

Research Report 2018–2020

**MAX PLANCK INSTITUTE
FOR THE HISTORY OF SCIENCE**



"Emergence": This illustration by James O'Brien symbolically depicts the concept of emergence, the appearance of novel and complex behavior arising from the interaction of simple and fundamental components. The rise of complexity out of simplicity is depicted here by the contrasting red explosion of planets, moons, and stars, emerging from a blue sea of molecules, atoms, and other fundamental particles. Illustration © 2021 James O'Brien

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FOR THE HISTORY OF SCIENCE**

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Introduction

The thirteenth research report of the Max Planck Institute for the History of Science (MPIWG) presents the main outcomes of the Institute's research during the years 2018 to 2020. Since its foundation in 1994, the Institute has become a truly international institution where researchers, guests, and visitors convene to debate innovative and fundamental questions of the historical development of science, technology, and medicine. Its brand is historical epistemology. By continuously organizing new projects and refining and innovating its methods, the Institute has established itself as a well-respected and leading site for historical research, well integrated into the wider academic communities interested in the history and sociology of knowledge—not only in Berlin, Germany, and Europe but also globally.

The report covers three years, during which the Institute witnessed the arrival of many researchers initializing new projects, and the departure of their predecessors to follow rising career paths. A new structure has been chosen for the report focusing on the chief lines of research at the Institute. It presents main activities and scientific outputs conducted during the reporting period in their wider context, while also elucidating links between the various units. With this new format, we intend to show that history, sociology, anthropology, and the sciences themselves stand to benefit from joining forces. Together, they can reach an in-depth understanding of knowledge dynamics and address some of the burning issues facing society today. Among these are the challenges of the climate crisis and the Anthropocene, rising inequalities, polarization in societies, massive changes in science and society wrought by digitalization, and health issues, including those related to the current pandemic.

During the evaluation period, research at the MPIWG, in its full breadth, reached this goal in new ways. Dedicated to studying the historical development of practices and categories of knowledge, the Institute is directly positioned to illuminate the role that science plays in current debates. In revealing how practices and fields of science have been embedded within cultural contexts, its research sheds light on how these debates are being framed and carried out, and on how policy decisions are being made. Moreover, the challenges posed to scientific research by today's crises spurred the Institute to respond by deepening its commitment to collaboration across disciplines. The aim is to more robustly rethink the structural premises of research into the historical dimensions of science, in order to better understand scientific fields crucial to our present. Department I made new insights into the history of industrial practices, resource management, and the *longue-durée* changes of the Anthropocene. Department II concluded investigations on data and rules. Department III dedicated

its attention to historical inequalities of owning knowledge and the way animals have been used as materials and subjects of science.

A constituent element of the national and international role of the MPIWG within debates on science, knowledge, and history is its attractiveness for junior researchers. The three independent Research Groups hosted in the evaluation period played a large part in expanding the agendas of the historiography of science. In “Epistemes of Modern Acoustics,” Viktoria Tkaczyk successfully concluded her research program on the history of sound. In “Experience in the Premodern Sciences of Soul and Body ca. 800–1650,” Katja Krause unpacked the global role of experience in early modern times. In the Research Group “Historical Epistemology of the Final Theory Program” under the leadership of Alexander Blum, an interdisciplinary collaboration with the Albert Einstein Institute (Potsdam), researchers explored a broad focus ranging from nonempirical to mathematical and antireductionist physics. Furthermore, the Institute became home to a Lise Meitner Research Group in 2020, “China in the Global System of Science.” This format was created by the Max Planck Society to attract excellent female researchers. Led by Anna Lisa Ahlers, the Group focuses on the societal environment and the social dynamics of science and scholarship in twenty-first century China and beyond.

Projects such as the History of the Max Planck Society, the ongoing engagement of the two emeritus directors, Hans-Jörg Rheinberger and Lorraine Daston, our external scientific member Glenn W. Most, and Max Planck Fellow Gerd Graßhoff have made substantial contributions to the research profile of the MPIWG and have helped to forge links between different approaches. Moreover, within the reporting period the MPIWG was able to bring on board Sophia Roosth in the framework of the Max Planck Sabbatical Award. The Max Planck Sabbatical Award offers scientists the opportunity to explore the possibilities of working at a research institute and to cooperate closely with the MPIWG over two years.

In 2020, the Institute defined “knowledge” in a more comprehensive sense as the core topic in furthering its fruitful collaboration with three Berlin universities (the Technische Universität Berlin, the Freie Universität Berlin, and the Humboldt-Universität zu Berlin under the auspices of the Berlin Center for the History of Knowledge). Together, these four institutions applied successfully to establish an International Max Planck Research School (IMPRS) on “Knowledge and Its Resources: Historical Reciprocities.” Among the epistemic resources to be analyzed, we have highlighted ones that impact substantially upon the creation, maintenance, and advancement of knowledge and its reciprocal effects on human culture. These range from raw materials, artifacts, material objects, and instruments to human skills, ideas, and practices, and to personal networks and large-scale technological infrastructures. Starting in 2022, the IMPRS “Knowledge and Its Resources” will focus on disentangling interrelationships between knowledge production and its resources from a long-term perspective that expressly affords a sensitivity to and appreciation of local and global specificities.

This new international training center has the goal of educating a new generation of globally informed historians of science, and it will further strengthen the strong embedding of the MPIWG in the Berlin community and both nationally and internationally. This is reflected in the growing community and network around the MPIWG, which gathered on site on May 17, 2019, for its twenty-fifth anniversary, in a celebra-

tion including video statements and greetings from around the world that were documented on the Institute's website; and then again on June 21, 2019, on the occasion of the retirement of Lorraine Daston as director of Department II—at a time when the opportunity to organize and attend a large gathering was still being taken for granted.

As the pandemic unfolded in 2020, researchers—and engaged staff—stood together and stood up for their community and its interest in the history of science. The Institute's long experience in virtual formats and its interest in reorganizing sources with new digital tools facilitated this technical shift and allowed an almost seamless transition. We are both proud and grateful to have been able to operate continuously. Among the many highlights of this period was a series of video statements, **History of Science on Call: Listening, Attending, Acting**. Aggregating two streams of information—research and education—this initiative highlighted how actors in crisis have historically assessed the role of knowledge in significantly different ways, thus providing an important resource for the role of science in our modern society. Indeed, exchange via electronic media has taken on a new role during the pandemic, both for collaboration and public communication. An example is the organization of a physical and virtual exhibition by Department I, *Leonardo's Intellectual Cosmos*, in collaboration with the Staatsbibliothek zu Berlin and the Museo Galileo in Florence, which attracted much attention despite the constraints of the pandemic.

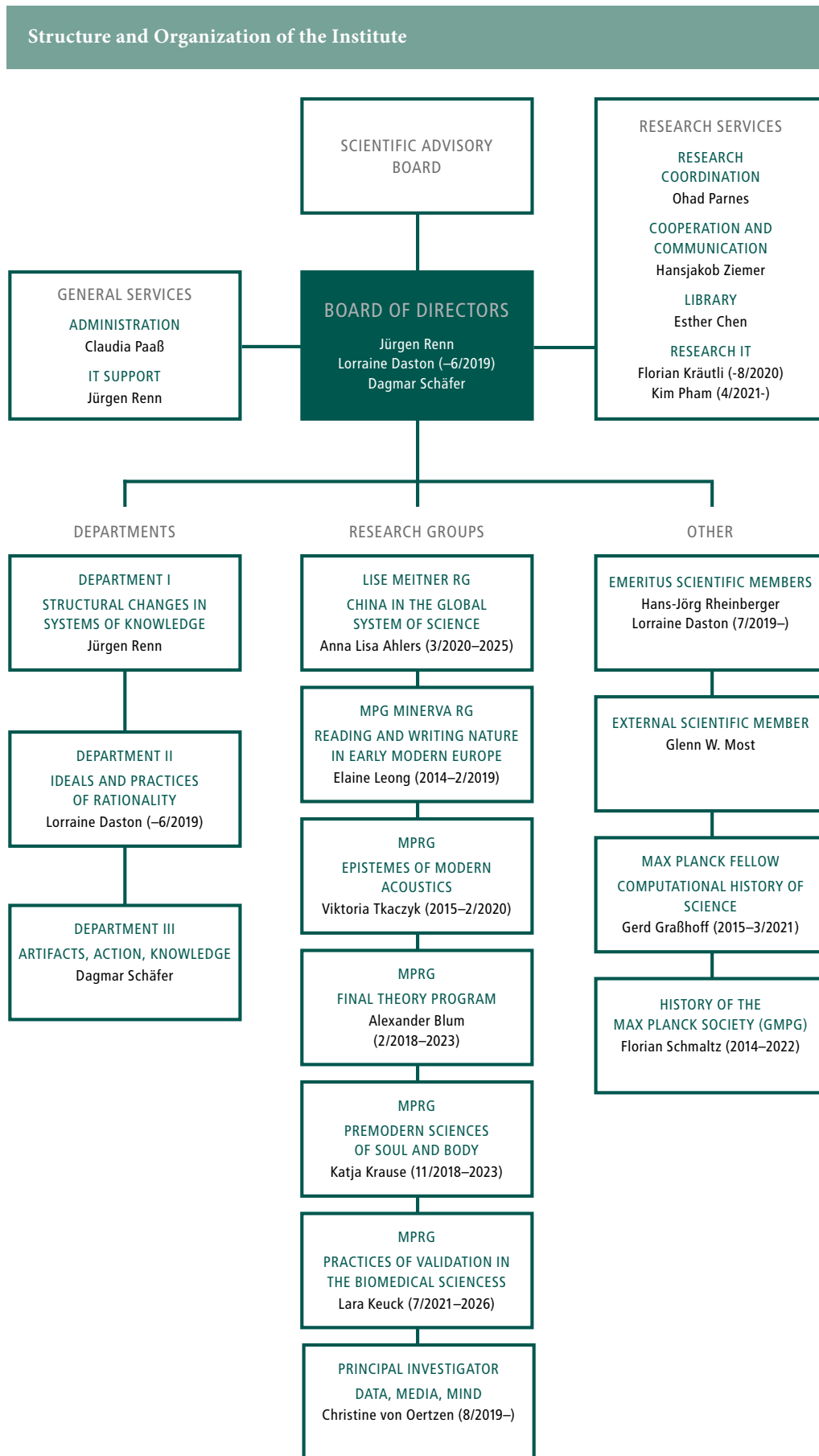
Such initiatives on present and past themes show how the Institute has used both the need to adjust to the current practical circumstances and the urge for digitization as opportunities to expand our audience. The Institute continues to be a place for reflected dialogue about the role of science in the past and present, especially given recent attempts to question the trust placed in science. It provides solid structures and collaborative work environments allowing new projects to emerge and its varied initiatives to thrive. The result is interdisciplinary research that is both at the leading edge and nexus of a global intellectual community.

<https://www.mpiwg-berlin.mpg.de/research/projects/history-science-on-call>



<https://www.mpiwg-berlin.mpg.de/research/exhibition/leonardos-intellectual-cosmos-2021>





Department I

Structural Changes in Systems of Knowledge

DIRECTOR Jürgen Renn



Structural Changes in Systems of Knowledge

Introduction

Department I continues to pursue its long-standing tradition of research on structural changes of systems of knowledge, taking into account the mental, material, and social dimensions of knowledge systems. Following a trajectory initiated almost a decade ago, in the period covered by this report the focus of research of Department I has shifted even more toward questions of the role of science and technology for the dynamics shaping the Anthropocene, the epoch of Earth history marked by the planetary impact of humanity. Science and technology have played a key role in how humanity has become a geological force. They are quintessential to the functioning of the technosphere: the human-created fabric of industrial technologies, infrastructures, social institutions, and powers that has grown out of earlier forms of human “niche construction,” and that now functions on a magnitude equivalent to that of the natural Earth spheres, such as the biosphere or hydrosphere, and increasingly interacts with them. We cannot understand the escalating step changes of human civilization and sociocultural evolution unless we understand the interlaced dynamics of technological and scientific developments and the way they have profoundly impacted the relationship between humans and the global environment.

When and how did science and technology begin to play their role as drivers of the Anthropocene? When did the technosphere historically come into being? How did societal structures and knowledge systems interact under different historical and cultural circumstances, and which historical processes have amplified the planetary impact of science? When and how did the economy of knowledge become entangled with the material economy to give rise to the self-reinforcing dynamics fueling the technosphere? These are some of the key questions concerning a history of the science for the Anthropocene. The historical dynamics of the Anthropocene, however, can hardly be understood without expanding the history of science to a history of knowledge—pioneered by the Department in the past decades—nor without taking into account long-term development processes and global history, which have been at the center of our research since the founding of the Institute.

In pursuing our questions, we have developed and used innovative methods of investigation. Intercultural comparison, global history, longitudinal studies, and the most advanced tools of the computational humanities have long been among the methodological arsenal of the Department. More recently, members of the Department have pioneered novel, computer-assisted approaches to historical network analysis, open-

Early modern organization of knowledge mirrored in the library system of the University Library of Leiden in 1610. On the left: *mathematici, philosophi, literatores, and theologi*. On the right: *historici, medici, and iurisconsulti*. Engraving by Woudanus in *Stedeböck der Nederlanden* (Amsterdam: Willem Blaeu, 1649). Public domain.

ing up entirely new perspectives on the combination of interpretative historical studies and quantitative data analysis. Research endeavors in the Department operate at the forefront of machine learning and its employment for historical investigations.

Cooperation

Most of the Department's research projects are pursued in the context of wide-ranging international cooperation, not only within the history of science community, but also with scholars and institutions from fields ranging from archeology, various disciplines of history and philology, via computer science, mathematics, and the Earth sciences, to cultural anthropology, human geography, and media studies. Some of our projects are supported by external funding, for example, the CRC "Episteme in Motion" at the Freie Universität Berlin (DFG), or the exhibition project "Leonardo's Intellectual Cosmos" (NOMIS Foundation). Others are pursued in the context of or as contributions to larger research endeavors, such as the project on the history of the Max Planck Society. To secure the outcomes of its digital projects, the Department is involved in major European endeavors to create a European infrastructure for the arts and humanities (DARIAH-EU) and is participating in the creation of consortia (NFDI4Objects) for the national research data infrastructure NFDI. For all activities related to the Anthropocene, the Haus der Kulturen der Welt (HKW) in Berlin has been a crucial cooperation partner.

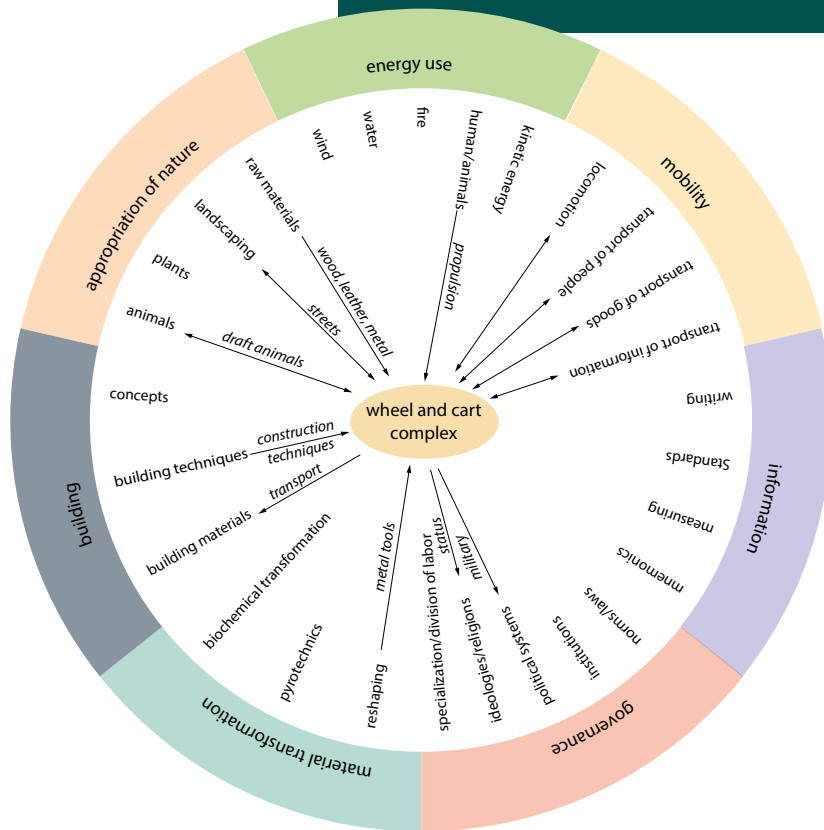
The challenge of the Anthropocene for the history of science lies not only in new questions, topics, and methodological approaches. The history of science also gains new opportunities to use its insights and reflective potential to develop innovative knowledge economies, in particular with a view to a possible reorientation of the current knowledge economy away from increasingly specialized, fragmented knowledge production and toward one with greater global responsibility and more reflection, emphasizing local perspectives and historical contexts. In the period covered by this report, we have continued to test such new forms of cooperative knowledge production together with the Haus der Kulturen der Welt in Berlin within the framework of the joint platform "Anthropocene Curriculum." This platform serves as a laboratory for exploring new forms of research and education, involving a great number of international scientists and artists, and has meanwhile become a global undertaking with numerous spin-off projects around the world.

The following report follows a roughly chronological order, beginning with the roots of the technosphere in prehistory and the early urban civilizations of Egypt, Mesopotamia, ancient Rome, and China to explore the conditions for the beginning of the long-term expansion of science and technology. We next turn to premodern cultures of religious knowledge, for which we show how the entanglement of different systems of knowledge may lead to a sharpening of cultural boundaries and, at the same time, create new spaces for intercultural dialogue and further facilitate the transmission of knowledge.

A central project of the Department is dedicated to the knowledge network shaped by a key text of medieval and early modern astronomy, Sacrobosco's *Sphere*. Here we show how network dynamics contribute to a homogenization of knowledge, creating a shared scientific culture depending on and fostering, in a feedback loop, the mobility of knowledge and people. This theme is also central to the project on Leonardo's intellectual cosmos, as well as to our investigations of the knowledge circulation in the context of the Jesuit mission to China.

Our investigations of the relationships between colonialism, the Industrial Revolution, and energy transitions have revealed how the entanglement between different types of knowledge—for example, between geological and chemical knowledge—have favored feedback loops between the knowledge economy and the material economy. We were able to further demonstrate the mutual reinforcement between technoscientific developments and network effects as a consequence of the increasing connectivity among different parts of the world in the eighteenth and nineteenth centuries, and as fostering both the further expansion and homogenization of the technosphere and launching the planet into the Anthropocene. Seen through this prism, the onset of the “Great Acceleration” (the exponential rise of socioeconomic activity, resource consumption, and the destruction of natural ecosystems that began in the period following World War II) is the point at which such connectivity becomes the momentous inflection point of human and Earth-system history that is now commonly labelled as the Anthropocene. The transdisciplinary project investigating the Mississippi River Basin as a model region for the historical interplay of colonial, industrial, and agricultural transformations over many centuries serves as an example of such mutual reinforcement, as does the rise of the environmental and Earth system sciences during the Cold War era. The rapid development of particular branches of physics in that same period set another incentive to test our analytical methods for understanding the network dynamics of the regulative mechanisms of knowledge economies. Finally, our studies of Anthropocene dynamics have brought us to lay the foundations of a new discipline, “geoanthropology,” which integrates perspectives and methods of the Earth system sciences with those of the social sciences and the humanities.

Research Results of Department I



The historical evolution of the technosphere is the center of investigation in the Digital Atlas of World Technologies (DWAT), a further development of the Digital Atlas of Innovations (<https://atlas-innovations.de/>).
Graphic: Jochen Büttner.

<https://atlas-innovations.de/en/>



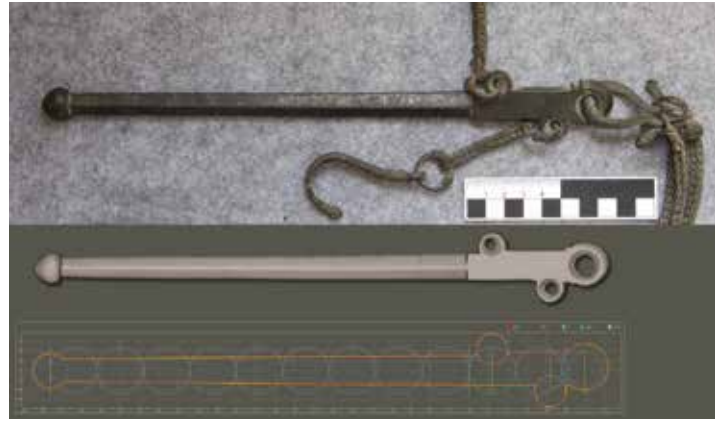
In keeping with and expanding on the Department's long-standing emphasis on the deep historical roots of the knowledge dynamics responsible for the expansion of science and technology, and thus for the emergence of the technosphere, we have collaborated with the Deutsches Archäologisches Institut (DAI) in extending the temporal scope of our studies beyond the historical period to include prehistoric developments. In the context of the project **Digital Atlas of Innovations**, for instance, we have examined weighing in order to study the beginning of measurement as a fundamental knowledge practice in Egypt around the transition from the predynastic to the dynastic period (ca. 3000 BCE).

Evidence has been gathered indicating that abstract weighing was preceded by and emerged from concrete or protoweighing, that is, from the direct comparison of objects according to their weight. We suggest our evidence indicates a typical pattern for disruptive innovations, in which concrete weighing started out in a niche as a solution to the initially somewhat marginal problem of rationing wool. Among the socioeconomic factors that preconditioned the transition from concrete to abstract weighing—and the quick rise of the latter to a dominant technology—was the formation of increasingly complex modes of exchange and production. The determination of quantity played an ever-more important role over the course of the fifth millennium BCE, such as in metallurgy or in the distribution of goods in the newly emerging, centrally administered city-states. Abstract measurement furthermore hinged on availability of the means to symbolically record and store the results of measure-

ments, which emerged with the development of protowriting in the second half of the fifth millennium BCE. Abstract weighing did not only result in a quantitative concept of weight. Almost instantaneously, the new technological knowledge became entangled with the material economy in a profound way: equivalencies to precious metals specified by weight provided an entirely new way of determining value. Weighing, as we have explicated in detail, thus paved the way to a precoinage monetary economy that would quickly and disruptively reshape the Bronze Age world.

The next 2,500 years in the development of weighing are characterized by a high path dependence. As weighing technology spread and improved, it remained based on a single principle: that of the equal armed balance. This only changed around 500 BCE when balances with variable arm length were introduced. A first type of such a balance, known as the Besmer, was used already in the ancient Greek world where it provided crucial stimulus for the emergence of one of the first theories of mechanics. It remained, however, a marginal technology and in the first century BCE, the Besmer was superseded by the Roman steelyard. The latter allowed for rapid weighing with adequate precision over a wide weighing range, while at the same time being easily transportable, which would explain the quick ascent of the innovation to the dominant weighing technology, in particular in contexts of nonstationary trade. The advantages of the steelyard in weighing practice, however, came at the expense of the difficulty involved in the design and production of functional instruments, a problem that could not be solved with extant theoretical knowledge. To understand how this problem was solved, as part of the work of the Research Group **“Between Knowledge and Innovation: The Unequal-Armed Balance”** in the excellence cluster Topoi, we took 3-D scans of extant instruments in museums throughout Europe. Based on a computational analysis of these scans, we were able to show that the problem of how to manufacture functioning steelyards was solved by applying production rules that determined elementary relations between the relevant dimension of the instruments. This finding has uncovered a hitherto completely unknown characteristic of ancient practical knowledge and technological production. Although the practical knowledge intrinsic to this mode of production was in a strong sense quantitative, it was not, however, theoretically founded. Furthermore, we could show that the stabilization, stratification, and circulation of such complex practical production knowledge depended on the existence of the synchronically and diachronically stable and regulatory infrastructures provided by the Roman Empire.

After the decline of the Roman Empire, in the Merovingian period, steelyards were manufactured in only simplified form, with just a single fulcrum. The instrument thus lost its specific advantage, resulting in the remarginalization of its particular technology. It was only in the High Middle Ages that the steelyard reentered the Latin West through the Islamic world, where production knowledge from antiquity had been preserved and further developed. In the medieval Islamic sciences, a genre of texts emerged that combined the description of mechanical practices with a treat-



Top image: Steelyard balance from Pompeii in the Museo Archeologico Nazionale, Naples (inv. no. unknown, photo: Jochen Büttner).

Bottom image: model of the same balance, created on the basis of 3-D scan data, and the geometric construction scheme of the same object, as reconstructed on the basis of a computational analysis of the model.

<http://www.topoi.org/project/d-5-5/>



ment of the foundation of theoretical mechanics going back to Greek antiquity. A fresh analysis of the most prominent text of this genre, Al-Khazini's *Balance of Wisdom*, newly translated by the project members, has allowed for a more precise assessment of the relation of theory and practice in the text. It has been demonstrated that the *Balance of Wisdom* includes concepts that are completely absent from ancient Greek theories of mechanics, and that can be traced to the workshops and knowledge of the medieval Islamic scale builders. In this text, which emerged in a cultural setting fundamentally different from that of the ancient Greek and Roman periods, we thus encounter a genuine precursor of engineering knowledge as is familiar from later periods, namely, scientifically informed knowledge geared toward solving practical problems.

In view of this historical dynamics between different forms of practical knowledge (such as intuitive or rule-based knowledge) and its theoretical reflections, as well as the path dependence of the development of knowledge that follows from this dynamics, the exploration of alternative, historically given scenarios is of particular significance. One source documenting such an alternative is the *Mohist Canon from Warring-States China* (ca. 300 BCE). The text presents a broad theory of knowledge and reasoning, not abstractly but by examining concrete worldly issues, including the behavior of heavy objects, shadows, and mirror images, and thus documents a reflective abstraction from practical knowledge independent of similar developments on the western half of the Eurasian continent. The similarities and differences between the two traditions may have their origin on various levels of the knowledge hierarchy and its societal embedding. Thus, contrary to earlier claims in the literature, a passage in the *Mohist Canon* on the lever appears to be a reflection not on a weighing instrument, but on a practical device, such as a shoulder pole, that does not involve quantitative measurement. This disparity in what kind of mechanical devices were available for reflection may be part of an explanation for the development of a mathematized theory of mechanics in Greece, and in contrast, for its absence in China. The diverging developments would then be a consequence of the timing of discursive-theoretical traditions on one hand, and technological traditions on the other: when the cultural conditions were favorable for the emergence of a tradition of theoretical mechanics in China, as documented in the few sections on mechanics in the *Mohist Canon*, no technological device embodying quantitative relations connected to the lever principle was present.

Another level on which path-dependence plays out is that of different strands in the theoretical traditions themselves: the Mohist case shows that there does not have to be a developed deductive theory of geometry for mechanics or optics to become topics of a rigorous science. At the same time, the rigor of these sciences appears to imply a certain kind of protodeductivity as given by the specific differentiation between definitions and propositions, and a close logical, albeit not strictly deductive, interrelatedness of the different statements within the *Mohist Canon*. There are no historical traces of a further development of Mohist science after the Qin unification of the Chinese empire in the third century BCE. Yet, from the way the different topics are treated in the *Mohist Canon*, one could envision a development alternative to the one known from ancient Greece, a development in which geometrical, mechanical, and optical topics are treated with increasing rigor and breadth without one particular science pioneering the others.

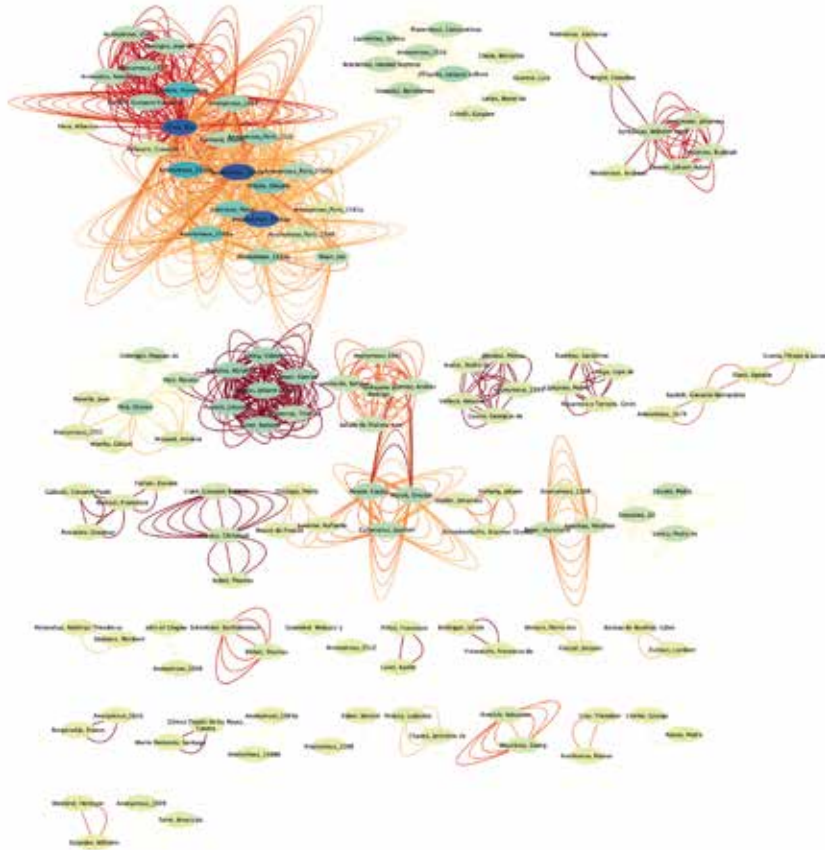


Reflecting the research undertaken as part of the "Convivencia" project, this manuscript page shows two scholars in conversation in mid-sixteenth century Mexico: a Mexican (right) explains aspects of Mesoamerican culture to a European (left). Firenze, Biblioteca Medicea Laurenziana, Ms. Med. Palat. 220, f. 21v.

In colonial Spanish America, knowledge was transferred in the missionaries' monastic schools and brought into a hierarchy through codification, albeit in a different manner from China. In the early modern period, knowledge with religious connotations transferred ancient knowledge and mediated between different regional traditions. Religiously and politically motivated conflicts did not lead to a complete dominance of one knowledge system in the studied societies of Southern and Central Europe and Spanish America, but to an integration of different and differently represented dimensions of knowledge.

The hierarchies created in this process of transmission were also based on the integration of knowledge components that were deemed unacceptable in the representation of knowledge. Institutional, political, and social shifts and disruptions also modified the way in which the entire knowledge economy was integrated. Furthermore, material changes, such as the introduction of printing technology, played a role in the dynamic transformation of knowledge economies. Knowledge cultures that transcend religious, geographical, or political boundaries have been studied within the framework of the CRC "Episteme in Motion" and the research project "Convivencia."

Network of authors of text parts constituting the treatises collected in the Sphaera corpus, which contain, among others, Johannes de Sacrobosco's *Tractatus de sphaera*. Using this network, it was possible to identify Georg Rheticus as the author of some of these previously anonymous texts. Network data and network visualization by Beate Federau.



<https://sphaera.mpiwg-berlin.mpg.de>



One such knowledge culture transcending boundaries is the tradition of cosmological knowledge represented by the treatises of the sphere. A large collection of such treatises has been investigated in the project “[The Sphere: Knowledge System Evolution and the Shared Scientific Identity of Europe](#).” This research focuses on textbooks used at European universities to teach astronomy and cosmology between the thirteenth and seventeenth centuries. In particular, it investigates the edition history of Johannes de Sacrobosco's *Tractatus de sphaera*, a thirteenth-century qualitative introduction to cosmology profoundly based on al-Farghānī's similar work on *The Sphere*. The latter reached Western culture through the exchange that took place on the Iberian Peninsula during the phase of Convivencia, and was translated into Latin during the Late Middle Ages, mostly under the title *De aggregatione stellarum*.

The general aim of the project is to understand the mechanisms by which scientific knowledge evolved and was homogenized. While the history of science and of astronomy in particular tends to focus on the major accomplishments of well-known scientists such as Nicolaus Copernicus, Galileo Galilei, or Johannes Kepler, this research reconstructs the shared knowledge of the recipients of such ideas: educated readers, scientists as a general category, and numerous astronomers. It was shown that the geocentric worldview contoured an ample frame for debate, scientific engagement, and knowledge evolution. It is the geocentric worldview that provided Europe with common scientific knowledge, which in turn is assumed to be at core of

the process of identity shaping on the continent. The network-based methodology was applied to the early modern set of historical sources. In 2018 the corpus of sources, a collection of 359 university textbooks on cosmology and astronomy (1472–1650), was completed. Development and application of machine learning technology in the institutional frame of the project “BIFOLD” supported the data extraction and data clustering processes.



<https://bifold.berlin>

Network Theory

Members of the Department collaborated with Holger Kantz’s team at the MPI for the Physics of Complex Systems to reveal mechanisms by which knowledge was homogenized: during the period under examination, a specific cluster of texts became hegemonic, meaning that it was imitated throughout Europe without its provenance being acknowledged. Such clusters of texts began to emerge in 1530s Wittenberg in the cultural and scientific framework of the Reformation and are directly linked to figures such as Philipp Melanchthon and Georg Rheticus.

Two international Working Groups examined the social actors involved in the production of the treatises of the corpus: authors, printers, and publishers. These groups reached the conclusion that the process of imitating the treatises was based on an increase of mutual awareness between printers and publishers in the framework of the academic book market, which was largely transregional from its beginning in the fifteenth century. Second, it was established that the role of treatise authors was not autonomous but dependent on the network of printers and publishers. In their role as university instructors, authors were able to influence how knowledge was homogenized because this role implied their participation in a continuous exchange with the book producers, who were concerned with conceiving and designing future editions



A printing press, ca. 1600. Plate from a print series, *Nova reperta* (New inventions of modern times), engraved by Jan Collaert I, after Stradanus (Antwerp: Theodoor Galle; Metropolitan Museum of Art, Harris Brisbane Dick Fund, 1934).

The exhibition *Leonardo's Intellectual Cosmos* was conceived by Department I in cooperation with the Staatsbibliothek in Berlin. Bottom: central view of the exhibition. Photo by Vivienne Rischke. Top: the exhibition catalogue published in German and English by Giunti (2021). Originally planned for 2020, the exhibition was rescheduled due to the pandemic to run from May 11 to July 17, 2021.



of the textbooks. Such trade-offs depended in turn on the number of enrolled students, and therefore had an almost yearly cadence. In terms of market, textbooks were primarily conceived of only for the local market of each book producer involved. The research also disclosed further aspects of knowledge economy, namely the regulative function of the institutions involved in the circulation and use of the treatises constituting the corpus: the universities. It appears that the evolutionary process of the treatises was bound to the normative frame decided by the universities, their statutes, and their habits.

Compared to the case of cosmological knowledge, in the case of mechanics other regulative frameworks besides the university, such as courts, confessional organizations, and engineering schools, also played an important role for knowledge evolution. In particular, it has been shown how developments in practical and theoretical mechanics were closely dependent on the emergence and establishment of specific power and decisional structures, especially on the establishment of absolutism as a form of power execution: absolute power was closely bound up with confessional orientations, and this in turn explains the different evolutionary paths of mechanical knowledge in regions characterized by the dominance of specific religious confessions.



<https://www.mpiwg-berlin.mpg.de/research/exhibition/leonardos-intellectual-cosmos-2021>



The fundamental role of the advent of print technology for the mobility of knowledge, noted above in the analysis of cosmological treatises, is at the core of another research endeavor, namely the reconstruction of the **Library of Leonardo da Vinci**. Building on his familiarity with a broad variety of literary and practical traditions, Leonardo attempted to develop what may be called a “science of practice.” In this he did not want to rely on mere practitioners’ rules but instead envisioned a mathematical science that would do justice to the everyday realities faced by a practitioner, such as friction, material constraints, or the way human vision shapes the perception of perspective. His example therefore shows that the concrete relation between, on the one hand, practices such as engineering or painting, and on the other, the theoretical reflections based on them, from which a major part modern science evolved, was not fixed or predetermined but negotiable and open to variation at any point in history. And although the science that soon followed him—of Galileo and Newton—seems to

contradict da Vinci's vision with its remoteness from practicality, later developments in analytical and technical mechanics may be seen as its vindication. The variability of the relation between practice and theory at each point in history also means that its development is not one-directional.

We have thus identified the spread of printing technology as a key factor to explain and describe the emergence of Leonardo da Vinci's "science of practice." The access to knowledge was simplified not only because of the improved economic conditions to possess and use the source of knowledge—the book—but also and especially because the printed book became a highly mobile good on the market, thus reaching an audience of a previously unknown size.

The knowledge mobility that enabled Leonardo to pursue such an impressive range of interests was the material mirror of the exceptional social mobility characterizing the early modern period. Paradigmatic for such social mobility is the phenomenon of exploration journeys, which connect to the process of the globalization of knowledge; and among its protagonists was the Jesuit Order.

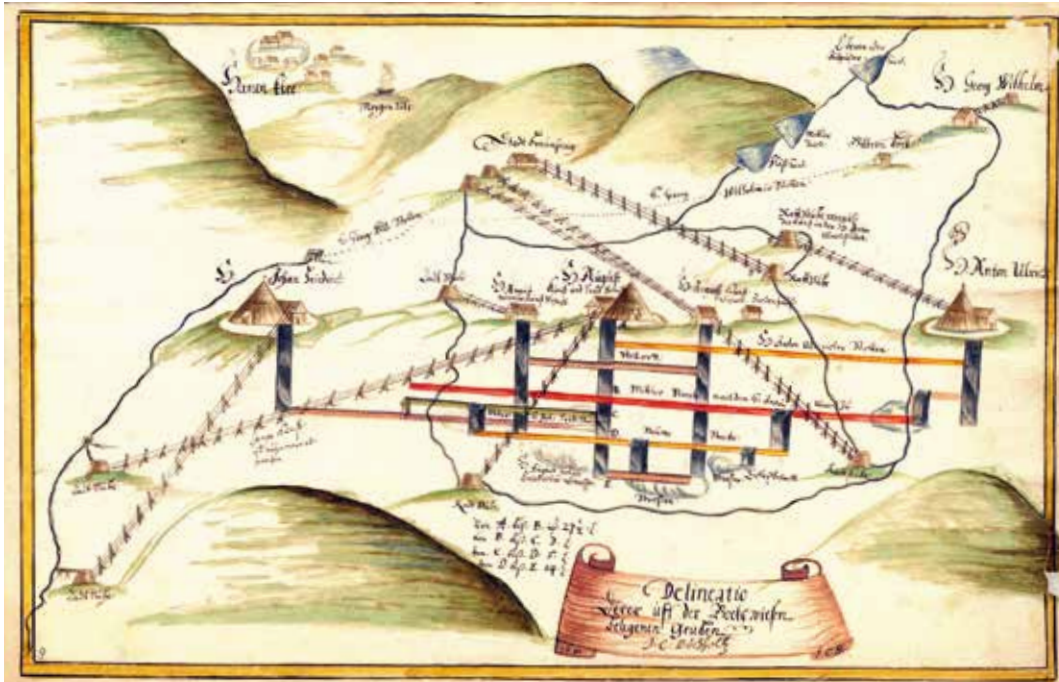
The **seventeenth-century transfer of European scientific knowledge to China** through the Jesuits further corroborates the idea that successful knowledge transfer can only occur when there are certain matches between the knowledge systems of source and target cultures. In earlier research, we emphasized that there was a match between the Jesuit missionaries and Chinese scholar-officials as regards their interest in practical knowledge, for example, of water management or geography—a match that enabled the Jesuits to "use" their science as a means of promoting their faith. Our research into the networks of personal relationships, intellectual connections, and more broadly, cultural, political, and religious contexts (in particular of the Jesuit Johannes Schreck and the Chinese scholar-official Wang Zheng who cooperated to produce *Qiqi tushuo*, the first Chinese book on Western mechanics) suggests that this match went further than simply sharing interests and included aspects of ideology. Both sides held parallel ideas about statecraft and the duty of the elite to promote "useful knowledge." On the Jesuit side, these ideas are reflected in the writings of political authors such as Giovanni Botero, who fostered the development of useful knowledge instruction separate from immediate practice.

The question of what we are able to do and make lies at the heart of **organized technological inquiry**. The history of the West shows that this basic technological question has long been linked systematically with the question of the natural conditions for technical practices and related scientific inquiry. Beginning in the Renaissance, technical experts and learned men who were engaged in practical technical endeavors (hybrid "scientific-technological experts") have contributed to a mixed technological-scientific tradition of knowledge. For centuries, this technoscientific tradition has evolved alongside and in interaction with the much better known natural philosophical tradition, as well as with the technical knowledge firmly embedded in the arts and crafts. In the course of the eighteenth century, combined technological and scientific inquiry, or "technoscience," was for the first time systematically organized in Prussia as well as in other European countries. New kinds of research and teaching institutions were established, including mining academies, schools for civil engineering, and schools for agriculture and forestry. The project "**Technoscience in History**" has focused on the period 1750–1850, which historians of science have long recognized as formative for the disciplinary structure of the modern natural and



Panel 3 of the manuscript copy—
a rare seventeenth-century
variation—of Matteo Ricci's 1602
map of the world. Courtesy of the
New Bedford Whaling Museum.

technological sciences. Based on a plethora of new archival materials, the project has shown that the “useful sciences,” which the Prussian state organized after the Seven Years War (1756–1763), were an early form of technoscience. The early technosciences (such as mining science, technical chemistry, agricultural science) provided the epistemic platform for Europe’s industrialization. Today’s technoscientific disciplines thus do not signal a radical departure from the scientific traditions.



The questions of what is possible to do and to make, and what the natural conditions for such practices are, also belong to the key investigations that guide the Department in studying the gradual emergence of the Anthropocene, as posed at the outset of this report. When and how did science, and technology, and technoscience begin to play a role as drivers of the Anthropocene? When and how did the economy of knowledge become entangled with material practice in such a way as to give rise to the self-reinforcing dynamics that fuel the technosphere? The emphasis here is both on technical making as such, as in the history of industrial catalysis described below, and on the reverberations of collective doing and its sociotechnical and political organization on a global scale.

A multimodal investigation of this kind, one that traverses and loops together different historical constellations from the institutionalization of the “useful sciences” in the second half of the eighteenth century to the (post-)Cold-War sciences of the second half of the twentieth century, is central to a new research focus of the Department, under the umbrella theme of “**Anthropocene Formations**,” which was newly established in 2017. Covering squarely the historical period in which the use of fossil energies and science-fashioned materials became a dominant socioeconomic force (having culminated—so far—in the Great Acceleration), the varied research strands collated under this theme focus on two epistemological aspects: the material practices that led to the formation of the Anthropocene in a material sense, and the epistemic configurations at play in the gradual formation of Anthropocene knowledge,

A plan of the mines at Bockwiese, Upper Harz, showing their main galleries and shafts. Constructed by practical mathematicians designated as “mine surveyors,” such plans embody both technological and natural knowledge. From J. Buchholtz (1681). Bergarchiv Clausthal, Riss No. 3382. Cited in Ursula Klein, *Technoscience in History*, 97.

that is, the reflexive mode of contemporary sciences to monitor, understand, and counter the Anthropocene crisis. The Janus face of modern science and technology is that they both advanced the Great Acceleration and have been instrumental in alerting us to its perilous effects.

<https://www.mpiwg-berlin.mpg.de/page/anthropocene-colloquium>



Regular scholarly exchange on the theme of “Anthropocene Formations” takes place once a month during the **Anthropocene Colloquium**. Devoted to the critical discussion of new research outputs at the forefront of Anthropocene history and epistemology, it features young and established guest speakers from diverse disciplinary backgrounds such as Earth system science, economic history, cultural anthropology, environmental humanities, and the arts.

To understand this double-sidedness, a key scientific practice has to be investigated, namely, the **chemistry of industrial materials**, and in particular, the fundamental role of **catalysis** for the transformation of the molecular basis of modernity. So far, neither the material history of science and technology nor cultural theories have drawn appropriate attention to the technicality of key drivers of modernity, that is, mostly, catalysis products such as motor fuels, artificial fertilizers, ammunition, lubricants, plastics, and pharmaceuticals. From the nineteenth century until today, the particular agency of catalysts, and their peculiar position in both industrial and biochemical processes, give occasion to use catalytic phenomena to interpret human agency in the industrial age.

Given the urgent need to transform our current energy system, the study of past **energy transitions** can provide insight into the deep defossilization required to shift the current configuration of the global energy system into a less destructive mode of operation. The applied use of historical knowledge is no small challenge, given that the global energy system is the largest network of infrastructure ever built, assembled over at least two centuries and supported by a vast swathe of institutions that have coevolved alongside it. The remit of possible inquiries is therefore wide-ranging, moving from the history of the science underlying coal-powered carbonization in a global perspective, to the micro-macro molecular transformations of industrial catalysis, the infrastructure of North America’s electrical grid, the public relations of the oil industry during the Great Acceleration, the role of the built environment as a configuration of embodied energy that helps determine patterns of energy consumption, and the shifting dynamics of energy conservation as both a science and as policy.

Our research shows that energy transitions are full of preconditions and can take different and unexpected paths. The example of the Americas in the eighteenth and early nineteenth centuries shows that an energy transition toward coal was in principle possible given the availability of coal. However, it was delayed by several decades due to two factors: the abundance of traditional energy resources such as (enslaved human and animal) muscle power, water, and firewood; and the advice of European colonial experts who recommended focusing mining activities instead on the exploitation of other resources, such as mercury.

A more systematic and historiographical approach to understanding the dynamic shifts from wood to fossil fueled economies revealed three predominant theories of

transition termed “constellations of scarcity and science,” “demographic structure,” and “alleviation of areal constraint.” A supporting review of the literature has drawn out a long genealogy of transition-relevant thermodynamic thinking within geographical thought since at least the mid-nineteenth century, providing both exemplary and cautionary progenitors to contemporary Earth systems thinking. This affirms the intellectual credibility of a holistic thermodynamics of the Earth system while warning us of reductionist views of the relation between energy and society.

The role of engineered increases in energy efficiency, and their integration with the science and politics of energy resource conservation, has been a largely neglected aspect of studies on the history of energy. This is despite the central role energy

efficiency is expected to play in achieving a low-carbon transition. Inquiry into the history of this idea’s underlying science and conflicting terminologies has revealed that only a small number of events, such as the Great Depression, the successive oil crises, and the fall of the Soviet Union have been shown to have actually reduced the overall rate of energy consumption, while state- and market-led interventions have achieved only temporary or small-scale reductions in consumption rates. In advancing histories of saving energy, this work has drawn attention to inescapable rebound effects unavoidably associated with increased efficiencies in energy use and the knock-on effects across the Earth system of such incremental changes in efficiencies.

As the field of energy history is one that is highly relevant to society, the work of the Anthropocene Formations group has linked close analyses of the energy historical past to the unfolding planetary future of the Anthropocene condition. A series of exploratory symposia and a sustained period of work regarding the applicability of energy history to energy system transformations, including a multidisciplinary workshop on the past, present, and future of [Germany’s coal phaseout policy](#), have resulted in a sequence of historically informed white papers addressing the subject of the “Energy System of the Future” (“Energiesysteme der Zukunft”) on behalf of acatech, the Leopoldina, and the Union of German Scientific Academies. In addition, the Department has been engaged in the vibrant subfields of “petrocultures” and transition studies, including a number of *in situ* engagements with contemporary extrac-



Petrochemicals from the catalysis industry are among the most important means of political power in the Anthropocene, as the “Esso War Map” from 1942 bluntly shows. The Great Acceleration of the 1950s onwards transfers war production into civil use. Molecular technology with planetary effects. From Klose and Steininger, *Erdöl: Ein Atlas der Petro-moderne* (2020), 84.



<https://www.mpiwg-berlin.mpg.de/event/kohletag-multi-disciplinary-workshop-past-present-and-future-coal-use-germany-and-beyond>

Lidar (light detection and ranging) map of the changing path of the Lower Mississippi River using data compiled in 2000 shown next to Harold Fisk's *Ancient Meander Map of the Lower Mississippi River*. Source of Lidar data: Louisiana Statewide Lidar, LSU Department of Geography and Anthropology, Baton Rouge, LA. <http://atlas.lsu.edu>. Original map: H. N. Fisk, "Geological Investigation of the Alluvial Valley of the lower Mississippi River," U.S. Department of the Army, Mississippi River Commission (1944). Lidar map created by Nikos Katsikis.



tion sites, from Louisianan nitrogen and hydrocarbon refineries to Albertan tar-sands mines, and returning to the open-cast coal mines of Brandenburg, as artifacts of industrial and Anthropocene history. Drawing on the Louisiana field site, an analysis of available energy within the region and its anthropogenic diversion has been produced in collaboration with physicists from the Max Planck Institute for Biogeochemistry, which demonstrates the outsized potential of photovoltaics within the catchment area of the **Mississippi River**.

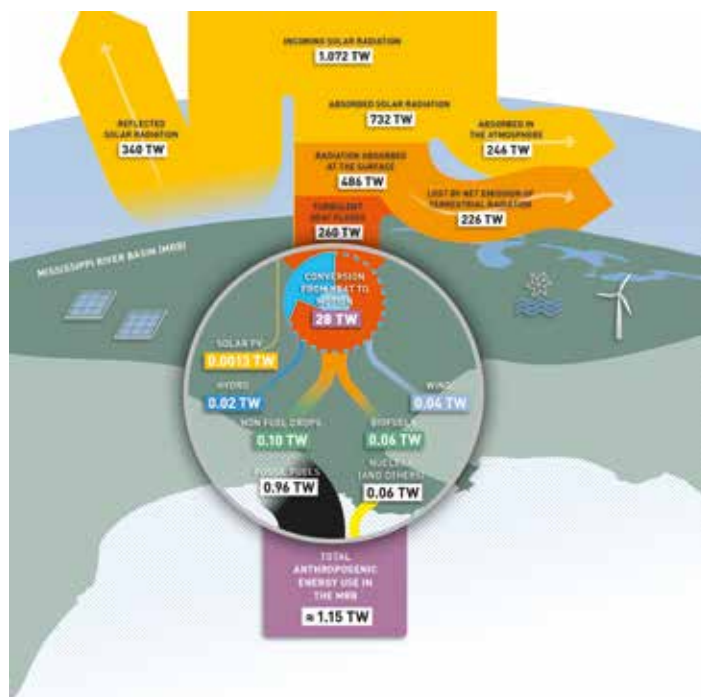
This example is but one output of a larger endeavor combining novel interdisciplinary and field-oriented research methods, site-specific historical research, and societal engagement, essentially putting political epistemology into practice. Organized by the Haus der Kulturen der Welt (HKW) and members of the Anthropocene Formations group, the two-year project "Mississippi: An Anthropocene River" was undertaken together with numerous project partners in the US, the UK, and Germany, bringing together more than 200 natural scientists, humanities scholars, artists, and local activists. In an exemplary attempt to "ground-truth" the historical formation and the current socioecological dynamics of the Anthropocene on a regional scale, the project investigated the historical legacies of and ongoing interactions between environmental, epistemic, economic, and political structures along the entire Mississippi River basin (MRB), stretching from northern Minnesota to the Gulf of Mexico.

As a region decisively formed by settler colonialism and subsequent agroindustrial development, resource extractivism, and resource transport, the MRB provides a model geography for understanding Anthropocene transformations. Registering a multitude of mutually reinforcing impacts of industrial-scale interventions and socioecological dislocations, this immense landscape of anthropogenic change provided a rich case study for some of the main questions of the Research Group on the (long-term) historical, sociotechnical, cultural, and epistemic drivers of such changes. It has been shown that a transcontinental river system such as the MRB can offer direct insights into the spatiotemporal dynamics of the Anthropocene on a subplanetary scale. Some of the themes investigated to that end are the self-reinforcing system of plantation

agriculture and chattel slavery, the idealistic though often unjust and insensitive hydro- and social engineering schemes of the twentieth century, and the struggles of the current population of the MRB, who are largely structurally incapacitated in their ability to react to the dangers of accelerating climate change, environmental degradation, and social unrest. The project has therefore helped to decode and document this region as one that demonstrates how sociotechnical development in conjunction with global history can shape larger-scale geographies.

The project also highlighted the difficulty of bringing into correspondence the systemic and cross-scale interactions of local to regional to planetary changes and their causes. Decadal-scale transformations (for example, the radical shifts in land use along the Mississippi; the transformation of a meandering and ever-changing riverscape into an industrial highway and the Sisyphean task of hydrological control; the environmental justice problems concerned with agricultural and petrochemical over-exploitation; or the existential threat to humans and ecosystems in a gradually sinking deltaic region) are all situated in an ambiguous space between personal concerns, abstract knowledge, and perceived economical imperatives. An eight-day Anthropocene River Campus in New Orleans with more than 150 international participants, including the first North-American meeting of the Anthropocene Working Group (AWG) explored the reciprocal logic of these historical dynamics in situ and in depth, while the journal *The Anthropocene Review* has devoted a double special issue to the project and some of its results.

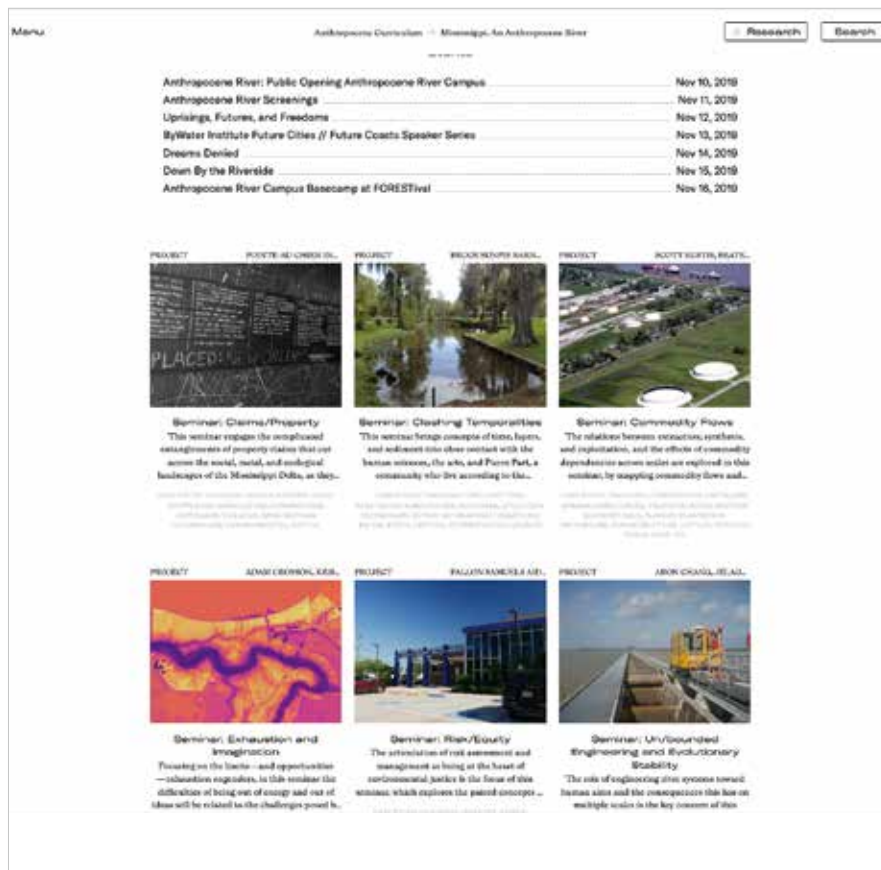
With the signs of the Anthropocene becoming more apparent throughout the period covered here—signs that are marked by the gradual but accelerating disruption of critical biophysical and geochemical parameters of the Earth system—our questions on the mobility and globalization of knowledge and technology (exemplified in our studies which range from ancient Rome via the Middle East and China to modern Japan) are also acquiring a pressing urgency. The question is not only how to “connect



The availability and anthropogenic diversion of energy in the Mississippi River Basin: all figures outside the magnifying circular frame indicate Earth system energy flows at a regional scale. Figures within the circular frame indicate anthropogenic energy use, other than “conversion from heat to motion,” which indicates the total power in generating motion within the MRB. Nonfuel crops (0.10 TW), though depicted, are not included in total anthropogenic energy use in this instance (1 TW = 1012 watt). Image by Alexander Schindler, from T. Turnbull, M. Renner, A. Panwar, N. Katsikis, A. Kleidon, and A. Schindler, “Quantifying Available Energy and Anthropogenic Energy in the Mississippi River Basin,” *Anthropocene Review* 8, no. 3 (forthcoming 2021).

An extensive documentation of the various parts of the Mississippi project and its many findings can be found at www.anthropocene-curriculum.org. The website, jointly run by HKW and MPIWG, brings together all research sites and activities of the global network project “Anthropocene Curriculum” and provides a collaborative platform for exchange and publishing at the intersection of Anthropocene debate, research, and education.

<https://www.anthropocene-curriculum.org/>



the dots” between local nodes in a globalized network, but how to understand the qualitative change and effects that this interconnectivity has wrought on the Earth as a system. Is it possible to connect the traces (and scars) of the long-term transformations on the local and regional level—that is, the very scale that has mattered for humans over its entire history so far—to the global traces (and scars) that matter to the Earth system? At what point do local environmental problems become global? And what are the appropriate epistemic and institutional conditions to think, analyze, and counter this shift?

The rise of Earth system science (ESS) in the second half of the twentieth century and the intellectual and epistemic antecedents that made it possible to conceptualize a global environment as a system of biogeochemical flows is an important research trajectory in the work of the Department. In the attempt to implement biosphere and Earth system visions in specific research agendas and attain credibility through international programs, varied limitations, constraints, and conflicts emerged in line with specific interests, scientific practices, and technocratic visions that still shape the political formulation of sustainability goals and environmental governance. Earth system and global change sciences are as much technosciences as they are policy sciences.

The gradual rise of ESS and global environmental concerns took place amidst seismic geopolitical reconfigurations, such as the new Cold War order (and the ensuing post-Cold War disorder), an extended period of decolonization driven by ongoing economic dependencies and punctuated by resource conflicts (e.g., the rise of petro-states such as Saudi Arabia and Venezuela), and continental-scale attempts at market

integrations in Europe, Asia, and North America. In the post-Hiroshima world, the social role of science has dramatically transformed its public perception and political dimension, leading to close entanglements between political, social, and scientific worlds.



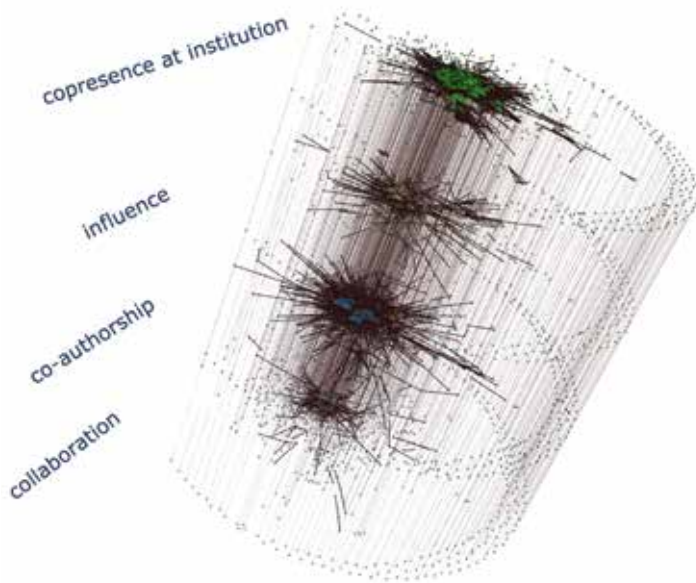
Within the academic world, some of these challenges have been taken up by the foundation of new **scientific institutions and organizations**. A prime example studied by a research project in the Department is the establishment of the Max Planck Institute for the Study of the Scientific-Technical World in Starnberg (1970–1980). Its founding may be seen as a reaction to the new public and political role of science. In the 1960s, the awareness of global crises had already deepened, as exemplified by the Cuba crisis and the danger of nuclear annihilation, global inequalities and the questionable future of growth, and the local and global environmental consequences of the world economy. As a reaction to this awareness and under names such as futurology, strategic studies, peace research, and world economics, institutions that engaged with these problems in a scientific manner were established in various countries (RAND corporation, Club of Rome, IIASA). At the Starnberg Institute, the global problems were seen as a challenge for basic research, and the role that science itself plays in their critical development was addressed. In the light of the Anthropocene predicament, certain concepts and results developed at the institute (such as the idea of scientific truth as an ecological niche in the evolution of knowledge), appear highly topical today and are being reevaluated in a dedicated research activity.

A collage of photographs taken on July 26, 1948, by one of the first test rocket flights into near space showing cloud patterns over New Mexico and the Gulf of California. Johns Hopkins Applied Physics Laboratory, https://www.nasa.gov/multimedia/imagegallery/image_feature_1298.html.

Anthropocene Lecture Series

Conceived as an interinstitutional event in the Berlin-Brandenburg region, the Anthropocene Lectures series has drawn the attention of larger public audiences at the three locations of MPIWG, HKW, and IASS Potsdam. Renowned speakers such as Phillipe Descola, Sheila Jasanoff, Prassanan Parthasarathi, Bruno Latour, Julia Adeney Thomas, and Anna Tsing were invited to elaborate their positions on the ongoing sociocultural debates on the Anthropocene concept.

Our research has shown the instrumental significance of the creation of new global institutions in the wake of the Cold War and the rising tide of the Great Acceleration. These new institutions led to structures of global governance that involved science in different ways: as an intellectual resource, as a globalized high-tech and technoscience concerned with global measurement networks and means of data sharing, and as a conduit for intergovernmental **science diplomacy**. These structures concerned such impactful developments such as the role of the Pugwash Conferences on Science and World Affairs as a channel of unofficial communication (“track-II diplomacy”) between the Eastern and Western Bloc countries, problematizing the clear-cut division between state and nonstate actors in transnational relations, the role of the Inter-



Representation of the multilayer network of the different social relationships of the scientists working on general relativity between 1925 and 1975: an application of the project on socioepistemic networks to a case study on the history of general relativity research. Graphic by R. Lalli and D. Wintergrün.

epistemic changes. One example for this kind of international community building that is being investigated by a research project in the Department is the **renaissance of general relativity** in post–World War II Europe and North America. To delve into the complex mechanisms that relate social transformations to knowledge changes, a conceptual and methodological framework based on network concepts and tools has been further developed. Called **socioepistemic networks**, this integrated multilayer network approach has been successfully employed to investigate the integrated dynamics of social interactions, citation patterns, and the reconfiguration of knowledge in general relativity. Its data-driven computational method shows that this phenomenon was neither a consequence of astrophysical discoveries in the 1960s nor a simple by-product of socioeconomic transformations in the physics landscape after World War II. Instead, the socioepistemic network approach robustly establishes that the renaissance has to be understood as a process which intertwines the social and the conceptual dimensions.

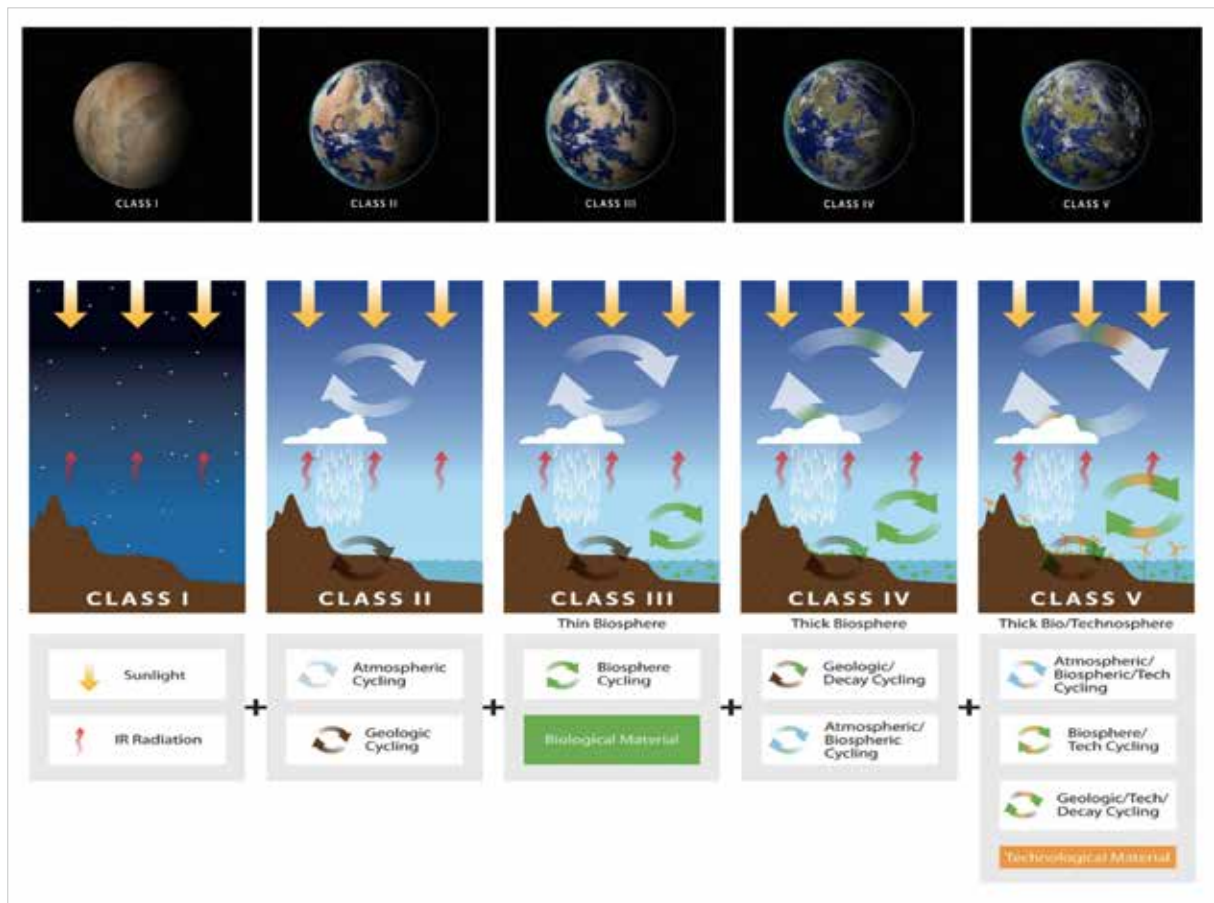
Based on these experiences and insights in the context of specific fields, we have begun to apply our methods of socioepistemic networks more broadly to the **History of the Max Planck Society**. The same approach is moreover being employed to analyze the very recent dynamics behind the growth of the field of **exoplanet search** and its relation to the institutionalization of the field of astrobiology around the turn of the millennium. The project is highly experimental, in that the semantic layer of knowledge elements is being built by applying machine learning algorithms for textual analysis in the context of a large-scale cooperation with the Berlin Center for Machine Learning. Preliminary results indicate that machine learning techniques reliably retrieve topics and keywords characteristic of research in a specific period, enabling researchers to build dynamic conceptual maps of exoplanet search as a field.

In our research, we contend that the **technosphere** has to be understood not in a narrow sense as a merely technological or technocratic entity. Instead, its usefulness stems from a conceptual framing of both the highly amorphous network of planet-affecting technical infrastructures and the cultural, institutional, and knowledge

national Atomic Energy Agency in setting the standards for radiation protection in the late 1950s, or the founding of the European Physical Society in 1968, which functioned as support network for dissident physicists in the Eastern Bloc. But in no other area were these shifts more pronounced than in the establishment of global environmental programs such as the UNESCO Man and Biosphere Program (MAB) in 1971, the World Climate Research Programme (WCRP) in 1979, and the International Geosphere-Biosphere Program (IGBP) in the late 1980s—all consequences developing from the International Geophysical Year in 1957/58 and the establishment of the International Science Council (ICSU).

In practically all fields of science, the Great Acceleration saw an intensification and globalization of cooperative networks, leading to major

systems that together exhibit multiple forms of agency. Such a notion stands in an intriguing if paradoxical position vis-à-vis the ancient tradition of the “sphere” concept since the times of Sacrobosco. The sphere concept’s applicability in integrating different experiences in Earth-centered world views has persevered over centuries, even though the concrete experiences to which it has been applied are hugely diverse, ranging from the observation of recurring astronomical movements to the study of the global circulation of energy, matter, and knowledge on the planet. Unlike its ancient and medieval predecessors of the sphaera, the technosphere no longer relies on extrahuman stewardship, and instead represents a self-amplifying yet inherently fragile system, one which is itself endangered by the global dynamics it has set in motion.



Today we are witnessing the outsize effects of the increasing operational closure between the technosphere and the former “natural” spheres. Industrialized humanity steers our host planet into a state that might find doppelgänger on other planets, but finds no clear analogue in Earth history. One project of the Department looks at this very motif of the “**geological analogue**,” a concept that encapsulates the hybrid nature of the climate and Earth system sciences, which flexibly combine empirical traditions in geology or paleoclimatology with computer simulations driven by first principles. This epistemic mobility is interpreted as a productive unrest, blurring the boundaries between data and models while at the same time enabling current sciences to advance their research questions toward Anthropocene concerns.

A rendering of theoretical classes/stages of planets with different abilities to generate free energy. For Class V, a technobiosphere holds the planetary system within acceptable boundaries for energy intensive technological civilization. Collage created by Christoph Rosol from Figures 2 and 3 of Adam Frank et al., “Earth as a Hybrid Planet: The Anthropocene in an Evolutionary Astrobiological Context,” *Anthropocene* 19 (2017): 13–21.

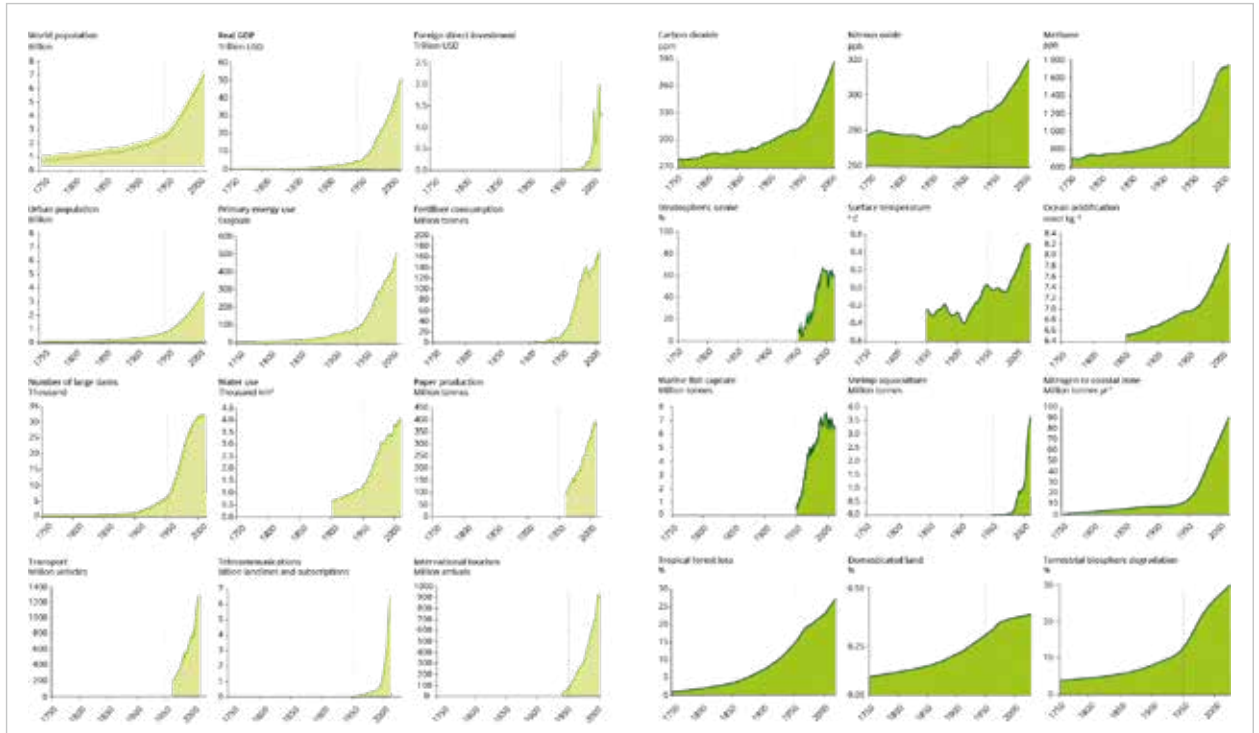
Coronavirus and Planetary Health

One immediate effect of humanity's disruptive power over the biosphere is the recent rise in emerging infectious diseases caused by zoonotic spillover, the most prominent of which is COVID-19. Shrinking habitats, a result of the reach of the technosphere into the remains of pristine rainforests, are enabling ever more humans and vector species to come into contact with host organisms. Department I has contributed to efforts to shed light on this connection in several public statements and scientific reports. Moreover, it has focused on the political epistemology of new scientific and public health concepts such as "Planetary Health" or "One Health" that take the reciprocal relationship between human health, ecosystem integrity, and the presence of biotic and genetic diversity into account, and that add historical context to the science of the relation between pathogens and environmental pressures, humans, and microbes. As part of the series "Basic Research for a Livable Future," organized by the Department as a regular prelude to the annual meetings of the Scientific Council of the MPG, an evening symposium on planetary health was held in late February 2019, just days before the pandemic hit the Western hemisphere.

In sum, the technosphere is a unifying concept that helps to guide and further develop the questions posed at the outset of our report. Can one delineate historical turning points in the ways (some) humans have started to harness new sources of energy—and thereby also increase their technological and political power? Is there an intrinsic knowledge economy at play in the coupling of material and ideological systems of modernity?

Our contention, based on preliminary research, is that the dynamics of the Anthropocene started with the operational closure of systems of globalization: the interlinking and ensuing codependency of production and consumption sites as an effect of a globalized colonization system; the extraction and circulation of resources in global markets; the global transport of goods, humans, and other species (the Columbian exchange); and the technoscientific undergirding of all these developments, including the design of novel materials and thermodynamic engines. Particularly salient within such historic network effects is the marked rise of fossil fuel-driven industrial capitalism, and the ensuing surpassing of the biological energy barrier. Mechanized agriculture and synthetic fertilizers increased agricultural yields multiple times over, while air transport, electronic media, and computer-aided financialization of global markets significantly contributed to the operational lock-in of the Anthropocene system.

An analysis of the gradual yet momentous crystallization of the technosphere is therefore a powerful approach for identifying the drivers and dynamics of the Anthropocene. Such a techno-Earth system view provides a conceptual entry point for understanding the Anthropocene as a transition that delineates biophysical and geochemical change processes as interdependent with historical and societal developments. We have labelled such an integrated framework guided by the heuristic notion of the techno-Earth system as "geoanthropology." Cast into a research framework that studies the complex coevolution of natural and human systems, geoanthropology focuses on temporal processes, presenting an opportunity to develop the key competency of the historical discipline further into a comprehensive understanding of the



coevolutionary behavior of socio-cultural-technological transformations and biophysical systems. One way to do this, for instance, is by complementing the signature pattern of the Anthropocene's onset, the Great Acceleration graphs, with an in-depth historical analysis of the underlying processes and causes, which are characterized by temporal but also spatial varieties, different historical trajectories, phases, and scales.

The establishment of geoanthropology as a new science and the execution of its highly interdisciplinary research is far beyond the scope of the Department. Nevertheless, an intensive effort has been undertaken to sketch out its scientific goals and institutional framework. A series of international conferences and workshops attended by leading scientists and humanists from fields as diverse as Earth system and climate science, systems ecology and evolutionary biology, environmental history and environmental humanities, human geography, and ecological economics have helped to inspire and further shape the programmatic outlines of such an enterprise.

This collaboration has been enabled and significantly strengthened by the Department's success in obtaining **third-party funding** during the report period. In 2018, the Department's Edition Open Access project (relocated to the library in 2020) was awarded a grant from the German Federal Ministry of Education and Research (BMBF) to improve its functionality and to simplify usage and installation. As a cooperation partner in a historical project on the establishment of the global system of research data circulation and exchange, the Department obtained an ERC Advanced Grant in 2020. Also in 2020, major BMBF funding in the field of digital humanities was granted in order to further develop the mathematical and theoretical foundations of socioepistemic networks (modelSEN). The Department also raised substantial funding from the MPG for the realization of the inter-institutional project "Mississippi: An Anthropocene River." Finally, the Department was awarded BMBF funding within the framework of BIFOLD to develop a deep neural network to calculate similarities between astronomical tables printed in early modern scientific papers.

A selection of indicators showing the Great Acceleration of socioeconomic and Earth system parameters around the mid-twentieth century. Source: European Environment Agency, "The European Environment: State and Outlook 2020" (Copenhagen, 2019), 36–37; based on Will Steffen et al. "The Trajectory of the Anthropocene: The Great Acceleration," *The Anthropocene Review* 2, no. 1 (2015): 81–98.

The Department is thus a leader in a new field that demands global collaboration among previously separate fields in order to understand urgent problems facing humanity and the Earth as a whole.



2018–2020

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Department I

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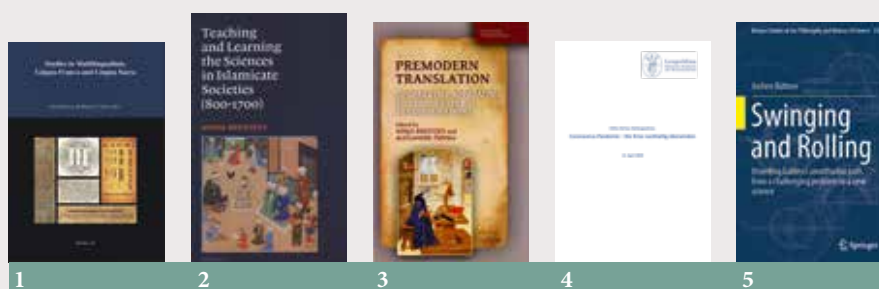
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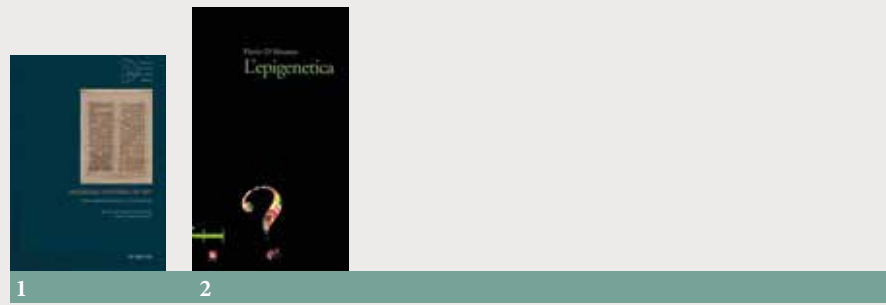
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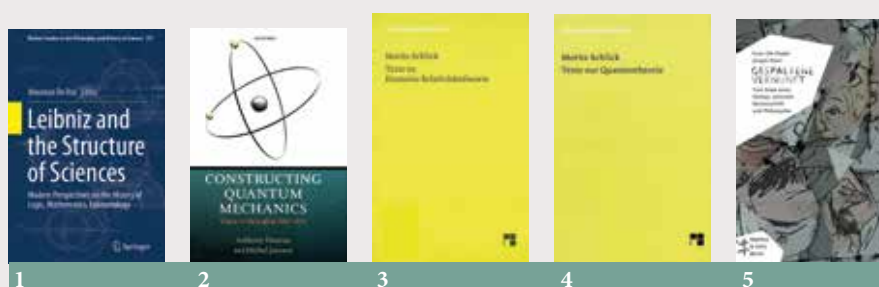
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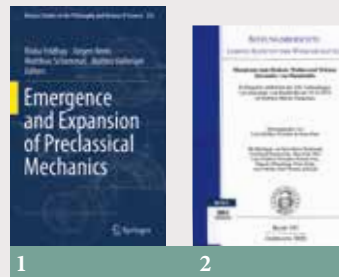
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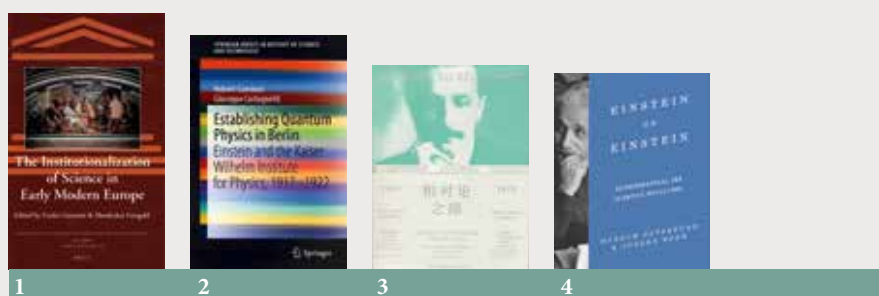
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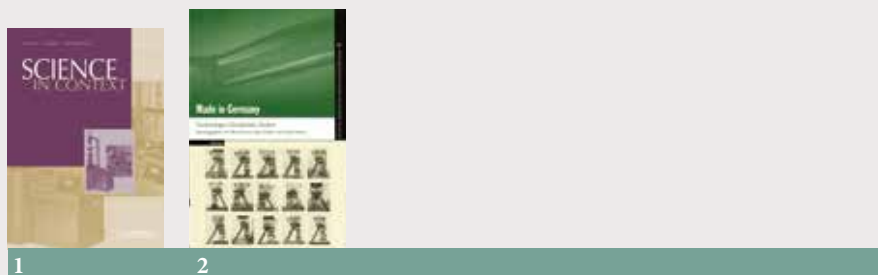
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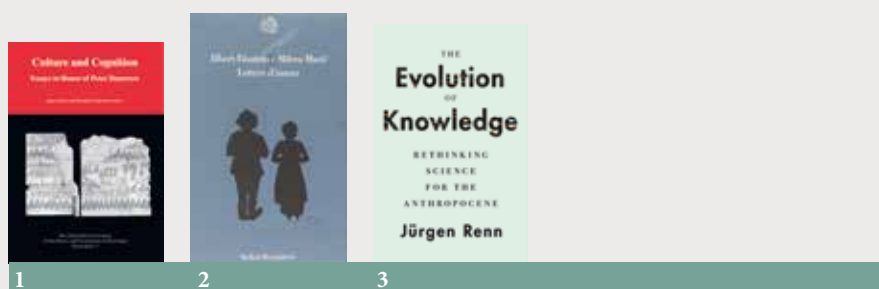
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Wintergrün, Dirk *see also* Lalli, Howey, and Wintergrün.

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Department II

The Ideals and Practices of Rationality

DIRECTOR Lorraine Daston



The Ideals and Practices of Rationality

Introduction

On June 30, 2019, Department II concluded over twenty-four years of research conducted by almost a thousand scholars from over thirty countries to explore the history of the ideals and practices of rationality, from ancient mathematics to contemporary neuroscience, from the medieval observatory in Samarkand to nuclear-powered submarines patrolling the Mediterranean. In the last *Research Report* (2015–2017), Department II retrospectively surveyed the who, what, why, and how of this research program to mark its last [full reporting period](https://www.mpiwg-berlin.mpg.de/research-reports). In addition to documenting the fruits of the research pursued during Department II's last eighteen months (January 1, 2018–June 30, 2019), this report takes a long view of how Department II's research program—and the very meaning of research—has evolved over almost a quarter century in tandem with broader trends within the history of science and knowledge.

<https://www.mpiwg-berlin.mpg.de/research-reports>



Donato Creti, *The Comet: Astronomical Observations* (1711). Museum: Pinacoteca Vaticana. License: Courtesy of Wikimedia Commons.

Twenty-Four Years of the History of Rationality



Willem Blaeu, *Licht der Zeevaart* (1608), frontispiece.

A navigator fixes a course by the stars; a weaver strings a loom with an intricate pattern of colors and shapes; a city official discerns a link between a certain well and the outbreak of an epidemic; a brewer adjusts ingredients to speed up fermentation; a courtier infers a royal intrigue from an exchange of glances; a bureaucrat organizes the tax system of an empire; a herbalist identifies a plant that heals wounds. All of these accomplishments certainly qualify as knowledge, and highly refined knowledge at that, based on close observation, seasoned judgment, and subtle inference. Their accuracy, reliability, and utility are not in doubt; their rationality in matching means to ends is indisputable. But is the same kind of rationality exemplified in a mathematical demonstration, a

precise measurement under controlled laboratory conditions, solving a game-theoretical matrix, making an anatomical image, or constructing the stemma of an ancient text? Is there any common denominator that links all of these rational practices, which cut across divides of head and hand, science and knowledge, the natural and the human sciences?

These are the kind of questions that have shaped the research program of Department II since 1995. Dedicated to understanding the “Ideals and Practices of Rationality,” Department II has for the past twenty-four years probed the forms of rationality using historical, cross-cultural, and cross-disciplinary comparisons. The retirement of director Lorraine Daston in June 2019 has brought the work of the Department to an end. What have we learned about rationality?

First, giving an apparently timeless concept like rationality a history means confronting the extraordinary variety of forms it takes.

What a philosopher might regard as conceptual incoherence is a windfall for the historian. Variety points to different histories and different epistemic goals. Department II Working Group volumes such as *Biographies of Scientific Objects* (2000), *Histories of Scientific Observation* (2011), and *Data Histories* (2017) document the diversity of forms of rationality embodied in scientific experience and the contexts in which they first arose. Other Working Group volumes, such as *How Reason Almost Lost Its Mind: The Strange Career of Cold War Rationality* (2013) and *Ancient Mathematical Commentaries* (2021), examine the equally remarkable diversity of more formal versions of rationality, from calculation to Bayesian probability. Some forms of rationality emerge very early and endure very long, such as the regimes of systematic astronom-

ical observation initiated in ancient Mesopotamia and China or clinical observation in ancient Egyptian and Greek medicine; others, such as the chemical assay, the sociological survey, or the randomized clinical trial, emerge much later; and new forms are still emerging, such as the computer simulation and big data mining.

Working Group: “Mathematical Commentaries in the Ancient World: A Global Perspective” 2018–2020

ORGANIZERS Karine Chemla (Sphere, CNRS/University of Paris I) and Glenn W. Most (Scuola Normale Superiore di Pisa/MPIWG)

Commentaries are a worldwide phenomenon, stretching back to ancient times in many intellectual traditions, which provide the history of science with precious insights into the concrete practices with which practitioners read and dealt with the documents they used. Particularly in the case of foundational mathematical texts, these commentaries have rarely been translated or incorporated into critical editions, depriving the modern reader of evidence of how ancient readers experienced these texts. The Working Group volume is the first attempt to exploit this source for the history of ancient mathematics in comparative perspective.

Forthcoming with Cambridge University Press in 2022.

Mount Meru instrument (*Meru-yantra*).
Produced by the Devipuram Temple,
Andhra Pradesh, India. Public domain.



These diverse histories leave deep traces in current scientific practice. Although all of these forms of experience, systematized by method and reflection, are undeniably rational, their different histories make integration challenging: how, for example, to integrate the results of clinical observation and randomized clinical trials in medicine, or physical and statistical models in meteorology? As the Working Group volume *Data Histories* (2017) shows, the empiricism of the laboratory, driven by the quest for causes, and of the field, rooted in intimate acquaintance with specimens in context, sometimes clashes with the search for patterns in amalgamated data using machine learning algorithms. Even within more formal sciences, particular historical circumstances can generate divergences: for example, the Working Group volume *How Reason Almost Lost Its Mind: The Strange Career of Cold War Rationality* (2013) showed how the nuclear standoff between the United States and the Soviet Union during the Cold War fostered a rationality of rigid rules at odds with traditional ideals of reason and judgment.

Time-honored philosophical categories like “empiricism” and “rationalism” have proven inadequate to the variety and creativity of rationality in practice. Even if the examples were confined just to the realm of modern scientific disciplines, doing full justice to this rainbow of forms of rationality would entail a fundamental rethinking of rationality as a uniform, unchanging set of norms.

Historians of science are unlikely to be surprised by this diversity and dynamism. For several decades, even the history of modern science, circumscribed by current definitions of science and scientific disciplines, has revealed a plethora of forms of inquiry and standards of evidence, explanation, and proof—even within a single discipline such as physics or biology. Moreover, especially historians of early modern science have shown how practices that were originally developed in the scholar’s library, the artisan’s workshop, or the apothecary’s still were repurposed into the



Meteorological station in Barombi (German Cameroon), ca. 1900. Archive of the Deutsche Kolonialgesellschaft, University Library, Frankfurt am Main.

observer's notebook, the natural philosopher's experiment, or the chemist's distillation. The net result of this large and growing literature has been to cast doubt on any static, monolithic, and sharply bounded concept of science. There turn out to be many ways of being—and becoming—scientific, and it is in the dynamic nature of scientific inquiry to be inventing new ways all the time.

But the aim of these studies in the history of science and more broadly of rationality has not been to fragment, much less discredit rationality as both ideal and practice. To give rationality a history means not only confronting the diversity of its expressions but also explaining how its dif-

ferent forms, developed in different contexts to different ends, have been integrated with each other in research and demonstration. One of the oldest examples of such integration treated by a Department II Working Group was how observation and experiment, once distinct pursuits, came to be yoked together in the seventeenth and eighteenth centuries (*Histories of Scientific Observation*, 2011); one of the newest examples concerns how fieldwork in the earth and climate sciences is being intercalated with data from satellite surveillance (*Experiencing the Global Environment*, 2018). The work of collecting and integrating the accumulated practices of rationality, as old as observation and as new as Bayesian modeling, often goes on behind the scenes, in graduate seminars and the production of standard reference works, as shown by the Working Group “Learning by the Book: Manuals and Handbooks in the History of Science” (2020).

Working Group : “Learning by the Book: Manuals and Handbooks in the History of Science” 2017–2020

ORGANIZERS Angela N. H. Creager (Princeton University), Mathias Grote (Humboldt-Universität zu Berlin), Elaine Leong (MPIWG/University College London)

Instructional manuals and handbooks are central to the making of scientific and other kinds of knowledge. Across diverse communities, from learned societies to biomedical laboratories to artisanal workshops, instructional texts codify and communicate key knowledge to new practitioners, thus bringing local know-how into a global context. This project uses manuals and handbooks as a focal point to weave together a long view and geographically broad history of knowledge transmission, paying particular attention to processes of revision, standardization, maintenance, and preservation. The Working Group brings together the history of science and the history of the book to consider how practices relate to texts and learning relates to doing.

Published as volume 5 of the *British Journal of the History of Science Themes* in December 2020 and available [open access online](#).



<https://www.cambridge.org/core/journals/bjhs-themes/volume/7001F78A212097C-CB7683031434BFD54>

These questions and many others show that once rationality is revealed to be inventive and multifarious, rather than timeless and monolithic, new fields of inquiry emerge—fields of inquiry that will require cooperation among historians, philosophers, anthropologists, sociologists, and scientists.

Second, this kind of history forces a rethinking not only of the chronology and geography but also of the shape and subject matter of the history of science.

In the past thirty years, the history of science has been transformed by a focus on context and practice. The work of Department II has been deeply indebted to this turn. But strictly local contexts, often defined by the standard subfields of general history (themselves the products of nationalist historiographies), have always been a bad fit for the history of science, which has been a polyglot, multicultural undertaking since ancient times. Modern nationalist historiographies are an even worse fit for the slow, sprawling history of rationality, which spans continents and centuries. Working Group volumes like *The Moral Authority of Nature* (2004), *Science in the Archives* (2017), *Entangled Itineraries: Materials, Practices, and Knowledges across Eurasia* (2019), and *Histories of Bureaucratic Knowledge* (2020) therefore framed their topics within long timelines and broad geographies that deliberately cut across traditional specialties in history and the history of science.



Shiba Kōkan (attr.), *A Meeting of Japan, China, and the West* (late eighteenth century). Minneapolis Institute of Art. Public domain.



Al-Idrisi, Map of the world, from a 1456 copy. Bodleian Library, Oxford University, MS Pococke 375, fols 3v–4r. Public domain.



Uniform of a middling civil servant at the Prussian Railway Administration, 1890. Striking dress helped to define the persona of bureaucrats in fin-de-siècle Europe. Source: Deutsches Historisches Museum, U 61/111.

<https://journalhistoryknowledge.org/collections/special/histories-of-bureaucratic-knowledge/>



Working Group : “Histories of Bureaucratic Knowledge” 2017–2020

ORGANIZERS Sebastian Felten (MPIWG/University of Vienna),

Christine von Oertzen (MPIWG/Humboldt-Universität zu Berlin)

Bureaucracies are in perpetual motion, constantly adapting their procedures to meet shifting goals as they regulate state, economic, or religious affairs. Applying a history of science approach to analyze bureaucratic actions as knowledge practices, the Working Group examined routine procedures and rule following by focusing on their epistemic dimensions. Each of the resulting nine case studies examines the concepts and cognitive practices that underpinned bureaucratic rule in settings ranging from the medieval Latin West, Chosŏn Korea, Spanish America, the Dutch East India Company, the Ottoman Empire, Saxony, Qing China, Prussian colonial expansion into Poland, and colonial rule in German New Guinea. Understanding bureaucracies in the past is best done by attending to the knowledge processes they have enabled and through which they have been sustained. Published as the inaugural special issue of the *Journal for the History of Knowledge* in December 2020 and available [open access online](#).

Other Working Group volumes such as *Historia: Learned Empiricism and Erudition in Early Modern Europe* (2004) and *Canonical Texts and Scholarly Practices: A Global Comparative Approach* (2016) straddle boundaries between science and knowledge and between the natural and human sciences. All historians of science know that their subject matter, science, is itself a product of history, and that different epochs, cultures, and languages define their own versions of the most prestigious form of knowledge in strikingly different ways. Some may value textual erudition; others may favor technological innovation; still others may enshrine theoretical understanding. How knowledge is classified and arranged in hierarchies is itself an object of historical inquiry, as are the values that knowledge serves. To project current disciplinary divides as they are institutionalized in the modern university onto other times and places is to erase the history of the subject matter of the history of science.

What the history of rationality contributes to this ongoing debate over what the history of science is about are dimensions of comparison that do not presume the perspective of modern science but are nonetheless undeniably relevant to that perspective. For example, epistemic virtues such as explanatory coherence, continuity of tradition, predictive accuracy, generality, certainty, precision, and objectivity are not always found together, are not always in harmony with each other when they are, may occupy different rungs in a hierarchy of such values depending on context, and all have their particular histories. These epistemic virtues are integral to rationality, but not all of them in equal measure to all forms of rationality. Thinking about these ideals of rationality as well as the practices that instantiate them offers an alternative way of conceptualizing the current wildly asymmetric division between modern science and knowledge, the latter nebulously defined as everything except modern science, from the humanities to ship-building to military strategy.

Instead of asking what kinds of knowledge do or do not resemble modern science, the history of rationality asks what kinds of knowledge are upheld as most worthy of cultivation and why. Our epoch elevates knowledge that promises practical applications to the pinnacle of the hierarchy; other epochs have prized purity above all else. Who pursues knowledge where can be as consequential in ordering the hierarchy as



Homemaker writing in her account book. Porcelain figure by Joachim Kändler, ca. 1756. Copyright Stéphane Piera/Musée Cognacq-Jay/Roger-Violet.

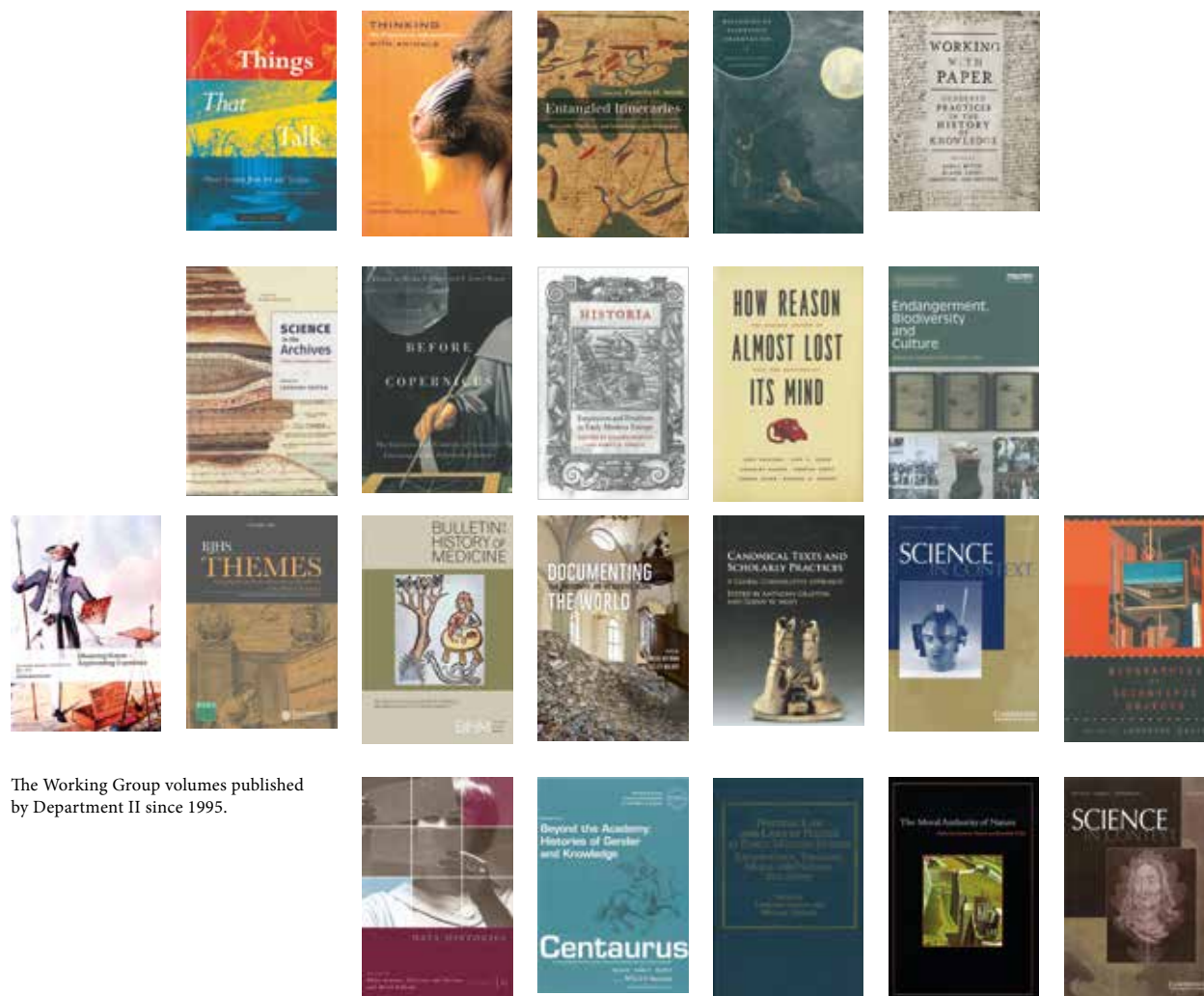
what and how. Bespectacled men in white lab coats have in recent years been joined by women calculators in offices, glass-blowers in workshops, engineers on the battlefield, citizen scientists in front of their computers, and herbalists almost everywhere as the *dramatis personae* of the history of science. The Working Group volume *Working with Paper: Gendered Practices in the History of Knowledge* (2019) highlighted this expanded cast of characters by tracing the uses of that versatile and still most essential material in the making of all kinds of knowledge: paper.

Third, the history of rationality conceived on this panoramic scale can only be done by a collective of scholars.

The resources of the MPIWG made possible sustained collaborations that could not have been accommodated by either a university or even an institute for advanced study, where priority is given to the individual research projects of scholars in the humanities and social sciences. These Working Groups, consisting of anywhere from six to eighteen scholars who work together to produce a collective publication, have been the backbone of the research program in [Department II](https://www.mpiwg-berlin.mpg.de/page/dept-daston-working-group-books) since its beginning in 1995.



<https://www.mpiwg-berlin.mpg.de/page/dept-daston-working-group-books>



The Working Group volumes published by Department II since 1995.

The Working Group format, which has also become a hallmark of research at the MPIWG, is still a work-in-progress. Most groups have opted in favor of individually authored chapters that have been framed within a shared analytical framework hammered out in group discussions. These discussions may go on over a period of weeks, when all members of the Working Group are resident at the MPIWG, or in a series of meetings that stretch over several years. This format strikes a compromise between intense collaboration and the individual authorship by which most universities still evaluate scholarly achievement in the humanities. However, a few groups have aimed for a multiauthored volume written in a single, collective voice—obviously more labor-intensive but a further step toward conceptual coherence. Other formats are still being explored by all the research units at the MPIWG.

Such collaborations are rare in the humanities, but if the experience of Department II over the past twenty-four years is any index, there is every reason to attempt more of them as the scope of the history of science expands to encompass more cultural traditions and the well-nigh constant exchanges among them. One good reason to join forces is the same as that for collaboration in the sciences: experts from different specialties can pool their knowledge to address a shared problem. But the MPIWG Working Group collaborations diverge from the scientific model in at least two important respects. First, the aim is not to achieve efficiency through a division of labor

but rather to overcome the division of labor. A successful Working Group is one in which all members have steeped themselves in the work and approaches of the other members to the extent necessary for informed criticism and agreement on shared assumptions. Second, the Working Group does not simply address a shared topic of interest; it ultimately strives to redefine that topic or create a new one. The goal of Department II's Working Groups has been to open up new fields of research—to have the first word, not the last.

Research itself—its forms, its aims, its history—has engaged the attention of Department II scholars from beginning to end. The last workshop held under the auspices of Department II, coorganized by Lorraine Daston (MPIWG) and Peter N. Miller (Bard Graduate Center, New York City) asked, “*What Is Research?*” (June 12–13, 2019) and sought answers from ancient China and Mesopotamia to twentieth-first-century research and development, from the sciences, the social sciences, humanities, and the arts, and from those who do research and those who fund it. Nothing reveals a culture's deepest values more distinctly than what it wants to know more about, often at great cost in time, talent, and resources. Time alas did not permit Department II to continue this investigation with a Working Group, but further activities concerning this topic are planned at the [Bard Graduate Center](#).

Not all of the almost 1,000 scholars who were part of Department II were members of the Working Groups that produced the volumes that became the Department's signature publications, but every single one of them contributed to the spirited intellectual community that will live on among the Department's alumnae and alumni. On June 21, 2019, over 250 Department II scholars, past and present, gathered at the MPIWG on a bonny summer day to review twenty-four years of thinking together about how to do the history of rationality. Those two-plus decades yielded many surprises for all of us, a surprising number of them fruitful, and the occasion was fittingly marked by a volume edited by Mechthild Fend, Anke te Heesen, Christine von Oertzen, and Fernando Vidal with contributions from 107 Department II scholars, entitled *Surprise: 107 Variations on the Unexpected*.



Every academic year in Department II began with a day-long workshop at which all scholars presented their research in five minutes and with one image (September 2018).

→ Workshops and Conferences

<https://www.bgc.bard.edu/publications/all/96/what-is-research>



<https://www.mpiwg-berlin.mpg.de/resources/publications/books/surprise-107-variations-unexpected>



Surprise: 107 Variations on the Unexpected.





Celebrations on the occasion of Lorraine Daston's retirement as Director of Department II. A ninety-minute program with talks and musical performances, and a reception in the Institute's courtyard, was followed by the unveiling of a miraculous and delicious cake created by a pastry artist. Photos by Arne Sattler, Herbert Stattler, Tanja Neuendorf, and Anke te Heesen.



2018–2019

DIRECTOR Lorraine Daston

SENIOR RESEARCH SCHOLARS Christine von Oertzen, David Sepkoski,
Annette Vogt

RESEARCH SCHOLAR Sebastian Felten

MINERVA RESEARCH GROUP LEADER Elaine Leong

POSTDOCTORAL FELLOWS Maria Avxentevskaya, Hansun Hsiung, Katja Krause

PREDOCTORAL FELLOWS Lily Xiaolei Huang, Kristine Palmieri, Laura Sumrall

VISITING SCHOLARS Ken Alder, Gadi Algazi, Bruno Belhoste,

Maria Montserrat Cabré Pairet, Joan Cadden, John Carson, Sandra Cavallo,
Karine Chemla, Jamie Cohen-Cole, Angela N. H. Creager, Flavio D'Abramo,
Sietske Fransen, Sebastian Felten, Cathy Gere, Daniela Helbig, Patricia Kitcher,
Philip Kitcher, Suzanne Marchand, Andrew Mendelsohn, Javier Moscoso,
Projit Bihari Mukharji, Meera Nanda, Katharine Park, Jennifer Rampling,
Jaya Remond, Joan L. Richards, Francesca Rochberg, Daniel Rosenberg,
Sophie Roux, Anne Secord, James A. Secord, Mårten Söderblom Saarela,
Mirjam Voerkelius, Dror Weil, Benjamin Wilson, Elaine Wise, Norton M. Wise,
Gloria Yu

VISITING POSTDOCTORAL FELLOWS Minakshi Menon, Omer Michaelis,
Ion Gabriel Mihailescu, Michael Squire, Xiaona Wang

VISITING PREDOCTORAL FELLOWS Audrey Borowski, Vincent Deluz,
Thomas Erslev, Christian B. Flow, Eric Moses Gurevitch, Abram Kaplan,
Andrew Lea, Anna-Maria Meister, Nicholas Michel, Yasuhiro Okazawa,
Carola Ossmer, Aaron Richmond, Richard J. Spiegel, Ohad Reiss Sorokin

ARTIST IN RESIDENCE Tal Halpern

JOURNALISTS IN RESIDENCE Siobhan Roberts, Julia Voss

SUPPORT TEAM Josephine Fenger, Regina Held, Anna Radetckaia, Chaonan Zhang

STUDENT ASSISTANTS Marius Brunzel, Nina Ludwig, Laura Selle, Anna Wolk

Department II

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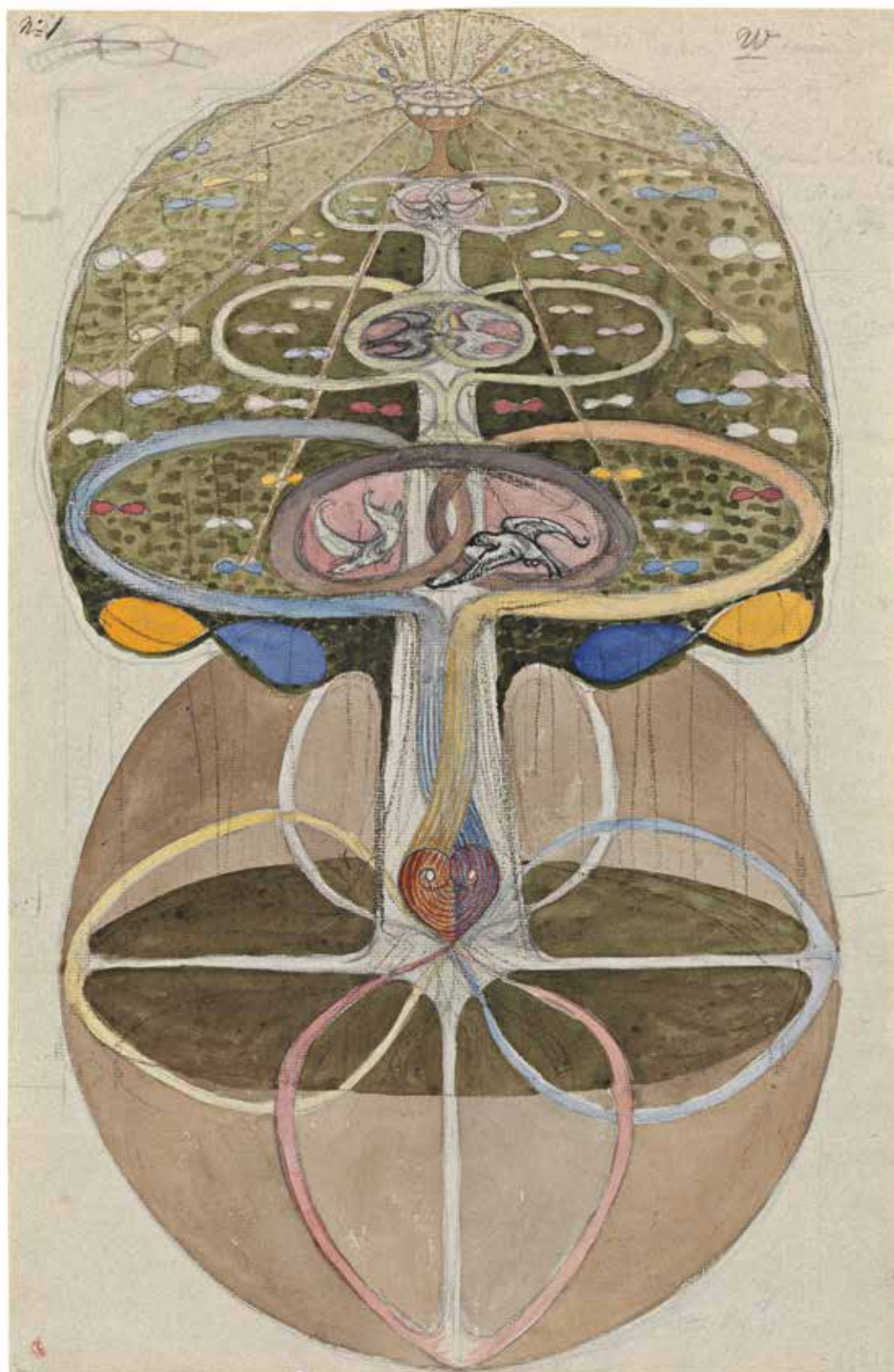
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Department III

Artifacts, Action, Knowledge

DIRECTOR Dagmar Schäfer



Artifacts, Action, Knowledge

*If there were only one truth, you couldn't paint
a hundred canvases on the same theme.*

Pablo Picasso

Introduction

“If we say that science is organized knowledge,” Herbert Spencer remarked in 1857 in his *Genesis of Sciences*, “we are met by the truth that all knowledge is organized in a greater or less degree.” Historically, he argued, it was “not logically justifiable” to maintain that an ordinary action such as dyeing household cloth was more or less systematic than, for example, that of a geologist sampling minerals. In both cases things and information were tied together, inferences drawn, results expected. Inspired by Charles Darwin’s evolutionary theory, Spencer suggested that over time humans expand ordinary knowledge and deepen their understanding of the world’s informational structures. He eventually endorsed a distinction between common and scientific knowledge, but he also cautioned his reader that no “one” rational system of knowing existed among the many possible subjects or communities, nor was there any inevitable, linear system of progression in such ordering practices or concepts apart from human convention itself.

More than a century after Spencer, Evelyn Fox Keller likewise emphasized this diversity of orders in understanding the structures of nature, juxtaposing herself to those who would understand nature in terms of laws entirely independent from the structures of knowledge. Honing in on such kinds of order revealed by the history and sociology of science, Fox Keller unfolded the gender-based power hierarchies in Western academia, and specifically “undercut some of the irrefragable intuitions” that persist in our modern view of science. Her work has become part of emerging, less biased, ways of studying the history of science, technology, and medicine.

Building on these insights, Department III voyages onto history’s oceans of order, plotting how the gravitational pull of the ordinary has enabled people to navigate unruly currents and maelstroms on the seas of knowledge. Inspired by Jean Piaget’s notion of knowledge acquisition as a process of ordering, we study the history of science as a continuous navigation to find and establish different orders, rather than a process of locating the small islands of singularity in which the truth reigns supreme as laws. Our research practice weaves together the strands of experience to furnish an overview of ordering principles while still maintaining the integrity of each strand. We focus on three of the tools—social (action), material (artifacts), and epistemic (knowledge)—that cultures have, in our view, used to order knowledge and to know-

Tree of Knowledge, Hilma af Klint, HaK133,
courtesy of The Hilma af Klint Foundation.
Copyright photo: Moderna Museet,
Stockholm.

ingly create order. Each tool provides the impetus for a research pathway. We present them here in an order that reflects our methodological approach and schools of debate in historical China, which is also the chronological order of the research pathways forged organically during the reporting period.

The **first, social (action)**, follows ordinary knowledge(s) and practices of organizing and systematizing our world. Our working hypothesis is that knowledge emerges as a result of the social action of ordering. We are particularly interested in the intentionality of this act—of how people, in the effort to make things work, produce knowledge through ordering. We trace these processes as they historically become apparent in plans—failed and successful, routes taken and not taken—and we explore how power and judgement play out in shaping orders. Planning has allowed individuals, communities, and states to develop, experiment on, stabilize, and distinguish different kinds of orders—ordinary or scientific, valid or pragmatic, etc.

The **second, material (artifacts)**, concerns the material basis of and for ordering—how order is derived from things and ordering means making things. Focusing on ordering, we see how making has historically not only been limited to the making of objects, but that through submitting to human ordering, words, bodies, and objects equally come to be “things” that are made. Crops are thus not only a thing of our lived reality but are made to be distinguishable from weeds. We are attentive to how material instantiations of ordering efforts affect human action by discriminating realities such as how animals, meaning animals that moved in the wild, were made into things that could not move, as people learned to domesticate them. To understand how practices, concepts, or logics of systematizing and ordering the world came about, it is equally imperative to understand how, with things, order was established and how, without them, knowledge has vanished—as animals and plants have gone extinct, bodies have been silenced or ignored, objects have decayed and books have been lost.

The **third pathway, epistemic (knowledge)**, critically engages with ways in which one system of order is imposed over another. This imposition of order over order—to modify Evelyn Fox Keller’s description of how science “produces order from order”—constitutes the *work* of knowledge. We scrutinize how, throughout time and space, people have taken the distinctive patterns and order they discern as arising from within phenomena, as the “natural” order that they then expand and escalate as a means to order the same and other phenomena. We wish to understand how the world has changed with the imposition of different versions of knowledge orders and to thus render visible the historical plurality of order, thereby not only undercutting but changing some of the “irrefragable intuitions” that have driven science, technology, and medicine and continue to engender inequalities.

Before presenting this research in more detail, it is crucial to first convey how the Department works. Department III researchers work in diverse fields. They may be historians, philosophers, anthropologists, archaeologists, artists, or museum or digital humanities scholars, and engaged in disciplines such as art, environmental studies, or cultural studies. Our international multidisciplinary scholars pursue our goals using a variety of methods, including micro- and macrostudies, cross-cultural comparison, material scientific analysis, text-critical research, object and material culture research, and archival and computational methods. We use the flexibility of MPG structures to move away from projects neatly defined by time spans. Instead, we set up a research theme and then allow Working Groups to develop organically, focusing

on specific topics or choosing a temporal focus. Underlying these structures, we have several long-term initiatives, which we call source-based initiatives, that deal with our historical sources as the artifacts of efforts to create order. In some cases, we directly investigate the orders of these sources, such as in the project on Chinese local gazetteers. And in others, such as in the project on visualizing the heavens, we attempt to break apart the historical artifacts and reorder what we find to see how politics, material conditions, and social ideals of the past and present have affected our view of historical scientific dynamics.

In the following, we outline our major research areas in the chronological order in which they were established within Department III: **(1) action and histories of planning order socially; (2) artifacts and the body of animals as material conditions; and (3) knowledge processes of differentiation.** In each section we highlight some of the work carried out in each of these areas from 2018 to 2020 and how we have contributed to methodological debates. The projects under the rubric of “Action” are now in their eighth year of activity, with a large body of research that has been consolidated and published during the current report period, while the projects under the rubric of “Artifacts” are presently most active in terms of workshops and producing new knowledge, having begun their research program in 2016, with publications to follow in the next reporting period.

1 Planning Order Socially: Baselines, Local Knowledge, and Ownership



The Pasterze Glacier in Austria.
Photo: Nathan Wong, 2007.

Like any other order, the realm of ordinary knowledge is a moving target. Historically it comes in many guises: as common sense; as reliable, useful, everyday, vernacular understanding; as collective or individual experience. In the wake of feminist studies, sociologists and philosophers defined ordinary knowledge as knowledge of the sort that we use to orient ourselves in and move through society. This definition has been highly influential, decisively impacting some historical studies in particular, where it was taken as a counterpoint to specialist knowledge and science, technology, and medicine. Into the twenty-first century, a

growing body of research then nuanced the term “everyday” or “ordinary” knowledge to address a cultural and geographic bias in the history of science and technology, and to show that local, indigenous, or situated knowledges have been key to scientific and technological change. Such studies have emphasized the actors who detect patterns and connect information to do science beyond the laboratory, arguing that scientific orders have always reflected social ordering and structures of power. “Science is created locally but then, by other processes, is transferred outward toward more general contexts,” noted James Secord in 2004. Kapil Raj (2010) similarly saw this as a reversal of science’s primacy of universality over locality in which science was challenged by local knowledge. In this view local meanings, practices, and contents became important in the making of global sciences simply by their very existence.

Working within this important and rich body of scholarship, Department III has dedicated the first strand of its research program to scrutinizing how knowledge that is taken for granted is partnered with scientific and technological systems of ordering. Our working hypothesis is that all knowledge organization relies on basic actions—actions that aim to make knowledge work, that is, to make its things work out for its actors; and that these actions leave behind a diverse landscape of evidence as well as historical alternatives—routes taken and not taken—which go beyond our most deeply held convictions and indubitable assumptions.

Many of these projects evolved out of, or were completed within, an inaugural research cluster within the focus on histories of planning that we called “**The Art of Judgement.**” Working Groups under this thematic umbrella tackled historical efforts to deal with locally diverse information and knowledge orders—either by reducing and “baselining” such diversity from a global view; or by determining how, where, and when such diversity has to be managed/taken into account—on the central state or local level, communally or by individuals. A second thematic umbrella, “**Scale and Scope,**” was concerned with the magnitude and comprehensiveness of efforts to create order.

Thinking in Many Tongues

The Working Group “Thinking in Many Tongues”—which explores the role of language and how people have always lived, and scholars have always worked, in plurilingual worlds—developed into the Working Group book *Thinking in Many Tongues: A Reader on Plurilingualism in Traditional Eurasian Scholarship*, forthcoming from Brill.

The Working Group “**Baselining Nature**” is focused on one historically prevalent way of responding to the challenge posed by the incredibly diverse and complex world in which humans live, practiced frequently by political and social elites: namely, to reduce complexity by abstraction or by establishing normative frameworks. By 1074, for instance, it had become clear that Chinese astronomers were unable to accurately predict the movement of heavenly bodies and foresee possible anomalies, furnishing critics with ammunition to attack the legitimacy of the Song rulership. In response, Chancellor Shen Gua suggested considering the determining factors of these predictions—the premises of astronomical inquiries—and urged the astronomers and mathematical experts of his time to first “simplify their instruments for measurement.”

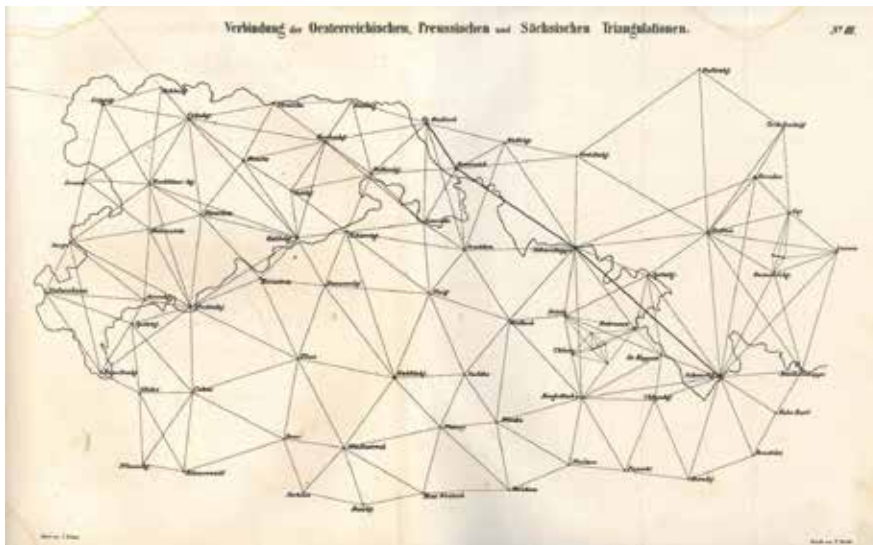
Shen Gua is one of many historical examples illustrating that an important tool for finding and maintaining order and patterns in our complex environment has been the ability to make and enforce decisions about where to select from the mass of available information. Research in Department III has accordingly honed in on other, similar cases to explore how science has determined places, ecosystems, and timelines to be natural by setting reference points.

Baselines and reference points figure as central boundary markers of the emergence of sciences. Since the nineteenth century they not only produce divides but also contribute to making the environment a legitimate subject for research. They split, for instance, the world into what is considered to be natural or healthy and what is not. Or they create clear markers between different spatial elements, such as land and sea or hills and mountains. Inspired in part by Daniel Pauly’s identification of the “shifting baseline syndrome”—a process in which each generation of scientists takes the impoverished ecosystems at the beginning of their career as “natural,” often missing the longer-term processes of degradation that preceded their investigations, the interdisciplinary group “Baselining Nature” investigated the “baselining” practices by which scientists and policy-makers determine and evaluate such ideal ecological conditions in the first place.

In its results, published in a special issue of *Environment and Planning E*, the Working Group collectively revealed the role of uneven power relations and inequality for any cultural imagination of a “natural” state. These articles demonstrate that the choice of certain historical baselines has historically functioned intentionally at a variety of spatial scales as a means to facilitate or hinder the use of landscapes, animals, or humans for capital or moral economies. The takeaway is that definitions in different fields of scientific inquiry depend on political judgements that scientists make, consciously or unconsciously, when they accept standards or reference points as objective. The challenge that remains is to peel back and expose the layers of knowledge-making active in an ongoing process in which the incidental is accepted as the inevitable.

Taking up this challenge means questioning the commonly accepted narrative that while baselines were developed primarily to allow for comparative research across time and space, it is only at a later stage that they became reified as objects of political debate. The group's research rather points to ways in which "comparisons transform the world, establishing bonds between entities that traditionally were deemed as different, even incommensurable." Returning to histories of baselining: contextualizing them within debates about the Anthropocene and global health thus has the potential to make a significant impact by offering new tools for assessing environmental change—by showing, for instance, how the exploitation of shale gas depends heavily on a nullification of formerly acceptable baseline conditions. This case study in particular contributes to a wider debate in recent scholarship about the need to join work in the history of science with the methods and techniques of environmental history in order to further our understanding of the historical development of the perception of, interaction with, and response to global environmental change.

The introduction to the special issue of *Environment and Planning E* by Sebastián Ureta, Thomas Lekan, and Wilko Graf von Hardenberg, "Baselining Nature: An Introduction," argues that the scientific practices that produce baselines are not "innocent" and do not only become politicized ex post, but are themselves products of political debate.



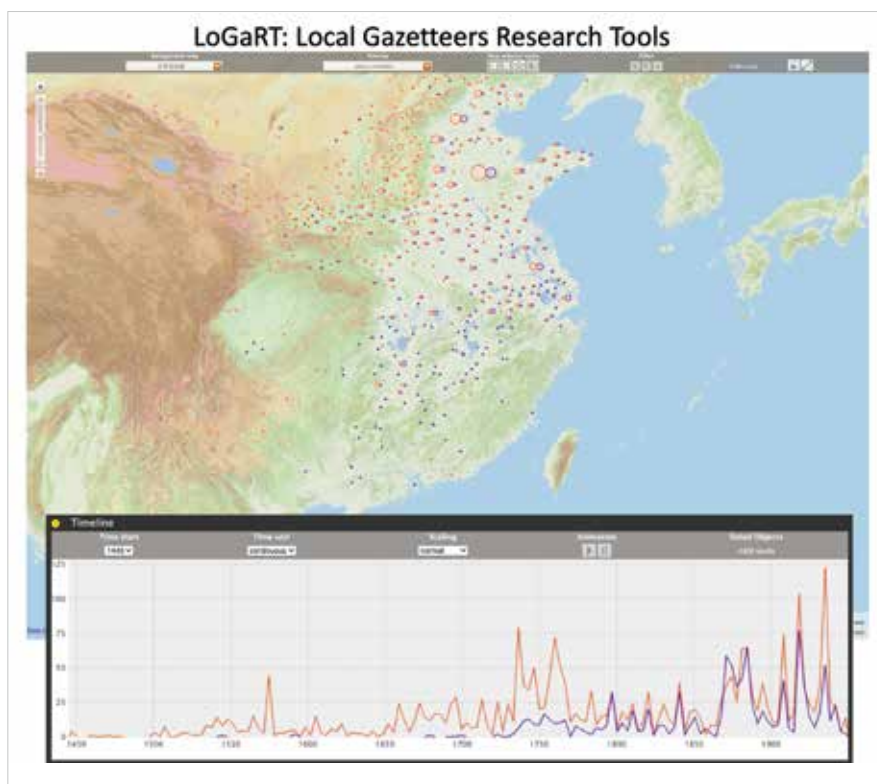
Connection of the Austrian, Prussian, and Saxonian triangulations according to Johann Jacob Baeyer. *General-Bericht über die mitteleuropäische Gradmessung pro 1863* (Berlin: Reimer, 1864). Public domain.

This work on baselining nature is complemented by the source-based initiative on "Measuring the Earth." Aiming to produce an exemplary case study of how computational methods can contribute to foster such research venues, Department III invested in an open repository of primary sources for the history of geodesy. At the center of this project lies a multilingual corpus of conference minutes produced in the late nineteenth century by what later became the International Association of Geodesy, digitized in cooperation with the GeoForschungsZentrum in Potsdam. Working on a thematically coherent corpus of more than 15,000 pages, the group has

continued under the leadership of Hardenberg to evaluate different methods for corpus analysis and distant reading, and to develop appropriate techniques to study and interpret multilingual corpora. The project provides open access to the whole repository through an advanced search and filtering interface that makes it possible to overcome the known limitations of OCR through a combination of fuzziness and curation. The ability to combine browsing with complex searches is showing potential to uncover fruitful insights, contributing to one recent article by Hardenberg (“Measuring Zero at Sea,” 2020), and enabling the work of former visiting fellow Julia Sanchez-Dorado, who is using the system to explore the use and placement of images. The group is considering the feasibility of embedding this corpus in a wider knowledge network through linked data, as well as the possibility of enriching the corpus itself with other historical series of geodetic research reports and minutes, possibly further broadening its linguistic breadth. The project promises to break new ground in the combined analysis of the historical development of perceptions of environmental change, transnational and interdisciplinary debate in the field, and the minutes of scientific meetings as a genre.

The credibility of knowledge, experience, or information has always been a crucial dimension within the social planning of order. In order to scrutinize how the taken-for-grantedness of local knowledge was framed and practiced historically in China, the source-based initiative “China’s Local Gazetteers,” developed new digital analysis methods that have spawned several associated research projects. These include the workshops “[Knowing an Empire: Imperial Science in Early Modern Chinese and Spanish Empires](#)” and “[Locality and Geographical Knowledge in Imperial China](#),” for which special issues are currently in preparation. Attention is now being directed to the visual material in Chinese Local Gazetteers.

→ [Workshops and Conferences](#)



Data collected via LoGaRT can be directly visualized by linked third-party tools.

Assessments of Chinese approaches to rational order in general and science in particular have assigned a major role to the unity of imperial rule and the interest of its elites in establishing uniform bodies of information to form a basis for credible knowledge. Within this narrative, historians have drawn attention to how, over centuries, Chinese imperial rulers and local actors practiced ways of reading, compiling, and ordering local information in writing local knowledge within local gazetteers. Spanning a time period from the tenth to the twentieth centuries and covering nearly all populated regions of historical China, an impressive number of 8,000 local gazetteer titles are still extant today. This sheer number poses a unique challenge and also an opportunity for scholars to understand the structures of knowledge of this genre, the conditions of different time periods and locales for recording and reporting it, and the epistemologies that are embedded within these practices.

The software “Local Gazetteers Research Tools”—or LoGaRT for short—was built *primarily* to enable the genre itself to be examined: to determine, for instance, how individual or communal a practice such as disaster control was, and whether a locality set standards, adhered to them, or ignored them; and thus to shed light on how local knowledge was nurtured under Chinese imperial rule as a practice and concept that allowed for chance developments and fostered the generation of diverse specialist (and very individual) expertise. The software helps us see how this knowledge was an order neither inherently bound by law nor chaotic and unruly: how it produced certainty and chance at the same time—not as a dichotomy or a hierarchy, but as a relationship of mutual interdependence.

From 2016 to 2020, the Working Group attracted fifty scholars whose individual research interests collectively reflect the eclectic themes documented in local gazetteers, and whose research needs motivated iterative technical refinements and new, unanticipated features. Scholars have mostly used LoGaRT to conduct their research in three ways.

First, many identify key terms as a proxy for the historical presence or absence of certain objects or phenomena. The [collaborative research of Schäfer, Chen, and Che](#) on the historical politics of disaster records initially adopted this approach to trace records of mulberry crop failures. The research expanded using the methods listed below to include contextual studies of disaster politics and discourses around the Mandate of Heaven. The results were published in the Digital Humanities special issue in the *Journal of Chinese History*.

Second, scholars have used LoGaRT’s section search function to isolate the same thematic section across multiple local gazetteers, enabling them to extract information about a specific theme across geographic regions and/or time periods. In some cases, the presence or absence of certain thematic sections in specific gazetteers was also indicative of large-scale patterns or historical changes. [Matthew Miller’s research](#), which looks at the long-term interplay between social and environmental change, is one such example. Miller used LoGaRT to track down the logging locations where the imperial courts sourced their timber, proving that from the Ming to Qing periods logging was gradually transferred from state-organized efforts to local efforts and local markets (relying on local logging industry to supply wood through commercial markets).

Third, using LoGaRT’s extraction interface, scholars have tagged texts from multiple local gazetteers to collate and compile stand-alone data sets that serve as a

→ Dagmar Schäfer, Shih-Pei Chen, and Qun Che, “What Is Local Knowledge? Digital Humanities and Yuan Dynasty Disasters in Imperial China’s Local Gazetteers,” *Journal of Chinese History* (2020)

→ Matthew Miller, *Fir and Empire: The Transformation of Forests in Early Modern China* (2020)

curated digital concordance for reuse and further investigations. Joseph Dennis is using LoGaRT to curate 30,000 records of local school library holdings from 4,000 digital gazetteers, producing a data set that forms the basis of the Books in China online database. Based on this data set, Dennis has been able to offer a systematic view of book circulation and knowledge distribution in historical China for the first time, which is now informing historians about how Chinese historical intellectuals acquired various kinds of knowledge at different times and localities. An important feature of this project is to make available the data that was originally curated for this research for new research questions in the future. During 2020/21, the Department launched a cooperation with Brill publishing house to develop [a new platform for publishing such digital concordances as peer-reviewed scholarly contributions](https://www.mpiwg-berlin.mpg.de/news/brill-and-max-planck-institute-history-science-sign-agreement-digital-concordances).



<https://www.mpiwg-berlin.mpg.de/news/brill-and-max-planck-institute-history-science-sign-agreement-digital-concordances>



Using the Books in China online database, Joseph Dennis compares the number and geolocations of military and medical books in a defined period.

The project has also developed a global comparative perspective. China is indeed not the only large political superstructure that has imposed centralized rule over disparate social groups across a large geographic space. Venturing into comparative empire studies, Shih-Pei Chen, Mackenzie Cooley, and Huiyu Wu brought together scholars from both Chinese and Spanish studies to trace the strange parallels between the *difangzhi* (local gazetteers) of imperial China, and the *relaciones geográficas* of the Spanish Empire. This work showed that striking similarities existed between these two genres in terms of their *raison d'être*, structure, and format. Chinese local gazetteers developed bottom-up, however, whereas the Spanish *relaciones* were emphatically top-down, centralized, secretive, and exponentially smaller in scale. *Relaciones* took shape in a context fraught with conflicts and fractures. Chinese local gazetteers were equally ambivalent in their relation to imperial rule. Yet they exhibit no such sharp cultural and political rupture, recording instead cumulative knowledge over centuries despite the waxing and waning of dynasties. Comparative research reveals how the making of the “local” (i. e., localizing information) depends not only on politics of intervention—that is, whether local or external uses of information were

facilitated by regulations (*fanli*) in China or questionnaires in New Spain. Judgement is also imposed subtly through the management of size and scales, and by how empires decide to silence or accept all that can be known—in China, by systematically collecting information or spurring local actors to do so; or in the case of New Spain, by excluding local actors almost entirely.

Local Gazetteers operates within a wide net of collaborations; one between Shanghai Jiao Tong University (SJTU) and the Department resulted in the CHMap, an open-access WebGIS platform that hosts 4,088 large-scale historical land survey maps of China produced in the late nineteenth and early twentieth centuries. This is an open and nonprofit platform for sharing resources on Chinese historical maps. These maps provide a baseline for both modern and historical periods, allowing researchers to compare maps and spatial depictions produced at different times, by different cartographic technologies, within different cultural and political contexts, that are now hosted in different archival institutions.



On CHMap, researchers can easily compare land survey maps produced in the early twentieth century with hand-illustrated maps from earlier periods in local gazetteers.

In another example of how these digital tools have spurred new research, the Working Group “**Visualization and Material Cultures of the Heavens**” is creating a protected image database allowing researchers to contextualize objects beyond their current location in museum collections. The aim is to investigate the astral sciences as a material practice relevant for people in everyday life. It understands astronomy as a ubiquitous practice that, as the oldest of human sciences, was not only developed by experts and described in textual accounts but also concerned many hands and minds. In almost every region and period of human history we can find evidence of people observing and interpreting the night sky. We look at objects—vessels, statues, textiles, paintings, and prints—to explore how people visualized the planets, stars, and meteorological phenomena that populate the sky, and how they came to interpret them in different ways. Drawing from other source-based initiatives, the Working Group uses digital means to look at such visualizations irrespective of their current location in museums in Europe, Asia, North America, and North Africa and asks where and when objects were situated and how they were used, contributing from below to an understanding of the heavens above.

In all of the research unfolding the “Art of Judgement,” scholars critically engaged with historical and sociological scholarship itself in the notion of past knowledge cultures. Drawing from work in the previous evaluation period on post- and decolonial histories of planning, Department III formed a Working Group on the “**Ownership of Knowledge beyond IP**” that addressed how, in planning, normative factors are related to epistemic concerns. The group asks, in other words, how one can or cannot know, with the aim of consolidating two strands of research on the ownership of knowledge: one the one hand, scholars of science, technology, medicine, and law have all come to emphasize knowledge as the sum of human understanding and the many *forms* it can take; and on the other, they have thus shed light on its ownership in the form of possession by law and as acts of social sharing. There is scant scholarship that has contributed to refining a particular nomenclature of alienable/inalienable and tacit/explicit into one that would equally value all knowledge—brain and body—while also acknowledging differences.

Where such scholarship has emerged (such as in the work of John Pickstone or Andrew Pickering), it has operated with a nomenclature of distinction, and as part of efforts to equalize the field, thus emphasizing variety and leading to the conclusion that there have been different ways of knowing, such as everyday knowledge, science as practice, etc. Many efforts have critically engaged with dichotomies—local/global; periphery/center; indigenous/universal; traditional/modern; epistemological/ontological—and attempted to tip the balance by giving at least “equal” power or agency to objects, bodies, or things. Other attempts by scholars such as Sheila Jasanoff or Ursula Klein have attempted to reunite what had been broken apart by showing that knowledge and ownership, for instance, have been coproduced or have coevolved, or by proposing compounds such as technoscience. As a result, explication has become the widely accepted silver bullet to uncover the relation between knowing and owning knowledge. The vast body of literature dealing with or using terms such as tacit-



Cornelis Cort, “Astronomy,” plate 7 from “The Seven Liberal Arts,” 1565 [National Galleries of Scotland], https://www.nationalgalleries.org/art-and-artists/133782/astronomy-plate-7-seven-liberal-arts?search=astronomy&search_set_offset=4.

ness, or equivalences such as “intangible,” local, indigenous, etc., reflects this problem in its struggle to communicate all knowing, and explain the equal importance of bodily performance, cognitive, chemical, or physiological processes in the brain and body. Accepting the deficiency or difficulty of communication, these studies offer compound terms to draw attention to how some issues we think of as separate—technology and science, for instance, embodied practices and knowledge—can never be fully broken apart. They use terms as a vehicle for negotiating ownership claims by bracketing that very difficulty. In the process, they further substantiate language as *the* determinant of knowing and owning: music becomes ownable because notation exists; tanners can own their knowledge as science only when they have learned to express it in chemical formulas.

This mediation through the word concerns us as scholars who decide what actually counts as knowledge historically—body, artifacts, or words. Unlike things, knowledge is property that is dispensed subtly by researchers—for example, when they define Chinese order as rational or parochial, Jesuit scientia as of global importance, or the epistemologies of Africa as situated experiences. Implicit in this scholarship is a “judgement” (*Urteil*) in the Kantian sense that emphasizes the ethics and effects of such an intervention. It also is a question of power as the historian-archeologists themselves are in a position to dismiss or perpetuate historical order and the values within them, as Michel Foucault once pointed out.

kn/own/ables

Based on earlier research on post- and decolonial knowledge and on a conference in 2016, a Working Group within the Department has dedicated attention to knowledge as property. The forthcoming book produced by this group, *Ownership of Knowledge: Beyond Intellectual Property*, edited by Dagmar Schäfer, Annapurna Mamidipudi, and Marius Buning, reveals how notions of knowing and owning emerge because they reciprocally produce and determine the limits and possibilities of each other: when scientists examine genes and transform them into intellectual property; when a tenth-century carver produces or destroys woodblocks; when a banana becomes a tool to explain the laws of physics to underprivileged American pupils. It establishes the concept of *kn/own/ables* to indicate a **process of mutual conditioning**: that is how we, when we identify how we know, inevitably preset how we can own what we know; and how we own always impacts how and what we are able to know.

In focusing on the notion of decision-making, work within the Department aims to highlight the empowering of a specific moment of knowledge-making and understanding for the purpose of ownership. In the formation of knowledge ownership, power lies exactly in the processes that make knowledge a discursive matter or not: using or not using, performing or not performing, saying or not saying can all be acts of owning knowledge. Precisely because knowledge ownership is established through processes of distinction, one of the Department’s research results was to promote methods developed in the history of technology (SCOT, ANT, assemblage theories) and to further Foucault’s methods of archeology for scholarly research on historical

knowledge cultures beyond intellectual history and epistemological considerations to see that *objects*, *bodies*, and *words* are all equally relevant *material instantiations* of knowledge ownership—and that many inequalities in our modern world and its knowledge economy arise because social owning has been made to always emphasize sharing, whereas legal practices prioritize owning knowledge as word and science.

Thinking about the social dimension of the ordinary within science, we can see that an archeology of knowledge has to take seriously the role of materials as objects that are imprinted with an agency that always affects scientific change. Such agency becomes apparent, for instance, when crops move—an example of material instantiations that is the focus of *Moving Crops and the Scales of History*, a book project realized by four collaborators Tiago Saraiva, John Bosco Lourdusamy, Barbara Hahn, and Francesca Bray, that proposes a new, experimental method for writing global history. The volume explores the dual nature of crops as rooted and moveable things reconnecting local and global in history. Its argument unfolds through a series of intriguing and contrasting crop histories, carefully structured to play with scales of time, space, and agency. In order to bring the multiple materialities of crops into systematic conversation, *Moving Crops* introduces the concept of “cropscape” as a framing and organizing device. In tune with the new materialism, the group defines the cropscape as an *assemblage* formed around a crop: the heterogeneous elements or actors brought together in a specific place and time that make and grow that crop. In mutating over space and time, cropscales comprise crops and other plants; people and climates; environment and institutions; skills, knowledge, cosmologies, and ideologies; taxes, tastes, and markets; values and meanings; modes of care and forms of violence; and histories—not only the unfolding history within which a cropscape or crop is embedded, but the histories or narratives that they have been used to tell in the past, and still today. Crops are one example showing how materials are made to fit certain categories that then have or do not have certain properties; for example, that because they are “plants,” they must be local, must grow roots in one kind of ground, and then be made into things that are able to be moved to other territories, as people learn to grow them. *Moving Crops* helped develop our methods for critically engaging with materials, as natural conditions, material artifacts, or commodities that are the stuff of global histories of knowledge.

2 Material Conditions: Body of Animals



Reproductive Exile (2018), a film by Lucy Beech. Image courtesy of the artist.

Considering animals as artifacts—and thus as both a basic constituent of natural orders and a resultant product of human ordering efforts—allows us to complicate the study of animality and in so doing redefine what artifacts/making things mean for understanding the processes of making knowledge. The “**Body of Animals**” research theme hones in on animal artifacts by investigating the relationship between different ways

of knowing animals and various practices of “doing science.” Projects pave divergent yet intersecting paths that explore new scales of knowledge beyond the now-familiar spaces of laboratories or natural history museums, and that collectively analyze literal bodies of animals with attention to their behaviors, reproduction, and sexuality; their materiality; their movement or arrested states; and their cosmological significance. Each of these facets has served as distinct research nodes in examining how humans have come to know animals, how animal bodies and materials are used; how animals bear significance for social and ecological orders; and the ways in which material understandings about animals are integral for studying knowledge production. For example, the “Proteins and Fibers” Working Group investigated the methodological approaches used by scientists to explain patterns of human dairy consumption in deep time. The “Out of Place, Out of Time” Working Group examined in-depth how the same bodily substance of milk was related to the regulation of individual animals’ reproduction in large herds, which in turn shaped knowledge of human reproduction. And the crossover project “Animal Mobilities” analyzed mobility beyond the technological and logistical realms, addressing questions that include how the notion of animals rests on cultural assumptions about race, gender, sexuality, and ability. Ultimately, the studies organized under this theme have demonstrated that animality itself has arisen through various processes of making animal things, materials, and bodies, and how notions of animality have changed through formalized studies that have hardened the contours between humans and nature.

Scientists have learned to examine books not by reading their inscriptions but by scrutinizing the animal skin used as writing surfaces. As librarian Megan Rosenblum put it in 2021, “This kind of work can reveal historical insights into medieval livestock economies and craft techniques about which no contemporary written records exist.” Just as this new science of biocodicology is interrogating manuscripts in new ways, the “Proteins and Fibers” Working Group has taken on a novel approach to the history and historiography of science by looking even more broadly at how scientists

have examined animals—not as objects or whole organisms, but rather as materials and remnants that can be used to supplement written, oral, and visual historical records, or even to reconstruct histories in their absence. This research investigates transformative processes by which people in various cultures have created and used animal materials derived from the tissues and waste of animal bodies. The Working Group also pursued a survey and case study of the history of diagnostic approaches to the analysis of animal materials in archaeological contexts, including hair, hides, bones, teeth, and microbial symbionts, which are now being used to open up the “biological archive.” A two-pronged investigation into animal materials and material culture guided its approach.

The first research prong took a sociocultural perspective with a series of case studies on the history of animal materials since the eighteenth century that aimed to draw connections between the active matter of animal materials and human-scale practices, which together contribute to new material transformations. The project has allowed its researchers to understand how historical actors observed, envisioned, extracted, processed, and repurposed animal materials. For instance, butchered remnants mattered differently to mid-twentieth-century Japanese craft and industrial workers who needed adhesive agents than they did to early modern French artisanal soap-makers. The group’s [workshop “Animal Materialities, Composition and Practices in the History of Science”](#) approached animals as sources of changing materials and technologies that are generative of the built environment, rather than as whole, living organisms, or users whose higher-level perception facilitates responses to their surroundings. The Working Group’s focus on the processes involved in the changing physical properties of animal materials has highlighted cross-cultural distinctions in how people have understood these transitions or phase changes from animal to more-than-animal.

A further point of analysis has been how animality has endured through these processes, as the original bodily manifestation of a charismatic animal recedes in the making of a useful “natural” product. By inquiring into the “affordances” of animal materials—a term coined by James J. Gibson to conceptualize what an environment “offers the animal or what it provides or furnishes”—the Working Group demonstrates the practical aspects of animal materials and their makers at different historical moments and scales of inter- and intraspecific relationships, particularly in ways that counter narratives of the reduction of animals into materials. Yet this research also spurred the Working Group to [reformulate the concept of affordances in order to explore the relationship between the properties and potentialities of animal materials](#). The opportunities and constraints presented by animal materials in our view of affordances, as discussed in our publication project “Making Animal Materials in Time” (under review), underscores how the interrelatedness of human makers, animals, and environments enriches the historical method of studying knowledge production. Shifting between scales and perspectives has allowed us to recognize animal materials as temporal entities that involve biological, cultural, and physical processes alike, and which together bring about new ways of articulating the conceptual interplay of place, process, and time in the work of writing history. The endeavor to historicize animal materials operates beyond binary ways of narrating



Black braided silk sutures, treated with wax and silicone, magnified 150-fold.
Nicole Ong, *Biomaterial Matters* (2017).



<https://www.mpiwg-berlin.mpg.de/event/animal-materialities-compositions-and-practices-history-science>

→ [Workshops and Conferences](#)

→ Lisa Onaga, “A Matter of Taste: Making Artificial Silkworm Food in Twentieth-Century Japan,” in *Nature Remade: Engineering Life, Envisioning Worlds*, ed. Luis Campos, Michael R. Dietrich, Tiago Saraiva, and Chris Young (The University of Chicago Press, forthcoming 2021)

based on distinctions between what is alive or dead, or artificial or natural. And it clarifies how unique theoretical insights about animality gained in dialogue with histories of craft knowledges can explicate little-known epistemological contexts in the histories of sciences that are implicated in the making of new substances and materials.

The second research prong investigated the development of routine practices of testing samples of animal materials. Here, the Working Group focused on some of the most historically mundane technologies coproduced by animals and humans, such as silk and wool textiles and fermented dairy products. After an initial period of research that surveyed recent developments in diagnostic tools and methods used by scientists in the historical sciences, ranging from zooarchaeology, to museum conservation science, archaeogenetics, and proteomics, the group developed a line of questioning into the history of assaying animal materials.



Chicken Coop at Mikveh Israel (agricultural school and experimental station), February 1, 1940. Israel State Archives, Zoltan Kluger Image Collection 12518-12590, ISA-Collections-ZKlugerPhotos-00132fo.

By reconstructing scientific research on lactase persistence—the phenomenon in which the enzyme for digesting fresh milk remains active in some adult humans after weaning—the Working Group found that recent practices of assaying animal residues on ancient human teeth and pots have also reinforced understandings about human biocultural differences established through various disciplinary, cultural, and technological concerns and biases. The study makes clear that any ancient animal material studied in an archeological context becomes itself a cultural artifact, which is then used by scientists to reconstruct deep histories. Here we can see how the sciences co-constitute each other in their view on animal materialities. Tracing this scientific inquiry to its roots revealed how biomedical methods converged with geographical research on

global dairy consumption, while also hardening Eurocentric notions of racial difference grounded in nineteenth-century cultural and racially biased assumptions.

Exceptions, irregularities, and disruptions to order are often the driving force behind efforts to know nature. Animals likewise tend to participate in knowledge production processes through disruption: as anomalies that challenge the limits of what is known. Through the perspective of disruptive animality, the Working Group “**Out of Place, Out of Time**” investigates how knowledge of animals was motivated by the defiance of spatial and temporal regimes, and the extent to which it ultimately shaped them.

During the period 2018 to 2020, the group focused on studying the realms of animal reproduction, sexuality, and labor in order to excavate how animal bodies and behaviors relate to the understanding and management of time. Members published individual work in the journals *Social History of Medicine* (2019), *Theory & Criticism* (2019), and *Journal of American History* (2020). The group’s publication project, to be published as a special issue in *Technology and Culture* under the title “Bovine Regimes,” analyzes time management in cattle herds across geographical and culture contexts. By tracking the efforts to regulate and synchronize the production and reproduction of individual animals in the herd, this scholarship illustrates how animal bodily production and sexual behavior challenged social and economic structures. The project reveals that these efforts to regulate bovine temporalities ultimately reshaped knowledge of human reproduction and work. Taken together, this work demonstrates that animals are destabilizing, rather than reinforcing, elements within knowledge systems and notions about time.

In the course of their research, both Working Groups “Out of Place, Out of Time” and “Proteins and Fibers” identified “Animal Mobilities” as an important theme to address how the movement or arrest of living things feature in the making of knowledge orders. The groups came together to examine how scientific knowledge production has been and is being mobilized by animals and animality. The joint research took the concept of mobility beyond the technological and logistical realm to show how human efforts and endeavors to understand animals bear upon cultural assumptions about ability, and relatedly, race, gender, and sexuality.

These inquiries into movement and animal bodies demonstrate new research approaches to the history of animal knowledge that are peripheral to most of the direct observational and experimental practices used by scientists. The resulting analyses of animal mobility yield insights into both the production of knowledge about life and how humans interrelate. The research sheds light on how framing such mobility is related to making sciences: how animals move themselves (and the assumptions that animals are defined by movement), how scientists move animals, and how scientists arrest the movement of animals to produce knowledge. And it shows the need to investigate affective relationships and animal substances by focusing on the interrelatedness of movement, ethics, environment, and science. The project is now conceptualizing mobility as inherently political by highlighting animals at the nexus of technology and ability in order to explicate why the history of animals in science has been so tightly bound to the arrest, capture, and control of animal movements.



A camel, illustration from the Ottoman-Turkish translation of *Ajā'ib al-makhlūqāt* (Wonders of creation) by Zakariyā al-Qazwīnī (d. 692 AH/1293 CE). Source: The Walters Art Museum, Ms. W.659, fol. b.

Gottfried Wilhelm Leibniz Prize

Department III director Dagmar Schäfer was awarded the Gottfried Wilhelm Leibniz Prize 2020 for her pioneering contributions to a comprehensive, global, and comparative history of technology and science. The opportunities thus enabled have been invested in the third research theme, to more deeply investigate the historical nature of knowledge orders.

3 Organizing Knowledge, Producing Order



A chain pump depicted in Wang Zhen's *Nongshu* (The book on agriculture), first published in Yuan-period China. National Archives of Japan Digital Archive, Naikaku Bunko Collection, 300-0073, 4.

In 2020, work in Department III moved into its third research theme on the imposition of order over order. Informed by our research results on action and artifacts, the projects under this research return to the question of knowledge, while advancing new cross-cultural, linguistic, and regional comparisons within a global view across early, medieval, and early modern sciences. What kind of work is done in organizing knowledge and what are the effects of imposing working orders upon the patterns and rationalities observed in our world?

Historical sources about various practices and skills were

composed by intellectuals who did not necessarily possess on-the-ground knowledge. Informed by these sources and influenced by Marxian or Weberian models and consumerism debates, previous studies by historians of science have emphasized the influence of the political structure, state policy, and high culture on the skills of many professions (that is, how science was special). In revisiting this perspective, the Working Group pursues both *longue-durée* and microstudies. It places the experts and their practices in the center of historiographical investigation. The aim is to explore how the most ordinary and at the same time most essential knowledge order of working the soil and “cultivating” nature has led to different ways of organizing knowledge.

Previous historians of science have often seen past agriculture from the perspective of modern agronomy *ex post facto* within a single ethnolinguistic context. The Working Group “Agriculture and the Making of Sciences, 1100–1700” reverses this approach and adopts a global perspective by exploring how agricultural practices shaped premodern understandings of nature and informed the emergent “sciences” in disparate cultural and literary traditions across the world. The group looks at practices such as grafting, manuring, hydraulic engineering, and seed production, to study how patterns and rationalities of the natural world were abstracted, defined, and systematized. By examining concrete practices of agriculture, this research looks from the “ground up” at the formation of different fields of knowledge (such as philosophy, mathematics, medicine, or astronomy) and knowledge cultures in which these practices found expression, to then employ this perspective to examine the production of farming knowledge.

This endeavor began by comparing order-production in agricultural practices by considering two reference points: the Sinographic and the Arab and Turko-Persian literary traditions. The main focus has been the study of agricultural practices documented in Classical Chinese, Arabic, Persian, and Ottoman Turkish. Since the Working Group's inception in 2020, a primary source reading group has met every two weeks where scholars from both within and outside the MPIWG are invited to read, translate, and compare two fourteenth-century agricultural treatises: *Nongsang yishi cuoyao* 農桑衣食撮要 (Selected essentials of agriculture, moriculture, clothing, and food) in Classical Chinese from the Mongol-Yuan dynasty, and *Al-Filāḥa al-Muntakhaba* (Selected agriculture) in Arabic from the Mamluk period. The reading sessions are now laying the groundwork for a comparative study of agricultural knowledge in the post-Mongol world. Researchers are moreover preparing an open-access Working Group book for publication that pairs annotated English translations of the two foundational agricultural manuals with essays that discuss the translated texts within their epistemological, environmental, and cultural contexts. By comparing material across two linguistic corpora, the book will address questions about content choices and literary approaches to knowledge against the background of the political landscape in Asia following the thirteenth-century Mongol conquests. The volume will also inaugurate a new book series, also called **Agriculture and the Making of Sciences, 1100–1700**, to be published by Brill. In addition to farming manuals and treatises, the group also examines diverse forms of agricultural knowledge that did not conveniently fit into the discrete scholarly categories of their respective times, thus foregrounding the dynamics of genre/category-making in premodern sciences. Researchers use legal writings, cosmographies, dictionaries, *materia medica*, and manuals of mechanical art, as well as artifacts and visual representations, to examine the tools and practices of collecting, comparing, classifying, and discarding agricultural practices in various forms of knowledge.

The Working Group has inaugurated the book series **Agriculture and the Making of Sciences, 1100–1700** with Brill, which explores how agricultural practices shaped premodern understandings of nature and informed emergent “sciences” across the world. Premodern agriculture, especially in extra-European contexts, has previously been treated as a form of “traditional knowledge” lying beyond the purview of the histories of science and technology. By contrast, the book series treats agriculture as foundational to many premodern “sciences,” furnishing a sustained platform for methodologically innovative research into how agricultural knowledge, and its practices and materialities, migrated into other fields of knowledge. Treating agriculture as “knowledge orders” allows the series to address central questions in the histories of not only agriculture but also of science, technology, medicine, and the environment.

The Working Group is organized around annual themes: soil, water, wood, fire, and metals. Each year, researchers explore a special topic through a program of events in various formats, such as lectures, seminars, reading groups, and the closing annual conferences. In the 2020/21 academic year, the group addressed the annual theme of

“soil.” Researchers working on disparate knowledge orders across time and space were invited to revisit their research from a comparative perspective: Mamluk practices of soil taxonomy and fertilization and the knowledge order they produced were juxtaposed with those of Ming China, while the ethnobotanical implications of Late Imperial Chinese *materia medica* were compared with the naturalist knowledge(s) informed by the same genre in Tokugawa Japan. Grouped in themed panels, researchers had the chance to focus on particular knowledge orders in their own terms, while being mindful of the cross-cultural and *longue-durée* interplay between different fields and traditions of knowledge. A conference has been organized for July 2021, titled “Towards a Global History of Soil: Sciences, Practices, Materialities, and Mobilities, 1100–1700,” to conclude the year on “soil.” Beginning in October 2021, a joint seminar series “Agriculture and the Making of Sciences” will be coorganized with the European Research Center for Chinese Studies and the Institute for the History of Natural Sciences, Chinese Academy of Sciences in Beijing. Through these and other future events, our objective is to pursue comparative discussions, thereby sowing the seeds for a flourishing long-term, global network of researchers. Upcoming themes in the years to come include “water” and “woods” and will each provide their own unique opportunities to study the processes of category-making and knowledge differentiation through cross-cultural comparison and thus explore the historical plurality of knowledge orders informed by agricultural practices.

Detail from Zhu Yu, *Taiping fenghui tu* 太平風會圖 (Street scenes in times of peace) 1293–1365. The Art Institute of Chicago, Kate S. Buckingham Endowment, 1952.8.



Finally, among the projects on “Organizing Knowledge, Producing Order,” the Working Group “**Ability and Authority**” is taking its first steps toward a critical analysis of the relation that historians of China have drawn between epistemic and political changes, that is to say, the way that changes of rule brought about institutional and social shifts. This work examines **communities of practice/experts** between 1200 and 1450, the Yuan dynasty and the transition to the Ming dynasty (1368–1645). Bringing together scholars who study porcelain workers, mason carvers, astronomers, diviners,

translators and interpreters, military commanders, sailors, and ink makers, the Working Group engages with the social history of work and, at the same time, asks how one can use objects to unpack expert cultures in premodern China. Here the group picks up from insights gained on the substantial role of scholarship, past and present, on knowledge orders and from a growing emphasis on scholars in China and words as a method to appropriate, own, or disown those who knew with their bodies, or who, through objects, have affected our view on scientific and technological dynamics. In order to give voice to historical actors and understand how they worked and what they thought of work, we also experiment with new forms of history writing.

Conclusion

While it is in their nature to be by themselves perfectly logical, as Ernst Bloch noted in 1958, historically, all human efforts of ordering are characterized by a certain degree of arbitrariness. This adds a new dimension to Spencer's insight that all knowledge is organized, albeit in varying ways, shedding light on how its development is neither teleological nor linear. Not only do methods and formats vary: different starting and ending points can also be defined. Pablo Picasso, for instance, forcefully promoted modern abstract art in 1907, opening a pathway that would make him into one of the preeminent hero-artist figures of the twentieth century. At the same time, by contrast, Hilma af Klint (1862–1944) declared the world was not yet ready to appreciate her nonfigurative work and specified that her abstract paintings should be locked away for twenty years after her death.

By focusing on efforts of ordering, our research unveils local attempts to establish order as well as everyday ways of knowing and understanding. It thereby uncovers how historical actors created and lived with multiple and diverse—competitive, mutually constituent, or exclusive—ways of ordering, even as they aimed at uniformity and universality. It is the subtle and obvious implications of such different orderings and how actors distinguished them that interests us. Exploring these historical dynamics—and how they are still relevant for us today—we collaborate with individuals and institutions both locally and globally. Department III has thus built the agenda and resources to research the history of science and knowledge dynamics globally, thereby contributing in substantial ways to a critical engagement with developments in science and pressing questions about the role of knowledge for society today.



2018–2020

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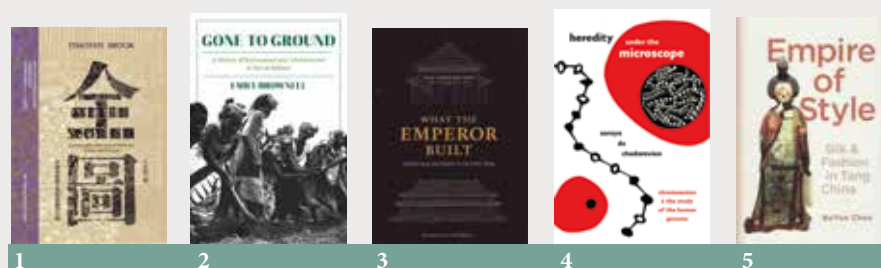
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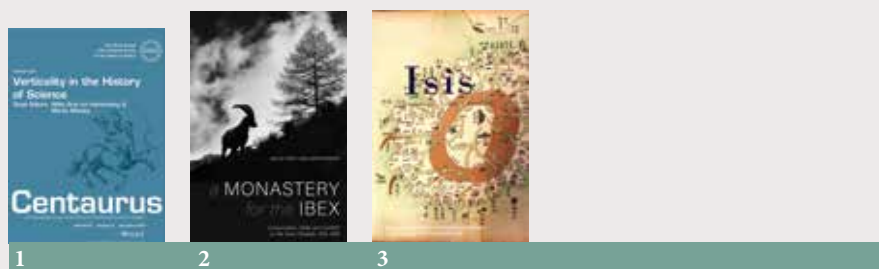
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Max Planck Research Group

Historical Epistemology of the Final Theory Program

MAX PLANCK RESEARCH GROUP LEADER Alexander Blum



Historical Epistemology of the Final Theory Program

Since commencing its work in February 2018, the intersectional Max Planck Research Group “Historical Epistemology of the Final Theory Program” has been investigating the historical origins of the current crisis of fundamental physics, a paradigmatic case of contemporary science in crisis. Our research shows this crisis to be multifaceted, though arising in a nutshell from one point of tension. In the 1970s, physicists constructed the theoretical framework that became known as the Standard Model of particle physics (SM), which consolidated the knowledge on the microscopic structure of matter that had accumulated since the late nineteenth century. The SM was widely viewed as a stepping-stone toward a future theory that would provide a unified description of all physical phenomena (*theory of everything*) and a logical-mathematical completion of physics as a science (*final theory*). Instead, it ushered in a long period of stagnation, culminating in the multibillion-euro Large Hadron Collider experiment at CERN, which provided a splendid confirmation of all predictions of the SM (in particular through the discovery of the Higgs Boson in 2012) but has so far failed to deliver evidence for any of the manifold conjectures as to what may lie beyond the SM.

A first focus of the group’s work has been to understand the way in which the SM was viewed as deficient, as falling short of being a final theory. We have classed these perceived deficiencies into three main categories: empirical, formal-mathematical, and methodological.

Falling Short of a Final Theory

The most clear-cut deficiencies of the SM are empirical, and it is noteworthy that these have come from astronomy—a field with a long tradition of producing empirical anomalies challenging the scientific paradigms of physics, which had, however, played little to no role in the construction of the SM. Two projects in the Research Group focus on this history. The master’s thesis of Giulia Carini studies the work of the Italian physicist Bruno Pontecorvo. Working in the 1930s, Pontecorvo early on identified the sun as a powerful source of neutrinos, far more powerful than any man-made nuclear reactor. He thus identified an astronomical object as a resource for investigating questions in particle physics, in particular the question whether neutrinos have a mass. Neutrinos do not have a mass in the SM, but by the 1990s Pontecorvo’s prediction of massive neutrinos was spectacularly confirmed precisely by investigating the neutrinos emitted by the sun. In another project, predoctoral fellow Adrien De Sutter shows how the dark matter problem similarly arose in astrophysics to become

Werner Heisenberg presenting his “world formula” at the 1958 Planck centenary in West Berlin. Source: DPA.

Cornelia Parker, *Cold Dark Matter: An Exploded View*, 1991. Photo: Caroliney76; license: CC BY-SA 4.0.



a crucial question for particle physicists. De Sutter is further investigating how problems in physical cosmology, such as recently established tensions in the value of the Hubble Constant (the speed at which the universe is expanding), continue to provide a source of empirical problems for particle physics. Together, both of these projects show how unsolved problems of cosmology and astrophysics have come to mark genuine lacunae in the account of the constitution of the physical world as provided by microscopic particle physics.

→ Research Group Krause

Together with Katja Krause and Michael Chase of the Research Group “[Experience in the Premodern Sciences of Soul and Body](#),” the group has initiated a research project on foundational scientific questions that appear to have recurred throughout history, such as questions on the origin of the universe or the nature of time. Take-off will be with a series of lectures in the academic year 2021/22.

The formal-mathematical difficulties of the SM center around the theoretical framework on which it is built, namely, quantum field theory. Postdoctoral fellow Martin Jähnert and group leader Alexander Blum have traced the origins of these difficulties back to the creation of quantum mechanics in the 1920s. Quantum theory emerged around 1900 very much as a continuation of nineteenth-century physics, with its focus on continua and fields, as embodied in Maxwellian electrodynamics. Yet the theory that ultimately emerged from these developments was decidedly a quantum *mechanics*, taking its cues from Newton rather than Maxwell. As Blum and Jähnert have shown, this was the result of an active decision by the creators of quantum mechanics, Werner Heisenberg and Erwin Schrödinger, to temporarily abandon the difficult problem of continuous radiation and its interaction with discrete, atomic matter and focus instead on the physics of matter alone. QFT then emerged not as a theory *sui generis*, but rather as an application of the principles of the now-established quantum mechanics (“quantization”) to fields.

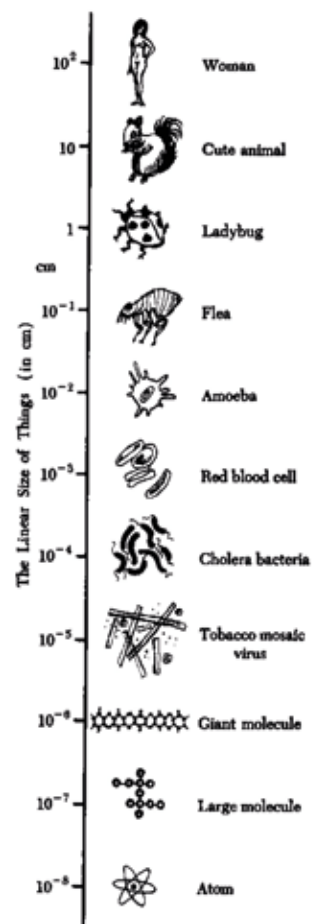
This construction appeared deficient from the outset, and even after its most grave difficulties (the frequent appearance of infinities) were resolved in the late 1940s, with unprecedented empirical success, the ultimate mathematical consistency of QFT was still heavily debated. For an upcoming book with Cambridge University Press, Blum has studied this debate and has shown how physicists were forced to retreat from established standards of mathematical consistency (dating back to the nineteenth century) and instead embrace a whole spectrum of mathematical rigor and adequacy. On this spectrum, partial gains in consistency could be achieved for quantum field theory, with full consistency, however, remaining an elusive goal.

Methodological Transformations

The empirical and mathematical problems, far-ranging as they were, could not by themselves have had the destabilizing effect of inducing a crisis in fundamental physics. The main focus of the group's research has thus been a third class of difficulties cutting to the core of physics as a scientific discipline that we have broadly labeled "methodological."

Perhaps the most central such difficulty is the absence of any exact solutions to the equations of quantum field theory. Here, as well, two projects in the group engage this issue. Research scholar Pablo Ruiz de Olano has investigated how the construction of novel approximation methods became a central element of physical theorizing in the decades after World War II. His results highlight how approximation methods acquired new roles in this period: in particular, they played an essential role in interpreting the representational content of theories and models, which had traditionally been done on the basis of the simplest exact solutions. Among these approximation methods, the effective field theory (EFT) approach was perhaps the most successful, and it is this method whose genesis is being studied by postdoctoral fellow Sébastien Rivat. The EFT approach implies a physical interpretation of quantum field theory in which different scales (such as the atomic, nuclear, or subnuclear scales) are largely independent of each other and are best treated separately. This runs counter to the notion of a final theory, which sought to combine diverse scales in one reductionist framework. Rivat has shown how this message was driven home by the fact that the EFT approach emerged in parallel both as a highly refined approximation method and as a tool for probing the physical interpretation of QFT. He concludes that already by the late 1970s, the SM itself was commonly considered just an "effective field theory."

That the search for a final theory continued in spite of these developments is substantially due to a second methodological novelty that has lain at the focus of the group's research. While hard to classify as a difficulty per se, the ease of constructing novel and widely different theoretical hypotheses even in the absence of new (or decisive) empirical data was ultimately similarly destabilizing to the difficulties discussed so far. The group has studied such nonempirical theory construction both in unsuccessful cases (Heisenberg's *Weltformel* of 1958) and in a very successful one, the construction of nonabelian gauge theory, which became a central pillar of the SM almost two decades after its invention in 1954.



The rigorous separation of the physical world into independent "scales," presented in a textbook on quantum physics, offers a stark counternarrative to the final theory program. *Berkeley Physics Course*, vol. 4, by Eyvind H. Wichmann (1967).

In both cases, the group's research showed how this ease of theory construction arose from the combination of the established and highly restrictive formal machinery of modern physics (relativity and quantum theory) with a small number of additional, essentially philosophical principles. In the case of Heisenberg, Alexander Blum has shown how Heisenberg's invocation of pre-Socratic monism led him to the construction of his "nonlinear spinor model," which was promoted by Heisenberg to the public as a viable candidate for a final theory ("Weltformel") but rejected by the scientific community because of its inability to deal with the difficulties of mathematical consistency and lack of predictive power. In the case of nonabelian gauge theory, by contrast, it was the philosophical idealism of Hermann Weyl that provided the principles for theory construction. Noah Stemmeroff, visiting postdoctoral fellow as part of the exchange with Tel Aviv University, has shown that when physicists in the United States took up Weyl's gauge principle in the 1950s, they ignored his idealist argument while preserving a conception of gauge symmetry as an apodictic, quasi-philosophical principle that cannot be argued for (within physics). Further focusing on this scientific tradition, Pablo Ruiz de Olano has studied the work of the physicist J. J. Sakurai who constructed the first (nonabelian) gauge-symmetric model QFT in 1960. Ruiz de Olano has argued that the focus on symmetry allowed for definite *qualitative* predictions, which Sakurai used to argue for the pursuit-worthiness of the gauge approach.

These nonempirically based methods of theory construction ultimately culminated in the construction of the SM in the 1970s, which the development of powerful

computer-based approximation methods then transformed into an empirically well-founded theory. But the nonempirical methods were conserved and honed in the subsequent attempts to complete the SM to a final theory, where empirical confirmation was no longer just mathematically challenging, but physically impracticable. These attempts at constructing a final theory beyond the SM, which primarily took the form of finding a quantum field theory of gravity, are a further focus of the group's research.

The 1950s and 60s saw a bewildering number of newly discovered particles. The emergence of this “particle zoo,” later consolidated in the Standard Model, is shown in *the Brief History of Particle Physics in Brush Strokes* by the physicist Gerson Goldhaber (courtesy of the Goldhaber family).



Quantum Gravity

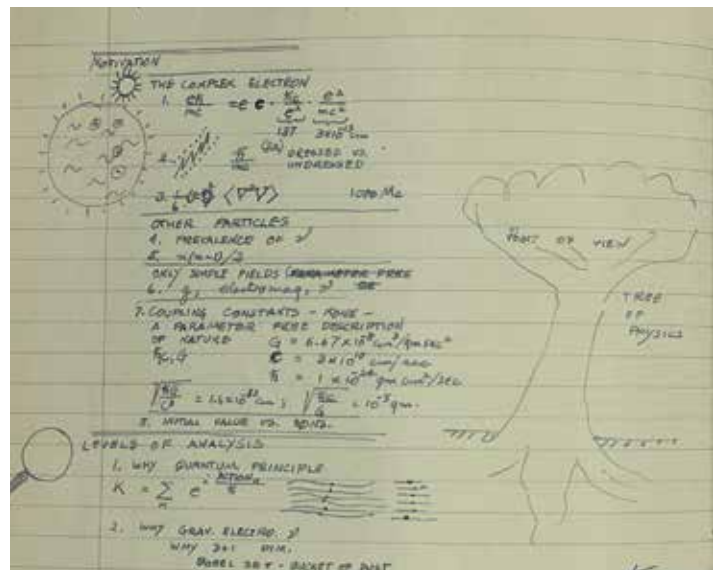
Together with Dean Rickles of the University of Sydney, Alexander Blum has conducted a wide-ranging survey of the early history of quantum gravity (up to 1950). While the earliest such work could be traced to soon after Einstein's formulation of general relativity (as the modern theory of gravity) and even before the final formulation of quantum mechanics, Blum and Rickles were also able to establish that at the time quantum gravity was nowhere close to being considered the central element for a theory of everything. Integrating general relativity and quantum mechanics was merely a conceptually and mathematically intriguing exercise that appealed to a handful of aficionados interested in both of these new theoretical frameworks.

As these attempts at integration intensified in the 1950s and 60s, they also encountered opposition. Postdoctoral fellow Bernadette Lessel has investigated the sharp criticism of the quantum gravity program in this period by Léon Rosenfeld, who himself had pioneered the program with two foundational papers in 1930. Lessel has reconstructed Rosenfeld's criticism and how it arose from his engagement with the philosophical views of Niels Bohr. Rosenfeld criticized the fallacious strategy of elevating structural elements of the empirically established quantum mechanics to formal-mathematical axioms for future theory construction.

The central figure in elevating quantum gravity from a formal exercise to the prime candidate for a theory of everything was John Wheeler, as has become apparent through the research conducted by Alexander Blum (together with Dieter Brill of the University of Maryland) and by predoctoral fellow Stefano Furlan. Through a detailed study of Wheeler's notebooks, Blum and Brill have reconstructed how in the mid-1950s Wheeler turned away from the mainstream of particle physics and embraced a hypothetical theory of quantum gravity as the future foundation of physics. They have shown that Wheeler was primarily motivated in this move by what he perceived as the untapped conceptual potential of general relativity, as he explored the possibility of representing elementary particles through novel solutions of general relativity, such as wormholes. Blum has further argued that this methodology, of teasing out the potential of (combining) existing theories, rather than constructing new ones in dialogue with experiment, represents an explicitly conservative methodology that goes hand in hand with a nonempirical approach.

Furlan has investigated the further evolution of Wheeler's thought and its wider influence in the ensuing decades. He has shown how Wheeler crafted a narrative of quantum gravity as the natural endpoint of modern physics, reconciling the legacy of the two towering figures of the scientific revolutions of the early twentieth century, Albert Einstein and Niels Bohr. Furlan has shown the far-reaching influence of this view, as Wheeler worked tirelessly to promote his vision around the world, from the Soviet Union to Japan. By presenting quantum gravity as a holy grail, to be attained in the future, Wheeler also effectively promoted what Furlan has called an epistemology of procrastination: the qualitative promise of a future theory is taken as a justification for setting aside concrete quantitative difficulties in the current theoretical framework.

In summary, the group's research has identified and traced the origins of a number of structural features in the practices of post-WWII physics that contribute to both the substance and the perception of the contemporary crisis of fundamental physics. That impending crisis was not merely observed by the historical actors but also led to reactions in the form of vastly different conceptualizations of what a final theory could and should look like. The emergence of these novel views on the ultimate aims of physics form the last research focus of the group to be discussed in this report.



This page from the notebooks of John Wheeler (1956, held by the library of the American Philosophical Society) shows Wheeler imagining the “tree of physics” with its roots in a fundamental theory that combines the quantum principle and Einstein’s theory of gravitation.

New Narratives

The first newly emerging narrative is that of a theory of everything as a methodologically unified explanatory framework, rather than as an ontological reduction. Two physicists here have been the focus of the group's research: Yoichiro Nambu and Philip Warren Anderson. In the late 1950s, Nambu analyzed the process of spontaneous symmetry breaking in superconductors and then by analogical reasoning transferred this concept to elementary particle physics. Rocco Gaudenzi, postdoctoral Rubicon Fellow of the Netherlands Science Foundation, argues that this cross-fertilization was made possible by the academic tradition from which Nambu came: faced with a lack of material resources, academic posts, and career perspectives, physics training in Japan focused less on thematic subdisciplines and more on versatile and transferable methods. Gaudenzi shows that Nambu's breakthrough implied a shift for fundamental physics away from the primacy of dynamical laws to a central role for complex ground states, which were traditionally the defining factors in the physics of larger material systems. Fifteen years later, Anderson took up these beginnings to form

a novel programmatic narrative of an emergentist physics with his now iconic paper "More is Different." Revealing a misconception in popular perception, predoctoral fellow Núria Muñoz Garganté has shown how Anderson never argued against scientific reductionism. Instead, he argued that his field of condensed matter physics offered a greater potential for solving a wide range of questions. Muñoz Garganté has demonstrated how Anderson bolstered this argument by elevating the concept of symmetry breaking to a general explanatory pattern that could give insight into questions not only at the most fundamental scales of physics but also at the highest scales of complexity: life, consciousness, and society.



American and European physicists being welcomed to the first major international physics conference in Japan in 1953, reflecting the increasingly global nature of modern physics. Photo: AIP Emilio Segrè Visual Archives, Yukawa Collection.

The second new narrative the group has studied is that of fundamental contingency. Alexander Blum and Stefano Furlan have begun studying the origins of John Wheeler's 1970s conjecture of "law without law," which claims that all laws of physics are contingent on the initial conditions at the big bang; our universe is just one in a long string of expanding and recollapsing universes, each with vastly different laws of physics. Blum and Furlan have shown that Wheeler's endorsement of fundamental contingency was the result of the observation that the collapse of a black hole appeared to, in Wheeler's terminology, "transcend" several established physical principles.

In September and November 2019, Bernadette Lessel organized two "History for Physics" events in Vienna and Potsdam, respectively. Featuring tandem talks by historians and physicists, the event highlighted the value of historical reflection for both the history and practice of physics as a field and was well attended especially by physics graduate students. Student training in particular forms a crucial secondary focus of the Research Group, with many of the group's researchers crossing over between physics, mathematics, and the history of science.

This compact outline of the group's research naturally skims over many of its aspects, in particular the manifold interconnections among the various research projects. These interconnections, and the close thematic knit of the group in general, have played an essential role in the group's secondary aim, training. Many of the group's researchers joined directly after obtaining a degree in physics and mathematics and were able to retrain as historians of science in the group's interdisciplinary research environment. Two students also went on to pursue a PhD in physics, after completing their master's thesis in the group. In this way the group fulfilled its intersectional mission both by combining rigorous formal analysis with professional historiography in its work, and by serving as an institutional locus of collaboration and dialogue between history and physics.



2018–2020

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MPRG Historical Epistemology of the Final Theory Program

Publications 2018–June 2021

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Max Planck Research Group

Experience in the Premodern Sciences of Soul and Body, ca. 800–1650

MAX PLANCK RESEARCH GROUP LEADER Katja Krause



Experience in the Premodern Sciences of Soul and Body, ca. 800–1650

Standard narratives in the history of science portray the role of premodern experience in relation to observation and experiment predominantly from the perspective of seventeenth-century developments. Established in November 2018, the Max Planck Research Group “Experience in the Premodern Sciences of Soul and Body ca. 800–1650” has opened a new research field by setting the history of premodern experience in a much wider context of associated epistemic qualities, practices, and norms. This broader contextualization focuses on what the Research Group calls “epistemic cultures” and their incorporation of epistemic concepts and practices such as experience, quite independently of periodizations or localizations that have remained prevalent in current historiographies. Such theoretical innovation has also required changes in how this research is carried out: the Research Group’s approach has entailed bringing together disciplines that have not worked together historically and building on new institutional collaborations.

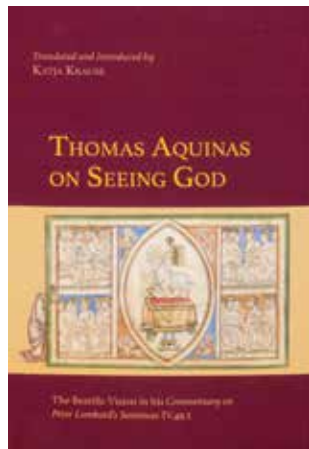
The research projects conducted under the auspices of the group examine experience as an indispensable part of the premodern sciences of soul and body, which ranged from medicine to the philosophy of living beings, to ethics, and even to theology. The projects reveal that although, in these disciplines, experience escaped consolidation into a single empirical method, it was at once an object and an instrument of science, subject to evolving shapes and shifting manifestations.

These shapes and manifestations of experience—expressed in languages as varied as ancient Greek, Arabic, Hebrew, Latin, Chinese, and the European vernaculars—pose challenges to scholars today in appreciating the epistemic worth and meaning of experience throughout the premodern era. If experience was not a single method guiding theory and practice, what was its significance for premodern science? More concretely: What were the roles of experience in the premodern sciences of soul and body? And how did experience evolve as those sciences traveled the globe between 800 and 1650 CE?

While members of the Research Group approach premodern experience predominantly through microhistorical and comparative case studies, three **themes in focus** have allowed them to connect their work to the much wider epistemic, practical, and normative questions at stake. These themes are “**Epistemic Qualities of Experience**,” “**Premodern Experience as a Network**,” and “**Premodern Experience in Conversation with the Present**.”

The first two years of the group have been dedicated to consolidating the structure and conceptual framework of our research projects. Many interim results of the single-

Center image: Manfredus de Monte Imperiali, *Liber de herbis et plantis*, ca. 1330–1340, Paris, Bibliothèque nationale de France, Ms. lat. 6823, fol. 1 r. Script samples, clockwise from top left: Folio from Aja’ib al-makhlūqat wa-ghara’ib al-mawjudat (Wonders of creation and marvels of creatures and strange things existing) by al-Qazvini (d. 1283), Smithsonian Institution; 大宝积经 (Pregnancy taboos in medieval China), Dunhuang manuscript, British Library; sixteenth-century Greek bestiary (Burney MS 97), British Library; eighteenth-century *Pancatantra* manuscript in Braj, Stella Kramrisch Collection, 1994 PMA Object Number: 1994-148-457.



scholar projects have been published in respected journals and edited volumes, and/or have been shared at international conferences and taught at our summer school, in addition to being discussed in the Research Group's regular colloquium meetings, which include external guests as respondents. Two of our postdoctoral fellows have been able to secure permanent positions at distinguished universities. Jonathan Morton was appointed assistant professor of French at Tulane University, and Dror Weil was appointed university lecturer in early modern Asian history at the University of Cambridge.

Offering an annotated translation of a key medieval text, Katja Krause's book *Thomas Aquinas on Seeing God* lays out the historical and speculative aspects of Aquinas's take on the ultimate fulfillment of the human being: the intellectual vision of God in the life after death.

<https://www.mpiwg-berlin.mpg.de/research/projects/epistemic-qualities-of-experience>



The first of our themes in focus is “**Epistemic Qualities of Experience.**” In the cases of sense perception, logic, fact, and mathematization, experience in premodern science was imbued with epistemic qualities that oscillated between the empirical and the formal.

Within the Aristotelian philosophical and Galenic-Avicennian medical frameworks, experience as an object of scientific study is described as arising out of sense perception and serving as a means to acquire knowledge. But did this causal path hold universally true for all historical actors in these two groups? Some of the research projects in this theme analyzed the epistemic locus of experience in premodern science and the developing epistemic relations that mediated between sense perception, experience, and scientific knowledge. One of their results has been to reveal that the history of experience as an object of scientific study involves complex and different processes of inductive reasoning.

Other projects in the theme have shown that experience appears in distinctive ways in different types of scientific arguments. For example, both the Aristotelian philosophical tradition and the Galenic-Avicennian medical tradition hold, in one way or another, that experience plays a vital role for inductive proofs. But our research has revealed that experience held a similarly dominant role in demonstrations and common sense arguments. Though seldom featuring in conclusions, it is found in premises, introduced by way of indications, or used in analogies.

These questions prompt new inquiries: how exactly were the experienced facts that went into such premises, indications, and analogies produced? Without advanced scientific instruments to make hidden features visible, only certain phenomenal properties caught the eye of premodern scientists and found their way into the various systems of classifying the natural world, including animals and plants. Particular projects in this group have thus excavated the different practices and values that went into the making of descriptive and explanatory parts of the premodern sciences of soul and body. They reveal that descriptions of experienced nature in its macroscopic composition were subject to constant change.

In particular, experience was increasingly articulated in the formal language of mathematics, for example, as measurements of the human body. By overcoming the specificities and apparent isolation of qualitative properties, the mathematization of experienced particulars of nature promised to classify the natural world entirely anew. Yet this mathematization of experience was itself a diversified project, riddled with difficulties that tested the ability to express the body and the soul in an unequivocal, unified, and formalized language.

Since the building blocks of premodern experience overlap and intersect, and thus cannot be studied only in separation, we have followed the tried-and-tested model of Working Groups at the Institute. In addition to hosting individual projects, each of the themes in focus is home to groups of between six and twenty-four scholars from different disciplinary backgrounds, based at the MPIWG and at other institutions around the world, who prepare a publication on their particular aspect of the Research Group's interests. Through regular meetings, these publication projects hone a unified conceptual focus while reaching across thematic and disciplinary boundaries.



Anatomy of the eye, copied from a ninth-century work by Hunayn ibn Ishaq. Cheshm manuscript ca. 1200 CE, Cairo National Library.

The Research Group's regular activities include a reading group on early science, led by Steven Harvey and Katja Krause, and the seminar series "Early Science in Conversation" (previously known as "Premodern Conversations"), led by Maria Avxentevskaya.

The Working Group "Premodern History of Signification: Putting Experiences into Words, Images, and Signs" seeks to clarify how language and other semiotic means articulated, communicated, and codified experiences in premodern science. The Working Group is preparing an edited collection of primary sources with introductions, translations, and commentaries, ranging from ancient traditions to early modernity on a global scale. It is organized by Glenn W. Most and Maria Avxentevskaya.

Another Working Group, "Avicenna on Experience: Philosophy, Medicine and Mysticism," explores lesser-known works by Avicenna, such as the *Notes on the Theology of Aristotle*. These works suggest the possibility that a more experientially based approach to science, perhaps akin to that advocated by the Islamic mystics known as the Sufis, may be better equipped than the path of rationality alone to study the more individual aspects of reality. The group is organized by Michael Chase, Mohammed

Javad Esmaeili (Tehran Institute of Philosophy), and Meryem Sebtı (CNRS, Centre Jean Pépin).

“Demarcating Experiential Knowledge and Scientific Knowledge in the Premodern Islamic Context (9th–14th Century CE)” seeks to discover the precise relationship of experiential knowledge to scientific knowledge in the study of the natural world in the chosen period. This includes questions about the ways in which experience manifested itself and the groups with which it was associated. The Working Group is organized by Hannah C. Erlwein.

“Experiencing Nature through Old and New Epistemes around the Globe” is a Working Group that asks how missionary explorations of new lands heightened epistemic tensions through encounters with new plants and animals, diseases, and remedies. On the European continent, philosophers and scientists alike were confronted with philosophical, medical, and religious dilemmas regarding how to build these new facts into the epistemic fabric of their sciences. This group is organized by Rainer Godel (German National Academy of Sciences Leopoldina), Tracy Wietecha, and Holger Zaunstöck (Francke Foundations).



<https://www.mpiwg-berlin.mpg.de/research/projects/premodern-experience-as-a-network>

The second theme is “**Premodern Experience as a Network.**” The epistemic qualities of experience were not only mutually related but were located within a much wider network of interconnections between the individual, society, ethics, theology, and technology.

Experience could be a cognitive achievement, or it could be a psychological perfection located in the soul of the scientist. But what was experience’s purpose as achievement or perfection? Some projects in this theme address such second-order functions of experience in the soul. They have found that experience grounded scholarly agreement, justified established scientific practices, or served the intellectual or

spiritual fulfillment of the scientist. This sometimes went so far as locating experience in the scientist’s soul beyond what is empirical and even rational, in a guided ascent to union with the divine. Experience in premodern science was therefore not limited to an instrumental relation to scientific theory; rather, scientific theory could be instrumental in reaching a higher type of experience in the scientist.

Nor was experience in premodern science limited to direct and first-hand perceptions—whether of the senses or of the intellect. It could also be gained from other people’s scientific practices. Testimony of authorities and experts shaped experience across time and space. Other projects in this theme have presented the many forms of sharing experience: scientists spreading their modes of epistemic interaction, practitioners passing on know-how and its impact on epistemic practices, or texts moving along paths of global exchange. These projects have shown that experience’s authoritative values were as crucial as its evidentiary ones.

Evidentiary values can also be attached to new epistemic practices, for instance to those that produced flaps in books or models made of ivory and wood showing the morphology and physiology of sense organs. As advances in technology prior to the invention of the microscope, these flaps and models made perceptible what lay

Flaps representing the anatomy of the eye in Georg Bartisch’s *Ophthalmoduleia* (1583). David M. Rubenstein Rare Book and Manuscript Library, Duke University.



hidden beneath the skin, and they generated new practices that left lasting marks on experience's epistemic qualities. Although conceptually separable, experience's epistemic qualities only appear, thrive, and evolve in interconnection with social, moral, theological, and/or technical dimensions. These are, as well, in constant flux, building ever new formations of interaction with experience's epistemic qualities.

The largest event of the Research Group so far has been the international conference “**Premodern Experience of the Natural World in Translation.**” Held on June 26–27, 2019, it brought together thirty-four scholars from around the world to explore the different ways in which experience of the natural world was conveyed through translations in late medieval and early modern Arabic, Hebrew, Latin, Sanskrit, Chinese, and vernacular thought, practices, and artifacts, under the headings “concepts,” “toolkits,” and “layouts.”

<https://www.mpiwg-berlin.mpg.de/event/premodern-experience-natural-world-translation>



The Working Group “Experience in Translation: Making Sense of Nature in the Premodern World” presents a global palette of historical and philosophical studies on the ways in which experience—as a tool and object of science—traveled through the premodern world. These epistemic journeys of experience were translations in multiple senses. In detailed case studies ranging from ancient Greek medicine to Byzantine alchemy, Latin natural philosophy, Arabic tabulated works, or Chinese Jesuit sciences, the group examines the dynamics of these translations through the prisms of terminologies, arguments, visual and verbal systems, and social normativities. The Working Group thus touches on the first two themes in focus from a dynamic perspective of transmission between different epistemic spaces. Organized by Maria Avxentevskaya, Katja Krause, and Dror Weil, it is nearing completion with the publication of twenty-three single-authored contributions in a collected volume.

“Confessionalization of Medicine” explores the relationships between the projects and practices of the Reformation broadly construed and developments in European academic medicine (both theoretical and practical), as well as nonuniversity medical training, accreditation, and practice, between 1500 and ca. 1650. Concretely, it investigates the dynamic interrelationships of medicine, natural philosophy, and theology in early modern medical texts. The Working Group, organized by Julia Reed, is midway to publishing a special issue of *Early Science and Medicine*.

The Working Group “The Eurasian Life of a Seventeenth-Century ‘European’ Botanical Classic” examines the *Hortus Indicus Malabaricus* (1678–1693)—a survey of the floral riches of Malabar in southwest India and an ideal example of experiential natural knowledge making in seventeenth-century Europe and India. Scholars analyze how reading and observation came together to form a reader-viewer’s conception of plant-objects and aims to identify the Keralan caste-based categories through which medical practice and *materia medica* appear in the Latin descriptions. It will produce a critical edition of the Hortus, accompanied by scholarly essays on different aspects of the work. The Working Group is organized by Minakshi Menon.



Rounding off the theme is a biweekly **podcast on classical Islamic theology** (*kalām*), hosted by Hannah C. Erlwein. *Kalamopod* covers topics discussed by *kalām* scholars and asks how the science of *kalām* came about, the types of arguments and

<https://anchor.fm/kalamopod>

methods it used, including arguments from experience, the aims and concerns of its practitioners, and the defenses they offered to their science's detractors.

The work of these first two themes in focus will be supplemented by an overarching project entitled “The Virtual-Classroom Sourcebook: A Global History of Experience.” The virtual publication seeks to give students in the history of philosophy, science, and medicine a geographically wide-ranging selection of primary sources on experience in the premodern sciences of soul and body. It invites scholars around the world to contribute their favorite source text on experience and complement it with an English translation and a short introductory essay. The project is organized by Katja Krause.

The Research Group's third theme, “**Premodern Experience in Conversation with the Present,**” transcends the confines of the period between 800 and 1650 and connects our insights on the contours of experience with themes of contemporary relevance. Although experience in the premodern sciences of soul and body cannot be forced into a single method, it nonetheless seems to carry some of its epistemic, moral,

and social standards across time and space. Experience is put to use in pursuit of other much-desired epistemic ends; it is conveyed over generations of scientists within the paradigms of stable epistemic theories and practices; and it seems to be applied consciously by scientists. Instrumental functions, testimonial forms, and scientists' agency are but three ways in which premodern experience, in its dynamic network of normativity, reveals meaningful connections to present-day experience.



<https://www.mpiwg-berlin.mpg.de/research/projects/premodern-experience-and-the-present>



Maimonides teaches about the “measure of men.” Compared to the earth and the universe, man is very small. A Hebrew translation of Maimonides's *Guide of the Perplexed* (originally authored in Arabic) dating from 1347. Cod. Heb. 37 from the Royal Library in Copenhagen.

This third theme addresses the norms embedded in premodern experience that seemingly transcend history—the Research Group's wider research object going forward.

A Working Group on the theme has been initiated by Alexander Blum (leader of the MPRG “Historical Epistemology of the Final Theory Program”), Michael Chase, and Katja Krause with a series of lectures to be titled *Scientific Questions Then and Now*. Focusing on several questions that seem to recur in the history of science and philosophy, we invite practicing scientists, historians of ancient and medieval philosophy, and historians of science to reflect on the relevance of these questions to their own research practices and those of the historical actors they study. Our aim is to understand how the epistemic, social, and moral contours of experience in the premodern sciences align with those of the modern sciences up to the present day.

Together, our three themes in focus set out and elaborate our research finding that experience is far from being only something built into the laws of nature and outsourced into technology. Instead, experience has value inherent in humans and is imbued with meaning for them. In this way, we advance a reformed historical epistemology that studies the sciences as dynamic formations and products of the human

being and of human thought in its manifold structured and justified interactions with the world. The framework for this investigation is a new research field connecting a wide variety of disciplines—the history of science, the history of medicine, the history of philosophy, area studies, and art history, among others—in order to write a much-needed history of shared epistemic cultures that is capable of overcoming the oftentimes artificial divisions in the periodizations and localizations of current historiographies.



2018–2020

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MPRG Experience in the Premodern Sciences of Soul and Body, ca. 800–1650

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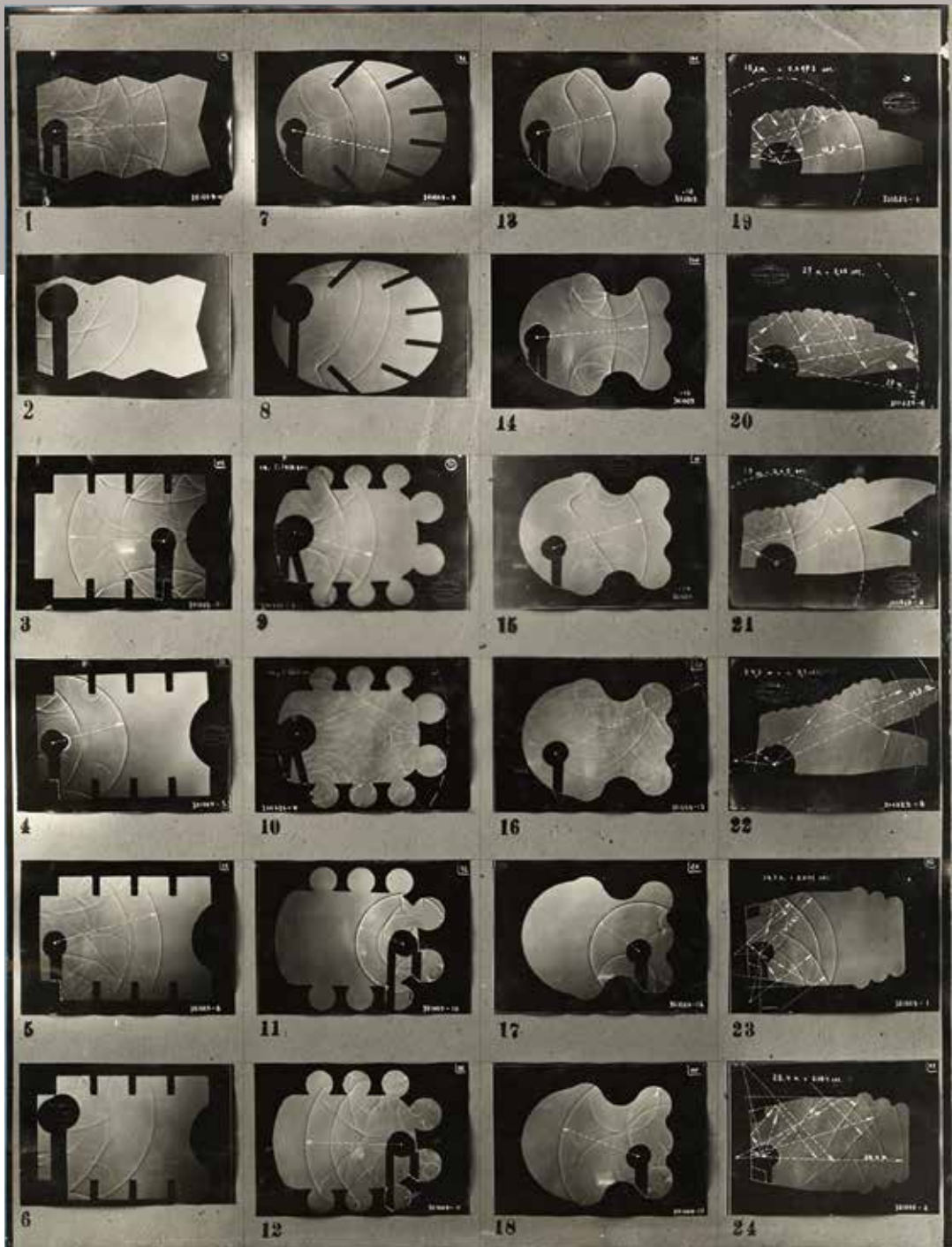
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Max Planck Research Group

Epistemes of Modern Acoustics

MAX PLANCK RESEARCH GROUP LEADER Viktoria Tkaczyk



Epistemes of Modern Acoustics

The Max Planck Research Group “Epistemes of Modern Acoustics” ran from March 2015 to February 2020. We began from the observation that acoustics has never been a discipline of its own. Even its name-giver, French mathematician Joseph Sauveur, described acoustics in 1701 as a “general science of sound” that required the expertise of different classes of the Académie royale des sciences. From then and throughout the long modern period, acoustic research was “parasitic”: harbored by a wide range of disciplines in the sciences and humanities, acoustic topics never achieved the status of autonomous fields of research, yet they made countless scholars and scientists hear the world with different ears.

The Research Group charted the key moments in the making of acoustics in the modern period, tracking the emergence of widely divergent subdisciplines such as physical acoustics, architectural acoustics, and bioacoustics. At the same time, the group investigated the deployment of sound technologies and techniques of listening beyond the realm of acoustic research: the application of stethoscopes in the medical sciences, oscilloscopes in phonetics, tape recording in anthropology, sonar technologies in oceanography, and seismic and infrasonic monitoring systems in geophysics. By giving equal weight to disciplinary and technological developments, we were able to demonstrate that modern scholarship was not in fact exclusively ruled by what historians of science have called the “nobility of sight” or a “hegemony of vision.” It would nevertheless be misleading to claim that a completely new and uniform discourse on sound arose in the period. Instead, these diverse knowledge formations suggest a history in which the epistemes of acoustics need, precisely, to be treated in the plural.

In its final phase, the Research Group redefined the notion of the “applied sciences” in the context of acoustics. Application-oriented research is generally seen as the less exciting side of the history of science, where sophisticated epistemologies are scaled down for the purpose of broad-based usefulness. Yet far from being the sites of the plain and simple implementation of purer knowledge, fields of applied acoustic research turn out to have been dynamic environments where scientific, industrial, and political actors engaged in often heated epistemic negotiations. In most of the cases studied by the group, experts in acoustics reached new insights by tackling challenges in music, industrial technology, architecture and city planning, or the environment. In other cases, acoustic studies were conducted as basic research but applied belatedly, in unforeseen contexts.

The group’s leader, three postdoctoral researchers, and thirty-two associated and visiting scholars collaborated closely in this final phase, contributing to the three

Franz Max Osswald’s photographic studies of sound propagation in architectural models of 1933. ETH-Bibliothek Zurich, Image archive: Osswald, Franz Max/Ans_10391-011.

umbrella research themes described in more detail in the previous research report. Each theme now proved particularly productive for gaining a larger picture of the widespread applications—both immediate and delayed—of acoustic knowledge in the modern period.

Work on the first theme, “**Betwixt and Between: Sound in the Humanities and Sciences,**” showed that applied acoustics research is not the preserve of science alone, but also forms part of the humanities. Research on auditory cognition, for example, broke through all disciplinary borders in the modern period. Viktoria Tkaczyk illuminated the process by which the identification of the auditory cortex in late nineteenth-century neuroanatomy affected numerous disciplines across the sciences and humanities. These encompassed knowledge about the body and the production of language, in fields such as psychophysiology, or in linguistics, phoniatriy, and language pedagogy; it extended to intersections of experience and intellect, such as in the philosophy of life, psychoanalysis, and experimental aesthetics, to the study of physical phenomena such as in shock-wave physics, materials science, and architectural acoustics, and finally to practical fields such as sound engineering and communication studies. Each field now attended to the mind’s ear and created sound-related knowledge techniques central to its own epistemological agenda. The scholars and scientists studied by Tkaczyk responded creatively to the new cultures of music and audio communication arising around 1900, and to technologies that generated alternate modes of recording, collecting, and comparing sound data. In turn, their auditory knowledge was both challenged and widely applied in domains outside the academic realm, whether industrial, aesthetic, therapeutic, educational, social, or political. These conjunctions open up a discussion about what applied research in the sciences and humanities can or should aim for.

Phonetician Wilhelm Doegen, director of the Lautabteilung at the Prussian State Library, tests the “glyphic” gramophone recording technique that he invented to record speech sounds. His findings were used by Odeon Records in the late 1920s. © Deutsches Historisches Museum, inventory number BA 98/151.



*Platten-Prüfung v. Prof. Doegen
in seinem Institut. (links)
links: Tschirch Tempel-
Müllers Sekretariat Dr. Unger
1922*

Tkaczyk's study is scheduled for publication with the University of Chicago Press in 2022 under the title *Thinking with Sound: A New Program in the Humanities and Sciences around 1900*. It combines microhistorical with synoptic and panoramic perspectives on deeply entangled international research settings, breaking new ground for our understanding of discipline formation in the modern period.

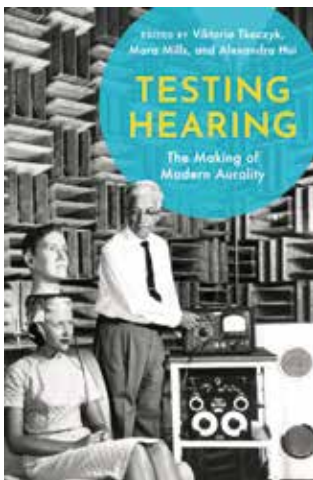
Another area of research that drew on both the humanities and the sciences in the twentieth century is automatic speech recognition. As the project of postdoctoral researcher Xiaochang Li revealed, the peculiar problem of mapping sound to language laid the epistemic, economic, and technical groundwork for the rise of data-driven computational modeling and machine learning as privileged and pervasive forms of knowledge work, across domains from genomics to finance and in the sphere of everyday life. Starting from turn-of-the-century experiments in phonetics that brought language into the laboratory with the aid of acoustic inscription devices, Li found an array of disciplines converging around an application-oriented interest in the acoustic speech signal. Speech recognition research was first taken up in commercial telecommunications research, then expanded into the tangled network of military, industrial, and academic collaborations of postwar computer science and data management, at a moment when computers themselves were being reimagined toward new aims, applications, and users. Along the way, what communications engineers had termed the “measurement-meaning relation” of speech recognition was refashioned. From the study of physiological and perceptual processes, they moved to the procedural representation of expert knowledge and linguistic intuition, and finally to the automatic detection of statistical patterns in large quantities of data. Li's work is part of a larger book project on the datafication of language, artificial intelligence, and machine learning in twentieth-century scientific, military, and industrial domains.

Xiaochang Li and Mara Mills received the SHOT Bernard S. Finn IEEE History Prize in 2020 for their essay “Vocal Features: From Voice Identification to Speech Recognition by Machine” (*Technology and Culture* 60, no. 2, 2019: 129–160).

This umbrella theme also resulted in two of the group's collective publications. The special issue “Listening to the Archive: Sound Data in the Humanities and Sciences” (*Technology and Culture*, 2019), edited by Carolyn Birdsall (University of Amsterdam) and Viktoria Tkaczyk, asks how developments in sound archiving prompted new comparative methods in the sciences and humanities of the twentieth and twenty-first century. Scientists and scholars created, shared, and defined the sound data that they compared, and the resulting comparisons were far from being neutral. The theme issue “Sounds of Languages—Languages of Sounds” (*History of Humanities*, 2021), edited by Julia Kursell (University of Amsterdam), Viktoria Tkaczyk, and Hansjakob Ziemer, traces the routes by which a new attention to the spoken word both enabled and necessitated new alliances between humanities and scientific disciplines from the late nineteenth century onward. At the same time, new languages and

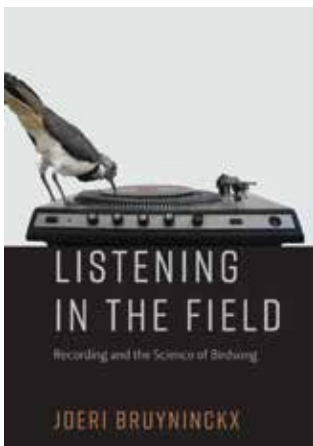
modes of speaking arose, across the “great divide,” as tools to examine, represent, and utilize sonic phenomena—whether in speech, music, or other sonic environments. Again, in all the cases discussed, the choice of certain sounds and languages was deeply permeated by issues of power and politics.

The projects subsumed under the second theme, “**Testing Hearing: Science, Art, Industry**,” explored the nature of testing as an enduring cultural technique in the modern period, crisscrossing histories of scientific experimentation and fields of application. Viktoria Tkaczyk, Mara Mills (NYU), and Alexandra Hui (Mississippi State University) edited the volume *Testing Hearing: The Making of Modern Aurality*. From different disciplinary perspectives, its twelve contributors demonstrate how auditory tools—testing anything from auditory impairment to tone differentiation skill—underwent especially intensive development in nineteenth-century experimental physiology. Hearing tests received a further boost around 1900 as a result of injury compensation laws and state and professional demands for aptitude testing in schools, conservatories, the military, and other fields. The results of these tests fed back into modern epistemologies of the human ear as the role accorded to hearing expanded in the twentieth and twenty-first centuries. Hearing became both test object and test instrument; in the latter case, it was a gauge by which to evaluate or regulate materials, nonhuman organisms, equipment, and technological systems.



Testing Hearing: The Making of Modern Aurality, edited by Viktoria Tkaczyk, Mara Mills, and Alexandra Hui (Oxford University Press, 2020), argues that the testing of hearing became a key cultural technique in the modern period, affecting many different fields and turning the world into a testbed.

As postdoctoral researcher Joeri Bruyninckx demonstrated in his monograph *Listening in the Field: Recording and the Science of Birdsong*, the modern history of testing was not confined to human ears. Throughout the twentieth century, biologists used a variety of techniques to register wildlife sounds, including the communication of birds. The practice of recording and studying birdsong took shape at the intersection of scientific ornithology and popular entertainment, shaping a new understanding of the environment as a sonic sphere. Bruyninckx’s subsequent project traced the application of acoustic tests in the study and governance of human behavior at work. In this study of sound management in postwar work spaces, including cockpits, control rooms, and offices, he asked how a new scientific and managerial concern with information and communication prompted a reconceptualization of office work and environments and their acoustic reorganization to secure efficiency, comfort, and privacy.



In *Listening in the Field: Recording and the Science of Birdsong* (MIT Press, 2018), Joeri Bruyninckx traces the process by which twentieth-century biologists made wildlife sounds into scientific objects.

Scholars working on the third umbrella theme, “**Sound Objects in Transition,**” generated new insights into the making of “sound objects” through long-term, global negotiations between actors in the sciences, humanities, and political sphere. For example, the determination of musical pitches was fiercely debated between nations and across different fields of applied research in the nineteenth century. In her archival work, postdoctoral researcher Fanny Gribenski documented the conversations, technologies, and practices that ultimately led to the adoption of concert pitch A 440 at an international conference held in London in 1939. Adding a sonic dimension to existing work on scientific and technical standards, she examined the Western world’s construction of a sonic point of reference, highlighting the broad range of actors and fields of expertise involved as well as the many technological means of measuring and regulating sound frequencies. The outcomes of Gribenski’s research will appear as *Tuning the World: Aesthetics, Acoustics, Industry, and Global Politics (1834–1939)*, under contract with the University of Chicago Press.

Two further collective publications resulted from the “Sound Objects” theme, scrutinizing the status of objects in the arts and sciences from several different perspectives. The special issue “Opening the Doors of the Studio” (*Contemporary Music Review*, 2020), edited by Fanny Gribenski, Jonathan Goldman (University of Montréal), and João Romão, sheds new light on the objects produced in music studios in the modern period. By querying the notion of studios as “laboratories of the arts,” the special issue demonstrates the importance of the myriad circulations of technological objects, artifacts, knowledge, and economic models for the global history of music studios.

The seven contributors to the special issue “Sonic Things: Knowledge Formation in Flux” (*Sound Studies*, 2020), edited by Viktoria Tkaczyk and Leendert van der Miesen, describe the histories of elusive, noncochlear, and ideal sounds: sounds of faraway places and times, divine or imaginary sounds, scientifically unexplorable sounds, private or secret sounds. Such “sonic things” accumulate multiple epistemologies, folding together legacies of history and harbingers of the future. The knowledge that gathers around them is always in flux; it contributes to new and constantly revised epistemes of acoustics while also being used in practical fields that include the building of echo chambers, church architecture, musical instrument building, bird training, language teaching, and the formation of sonic identities more generally.

The Research Group “Epistemes of Modern Acoustics” offered an opportunity to reconfigure sound studies into a new field of scholarship within the history of science, and we hope it will inspire research on sound for years to come. Together, the members and visiting scholars organized influential conferences as well as an inspiring monthly colloquium. In addition to the group’s numerous publications, its members’ archival research and conceptual work came to fruition in an extensive and ongoing open-access database on the history of acoustics, “**Sound & Science: Digital Histories.**” The rich, and often rare, sources are presented in curated categories, with an extensible tagging system to facilitate research use along with a growing collection of multimedia essays that contextualize and mine the material.



Prototype of the “diapason normal,” the first national standard of pitch, adopted by the French government in 1859. Jules-Antoine Lissajous, France, 1859, E.378, Collections Musée de la musique/ Cliché Anglès.



<https://soundandscience.de/>

When the Research Group ended in February 2020, management of the database passed to a collaboration between Humboldt-Universität zu Berlin, IRCAM in Paris, Ingenium: Canada's Museum of Sciences and Innovation in Ottawa, and the MPIWG.

Again looking forward beyond the end of the group, Viktoria Tkaczyk submitted a grant proposal for a Center for Advanced Studies in Humanities and Social Sciences to the German Research Foundation DFG (with Anke te Heesen), entitled "Historicizing the Applied Humanities." Projected for eight years, this international fellowship program plans to explore the historically varying relationships between humanities knowledge and artistic, technological, sociopolitical, and environmental change.

Viktoria Tkaczyk also pursued her interest in applied research by launching a new collaborative initiative on the geographic provenance and supply chains of the raw materials of the technologies that made modern knowledge possible. This initiative includes the lecture series *The Resources of Media: Global Transfers of Materials, Knowledge, and Technologies*, organized with Christine von Oertzen in 2021, and the online workshop "Sound Supplies: Raw Materials, Supply Chains, and the Political Economy of Instrument Building," organized with Fanny Gribenski and David Pantalony in 2021. Preparing these projects also helped shape the [International Max Planck Research School \(IMPRS\) "Knowledge and Its Resources,"](#) due to start work in 2022, in which Tkaczyk will be part of the teaching faculty and the first year's co-speaker.

Viktoria Tkaczyk and her colleagues are most grateful for the support that the "Epistemes of Modern Acoustics" group received from the Max Planck Society, the MPIWG, Volkswagen Foundation, and additional funders of graduate students, post-doctoral scholars, and visitors. Time was short, but the MPIWG was the best possible research environment for the group, and a magnificent source of intellectual inspiration and exchange.

→ [Berlin Center for the History of Knowledge](#)



2018–2020

RESEARCH GROUP LEADER Viktoria Tkaczyk

RESEARCH SCHOLAR Joeri Bruyninckx

POSTDOCTORAL FELLOWS Fanny Gribenski, Xiaochang Li

VISITING PREDOCTORAL FELLOWS Christina Dörfling, Charles Eppley, Felix Gerloff, Benjamin Lindquist, Leendert van der Miesen, João Romão, Lotte Marie Schüßler, Sebastian Schwesinger

VISITING POSTDOCTORAL FELLOWS Bo An, Carolyn Birdsall, Andrea Bohlman, Nikita Braguinski, Lino Camprubí, Leonardo Cardoso, Leon Chisholm, Flora Dennis, Alfredo Thiermann, Hannah Wiemer

VISITING SCHOLARS Karin Bijsterveld, Camilla Bork, Martin Brody, Shane Butler, Brigid Cohen, Veit Erlmann, Alexandra Hui, Marie-Madeleine Mervant-Roux, Mara Mills, David Pantalony, Benjamin Steege, Jonathan Sterne, Emily Thompson, Roland Wittje

SUPPORT TEAM Kate Sturge, Birgitta von Mallinckrodt

STUDENT ASSISTANTS Hannah Eßler, Jonathan Haid, Yaroslav Koshelev, Julia Steinmetz, Alina Topf, Fabian Voigtschild

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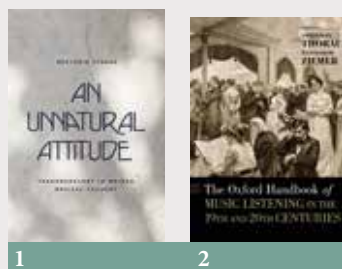
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Lise Meitner Research Group

China in the Global System of Science

LISE MEITNER RESEARCH GROUP LEADER Anna Lisa Ahlers



China in the Global System of Science

China's rise in the global system of science and scholarship since the turn of the century is unprecedented and provoking. The country is home to scientists whose groundbreaking findings and methods regularly make world news, and it pours a staggering amount of money into funding research and frontier experiments, both domestically and internationally. The People's Republic is racing to the top of all the significant worldwide rankings, including those counting scientific publications and assessing the reputation of universities and other research organizations. These developments, achieved in record time, seem to already testify to the success of the Chinese government's strategy to make China a science powerhouse by 2020 and the leading global science power by 2050.

Looking at this unparalleled process, a whole array of questions arises. While some observers wonder whether the projected dominance of "Chinese contributions" might change the way science is practiced, others argue it is impossible to achieve genuine scientific leadership under an authoritarian regime. But there are many other aspects pertaining to the overall societal environment for science and scholarship in China that are worth studying in order to analyze and understand these current developments in all their complexity. For instance, does the Chinese case signal that there are potential alternatives to the seeming imperatives of the *autonomy* and *unity* of science? To what degree can scientific innovation be technocratically planned and steered? What role does the public valuation and understanding of science and scholarship play in China? And how should one interpret the mixed global reactions to China's unprecedented ascent to science superpower status?

In-Depth Analytical Perspectives on Spectacular Developments

The new Lise Meitner Research Group "China in the Global System of Science" takes a close and thorough look at these various developments. The group is the first of its kind worldwide that combines perspectives from the social sciences and the expertise of area studies to produce comprehensive analyses of the Chinese system of science and its global integration. It provides a new platform for both junior and senior researchers with a special interest in exploring the role of the political regime and other social structures as environmental factors for science and scholarship in contemporary Chinese society, international academic cooperation, and world science. The larger research themes that scholars in this group are dealing with include Chinese perspectives on the status of science and scholarship in society; the structures,

DNA sculpture at China Science & Technology Museum, Beijing. Source: Mitch Altman, via Flickr.com, CC-Lizenz (CC-BY-SA 2.0), 2011.

dimensions, and norms of China's contemporary science policy; the external steering versus the internal agency of scientific communities and individuals, locally and globally; and the interactions of academic standards and practices with societal values and ethical principles in China and beyond.

Group members with diverse disciplinary backgrounds are pursuing analyses in and across these research areas through individual and collaborative projects. Among the more than fifteen projects currently hosted by the group, we find, for example, an analysis of the internationalization strategies of Chinese universities, a study of how Chinese polar scientists navigate between research and diplomacy, investigations into the seeming interrelatedness of foreign policy and the evolution of new scientific disciplines and communities in China and abroad, and a study of the ethical principles and social values that underpin Chinese scientists' and other social actors' coproduction of artificial intelligence technologies. Inspired by recent events, one joint project traces the different roles that scientists performed—as advisors, crisis managers, and transmitters of information to the domestic public and their global peers—following the COVID-19 outbreak in China. In addition, “The Merton Project” is a collaborative attempt to synthesize and further develop theory building on the interactions of science and political structures in contemporary society, taking into account the insights generated in this group.

Although the group's research mainly focuses on the contemporary period and is predominantly based on approaches grounded in the qualitative social sciences, it will also include historical perspectives and a variety of innovative methods. Being hosted by the MPIWG provides the group with plenty of opportunities in these regards.

Starting a Research Group in a Pandemic, and Looking Ahead

The ongoing global COVID-19 pandemic has had a tangible impact on the group's formation and work. Nevertheless, members were able to gradually gather in Berlin over the summer and fall of 2020. In addition to the group's core members—one research scholar, one postdoctoral research fellow, three predoctoral fellows, and the PI—the group hosts several guest researchers and has also started to network with the most renowned experts in the field. For the time being, as travel restrictions constrain field access in China and beyond, and physical encounters are restricted, the Research Group is exploring new ways of collaboration. At the end of 2020, an online research workshop series and an in-house open access publication format, *Observations: Short Papers on Science and Society in China and the World*, were launched.

The group also actively seeks to make its research accessible for comparative analyses of related topics in different time periods and world regions. It thereby wishes to develop into a hub supporting further contributions to our understanding of the relationship of science and academe and political regimes in the twenty-first century, and it looks forward to hosting many visiting researchers and events at the Institute in the coming years.



2020

RESEARCH GROUP LEADER Anna Lisa Ahlers

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SUPPORT TEAM Dieu Linh Bui Dao

RESEARCH ASSISTANTS Yu-Fen Lai, Sonia Qingyang Li

Lise Meitner RG China in the Global System of Science

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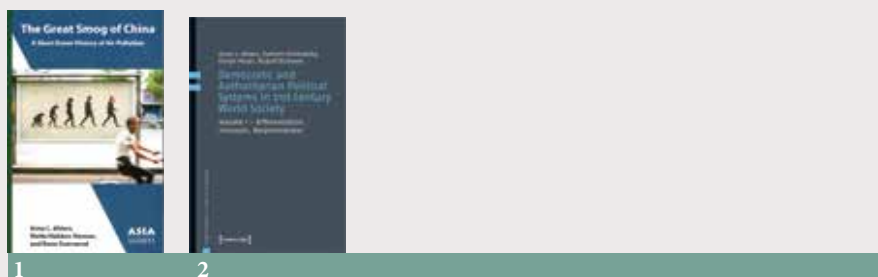
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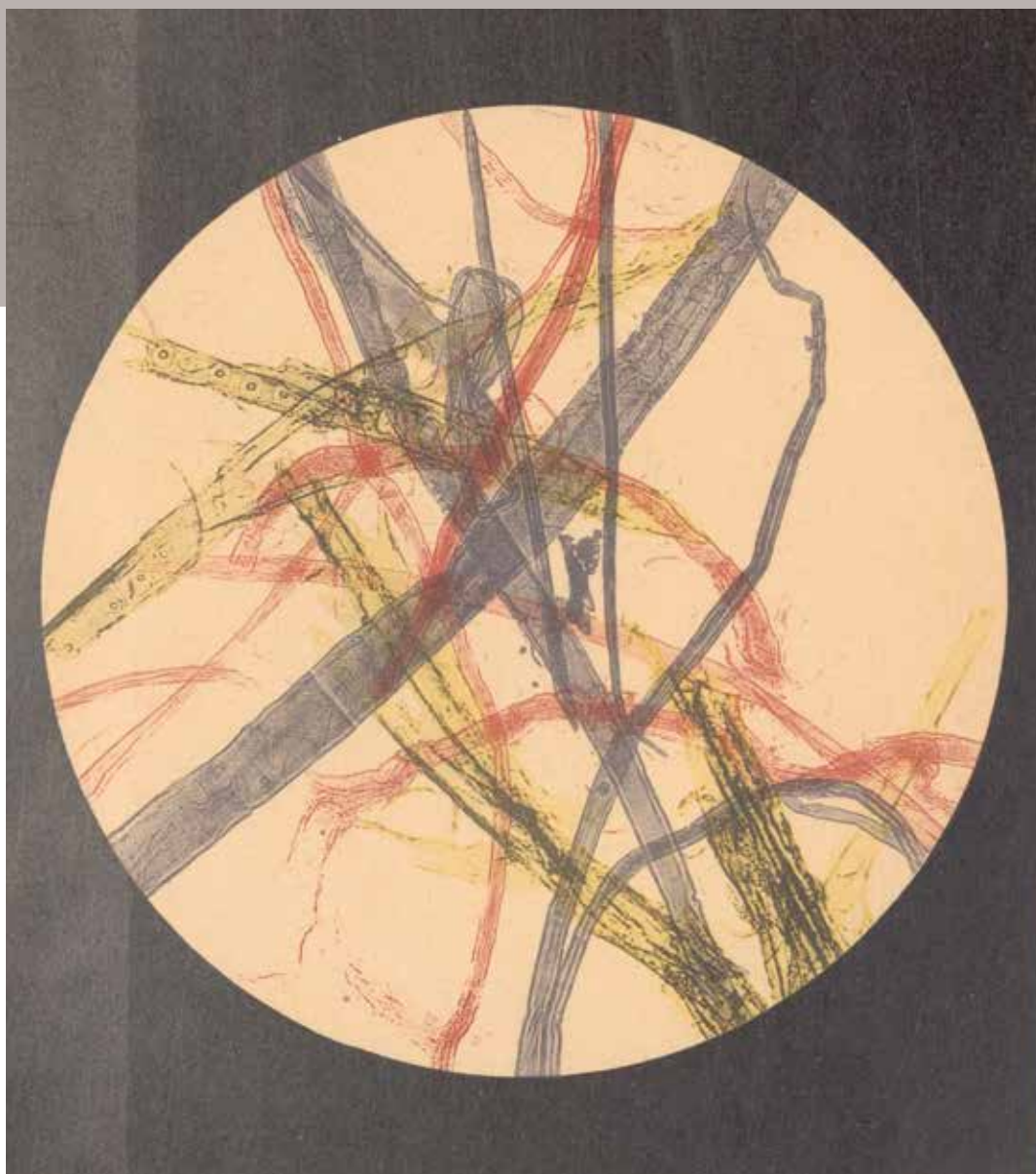
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Principal Investigator

Data, Media, Mind

PRINCIPAL INVESTIGATOR Christine von Oertzen



Data, Media, Mind

The overall theme of my projects, “Data, Media, Mind,” reflects a productive shift within my research that has also shaped my teaching commitments and research collaborations. My research combines a long-term focus on the material culture and epistemologies of personal data with a keen interest in pushing the boundaries of history of science further toward a history of knowledge by engaging with media studies and the histories of bureaucracy, with the social, human, and cognitive sciences, and with citizen science. Within the MPIWG, my role in the Institute has also seen profound changes during the reporting period, as I was granted the independent status of Principal Investigator upon the closure of Department II.

As the long-standing W2 Group Leader of Department II, I brought two Working Groups to completion before the Department’s closure in summer 2019. *Working with Paper: Gendered Practices in the History of Knowledge*, edited with Carla Bittel and Elaine Leong, was published by Pittsburg University Press in spring 2019; *Histories of Bureaucratic Knowledge* had its last authors’ meeting in June 2019. The resulting volume, edited with Sebastian Felten, was published as inaugural special issue of the open access *Journal for the History of Knowledge* in 2020. A third volume, *Surprise: 107 Variations on the Unexpected*, edited with Mechthild Fend, Anke te Heesen, and Fernando Vidal, was composed of miniatures by former members of the Department to pay tribute to Lorraine Daston and her inspiring leadership. This collection of essays was presented during the Department’s memorable farewell festivities on June 21, 2019.

Shortly after Lorraine Daston’s retirement, I was appointed professor for media practices in the Media Studies Department at Berlin’s Humboldt-Universität. Established as a tenured special professorship (S-Professur), this new position emerged from the cooperation agreement between the MPIWG and the three Berlin universities. The position was offered to me in order to further consolidate collaboration between the Institute and the Humboldt-Universität; to strengthen the study of historical media epistemologies at the university; and to bolster the Berlin Center for the History of Knowledge, a network established in 2011 with our [three Berlin partner universities](#).

This appointment gave momentum to collective efforts by colleagues from the three Berlin universities and the MPIWG directors to develop a proposal for an International Max Planck Research School on “Knowledge and Its Resources: Historical Reciprocities” (IMPRS-KIR). Building on a cotaught master’s seminar with professors Anke te Heesen (HU), Friedrich Steinle (TU), and Viktoria Tkaczyk (HU), and in close collaboration with all involved parties, I finalized the concept for an interna-

→ Working Group in Dept. II report, “Histories of Bureaucratic Knowledge”

→ Notes and collage in Dept. II report

→ Berlin Center for the History of Knowledge

Paper sheet with linen and cotton (red), wood and straw pulp (violet), and groundwood fibers (yellow), treated with a solution of chlorine, zinc, and iodine. Colored print of a microscope photograph. In Wilhelm Herzberg, *Papierprüfung: Eine Anleitung zum Untersuchen von Papier* (Berlin: Julius Springer, 1902), plate 14.

→ Berlin Center for the History of Knowledge

tional PhD program based in the history and philosophy of science, technology, and medicine. Our collective proposal was submitted to the MPG in June and approved in November 2020. **This program will start with the first cohort of graduate students in September 2022 (IMPRS-KIR)**, with me serving as the MPIWG's cospeaker.

My own research is focused on two main current projects. Taken together with the collaborations mentioned above, it aims to open new avenues for research in which media studies, the history of data, and the history of the social and human sciences cross-fertilize.

“Media of Veracity” explores the concepts, tools, and practices of manual data compilation in census taking during the nineteenth century, a period that witnessed a new, innovative reflexivity toward cumulative, quantifying methods across science, commerce, and the state. Recent scholarship in the history of anthropology, biomedicine, genetics, and the social sciences has shown how individuality, intimacy, and personal ownership form a crucial part of a history that critically reflects material cultures, epistemic shifts, and political economies of data regimes. Building on this historiography, the project seeks to further enrich our historical understanding of personal data in the making. It explores implementation and impact of “self-inscription” within census taking, a method bolstered by scientific ideals prevalent in the exact sciences of the time that aimed to retrieve spontaneous, and thus truthful, personal information.

→ Research Group Tkaczyk

“Supply Chains for Data” evolved from the collaborative HU lecture series **The Resources of Media: Global Transfers of Materials, Knowledge, and Technologies** and a roundtable on “**Raw Materials, Supply Chains, and the Politics of Scientific Technologies**” at the 2021 annual meeting of the History of Science Society in New Orleans, both organized with Viktoria Tkaczyk (HU Berlin). The project is part of a three-year collective endeavor to trace the geographic provenance and the processing of a wide range of materials, contained in scientific instruments and media, that made

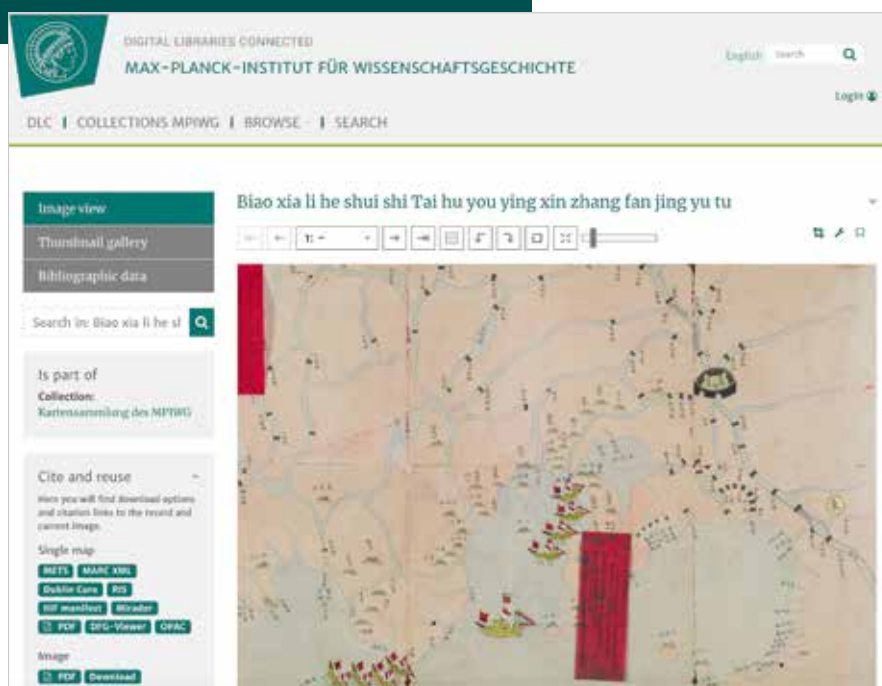
modern knowledge possible. It examines the technologies of production, examination, use, and disposal of paper forms needed for nineteenth-century data processing, with the aim of carving out the intricate ways in which local means and knowledge practices intersected with regional and global infrastructures and thus necessitated a constant “flow” of materials indispensable for data-driven ways of knowing.

The image shows a historical Prussian census card from 1900. The title is 'Volkszählung am 1. Dezember 1900. Großherzogthum Mecklenburg-Schwerin. Zählkarte für in der Haushaltung Anwesende.' The card is filled with handwritten entries in ink. At the top, it says 'Hauptort: Mecklenburg-Schwerin'. Below that, it lists 'Zählkarte Nr. 1' and 'in der Haushaltung Anwesende'. The card is divided into several sections with numbered questions. The answers are handwritten in ink. For example, '1. Name und Familienname: Paul Gräber', '2. Geburtsort: Mecklenburg-Schwerin', '3. Geburtsdatum: 1. Sept. 1874', '4. Wohnort: Levensdorf', '5. Beruf: Bauer', '6. Religion: Evangelisch', '7. a. Gewerbe (Erwerbsart), b. Beruf (Erwerbsart), c. Beruf (Erwerbsart)', '8. Religionszugehörigkeit: Evangelisch', '9. Staatsangehörigkeit: Preussisch', '10. Zeit der Einreise in das Reich: 1. Sept. 1874', '11. Zeit der Einreise in das Reich: 1. Sept. 1874', '12. Sonstige Bemerkungen: ...'. The card is a good example of a historical data form used in the early 20th century.

Prussian census card, 1900, self-inscribed by Paul Gräber, Levensdorf, Mecklenburg-Schwerin. Private owner. Made available on Wikimedia Commons Media Archive.

Research Services

Research Library



Overview: The Library's Core Collections and Services

The library caters directly to the needs of the MPIWG Departments and Research Groups in order to facilitate research in many areas of the history of science. It is not open to the public but provides around 500 MPIWG scholars per year with a print collection of more than 85,000 books, 3,500 rare books, and 10,000 twentieth-century archival items, in addition to over 30,000 electronic journals, more than 200 full-text and reference databases, and 650,000 e-books, most of them licensed by the Max Planck Digital Library.

These collections are closely tailored to the needs of the Institute's scholars. Services focus on a) quickly providing necessary scholarly sources (acquisition, inter-library loan); b) supporting the publication process (digitization on demand, image editing, copyright and permission request, open access publishing, the Institute's bibliography); and c) handling research data (infrastructure for accessing and archiving, advising for research projects).

Map of the Lake Tai Right Battalion's Newly Established Inland Waters Naval Forces with Explanations (標下裏河水師太湖右營新章汎境輿圖). Manuscript map, China, 1871.

2018–2020: Digital Publication and Dissemination of Research Outputs

During the reporting period, the library focused its efforts on building, refining, and extending its infrastructure and services for the digital publication and dissemination of research results, including research data. The difficult situation caused by the COVID-19 pandemic fostered greater digitization in certain work areas: while the growth of the print collection remains stable with a rising tendency, the number of purchased e-books doubled in 2020 and the library developed concepts for digital introductions into collections and services.

The Shift toward a Library of (Open) Data: MPG-DRIH—A Digital Research Infrastructure for the Humanities

As research projects have become more digital, digital research data is becoming a growing challenge. The format of scholarly output is changing, since it no longer necessarily flows back into any reliable information system that guarantees persistent data retrieval. This interrupts the research lifecycle as known from the print age, causing valuable data to vanish. As an answer to these problems, during the reporting period the library worked closely with the [Research IT Group](#) to build MPG-DRIH, a prototype for a cutting-edge digital research infrastructure based on linked data technology in order to efficiently support digital humanities projects and assure the long-term accessibility and visibility of its digitized sources and research data. This infrastructure takes advantage of semantic web technology to interlink the Institute's heterogeneous data sources, including research project output and Institute infrastructural data resources such as its digitized rare books. At its core is a graph database using RDF triples based on the standard data model CIDOC-CRM. The philosophy guiding this project is to separate data from software in order to retain the data as open data, while most likely keeping neither custom user interfaces nor ageing software. Separating the data from the software means it can be integrated in various retrieval systems, while different user interfaces allow for modified views. According to the FAIR open data principles, data should be findable, accessible, interoperable, and reusable.

In the course of this development the library expanded its scope in the area of research data management and data modeling. While the library provides the digitized sources in the standardized data format and makes it usable for the research projects, Research IT focuses on the provision and development of digital tools and research methods. The important task of advising the research projects in the use of controlled vocabularies throughout their projects is shared by the library and Research IT. Following the recommendations of the advisory board, the library received a permanent position of a research data manager. The position was filled with an outstanding expert in data modeling and ontologies for the humanities.

→ [Research IT and Digital Humanities](#)

Securing the Digital Sources

An important step within the project MPG-DRIH was to secure the sources that had been digitized and accumulated by the library over the past two decades and were still stored and displayed in the framework of the ECHO project. Within one and a half years a new software, Goobi, already used by the [History of the Max Planck Gesellschaft project](#), was chosen to curate and display the digital collections, and the migration was accomplished. The project was a collaboration between the MPIWG and three other MPIS: The Kunsthistorisches Institut in Florenz, the MPI for Legal History and Legal Theory, and the MPI for Human Development. The project was realized with presidential funding from the [Max Planck Society](#).

→ [GMPG](#)

<https://dlc.mpg.de/>



Publishing Open Access

In order to foster open access publishing, the library has made significant efforts to develop various initiatives and workflows and bundle them with the current infrastructure to create a broad and transparent open access portfolio. Researchers are advised on how to benefit from the open access contracts negotiated between the Max Planck Digital Library and leading publishing houses. And since 2018, the library has supported these efforts by dedicating part of its budget to an open access fund that enables scholars to publish their research open access. Moreover, to benefit from the German right of secondary publication, which enables authors to make their research publicly accessible (green open access) under certain circumstances, the library established a workflow to identify potential articles and publish the work on PuRe, the repository of the Max Planck Society. The library has also strengthened its collaboration with the research departments' publication management. Together, a publication services portfolio was established for the Institute that integrates the open access portfolio. The most significant part of this portfolio consists of [Edition Open Access](#) (EOA), a platform for open access monographs; unlike open access journals, this is still a relatively undeveloped field in the publication landscape. Initiated by Department I in 2011, the project shifted to the library at the beginning of 2020. The aims are to increase its visibility across the Institute, develop it further as a relevant and innovative publication environment for the digital humanities, and integrate and interlink it with the other components of the Institute's digital research infrastructure, such as the digital library, Jupyter notebooks, and the knowledge graph.

<https://edition-open-access.de>



Cooperation and Outreach

The library is involved in numerous collaborations related to its digital infrastructures and to foster the exchange of sources and expertise. In particular, the concept and architecture of its digital research infrastructure has generated significant interest within the Max Planck Society and beyond. To communicate the library's key concepts, Esther Chen has frequently presented at conferences for librarians and scholars. As a member of the Expert Advisory Board of the German Digital Library (DDB) and the Beirat Netzwerk Digitale Sammlungen Berlin, Esther Chen also advises these institutions from the professional and intellectual perspective of research libraries.



LIBRARY TEAM

HEAD OF LIBRARY Esther Chen

STAFF Sabine Bertram, Urte Brauckmann, Ellen Garske, Steffen Hennicke, Ralf Hinrichsen, Hartmut Kern, Ruth Kessentini, Beate MacPhail, Cathleen Paethe, Anke Pietzke, Matthias Schwerdt, Klaus Thoden

Research Library

Publications 2018–2020

Bertram, Sabine *see Valleriani, Kräutli, Zamani, Tejedor, Sander, Vogl, Bertram, et al.*

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Research IT and Digital Humanities

Since it was founded in 1994, the MPIWG has had a long history of adopting digital technologies in research. Now more than ever, research in the history of science relies on online resources and digital methods. The Research IT Group was reorganized in 2016 to respond to these changes and facilitate close collaboration among the group and with the Institute’s scholars: three IT researchers are embedded in the MPIWG’s departments, while a central unit of two people coordinates support for common digital research needs across the Institute.

Working with the library, these IT researchers assist scholars at every step of the digital research process, from accessing, creating, and analyzing digital resources to preserving and publishing results. IT researchers provide expertise in identifying existing digital tools and developing novel digital methods. This successful cooperation has attracted broad scholarly attention and led to significant grant funding in the field of digital humanities.



A digital map of the treatises belonging to the Sphaera corpus demonstrates the geographic and temporal distribution of epistemic communities.

Revisiting Sources with Digital Analytical Methods

Digital forms of sources, whether scanned images, digital texts, or bibliographical records and abstracts, open up possibilities for reviewing, reordering, and remixing the sources that researchers have long studied. New corpora thus become accessible for systematic research in the history of science to reveal undiscovered patterns.

Some exemplary projects in this area are the [Islamic Scientific Manuscripts Initiative](#), which brings together scholars collecting bibliographic information on currently more than 15,000 manuscripts in over 9,000 codices from the ninth to the nineteenth century in the exact sciences in Arabic, Persian, Turkish, and other languages. This database allows scholars to examine chains of transmission and networks of dissemination of scientific knowledge in the Islamic world across regional and language boundaries. The Institute also hosts the long-term archive of the [Cuneiform](#)

→ [Islamic Scientific Manuscripts Initiative Workshop](#)

→ CDLI, Dept. I

[Digital Library Initiative](#), which is recognized as one of the most important resources for research in Assyriology. In addition, the first version of the website of the Hilprecht Collection of the University Jena is now available, presenting more than 1000 3-D scans of tablets.

→ Research Group Leong, Dept. II

→ Dept. III

→ Research Group Tkaczyk

→ Dept. III

Other projects focus on specific textual traditions, such as the Sphere project (Dept. I), which sheds light on Sacrobosco's *Sphaera*, an important treaty on cosmological knowledge. The [Reading Early Medicine website](#) hosts a bibliographical collection of early modern English texts on health and healing. The Working Group "[Visualization and Material Cultures of the Heavens](#)" collaborates with scholars and institutions across the world, continuing its work on a protected database to collect digital images of representations of the heavens with the aim of tracking the movement and change of astral knowledge across space and time. [The Sound and Science database](#) collects sound files as well as articles and images to create a rich network of relations documenting the history of the field of acoustics.

These digital collections open up new research possibilities and require new analytical methods to help scholars pose relevant questions and reveal emerging patterns. For instance, the Working Group "[Local Gazetteers](#)" is developing a LoGaRT toolkit to explore 4,400 titles of Chinese local gazetteers as a collective database and to analyze the data in order to answer specific questions about local knowledge making and political epistemology. In [CHMap](#), 4,088 large-scaled land survey maps of early twentieth century China have been scanned, georeferenced, and displayed to serve as a baseline and reference point for both modern and historical data. In "[Measuring the Earth](#)," digital tools are being built to analyze the multilingual corpus of meeting minutes from the European Association of Geodesy. Computational methods such as named entity recognition and machine learning are being introduced to extract important entities from texts and relationships among actors, places, and organizations.

→ Dept. I, Socioepistemic networks

One key concept that Department I has developed into a framework to bridge qualitative and quantitative research in historical and political epistemology, and to apply network analysis to historical research, is that of socioepistemic networks. This concept was successfully employed in the project of the [history of general relativity](#) and has been extended to other fields such as research on the history of exoplanet research and research on the knowledge system of the Sphere. In collaboration with Technische Universität Berlin, under the umbrella of the Berlin Institute for the Foundations of Learning and Data (BIFOLD), machine learning methods are being exploited to extract topics and central keywords from scientific publications in order to understand the semantic structure of the underlying knowledge systems. Similar techniques are also now used in the [History of the Max Planck Society Research Group](#) to understand the formation of semantic networks.

→ GMPG

→ Dept. I

Image recognition technologies developed as part of BIFOLD have led to new insights into the relationships between different editions of the [Sphere](#). These results are helping scholars look at the collections to reconstruct missing relations among artifacts.

Research Infrastructures

In digital projects, research data and programming logic have often been entangled. While software has a relatively short lifespan, research data must be designed to be sustainable. In 2017, Research IT and the library jointly initiated a digital research infrastructure project, MPG-DRIH, to address this challenge. One part of the solution is to preserve data in a flexible semantic data format called CIDOC CRM (Conceptual Reference Model). Widely used by cultural heritage institutions, it provides the foundation for data interoperability. By following open standards and the principle of findable, accessible, interoperable, and reusable (FAIR) open data, research results can be reused and preserved for the long term. Moreover, this solution allows research data produced in different projects to be linked and queried together, creating a universe of interoperable research data.

The team works with the library to build a digital research infrastructure that introduces a digitization workflow and builds a processing engine producing CIDOC-CRM data, along with a flexible user interface to access this data. Data is first being used from two of our existing projects to validate and develop this infrastructure's design and will continue to integrate past, current, and future digital research projects within our Institute, opening the door for research data interoperability, long-term preservation, and new forms of publications of open science.

This initiative is but one facet of a broader vision of digital research infrastructure at the MPIWG toward interoperability and the elimination of data silos. Another part of this vision is RISE, Research Infrastructure for the Study of Eurasia, which we developed to form a secure and legal network among public and private institutions of digital resources and tools. RISE provides a lightweight network infrastructure for legal secure data transfer of digital resources and digital research tools between public and private institutions without (re)aggregating resources and tools in a centralized technical architecture, thus increasing interoperability and avoiding data silos.

RESEARCH IT TEAM

Pascal Belouin, Robert Casties, Shih-Peh Chen, Florian Kräutli (–8/2020),
Kim Pham (4/2020–4/2021), Dirk Wintergrün

Communications



Podcast series Science Social. Image 2021.

New Perspectives: Reflecting and Developing Communications at the MPIWG

The MPIWG's 2018 website relaunch marked a new beginning for the Communications Team as a unit within the Institute, providing an opportunity to develop its long-term strategy. In 2019 the new role of press and communications manager, held by Stephanie Hood, facilitated developments in print design, social media, and public events. In 2020 the new position of media officer, held by Verena Braun, was created in order to conduct pi-

lot projects in audiovisual media management and production and to open up new avenues of research communication. Accordingly, the Communications Team has developed into a multiskilled unit able to communicate the Institute's research in a variety of digital and print formats, provide in-house advice and training in communication, and facilitate collaborative work through digital platforms.

A central focus in this phase was the planning and implementation of communications projects aimed at disseminating research to the wider academic community and public, while also internally promoting the Institute's research in a way that spurs more scholars to become involved. Social media channels—Facebook, Twitter, and LinkedIn—and a digital newsletter are now key in communicating the Institute's research, events, career opportunities, and related news. Audiovisual media has been developed in line with an ongoing global trend toward digital communication, reinforced by the COVID-19 pandemic. The team has also widened and strengthened its collaborations with external partners, including contributing to large-scale public events such as the Lange Nacht der Wissenschaften, as well as its own Journalists- and Artists-in-Residence programs.

Finally, strategy has become a more central aim, with the production of general and targeted communications packages that utilize a variety of media types and focus upon clear goals and measurable objectives. The development of evaluation strategies including website and social media statistics has increased emphasis on quantifiable academic and public impact as well as on supporting researchers' academic success, with an increased emphasis on the collaborative and interdisciplinary nature of the MPIWG's research.

Of these targeted communications packages, several exemplary projects can be highlighted:

Communicating during the COVID-19 Pandemic

In 2020, restrictions imposed in light of the COVID-19 pandemic necessitated a prompt adaptation of the MPIWG's communications strategy. Digital media formats became

increasingly necessary; events including the Institute's Colloquium series are now streamed online, recorded, and published on our Mediathek and YouTube channels. The pandemic influenced not only the formats but also the content of the MPIWG's communications work. The 2020/21 Institute's Colloquium series focused on humanities and social sciences perspectives on the pandemic, opening the topic up to interdisciplinary discussion. Going remote enabled the Institute to invite speakers from across the world, including alumni such as journalist-in-residence Laura Spinney, and to open up topical discussions around public trust in science to a wider global audience.

Additionally, together with colleagues in Department III, the Communications Team developed a video project, **"History of Science ON CALL,"** in which humanities and social sciences researchers across the world were invited to submit short video monologues presenting their perspectives on the pandemic. Finally, the recently launched MPIWG website and intranet enabled the team to present COVID-19-related research projects, publications, and media outputs, as well as practical pandemic-related information for MPIWG staff and researchers.

<https://www.mpiwg-berlin.mpg.de/research/projects/history-science-on-call>



Lise Meitner Research Group "China in the Global System of Science"

The launch in January 2020 of the new Lise Meitner Research Group **"China in the Global System of Science,"** led by Anna L. Ahlers, enabled the Communications Team to put its new skills and policies into practice. A communications package was put together including a Research Group page on the MPIWG website, a print and online feature story and postcard series, and a press release. The team also produced a web and print design for the Research Group's new open-access short paper series, *Observations*, which is aimed at a broad academic audience. External collaborations were strengthened through an open-access video produced by the Latest Thinking agency, along with public speaking opportunities such as Berlin Science Week 2020. The inaugural episode of the MPIWG's new podcast series *Science Social: Conversations on History, Science, and Society*, titled "China on the Rise in the Global System of Science," also marked a new development in communicating the Institute's research to the general public through digital media.

<https://www.mpiwg-berlin.mpg.de/feature-story/china-global-system-science>



The Mask-Arrayed Project

Developed in the early stages of the COVID-19 pandemic by Department III researchers Noa Hegesh, Jaehwan Hyun, Carolin Roeder, and Marianna Szczygielska, together with the MPIWG Research IT team, the "Mask-Arrayed" project invites historians of science, technology, medicine, and the environment to explore, in short essays, the most iconic artifact of the COVID-19 crisis: the face mask. Recognizing the opportunity to share with the academic community and wider public, the Communications Team commissioned a feature story and episode of its *Science Social* podcast series, in addition to sharing updates on the project through its digital newsletter and social media platforms. The project generated extensive interest, subsequently finding a place on the Max Planck Society landing page, receiving external essay contributions, and enjoying high engagement on the MPIWG website and social media channels.

General Relativity and Black Holes

The Communications Team also facilitated collaboration between Department I, the Research Group “Historical Epistemology of the Final Theory Program,” and the Research Program “History of the Max Planck Society” (GMPG) in disseminating their research on general relativity and black holes. This included an external commission to Bagage Media for a video interview of Research Group Leader Alexander Blum on “Heisenberg and the Search for a Final Theory,” social media posts for the book *The Renaissance of General Relativity in Context* (Blum, Lalli, Renn), and a feature story and Science Social podcast episode on black holes to coincide with the Nobel Prize awards to Roger Penrose, Reinhard Genzel, and Andrea Ghez.

Looking Ahead: The Future of MPIWG Communications

The long-term trend toward digital media in both academic and public life is projected to extend past the pandemic restrictions. At the Institute, the continued development of our audiovisual media structure and workflow, Mediathek, and other platforms will be crucial in strengthening digitization efforts at the Institute necessary for academic research and communication. The movement toward broader academic and public engagement will continue to be supported with the online streaming and recording of our Institute’s Colloquium series, as well as dissemination of our research and career opportunities through our digital newsletter and social media platforms. We also aim to relate the research of the MPIWG to current public debates—such as public trust in science, or the Anthropocene—and where the themes and methods of the history of science, as practiced at our Institute, should be heard and could make an impact. A continuation of our current strategy along with new targeted, interdisciplinary, and multimedia projects will enable us to continue to support MPIWG researchers’ careers and research, communicate to the academic community and public, and assess our impact in all of these areas.



COMMUNICATIONS TEAM

Verena Braun, Stephanie Hood, Hansjakob Ziemer

Berlin Center for the History of Knowledge

A New Graduate School for the History of Knowledge

In November 2020, the MPIWG and its three Berlin university partners—the Freie Universität (FU), the Humboldt-Universität zu Berlin (HU), and the Technische Universität Berlin (TU)—secured a grant from the Max Planck Society to establish an [International Max Planck Research School \(IMPRS\)](#). This award marks the highpoint in the year-long collaboration of the four partner institutions under the umbrella of the Berlin Center for the History of Knowledge. The IMPRS will formally begin with the arrival of the first graduate student cohort in autumn 2022.

Since its inception, the Berlin Center has evolved into a productive network that has forged close ties between the MPIWG and the three universities, both intellectually and institutionally. The center has become a forum for dialogue to frame possible avenues of inquiry within the history of knowledge; at the same time, it provides an infrastructure to support postdoctoral students and serves as a clearing house for information on the courses being offered in the history of knowledge across Berlin. These activities, including a relaunch of the center's website in 2019, have significantly bolstered communication among our scholarly community within and beyond Berlin.

Three further developments expedited further consolidation. Firstly, joint appointments with the universities deepened longer-term institutional bonds between all partners. Katja Krause was appointed as [Max Planck Research Group Leader](#) and associate [professor at the TU Department for the History of Science](#) in 2018. When Viktoria Tkaczyk, Max Planck Research Group Leader and associate professor at the HU, was offered a full professorship at HU, the Institute and the HU negotiated a special agreement. This agreement enabled Tkaczyk to accept the HU position in 2018, while also completing the program with her [MPIWG Research Group](#), before she fully moved into her [HU professorship on media and knowledge](#) in February 2019. Additionally, the Institute supported the appointment of Christine von Oertzen as [professor for the history of media practices at the HU](#) in 2019 while she maintained her position as [Principal Investigator at the MPIWG](#). The search to fill a MPIWG Research Group position combined with a five-year professorship at the Freie Universität is currently under way and expected to be finalized by the end of 2021.

Secondly, the Berlin Center established a joint postdoctoral program that ran from 2013 to 2018. Sponsored by all four partner institutions, two cohorts of international postdoctoral scholars have participated in this program. This program of twenty-two two-year fellowships sponsored jointly by all four institutions culminated in a [series of public lectures and masterclasses in 2018 organized by postdoctoral scholars](#).



Screenshot of website, Berlin Center for the History of Science, showing main laboratory of the court pharmacy in Berlin. Johannes Hörmann, *Die Königliche Hofapotheke in Berlin 1598–1898*, Hohenzollern-Jahrbuch (1889): 206–226 (left). First doctorate awarded to a woman (Elsa Neumann, 1872–1902) at the University of Berlin. 1899. Engraving after a drawing by Ewald Thiel.

<https://www.mpiwg-berlin.mpg.de/de/research/departments/imprs>



→ [Research Group Krause](#)

→ [Research Group Tkaczyk](#)

→ [Principal Investigator von Oertzen](#)

→ [Workshops and Conferences, masterclasses “Knowledge in Translation”](#)

The postdocs have produced exciting research, while the program as a whole has yielded an impressive employment record that has also increased the center's international visibility. Within Berlin, the program has greatly inspired the intellectual exchange between the four institutions.

Thirdly, building on these developments, our university colleagues designed several master courses with the aim of collectively exploring how best to teach the history of knowledge. To date, two courses have been cotaught in this collaborative fashion. In 2018, Anke te Heesen (HU), Hans-Christian von Herrmann, Friedrich Steinle (both TU), and Viktoria Tkaczyk (MPIWG/HU) organized a seminar on the boundaries of the histories of knowledge and science, inviting participants from all Berlin institutions as guest speakers. In 2019, a second joint course followed suit, cotaught by Anke te Heesen (HU), Christine von Oertzen (MPIWG/HU), Friedrich Steinle (TU), and Viktoria Tkaczyk (HU). This course, entitled “The Resources of Knowledge,” laid the conceptual groundwork for the IMPRS proposal, in that it examined knowledges in the plural, as mutable processes always in the making—and as such, as not only rife with potential but also unstable and vulnerable. The course's reading list served as a model for parts of the IMPRS curriculum.

Deepened institutional ties, the center's postdoc program, and collaborative teaching organized by our university colleagues led to a collective IMPRS proposal entitled “Knowledge and Its Resources: Historical Reciprocities.” Finalized by Christine von Oertzen and Hansjakob Ziemer, the proposal was submitted to the MPG in June and approved in November 2020.

The IMPRS will offer graduate training to PhD students based in the history and philosophy of science, technology, and medicine (HPSTM). The school aims to train students in the analysis of knowledge, its resources, and the multiple reciprocities between the two categories. Its program builds on the observation that resources substantially impact the creation, maintenance, and advancement of knowledge. Knowledge, in turn, is necessary to define and unlock such resources, as well as being itself one of the key resources of human culture. The school focuses on disentangling these relationships between knowledge and its resources, from a long-term perspective that expressly affords an appreciation of both global trends and local specificities.

The school is interdisciplinary in its scope and expects dissertations in the field of the history of knowledge at the intersections of HPSTM with regional and global studies, media studies, art history, literary studies, environmental studies, and digital humanities research. Students will be trained to apply innovative methodologies to their research and will become experts who can bring a much-needed comparative perspective, reflection, and historical depth to the shaping and sustaining of knowledge societies around the globe, within a wide spectrum of occupational fields including journalism, social media, art, museum and archive curatorship, and science and education policy. Located at the MPIWG, this school is also supported by international partner universities in the United States and Asia. Given the institutional and intellectual scope of this school, we envision the IMPRS as a training ground for the history of knowledge, and as an institutional hub from which further collaborative programs in Berlin may emerge.

Additional Members and Groups

Max Planck Fellow Gerd Graßhoff

In Collaboration with Department I

Computational History of Science

As a Max Planck Institute Fellow, Gerd Graßhoff has developed the emerging field of computational history and philosophy of science into a new paradigm of computation-based historical studies that use large unstructured historical data. By applying computational approaches from different fields of machine learning, natural language processing, and 3-D and image analysis, Graßhoff's research project has generated knowledge engineering tools that combine recent advancements in machine learning with new applications in the analysis of sources for the history of science.

It is largely machine learning-based natural language processing (NLP) that has enabled the development of new approaches to interpreting complex historical texts—ranging from single author writings such as Kepler's *Astronomia nova* in the context of his *Gesammelte Werke* to large text corpora such as the published corpus of COVID-19 research, which currently consists of more than 300,000 articles. These techniques of knowledge discovery have allowed us to reapproach hitherto unsolved historical questions, including Kepler's notion of an empirical observation and his shift from the concept of a "spirit" as the source of planetary motion to that of a moving "force." Other terms are conceptually linked, such as the rise of the term "natural law" used by Kepler (though he himself never called natural regularities "laws"). A newly developed comprehensive Python library, which examines all the relevant word occurrences in Kepler's entire text corpus, including their grammatical flexions, in a semantic tree structure, provides researchers with powerful new hermeneutical tools. This tool has made it possible to show, for example, that when Kepler integrated moving forces into his explanation of celestial motion, he introduced the notion of law as a complement to, rather than a substitute for, the effects of "spirits." Kepler believed that the elliptical path of Mars was a consequence of laws—a new finding for Kepler and astronomers of his time—but not an actual law itself. The study has revealed that Kepler underwent a complex change in his conceptual thinking between 1600 and 1605. The techniques enabled by this new Python library will also make it possible to include all the formulations in Kepler's entire corpus, while recognizing them in their original language and in great detail. This research was successfully

integrated into the Max Planck Research Group led by Jürgen Renn and with Matteo Valleriani as part of the Berlin Institute for the Foundations of Learning and Data (BIFOLD), one of the goals of which is to conduct research into machine learning in the digital humanities.

<https://www.mpiwg-berlin.mpg.de/users/grasshoff>



Since Antiquity, causality has been a key concept in the history of science: it rules medical diagnostics, astronomical prognostication, and knowledge structures. Causal reasoning is also an important feature of experimental research in all aspects of modern science. Examples include Graßhoff's theoretical proposal of a philosophical theory of causality and causal reasoning and the creation of a Python library for machine-learning purposes. Research literature shows that causal theory has been successfully implemented in causal and mechanical models to function as semantic templates for scientific reasoning. (Earlier research on which the work discussed in this report is based is referenced on the MPIWG website.) Graßhoff's research project has specifically implemented the model of causal reasoning that was fully ported to computational environments in order to facilitate the analysis of large unstructured sources in the history of science. The causal reasoning programming packages have already been successfully used in graduate courses of all disciplines at the Humboldt-Universität zu Berlin to analyze modern scientific literature, with an emphasis on coronavirus research. This integration of research into university teaching was one reason Graßhoff was the recipient of the university's Faculty of Arts and Humanities prize for excellence in teaching in 2019–20.

Extensive and curated data repositories are best evaluated in the computational history and philosophy of science when they are systematically compiled, comply with the highest scientific standards, and are accessible through a machine-readable API. Since the start of Graßhoff's fellowship, scientifically valuable repositories, some of which took many years to bring together, have been processed to allow direct computational interface and published as scholarly datasets in the Edition Topoi repository. With more than 70,000 DOI reference entries, this repository is now one of the world's largest special collections. During the course of his fellowship, Graßhoff has edited or authored the following repositories:

- Ancient Sundials
- The Digital Pantheon
- Copernicus's Heliograph
- Construction Drawings
- Babylonian Diaries
- Medieval Diagrams
- Rock Paintings in Indonesia
- The *Kreisgraben* Phenomenon

Computational interfaces have enabled researchers to interpret data in innovative ways. Research into Copernicus's heliograph, for example, was able to establish that contrary to the received view Copernicus measured the daily motion of the sun using new instrumentation while searching for evidence for his new heliocentric world model. The Ancient Sundials repository, which has a comprehensive dataset that includes more than 400 3-D models, has become a global reference. The computational analysis of these models has led to a complete overhaul of the implied geographical latitudes of ancient sundials. Together with a classification of the key construction

parameters of the sundials, it has provided us with new proxies for understanding sundials and their role in Antiquity (see Graßhoff 2018, “Innovation der Zeit: Evolution antiker Sonnenuhren,” and Graßhoff et al. 2021, “Data of Ancient Greek Parapegmata”). And in a joint project with the late Markus Wäfler, more than 5,000 prehistoric drawings were collected and processed for the Rock Paintings in Indonesia repository, which aims to survey the prehistoric subjects of symbolic expressions. The application of deep learning techniques will allow researchers to analyze the earliest preserved human symbolic expressions. The systematic coverage of the large geographical area of Indonesia has provided extremely valuable data, with accessible computational tools, for the study of early humans.

These computational tools are undoubtedly effective in managing large text repositories in the history of science. One example is the edition of Euler’s complete works maintained by the century-old Euler Committee of the Swiss Academy of Sciences. This edition integrates perfectly into the study of the exact sciences in the seventeenth and eighteenth centuries. As part of an ongoing project, Euler’s entire corpus will be retrodigitized and transferred to models of NLP, so that an in-depth analysis of its content, comparable to the project on Kepler’s *Astronomia nova*, can be carried out. Euler’s as well as Bernoulli’s scientific writings and correspondence will serve as reference projects and should achieve high international visibility. The generality of the approaches that have been developed has made them particularly applicable to the large corpora from the history of science and to the publication of research in 2020 related to the coronavirus pandemic (250,000 scientific publications in total). The large digital repository of 3-D models of scientific instruments and knowledge-structured architecture, such as the Pantheon in Rome and Neolithic circular enclosures (*Kreisgrabenanlagen*), will serve as a testing ground for scientifically innovative computer models.

Max Planck Fellow Gerd Graßhoff

Publications 2018–June 2021

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External Scientific Member Glenn W. Most

Research Activity 2018–2020

During the period 2018–2020, as in the previous research period 2015–2017, my research continued to oscillate between two poles, one directed more toward the specific discipline of Classical Greek and Latin philology, the other more toward systematic comparison among various philologies, both of these poles being conceived within the perspective of the history of science.

On the one hand, I continued to apply the methods of Classical Greek and Latin philology to problems directly involving ancient Greek culture and to reflect upon the history, nature, and limits of those methods. In particular, in 2018–2020 I continued to work on the earliest Greek philosophers (known as the “Presocratics”), based on a large-scale edition and translation of the fragments and testimonia from these philosophers that I published before the reporting date together with André Laks. This ongoing work examines how these texts raise questions, propose answers, and experiment with methods that have continued to perplex and inspire philosophers and scientists until the present. They are thus of inestimable importance for studying the development of European philosophy, cosmology, medicine, mathematics, musical theory, and other fields, as well as for investigating the interrelations between early Greek science and comparable phenomena in other contemporary and earlier cultures such as Mesopotamia and Egypt. I also convened a workshop, to be published shortly, on the extremely problematic first columns of one of the most extraordinary documents in this field, the Derveni Papyrus, with the (apparently successful) intention of testing the extent to which the explicit discussion of the premises and methods shared by contemporary Classical philologists could help bring to a greater convergence a scholarly discussion that had hitherto been characterized by controversy and misunderstanding. So, too, I published a number of studies of various aspects of the Western Classical tradition, considering some of the ways in which texts and images produced in ancient Greece continued to influence European culture for millennia, often precisely through distortions and mistakes.

On the other hand, I continued to apply what I have learned from the practice of philology in my own discipline to the cross-cultural comparison of philological procedures in a variety of canonical textual traditions (Greek, Latin, Hebrew, Arabic, Mesopotamian, Sanskrit, Chinese, etc.). The creation of canons of written texts—religious, literary, philosophical, scientific—is a feature of numerous literate cultures from ancient times to the present. Such canons may crystallize cultural identities, confessional orthodoxies, school curricula, standards of taste and refinement, and/or the qualifications of ruling elites. They also give rise to learned textual practices, some of them quite technical, to stabilize, reproduce, store, access, format, correct, and interpret the canon. In ancient Chinese and ancient Greek, in medieval Arabic and medieval Latin, in Sanskrit and in Persian, and in the modern European vernaculars since the Renaissance (to name only a few), highly trained scholars have developed, cultivated, and transmitted the textual practices of their respective canons. Building

on recent work on the origins and cultural significance of canons, and following the example of historians of science and scholarship who have examined scientific practices such as collecting, measuring, and note-taking, I have developed a number of projects, some of them centered at the MPIWG, which investigate the distinctive practices that make texts objects of systematic inquiry.

In this context, I worked especially on the following projects during the period 2018–2020:

- Together with Dagmar Schäfer and Mårten Söderblom Saarela, I coorganized a Working Group (“Thinking in Many Tongues”), funded by Department III of the MPIWG, which has focused on the impact of historical plurilingualism on knowledge cultures. We are producing a reader consisting of texts illustrating various aspects of this phenomenon, forthcoming from Brill.
- Together with Karine Chemla and Markham J. Geller, I coorganized two workshops on commentaries on texts in Chinese, Sanskrit, Arabic, Babylonian, and ancient Greek, funded by Department II of the MPIWG. One, focused on commentaries on mathematical texts, is resulting in a volume of essays coedited by Karine Chemla and myself; we expect to complete this volume in the spring of 2021 and to publish it soon thereafter with Cambridge University Press.
- Together with Martin Kern and Anne Eusterschulte, I have organized a large one-volume lexicon of indigenous terminologies for philological agents, procedures, objects, and institutions in approximately twenty-five Classical traditions throughout the world. We have received a contract from Princeton University Press to publish this lexicon and the introductions and other preparatory materials for all the chapters are currently being refereed by the press.
- In the research period 2018–2020 I continued to work within the terms of the Anneliese-Maier Research Prize that I was awarded by the Alexander von Humboldt Foundation in 2016 for a project, located principally at the Humboldt-Universität zu Berlin, designed to study editorial procedures in a variety of periods, cultures, and disciplines. I have been conducting a series of workshops and research seminars with colleagues and students in Berlin and expect to organize two international conferences in 2022 and 2023.
- At the MPIWG I initiated a monthly workshop on philological procedures and texts as these relate to the history of science and I participated in a number of other regular workshops, above all in the groups led by Dagmar Schäfer and Katja Krause.

External Scientific Member Glenn W. Most

Publications 2018–June 2021

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Emerita Scientific Member Lorraine Daston

Lorraine Daston directed Department II until her retirement on June 30, 2019. Since then, she has pursued research as director emerita at the MPIWG.

It is an eerie feeling for a historian when early modern science suddenly becomes topical. As the outbreak of the coronavirus pandemic catapulted scientists, doctors, and almost everyone else into a state of radical uncertainty, research projects on the history of observation in the seventeenth and eighteenth centuries and the history of when rules do and don't work seemed surprisingly timely. A blogpost on "[Ground Zero Empiricism](https://critinq.wordpress.com/2020/04/10/ground-zero-empiricism/)" in April 2020 that drew analogies between seventeenth-century observers and the plight of virologists and clinicians ambushed by a new virus struck a chord with frontline doctors. [Another short piece](https://www.newyorker.com/science/medical-dispatch/what-we-dont-know-about-covid-19) on the dangers of relying on averages in a dynamic situation like the pandemic was informed by [research about how rules and regulations took hold in European cities during the eighteenth century](https://muse.jhu.edu/article/764861). The past remained a foreign land, but for a time at least, it bordered all too closely on the present.

Conversely, the present illuminated the past. To be writing a book on the history of rules in a time when, as knowledge about the risks of contagion grew, constantly changing rules regulated who could meet when with whom where was to gain insight into the phenomena of rule casuistry, rule fatigue, and rule bending in medieval and early modern Europe. *Rules: A Short History of What We Live By* (Princeton University Press, 2022) charts the history of perhaps the most fundamental precondition for rational action: the rules that describe and prescribe the regularities that make plan-



<https://critinq.wordpress.com/2020/04/10/ground-zero-empiricism/>

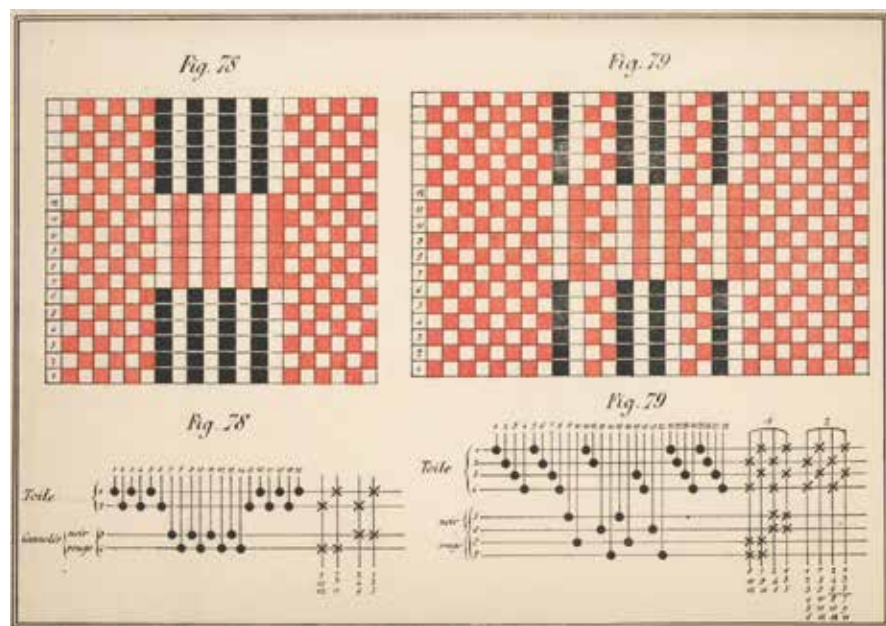
<https://www.newyorker.com/science/medical-dispatch/what-we-dont-know-about-covid-19>



<https://muse.jhu.edu/article/764861>



Textile pattern with Jacquard card transcription (1878). Public domain.



ning, promises, and prediction possible. Diverse though they are, the rules of monastic orders, games, spelling, the mechanical arts, computation by both humans and machines, cookbooks, bureaucracies, and natural laws reveal a long-term evolution from elasticized rules that anticipated exceptions and left latitude for interpretation to more explicit and rigid formulations designed to reduce the exercise of discretion and bar exceptions. Whereas the prototypical rule prior to circa 1800 was a model or pattern, by the mid-twentieth century it had become an algorithm. Pattern and algorithm converged in the Jacquard loom cards that partially automated the weaving of intricate designs and inspired the first computer punch cards. The book, which originated in the Lawrence Stone Lectures at Princeton University, will be published by Princeton University Press in 2022.

Against Nature (MIT Press, 2019), an essay on why we seek norms in nature from a historical perspective, has been translated into German, Dutch, Norwegian, Korean, and Romanian and been the subject of book review forums in the journals *Global Discourse* and *HAU: Journal of Ethnographic Theory*.

A new project on the origins of international governance in science in the nineteenth and twentieth centuries resonated with the impressive coordination of international scientific efforts in the face of the twin crises of pandemic and climate change, in contrast to the splintering of the community of nations over the same challenges. Fellowships at the Swedish Institute for Advanced Study in fall 2019 and the Department of the History and Philosophy of Cambridge in January to February 2020 advanced the project through both archival research and a stimulating seminar on “Science and Modernity.”

Insofar as international governance exists, it has very little to do with governments. In the face of two planetary crises, climate change and the coronavirus pandemic, it has not been the United Nations, or the G-8, or any other international union of governments that has organized itself to take stock of the situation and agree upon collective action. Rather it is what since circa 1945 has been called the scientific community that was able to command consensus about what the problem was and

how to solve it. How is it that organizations like these ever came into existence at all, without state backing, and have been able to bind members in enduring collective agreements, without treaties or hard sanctions?

Science circa 1850 was global in its scope and cosmopolitan in its networks, but its governance was at best national, and even that was precarious. Fast forward to circa 1900, and the sciences (and some of the humanities) had become almost as global as the phenomena they studied. The same globe-spanning infrastructures of telegraph and steamship networks that undergirded commerce and imperialism in the latter half of the nineteenth century also made possible the first international scientific congresses and projects. The earliest international scientific congresses



in the 1870s met to regulate everything from weights and measures (Paris, 1872) to chemical nomenclature (Geneva, 1892) to botanical nomenclature (Vienna, 1905).

Delegates to the International Botanical Congress, Vienna, 1905. Public domain.

All of these meetings were tense with controversy. Much was at stake, including professional reputations, commercial interests, research agendas for years or even generations to come, and national cultural prestige on the world stage. Yet in the end, resolutions were passed and, more significantly, honored for decades, despite the disruptions of war, revolution, decolonialization, and the complete remaking of the geopolitical order in the course of the twentieth century. The making of this international, transgenerational scientific collective is the story of internationalism without nations.

Emerita Scientific Member Lorraine Daston

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Emeritus Scientific Member Hans-Jörg Rheinberger

Hans-Jörg Rheinberger has been director emeritus at the Institute since February 2014. His appointment as emeritus will expire in February 2022. During the period from 2018 to 2020, Rheinberger continued to work on a number of projects connected with his longstanding interests in the relations between the sciences, the humanities, the arts, and literature, as well as the history of these different areas of cultural activity. In the period at issue, a number of books resulted from his ongoing studies.

Gaston Bachelard was not only the founder of historical epistemology, but also of a poetology of literary imagination, and he entertained extended relations with contemporary artists. Rheinberger's continued engagement with the writings of Bachelard led him to study Bachelard's encounter with Albert Flocon, a Bauhaus student in Dessau and later copper engraver and teacher at the Académie des Beaux Arts in Paris. The study focuses on the hand as the agent of artistic—and scientific—activity. The English version of the case study dealing with the relationship between a philosopher and an artist, from which a number of artistic book productions resulted, appeared with SUNY Press in 2018, titled *The Hand of the Engraver*.

In parallel, Rheinberger worked on a collection of conversations that a number of interlocutors had conducted with him on different occasions. The conversations highlight different aspects of work in the laboratory, the atelier, and the archive. A comparison of the practices of scientists, artists, and historians shows that tenacity and contingency do not exclude, but rather presuppose each other. These conversations spanned the years between 2010 and 2017 and have now been brought together in a volume published by Kadmos Press in 2018 as *Experimentalität: Hans-Jörg Rheinberger im Gespräch über Labor, Atelier und Archiv*.

Another long-term project came to a closure during this time period. It involved an artist (Hannes Rickli, Zurich), two scientists (marine biologist Philipp Fischer, Helgoland; and behavioral geneticist Hans Hofmann, Austin, TX), as well as three historians and philosophers of science (Gabriele Gramelsberger, Aachen; Christoph Hoffmann, Luzern; and Hans-Jörg Rheinberger, Berlin). The collaboration extended over more than a dozen years and included annual meetings in one of the scientific laboratories as well as a series of workshops and exhibitions. Specifically, it targeted the nature of data being collected—indoor and outdoor—as a basis of scientific work. These discussions led to the publication of a collective monograph by Diaphanes in 2020 with the title *Datennaturen/Natures of Data*.

Since 2018, Rheinberger has been working on his third comprehensive book on scientific experimentation (after *Toward a History of Epistemic Things*, 1997 and *An Epistemology of the Concrete*, 2010). It has taken the shape of a phenomenology of the experiment. The first part of the book deals with the infrascopic aspects of experimentation, such as tracing, modeling, visualizing, and grafting. A second part is devoted to its suprascopic aspects: its temporal, cultural, and narrative dimensions.

The book was published in Spring 2021 by Suhrkamp as *Spalt und Fuge: Eine Phänomenologie des Experiments*.

Last but not least, Rheinberger has pursued his own literary activities. He spent the spring term of 2017 as a guest of the principal at the Swedish Collegium for Advanced Study in Uppsala. Encouraged by Björn Wittrock, he took advantage of this stay to create a series of poems inspired by the singular atmosphere of Sweden's collegium, situated in a postglacial landscape. The bundle of miniatures was published by Edition Isele in 2019 under the title *Steinschiffe*.

During the time period between 2018 and 2020, Hans-Jörg Rheinberger continued to give talks and lectures—roughly one hundred—including the Ernst Cassirer Lecture at the University of Gothenburg in 2018 and the Featured Thinker Lecture at the Center for Theory and Methods of the Cultural Sciences at the University of Göttingen in 2019. In the fall of 2018, he was a Fellow at the Konrad Lorenz Institute for Evolution and Cognition Research in Klosterneuburg near Vienna, where he started to work on the history of the experimental insect studies of Richard Goldschmidt. With the publication of Bernd Gausemeier's monograph (*Zentrale Peripherie: Biologische und medizinische Forschung in Berlin-Buch, 1930–1989*, Stuttgart, 2019) on the history of the research site of Berlin-Buch as it transformed from an institute of the Kaiser Wilhelm Society to one of the German Academy of Sciences, GDR, a research project initiated by the Max Delbrück Center for Molecular Medicine under its former director Walter Rosenthal and supervised by Hans-Jörg Rheinberger, was successfully completed.

Albert Flocon, copper engraving on the four elements (signed, undated; archive of the author).



Emeritus Scientific Member Hans-Jörg Rheinberger

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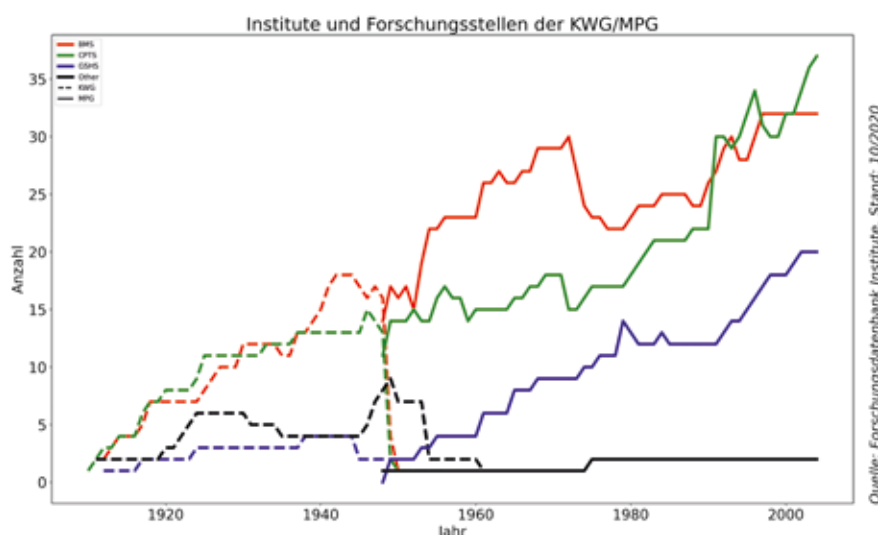
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Research Program History of the Max Planck Society (GMPG)

The research program “[History of the Max Planck Society](http://gmpg.mpiwg-berlin.mpg.de/en/)” (Geschichte der Max-Planck-Gesellschaft, GMPG) was launched in 2014. It includes twenty-seven scholars along with software engineers, office staff, and student assistants. GMPG has established cooperations with the DFG research unit 2553 “Cooperation and Competition in the Sciences” (Munich), the Gesellschaft für wissenschaftliche Datenverarbeitung (Göttingen), and the MPI for Legal History and Legal Theory (Frankfurt am Main). The research program is administered by the MPIWG’s service departments, for whose professionalism, collegialism, and support it is also tremendously grateful.

<http://gmpg.mpiwg-berlin.mpg.de/en/>



Development of institutes and research centers of the MPG (solid) and the KWG (dashed) differentiated by sections from 1911 (foundation of the KWG) to 2004. BMS = Biological-Medical Section; CPT = Chemical-Physical-Technical Section; GS = Humanities Section.

In 2020, in cooperation with the MPG archives, the GMPG spearheaded and completed a comprehensive digitization campaign including more than 2,000 shelf meters of records, resulting in a full-text searchable research infrastructure. The data curated by the GMPG serves as a unique source in combination with bibliographical, biographical, financial, and other databases for understanding the complex dynamics of the MPG. Methods from computational humanities produce novel insights into how the members of the MPG adapted to changing social and scientific environments by gradually increasing external appointments while simultaneously keeping self-recruitment intact.

The GMPG itself investigates the history of the MPG from its founding in 1948 until 2002. We analyze how research practices are embedded in societal contexts, combining approaches of institutional history with those of the history of science and contemporary history. Examining overarching trends, our research highlights the specific characteristics of the MPG in its position in the German and international system of science. Four main phases emerge from this analysis.

Between 1943 and 1955, a first transformative period from the Kaiser Wilhelm Gesellschaft (KWG) into the MPG was characterized by a continuity of research facilities and staff, resulting in significant path dependencies. It was by no means a given that the MPG would be founded, as the Allies planned to dissolve the KWG in response to the fact that many of its former scientists had been involved in armaments research and Nazi crimes. After its founding in 1948, the MPG positioned itself within the West German system of science as a private nonprofit organization, with social dynamics resembling a hierarchical association, including directors as scientific members who act as voting members to set policy and appoint successors.

In a second period from 1955 to 1972, as Germany grew economically, the scientific profile of the MPG began to expand. The lifting of Allied research control in 1955 enabled German scientists to reenter restricted research fields such as nuclear physics or supersonic aerodynamics, while adding new fields such as astronomy and astrophysics. Large budget increases allowed MPG-specific modes of institutional growth and restructuring to emerge as transformations, mutations, and sprouts. Accompanied by a generational change, this transformation process also helped to overcome the path dependencies inherited from the Nazi regime. This became visible for example in the closure, or refounding, of institutes in agricultural research and nutritional sciences.

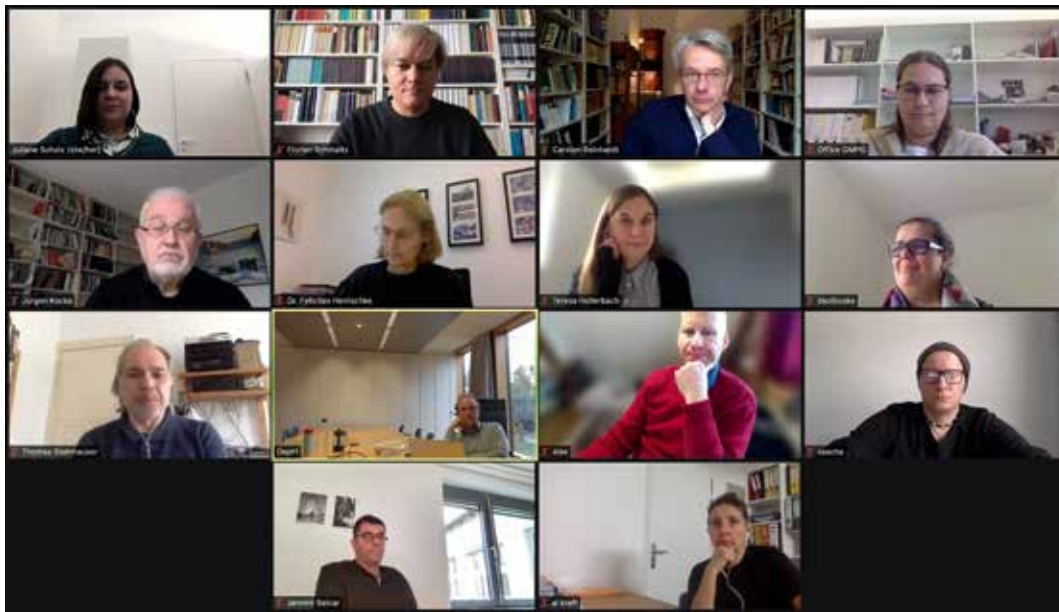
A third phase from 1972 to 1989 was characterized by fiscal stagnation on the one hand and continuity of existing trends and path dependencies on the other. The MPG's promotion of young scientists and their scientific networks resulted in informal cultures of scientific participation as outlined in the research program's publications on social history. Taking into account the specific rules for science-related corporations, the MPG implemented rather less formalized models of codetermination compared to universities or businesses.

From 1990 to 2005, a fourth phase was triggered by German unification, radically challenging the MPG's well-rehearsed development modes in the context of increasing globalization and Europeanization both within and beyond the scientific system. During this last phase, the MPG began to address the issue of gender equality, eventually initiating equal-opportunity efforts that helped break down the existing gender order.

In order to complement this focus on institutional development, cope with the large number of MPIs, and view this history from cognitive and epistemic levels, the GMPG focuses on the concept of clusters as a heuristic tool to scrutinize the rationales for how scientific fields in the MPG have autonomously organized and directed their research. Each cluster comprises a number of institutes or departments that share genealogies, themes, methodologies, or political and industrial settings. While some of these clusters already existed in the KWG, such as agricultural research, others such as astronomy, astrophysics, and the space sciences evolved after the Sputnik crisis in 1957. Ecology remained marginal for a long time. However, a new form of atmospheric science research entered the MPG in the 1970s by incorporating numerous Earth system processes (oceans, biosphere, geosphere, cryosphere) and their comprehensive interactions. The molecularization of the life sciences set on in the late 1960s, while various parts of the behavioral, cognitive, and neurosciences thematically and temporarily overlapped, constituting an interface between the life sciences, medicine, and the humanities. Contrasting the biological and physical sciences, the

humanities did not form coherent clusters with the exemption of the MPG's eight legal institutes, which conducted comparative legal research approaches and established strong intrasectional networks, as collaborative studies with the MPI for Legal Studies and Legal Theories have shown.

The multidimensional approach of the GMPG research program opens up new perspectives by emphasizing the interdependencies between the sciences and other social domains, such as the economy, technology, politics, and culture, by contributing to a better understanding of the crucial role of the sciences in contemporary history and the development of modern societies.



2018–2020

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In Memoriam



Paul Josef Crutzen (1933–2021)

The MPIWG mourns the death of Paul Josef Crutzen, who passed away on January 28, 2021, at the age of eighty-seven. Crutzen had a lasting impact on atmospheric and Earth system research. He headed the Department of Atmospheric Chemistry at the MPI for Chemistry from 1980 onwards for over two decades and played a decisive role in shaping the overall Earth system profile of the Max Planck Society. In 1995 Crutzen, Molina, and Rowland jointly received the only Nobel Prize in Chemistry to have been awarded explicitly for research on the atmosphere. In his final year in office, Crutzen introduced the concept of the Anthropocene as a possible new Earth age in which humans are the decisive factor in climate change. Department I's project "Anthropocene Formations" is grounded in Crutzen's findings and ideas.



Robert K. Englund (1952–2020)

We mourn the loss of a very dear friend and colleague, Robert K. Englund. In the late 1990s, Bob worked with members of Department I to found the Cuneiform Digital Library Initiative (CDLI), and we have been collaborating on this project with him ever since. Emeritus professor of Assyriology at UCLA and director of the CDLI, Bob was one of the world's leading specialists on protocuneiform texts, and published and republished more than 2500 Uruk and Jemdat Nasr period texts alone or with colleagues. He was also a leading specialist of the social and economic history of the Ur III period, and published groundbreaking articles on the bookkeeping system of the period. As director of the CDLI, Bob spearheaded the digitization and online dissemination of hundreds of thousands of cuneiform tablets from museums and collections across the globe and initiated the first fully online journal in the field of Assyriology (CDLJ). He was a meticulous and dedicated teacher and supervisor, who was devoted to the success of his students and postdoctoral scholars.



Klaus Heinrich (1927–2020)

The scholar of religion Klaus Heinrich has passed away at the age of ninety-three. He was a cofounder of the Freie Universität Berlin and also shaped the intellectual tradition of the MPIWG. His demand that science too should make its contribution to the consciousness of the species, his warning of the dangers of self-destruction that would result from the human domination of nature, and his resistance to the temptations of thinking in terms of mythical origins have accompanied much of our work and will continue to do so in the future. We will stay connected to him.

María Carmen Beatriz Loza Vidaurre (1962–2019)

We mourn the loss of María Carmen Beatriz Loza Vidaurre, who was closely associated with Department I during the early years of the Institute's establishment. A distinguished historian of science with a focus on prehispanic and colonial Bolivia and Latin America, she studied ancient Spanish sources to understand the function of the quipus in the accounting system both under the Inca administration and after its adoption by the Spanish colonial administration. With her passing, we sadly lose a passionate and inspiring researcher and a wonderful colleague.

**Aaron Stephen Moore (1972–2019)**

Aaron Stephen Moore, associate professor at Arizona State University, was a gifted multilingual historian whose groundbreaking work, *Constructing East Asia* (Stanford University Press, 2013) shaped new terrain for the history of technology in twentieth-century Asia. A visiting scholar at the MPIWG in 2017, Aaron's critical attention to developmental technology and its social, environmental, and postcolonial consequences inspired many younger historians to engage in the history of technology. Aaron's scholarship was marked by an intellectual curiosity that was only trumped by his quiet acts of enormous commitment to nurture the field through initiatives that brought people together across international and disciplinary boundaries. Aaron was a field-shaker, an inspiring collaborator, and a true friend to many at the MPIWG and in the history of science and technology in Asia. He will be sorely missed.

**Reinhard Rürup (1941–2018)**

The MPIWG mourns the loss of Reinhard Rürup, an eminent historian. He was chairman of the presidential commission "History of the Kaiser Wilhelm Society (KWG) under National Socialism," housed at the MPIWG. With the president of the MPG, Rürup published the volume *Denkorte* on the history of the KWG/MPG. He supported the creation of the Program on the History of the Max Planck Society.

**Thomas B. Settle (1930–2020)**

We mourn the loss of Thomas B. Settle, a great early modernist, Galileo scholar, and friend always ready to help by sharing his knowledge with us. His projects on "Galileo's Experimental Research," conducted at the MPIWG in the 1990s, impressed and educated us. He set standards for our work on Renaissance and early modern sciences.

**Michael Stolleis (1941–2021)**

The news of Michael Stolleis's death has affected us deeply. Stolleis was a great historian who left an impressive body of work, an astute and sensitive observer of contemporary history, and at the same time a much-loved colleague of the MPIWG. As well as being involved in the presidential commission "History of the Kaiser Wilhelm Society under National Socialism" (1999–2005), he was a major supporter of the Research Program "History of the Max Planck Society" from its inception. He also coorganized (with Lorraine Daston) the Working Group on "Natural Law and Laws of Nature in Early Modern Europe," a cooperation between the MPIWG and the Max Planck Institute for European Legal History. His ideas and input were of great importance to us and will be very much missed.



Key Activities, Achievements, and Events

Joint Activities

A number of initiatives across the Institute complement the research activities of its Departments and Research Groups. Conceived in various formats, they serve cross-departmental research interests while also supporting the career development of the Institute's members.

Institute's Colloquium Series

Since it was established in 1994, the Institute's Colloquium has become both an important in-house forum and internationally recognized venue for the discussion of cutting-edge trends in the history of science. Invited speakers usually stay at the Institute for a longer period of time, enabling an intense exchange with MPIWG scholars.

2018/19: Philosophy and the History of Science: A Troubled Relationship?

ORGANIZED BY Alexander Blum, Katja Krause, and Ohad Parnes

The talks in 2018/19 aimed to explore some particularly exciting aspects of the Institute's origins in historical epistemology. What are the relations between history and philosophy at present? How have the two fields developed, and what important intersections or boundaries can we identify between them? What opportunities and challenges do we face in forging relationships between the two disciplines in the future?

September 25, 2018

Michael Lackner (Friedrich-Alexander Universität Erlangen-Nürnberg)

Chinese Literati and Intellectuals on Mantic Arts: A Philosophy of Divination?

October 23, 2018

Philip Kitcher (Columbia University)

50 Years of HPS: A Philosopher's Perspective

November 13, 2018

Yemima Ben-Menahem (The Hebrew University of Jerusalem)

The Curious History of the Least Action Principle

December 11, 2018

Hasok Chang (University of Cambridge)

Where Can the Historian of Science Stand? Presentism and Philosophy in the Historiography of Science

January 22, 2019

Sabina Leonelli (University of Exeter)

Data and the Quest for Facts: Empirical Knowledge in the Age of Big and Open Data

February 12, 2019

Anne Eusterschulte (Freie Universität Berlin)

Epistemic Dynamics: Towards a Constitutive Relationship between Philosophy and History of Science from a Premodern Perspective

March 12, 2019

Shiv Visvanathan (O.P. Jindal Global University)

Science and Indian Nationalism

April 9, 2019

Kyle Whyte (Michigan State University)

An Awkward Proposal: Reconciling the Philosophy and History of Science through Confronting These Fields' Exclusion of Indigenous Knowledge

May 21, 2019

Helen Longino (Stanford University)

Neutrality versus Partiality in Feminist Critiques of Science

June 18, 2019

Aviezer Tucker (Davis Center for Russian and Eurasian Studies)

Philosophy of the Historiography of Science

2019/20: History of Science—Right Here, Right Now

ORGANIZED BY Ohad Parnes

The 2019/20 series featured ongoing research at the MPIWG and future perspectives, presented by Institute scholars. Events after March 2020 had to be cancelled or postponed because of the coronavirus pandemic.

October 22, 2019

Dagmar Schäfer

Local Science, Imperial Knowledge: Disasters in the Thirteenth Century

November 26, 2019

Alexander Blum

The Changing Fate of Eternal Questions

December 17, 2019

Lorraine Daston

Precision and Prestige in Nineteenth-Century Paris

January 21, 2020

Matteo Valleriani

The Mathematical Formalization of the Historical Disciplines: The Evolution of Cosmology in the Early Modern Period

February 18, 2020

Viktoria Tkaczyk

Thinking with Sound: A New Program in the Sciences and Humanities around 1900

2020/21: Crisis and Capacity: Perspectives in the Humanities and Social Sciences

ORGANIZED BY Lisa Onaga, Pablo Ruiz de Olano, and Stephanie Hood

This series facilitated conversations around how disciplines in the humanities and social sciences have established a long view of critical contemporary issues. It offered a platform to discuss inequalities linked to, for instance, race or gender; to connect to other dialogues within and beyond Berlin about plural histories and sociologies of crises; and to explore how these debates can be integrated into a future history of science.

The series had to be moved to an online format due to the COVID-19 pandemic. The individual events were recorded and made accessible in the Institute's mediathek. This led to a substantial expansion of our audience and the inclusion of more external guests.

September 22, 2020

COVID-19 in the Rearview Mirror? Pandemics and Historical Perspective

Harry Yi-Jui Wu (Hong Kong University)

Edna Bonhomme (Department III, MPIWG)

Anna Elsner (University of Zurich)

October 19, 2020

What Does Race Have to Do with the History of Science?

Tiffany Florvil (University of New Mexico), Black-German Intellectual Activism in the Past and Present

Yolonda Wilson (National Humanities Center), A Feminist Bioethic of Grief

November 17, 2020

Gendered Knowledges in Times of Crisis

Evelynn Hammonds (Harvard University), COVID-19 and the Racialization of Mistrust

Dóra Vargha (University of Exeter), The Acute and the Chronic: Temporalities of Medical Authority in an Epidemic

December 15, 2020

Historicizing Ableism and Ageism

Lara Keuck (currently: “Practices of Validation in the Biomedical Sciences,” MPIWG; at the time: Humboldt-Universität zu Berlin), *Historicizing Ageism in Medicine*

Aparna Nair (University of Oklahoma), *Centering Disability in a Pandemic*

March 23, 2021

Environments and Ecologies of Transmission

Nicole de Paula (IASS Potsdam), *Planetary Health: How to Unleash a Just and Resilient Post-pandemic World*

Christos Lightness (University of St. Andrews), *The Great Plague Panzootic: The Third Plague Pandemic Reconsidered*

Nükhet Varlık (University of South Carolina), *Plague Ecologies in the Ottoman Empire: Rethinking the Second Pandemic (ca.1340s–ca.1940s)*

April 20, 2021

Pandemic Politics: Science Governance in Democratic and Authoritarian Regimes

Anna L. Ahlers (Lise Meitner Research Group, MPIWG), *A Bitter Pill: The Responsiveness of Modern Autocracies in the COVID-19 Pandemic*

Lino Camprubí (Universidad de Sevilla & Department III, MPIWG), *What Makes a Crisis? Political Narratives of COVID-19*

May 18, 2021

Pulse Check: Public Communication and Trust in Science

Yishu Mao (Lise Meitner Research Group, MPIWG), *Scientists on Stage: Public Trust in China during the COVID-19 Pandemic*

Scott Knowles (KAIST/COVIDCalls), *History in the Making: COVIDCalls and the COVID-19 Pandemic*

Laura Spinney (*The Guardian*), *Pandemics Past and Present*

Science, Technology, and Diplomacy during the Cold War and Beyond: Frameworks, Perspectives, and Challenges

ORGANIZED BY Alison Kraft, Roberto Lalli, Giulia Rispoli, and Jaehwan Hyun

The Cold War seminar series provided a forum for discussing novel perspectives on the history of science during the Cold War, with a particular focus on the approaches of transnational and global history. These analytical frameworks are challenging models, developed in earlier scholarship, which portray a bipolar world dominated by the ideological, political, economic, and military rivalry between the superpowers. The program featured scholars currently opening new vistas onto the variation in the characteristics, patterns, and dynamics of science during the conflict, within and between different countries and across the east-west and north-south divides. Featuring themes including science diplomacy, scientific institutions, and environmental governance, the series also sought both to enrich understanding of the shifting temporalities of the Cold War and to situate “Cold War science” in the context of the years preceding and following the conflict.

Conference: Forgetting Knowledge (February 28–March 2, 2018)

ORGANIZED BY Katja Krause and Ohad Parnes in cooperation with the Descartes Center (Utrecht University), the Vossius Center (University of Amsterdam), and Huygens ING (Amsterdam)



<https://www.mpiwg-berlin.mpg.de/event/forgetting-knowledge>

Studying the evolution of knowledge, historians have traditionally focused on how knowledge is transmitted and persists, with memory as a central category for explaining these processes. But what about the failures, the knowledge that was forgotten? How can we define knowledge as forgotten and what does the process of forgetting mean? And can forgetting be understood and told as such, as an active mechanism that is not necessarily the “other side” of memory? In order to understand why and how knowledge has traveled, we must also understand why and how knowledge has been lost, suppressed, misunderstood, rejected, or simply forgotten. The conference’s four sessions focused on the materialization of forgetting, dimensions of forgetting knowledge, the dynamics of forgetting, and epistemologies of forgetting. [The full program can be found online.](#)

Tacit Knowledge Workshop Series (2018–2021)

ORGANIZED BY Ohad Parnes (2018/19 and 2019/20) and by Tamar Novick, Stephanie Hood, and Núria Muñoz Garganté (2020/21)

The Tacit Knowledge series at the MPIWG aims to identify and foster skills that are directly relevant to scholars’ activities but typically not part of the normal curriculum for a university degree. The series brings together members of the MPIWG at various stages of their academic career to discuss aspects of scholarly activities and share their tacit knowledge and relevant experience. It runs every academic year and includes topics such as presentation skills, audiovisual media training, publishing an article and book, writing a CV, time management, third-party funding, antidiscrimination at the workplace, and career opportunities in academia and beyond. The events take advantage of in-house expertise and invite external guests for specific subjects.

Predoctoral Meetings

The dissertations being written by the predoctoral fellows of the Max Planck Institute for the History of Science form an integral part of the Institute’s main research projects. All of the predoctoral fellows at the MPIWG are affiliated with one of the Institute’s departments or research groups and undertake their research as part of the research activities of their respective unit. At the same time, the predoctoral fellows of all departments and research groups meet once a month as part of the Institute’s cross-departmental activities. These meetings, organized by the predoctoral representative of the Institute, Núria Muñoz Garganté, together with the research coordinator, are intended to be as informal as possible in order to provide an open platform for exchange. The meetings also foster the exchange of general information about life and work at the Institute and allow for joint excursions.

Brown Bag Lunch and Show and Tell

Organized by the IT Research Group, two series of events—the Brown Bag Lunch for Digital Humanities (DH) and Show and Tell—promote knowledge exchange and community building on DH within the Institute. The Brown Bag Lunch events have fostered Institute-wide discussion on how to apply digital methods for research among scholars in the Institute since 2014. They showcase digital tools such as mapping, visualization techniques, network and textual analyses, and more. The events also feature presentations on state-of-the-art digital projects by internal and external research groups and discussions that reflect on the methodologies opened up by DH.

Show and Tell is a forum where digital humanities practitioners, including IT researchers, developers, and researcher assistants working on different digital projects, come together to create a joint body of knowledge in the digital humanities.

Workshops and Conferences

Department I

February 13–15, 2018, Workshop

The Authors of the Early Modern Commentaries on *De sphaera*

February 20–21, 2018, Symposium

**Transformations of Energy Systems: Historical Perspectives on the Anthropocene.
A New Research Environment within the Max Planck Society**

Coorganized with the Max Planck Society

February 28, 2018, Workshop

Multilayered Networks and Diffusion of Knowledge Innovations

March 19–20, 2018, Workshop

Convivencia, Iberian to Global Dynamics: Modes of Integration

May 17, 2018, Conference

The Spaces of Early Modern Architectural Production

May 30, 2018, Masterclass

The Intrinsic Place: Space as a Measurable Entity in Early Modern Art and Science
Coorganized with the Berlin Center for the History of Knowledge

June 18–19, 2018, Workshop

Semantic Analysis of Historical Texts by Means of Tools from Computational Linguistics

June 18–20, 2018, Project Workshop

Mississippi: An Anthropocene River

Katharine Ordway Natural History Study Area, Macalester College, St. Paul.

Coorganized with Haus der Kulturen der Welt, Berlin

June 20, 2018, Inaugural Symposium

Mississippi: An Anthropocene River

Weisman Art Museum, Minneapolis. Coorganized with Haus der Kulturen der Welt, Berlin, and Weisman Art Museum, Minneapolis

June 25–26, 2018, Workshop

The Safavid Multitext Manuscript 1984.463 (Harvard University, Sackler Museum): Its Content and Context

Coorganized with Hamburg University

July 2–7, 2018, Summer School

The Foundations of Geometry in Historical Perspective

Coorganized with MPI for Mathematics in the Sciences, Leipzig

September 4, 2018, Workshop

Entity-Fishing for Scholarly Publishing: Challenges and Recommendations

Coorganized with Göttingen State and University Library and the Max Weber Stiftung

September 5–8, 2018, Summer School

Network Science in the Humanities

Coorganized with MPI for Mathematics in the Sciences, Leipzig

September 20–22, 2018, Workshop

Multiculturalismo, Integración y Conflicto

Coorganized with KHI Florence, MPI for European Legal History, MPI for Social Anthropology, Halle (Saale)

October 10–12, 2018, Conference

The Epistemic Functions of Vision in Science

Coorganized with Università degli Studi di Bergamo

October 29, 2018, Workshop

Euclid on the Road: Cross-Cultural Transmission, Translation, and Transformation of the Elements

November 16–17, 2018, Workshop

Governing Environmental Change: Science Diplomacy and the Global Politics of Knowledge since the 19th Century

Coorganized with Freie Universität Berlin and University of Manchester

December 7, 2018, Workshop

Kohletag: A Multidisciplinary Workshop on the Past, Present, and Future of Coal Use in Germany and Beyond

March 10, 2019, Workshop

The Anthropocene: Archaeology of the Present

Cahokia Mounds State Historic Site, Collinsville, Illinois. Coorganized with Haus der Kulturen der Welt, Berlin, Washington University in St. Louis, and MPI for the Science of Human History, Jena

March 10–12, 2019, Workshop

Mississippi: An Anthropocene River

St. Louis, Missouri. Coorganized with Haus der Kulturen der Welt, Berlin

April 8–9, 2019, Workshop

What is a Table? A Machine-Learning Perspective

April 10, 2019, 500th Anniversary Event

Leonardo da Vinci. An Inquisitive Man: Technologist, Scientist, and Artist

Coorganized with the Italian Embassy, Berlin

June 3–5, 2019, Conference

How Do New Concepts Emerge? On New Knowledge, Old Patterns of Thought, and Structural Changes

Coorganized with Freie Universität Berlin

October 22–23, 2019, Workshop

Anthropocene and Public Health

October 27, 2019, Workshop

Dialectics and Digitization: Communist Ideal and Cosmology in Times of the Computational Mind

November 11–16, 2019, Field Research and Educational Event

Anthropocene River Campus: The Human Delta, New Orleans

Coorganized with Haus der Kulturen der Welt, Berlin, and Tulane University, New Orleans

November 26, 2019, Workshop

Cosmologies of Resource Transformations in the Early Modern Period

Coorganized with the DFG Collaborative Research Center 980, Università Ca' Foscari, Venice, and Freie Universität Berlin

December 4–6, 2019, Conference

Alexander von Humboldt: Circulation of State Knowledge in Europe and Latin America

Coorganized with Centre Marc Bloch and Ibero-Amerikanisches Institut, SPK

December 15–17, 2019, Conference

Geanthropology: Comprehending the Human-Earth System

February 19–21, 2020, Workshop

The Printing Press and the European Academic Milieu: 1470–1650. Defining Modes of Interaction and Scientific Exchange in the World of Printed Words

October 12, 2020, Online Workshop

The Technobiosphere

November 2, 2020, Online Workshop as Project Launch

Anthropogenic Markers

November 18, 2020, Online Workshop

Diplomatic Studies of Science in Germany and Russia

Coorganized with ERC HRP-IAEA and the Russian Academy of Sciences, St. Petersburg, Russia

Department II

May 24–26, 2018, Workshop

Histories of Bureaucratic Knowledge I

June 14, 2018, Workshop

Observing the Everyday: Journalistic Practices and Knowledge Production in the Modern Era

Coorganized with Deutsches Historisches Institut, Washington D.C.

July 9–11, 2018, Workshop

Science, History of Science, and Modernity

November 1–2, 2018, Workshop

Undead Texts: Grand Narratives and the History of the Human Sciences

Coorganized with Columbia University, USA

January 31–February 1, 2019, Workshop

Islamic Scientific Manuscripts Initiative Workshop

May 31–June 1, 2019, Workshop

Compression: Size, Storage, and Transmission in the History of Knowledge

June 9–12, 2019, Workshop

Histories of Bureaucratic Knowledge II

June 12–13, 2019, Conference

What Is Research?

Coorganized with Bard College Graduate Center

June 21, 2019, Conference

Solstice Celebrations: Ein Fest für Raine Daston

Department III

March 14–24, 2018, Workshop

Moving Crops

April 5–6, 2018, Conference

Technologies in Use

April 12–13, 2018, Workshop

Lifa 101: Reading Chinese Astronomical Procedure Texts

April 17–20, 2018, Conference

Visualization of the Heavens and Their Material Cultures

May 16, 2018, Workshop

Proteins & Fibers Inquiry I: Animal Histories on the Proteomic Horizon

June 7–8, 2018, Workshop

The Bare Necessities: Histories of Provisioning from the Second World War to the Present

June 21–22, 2018, Workshop

Shifting Baselines, Altered Horizons: Politics, Practice, and Knowledge in the Anthropocene

June 20–29, 2018, Workshop

Moving Crops

June 20–29, 2018, Workshop

Tu (圖) in Local Gazetteers

August 30–31, 2018, Workshop

Ownership of Knowledge

September 3–4, 2018, Workshop

Constructing Responsible Research: Collaborations between STS and History of Technology

September 13, 2018, Workshop

Proteins & Fibers Inquiry II: Animal Histories on the Zooarchaeological Horizon

October 25–26, 2018, Masterclass

Methods Intensive Masterclass: Oral History and the History of Scientific Practice: A Difficult Dialogue?

December 7, 2018, Workshop

Transnational Nature and Ecology

April 11–12, 2019, Workshop

Power in Medicine: Interrogating the Place of Medical Knowledge in the Modern Middle East

May 9–10, 2019, Masterclass

Methods Intensive Masterclass: Medieval Buildings, Textiles, and Murals

June 17, 2019, Conference

Tangut Astrology: Visuality, Materiality, Transculturalism

June 27, 2019, Workshop

Proteins & Fibers Inquiry III: Betwixt and Between. Reconstructing Animal Histories with Teeth

June 23–July 5, 2019, Workshop

Moving Crops

July 4, 2019, Symposium

The Artist-Silkworm Interface: The Agricultural Treatise as Source and Scrutiny for Creating an Artist Book

Coorganized with Art Lab Berlin

July 22–23, 2019, Workshop

Analysis of Premodern Maps of East Asia: Methods and Approaches

September 12, 2019, Workshop

Proteins & Fibers Inquiry IV: Reading the Book by Ignoring the Words

November 21–22, 2019, Conference

Knowing an Empire: Imperial Science in Early Modern Chinese and Spanish Empires

December 5–6, 2019, Workshop

Animal Materialities: Compositions and Practices in the History of Science

Coorganized with Humboldt-Universität zu Berlin

February 12, 2020, Workshop

German Purveyors of Natural History in the Age of Empire: Collecting in the Asia Pacific in the Long Nineteenth Century

March 24–25, 2020, Online Workshop

Bovine Regimes: Reproduction, Labor, Territory

June 11–12, 2020, Online Workshop

Global South Cosmologies & Epistemologies: A Transhemispheric Conversation

June 25–27, 2020, Online Workshop

Translating Vitalities

June 29 and July 1, 2020, Online Workshop

Locality and Geographical Knowledge in Imperial China

September 23, 2020, Online Workshop

RISE & SHINE: Tool Developers Workshop

October 26, 2020, Online Workshop

The Sociomaterial History of Masked Societies in East Asia

November 13, 2020, Online Workshop

Visualizing Geographies of Late Qing and Republican China: A CHMap Workshop

December 10–18, 2020, Online Workshop

Visual Materials in Local Gazetteers

MPRG Blum

March 27–29, 2019, Workshop

Nonempirical Physics from a Historical Perspective

Coorganized with Stockholm University

September 23–24, 2019, Symposium

History for Physics: Quantum Foundations

Coorganized with the University of Vienna and the Institute for Quantum Optics and Quantum Information Vienna (IQOQI-Vienna)

November 28–29, 2019, Symposium

History for Physics: Quantum Gravity

Coorganized with the Institute for Quantum Optics and Quantum Information Vienna (IQOQI-Vienna) and the MPI for Gravitational Physics (Albert Einstein Institute)

MPRG Krause

November 15, 2018, Workshop

The Future of Medieval Studies in the History of Science

May 22–25, 2019, Conference

Philosophy in the Abrahamic Traditions: Intellect, Experience, and More

Coorganized with Università di Pisa, the University of Notre Dame, and Marquette University

June 26–27, 2019, Conference

Premodern Experience of the Natural World in Translation

July 28–August 3, 2019, Workshop

Structuring Nature: An Interdisciplinary and Intercultural Summer School

September 19–20, 2019, Conference

3rd Symposium Petrinicum: Petrus Hispanus on Cognition and Experientia, Theories and Practices in Context

Coorganized with the Gabinete de Filosofia Medieval, Universidade do Porto, Portugal

December 3, 2019, Workshop

Alchemy between Practice and Theories

MPRG Tkaczyk

February 15–16, 2018, Workshop

Betwixt and Between: Sound in the Humanities and Sciences

Coorganized with the Vossius Center for the History of Humanities and Sciences, University of Amsterdam, Netherlands

March 16–17, 2018, Workshop

Acoustics of Empire

Coorganized with the University of Cambridge, UK, and Harvard University, USA

April 27–28, 2018, Workshop

Productive Sounds in Everyday Spaces

July 12, 2018, Workshop

Sound Objects in Transnational Contexts

September 14–15, 2018, Workshop

Sound Objects in Flux: Knowledge, Science, Heritage

Coorganized with Deutsches Museum, Munich, and the DFG Collaborative Research Center 980 “Episteme in Motion”

September 20, 2018, Workshop

For a Digital History of the Rundfunk: Archives, Methods, and Visualization Tools

November 9, 2018, Workshop

Opening the Doors of the Studio I

April 11–12, 2019, Workshop

Sounds of Language, Languages of Sound: Themes and Tools of the Humanities

April 16, 2019, Workshop

Capturing Sound in the Premodern and Early Modern World

Coorganized with the DFG Collaborative Research Center 980 “Episteme in Motion”

June 24–25, 2019, Workshop

Opening the Doors of the Studio II

Coorganized with the University of Montreal, Canada

October 11, 2019, Workshop

Slicing Sound: Speaker Identification and Music Censorship in the Former Eastern Bloc

Coorganized with Maastricht University, Netherlands

Lise Meitner RG Ahlers

October 22, 2020, Launch Event

Research Circuit: China in the Global System of Science

Digital Humanities

May 23–24, 2019, Workshop

Digital Humanities and Classical Studies: Prospects and Challenges

Coorganized with Department III and the University of British Columbia, Canada, and funded by the John Templeton Foundation

Berlin Center for the History of Knowledge

May 30, 2018, Masterclass

The Intrinsic Place: Space as a Measurable Entity in Early Modern Art and Science

June 4–21, 2018, Masterclasses

Knowledge in Translation

June 29, 2018, Workshop

13. Studenttag Literatur und Wissenschaftsgeschichte

Coorganized with Freie Universität Berlin

July 5, 2019, Workshop

14. Studenttag Literatur und Wissenschaftsgeschichte

Coorganized with Institut für Deutsche und Niederländische Philologie and
Friedrich Schlegel Graduate School (Freie Universität Berlin)

Collaborations

Albert-Ludwigs-Universität Freiburg (Germany)
American Institute of Physics, Maryland (USA)
Anthropocene Working Group (AWG)
Aquinas and “the Arabs” International Working Group, Marquette University (USA)
Art Laboratory Berlin, Berlin (Germany)
Augsburg University, Minneapolis (USA)
Auswärtiges Amt/Federal Foreign Office, Berlin (Germany)
Bard College, Berlin (Germany)
Bard Graduate Center, New York (USA)
Bar-Ilan University, Jewish Thought Department, Ramat Gan (Israel)
Berlin-Brandenburgische Akademie der Wissenschaften (BBAW), Berlin (Germany)
Berlin Research 50, Berlin (Germany)
BIFOLD Berlin Institute for the Foundations of Learning and Data, Technische
Universität Berlin (Germany)
British Library, London (UK)
CalTech, Pasadena, California (USA)
Capital Normal University, School of History, Beijing (China)
Chinese Academy of Sciences (CAS), Beijing (China)
CIUHCT Center for the History of Science and Technology, University of Lisbon
(Portugal)
Climate Change Center, Berlin (Germany)
Cluster of Excellence UniSysCat, Technische Universität Berlin (Germany)
CNRS Centre national de la recherche scientifique, Paris (France)
Cohn Institute, Tel Aviv University (Israel)
Collaborative Research Center 980 “Episteme in Motion,” Berlin (Germany)
Columbia University, New York (USA)
Comenius Garten Berlin (Germany)
Cuneiform Digital Library Initiative (CDLI), University of California, Los Angeles
(USA) and the University of Oxford (UK)
Deutsches Archäologisches Institut (DAI), Berlin (Germany)
Deutsches Museum, Munich (Germany)
DFG Research Unit 2553 “Cooperation and Competition in the Sciences”
(Germany)
Digital Research Infrastructure for the Arts and Humanities (DARIAH-EU/DE)

Durham University (UK)
 Einstein Center Chronoi, Berlin (Germany)
 ERC Group Early Modern Cosmology
 ETH Zurich (Switzerland)
 Fairbank Center for Chinese Studies, Harvard University, Cambridge (USA)
 Freie Universität Berlin (Germany)
 French Institute of Puducherry (India)
 Futurium, Berlin (Germany)
 Gesellschaft für wissenschaftliche Datenverarbeitung mbH Göttingen (GWDG),
 Göttingen (Germany)
 Goethe Institute Baku (Azerbaijan)
 Harvard Divinity School, Science, Religion, and Culture Program, Cambridge (USA)
 Harvard-Yenching Library, Harvard University, Cambridge (USA)
 Haus der Kulturen der Welt, Berlin (Germany)
 Hebrew University, Jerusalem (Israel)
 Humboldt-Universität zu Berlin (Germany)
 IASS Institute for Advanced Sustainability Studies, Potsdam (Germany)
 Indiana University at Bloomington (USA)
 Ingenium: Canada's Museum of Sciences and Innovation, Ottawa (Canada)
 Institut de recherche et coordination acoustique/musique (IRCAM), Paris (France)
 Institute for Quantum Optics and Quantum Information Vienna (IQOQI-Vienna)
 (Austria)
 Institute for the History of Science & Technology (RAS), St. Petersburg (Russia)
 Institute of Computer Science, Foundation for Research and Technology, Hellas
 (FORTH) (Greece)
 Institute of Ismaili Studies, London (UK)
 Israel Institute for Advanced Studies, Jerusalem (Israel)
 Istituto di Scienze Marine—Consiglio Nazionale delle Ricerche, Venice (Italy)
 Koninklijke Brill NV, Leiden (Netherlands)
 Latin American Center of Physics (CLAF), Rio de Janeiro (Brazil)
 Leiden University (Netherlands)
 Lichtenberg Group in History and Philosophy of Physics, Universität Bonn (Germany)
 Ludwig-Maximilians-Universität München (Germany)
 Maastricht University (Netherlands)
 Max Planck Institute for Biogeochemistry, Jena (Germany)
 Max Planck Institute for Chemistry, Mainz (Germany)
 Max Planck Institute for the Science of Human History, Jena (Germany)
 Max Planck Society Partner Group “Transmission and Interactions in Chinese
 Modern Physics,” Beijing Normal University (China)
 McGill University, Institute of Islamic Studies, Montreal (Canada)
 Museo Galileo, Florence (Italy)
 Museum für Islamische Kunst, Berlin (Germany)
 Museum für Naturkunde—Leibniz-Institut für Evolutions- und Biodiversitäts-
 forschung, Berlin (Germany)
 Nanjing University of Information Science and Technology, Nanjing (China)
 National Taiwan University, Research Center for Digital Humanities, Taipei
 (Taiwan)

New York University (USA)
 Nomis Foundation, Zurich (Switzerland)
 Palace Museum, Beijing (China)
 Pelagios Network Association
 Pontificia Universidade Católica do Rio Grande do Sul (Brazil)
 Portuguese Foundation for Science and Technology, Lisbon (Portugal)
 Princeton University (USA)
 Research Institute for Humanity and Nature (RIHN) in Kyoto (Japan)
 Scuola Internazionale Superiore di Studi Avanzati (SISSA), Trieste (Italy)
 Shandong University (China)
 Shanghai Jiao Tong University, Shanghai (China)
 Sino-Norwegian Centre for the Study of Society and Environment (SINORSE),
 the University of Oslo (Norway), and Zhejiang University (China)
 Sociedad Cubana de Física, Universidad de La Habana (Cuba)
 Sociedad Cubana de Historia de la Ciencia y la Tecnología (SCHT), Havana (Cuba)
 Société Internationale pour l'Étude de la Philosophie Médiévale (SIEPM), Katholieke
 Universiteit Leuven (Belgium)
 Staatsbibliothek zu Berlin (Germany)
 Stiftung Preußische Schlösser und Gärten Berlin-Brandenburg, Potsdam (Germany)
 Stiftung Preußischer Kulturbesitz, Berlin (Germany)
 Stockholms Universitet (Sweden)
 Technische Universität Berlin (Germany)
 Tel Aviv University (Israel)
 Toyo Bunko Library, Tokyo (Japan)
 Tufts University, Medford (USA)
 Tulane University, New Orleans (USA)
 Universidad de Chile, Departamento de Ciencias Historicas, Santiago de Chile (Chile)
 Universidad Panamericana México (Mexico)
 Universidade do Porto (Portugal)
 Università Ca' Foscari, Venice (Italy)
 Università degli Studi di Bergamo (Italy)
 Università di Pisa (Italy)
 Universität für angewandte Kunst, Vienna (Austria)
 Université de Paris VII (France)
 University of Calgary (Canada)
 University of Chicago (USA)
 University of Sydney (Australia)
 Vossius Center for the History of Humanities and Sciences, University of
 Amsterdam (Netherlands)
 Washington University in St. Louis (USA)
 Zoologischer Garten Berlin AG, Berlin (Germany)

Professorships

Lorraine Daston is visiting professor, Committee on Social Thought, University of Chicago, USA, and distinguished affiliated professor, Technische Universität München, Germany.

Gerd Graßhoff is professor at Humboldt-Universität zu Berlin, Germany.

Ursula Klein is adjunct professor at Universität Koblenz, Germany.

Katja Krause is professor at Technische Universität Berlin, Germany.

Glenn W. Most was professore ordinario at the Scuola Normale Superiore in Pisa, Italy, until his retirement in November 2020.

Jürgen Renn is honorary professor of the history of science at Humboldt-Universität zu Berlin and Freie Universität Berlin, Germany.

Hans-Jörg Rheinberger is honorary professor at Technische Universität Berlin, Germany.

Dagmar Schäfer is honorary professor at Technische Universität Berlin, Germany; adjunct professor at the Institute of Sinology, Freie Universität Berlin, Germany; and guest professor at Tianjin University, China.

Viktoria Tkaczyk is professor at Humboldt-Universität zu Berlin, Germany.

Matteo Valleriani is honorary professor at Technische Universität Berlin, Germany, and professor by special appointment at Tel Aviv University, Israel.

Annette Vogt is honorary professor at Humboldt-Universität zu Berlin, Germany.

Wilko Graf von Hardenberg was guest professor at Humboldt-Universität zu Berlin, Germany, for the summer semester 2018.

Christine von Oertzen is professor at Humboldt-Universität zu Berlin, Germany.

Academic Appointments

He Bian (visiting scholar March–June 2018) was appointed assistant professor of history and East Asian studies, Princeton University, USA.

Joeri Bruyninckx (postdoctoral fellow, June 2015–May 2018) was appointed assistant professor of technology and society studies at Maastricht University, Netherlands.

Mònica Colominas Aparicio (visiting scholar May 2016–December 2019) was appointed VENI researcher, tenure-track Rosalind Franklin fellow, University of Groningen, Netherlands.

Joseph Dennis (visiting scholar February 2018–August 2021) was appointed associate professor of history, University of Wisconsin, Madison, USA.

Jennifer L. Derr (visiting scholar January–July 2019) was appointed associate professor of history and founding director of the Center for the Middle East and North Africa, University of California, Santa Cruz, USA.

Lorraine Daston (emerita scientific member) was appointed fellow at the Swedish Institute for Advanced Study; visiting fellow at King's College, London; and visiting scholar at the Department of the History and Philosophy of Science, University of Cambridge, UK.

Sebastian Felten (postdoctoral fellow September 2015–December 2018, visiting scholar 2019) was appointed visiting assistant professor at University of Vienna, Austria.

James Fraser (postdoctoral fellow July 2017–December 2018) was appointed assistant professor (research) in the Department of Philosophy, University of Durham, UK.

Mats Fridlund (visiting scholar September 2018–December 2019) was appointed associate professor of history of science and ideas, University of Gothenburg, Sweden, and visiting instructor, Renmin University of China.

Fanny Gribenski (research scholar June 2018–February 2020) was appointed research scholar at CNRS (Centre national de la recherche scientifique), Paris, France.

Barbara Hahn (visiting scholar April 2018–July 2019) was appointed associate professor of history, Texas Tech University, USA.

Jonathan Harwood (visiting scholar March 2018–December 2020) was appointed honorary associate fellow, Science Policy Research Unit, University of Sussex, UK.

Hansun Hsiung (postdoctoral fellow September 2016–June 2019) was appointed assistant professor, School of Modern Languages and Cultures, Durham University, UK.

Martin Jähnert (postdoctoral fellow August 2019–December 2020) was scholar in residence at the Deutsches Museum, Munich, from February–July, 2020.

Shaul Katzir (visiting scholar September 2020–August 2021) was appointed director of the Cohn Institute for the History and Philosophy of Science and Ideas, Tel Aviv University, Israel.

Katja Krause (Max Planck Research Group Leader, since November 2018) was appointed W2 professor of history of science at Technische Universität Berlin, Germany.

Maikel Kuijpers (visiting postdoctoral fellow October 2018–January 2019) was appointed assistant professor in European prehistory, Leiden University, Netherlands.

Xiaochang Li (postdoctoral fellow September 2017–August 2019) was appointed assistant professor in the Department of Communication at Stanford University, USA.

Alexis Lycas (postdoctoral fellow September 2017–November 2019) was appointed Maître de conférences, École pratique des hautes études, France.

Omer Michaelis (visiting postdoctoral fellow September–November 2018) was appointed assistant professor of Jewish philosophy, Tel Aviv University, Israel.

Glenn W. Most was appointed visiting professor on the Committee on Social Thought, University of Chicago, USA, and visiting professor at Peking University, China.

Julia Reed (visiting postdoctoral fellow October 2019–June 2020) was appointed teaching assistant at Harvard College; instructor at Harvard Extension School; and instructor at Technische Universität Berlin, Germany.

Maria Rentetzi (visiting scholar 2019–2025) was appointed professor of science, technology and gender studies, Friedrich-Alexander Universität Erlangen-Nürnberg, Germany.

Lukas Rieppel (visiting scholar January–June 2019) was appointed associate professor of history, Brown University, USA.

Francesca Rochberg (visiting scholar May 2018–July 2018) was appointed chair of the Department of Near Eastern Studies, University of California, Berkeley, USA.

Carla Rodrigues Almeida (postdoctoral fellow, February–September 2020) was appointed an international fellow at the Institute for Advanced Studies in Humanities (KWI) in Essen, Germany.

Julia Sanchez-Dorado (visiting postdoctoral fellow March–August 2020) was appointed Alexander von Humboldt postdoctoral fellow, Technische Universität Berlin, Germany.

David Sepkoski (senior research scholar September 2012–August 2018) was appointed professor at the University of Illinois at Urbana-Champaign, USA.

Aleksandar Shopov (postdoctoral fellow September 2019–August 2021) was appointed assistant professor of early modern Ottoman history, Binghamton University, USA.

Mårten Söderblom Saarela (postdoctoral fellow March 2017–August 2018) was appointed assistant research fellow at the Institute of Modern History, Academia Sinica, Taiwan.

Mengmeng Sun (visiting postdoctoral fellow November 2018–October 2023) was appointed research assistant, University of the Chinese Academy of Sciences, China.

Marianna Szczygielska (postdoctoral fellow September 2018–August 2021) was appointed affiliated researcher, Department of Ecological Anthropology, Czech Academy of Sciences, Czech Republic.

Viktoria Tkaczyk (Max Planck Research Group Leader 2015–2020) was appointed professor of media and knowledge technologies at Humboldt-Universität zu Berlin.

Christine von Oertzen (Principal Investigator, since 2005) was appointed professor of media practices at Humboldt-Universität zu Berlin, Germany.

Dror Weil (postdoctoral fellow November 2018–August 2019) was appointed permanent university lecturer in history of Asia, pre-1750, at King's College London, UK.

Weijing “Vivian” Xu (artist in residence May–August 2019) was appointed assistant professor of media and art, Duke Kunshan University, China.

Daqing Yang (visiting scholar August 2018–January 2019) was appointed associate professor of history and international affairs, George Washington University, USA.

Completed PhDs

Lucas Erichsen. *História Desanima(liza)da: os matadouros da cidade do Rio de Janeiro (1777–1881)*. Federal University of Rio de Janeiro, Brazil, 2020.

Thomas Erslev. *The Danish Brains: An Archive Materiality and Temporality in a Collection of Pathological Human Brains, 1945–2018*. Aarhus University, Denmark, 2020.

Teresa Hollerbach. *Sanctorius Reconsidered: A New Look on the Origins of Quantification in Medicine*. Technische Universität Berlin, Germany, 2020.

Anna Jerratsch. *Der frühneuzeitliche Kometendiskurs im Spiegel deutschsprachiger Flugschriften*. Humboldt-Universität zu Berlin, Germany, 2018.

Abram Kaplan. *The Myth of Greek Algebra: Progress and Community in Early Modern Mathematics*. Columbia University, USA, 2018.

- Anna Laqua*. John Bulwer: Medizinisches Wissen und theatrale Kultur im London des 17. Jahrhunderts. Humboldt-Universität zu Berlin, Germany, 2018.
- Anna-Maria Meister*. From Form to Norm: The Systematization of Values in German Design circa 1922, 1936, 1953. Princeton University, USA, 2018.
- Sébastien Rivat*. Representation and Realism in the Age of Effective Theories. Columbia University, USA, 2020.
- Julia Sanchez-Dorado*. Scientific Representation in Practice: Models and Creative Similarity. University College London, UK, 2019.
- Lotte Marie Schüßler*. Theaterausstellungen: Spielräume der Geisteswissenschaften um 1900. Humboldt-Universität zu Berlin, Germany, 2020.
- Alfredo Thiermann*. Radio-Activities: The Architecture of Broadcasting in Cold War Berlin. ETH Zurich, Switzerland, 2020.
- Mirjam Voerkelius*. Evolution in Times of Revolution: Darwinism, Nature, and Society in the Soviet Union. University of California, Berkeley, USA, 2018.
- Hannah Wiemer*. Camouflage: Landschaftslektüren zwischen Theater, Kunst und Krieg, 1914–1945. Freie Universität Berlin, Germany, 2019.
- Tracy Wietecha*. Albert the Great on the Human Path to Perfection. Ludwig-Maximilians-Universität München, Germany 2020.
- Dirk Wintergrün*. Netzwerkanalysen und semantische Datenmodellierung als heuristische Instrumente für die historische Forschung. Doctor of Engineering, Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany, 2019.

Preprints

The MPIWG's preprint series presents the results of ongoing research, whether individual projects or projects originating in Working Groups. Many of these papers are later published in journals or edited volumes. The following preprints, most of which are available for download online, appeared in the evaluation period:

- 490** Stahnisch, Frank W., ed. *Émigré Psychiatrists, Psychologists, and Cognitive Scientists in North America since the Second World War*. 2018.
- 491** Sánchez Colina, María, Angelo Baracca, Carlos Cabal Mirabal, Arbelio Pentón Madrigal, Jürgen Renn, and Helge Wendt. *Historia de la física en Cuba (siglo XX)*. 2019.
- 492** Schemmel, Matthias. *Everyday Language and Technical Terminology: Reflective Abstractions in the Long-Term History of Spatial Terms*. 2019.
- 493** Wolff, Barbara. "Derartige kolossale Opfer ...": Der Nobelpreis für Physik für das Jahr 1921 – was geschah mit dem Preisgeld? 2019.
- 494** Horst, Thomas H. *The Reception of Cosmography in Vienna: Georg von Peuerbach, Johannes Regiomontanus, and Sebastian Binderli*. 2019.
- 495** Asper, Markus. *Science Writing and Its Settings: Some Ancient Greek Modes*. 2019.
- 496** Schäfer, Dagmar, Lu Zhao, and Michael Lackner, eds. *Accounting for Uncertainty: Prediction and Planning in Asian History*. 2019.
- 497** Nettelbeck, Joachim. *Verwalten von Wissenschaft, eine Kunst*. 2019.

- 498 Rodrigues Almeida, Carla. *Stellar Equilibrium vs. Gravitational Collapse*. 2019.
- 499 Beyer, Victoria. *How to Generate a Fingerprint*. 2019.
- 500 Høyrup, Jens. *From Hesiod to Saussure, from Hippocrates to Jevons: An Introduction to the History of Scientific Thought between Iran and the Atlantic*. 2020.
- 501 Shlomi, Noga. *The Tacuinum sanitatis: Practices of Collecting and Presenting Medical Knowledge between the Middle Ages and the Renaissance*. 2020.
- 502 Høyrup, Jens. *Reinventing or Borrowing Hot Water? Early Latin and Tuscan Algebraic Operations with Two Unknowns*. 2020.
- 503 Rentetzi, Maria, Flavio D'Abramo, and Roberto Lalli. *Diplomacy in the Time of Cholera*. 2020.
- 504 Furlan, Stefano. *John Wheeler between Cold Matter and Frozen Stars: The Road towards Black Holes*. 2021.
- 505 Klein, Ursula. *Experten in der Corona-Krise und Geschichte*. 2021.

Teaching Activities

Winter 2017/18

- David Sepkoski. Data History: Information Overload from the Enlightenment to Google. Seminar, University of Chicago, USA.
- Viktoria Tkaczyk. Applied Humanities: Grundlagentexte eines vernachlässigten Forschungsprogramms. Graduate seminar, Humboldt-Universität zu Berlin, Germany.
- Annette Vogt. History of Statistics. Seminar, Humboldt-Universität zu Berlin, Germany.
- Annette Vogt. History of Economic Thought in the 20th Century. Seminar, Humboldt-Universität zu Berlin, Germany.
- Helge Wendt. Energiewenden in der Vergangenheit: (Wissens)historische Konzeption eines aktuellen Themas. Seminar, Technische Universität Berlin, Germany.

Spring/Summer 2018

- Maria Avxentevskaya. Down-to-Earth Knowledge in the Early Modern World. Advanced undergraduate seminar, Bard College Berlin, Germany.
- Angela Axworthy. Practical Mathematics in the Early Modern Period. Graduate seminar, Technische Universität Berlin, Germany.
- Lorraine Daston. Knowledge on a Platter: Comparative Perspectives on Knowledge Texts in the Ancient World. Seminar, with Wendy Doniger, University of Chicago, USA.
- Roberto Lalli. Twentieth-Century Physics in Context. Seminar, Technische Universität Berlin, Germany.
- Giulia Rispoli. Anthropocene Knowledge: Earth History in the Making. Seminar, Indiana University Bloomington, USA.
- Matthias Schemmel. Geschichte des Raumbegriffs von der Antike bis in die Gegenwart in erkenntnistheoretischer Absicht. Seminar, Humboldt-Universität zu Berlin, Germany.

Viktoria Tkaczyk, Anke te Heesen, and Friedrich Steinle. Wissens- und Wissenschaftsgeschichte: Positionsbestimmungen. Graduate seminar, Humboldt-Universität zu Berlin, Germany.

Matteo Valleriani. Das aristotelische Weltbild: Die Lektüre von Aristoteles *De coelo*. Seminar, Technische Universität Berlin, Germany.

Annette Vogt. Selected Topics in the History of Statistics. Seminar, Humboldt-Universität zu Berlin, Germany.

Wilko Graf von Hardenberg. Lebenswelten: Meeresbiologie im Anthropozän. Seminar, Humboldt-Universität zu Berlin, Germany.

Wilko Graf von Hardenberg. Das Meer in der Moderne: Zur Wissens- und Umweltgeschichte eines globalen Raumes. Lecture course, Humboldt-Universität zu Berlin, Germany.

Wilko Graf von Hardenberg. Die Tiefsee in Wissenschaft und Fiktion. Seminar, Humboldt-Universität zu Berlin, Germany.

Wilko Graf von Hardenberg. Zwischen Land und Meer: Küsten, Messungen, Darstellungen. Seminar, Humboldt-Universität zu Berlin, Germany.

Helge Wendt. Natürliche Rohstoffe im europäischen Kolonialismus des 19. Jahrhunderts. Seminar, Humboldt-Universität zu Berlin, Germany.

Winter 2018/19

Anna Izdebska. Introduction to Islamic Philosophy. Undergraduate seminar, Jagiellonian University of Krakow, Poland.

Katja Krause. Vom Licht des Intellektes zum Licht der Natur: Wissen und Wissenschaft vor 1500. Graduate seminar, Technische Universität Berlin, Germany.

Tamar Novick. The Invention of Urine. Seminar, Tel Aviv University, Israel.

Sébastien Rivat. Contemporary Civilization. Undergraduate core course, Columbia University, USA.

Dagmar Schäfer and Karin Gludovatz. Tiere zwischen Kunst und Wissenschaften: Vormodernes China und Europa im Vergleich. Seminar, Freie Universität Berlin, Germany.

Elena Serrano. Women in Early Modern Science: Gender and Knowledge in Historical Contexts. Intensive course, University of Sydney, Australia.

Viktoria Tkaczyk. Forschungsmedien in und zwischen den Natur- und Geisteswissenschaften. Lecture course, Humboldt-Universität zu Berlin, Germany.

Matteo Valleriani. Die Strukturen praktischen Wissens. Seminar, Technische Universität Berlin, Germany.

Annette Vogt. History of Economic Thought in the 20th Century. Seminar, Humboldt-Universität zu Berlin, Germany.

Christine von Oertzen. Zur Geschichte von Big Data. Graduate seminar, Technische Universität Braunschweig, Germany.

Hannah Wiemer. Camouflage: Mediale Strategien der Tarnung und Täuschung. Seminar, Humboldt-Universität zu Berlin, Germany.

Spring/Summer 2019

Maria Avxentevskaya. Premodern Knowledge in Translation. Seminar, Technische Universität Berlin, Germany.

Senthil Babu, Sascha Freyberg, Pietro Daniel Omodeo, and Matthias Schemmel.

Political Epistemology. Seminar, Università Ca' Foscari, Venice, Italy.

Sonja Brentjes. History of Science in Islamicate Societies. Seminar, Freie Universität Berlin, Germany.

Shih-Pei Chen, Dagmar Schäfer, and Calvin Yeh. History of Science, Local Gazetteers and New Digital Methods. Seminars, Princeton University and University of Michigan, USA.

Lorraine Daston. Thinking the Present through the Past: Classic Works of History since 1750. Seminar, University of Chicago, USA.

Vincenzo De Risi. On Lambert's Epistemology and Metaphysics. Graduate Seminar, Stanford University, USA.

Hansun Hsiung. A Global and Comparative History of the Book. Undergraduate seminar, Humboldt-Universität zu Berlin, Germany.

Katja Krause and Friedrich Steinle. Zoologie in Antike und Mittelalter. Graduate seminar, Technische Universität Berlin, Germany.

Roberto Lalli. Science Goes International: Ideals and Practices of Scientific Internationalism from the 19th Century to the Present. Seminar, Technische Universität Berlin, Germany.

Razieh-Sadat Mousavi. History of Science in the Islamic World. Undergraduate seminar, International Al-Mustafa University, Berlin, Germany.

Tamar Novick, Dagmar Schäfer, and Alma Igra. Knowing through Animals: The Animal Turn in the History of Science. Seminar, Columbia University, USA.

Giulia Rispoli. Historicizing the Anthropocene. Seminar, Freie Universität Berlin.

Sébastien Rivat. Contemporary Civilization. Undergraduate core course, Columbia University, USA.

João Romão. Intellectual Property: Authorship, Ownership, Access. Undergraduate seminar, Humboldt-Universität zu Berlin, Germany.

Dagmar Schäfer. 物质文化史的方法和实践 (Methods and practices of material cultural history). Lecture series, Peking University, China.

Lotte Marie Schüßler. Die Stimme aus dem Off. Seminar, Humboldt-Universität zu Berlin, Germany.

Marianna Szczygielska. Queer Zoo Animals: Between Species, Sex, and Politics. Seminar, Humboldt-Universität zu Berlin, Germany.

Viktoria Tkaczyk. Mediale Infrastrukturen. Graduate seminar, Humboldt-Universität zu Berlin, Germany.

Annette Vogt. History of Statistics. Seminar, Humboldt-Universität zu Berlin, Germany.

Helge Wendt. Das Verhältnis von Geologie und europäischem Kolonialismus im 19. Jahrhundert. Seminar, Humboldt-Universität zu Berlin, Germany.

Winter 2019/20

Maria Avxentevskaya. Mobilizing Knowledge in Translation. Seminar, University of Sydney, Australia.

Flavio D'Abramo. The Anthropocene, Biology and Public Health. Advanced seminar, Tel Aviv University, Israel.

Dominic Dold. Aristotelische Wissenschaftstheorie von Aristoteles bis Zabarella. Seminar, Technische Universität Berlin, Germany.

Anna Izdebska. From Athens to Mecca: Premodern Philosophy in the Eastern Mediterranean. Undergraduate seminar, Jagiellonian University of Krakow, Poland.

Katja Krause. Die Wissenschaft der Seele in Antike und Mittelalter. Graduate seminar, Technische Universität Berlin, Germany.

Katja Krause and Nicola Polloni. Ancient and Medieval Visions of Light and Colour. Graduate seminar, Technische Universität Berlin, Germany.

Roberto Lalli. History of Science. Seminar, University of Turin, Italy.

Tamar Novick. The Animals We Know. Seminar, ETH Zurich, Switzerland.

Lisa Onaga. The Public Lives of Objects. Winter School, Srishti Institute of Art, Design, and Technology, Bengaluru, India.

Sébastien Rivat. Contemporary Civilization. Undergraduate core course, Columbia University, USA.

João Romão. Experimentalism: Music, Science, and Technology. Undergraduate seminar, Humboldt-Universität zu Berlin, Germany.

Aleksandar Shopov. Environmental History of Istanbul. Seminar, Masaryk University, Czech Republic.

Marianna Szczygielska. Museum of the Anthropocene. Lecture series, University of Wrocław, Poland.

Marianna Szczygielska. Zoological Gardens. Seminar, University of Warsaw, Poland.

Matteo Valleriani. The Impact of Scientific Press on Scientific Culture in the Early Modern Period. Seminar, University of Tel Aviv, Israel.

Matteo Valleriani. Die wissenschaftlichen Errungenschaften Robert Boyles aus der Perspektive seiner Korrespondenz. Seminar, Technische Universität Berlin, Germany.

Leendert van der Miesen and Leon Chisholm. String, Synthesizer, Sundial: Instruments of Music and Science. Graduate seminar, Humboldt-Universität zu Berlin, Germany.

Annette Vogt. History of Statistics. Seminar, Humboldt-Universität zu Berlin, Germany.

Christine von Oertzen, Anke te Heesen, Friedrich Steinle, and Viktoria Tkaczyk. Ressourcen des Wissens: Neue Ansätze der Medienwissenschaft und Wissenschaftsgeschichte. Graduate seminar, Humboldt-Universität zu Berlin and Technische Universität Berlin, Germany.

Helge Wendt and Mònica Colominas Aparicio. Social Differentiation and Transmission of Religious Knowledge in the Hispanic World (14th–16th Centuries). Seminar, Bard College Berlin, Germany.

Spring/Summer 2020

Alexander Blum and Pablo Ruiz de Olano. The End of Physics. Seminar, Technische Universität Berlin, Germany.

Flavio D'Abramo. The Cultural and Political Origins of Biology. Undergraduate seminar, Bard College Berlin, Germany.

Lorraine Daston. Wonder, Wonders, and Knowing. Seminar, University of Chicago, USA.

Evelina Miteva. Sprechen in der “Ich”-Form im Mittelalter. Undergraduate seminar, Universität Köln, Germany.

Jaume Navarro. Science and Values. Graduate seminar, University of the Basque Country, Spain.

Julia Reed. The Art and Science of Memory. Seminar, Harvard Extension School, USA.

Julia Reed. Early Modern Medicine. Seminar, Technische Universität Berlin, Germany.

Maria Rentetzi and *Elena Serrano*. How Does Gender Shape Science? The Intermingling of Gender and Science in Historical Contexts. Seminar, Technische Universität Berlin, Germany.

Giulia Rispoli and *Jürgen Renn*. The Evolution of Knowledge and Science in the Anthropocene. Seminar, University of Bergamo, Italy.

Sébastien Rivat. Contemporary Civilization. Undergraduate core course, Columbia University, USA.

Pablo Ruiz de Olano. Knowledge and Values. Graduate block seminar, University of the Basque Country, Spain.

Rudolf Stichweh. Weltgesellschaft I: Eigenstrukturen und funktionale Differenzierung. Seminar, University of Bonn, Germany.

Rudolf Stichweh. Demokratische und autoritäre politische Systems in der Weltgesellschaft der 21. Jahrhunderts. Lecture series, Universität Luzern, Switzerland.

Andrea Braun Štřelcová. China: A Science Superpower? Introduction to China through Science Policy. Seminar, Technische Universität Berlin, Germany.

Annette Vogt. History of Statistics. Seminar, Humboldt-Universität zu Berlin, Germany.

Christine von Oertzen. Sammlung, Liste, Datenbank: Medien, Praktiken, und Ökonomien der Verdatung. Graduate seminar, Humboldt-Universität zu Berlin, Germany.

Winter 2020/21

Hannah C. Erlwein. Der Islam und Wissenschaft: Von der Vormoderne bis zur Moderne. Seminar, Technische Universität Berlin, Germany.

Jelena Große-Bley. Stadt und Land. Undergraduate seminar, Freie Universität Berlin.

Katja Krause. Instrumente wissenschaftlichen Denkens und Handelns: Vorstellung, Zeichen und Sprache. Graduate seminar, Technische Universität Berlin, Germany.

Katja Krause. Ein Archiv für die Zukunft in Vorstellung, Zeichen und Sprache. Study project, Technische Universität Berlin, Germany.

Dagmar Schäfer. Landwirtschaft in China von den Anfängen bis zur Neuzeit: Eine Wiege der Kultur. Seminar, Freie Universität Berlin, Germany.

Rudolf Stichweh. Theorie der Weltgesellschaft. Lecture series, Universität Luzern, Switzerland.

Rudolf Stichweh. Weltgesellschaft II: Ungleichheit und asymmetrische Abhängigkeit. Seminar, Universität Bonn, Germany.

Andrea Braun Štřelcová. China, Science and Technology: An Introduction. Training seminar for faculty at Technische Universität Berlin, Germany.

Andrea Braun Štřelcová. Migrating People, Travelling Ideas: The World in China and China in the World. Seminar, Technische Universität Berlin, Germany.

Alberto Tiburcio. Conversion Narratives and Interreligious Polemics in Historical Perspective. Seminar, Bard College Berlin, Germany.

Leendert van der Miesen. Music, Travel and the World: 1400–1800. Undergraduate seminar, Humboldt-Universität zu Berlin, Germany.

Annette Vogt. History of Economic Thought in the 20th Century. Seminar, Humboldt-Universität zu Berlin, Germany.

Christine von Oertzen. Medien der Bürokratie. Graduate seminar, Humboldt-Universität zu Berlin, Germany.

Helge Wendt. Nebenprodukte der Kohle: Entwicklungen von Wissen, Technik und Industrie. Seminar, Technische Universität Berlin, Germany.

Tracy Wietecha. Medieval Conceptions of Happiness. Seminar, Bard College Berlin, Germany.

Awards

Anna L. Ahlers (Research Group Leader) was appointed fellow of the Wissenschaftskolleg zu Berlin (IAS) for the academic year 2020/21.

Gadi Algazi (visiting scholar) won the Rita Levi Montalcini Research Prize in 2020.

Karine Chemla (visiting scholar) received the title Doctor Honoris Causa from Vrije Universiteit Brussel in April 2019.

Lorraine Daston (director until June 2019, emerita scientific member thereafter) was awarded the Dan David Prize in the history of science (2018); the Austrian Decoration for Science and Art (2019); a Social Sciences Research Council annual fellowship (2019); the Heineken Prize for History, Royal Netherlands Academy (2020); and the Gerda Henkel Prize (2020).

James Fraser (postdoctoral fellow) received the Ernst Nagel Early Career Essay Award for his essay “Spontaneous Symmetry Breaking in Finite Systems” (*Philosophy of Science*, 2016) in 2018.

Mats Fridlund (visiting scholar) received the Language Bank of Finland Researcher of the Month award, January 2020.

Cathy Gere (visiting scholar) received the Choice Award for Outstanding Academic Title for her book *Pain, Pleasure and the Greater Good* in 2018.

Gerd Graßhoff (Max Planck fellow) was awarded the 2019/20 prize for teaching excellence at the Philosophical Faculty, Humboldt-Universität zu Berlin.

Dieter Hoffmann (emeritus scholar) was awarded the Abraham Pais Prize for History of Physics 2020 by the American Physical Society.

Abram Kaplan (visiting predoctoral fellow) received the 2018 Clough Prize for best dissertation in European history from Columbia University, Department of History, for his thesis “‘The Myth of Greek Algebra’: Philology and the Discovery of Calculus, 1580–1710.”

Xiaochang Li and *Mara Mills* received the SHOT Bernard S. Finn IEEE History Prize in 2020 for their paper “Vocal Features: From Voice Identification to Speech Recognition by Machine” (*Technology and Culture*, 2019).

Omer Michaelis (visiting postdoctoral fellow) received the Shlomo Pines Memorial Prize from Hebrew University of Jerusalem, 2019.

Glenn W. Most (external scientific member) was awarded a Chronoi Fellowship at the Einstein Stiftung, Berlin, in November 2020.

Gabriela Radulescu (predoctoral fellow) won the Sixth Russian-European Research Papers Competition for Graduate and Postgraduate Students, St. Petersburg, in November 2019.

Ohad Reiss Sorokin (visiting predoctoral fellow) received the Nathan Reingold Prize from the History of Science Society for his essay “The Early Biography of ‘Intelligence’ as a Scientific Object: Alfred Binet’s Experiments on His Daughters” in 2018.

Jürgen Renn (director) was awarded the NOMIS fellowship, the Zeeman fellowship, and was appointed as Corresponding Member of the Deutsches Archäologisches Institut (2019).

Hans-Jörg Rheinberger (emeritus scientific member) was featured thinker at the Universität Göttingen in June 2019.

Sébastien Rivat (postdoctoral fellow) received the David H. Siff Award for the best paper in philosophy of science, Columbia University, in September 2019.

Jean Sanchez (visiting postdoctoral fellow) received the Young Researcher Award 2020 from the Fondation Les Treilles, Paris.

Dagmar Schäfer (director) was awarded the Gottfried Wilhelm Leibniz Prize by the German Research Foundation (DFG), 2020.

Mårten Söderblom Saarela (postdoctoral fellow) received the Taiwanese Ministry of Science and Technology Excellent Talent Award in 2020.

Xiaona Wang (postdoctoral research fellow) received the 2018 Charles Schmitt Prize for her article “By Analogy to the Element of the Stars: The Divine in Jean Fernel’s and William Harvey’s Theories of Generation” (*Intellectual History Review*, 2019).

Tracy Wietecha (visiting predoctoral fellow) was awarded the Johann-Lorenz-Bausch-Förderpreis, Leopoldina Akademie Freundeskreis, Halle.

Norton M. Wise (visiting scholar) received the Sarton Medal, the highest award of the History of Science Society, for lifetime scholarly achievement, 2019.

Exchange Programs

The Institute maintains close relationships with universities worldwide in order to foster collaborative research projects and to facilitate teaching experience for our scholars who are not yet tenured. We have formal agreements on scholar exchange with three universities outside Germany and one with Bard College in Berlin on collaboration in teaching. The following MPIWG scholars participated:

University of Sydney

Elena Serrano (Dept. I), 2018; Maria Avxentevskaya (RG Krause), 2019; Martina Schlünder (Dept. I), 2020 (postponed).

Tel Aviv University

Tamar Novick (Dept. III), 2018; Bernadette Lessel (RG Blum), 2019; Flavio D’Abramo (LMRG Ahlers), 2019.

Bard College Berlin

Maria Avxentevskaya (RG Krause), 2018; Edna Bonhomme (Dept. III), 2018; Elena Serrano (Dept. I), 2018; Mònica Colominas Aparicio (Dept. I), 2019; Helge Wendt (Dept. I), 2019; Maria Avxentevskaya (RG Krause), 2020; Flavio D'Abramo (LMRG Ahlers), 2020; Rocco Gaudenzi (RG Blum), 2020; Alberto Tiburcio (Dept. III), 2020; Tracy Wietecha (RG Krause), 2020.

Indiana University at Bloomington

Giulia Rispoli (Dept. I), 2018.

Journalists in Residence

<https://www.mpiwg-berlin.mpg.de/journalists-in-residence>



The **Journalist-in-Residence** program has drawn much attention to the Institute since it began in 2013. Coordinated by the Institute's communications team, it supports journalism in the history of science, fosters communication with the broader public, and improves dialogue between the humanities, social sciences, and natural sciences. Journalists are chosen on the basis of their interest in the history of science and their journalistic credentials. They stay at the MPIWG for around two months, taking an active part in the Institute's academic life, sharing their expertise in journalistic writing, and offering a workshop or seminar for scholars.

Olivia Judson was hosted by Department I (January–March 2018) for the project “Writing and Publishing Books.”

Julia Voss was hosted by Department II (April–July 2018) for the project “Is It a Story?”

Anja Krieger was hosted by Department I (February–March 2019) for the project “Storytelling for Podcasting.”

Laura Spinney was hosted by Department III (April 2019–May 2020) for the project “The History of Science behind the Front Page: Making Your Research Topical.”

Siobhan Roberts was hosted by Department II (November 2019–January 2020) for the project “Annals of Scientific Storytelling.”

Rachel Waldholz was hosted by Department I (November 2019–January 2020) for the project “Tell Your Story: Presenting Research to the Public & Media.”

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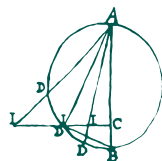
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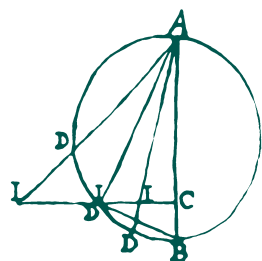
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