knowledge, both scientific and technological, becomes trustworthy: what are the forms of argument, the techniques, the procedures that guarantee various kinds of knowledge; under what circumstances did they emerge historically; how did they become authoritative? Mathematical and scientific knowledge served as the departure point for the project, but comparisons were drawn from cases in the history of medicine, law,

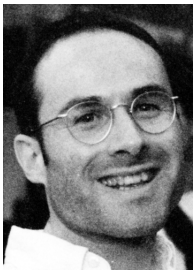
and theology as well. Of particular interest were examples of (1) prototypical forms of argument that become models for all other forms of secure knowledge (e.g. the demonstrations of Euclidean geometry or scholastic proofs for the existence of God); (2) procedures and standards that migrate from one disciplinary context to another (e.g. the application of legal standards of evidence and proof to early modern civil and natural history); (3) the introduction of novel methods to prove and test (e.g. double-blind randomized trials in clinical research): and (4) the convergence and conflict of different ways of securing knowledge about the same objects (e.g. computer simulations versus laboratory experiments in recent physics).

Joan Cadden

Catherine Goldstein

In the Greek, Arabic, Latin, and later vernacular scientific traditions the significance of logical syllogisms and mathematical demonstrations as models for all conclusive argumentation, be it in theology, natural philosophy, or ethics, has been immense. Hence the history of the emergence, transmission, and evolution of logical and mathematical demonstrations is central to any history of proof. *Sonja Brentjes* continued earlier work on the transmission of Euclidean geometry in the medieval and early modern Islamic world, with particular emphasis on sixteenth- and seventeenth-century scientific exchanges between European, Safavid, and Ottoman scholars. She discovered several Arabic and Persian translations of European mathematical, geographical, astronomical, and medical works in India, and a unique Arabic version of Euclid's *Elements* in Bombay, which latter she is preparing as an edition. *Joan Cadden* explored criteria for legitimate forms of argument and objects of inquiry in late medieval Latin natural philosophy, especially the *Problemata* literature. The *Problemata* posed questions that often challenged the demonstrative methods of natural philosophy, or trespassed upon the territory of other disciplines, such as ethics and theology. These tensions between philosophical precept and practice can be studied to good advantage in the *Problemata* commentary (1310) of natural philosopher and physician Pietro d'Abano, whose explanations rely less on deductions from first principles or analysis by standard analytical categories than on the deployment of analogies and references to authoritative texts. *Catherine Goldstein* also studied alternatives to paradigmatic models of demonstration, particularly Euclidean demonstration, in the context of early modern number theory. She discovered suggestive analogies between the work of Bernard Frenicle de Bessy's procedures in Diophantine analysis and Francis Bacon's proposals for a reformed natural philosophy. *Joan Richards* addressed the valuation of rigor in mathematical demonstrations, contrasting geometry texts of the eighteenth and nineteenth centuries. She also explored the relationships between logical and mathematical demonstrations in Victorian Britain. *Alain Herreman* conducted semiotic analyses of mathematical texts in twentieth-century algebraic topology and twelfth-century Latin algorithms.

The transfer of methods of proof between cultures and disciplines provide historians with the clearest examples of how local knowledge succeeds or fails to become global. Since many if not most forms of conclusive argument in the sciences, mathematics, and technology lay claim to universal status, these transfers are often regarded as the ultimate test of validity: will the same methods work in Berlin, Boston, Bombay? *Carmen Loza* investigated how sixteenth-century Spanish colonial courts came to accept calculations performed by the traditional methods of the *quipu*, a set of knotted cords that served as an instrument of calculation and *aide mémoire*, as valid legal evidence for the payment of taxes and duties by indigenous peoples – a case of successful transfer made all the more striking by the fact of the imbalance of power between the Spanish authorities and the masters of the *quipu* calculations, and the competing interests of the parties in matters of tax collection. In another case of cultural transfer in a colonial situation, *Christophe Bonneuil* studied attempts in British, French, and Belgian African colonies to import scientific farming, and to compile unified botanical classifications on the basis of specimens and descriptions furnished by botanists, travelers, traders, and indigenous peoples. In both instances, bureaucrats and researchers found they had to modify ways of village life in order to produce the forms of knowledge they wished to collect and monitor: intellectual transfer required cultural transformation. *Giovanna Cifoletti* examined a case of disciplinary transfer, between rhetoric and algebra in early modern Italy and France. Noting the prominence of jurists among the early algebraicists, she points to the

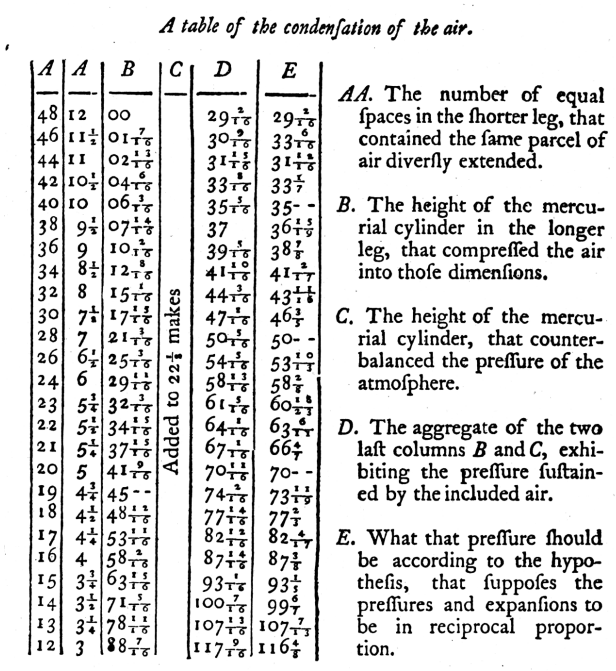


Jordi Cat

Friedrich Steinle

influence of the French court, the Collège Royal, and the Parliament of Paris in the creation and reception of the work of Viète and Descartes. *Jordi Cat's* study of the electromagnetic theories of James Clerk Maxwell revealed the transfer of analogies and explanations drawn from industrial machines, physiological research on muscles, and artisanal and athletic practice into the Maxwellian physics of potential functions.

Lorraine Daston, *Sophie Roux*, and *Friedrich Steinle* formed a study group to examine another case of disciplinary transfer in early modern Europe: the adoption of the metaphor of "natural law" by both jurists and natural philosophers in the seventeenth century to describe the fundamental regularities of nature and society. *Steinle* surveyed the terminology of natural regularities (not only "law" but also alternatives, such as "rule") in the context of seventeenth-century English natural philosophy, noting extension of the term "natural law" after the 1660s to empirical regularities as well as to a priori principles. *Roux* examined the theological and philosophical foundations of early modern natural law doctrines in both natural philosophy and jurisprudence with attention to three issues: ontology (how God created and then governed the world); epistemology (how humans come to know natural laws); and architectonics (how the laws of nature are integrated into systems of propositions). *Daston* sought parallels between standards for the evaluation of evidence among jurists and natural philosophers, especially in cases of apparent exceptions to natural laws. (This work was part of a collaboration with the Max Planck Institute for European Legal History in Frankfurt am Main, and was presented at a conference on "Natur-Gesetz-Naturgesetz" held under the auspices of the Deutsche Forschungsgemeinschaft: see "The Moral Authority of Nature", p. 44.)



A table of the condenſation of the air.

A	*A*	*B*	*C*	*D*	*E*
48	12	00	Added to 22⅛ makes	29 2/16	29 2/16
46	11½	01 7/16		30 9/16	33 6/16
44	11	02 13/16		31 15/16	31 15/16
42	10½	04 6/16		33 8/16	33 7/7
40	10	06 3/16		35 5/16	35- -
38	9½	07 14/16		37	36 15/19
36	9	10 2/16		39 5/16	38 7/8
34	8½	12 8/16		41 10/16	41 2/17
32	8	15 1/16		44 3/16	43 11/16
30	7½	17 12/16		47 8/16	46 3/5
28	7	21 3/16		50 5/16	50- -
26	6½	25 3/16		54 3/16	53 10/13
24	6	29 11/16		58 13/16	58 2/3
23	5¾	32 3/16		61 5/16	60 18/23
22	5½	34 15/16		64 8/16	63 6/11
21	5¼	37 15/16		67 1/16	66 4/7
20	5	41 9/16		70 12/16	70- -
19	4¾	45- -		74 2/16	73 11/19
18	4½	48 12/16		77 14/16	77 2/3
17	4¼	53 1/16		82 12/16	82 4/17
16	4	58 2/16		87 14/16	87 3/8
15	3¾	63 12/16		93 1/16	93 1/5
14	3½	71 5/16		100 7/16	99 6/7
13	3¼	78 12/16		107 13/16	107 7/13
12	3	88 7/16		117 9/16	116 4/8

AA. The number of equal ſpaces in the ſhorter leg, that contained the ſame parcel of air diverſly extended.

B. The height of the mercurial cylinder in the longer leg, that compreſſed the air into thoſe dimenſions.

C. The height of the mercurial cylinder, that counterbalanced the preſſure of the atmoſphere.

D. The aggregate of the two laſt columns *B* and *C*, exhibiting the preſſure ſuſtained by the included air.

E. What that preſſure ſhould be according to the hypotheſis, that ſuppoſes the preſſures and expanſions to be in reciprocal proportion.

In this table, Robert Boyle (1627-1691) arranged experimental data in order to argue for the inverse relation (later on called Boyle's law) between the pressure and the volume of a quantity of air (Robert Boyle: A defence of the doctrine touching the spring and weight of the air, (1662).

The sciences have been fertile in creating new forms of demonstration, test, and proof. Some of these are forms of argument in the purest sense (e.g. mathematical induction); others depend on protocols, instruments, techniques, and methods. Some, but not all, of these innovations become part of the permanent equipage of proof. The conditions of their acceptance or rejection are hence as important as those of their emergence for a history of modes of validity. Continuing her earlier research on the relation between the rational and irrational both in ancient Greece and in the

history of classical studies, *Sally Humphreys* explored how cultic innovations could be made objectively "right" through a coincidence of pattern, e.g. a ritual that can be interpreted as marking a point of transition in astronomical, agricultural, and social time, and as re-enacting a significant event from the mythical past. *Javier Moscoso* studied how the anatomical study of monsters acquired special epistemological status in the eighteenth century: these were nature's own experiments, proving or disproving hypotheses about normal embryological development. The special status of monsters as rare anomalies also raised problems of evidence, including the evaluation of witness testimony and the epistemological relationship between texts and illustrations. *Marc Ratcliff* began research on the epistemology of the microscope 1740–1830, which will form the basis for a Ph.D. dissertation in the history of medicine at University College London. *William Clark* analyzed the arguments of German archaeologists (1762–1862) on how to date cultural objects, in relationship to debates about how to reconstruct excavated sites and objects: should reconstructions sacrifice authenticity to the closest possible resemblance to the original, or should only materials excavated at the proper site and dating from the proper period be used?

William Clark

Modes of demonstration, test, and proof must often be used in tandem with one another, raising vexed issues of convergence and relative degrees of validity. For example, all of the historical sciences are familiar with conflicts between various dating techniques: carbon 14, stratigraphic position, phylogenetic lineage, stylistic criteria for artefacts, and site context are all tried and true methods by which to prove the age of an object, but their results do not always agree. *Morgane Labbé* studied the conflicts among nineteenth-century statisticians, ethnographers, and geographers on how to capture the essence of nationality: was it a territorial distribution? a population that grew like an organism as a function of time? a homogeneous language group? Each of these definitions was linked to distinctive methods of representation, inquiry, and proof: the map, the census, the field study. *Evelyn Fox Keller's* research concentrated on the controversial uses of mathematical and computational models in developmental biology, from D'Arcy Thompson's *On Growth and Form* (1917) to the recent debates about the possibility of "computing the embryo".

Evelyn Fox Keller

In the research undertaken by the project group as well as in the papers presented at the two international conferences held in conjunction with the project, the relationship between the precepts and practices of proof was central. Studied up close, the practices of even the most formalized proof procedures (e.g. automated proof procedures to check computer programs that control nuclear missle systems) reveal an irreducible element of judgment and pragmatism. There is apparently no clear-cut relationship between the degree to which proof procedures are formalized and the solidity of the knowledge based upon them. Indeed, there may even be an inverse relationship: at least, physicists rarely resort to inference statistics to evaluate the robustness of their results, while psychologists use such techniques routinely. Practices of "making certain" loom large in mathematics as well as in the empirical sciences. Chinese traditions of algorithmic mathematics evolved sophisticated methods of checking results, but not an apparatus of demonstration. Even within mathematics in the Greek tradition of demonstration, the practice of constructing solutions (as opposed to proving them) remained significant through the early eighteenth century. Demonstrations, even the most formalized and automated, should be regarded as systems that integrate deductive procedures with elaborate, if implicit codes of practice. The opposition between rigorous demonstration and other more informal and pragmatic ways of making knowledge secure gives way to a continuum.

Related Conferences and Workshops:

"QED: Demonstration in Historical and Cross-Cultural Context"
(Max Planck Institute for the History of Science, 28–30 May 1998).

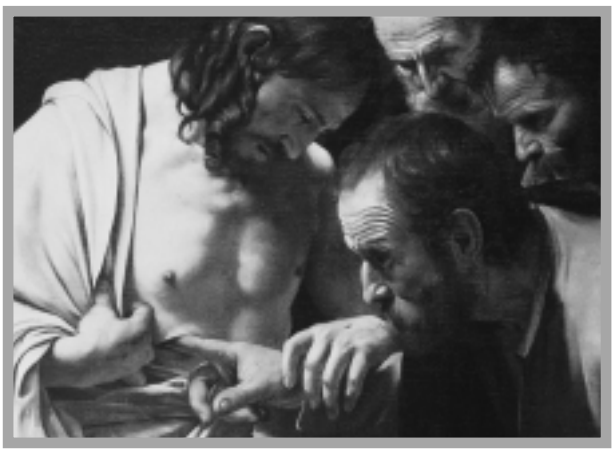
Organizer: *Lorraine Daston* (Max Planck Institute for the History of Science)
Speakers:
Kirsti Andersen (University of Aarhus, Netherlands): The Trust in an Analysis
Henk Bos (University of Utrecht, Netherlands): QEF – The Primacy of Construction over Proof in Early Modern Mathematics
Karine Chemla (CNRS-Université de Paris, France): The Ideals and Practice of Demonstration in Liu Hui's Commentary (263 AD) on *The Nine Chapters on Mathematical Procedures*
Giovanna Cifoletti (EHESS, Paris, France): Dialectical and Algebraic Arguments in the Sixteenth-Century
Peter Engelfriet (Rijksuniversiteit Leiden, Netherlands): Chinese Reception of Euclidian Mathematics
Catherine Goldstein (CNRS-Université de Paris, France): Infinite Descent: a Proof and its Histories
Niccolò Guicciardini (Università degli Studi di Bologna, Italy): The Debate on Newton's Mathematical Methods for Natural Philosophy
Ralf Haubrich (Universität Göttingen, Germany): Argumentation in Geometry: What is the Context of a Continuous Line?
Eberhard Knobloch (Technische Universität Berlin, Germany): Archimedes and his Adherents: Kepler, Guldin, and Leibniz
Herbert Mehrtens (Technische Universität Braunschweig, Germany): Proof and Representation in Modern Formalist Mathematics: The Debate between Pasch and Study
Reviel Netz (University of Cambridge, UK): Mathematical Fetishism: Practice and Ideology
Joan L. Richards (Brown University, Providence, USA): Proof and Persuasion: The Place of Logic in Victorian England

"Demonstration-Test-Proof" (Max Planck Institute for the History of Science, 25–28 June 1998)

Organizers: *Lorraine Daston* (Max Planck Institute for the History of Science) and Arnold Davidson (University of Chicago)
Speakers:
Ken Alder (Northwestern University, Evanston, USA): Proving a Lie: The Polygraph Technique and the Validation of Scientific Evidence in America
Francesca Bordogna (Northwestern University, Evanston, USA): A Geography of Evidence: Psychical Research, 1870–1910
Joan Cadden (University of California at Davis, USA/Max Planck Institute for the History of Science): Just Like a Woman: Authority and Comparison in the Anatomy of an Argument
John Carson (Cornell University, Ithaca, USA): Why Is "Intelligence" What Intelligence Tests Test?
Simona Cerutti (EHESS-CNRS Paris, France): Vicissitudes of the Judicial Proof: The Civil Procedure in Turin in the XVIIIth Century – Vicissitudes de la preuve judiciaire: la procédure sommaire à Turin au XVIIIe siècle
Brigid Doherty (Johns Hopkins University, Baltimore, USA): Modernism and the Medium of the Test: A Preliminary Study in Two Parts
Barbara Duden (Universität Hannover, Germany): The History of "Security" in the Knowledge of Pregnancy
Peter Galison (Harvard University, Cambridge, USA): An Accident of History
Ian Hacking (University of Toronto, Canada): Dreams in Place

Max-Planck-Institut für Wissenschaftsgeschichte

Max Planck Institute for the History of Science, Berlin



25 – 28 June 1998

Ken Alder, Francesca M. Bordogna, Joan Cadden, John Carson, Simona Cerutti, Roger Chartier, Lorraine Daston, Arnold Davidson, Brigid Doherty, Barbara Duden, Rivka Feldhay, Peter Galison, Carlo Ginzburg, Ian Hacking, Glenn Most, Donald MacKenzie, Ian Maclean, Harry Marks, Krzysztof Pomian, Emmanuela Scribano, David Wellbery

Demonstration Test Proof

atelier : [doppelpunkt]

Donald MacKenzie (Harvard University, Cambridge, USA): Trusting the Computer: Technology, Risk, and Proof
Ian W. F. Maclean (University of Oxford, Great Britain): Signs, Observations, and the Principle of Charity in late Renaissance Law and Medicine
Harry M. Marks (Johns Hopkins University, Baltimore, USA): Trust in the Marketplace: Statistics and Clinical Research, 1940–1960
Glenn Most (Ruprecht-Karls-Universität Heidelberg, Germany): Persuading Thomas
Krzysztof Pomian (EHESS-CNRS, Paris, France): Proof in History
Emmanuela Scribano (University of Siena, Italy): Demonstrating the Existence of God. History and Problems
Commentators:
Roger Chartier (EHESS Paris, France)
Lorraine Daston (Max Planck Institute for the History of Science)
Arnold Davidson (University of Chicago, USA)
Rivka Feldhay (Tel Aviv University, Israel)
Carlo Ginzburg (University of California at Los Angeles, USA)
David E. Wellbery (Johns Hopkins University, Baltimore, USA)

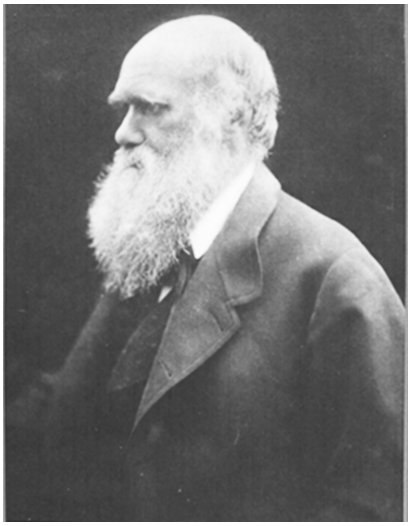
The Scientific Persona (1998–99)

Gadi Algazi, Francesca Bordogna, Sonja Brentjes, Kevin Chang, Lorraine Daston, Patricia Fara, André Laks, Hélène Mialet, Tara Nummedal, Kathryn M. Olesko, Andreas Renner, H. Otto Sibum, Charles Thorpe, Irmline Veit-Brause, Michael Wintroub. Short-term Visiting Scholars: *Elisabeth Crawford, Anne Secord, Steven Shapin, Thomas Söderqvist, Andrew Warwick*
Intermediate between the individual biography and the social institution lies the persona: a cultural identity that simultaneously shapes the individual in body and mind and forges a collective with a shared and recognizable physiognomy. The bases for personae are diverse: a social role (e.g. the mother), a profession (the physician), an anti-profession (the flâneur), a calling (the prophet).

The persona of the medieval scholar (woodcut from J. Sambucus, Emblemata, Antwerp 1566)

There is no one-to-one correspondence between any given social category and the existence of a persona: many venerable professions do not crystallize into a persona (e.g. the cook), while other activities that are established neither by institution nor remuneration nor specialized education nonetheless do cohere into one (e.g. the social critic). Personae are creatures of historical circumstance; they emerge and disappear within specific contexts. A nascent persona indicates the creation of a new kind of individual, whose distinctive traits mark a recognized social species. The members of the research group on “The Scientific Persona” traced the emergence of various scientific personae, where “scientific” is understood broadly enough to embrace the instrument-maker, the scholar, the technocrat, and the professor, as well as the experimenter and the naturalist. Although the chronological center-of-gravity was the nineteenth century, the period during

which new words like “scientist”, *der Naturwissenschaftler*, *le scientifique* were coined for a group that laid claim to ever greater cultural recognition, the topics pursued by members of the research group spanned the Pre-Socratics through the twentieth-century physicist. In the same comparative spirit, cases in Britain, France, Italy, Germany, and the United States, as well as disciplines ranging from physics to botany to astronomy to philology were studied. The aim was to investigate the personal element in science not as biographers but more as botanists, piecing together a type specimen that represents a class rather than any individual in particular. The aim of the project is to introduce the concept of persona to the history of science, by showing how it can be fruitfully deployed in diverse periods, locales, and disciplines.



Portrait of Charles Darwin (photography by Julia Margaret Cameron 1868)

“Persona” was a concept originally developed by the French anthropologist Marcel Mauss in the context of cultures as various as the indigenous peoples of the Pacific Northwest and the ancient Romans to the history of modern science. Like Mauss, the members of the research group were concerned with the emergence and implications of categories of people – of collective ways of thinking, feeling, judging, perceiving, working – rather than with individual biographies in all their idiosyncratic particularity. If personae are not individuals, nor are they stereotypes or social roles. The Latin word *persona* originally meant “mask”, but we must be careful not to project our modern understanding of the mask onto antique usage. For us, masks are easily donned and doffed, just as for us actors (both on stage and in society) step easily in and out of roles, without thereby transforming their core identities as individuals. As a metaphor, the mask in modern parlance is a topos of insincerity: to wear a mask is to disguise one’s authentic self, to succumb to social constraint and convention. The modern opposition of mask to true self mirrors that between the artifice of society versus the genuine nature of the individual, both the legacy of Rousseau’s moral and political theory of inauthenticity. In contrast, the ancient meaning of persona invoked by the research project recalls the dramaturgy of masks as makers, not destroyers of true identities. To put on a mask in ancient Greek and Roman theatre (and in the rites of passage analyzed by Mauss) was transformative, to attain rather than to suppress genuine selfhood. To understand personae in this sense is to reject a social ontology that treats only flesh-and-blood individuals as real, and dismisses all collective entities as mere aggregates, parasitic upon individuals. Personae are as real or more real than biological individuals, in that they create the possibilities of being in the human world, schooling the mind, body, and soul in distinctive and indelible ways.

Perhaps the most striking feature of the personae is that there are so few of them in comparison to individuals. In some cultures – Mauss provided several examples in his seminal essay – a small set of social identities, derived from ancestors or totem animals or gods, is endlessly

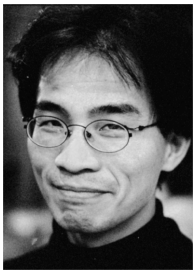
repeated, generation after generation. Often the assumption of a persona is combined with a coming-of-age ritual, and the assumption of a new-old name, as in the case of confirmation, induction into certain religious or fraternal orders, or assuming the office of pope. Even in secularized cultures like our own, the stock of names is paltry compared to the number of individuals who bear them, and the choice of a name for a baby almost always locates the newborn within a tradition – be it of saints, forbearers, or heroes. The individual is subsumed within a collective identity, symbolized by names handed down for generations. In many cultures, personae are the literal incarnation of tradition, projecting a past (legendary or historical) onto the present and into the future. Personae negate the facts of human mortality and individuality. In every generation there will be bearers of the ancient names and identities; in every generation the social order crystallized by personae will be renewed.

Such customs may seem quaint in connection with modern science, with its bold individualism (think of the eponymy of laws, theorems, and units of measurement, and of the historiography of great names), and its prestissimo pace of change. Since at least the seventeenth century, the natural sciences seem to have resolutely erased, not relived their past. They are amnesiac disciplines, and insofar as they have a history of their own making, it is an epic history of titanic (and quirky) individuals. Hence the modern sciences seem to be poor candidates for the anthropological category of the persona. But before leaping to the all-too-familiar opposition between traditional and modern cultures, we might reflect on the stubborn collectivity of words like *der Wissenschaftler*, *le scientifique*, the scientist: although we have a plethora of names for scientific specialists (crystallographers, zoologists, mycologists, chemists, ornithologists, etc.), and although specialist journals and societies have notoriously fragmented the unity of science as both a corpus of knowledge and a social institution, both practitioners and laymen nonetheless cling to the collective denomination “scientist” and its various cognates in other languages. The very superfluity of umbrella organizations like the British Association for the Advancement of Science or the Versammlung deutscher Naturforscher und Ärzte should give us pause: they were established just at the time (early nineteenth century) that scientific specialization, as documented by the hyperbolic increase in specialist journals, societies, and university chairs, took off. The modern word “scientist” (coined ca. 1835) bears witness to a persona that resists the multiplication of identities even at the disciplinary level, not to speak of the level of the individual.

Louis Pasteur, painted by Albert Edelfelt

However recent the current names applied to students of nature may be, the history of this persona has a long prehistory. *André Laks* explored the problem of “intellectual differentiation” in Greek philosophy, with particular attention to the Pre-Socratics. His research focused on the re-evaluation of the relationship between eschatology and natural philosophy in light of recently discovered papyrus fragments containing new material from Empedocles. A cluster of studies on the

Gadi Algazi



Kevin Chang

Patricia Fara

Irmline Veit-Brause

Francesca Bordogna

figures of the scholar, the magus, and the alchemist in the late medieval and early modern period shed light on possible models and components of the scientific persona as it later emerged. *Gadi Algazi* examined how western European scholars (especially German humanists between 1470 and 1550) transformed their received persona and habitus once they no longer lived in monasteries and colleges and began to found family households in urban communities, in particular how the engrained dispositions of scholars (such as concentration and "learned forgetfulness") shaped modern ways of life that could be cultivated by other social groups and professions. Using three seventeenth-century French scholars (Nicolas Fabri de Peiresc, Balthazar de Monconys, and Joseph Pitton de Tournefort) with direct contacts in the Middle East as case studies, *Sonja Brentjes* studied the impact of European interests in and perceptions of their Middle Eastern counterparts for the formation of a self-consciously European scholarly persona. *Tara Nummedal* addressed the persona of the alchemist in the Holy Roman Empire (1550–1620) through transcripts of criminal trials that prosecuted alchemists on charges of fraud. In contrast to extant studies on learned alchemists, her work reconstructs the figure of the working alchemist. At the other end of the social spectrum, *Michael Wintroub* analyzed the royal entries in early modern France as a key to the construction of elite identities, and continued earlier research on the practices and persona of the early modern collector. *Kevin Chang's* study of the German chemist and physician Georg Ernst Stahl (1659–1734) situated the persona of the early modern empiricist within the context of the spiritual, intellectual, cultural, and institutional context of the University of Halle and its Pietist milieu. *Andreas Renner* investigated how the seventeenth-century reforms of Tsar Peter I created a new and self-conscious elite of learned men and specialists who challenged the traditional Russian social structure of estates.

The monumental figure of Sir Isaac Newton marks a watershed in the history of the scientific persona, as well as in the history of science *tout court*. *Patricia Fara* explored how Newton's reputation crystallized the figure of the natural philosopher over the last three centuries, drawing on a wide range of sources (including literary media and material culture) to show how Newton's conversion into a cultural figurehead depended on broader social shifts in attitudes towards science and genius. The late eighteenth and early nineteenth centuries were the critical period for the emergence of distinct (the scientist versus the philosopher) and increasingly differentiated (the theorist versus the experimentalist) identities among naturalists. Although novel, these identities were not created ex nihilo. Rather, they incorporated aspects of older personae (the sage, the saint, the scholar) and drew upon the habits and skills already cultivated in non-scientific contexts. Focusing on the production of scientific practitioners in the mathematico-physical seminar of the University of Königsberg, *Kathryn M. Olesko* investigated how ordinary life (including family) served as a cultural reservoir for the production of *der Wissenschaftler* in Biedermeier Germany, i.e. in the transitional era between the idiosyncratic Romantic genius to the mid-century outwardly objective, communitarian, displine-based, and formally-educated scientific practitioner. *H. Otto Sibum* studied how "the art of experiment", traditionally the province of artisans rather than scholars, became the core of a new scientific identity, the experimentalist, in the exact sciences during the late eighteenth and early nineteenth centuries. Here again the scientific persona assimilated abilities (e.g. manual techniques) and dispositions from other social categories. The process of differentiation within the scientific persona had driven a wedge between the humanist scholar and the natural scientist by the late nineteenth century. *Irmline Veit-Brause* traced the origins of the schism between C.P. Snow's "Two Cultures" to the institutional struggles over resources between the *Natur-* and *Kulturwissenschaften*, relying primarily on the career and correspondence of the German physiologist Emil du Bois-Reymond.

Once firmly established as a culturally recognized type, the scientific persona could be enlisted as a model for aspiring scientific disciplines. *Francesca Bordogna* contrasted images of the "ideal" scientist among American psychologists in the early twentieth century, interpreting these as attempts to reorder the rapidly changing field of psychology, in terms of both epistemological and political orientation. Closely intertwined with the scientific persona, especially after World

War II, was the "scientific expert". *Charles Thorpe* charted the emergence of the scientific expert, focusing on the career of the American physicist J. Robert Oppenheimer and the American atomic bomb project and its aftermath, and linking the emergence of experts to the institutional setting of large-scale bureaucracies. The study suggests that scientists have gained, in the post-war period, unprecedented power in the modern state. But, arguably, their role as experts has involved a dangerous narrowing of interest and authority. *Hélène Mialet's* study of the knowing subject "in the making" inquired into the contemporary category of the scientific genius, comparing the "organizationally bound genius" at an applied research laboratory with the "heroic genius" represented by the physicist Stephen Hawking. She sought to rehabilitate the role of the individual actor in the increasingly complex and collective process of scientific creativity.

In its year-long discussions and at the conference held on the topic (see below: Related Conference), the research group addressed fundamental issues concerning scientific personae: how do they emerge and develop in historical context, in what ways are they consolidated and transmitted, how do they shape the individuals who exemplify them, what purposes do they serve, and what is the relationship between knowledge and the persona of the knower? This last question was a central preoccupation. Although members of the research group necessarily drew upon representations of scientists (as characters in literature and film, subjects of portraiture, icons of popular culture), the presumption was that a scientific persona is more than a perception of who scientists are and what they do. It is also a reality that molds selves from within: sharpening the senses, training the hand, channeling attention, expanding or contracting the credible, fixing patterns of inference and argument, instilling an ethos. Personae create new ways of being in the world, modifying perception (the chemist's refined sense of smell), character (the patience and perseverance demanded by precision measurement), forms of inference and problem solving (the technocrat's pinpoint focus), and bodily demeanor (the dexterity of the experimenter). Hence the interaction between habitus (dispositions instilled by long practice, usually beginning with childhood instruction) and persona was a recurring theme in group discussions.

The research group's inquiry into the formation and function of scientific personae challenged the traditional epistemological separation between knowledge and the knower. Instead of assuming that the knower is a Cartesian ego, stripped of personality and body, the results of the research group pointed towards forms of knowledge that depended crucially on the cultivation of specific personal traits – the prodigious memory of the comparative linguist, the skilled hand of the experimentalist, the eye for the essentials of a mathematical modeler. These traits may be present to a greater or lesser degree in individuals, but it is the work of a persona to bind them together, to instill them by rigorous discipline, and to make them into the identifying marks of a collective. No specific individual ever fully incorporates the scientific persona, just as no individual biological organism ever fully incoporates the species or genus, but in the case of personae, individuals can be shaped by upbringing and training.

Related Conference

"Scientific Personae" (Max Planck Institute for the History of Science, 4–6 June 1999)

Organizers: *Lorraine Daston* and *H. Otto Sibum* (Max Planck Institute for the History of Science)
Speakers:
Gadi Algazi (University of Tel Aviv, Israel/Max Planck Institute for the History of Science): Scholars in Households: Refiguring the Learned Habitus, 1400–1600
James Bennett (Museum of the History of Science, Oxford, UK): Personae of Instrument Makers in the Eighteenth Century, and their Contradictions
Janet Browne (Wellcome Institute for the History of Medicine, London, UK): Darwin as Celebrity

Cathryn Carson (University of California at Berkeley, USA): What is a Scientist? Answers from Heisenberg's Audiences
William Clark (Cambridge University, UK): On the Apollonian Decadence of the Professorial Voice
Paula Findlen (Stanford University, USA): Becoming a Scientist: Gender and Knowledge in the Eighteenth Century
Nick Hopwood (Cambridge University, UK): Comrade Professor? Scientists and the Left
Myles W. Jackson (Willamette University, Salem, USA): The Savant versus the Handwerker in Nineteenth-Century Germany
Andrew Mendelsohn (Max Planck Institute for the History of Science,): The Scientist as Technocrat
Kathryn M. Olesko (Georgetown University, Washington D. C., USA): Assimilating the Everyday: Ordinary Life and the Production of Scientific Personae
Dominique Pestre (EHESS/CNRS, Paris, France): The French Savant (late XIXth Century-early XXth Century)
Silvan Schweber (Brandeis University, Waltham, USA): Homo Scientificus Americanus: Shaping New Roles and New Niches Under the Shadow of the Bomb
Anne Secord (Cambridge University, UK): "Be what you would seem to be": Samuel Smiles, Thomas Edward and the Making of a Working-Class Scientific Hero
Steven Shapin (University of California at San Diego, USA): Who is a Scientist? Notes Towards a Cultural History of the Scientist's Role
H. Otto Sibum (Max Planck Institute for the History of Science): Experimentalists in the Republic of Letters
Commentators:
Valentin Groebner (Universität Basel, Switzerland),
Karin Knorr-Cetina (Universität Bielefeld, Germany)
Thomas Söderqvist (Roskilde University, Denmark)

The Moral Authority of Nature (1999–2001)

Book Project: *Danielle Allen, Marie-Noëlle Bourguet, Joan Cadden, Arnold Davidson, Lorraine Daston, Fa-ti Fan, Eckhardt Fuchs, Valentin Groebner, Abigail Lustig, Gregg Mitman, Michelle Murphy, Katharine Park, Matthew Price, Robert Proctor, Helmut Puff, Robert Richards, Londa Schiebinger, Laura Slatkin, Julia Thomas, Fernando Vidal.* Affiliated: *Carrie Asman, René Sigrist, Emma Spary, Anke te Heesen, Till Wahnbaeck.*
The conflation of the natural with the normative has counted as a philosophical fallacy for centuries, if not for millennia: the oppositions of nomos *versus* physis, is *versus* ought, and nature *versus* culture all aim to drive a wedge between the inexorable facts of nature and the human values of ethics and art. This division is a principal feature of our metaphysical terrain. Yet the very frequency with which these oppositions must be invoked and insisted upon suggests that the naturalistic fallacy of inferring from "what is the case" to "what ought to be the case" is still a deeply rooted habit of thought and feeling. At least within the western tradition, it has proved robustly resistant to philosophical harangues, and to a metaphysics of airtight categories that would prevent any mingling of the natural and the normative. The moral authority of nature surfaces in the most diverse contexts, some ancient, some modern, and others almost futuristic: the reproach "unnatural mother" is as old as the legend of Medea, but the notion of "natural human rights" is the invention of the Enlightenment, and the "unnaturalness" of human clones is a moral spectre conjured up in tomorrow's newspaper. Appeals to the moral authority of nature are not restricted to popular culture: debates about nature as a standard for the good and the beautiful are also waged in science (e.g. in evolutionary theory) and law (e.g. in environmental regulations). If the naturalistic fallacy is indeed a fallacy, it is a remarkably widespread and persistent one, the resilience of which cries out for historical explanation.

In order to address this highly complex and still controversial topic within a comparative framework, both historical and cross-cultural, a working group of twenty scholars of diverse disciplines and nationalities was constituted in fall 1999. Their research topics embrace a broad range of historical cases, ranging chronologically from Antiquity to the twentieth century, and thematically from political theory to evolutionary biology to waste disposal. The group aims to produce a unified volume of essays on the topic, individually authored but conceptualized and revised in light of group discussions (editors: *Lorraine Daston* and *Fernando Vidal*). To this end three intensive meetings to discuss and revise drafts have been planned, the first of which took place at the Institute 13–25 September 1999; the two remaining meetings are scheduled for 19–30 June and 21–25 August 2000. Authors and topics are as follows:

Medieval personification of Nature – Confession of Nature to Genius, Roman de la Rose, London, Brit. Libr.MS Harley 4425, fol. 143

Danielle Allen (University of Chicago, USA): Mandeville's Fable of the Bees: Nature Metaphors and the Philosophy of Natural Laws and Natural Rights

Marie-Noëlle Bourguet (Université de Paris VII, France): The New Nature of the Scientific Voyages of Discovery (1700–1830)

Joan Cadden (University of California at Davis, USA): The Natural Philosophy and Ethics of Sexuality in Medieval Aristotelian Thought

**Lorraine Daston* (Max Planck Institute for the History of Science): Normative Habits of Observation and Explanation in Enlightenment Natural History

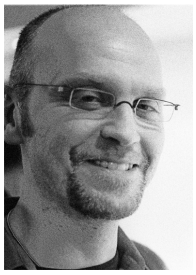
Arnold Davidson (University of Chicago, USA): Philosophical Reflections on the Natural and the Unnatural

**Fa-ti Fan* (Ph.D. University of Wisconsin at Madison, USA/Max Planck Institute for the History of Science): Nature and National Identity in China: Archaeology, Paleoanthropology, and Biogeography in the Early Twentieth Century

**Eckhardt Fuchs* (Ph.D. Universität Leipzig/Max Planck Institute for the History of Science): The Nature of Internationalism and the Internationalism of Nature: Science as Universal Norm and Social Institution (1800–1920)

Valentin Groebner (Universität Basel, Switzerland): Deciphering the Body, Reading the Face: Arts of Identification (1450–1700)

**Abigail Lustig* (Ph.D. University of California at Berkeley/Max Planck Institute for the History of Science): Altruism, Biology, and Society



Helmut Puff

Londa Schiebinger

Gregg Mitman (University of Oklahoma at Norman, USA): Breathing Space: A History of Asthma and the Environment
**Michelle Murphy* (Ph.D. Harvard University, USA/ Max Planck Institute for the History of Science): Producing "Nature" and Seizing Reproduction in the Women's Health Movement (1970–89)
Katharine Park (Harvard University, USA): Nature's Secrets: Personifications of the Natural Order (1150–1620)
**Matthew Price* (Ph.D. Stanford University, USA/Max Planck Institute for the History of Science): Other People's Garbage: Nature and Culture in the Category of Trash
**Robert Proctor* (Pennsylvania State University, USA): The Political History of Agates
**Helmut Puff* (University of Michigan at Ann Arbor, USA): Sodomy and the Law Courts in Late Medieval Northern Europe
**Robert Richards* (University of Chicago, USA): Romanticism and Nineteenth-Century Biology
**Londa Schiebinger* (Pennsylvania State University, USA): Gender in the Voyages of Scientific Discovery
Laura Slatkin (University of Chicago, USA): Nature and Justice in Hesiod
Julia Thomas (University of Wisconsin at Madison, USA) Ideals of Nature in Japanese Nationalism
**Fernando Vidal* (Harvard University, USA): The Naturalized Sciences of Man in the Eighteenth Century
A two-year program of colloquia and related conferences accompanies the book project, involving some members of the working group (designated by *) resident for longer periods at the Institute and affiliated scholars, as well as the other Research Scholars and Visiting Scholars in Department II.

Concomitant with the project on "The Moral Authority of Nature", *Lorraine Daston*, *Sophie Roux*, and *Friedrich Steinle* have continued and enlarged their working group on "Natural Law in Early Modern Europe" (see "Demonstration-Test-Proof", see p. 34). The remarkable spread of natural law terminology to describe both regularities in the natural realm (e.g. the laws of collision in mechanics) and rights and duties in the legal realm (e.g. the natural law of human equality) is one of the most striking parallels between conceptual developments in the moral and natural sciences. The temporal coincidence of this parallel with the expansion of the moral authority of nature – in every sphere from pedagogy to weights and measurements –, an authority often grounded on appeals to natural law, is highly suggestive. However, historians of science and historians of law have yet to investigate this coincidence, its causes and consequences, closely. Following up on the conference "Natur-Gesetz-Naturgesetz" (see below: Related Conferences), a group of historians of early modern science and law met at the Max Planck Institute for the History of Science to plan a further collaboration, with the ultimate goal of a publication.

The discussions of the group to date have revolved around three major themes: the type of order defined by natural laws, and its alternatives; the role of the natural laws in the legitimation of divine and worldly authority; and the epistemology of natural laws.
What kinds of order? The concepts and vocabulary of order during the 16th–18th centuries were both diversified and differentiated: jurists, physicians, natural philosophers, mixed mathematicians (including astronomers), and theologians had all developed elaborate ways of understanding and talking about the divine, human, and natural orders, and exceptions thereto. These orders sometimes overlapped (e.g. theology and natural philosophy), but they also specialized and diverged (e.g. with respect to how they classified and dealt with anomalies). Moreover, the kind of order – its origins, jurisdiction, authority, intelligibility, and structure – invoked by the learned disciplines in theory and practice varied considerably: in natural philosophy, for example, the order of nature's habits differed significantly from that of nature's laws. There exists no synthetic treatment of these kinds of orders in the historical literature, no doubt because of the quantity and variety of the sources involved. But even within specific disciplines (e.g. history of early modern natural philosophy and mixed mathematics) there is very little literature on the subject. Some such

synthetic overview would be a precondition for answering further questions concerning interactions among disciplines such as law, medicine, and natural philosophy, as well as for understanding what is distinctive about an order of laws (both in the natural in human realms) in particular. Although there seems to be an inflationary tendency (at least in English natural philosophy) in the late 17th c. to apply the vocabulary of "natural laws" to almost any natural regularity, its uses in the early 17th c. appear to have been restricted in both jurisprudence and natural philosophy to fundamental principles, from which the whole system could be derived – presumably mimicking the activity of the Divine Legislator. This legislative model raises obvious questions about parallels with models for ideal legislation among early modern political theorists, as well as actual practices of centralizing governments that sought to "rationalize" customary law.

Medieval personification of Nature at her forge. Roman de la Rose, Piermont Morgan Library Glazier 32, New York

What role do natural laws play in legitimation? In recent historiography of both early modern science and law the rise of natural law systems is often associated with a "crisis of legitimation" in a period of religious and civil strife. Appeals to natural law (so runs the story) replace appeals to tradition as the bedrock of justification for religion (natural theology), the state, and of course natural philosophy. Even if this story turns out to be true in its broad outlines, it begs an important question: how did nature become the kind of entity that could wield such authority? Nature's authority in medieval texts is circumscribed, centering on matters of the family, reproduction, and sexuality, with occasional extensions to heresy (as *contra naturam*, like sodomy). Moreover, the nature of the 16th and 17th centuries (and even 18th, if one thinks of Montesquieu) was often conceived as Hippocratic, i.e. as consisting of a patchwork of local climates and topographies that produced equally distinctive customs, complexions, and polities. Universal nature existed as a precept only in specific scientific contexts (e.g. rational mechanics); universal human nature was also debatable. Hence to claim that nature could serve as a legitimating force because it was universal begs two further questions: (1) how did nature come to be conceived of as universal, despite manifest evidence of variability? and (2) why should the universal carry authority? Beyond these specific questions is the more general (and as yet vaguely formulated) question about the practices of legitimation: how in fact were conflicts between authorities and insurgents resolved within a framework of natural law? There is for example considerable evidence that Newton, Richard Bentley, John Wilkins, and other Latitudinarians within the early Royal Society actively sought to make the new natural philosophy a cornerstone of a certain kind of religion and polity, but how (aside from the Boyle Lectures) did they put precept into practice?

How do we come to know natural laws, and how certain is that knowledge? Two epistemological models appear to have governed knowledge of natural law in early modern natural philosophy. On the one hand, the theology of divine voluntarism stressed God's inscrutable fiat: since divine will is absolutely free, the only way to discover natural laws is through empirical inquiry (the position of Robert Boyle and Samuel Clarke). On the other hand, rationalist appeals to the "light of nature" claimed to discover natural laws in the same way as mathematical truths, by the inspection of self-evident intuitions (the position of Descartes and Leibniz). Corresponding positions can be found among natural law jurists (e.g. Grotius), who contrasted what might be called empiricist (on the basis of anthropological universals) and rationalist (on the basis of irrefragable intuitions) methods of discovering natural laws. Epistemological positions on how natural laws come to be known implied differing stances on the certainty of that knowledge, rationalists arguing for certitude and empiricists for probabilism.

Meetings of the group to exchange and discuss first and second drafts of essays are planned for February 2001 (Berlin) and September 2001 (Oxford). Members of the Natural Law Group are as follows:
Jean-Robert Armogathe (EHESS, Paris, France)
Michel Blay (École Normale Supèrieure, Lyon, France)
Lorraine Daston (Max Planck Institute for the History of Science)
Gerd Graßhoff (Universität Bern, Switzerland)
Sachiko Kusukawa (University of Cambridge, UK)
Catherine Larrère (Université de Bordeaux, France)
Ian W. F. Maclean (University of Oxford, UK)
Sophie Roux (Centre Alexandre Koyré, Paris, France)
Jan Schröder (Universität Tübingen, Germany)
Friedrich Steinle (Max Planck Institute for the History of Science)
Michael Stolleis (Max Planck Institute for European Legal History, Frankfurt/Main, Germany)
Hubert Treiber (Universität Hannover, Germany)
Catherine Wilson (University of British Columbia at Vancouver, Canada)

Related workshops and conferences:

"Natur-Gesetz-Naturgesetz" (Bad Homburg, 20–23 October 1999)

Organizers: *Lorraine Daston* (Max Planck Institute for the History of Science), *Helge Ritter* (Universität Bielefeld), *Michael Stolleis* (Max Planck Institute for European Legal History, Frankfurt/Main)
Speakers for "Naturgesetz" Session:
Lorraine Daston (Max Planck Institute for the History of Science): Credibility and the Marvelous in Early Modern Natural Philosophy
Gerd Graßhoff (Universität Bern, Switzerland): Natural Law, Divine Creation and Regularities in Heaven: Natural Laws in the Copernican Revolution
Catherine Larrère (Université de Bordeaux, France): Loi commandement et loi rapport: le problème de la loi naturelle chez Montesquieu et ses antécédents dans la philosophie morale et la philosophie naturelle
Ian W. F. Maclean (University of Oxford, UK): Evidence, Logic, the Rule and the Exception in Renaissance Law and Medicine
Sophie Roux (Centre Alexandre Koyré, Paris, France): Les lois de la nature au XVIIe siecle: idee, concept, metaphore, polemique
Friedrich Steinle (Max Planck Institute for the History of Science): From a-priori Insights to Empirical Regularities: The Concept of Laws of Nature and its Alternatives in the Early Royal Society

Commentators for "Naturgesetz" Session:
Michel Blay (Ecole Normale Supèrieure, Lyon, France)
Catherine Wilson (University of British Columbia at Vancouver, Canada)

"Historical Perspectives on Anthropomorphism in the Sciences" (Max Planck Institute for the History of Science, 11–12 May 2001)

Organizers: *Lorraine Daston* (Max Planck Institute for the History of Science) and *Gregg Mitman* (University of Oklahoma at Norman, USA)

Since the emergence of modern science in the seventeenth century, anthropomorphism has been a methodological tabu. Nowhere has this tabu been more hotly debated than in the sciences of animal behavior. This workshop seeks to illuminate contemporary controversies on the scientific, political, and artistic (e.g. nature films) uses of anthropomorphism by situating them within a broader historical and philosophical context.

"Moralizing Nature, 1600–1750" (Max Planck Institute for the History of Science, 1–2 June 2001)

Organizers: *Lorraine Daston* (Max Planck Institute for the History of Science) and *Peter Reill* (University of California at Los Angeles, USA)

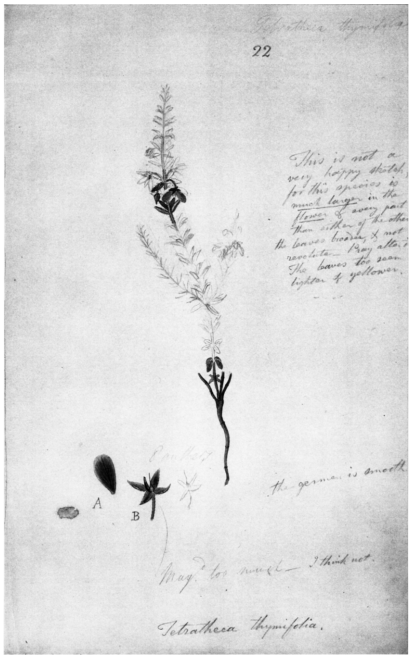
Early modern Europe witnessed a vast expansion of the authority of nature, especially in the domains of jurisprudence, theology, and political theory, but also within the arts. Appeals to "nature" became the bedrock of justification for religion (e.g. physico-theology), governments (e.g. social contracts deriving from a state of nature), and legislation (e.g. the natural rights of man). This conference explores the causes and dimensions of nature's new authority in the seventeenth and early eighteenth centuries, in conjunction with the rising prestige of natural philosophy and natural history. A follow-up conference on the period 1750–1830 is planned for December 2001, to be held at the Clark Library in Los Angeles.

History of Scientific Objectivity (1995–)

Lorraine Daston, Wolfgang Küttler, Annette Vogt
This ongoing project seeks to reconstruct the ideals and practices of scientific objectivity in historical context. The premise of the project is that scientific objectivity has a history, and a relatively short one, emerging in the middle decades of the nineteenth century. The history of the word "objectivity" is suggestive in this context. Its cognates in European languages derive from the Latin adverbial or adjectival form *objectivus*/*objective*, introduced by fourteenth-century scholastic philosophers such as Duns Scotus and William of Occam. (The substantive form does not emerge until much later, around the turn of the nineteenth century.) From the very beginning, it was always paired with *subjectivus*/ *subjective*, but the terms originally meant almost precisely the opposite of what they mean now. "Objective" referred to things as they are presented to consciousness, whereas "subjective" referred to things in themselves. The words "objective" and "subjective" fell into disuse during the seventeenth and eighteenth centuries, invoked only occasionally as technical terms by metaphysicians and logicians. It was Kant who dusted off the musty scholastic terminology of "objective" and "subjective", and breathed new life and new meanings into them. Only in the 1820s and 1830s did dictionary entries first in German, then in French, and later in English begin to define the words "objectivity" and "subjectivity" in something like the (to us) familiar sense, often with a nod in the direction of Kantian philosophy.

Current usage in several European languages packs a crowd of meanings – moral meanings, methodological meanings, metaphysical meanings – into the word "objectivity" and its various cognates. Viewed in its specific contexts of usage, objectivity is a complex and not wholly coherent

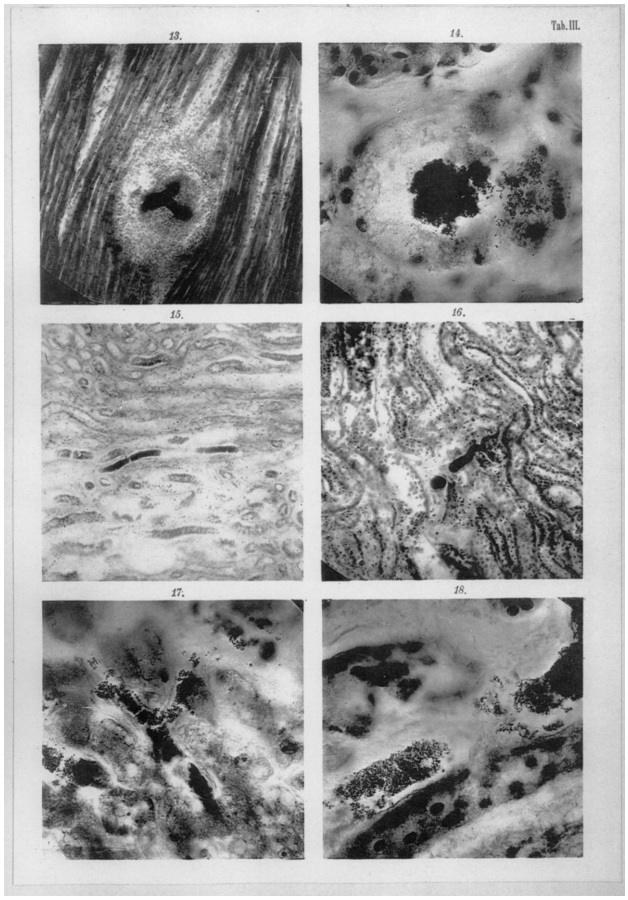
concept. However, viewed from a level of high generality, these multiple meanings of objectivity do converge in a common sense: all forms of objectivity seek to combat some aspect of the self, as not only subjective but as dangerously subjective. This is why objectivity and subjectivity are, since Kant, an inseparable pair, like concave and convex, each defining the other. Epistemology – the philosophical diagnosis of possible obstacles to knowledge – is older and broader than objectivity. Objectivity arises from the fear that certain facets of the self pose the greatest threat to knowledge. But in the long philosophical tradition of epistemology, this is only one of many fears about how we can fail to achieve knowledge. Scientific objectivity occupies such a central and commanding place in our modern catechism of epistemological virtues that it threatens to swallow up all other aims that might guide scientific inquiry. But the quest for scientific objectivity is not necessarily or even historically identical to the quest for truth or certainty or explanatory breadth or mathematical deep structures in the understanding of nature. Sometimes scientific objectivity coincides with these other epistemological virtues, but sometimes it conflicts with them: that is, it is possible to imagine (and to instantiate historically) concrete cases in which scientists may be forced to choose between, for example, a commitment to truth and a commitment to objectivity.



Botanical illustration by James Sowerby:
Tetratheca Thymfolia
(London Natural History Museum)

These conflicts among epistemological virtues – truth, certainty, objectivity, precision – can be seen most clearly in the specifics of quotidian scientific practice. *Lorraine Daston* investigated how the values of truth, beauty, and objectivity guided scientific image-making in the eighteenth and nineteenth centuries, particularly in botany and anatomy – sciences which owed great advances to illustration in the early modern period, and whose subject matter had long been objects of aesthetic contemplation in the fine and decorative arts. Among eighteenth-century scientific illustrators, four factors converged to harmonize the values of truth and beauty with one another: first, the pedagogy of drawing; second, the ornamental and artistic deployment of certain images, especially those of flowers and the human body; third, the characteristics and conventions of the various media (watercolor, gouache, pastels, etc.) and reproductive techniques (engraving, etching, lithography, etc.; and fourth, the imperative to represent types rather than individual natural objects. The image “drawn from nature” bore the imprint of draughtsmanship drills, aesthetic values, and the characteristic optic of its reproduction technique. Until the mid-nineteenth century, it also quite proudly and explicitly represented the naturalist’s conception of the object. For

the naturalist, this conception was as distinct from the phantoms of the imagination as it was from the bald appearance of the individual object at hand. The trained eye winnowed the essential from the accidental, the normal from the pathological, the typical from the anomalous, the variable from the constant. Eighteenth- and early nineteenth-century naturalists sought to condense and integrate a legion of individual impressions into a “true” representation, in both words and images, of the natural kind in question.

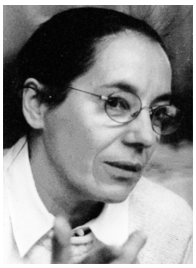


Endocarditis ulcerosa, 100 x magnification. photolithograph from Robert Koch, „Zur Untersuchung von pathogenen Organismen,“ Mittheilungen aus dem Kaiserlichen Gesundheitsamte 1 (1884): 1-48, Table III, Fig. 13

The advent of photography did not immediately challenge the alliance of truth and beauty that merged scientific illustration with the certain artistic genres, such as the still life. Scientists in the 1820s and 1830s were quick to remark upon the potential of the new invention for scientific illustration – but they often underscored its importance for art as well. The initial grounds for enthusiasm over photography as both a scientific and an artistic medium were similar, namely the possibility of capturing each and every minute detail almost effortlessly. Only in the 1840s–50s another discourse concerning the advantages of photography for scientific illustration emerged alongside the argument from minute detail: the argument from objectivity. The argument from detail had extended the accomplishments of the human artist to superhuman levels; in contrast, the argument from objectivity broke entirely with aesthetics and artistry. The new regime of objectivity drove a wedge between truth and beauty in scientific illustration, and between the personae of the scientist and the artist. These new oppositions pivoted around the fulcrum of the will. Subjective art invited, even demanded the externalized exercise of the will, actively molding matter and form to conform to the artist’s conception. For scientists, in contrast, the objective was all that resisted the external exercise of will; conversely, many of their worries about the possible interven-

tions of subjectivity centered upon the intrusions of the "arbitrary" or the "willful" into observation and representation.

The problem of variability in images haunted naturalists who pursued truth and beauty as much as it did their successors dedicated to objectivity. But different epistemic ideals made for different diagnoses of the sources of variability. Naturalists of the earlier period located variability in the objects themselves – in the accidental, the singular, the monstrous. Later naturalists shifted the source of variability inward, to the multiple subjective viewpoints that shattered a single object into a kaleidoscope of images. Hence the deliberate and open exercise of will on the part of the earlier naturalists, who selected and shaped both their objects and their illustrators, in contrast to the clenched self-restraint of the later naturalists, who turned the will inwards and who vainly hoped that through photographs, nature would illustrate itself.



Annette Vogt

The element of the personal in science may also be expressed in terms of the personal characteristics of scientists. "Impersonality", or blindness to individual traits such as nationality, religion, race, or sex is a scientific ideal closely allied to that of objectivity. *Annette Vogt's* comprehensive survey of women scientists at the Berlin University and the institutes of the Kaiser-Wilhelm-Gesellschaft (1898–1945) sought to answer the question of how the ideals and practices of early twentieth-century scientific research, particularly those of objectivity, promoted the recruitment and participation of women in surprisingly large numbers, as she was able to establish through archival research in the records of the Berlin University, the Max-Planck-Gesellschaft (successor to the Kaiser-Wilhelm-Gesellschaft), and the Academic Assistance Council (Oxford). She also studied how many women were expelled from laboratories after 1933, and their subsequent careers both in Germany and in exile.

Lise Meitner (1878–1968), Physicist, head of the physical department in the KWI for Chemistry, 1914-1938, first women Scientific Member in the KWG; Scientific Member in the MPG

Isolde Hausser (1889–1951), Physicist, head of the "Hausser-department" in the Institute for Physics in the KWI for Medical research in Heidelberg, Scientific Member, 1938–1951

Cécile Vogt (1875–1962), Neuroscientist, head of the department of neuroanatomy and architectonics in the KWI for Brain research, Scientific Member, 1919–1945

She was able to locate at least 239 women scientists employed by the Kaiser-Wilhelm-Gesellschaft, and to establish that women headed at least twelve departments in the institutes of the KWG. She is currently engaged in a reconstruction of the scientific careers of these dozen department heads, as well as those of women visiting scientists to the institutes. Documentation of women completing doctorates and habilitations at the Berlin University continued, and was partially incorporated into an exhibition at the Humboldt Universität Berlin on "Von der Ausnahme zur Alltäglichkeit. Frauen an der Universität Unter den Linden" (1 December 1999 – 13 January

2000). Further research will attempt to expand the study from biographies of individual women scientists to a prosopography revealing their intellectual and social backgrounds, and to investigate the culture of gender relations at Berlin's foremost scientific institutions during the first half of the twentieth century.

Wolfgang Küttler

Objectivity's flight from the personal is often expressed as an escape from perspective, as a "view from nowhere". This description has created special methodological tensions within the human sciences, insofar as they are simultaneously committed to objectivity and perspectivity. *Wolfgang Küttler's* monograph on the relation between perspectivity, objectivity, and historicity in the work of Max Weber explores this tension in three contexts: first, practical life in relation to the sciences; second, the subject matter of the historical sciences of culture and society; and third, the functions of science in modern society.

Weber's own methodology, as well as keen appreciation of the historical impact of modern science, prompted his investigations of the historical development and current state of science. Famously, he held science to be a historical and cultural activity centrally implicated in the processes of rationalization and disenchantment that formed the modern world. The implications of Weber's historical and philosophical inquiries into the nature of modern science were wide-ranging, including the recovery of the unity of scientific and cultural knowledge, the problem of the relationship between history and scientific progress, the interaction of science and value-formation in a "disenchanted" world, and the chances for objectivity in a value-dominated society.

Other research activities of the department's research scholars

Matthias Dörries: Book on "The Future of Science in Nineteenth-century France (1830–1871)": This book reconstructs the conflicting visions of what the future of science would look like at a time when for the first time science and technology were transforming French society to such an extent that change was no longer located in a distant future, but actually experienced within a single generation. "Speaking in tongues: Studies in science and language" is an edition of several articles – linking human and natural sciences – that explore how natural philosophers and scientists have found analogies to language and the development of languages fruitful in their scientific work (see p. 131).

Anke te Heesen: Research on the history of natural history cabinets in the eighteenth century, including an edited volume on e the relationship between the history of collecting and the history of science (see pp. 44, 54).

Antoinette Roesler-Friedenthal: Project on the relations between art history and art commerce in its widest sense. The study examines the development of the academic discipline of art history and its distinctive methods in interaction with socio-economic factors, including the art market, connoisseurship, and the literary genre of the collection catalogue (see pp. 131, 54).

Sophie Roux: Project on Descartes and Cartesianism in the seventeenth century, with special attention to the contexts of the science of mechanics, corpuscularian theories of matter, and different conceptions of physics in the early modern period (see pp. 32, 48).

Friedrich Steinle: Habilitation on "Der Einstieg in ein neues Feld: Forschungspraxis im frühen Elektromagnetismus bei Ampère und Faraday" (Technische Universität, Berlin) a study of early nineteenth-century electromagnetism, focusing on the early researches of André-Marie Ampère and of Michael Faraday with the aim of enriching the philosophy of experiment with detailed historical materials (see pp. 32, 48).

Planned Project

M. Norton Wise

The Common Languages of Art and Science (2001–03)

Organizers: *Lorraine Daston* (Max Planck Institute for the History of Science) and *M. Norton Wise* (Princeton University, USA)
Preparation: *Antoinette Roesler-Friedenthal, Anke te Heesen*

Related Workshop:

"What's in a Line: Drawing as Intelligence and Intelligibility"
(Max Planck Institute for the History of Science, 18–19 December 2000)

Antoinette Roesler-Friedenthal

Organizers: *Lorraine Daston* (Max Planck Institute for the History of Science), *H. Otto Sibum* (Max Planck Institute for the History of Science), *M. Norton Wise* (Princeton University, USA).

Drawing in science is at once ubiquitous and invisible. Scientific manuscripts and texts abound with sketches, diagrams, engravings, lithographs, and other products of the draughtsman's pen. Yet the process and purposes of drawing in science have only sporadically attracted the attention of historians. Historians of art have occasionally studied scientific illustrations, particularly in works of natural history, but have rarely shown interest in the significance of drawing per se for the working scientist. Historians of architecture and engineering treat drawings that depict buildings, bridges, machines, and other constructions as an important source, but until recently, these sorts of drawings were segregated from both scientific and artistic drawings under the rubric "technical". The aim of this workshop is to examine the phenomenon of drawing in science within a broader context that embraces artistic and technical drawing as well, focusing on the period ca. 1750–1850, and addressing two themes: the intelligibility of drawings and the form of intelligence drawing presupposes and cultivates.