3 Research programme

3.1 Objectives and work programme

General information

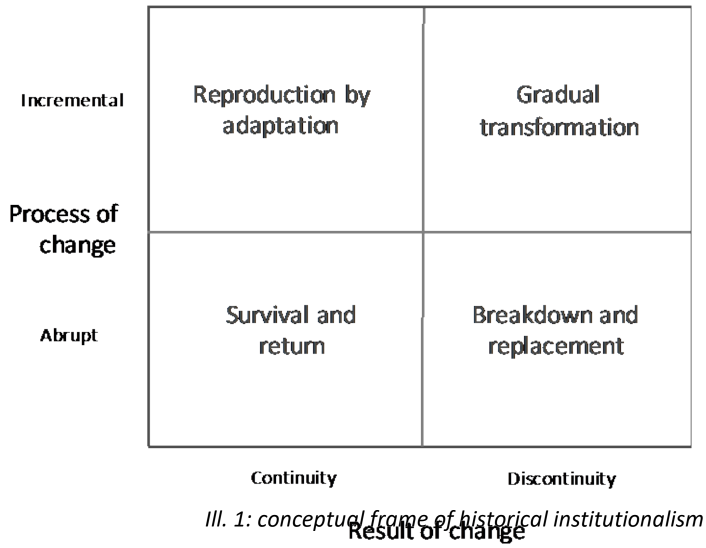
Starting point. Analyses of the development of science and technology have long been shaped by the idea that the creation of new knowledge is basically equivalent to the formulation and improvement of theories within academic disciplines. From this point of view, old theories were falsified and thus discarded, and new ones had to be proven true. This was the reason why history, philosophy and sociology of science were mainly focused on theories and their dynamics. Typical authors of this approach are Thomas S. Kuhn, Imre Lakatos, Robert K. Merton and Karl Popper (e.g. Carrier 2009; Barker/Kitcher 2013; Heinze et al. 2013). Following their classical contributions, the „New Experimentalism" that was influenced by history and philosophy of science stressed three important facts: (1) experiments can have an institutional and epistemic life of their own; (2) empirical science is organized in experimental systems, which constantly create new and surprising empirical facts (Hacking 1983; Rheinberger 1997; Heidelberger/Steinle 1998; Epple 1999) and (3) material conditions for the creation of the new are essential, such as workshops, laboratories and research and development departments - for example when analysing the history of technical universities (Gugerli et al. 2005) or when creating new instruments of research or large-scale scientific facilities (Galison/Hevly 1992; Shinn/Joerges 2002; Crease/Westfall 2016). In addition, Science and Technology Studies (STS) have revitalised the exploration of the material and the technical part of knowledge creation (Mol 2002; Mody 2011; Law 2012), including the social construction of technology, knowledge, and science and their embeddedness in power relations. They put the analysis of the co-production of social and scientific/technical order (Oudshoorn/Pinch 2003; Jasanoff 2004) and an understanding of science as practice centre stage (Pickering 1992 und 1993; Knorr-Cetina 2001; Epple/Zittel 2010; Gheradi 2019).

Conceptualisation of transformations. The debate about transformations in science and technology is ongoing. While the oftentimes limited perspectives of current approaches may seem plausible by themselves, they do not do justice to the complexity of the development as a whole. The *Research Training Group* (*Graduiertenkolleg*, henceforth: *GRK*)[1] takes this observation as a starting point to develop a more comprehensive view of the dynamics of science and technology. Rather than contesting claims of extreme forms of transformation, the proposed analytical framework integrates such assertions into a multi-dimensional picture of transformations in science and technology. We aim to examine the extent to which diagnoses of transformations are themselves constructions that shape a certain historical view rather than simply a reconstruction of scientific and technical development, as was illustrated in the debate about "Technosciences" (e.g. Nordmann 2011). This way, the GRK works reflectively in two ways (see Bourdieu 2004).

In this context the GRK will firstly strive to carve out more clearly the findings of the above mentioned "New Experimentalism" as well as the recent STS literature and relate them to each other. For example, this concerns the research on the social situatedness of the production and/or implementation of scientific knowledge and technology. This includes considering how power relations have been addressed in current feminist and post-colonial STS literature (Harding 2016; Pollock/Subramaniam 2016; Law/Lin 2017; Lyons et al. 2017; Lanza Rivers 2019). Secondly, the GRK will broaden the concept of institutions in order to capture both informal and cognitive dimensions of institutional orders in addition to formal rules (Scott 2013). This is important in regard to how scientists and their ideas are connected within their respective scientific or technical community as well as for establishing criteria, such as elegance, simplicity, and beauty (see McAllister 1999; Hossenfelder 2018; Ivanova/French 2020). These "hidden" criteria play an important role for research itself, for scientific publications and allocation of

[1] Information on the structure of *Research Training Groups* funded by the *German Research Foundation* can be found here: https://www.dfg.de/en/research_funding/programmes/coordinated_programmes/research_training_groups/forms_guidelines/index.html

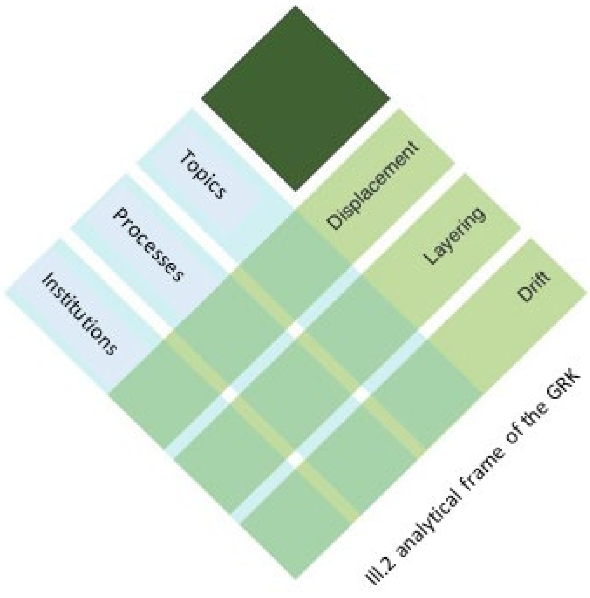
research funding. In particular, interdisciplinary research on technical innovations has challenged the idea that the "best" technology prevails, but instead identified economic, political, aesthetic and cultural interests and contexts, such as design, market orientation or institutional environment, as highly influential (Anderson/Tushman 1986, 1990; Bauer 2006; Oudshoorn 2011; Bijker et al. 2012; Bowman et al. 2017).



Ill. 1: conceptual frame of historical institutionalism

Dimensions. When it comes to the development of science and technology, three fundamental dimensions are important and have to be understood within the confines of their historical interdependences and preconditions. The **dimension of topics** that has dominated history of science so far covers often-debated theories as well as experiential knowledge which oftentimes is not specified or codified systematically. The **dimension of processes** that occur via behaviour and communication includes the experimental and communicative practices of knowledge as well as their technical applications. Here, aspects of teaching and the transfer of knowledge, competences, and skills as well as the diverse aspects of science communication come into view. We assume that modern science and technology increasingly operates under the expectation of being comprehensible and transmissible, both inside and outside the scientific community. Furthermore, it seems plausible to consider the **dimension of institutional conditions** in a historical-sociological way, that is, to include empirically founded analyses of the development and historical change of institutions. In so doing, the focus shall not only be on academic research at universities but also on non-university or government funded research facilities and industrial research laboratories as well. Other important institutional aspects are the educational system, the communication systems of academic disciplines and the mainly international entities for sharing scientific and technical knowledge and skills. All three dimensions mentioned are analytical tools that highlight aspects whose interaction we want to examine.

Interaction between dimensions. The tension created by continuity and discontinuity can be applied to all three dimensions, assuming that each dimension is somewhat independent from each other. This means that discontinuities within the dimension of topics (e.g. the theory of relativity) are neither necessarily accompanied by discontinuities within the dimension of processes (no fundamental change in physical research) nor within the dimension of institutions (no new research or teaching entities are created). On the other hand, despite continuity within the dimension of topics, institutional disruptions may endanger processes of scientific research (e.g., collapse of scientific publication system in Germany after World War I). A multidimensional description of what is happening is thus possible, where the three dimensions are more or less interwoven, depending on the particular historical situation and the scientific and technical communities' developmental stage. This means that each constellation of topics, processes and institutional conditions needs to be located historically and explained sociologically. Our framework, as shown below, goes beyond conventional history, philosophy and sociology of science in that it can be used to characterise transformations of particular phenomena in a more detailed way. Our model especially allows for the analysis of discontinuities as results of gradual changes within those three dimensions (Streeck/Thelen 2005). In this regard, we will clarify how STS studies, with their focus on power relations, can contribute insights to, for example, either the loss or maintenance of resource ensembles (Ash 2002; Plennert 2018).



Critical view on theory as a motor. Another starting point of the GRK is the general insight that research is not only driven by theoretical considerations, but that theoretical progress can also be decisively influenced by technical or methodical developments. Theory is rarely plausible as a driving force in technical areas where emphasis is less on whether something is true or not, but rather whether something works or whether technologies can survive in the market. This is also relevant in areas of theoretically oriented research, e.g. when big science facilities change their thematic orientation for the sake of survival, or when research strategies get influenced by trends in the form of the aforementioned "hidden criteria". Hence, it is the interaction between all three dimensions (topics, processes, institutional conditions) that matters the most.

Terminology and theoretical approach. In order to adequately capture transformations (discontinuity, change) within each dimension, we will probe historical institutionalism's concepts and terminology (Thelen 2003; Streeck/Thelen 2005). Within historical-sociological research, this interdisciplinary approach has been increasingly applied and has produced many new insights in recent years (Streeck 2009; Fioretos et al. 2016; Heinecke 2016; Aagaard 2017). In contrast to the widespread idea that cognitive and institutional changes either strengthen existing paths (Fig 1: top left) or bring an abrupt end to long phases of stability with either continuous (Fig 1: bottom left) or discontinuous impact (Fig 1: bottom right), research using the framework of historical institutionalism has shown that step-by-step-changes accumulate over time and can thus lead to comprehensive transformations (Fig 1: top right). Such incremental-cumulative transformations serve as the conceptual starting point of the GRK, including particular forms of change, such as **displacement** (substitution of existing theories, regulations and practices by new ones), **layering** (adding new theories, regulations and practices) and **drift** (keeping existing regulations, practices and theories in simultaneously changing social and cultural environments). This framework will both be adapted and applied to the three dimensions mentioned above (Fig 2).

Gradualism. We characterise our proposed analytical perspective as **multidimensional** and **gradual**, aiming to include established terms, such as evolution, revolution, standstill, disruption and continuity into our analysis. At the same time, we will examine concrete phenomena and examples based on the analytical categories of historical institutionalism and with reference to the STS literature mentioned above (see below: research projects).

Specific aspects

The Old. We will not exclusively focus on *the New*, but will keep an eye on the fate of *the Old* throughout. Exemplary analyses using this perspective have been conducted in the history of science and technology (e.g. waste disposal, failures of innovation) (see Bauer 2006; Edgerton 2006; Krebs et al. 2018). Thanks to modern computing capabilities, declining research fields in mathematics (e.g. invariant theory) were invigorated. Although it is not possible to bring back all forgotten or overlooked knowledge, the GRK will try to actively include this "sedimentary layer" into its analyses.

Interdisciplinarity. Previous analyses of continuity and discontinuity suffered from a certain lack of cooperation between science-reflective disciplines (history, philosophy, sociology) on the one hand, and the sciences themselves (e.g. geoscience, mathematics, physics) on the other hand. The GRK unites approaches of history of science and technology as well as philosophy and sociology of science with aspects of the history of education by considering education and teaching as crucial aspects of institutionalised science and technology. Science and technology are always taught and practised in particular institutional settings. While philosophy of science provides general models for the development of science that include normative statements, sociology of science aims to explain developments of science without reference to such normativity. In contrast, history of science and technology are descriptive as well as constructive. Analysing historical processes and developments provides not only the material for probing existing concepts of scientific and technological change but is fundamental for the development of new concepts as well (Schmaltz/Mauskopf 2011; Ash 2012; Carrier 2012; Kinzel 2012; Nordmann 2012; Schickore 2013).
We want to include **two typical aspects** – namely the "Cult of *the New*" and the "Drama of *the Old*" (Edgerton 2006; Krebs et al. 2018) – that seem to be closely connected with recent developments of science, research and technology. The rapidly increasing number of researchers combined with new technologies (especially the internet) leads to an undefinably large number of new results and artefacts. Deciding what is relevant and how to define "relevant" is thus crucial and makes new methods of editing and assessing information more and more important (e.g., bibliometrics, Jappe et al. 2018; Ball 2020).
Hidden criteria and power relations. Despite its centrality to modern praxis, the influence of criteria such as elegance, simplicity, implicit knowledge and socially embedded power relations (especially with regard to gender aspects and the "global North" and "global South" (see Harding 1990, 2016)) on scientific and technological research as well as on the allocation of funding and on the selection of research projects is rarely discussed. The efficacy and diffusion of these criteria depends on modern forms of communication that make possible their rapid spreading and full reception. As hidden criteria and power relations in theory and practice may have a lasting impact on careers, junior researchers need to be informed about them. Thus, reflection on these criteria is an essential part of the GRK.
Timeframe. We have deliberately chosen a broadly defined timeframe starting around 1800, considered a standard epochal divide in the history of science (e.g. Nye 2003), as after 1800 science became increasingly procedural, focusing on permanent change, the revision of existing concepts and the creation of new concepts. This "Cult of *the New*" is the insignia of a whole epoch as well as of modern science and technology. At the beginning of this timeframe, publicly funded and organised education systems (including the professionalisation of school teachers and university lecturers) and academic disciplines emerged across Europe (Servos 1990; Hiebert 1996; Lucier 2009). At the end of the timeframe, we observe what has been called "knowledge society" that is marked by a comprehensive scientification of society and an acceleration of its structural change (Weingart 2001; Szöllösi-Janze 2004). Our timeframe covers the Industrialisation that had a lasting impact on all fields of science and technology under consideration, and vice versa. This includes the emergence of industrial research laboratories in the second half of the 19th century (Pithan 2019) as well as government-funded research facilities outside the university sector, such as the Pasteur Institute in Paris or the Physikalisch-Technische Reichsanstalt in Braunschweig, thus starting a process that became more dynamic in the early 1900s when Kaiser Wilhelm Institutes were founded in Germany and National Laboratories were built in the United States. Industrialisation also led to the emergence of a new branch of the education system consisting of secondary and polytechnic schools that later became technical universities.
Our timeframe also covers the militarisation and massive governmental control of science and technology in the 20th century that occurred in the context of World War I and II, but especially after 1945, and that supported all forms of Big Science projects. In addition, we consider various expansion cycles of the education system, in particular the expansion in the 1960s[,] which considerably increased both academic and industrial research especially in Europe and North America and continued well into the 1970s. Also, we observe the waning pre-eminence of autonomous academic science in the 1980s, a phenomenon that has been discussed as

"Mode 1/Mode 2" (Gibbons et al. 1994) and that covers resource saturation in what has been called "steady state science" (Ziman 1994). At the end of our timeframe, we explore limits of government funding with regard to ever more sophisticated and costly Big Science facilities (e.g., cancellation of the Superconducting Supercollider in the United States, see Riordan et al. 2015) and we discuss the contested value of basic research in industrial research laboratories (e.g., closure of the Bell Laboratories, see Chesbrough 2006).
Geographical delimitation. The focus of our research is on Europe and Northern America (see 3.1.2, 3.1.3, 3.1.5, 3.1.8), but can be canonically broadened (see 3.1.4, 3.1.6) or rather is not bound geographically (see 3.1.1, 3.1.7, 3.1.9). Science and technology are embedded institutionally but are also locally situated – namely in universities, academies or non-university research facilities. With special reference to STS research, we will analyse institutional orders of knowledge also regarding their embeddedness into local contexts.

Key research questions of the GRK

- How does *the New* emerge and how do disruptions occur? What happens with *the Old* and how is continuity manufactured?
- How do the three dimensions (topics, processes, institutions) interact and where do they diverge?
- How important are actors when it comes to negotiating between *the New* and *the Old*? How can we adequately capture actors' relations of power and resources?
- How can we use, specify and advance the concepts and terminology of historical institutionalism (displacement, layering, drift) for the analysis of transformation in science and technology?
- Which STS concepts can be fruitfully combined with analytical categories of historical institutionalism, and where are persistent frictions between the two frameworks?
- What kind of influence do aspects of teaching (education system) and sharing (disciplinary communication systems) of knowledge and technology have? Vice versa: How do developments of topics, processes and institutional conditions influence teaching and sharing of knowledge and technology?

Outline of our research programme

No.	Principal investigator	Project title
3.1.1	Dardashti	The impact of meta-empirical theory assessment criteria on the development of string theory (20th/21st centuries).
3.1.2	Heinze	Disciplinary profiles and patterns at universities in Europe and Northern America in the 19th and 20th centuries.
3.1.3	Remmert	Forms and functions of historical writing about sciences and technology in Germany and Europe in the 19th and 20th centuries.
3.1.4	Achermann	Constitution and change of geoscientific disciplines viewed from an international perspective 19th and 20th centuries.
3.1.5	Volkert	Continuity and change in the field of geometry and at polytechnics in German-speaking countries in the second half of the 19th century.
3.1.6	Stehrenberger	Crisis and violence as research objects viewed from a global perspective from the 19th to 21st centuries.
3.1.7	Schiemann	Standard model of particle physics as a Kuhn paradigm (20th/21st centuries).
3.1.8	Krömer	Structural mathematics in the first half of the 20th century: Change of methods and loss of knowledge.
3.1.9	Leuschner	Scientific change through social diversity? A critical, empirical and normative discussion of feminist standpoint theory (20th/21st centuries).

Table 1: Overview of plans (in alphabetical order)

*3.1.1 The impact of meta-empirical theory assessment criteria on the development of string theory (*20th/21st *centuries).*

In popular scientific literature, string theory is called a "theory of everything": A theory that unifies all fundamental particles and their interactions in one formula and thus realises the "dream of reductionism". However, this "old" wish of unification could only be realised by a theory with higher dimensions (with 10 or rather 11 space-time dimensions). Furthermore, new fundamental entities had to be added, like one-dimensional strings and multi-dimensional branes. String theory has become an established field of fundamental physics within the last three or four decades: Annual conferences and summer schools as well as textbooks (e.g. for Bachelor students – Zwiebach 2004) are proof of that. The last edition of "Top Cited Articles of All Time" in the online archive of high-energy physics, Inspirehep, listed four articles about string theory among its top ten. From a philosophy of science perspective, the institutionalisation of string theory as a "normal science" without empirical evidence in support of it is the perfect research object in order to rationally explore the role and impact of meta-empirical theory assessment strategies (Dardashti/Hartmann 2019) when it comes to choosing a theory. Within the dimension of topics, string theory made a significant development. It originated as a theory of the strong nuclear force in the 1960s, was dismissed for theoretical reasons and was then rediscovered as a theory of all interactions and particles in the 1970s (**topics/layering, drift**). After initial theoretical problems, it underwent the so-called "first superstring revolution" in 1984. However, this was accompanied by the postulate of a multiplicity of theoretical possibilities that contradicted the desire for unification. Edward Witten was able to unify all these theoretical options in 1995 in the "second superstring revolution" **(topics /layering)**. Following these successes, string theory has been recently used as a "toolbox" for various fields of theoretical physics (particle phenomenology and solid-state physics, for instance) and pure mathematics (**topics/drift**), rather than as a unified theory of all interactions and particles. Those various fields interpret parts and results of string theory anew, or leave them uninterpreted as a methodical tool.

The difficulty of experimentally testing string theory (as a unified theory) was accompanied by an openly discussed change within the dimension of processes and institutions. How do I test and assess a theory that is experimentally inaccessible? How can string theory still be a scientific theory at all if it is not possible to test it experimentally? In regard to philosophy of science, this question led to alternative and rationally reconstructed assessment strategies, like the no alternatives argument or the argument of unexpected explanatory coherence (Dawid 2013). A question recently discussed in philosophy of science is whether these alternative assessment strategies replace (**processes/displacement**) the empirical method with a "post-empirical" method (Huggett 2014) or whether those strategies have always played a role in theory assessment, but have only recently been strengthened as empirical evidence is missing. According to Dawid's approach, the explanation for the development and success of string theory might be justified. In contrast, another option is that sociological and psychological conditions resulted in the development of string theory and its institutional dominance (Woit 2006; Smolin 2008). This means that the scientific nature of string theory is established as a sociological consequence of certain ideologies (Gieryn 1983, 1999; Ritson/Camilleri 2015). To understand the development of string theory as the interplay of these two competing dimensions is one of the main methodological theses of this project.

Possible dissertation projects.

(1) The development of the string theory from the point of view of meta-empirical theory assessment:

Although Dawid (2013) has created methods for meta-empirical theory confirmation, those are lacking a detailed application in the context of the historical development of string theory. Dawid's assessment strategies explicitly relate to the scientific community and thus its reliabil-

ity can be questioned by the sociological and institutional dynamic mentioned above (**processes/displacement**). We want to understand the development of the string theory by analysing the interaction of those different dimensions.
(2) The role of meta-empirical theory assessment in the history of physics:
It will be investigated how meta-empirical methods of theory assessment – covering Dawid's criteria as well as the conceptualisation of analogue experiments, developed in Dardashti et al. (2018, 2019) – are applied in the history of physics and what significance they have had for the development of the corresponding theories.
Possible doctoral candidates. Graduates of philosophy, history and sociology of science or of physics/mathematics.

3.1.2 Disciplinary profiles and patterns at universities in Europe and Northern America in the 19th and 20t century.

The questions of research for this project are: (1) Which academic disciplines and research fields have been established during the expansion of the university system, (2) how has their composition changed and (3) how can this change be explained from a historical-sociological point of view. Until now, empirical analysis of the global development and change of the structure of disciplines has been sketchy at best. The most influential study of Frank/Gabler (2006) compares lecture timetables and staff structures of the biggest national universities in 90 countries (n=90 universities). They find that the humanities have declined during the 20th century, whereas the natural and the social sciences have considerably expanded (**institutions/displacement**). However, this finding is contested because the methodical design of the study leads to under-representation of big countries (e.g. USA, FR and DE) and over-representation of small countries. Nevertheless, Frank/Gabler (2006) can be used to devise hypotheses. Further studies have explored institutional factors that favour the emergence of new academic fields at universities (Brint et al. 2010; **topics, institutions/layering**) and under which conditions established fields have been reduced or dismantled (Brint et al. 2012). One of the results of these studies is that universities in populated areas establish new academic fields more often and faster than universities of the same kind in thinly populated areas. Both studies of Brint et al. (2010, 2012) refer to the United States and need to be validated as well as expanded to the specific institutional contexts of other countries and regions. However, like the study of Frank/Gabler (2006), we can use them to formulate hypotheses.
Based on the aforementioned studies as well as other relevant treaties (e.g. Ruegg, 2004, 2010), we want to explore in this project the development and change of disciplinary patterns at universities in selected countries and regions. It is our aim to delineate regionally representative samples of universities which allow for the formulation of reliable statements about their development, especially concerning the growth of new disciplines and fields (**topics, institutions/layering**), the displacement processes between new and old disciplines and fields (**topics, institutions/displacement**), and regarding the disparity between societal demands for new knowledge and the actual growth of resources for new academic fields (**topics, institutions/drift**). In order to get this project operational, we will limit its scope in terms of space and disciplines. Lecture timetables and staff data will be our working material as well as student enrolment and bibliometric data. Regarding data gathering for Germany, we will use existing works about universities' institutional history (e.g. Tübingen: Paletschek 2001) as well as data manuals (Titze 1995; Lundgreen 2009). Furthermore, we will build on a feasibility study that gathered and documented disciplinary profiles of research and teaching at German universities for the period of 1992 to 2018 (see here).

Possible dissertation projects.
(1) Institutional context conducive for the growth of new academic disciplines
One possible project would compare the development of disciplines at selected universities in national research systems with a more (e.g., DE) or less (e.g., USA, NL) developed public non-university research sector. Especially regarding Frank/Gabler's claim (2006) that universities adapt their disciplinary structure to societal demands for problem-solving capabilities, one might expect a profound difference between Germany and the other above-mentioned coun-

tries. The project could find out to what extent such capabilities in Germany arise outside universities, and examine the repercussions on the transformation of field patterns compared to countries where the institutional environment of universities is populated by much fewer non-university research facilities. The dissertation project could examine whether university-based disciplines have higher perseverance in Germany (**topics, institutions/drift**) than in other countries due to the considerable size of the publicly funded non-university research sector.

(2) Professionalisation of academic expertise in the context of institutional stratification
A second possible project could examine the academic education of new expert groups (professionals) that emerge with the rise of the knowledge society. According to Brint et al. (2010, 2012), the social prestige of universities restrains the admission of application-oriented fields into the university curriculum (**topics/drift**) although those are really important for the growth of new professions. By systematically comparing universities or countries, the project could examine whether this empirical result can be generalised or whether it can only be applied to strongly stratified university systems (e.g., USA, UK, FR), whereas in more egalitarian university systems (e.g., DE, CH, AU, NL) other institutional processes influence the selection of application-oriented subjects into the university curriculum (**topics/layering**).
Possible doctoral candidates. Graduates of sociology and/or history as well as of empirical education research.

3.1.3 Forms and functions of historical writing about sciences and technology in Germany and Europe in the 19th and 20th centuries.

In the context of transformations of science and technology, various forms of historical reflexion about the development, legitimisation strategies and “success stories” of the sciences are an important part of negotiating their role in modern societies and academic systems. For the period from 1800 to the 1950s, this is equally valid for historical reflections and observations by practitioners of specific disciplines (as, for instance, prefaces, publications in newspapers or official speeches) as well as for the emerging field of historiography of science or the tension between master narratives about the history of science and technology, deeply rooted in the ideology of *the New*, and local historical narratives which may tend more strongly towards *the Old*. The project takes up the analytical categories of historical institutionalism in two ways. On the one hand it explores the importance of the two branches (for our purpose separated into ideal types) within the processes of categorising knowledge as “old” or “new”. For example, *the Old* is often used as a framework of reference when it comes to legitimising *the New* (invention of tradition), constitution of continuity or literally creating a national or European tradition or rather hegemony (**topics, institutions, processes/layering**). The veneration of scientists in the 19th and early 20th century (e.g. at official buildings such as the École polytechnique or statues/memorials such as the Kepler memorial 1871 in Weil or street names) is visible proof of such processes as well as a sign of their changing significance in society (see “statumania” (Hobsbawm/Ranger 1983)). Strengthening the meaning of old knowledge as opposed to the ideology of *the New* becomes a domain of historiography, which may have the role to highlight or construct gradual and implicit processes of change (**processes**/**displacement**) (Raffaello Caverni in Italy, Pierre Duhem in France). The constructed nature of master narratives, which are very much shaped by literary and narrative conventions, plays an important role in these processes (White 1991; Motzkin 2002). At the same time, when it comes to constructing historical narratives, it has to be considered that specific parts of history were actively forgotten or rather written out of the historiography, for example the role of women and gender or the production of knowledge outside of Europe.
On the other hand, the historiography of science and other forms of historical writing about science and technology can acquire a legitimising function when it comes to institutional or disciplinary processes of change. In this way, they can serve as an accompanying historical/narrative program to institutional processes of change that can be analysed as **layering**, **displacement** or **drift**. From this point of view and in the context of the GRK, the analysis of specific forms of historical writing about science and technology is an instrument that can contribute to studying and disclosing such processes of change.

Possible dissertation projects.
(1) Scientific Revolution
On the one hand an analysis of 19th- and 20th-century historical writings on (a) the Scientific Revolution (e.g. starting with Guglielmo Libri (Del Centina/Fiocca 2010)) or (b) the category of the *New* in 19th- and 20th-century science (North 2013), can be used to critically discuss (1) the emerging standard narratives about the history of science and technology or rather (2) success stories that have been codified by historiography of science. Questions are whether, how and why various plots have shifted, have been removed or have been overlaid (**processes/layering, displacement, drift**).
(2) The right to award doctorates at Technical Universities 1899
On the other hand, the role of historical arguments in institutional changes could be interpreted as **drift** and/or **layering**. An example for this analysis of historical arguments is the debate about the right to award doctorates that William II. gave to Technical Universities in 1899 (König 2007, 119-26) as well as the following historical assessment of this development. The granting of the right itself marks a timely graduated transfer of **drift** in **layering** because the system gets a new layer of universities that have the right to award doctorates. The current debate about giving the right to award doctorates to universities of applied sciences can also be viewed in the context of a **drift**.
Possible doctoral candidates. Graduates of history or history of science or (if candidates are interested in historiographical methods) philosophy or sociology of science.

3.1.4 Constitution and change of geoscientific disciplines in the 19th and 20th centuries from an international perspective.

Geosciences explore the composition of the Earth, its lithosphere, its hydrosphere, its atmosphere, its pedosphere and its cryosphere. This means, they explore processes in rocks, in water, in the air, in the earth as well as of ice and snow, and thus are based on the principles of physics, mathematics, chemistry and biology. They seek to understand how the Earth came into being and how its physical, chemical and biological processes work. Their questions of research have always arisen from a specific understanding of our environment or rather of environmental problems and their findings have an imprint on this understanding. Geosciences are highly instrument-based and interdisciplinary.
The relevance and organisation of geosciences changed greatly throughout the 19th century and especially in the 20th century. New instruments and theories as well as the changing relationships between man and the environment and between technology and the environment led to new questions. A growing understanding of the Earth as an Earth *system* finally pushed the cooperation and exchange of methods and approaches beyond established boundaries of disciplines. Next to traditional disciplines (as physics, physical geography, geology and meteorology), new areas of research were formed at the boundaries of those fields and established themselves as independent fields of research, for example crystallography, hydrogeology, geochemistry, paleoclimatology and so on (**topics**, **processes/layering**). In 1919, the International Union for Geodesy and Geophysics was founded as an institution to gather all geoscientific disciplines together. During the Cold War, geosciences became even more important because they were politicised and supported by enormous financial means.
Our project explores the creation of and [changes in geoscientific disciplines in the 19th and 20th centuries regarding its interdisciplinary character, the accompanied epistemic negotiations as well as research technology (e.g. mass spectrometry, computers, satellites, sonar, research vessels and aeroplanes). We want to explore under which conditions geoscientific disciplines have changed or formed anew. One interesting aspect is to find out how instruments, methods and approaches of physics and chemistry have come to other specialist fields, like glacier research and pedology, and how they changed them.
Furthermore, we want to explore how and under which conditions new specialist fields like pedology and physics of the atmosphere have formed on the edge of traditional disciplines. Have they formed as an addition to existing specialist fields, as it was the case with ice core research complementing glaciology (**topics, processes/layering**)? Or have new technologies and a new understanding of environment and environmental problems pushed “traditional” ap-

proaches away, as it was the case with model-based climate research replacing classical climatology (**topics, processes/displacement**)? Or have new problems only led towards new specialisation within pre-existing frames of theories and methods? How have new geoscientific fields of research been distinguished from chemistry or geophysics (**processes, institutions/layering**)? Moreover, how has epistemic authority on the boundaries between disciplines and possible conflicts between various scientific approaches been negotiated? In accordance with STS studies, we want to take the role of research instruments and institutions seriously and examine its conservational role as well as its role in supporting change. How important has research technology like computers and satellites been as a focal point of various disciplines within these processes? How did research instruments and institutions support a certain continuity of scientific problems and methods and thus a process of **layering** and even **drift**? How did specific research technology in particular support a change of approaches and research aims when they entered new disciplines?

Possible dissertation projects.
(1) On the history of tree ring research (Baumringforschung / dendrochronology)
In the 20th century, dendrochronology became an important impetus for reconstructing past vegetative conditions, studying the relation between the growth of trees and climatic changes as well as dating archaeological sites. We want to explore which conditions made dendrochronology a research field that was taken seriously. Furthermore, we want to find out how it changed other disciplines (e.g. climate research or ecology) and how it was related to other dating methods (meaning, whether there have been marginalisation effects regarding **topics** and **processes** (**displacement**) or **layering** – as can be expected in the case of radio carbon dating.
(2) Role of the International Union for Geodesy and Geophysics (IUGG) for geosciences in the 20th century.
Using the IUGG, we can examine the role this kind of union played in the discipline building processes of geosciences as well as which criteria contributed to the acceptance or rejection of disciplines. Furthermore, we want to explore how disciplines were related to already existing unions (**institutions/layering, displacement**) and what role the union played in imposing new instruments and theories. Additionally, we want to answer the question of how such an institution was able to adapt to oft-changing demands on geosciences in the 20th century and how it was part of creating these demands themselves.
Possible doctoral candidates. Historians interested in natural sciences as well as sociology of science or organisational sociology; geoscientists willing to familiarise themselves with methods and theories of the history of science.

3.1.5 Continuity and change in the field of geometry and at polytechnics in German-speaking countries in the second half of the 19th century.

During 1810-1860 the commercial-technical education sector (especially the polytechnics) in German-speaking countries was established. The main focus of the years thereafter from 1860 to 1900 was on the fight for revaluation or even equality of secondary modern schools and traditional high schools (Gymnasien) as well as of polytechnics and universities. This was also due to the rapidly expanding industrialisation. Descriptive geometry worked as a trademark for mathematics and thus played an important role (Benstein 2019). Some even demanded the teaching of this subject at universities – especially taking into consideration teachers-to-be (**institutions, processes/displacement**). Among obstacles for realising this proposition were institutional problems at universities (e.g. lack of rooms or facilities, but of competent teachers as well) and a strong aversion to any user-oriented field. Descriptive geometry becoming a subject at universities necessitated a break with traditional teaching methods because it could not be taught in the traditional way but required the active participation of students (**processes/displacement**) (Volkert 2018). Descriptive geometry has been a central part of training new engineers and architects ever since it was systematically taught at the École polytechnique in Paris (1794) by G. Monge (Barbin et al. 2019). At polytechnics, it was taught at a high level and research was done as well (**topics, processes/drift**). Against the background of

division of labour, the aim was to develop the mechanically taught and executed practice of drawing into a scientifically grounded field of geometry (**topics/drift**).
Together with other descriptive geometers, Wilhelm Fiedler (1832-1912) who was professor for descriptive geometry and geometry of position at the polytechnic in Zürich, developed an idea: in order to revalue descriptive geometry, his idea was to merge it with projective geometry, which was a highly respected and active field of research at the time (**topics/layering**). Continuity and change worked closely together (Volkert 2018, 2020).
Fiedler offers numerous options for further research in the above-mentioned field. This is due not only to his extensive work that was always dedicated to revaluing polytechnics, but also to his central role within a network that supported geometry. This network is often recognisable in Fiedler's extensive correspondence (nearly 2000 letters; Confalonieri et al. 2019). Debates of the time over the subject (the validity of various theories of descriptive geometry, whether it makes sense to merge descriptive geometry with projective geometry) as well as over institutional matters (the fight for free choice of field of study and for academic self-administration as well as the right to award doctorates, the Northern German vs Southern German way) are omnipresent in his correspondence and deeply intertwined. The theoretical frame of the GRK is well-suited for analysis of these intertwined and multi-layered developments with all its continuities and breaches.
One aspect that is deeply intertwined with teaching descriptive geometry and which needs further research was the use and creation of material models. Descriptive geometry got most of its very successful modelling in the second half of the 19th century from people working at polytechnics (e.g. A. Brill, L. Burmester, W. Fiedler as well as Wiener father and son).

Possible dissertation projects.
(1) The network of geometry and its traces in Wilhelm Fiedler's correspondence
In this regard, we need to analyse sources, particularly letters, and thus acquire detailed information about the situation[s] that Fiedler's partners were in (e.g. at which school/university did they teach?). Furthermore, we need to find out about typical disputed points like staffing, publications (**topics/layering**) as well as about institutional references (**institutions/layering, displacement**). Interesting correspondence partners are in particular R. Sturm, G. Hauck, H. C. H. Schubert, S. Gundelfinger and O. Schlömilch. Among others, research can be based on the annotated edition of the correspondence between Fiedler and Clebsch/Klein/Cremona as well as other Italian mathematicians (Confalonieri et al. 2019).
(2) Transfer of descriptive geometry at universities
In this regard, we need to find out when, where and by whom descriptive geometry was taught at universities (between 1860 and 1900). An interesting question is whether topics and institutional conditions changed (e.g. facilities of mathematical-natural scientific faculties or sections, regulations for examinations) (**topics, institutions/layering, and displacement**). For example, F. Klein tried to give a lecture on descriptive geometry, shortly after he had been appointed at Leipzig. Another agent of descriptive geometry is G. Hauck, who taught this subject in Tübingen for a while. At universities in the German speaking part of Switzerland, the subject of descriptive geometry was well represented. Research can be based on the dissertation of N. Benstein (2019). W. Fiedler's papers, which are conserved at the Archives of the ETH, are a great source.

Possible doctoral candidates. Mathematicians interested in history, especially teachers-to-be.

3.1.6 Crisis and violence as research objects viewed from a global perspective from the 19th to 21st centuries.

Since the second half of the 19th century, scientific interest in violence and crises has grown exponentially. On the one hand, already existing disciplines like medicine and sociology increasingly explored "war", "catastrophes" or "trauma". On the other hand, new interdisciplinary fields emerged, such as "disaster studies" or "conflict studies". This project examines how the phenomena of crisis and violence have been conceptualised in this process of scientification. In particular, we focus on how crisis and violence were interpreted as expressions and motors

of social and historical change, but also as "natural laboratories", that facilitated the observation of this change. We will explore how the formation of research objects and the generated research results are connected to the scientific practices employed in their production. These scientific practices are in a variety of fields characterised by considerable continuities – in particular, with respect to the "anchoring practices" (Camic et al. 2012), e.g. the methods that were prioritised and shaped the self-image of scientific communities. Leading scientists of various fields clung to the same definitions and methods for decades despite dramatic changes both in the phenomena of crisis and violence themselves as well as their societal contexts (**topics, processes/drift**). Shifts occurring at the margins of fields (**topics, processes/displacement**) – e.g. regarding the definition of "disaster" – were rejected by the mainstream at first or actively "ignored" (Proctor/Schiebinger 2008). Accepting new concepts and methods happened late, slowly and in supplement to existing core assumptions (**topics, processes/layering)**. Our project analyses such delayed developments as well as "roads not taken" that give an idea on how "science could have been" (Pickering et al. 2016). Potentially radical transformations of scientific practices that were discussed as desirable yet never implemented (e.g. on the level of interdisciplinary or "transcultural" research practices) belong to those roads not taken.
The project explores how in various fields continuities in the production and (non)-circulation of (new) knowledge, were connected to institutional change. In this regard, we want to focus on the influence of social inequalities (distributed along categories such as gender, class or able-bodiedness) and global power relations on the creation of knowledge as it has been examined within recent years, e.g. in research in the areas of feminist and post/de-colonial science studies (Harding 2016; Pollock/Subramaniam 2016; Lanza Rivers 2019). We want to examine what impact new, formal regulations (e.g. regarding gender equality) had on the actual division of labour. Furthermore, we will analyse the relationship between technological change (brought along e.g. by the use of computers) and "social stasis" in scientific practices. Moreover, we also want to analyse the epistemic consequences that the transformations on the level of scientific practices had on the generated research results.
Since the research goal of scientific inquiry into crisis and violence was often the creation of applicable and practical knowledge, the project includes a focus on the transformations and continuities that can be observed with respect to the ways in which the produced research results were put to use in political and practical forms of dealing with the phenomena of violence and disaster. We are particularly interested in analysing the persistence of a "science policy gap" (Knowles/Kunreuther 2014) – the non-implementation of scientific knowledge in e.g. disaster related policy making.

Possible dissertation projects

(1) History of social science research on pandemics from the 19th to the 21st century.
This project examines how continuities in power relations on the institutional and macro-social levels have prevented or complicated the implementation of critical social scientific knowledge about pandemics – for example, knowledge concerning the role that structural racism and social inequalities play in them, when it comes to the generated research results as well as their implementation, in particular in the context of policy-making. A special focus will be on the role of "colonial continuities" (e.g. with respect to the question of who is attributed the status of scientific "expert") that survived formal de-colonialisation (**topics, processes/drift**). At the same time, we want to analyse gradual transformations that came after the creation of international research facilities, especially in the Global South (**topics, institutions, and processes/layering**).
(2) History of social science research on "violent" protest movements in the USA and Latin America in the 20th and 21st centuries.
This project compares the impacts of changes in institutional and political contexts of exploration (e.g. "racial riots") on the creation of knowledge, and analyses them from a global perspective of comparison and interrelation. It analyses how the new phenomenon of protest (emerging e.g. in response to "environmental disasters") transformed scientific practices, especially in the case of scientists who were also (former) social or political activists (**institutions, processes/displacement**). At the same time, the dissertation explores continuities that survived institutional changes (**topics, processes/drift**), e.g. with respect to the conceptualisation

of “collective behaviour”, as well as the slow and gradual changes that led e.g. to the integration of participatory procedures into the mix of methods (**topics, processes/layering**).
Possible doctoral candidates. Graduates of history, sociology, philosophy and anthropology of science as well as of STS, but also graduates of other (interdisciplinary) studies of social sciences and humanities.

3.1.7 Standard model of particle physics as a Kuhn paradigm (20th/21st centuries).
Kuhn’s conception of scientific development has been used diversely, been developed further and been criticised. Its paramount importance for scientific research as a whole as well as its controversial reception have been stressed recently (Devlin/Bokulich 2015; Blum et al. 2016; Richards/Daston 2016). As he described science as scientific cultures and viewed scientific knowledge as influenced by the interaction between those cultures and their environment, Kuhn became one of the key drivers of STS research that continues to view him in a positive light. One of the most contentious objections in the philosophy of science is that Kuhn’s conception is exclusively tailored to physics, but that it is inapplicable precisely to physics.] On the contrary, his conception found great and lasting popularity in physics. Some people speak of a crisis of this discipline in the sense of Kuhn, as predictions that should have removed weaknesses of the standard model of particle physics, could not be confirmed (Giudice 2017). We want to examine whether Kuhn’s conception or its advancements (especially regarding terms like paradigm and normal science and the assertion of incommensurability) are a correct description of the present research in physics by analysing the dispute about the standard model of particle physics.
Ever since it was created in the 1970s, the standard model is one of the most successful theories in physics. At the same, it is confronted with phenomena that cannot be explained within its boundaries. The following questions are the centre of our project: To what extent can the standard model be viewed as a paradigm of Kuhn’s conception? Can we describe phenomena that do not fit into the frame of the standard model as anomalies? Moreover, would their successful explanation by alternative theories lead to a discontinuity that replaces the old paradigm with a new one (**topics/displacement**)? Has the expectation for a profound change expressed by representatives of alternative theories been based on a certain perspective of the development of physics and its public depiction?
Is using terms such as upheaval and break in order to describe the advancement of particle physics incorrect because it changes gradually through the assimilation of new theories (**topics/layering**)? In this context, we want to find out how Kuhn’s conception and its developments can be applied at all to the complex experiments and laborious institutional structures that are typical for accelerator experiments and to analysing their results (**processes, institutions/drift**).
We would set new limits for the use of Kuhn’s conception by proving that particle physics is a new type of a permanent normal science that nevertheless is confronted with profound anomalies (**topics/drift**). Clarifying all anomalies might be difficult due to the lack of explanatory approaches and the financial means that are necessary for building mediators that allow for higher energy and thus new discoveries.

Possible dissertation projects.
(1) The standard model as paradigm of high-energy physics? Capabilities and limits of a theoretical conception and its acceptance among physicists.
This project focuses on the question of how criteria of normal science can be used for contemporary high-energy physics (**topics/drift**). We would focus on identifying those elements of the meaning of paradigm that are suitable for high-energy physics and discussing them as well as on depicting the structure of the correlation between various theories of the standard model and its practical contexts. Additionally, we want to critically analyse previous references of physicists to the conception of normal science.
(2) Anomalies of high-energy physics: Common ground and boundaries with other unexplained phenomena of high-energy physics.
With this project, we want to analyse the challenges of high-energy physics that arise from unexplained phenomena regarding their potential as a foundation for a fundamental deviation

from the standard model (**topics/displacement, layering**). The term anomaly denotes this potential. Examples of phenomena for discussion are: the absence of the strong CP-violation, [the] existence of the neutrino mass, the lack of theoretical unity in the standard model.
Possible doctoral candidates. Graduates of physics with philosophical knowledge or of philosophy with knowledge of physics.

3.1.8 Structural mathematics in the first half of the 20th century: Change of methods and loss of knowledge.

With the transition from the 19th to the 20th century came a change in the methods used in mathematics]. The so-called structural methods in mathematics greatly shaped mathematics in the 20th century. Phases of this development are “modern algebra”, the contribution of the Bourbaki group and category theory (Corry 1996). This change of method can be easily seen on a bibliometric level: it was in the theory of Lie groups that the term “structure” was first used in mathematics in 1889 (Hawkins 2000, 85). The spread of this term gained speed in the following decades, as can be seen in the “Jahrbuch über die Fortschritte der Mathematik”, for example. A deeper investigation of this phenomenon within the analytical framework of the GRK seems profitable in several ways.
Firstly, the emergence of structural methods in numerous mathematical disciplines (algebra, functional analysis, topology, algebraic geometry and several others) lead to an amendment of traditional theories (**topics/layering**). It also led to a concrete loss of knowledge (**topics/displacement**). The theory of invariants is an example of a mathematical discipline that nearly petered out due to the methodical changes (Fisher 1967; Parshall 1990). Furthermore, there are numerous historical connections to “structuralisms” in other fields of science, such that a comparative approach seems promising. Finally, numerous institutional conditions play a role, such as the fact that the members of the Bourbaki group studied together, or the emergence of the Mathematisches Forschungsinstitut Oberwolfach after World War II (Krömer 2010; Remmert 2020). Bourbaki’s initial motive was to modernise the teaching practices at universities (**processes/displacement**); there was a subsequent attempt to expand this to schools as well. In the last few decades, the dominance of structural methods in mathematics subsided, which requires explanation. An obvious hypothesis is that the use of computers as a new tool allowed for an increase in numerically oriented research (and thus, for instance, for an increasing interest in concrete invariants within algebraic geometry). Another hypothesis is that the influence of the Bourbaki group was reduced – the reasons for that need to be analysed.

Possible dissertation projects.
(1) The term “structure” in mathematical discourse 1889-1942. A bibliometric study by using the “Jahrbuch über die Fortschritte der Mathematik”. On the one hand, data from the yearbook shows that the number of presented papers that include the term have increased throughout the mentioned period, both in terms of absolute numbers as well as percentage details. On the other hand, the number of affected mathematical disciplines has increased as well. The scope of the dissertation project should include more detailed analysis of these processes (**topics/layering**).
(2) Mathematical structuralism. Bourbaki’s influence regarding topics and institutions on the emergence and spreading of mathematical structuralism.
An analysis of the historical role of the Bourbaki group might focus on shifts occurring at the level of the content of the knowledge that was produced, but also on how knowledge production was coined by changing power relations (STS).This is due to the fact that the members of the group had an essential influence on the institutional level for decades – when it came to the appointment of important professors or even on a reform of schooling (that was oriented on a structural mathematical approach), especially in France. Furthermore, Bourbakism is referred to in structuralisms of other disciplines, especially in French speaking countries (de Saussure, Lévi-Strauss, Piaget) (**topics/layering; institutions/displacement**).

Possible doctoral candidates. Graduates of mathematics with history as a second subject or alternatively graduates of history of science with reference to mathematics.

3.1.9 Scientific change through social diversity? A critical, empirical and normative discussion of feminist standpoint theory (20th/21st centuries).

As feminist approaches of the STS (especially standpoint theoretical approaches) have emphasised, including as many perspectives as possible in scientific research is epistemically useful. According to standpoint theory, every person's perspective of the world is necessarily shaped by social status, education, nationality, sex, etc., which enters into research decisions in several ways (not only into the research agenda but also into hypotheses, methods, instruments, concepts, and design of experiments, as well as into the interpretation and classification of data and other evidence).

In particular, standpoint theory states that including women scientists in fields formerly dominated by men would lead to new approaches and ideas, and thus a more adequate understanding of the world (Keller 1985; Haraway 1988; Harding 1991; Longino 2002; Fehr 2011). In fact, female contributions in anthropology and behavioural research generated veritable paradigm shifts. Where male researchers had formerly focused on behaviour and characteristics such as aggression and hunting skills, women expanded the scope to include attributes such as cooperativeness, the willingness to help others, and the skills necessary to select, prepare and preserve plants, thereby leading to pioneering results for explaining the emergence of social behaviours or the generation of tools (Brown 2001, 201-204). Therefore, including women scientists was of great use for scientific change as old theories were replaced by new approaches (**topics/displacement**).

However, empirical studies show that women scientists still have to endure strong social pressure in many disciplines (especially STEM) due to gender bias. Consequently, they are afraid of being discriminated against as scientists which typically affects them in their scientific work. Self-censorship in particular has been found to be an issue (meaning that they tend to be overly careful and reluctant in their choices of research topics and hypotheses) as well as a tendency to be overly cautious and conservative in their methodological choices (Sonnert/Holton 1995; Valian 1998; Bright 2017). Therefore, women's contributions are not always helpful in correcting misguided androcentric perspectives; they can generate scientific change only in a limited way (**topics/layering**).

At the same time, these effects – self-censorship and methodological conservatism – reinforce their reasons: research of affected women scientists can be ignored and marginalised more easily because women tend to be less innovative and to publish less than men do. This shows a circularity, as ignorance and marginalisation reproduce and even enhance gender bias and hence pressure on women scientists. However, social studies have shown that some women may also react to experiencing gender bias not by behaving in a less confident manner but as a kind of backlash, by overcompensating, that is, by being especially assertive and productive. However, as Antony (2012) has pointed out, women academics who behave in such a way will also experience sanctions in the form of social exclusion because they violate common gendered expectations. Thus, both kinds of reactions will ultimately be disadvantageous. Hence, Antony argues that this poses a real double bind: If they behave according to gender-norms, they are marginalised but if they don't, they are maligned.

Although feminist science studies emphasise the potential of including women scientists in order to generate – corrective or innovative – change by adding new perspectives, this potential is limited by the mentioned dilemma. However, if the mere presence of women scientists is not sufficient – as empirical studies suggest – for achieving the epistemic benefit emphasised by feminist standpoint theory, we need to examine which institutional, structural and social conditions are required to do so (**processes, institutions/displacement**).

Possible dissertation projects.

(1) Criteria in theory choice

In this project, the role of methodological criteria in theory choice is to be examined. Traditional criteria, such as accuracy, external consistency, simplicity, scope, and fruitfulness need to be weighed and interpreted in their respective contexts (Kuhn 1977). This is also valid for feminist alternatives, such as novelty, ontological heterogeneity or complexity (Longino 2002). However, widely shared prejudices can be inconspicuously influence research decisions and thus be reproduced. Feminist criteria are in danger of serving as a fig leaf in the context of discriminative evaluations and thus contributing to concealing the problem (**processes, topics/layering**).

(2) Peer review as a guarantee for critical approaches

Although peer reviews are traditionally used to exclude non-epistemic preferences from assessing scientific work, a dispute has recently arisen as to whether anonymity in peer reviews is still feasible or rather a waste of resources (Bright/Heesen 2019). Online preprint archives are one proposed alternative to anonymous peer reviews. The key question is whether and to what extent peer reviews have a role today in encouraging criticism and contributing to reduced bias and increased inclusion in academia. (**processes, institutions/ displacement**).

Possible doctoral candidates. Graduates of philosophy, history or sociology of science or, graduates of a natural science with an interest in gender issues.

Bibliography

Aagaard, K.: The Evolution of a National Research Funding System: Transformative Change Through Layering and Displacement, in: Minerva, Jg. 55, Heft 3, 2017, S. 279-297.

Andersen, H.: Categorization, anomalies and the discovery of nuclear fission, in: Studies in History and Philosophy of Modern Physics, Jg. 27, Heft 4, 1996, S. 463-492.

Andersen, H.; Poulsen, M.B.J.: The Early History of the Protein-only Hypothesis: Scientific Change and Multidisciplinary Research, in: Infectious Processes: Knowledge, Discourse, and Politics of Prions, hrsg. v. E. Seguin; J.V. Pickstone, 2004, S. 4-37.

Andersen, H.; Barker, P.; Chen, X.: The Cognitive Structure of Scientific Revolutions, New York 2006.

Andersen, H.: The Second Essential Tension: On Tradition and Innovation in Interdisciplinary Research, in: Topoi, Jg. 32, Heft 1, 2012, S. 3-8.

Andersen, H.: Bridging disciplines, in: Classification and evolution in biology, linguistics and the history of science, hrsg. v. H. Fangerau; T. Halling; W. Martin, Stuttgart 2013, S. 33-44.

Andersen, H.: Epistemic dependence in contemporary science: Practices and malpractices, in: Science after the practice turn in the philosophy, history, and social studies of science, hrsg. v. L. Soler; S. Zwart; M. Lynch; V. Israel-Jost, New York 2014, S. 161-173.

Andersen, H.: Collaboration, Interdisciplinarity and the Epistemology of Contemporary Science, in: Studies in History and Philosophy of Science A, Jg. 56, Heft 1, 2016, S. 1-12.

Andersen, H.: Research ethics: Conduct and misconduct, in: SAGE Encyclopedia on Higher Education, Thousand Oaks 2020, S. 1281-1282.

Anderson, P.; Tushman, M.L.: Technological Discontinuities and Organizational Environments, in: Administrative Science Quarterly, Jg. 31, Heft 3, 1986, S. 439–465.

Anderson, P.; Tushman, M.L.: Technological Discontinuities and Dominant Designs: A Cyclical Model of Technological Change, in: Administrative Science Quarterly, Jg. 35, Heft 4, 1990, S. 604–633.

Antony, L.: Different Voices or Perfect Storm: Why Are There So Few Women in Philosophy?, in: Journal of Social Philosophy, Jg. 43, Heft 3, 2012, S. 227–255.

Applegate, C.: A Nation of Provincials: The German Idea of Heimat, Los Angeles 1990.

Ash, M.: Wissenschaft und Politik als Ressourcen für einander, in: Wissenschaft und Wissenschaftspolitik. Bestandsaufnahmen zu Formationen, Brüchen und Kontinuitäten im Deutschland des 20. Jahrhunderts, hrsg. v. R. vom Bruch; B. Kaderas, Stuttgart 2002, S. 32 51.

Ash, M.: Wissenschaftsgeschichte und Wissenschaftsphilosophie – Einführende Bemerkungen, in: Berichte zur Wissenschaftsgeschichte, Jg. 35, Heft 2, 2012, S. 87–98.

Assmann, A.: Erinnerungsräume. Formen und Wandlungen des kulturellen Gedächtnisses, München 1999.

Ball, R.: (Hrsg.): Handbook Bibliometrics, Berlin/Boston 2020.

Barbin, E.; Menghini, M.; Volkert, K.: Descriptive Geometry, the Spread of a Polytechnical Art, Cham 2019, S. 3–8.
Barker, G.; Kitcher, P.: Philosophy of Science. A New Introduction, New York 2013.
Bauer, R.: Gescheiterte Innovationen: Fehlschläge und technologischer Wandel, Frankfurt a.M. 2006.
Beaulieu, L.: Bourbaki. Une histoire du groupe de mathématiciens français et de ses travaux (1934–1944). Dissertation Université de Montréal 1989.
Benstein, N.: Zwischen Zeichenkunst und Mathematik: Die darstellende Geometrie und ihre Lehrer an den Technischen Hochschulen und deren Vorgängern in ausgewählten deutschen Ländern im 19. Jahrhundert, Dissertation, Bergische Universität Wuppertal 2019.
Bernshausen, S.; Bonacker, T.: Ist die Friedens- und Konfliktforschung auf dem Weg zur Disziplin? Ein wissenschaftssoziologischer Blick auf die Bedeutung von Studiengängen für die Ausdifferenzierung von Disziplinen, in: Konflikte vermitteln. Lehren und Lernen in der Friedens- und Konfliktforschung, hrsg. v. M. Bös; L. Schmitt; K. Zimmer, Wiesbaden 2015, S. 247-268.
Ben-David, J.: The Scientist's Role in Society. A Comparative Study with a New Introduction, Chicago/London 1971.
Ben-David, J.: Scientific Productivity and Academic Organization in Nineteenth-Century Medicine, in: Scientific Growth. Essays on the Social Organization and Ethos of Science, hrsg. v. G. Freudenthal, Berkeley/Los Angeles/Oxford 1991, S. 103-124.
Biddle, J.: Advocates or Unencumbered Selves? On the Role of Mill's Political Liberalism in Longino's Contextual Empiricism, in: Philosophy of Science, Jg. 76, Heft 5, 2009, S. 612–623.
Bijker, W.E.; Hughes, T.; Pinch, T.J. (Hrsg.): The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology, Cambridge/MA 2012.
Blum, A.S.; Gavroglu, K.; Joas, C.; Renn, J. (Hrsg.): Shifting paradigms: Thomas S. Kuhn and the history of science, Berlin 2016.
Bonaccorsi, A.; Daraio, C.; Lepori, B.: Indicators on individual higher education institutions: some methodological reflections, in: Research Evaluation, Jg. 16, Heft 2, 2007, S.66-78.
Bonaccorsi, A.; Cicero, T.; Haddawy, P.; Hassan, S.-U.: Explaining the transatlantic gap in research excellence, in: Scientometrics, Jg. 110, Heft 1, 2017, S. 217–241.
Bourdieu, P.: Science of science and reflexivity, Chicago 20042.
Bowman, D.; Stokes, E.; Rip, A. (Hrsg.): Embedding New Technologies into Society: A Regulatory, Ethical and Societal Perspective, Singapur 2017.
Bright, L.K.: Decision Theoretic Model of the Productivity Gap, in: Erkenntnis, Jg. 82, 2017, S. 421 442.
Bright, L.K.; Heesen, R.: Is Peer Review a Good Idea?, in: British Journal for the Philosophy of Science, 2019, online first, doi: https://doi.org/10.1093/bjps/axz029.
Brint, S.; Proctor, K.; Hanneman, R.A. et al.: Who are the early adopters of new academic fields? Comparing four perspectives on the institutionalization of degree granting programs in US four-year colleges and Universities, 1970-2005, in: Higher Education, Jg. 61, Heft 5, 2010, S. 563 585.
Brint, S.; Proctor, K.; Mulligan, K. et al.: Declining Academic Fields in U.S. Four-Year Colleges and Universities, 1970-2006, in: The Journal of Higher Education, Jg. 83, Heft 4, 2012, S. 582 613.
Brown, J.R.: Academic Freedom, Affirmative Action, and the Advance of Knowledge, in: Interchange, Jg. 28, Heft 4, 1997, S. 381–388.
Brown, J.R.: Who Rules in Science? An Opinionated Guide to the Wars, Cambridge (Mass) 2001.
Camic, C.; Gross, N.; Lamont, M. (Hrsg.): Social knowledge in the making, Chicago 2012.
Camilleri, K.; Ritson, S.: The role of heuristic appraisal in conflicting assessments of string theory, in: Studies in History and Philosophy of Science Part B: Studies in History and Philosophy of Modern Physics, Jg. 51, 2015, S. 44-56.
Cappelli, A.; Castellani, E.; Colomo, F.; Di Vecchia, P. (Hrsg.): The birth of string theory, Cambridge et al. 2012.

Carrier, M.: Wege der Wissenschaftsphilosophie im 20. Jahrhundert, in: Bartels, A.; Stöckler, M. (Hrsg.): Wissenschaftstheorie: Ein Studienbuch, Paderborn 2009, S. 15–44.
Carrier, M.: Historical Epistemology: On the Diversity and Change of Epistemic Values in Science. In: Berichte zur Wissenschaftsgeschichte, Jg. 35, Heft 3, 2012, S. 239–251.
Chesbrough, H.: Open Innovation. The New Imperative for Creating and Profiting from Technology, Boston 2006.
Choi, H.; Mody, C.: The Long History of Molecular Electronics: Microelectronics Origins of Nanotechnology, in: Social Studies of Science, Jg. 39, Heft 1, 2009, S. 11-50.
Chorlay, R.: From problems to structures: The Cousin problems and the emergence of the sheaf concept, in: Archive for History of Exact Sciences, Jg. 64, Heft 1, 2010, S. 1–73.
Clark, B.R.: Creating Entrepreneurial Universities: Organizational Pathways of Transformation, Surrey 1998.
Cloud, J. (Hrsg.): Earth Sciences in the Cold War, in: Special Issue, Social Studies of Science, Jg. 33, Heft 5, 2003, S. 629-633.
Cohen, H.F.: The Scientific Revolution: A Historiographical Inquiry, Chicago/London 1994.
Confalonieri, S.; Schmidt, P.M.; Volkert, K.: Der Briefwechsel von Wilhelm Fiedler mit Clebsch, Klein und italienischen Mathematikern (Siegener Beiträge zur Geschichte und Philosophie der Mathematik 12), 2019.
Confino, A.: The Nation as a Local Metaphor: Württemberg, Imperial Germany, and National Memory, 1871-1918, Chapel Hill/London 1997.
Confino, A.: Germany as a Culture of Remembrance: Promises and Limits of Writing History, Chapel Hill/London 2006.
Conze, E.: Schatten des Kaiserreichs. Die Reichsgründung von 1871 und ihr schwieriges Erbe, München 2020.
Corry, L.: Modern algebra and the rise of mathematical structures, Basel 1996.
Crease, R.P.; Westfall, C.: The new big science, in: Physics Today, Jg. 69, Heft 5, 2016, S. 30 36.
Daston, L.; Richards, R.J. (Hrsg.): Kuhn’s Structure of Scientific Revolutions at Fifty: Reflections on a Science Classic, Chicago 2016.
Dawid, R.: String theory and the scientific method, Cambridge et al. 2013.
Del Centina, A.; Fiocca, A.: Guglielmo Libri, matematico e storico della matematica. L’irresitibile ascesa dall’Ateneo pisano all’Institut de France, Florenz 2010.
Devlin, W.J.; Bokulich, A. (Hrsg.): Kuhn's structure of scientific revolutions – 50 years on, Heidelberg/NewYork 2015.
DiMaggio, P.; Powell, W. W.: The Iron Cage Revisited. Institutional Isomorphism and Collective Rationality in Organizational Fields, in: American Sociological Review, Jg. 48, Heft 2, 1983, S. 147-160.
Edgerton, D.: The Shock of the Old. Technology and Global History since 1900, London 2006.
Epple, M.: Die Entstehung der Knotentheorie, Braunschweig/Wiesbaden 1999.
Epple, M.; Zittel, C.: Science as Cultural Practice: Vol. 1: Cultures and Politics of Research from the Early Modern Period to the Age of Extremes (Wissenskultur und gesellschaftlicher Wandel 24), Berlin 2010.
Fassin, D.; Rechtman, R.: The empire of trauma: An inquiry into the condition of victimhood, Princeton 2009.
Fehr, C.: What Is in It for Me? The Benefits of Diversity in Scientific Communities, in: Feminist Epistemology and Philosophy of Science: Power in Knowledge, hrsg. v. H. Grasswick, Dordrecht 2011, S. 133–155.
Fernández Pinto, M.: Philosophy of Science for Globalized Privatization: Uncovering Some Limitations of Critical Contextual Empiricism, in: Studies in History and Philosophy of Science, Jg. 47, 2014, S. 10–17.
Fioretos, O.; Falleti, T.G.; Sheingate, A. (Hrsg.): The Oxford Handbook of Historical Institutionalism, New York 2016.
Fisher, C.S.: The last invariant theorists: a sociological study of the collective biographies of mathematical specialists, in: Archives européennes de Sociologie, Jg. 8, Heft 2, 1967, S. 216 244.

Frank, D.J.; Gabler, J.: Reconstructing the University. Worldwide Shifts in Academia in the 20th Century, Stanford 2006.
Frese, M. (Hrsg.): Fragwürdige Ehrungen. Straßennamen als Instrument von Geschichtspolitik und Erinnerungskultur, Münster 2012.
Galison P.; Hevly, B. (Hrsg.): Big Science – The Growth of Large-Scale Research, Stanford 1992.
Geison, G.L.; Holmes, F.L. (Hrsg.): Research Schools. Historical Reappraisals, in: Special Issue, Osiris, Jg. 8, 1993.
Gherardi, S.: Practice as a collective and knowledgeable doing, Universität Siegen: SFB 1187 Medien der Kooperation 2019, SFB 1187 Medien der Kooperation – Working Paper Series 8, (https://doi.org/10.25819/ubsi/40).
Gibbons, M. et al.: The New Production of Knowledge, London 1994.
Gieryn, T.F.: Boundary-work and the demarcation of science from non-science: Strains and interests in professional ideologies of scientists, in: American sociological review, Jg. 48, Heft 6, 1983, S. 781-795.
Gieryn, T.F.: Cultural boundaries of science: Credibility on the line, Chicago 1999.
Gillmore, C.S. et al. (Hrsg.): History of Geophysics, Vol. 1-7, Washington 1984-1997.
Giudice, G.F.: The Dawn of the Post-Naturalness Era (https://arxiv.org/abs/1710.07663), 2017.
Good, G.A.: The Assembly of Geophysics: Scientific Disciplines as Framework of Consensus, in: Studies in History and Philosophy of Modern Physics, Jg. 31, Heft 3, 2002, S. 259-292.
Gray, J.: The Development of Mathematics: A Response to A. F. Monna: Where does the Development of Mathematics lead to?, in: Nieuw Archief Wiskunde, Jg. 4, Heft 3, 1975, S. 289–294.
Gugerli, D.; Kupper, P.; Speich, D.: Die Zukunftsmaschine. Konjunkturen der ETH Zürich 1855–2005, Zürich 2005.
Hacking, I.: Representing and Intervening, Cambridge 1983.
Haraway, D.: Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspectives, in: Feminist Studies, Jg. 14, Heft 3, 1988, S. 575–599.
Harding, S.: Feministische Wissenschaftstheorie. Zum Verhältnis von Wissenschaft und sozialem Geschlecht, Hamburg 19902.
Harding, S.: Whose Science? Whose Knowledge? Thinking from Women's Lives, Ithaca (NY) 1991.
Harding, S.: Latin American Decolonial Social Studies of Scientific Knowledge: Alliances and Tensions, in: Science, Technology, & Human Values, Jg. 41, Heft 6, 2016, S. 1063–1087.
Hawkins, T.: Emergence of the theory of Lie groups. An Essay in the History of Mathematics, 1869–1926, Berlin et al. 2000.
Heidelberger, M.; Steinle, F.: Experimental Essays. Versuche zum Experiment, Baden-Baden 1998.
Heinecke, S.: The Gradual Transformation of the Polish Public Science System, in: PLoS ONE, Jg. 11, Heft 4: e0153260, 2016.
Heinze, T.; Heidler, R.; Heiberger, H.; Riebling, R.: New patterns of scientific growth. How research expanded after the invention of Scanning Tunneling Microscopy and the discovery of Buckminsterfullerenes, in: Journal of the American Society for Information Science and Technology, Jg. 64, Heft 4, 2013, S. 829–843.
Heinze, T.; Tunger, D.; Fuchs, J.E.; Jappe, A.; Eberhardt, P: Fachliche Forschungs- und Lehrprofile staatlicher Universitäten in Deutschland. Eine Kartierung ausgewählter Fächer. Wuppertal: BUW 2019, (DOI: 10.25926/9242-ws58).
Heinze, T.; Jappe, A.; Tunger, D.; Eberhardt, P.; Fuchs, J.E.: Universitäten mit Profil. Umfassende Daten zu Forschungs- und Lehrprofilen deutscher Universitäten frei zugänglich, in: Wissenschaftsmanagement, Vol. 26, 2020, S. 26-30.
Hiebert, E.N.: Discipline identification in chemistry and physics, in: Science in Context, Jg. 9, Heft 2, 1996 , S. 93-119.
Hobsbawm, E.: The Age of Capital 1848-1875, New York 1975.
Hobsbawm, E.; Ranger, T. (Hrsg.): The Invention of Tradition, Cambridge 1983.

Hollingsworth, J.R.: A Path-Dependent Perspective on Institutional and Organizational Factors Shaping Major Scientific Discoveries, in: Innovation, Science, and Institutional Change, hrsg. v. J. Hage; M. Meeus, Oxford 2006, S. 423-442.

Hossenfelder, S.: Lost in Math – How Beauty Leads Physics Astray, 2018.

Huggett, N.: Review of „String Theory and the Scientific Method“, in: Notre Dame Philosophical Review 2014, URL= https://ndpr.nd.edu/news/string-theory-and-the-scientific-method/.

Huisman, J.; Lepori, B.; Seeber, M.; Frölich, N.; Scordato, L.: Measuring institutional diversity across higher education systems. Research Evaluation, Jg. 24, 2015, S. 369-279.

Hüther, O.; Krücken, G.: Nested organizational fields. Isomorphism and diversity among European universities, in: The University under Pressure, hrsg. v. E. Popp Berman; C. Paradeise, S. 53-83, Bingley 2016.

Ismail-Zadeh, A.; Joselyn, J.A. (Hrsg.): The International Union of Geodesy and Geophysics: From different spheres to a common globe, in: History of Geo- and Space Sciences, Special Issue 10, 2019, S. 17-24.

Ivanova, M.; French, S. (Hrsg.): The Aesthetics of Science: Beauty, Imagination and Understanding, New York/London 2020.

Jappe, A.; Pithan, D.; Heinze, T.: Does bibliometric research confer legitimacy to research assessment practice? A sociological study of reputational control, 1972-2016, PLoS ONE, Jg. 13, Heft 6: e0199031, 2018.

Jasanoff, S. (Hrsg.): States of knowledge: the co-production of science and the social order, London 2014.

Keller, E.F.: Reflections on Gender and Science, Yale 1985.

Kinzel, K.: Geschichte ohne Kausalität. Abgrenzungsstrategien gegen die Wissenschaftssoziologie in zeitgenössischen Ansätzen historischer Epistemologie, in: Berichte zur Wissenschaftsgeschichte, Jg. 35, Heft 2, 2012, S. 147–162.

Knape, J.; Schindling, A. (Hrsg.): Fassaden-Botschaften: Zur Denkmalgeschichte und Programmatik der Tübinger Porträt-Galerie am Bonatzbau, Wiesbaden 2016.

Knorr-Cetina, K.D.: Epistemic Cultures. How The Sciences Make Knowledge, Cambridge Massachusetts 1999.

Knorr-Cetina, K.D.: Wissenskulturen: Ein Vergleich naturwissenschaftlicher Wissensformen, Frankfurt a.M. 2002.

Knowles, S.G.; Kunreuther, H.C.: Troubled Waters. The National Flood Insurance Program in Historical Perspective, in: Journal of Policy History, Jg. 26, Heft 3, 2014, S. 327–353.

Koshar, R.: Germany’s Transient Pasts: Preservation and National Memory in the Twentieth Century, Chapel Hill/London 1998.

Köhler, H.: Schulen und Hochschulen in der Deutschen Demokratischen Republik 1949-1989 (Datenhandbuch zur deutschen Bildungsgeschichte IX), Göttingen 2008.

Köhn, H.: Umbenennung von Straßen, ein Instrument der Geschichtspolitik, in: Lexikon der „Vergangenheitsbewältigung“ in Deutschland. Debatten- und Diskursgeschichte des Nationalsozialismus nach 1945, hrsg. v. T. Fischer; M.N. Lorenz, Bielefeld 20153, S. 429-432.

König, W.: Wilhelm II. und die Moderne. Der Kaiser und die technisch-industrielle Welt, Paderborn 2007.

Krebs, S.; Schabacher, G.; Weber, H. (Hrsg.): Kulturen des Reparierens. Dinge – Wissen – Praktiken, Bielefeld 2018.

Kroll, F.L.: Geburt der Moderne. Politik, Gesellschaft und Kultur vor dem Ersten Weltkrieg (Deutsche Geschichte im 20. Jahrhundert 1/ Schriftenreihe der Bundeszentrale für Politische Bildung 1340), Berlin 2013.

Kuhn, T.S.: Die Struktur wissenschaftlicher Revolutionen, Frankfurt a. M. 1967.

Kuhn, T.S.: Objectivity, Value Judgment, and Theory Choice, in: The Essential Tension. Selected Studies in Scientific Tradition and Change, Chicago 1977, S. 320–339.

Lanza Rivers, D.: Cartographies of Feminist Science Studies, in: Women's Studies, Jg. 48, Heft 3, 2019, S. 177-185.

Launius, R.D.: “We will learn more about the Earth by Leaving it than by Remaining on it”: NASA and the forming of an earth science discipline in the 1960s, in: Innovation in Science and Organizational Renewal: Historical and Sociological Perspectives, hrsg. v. T. Heinze; R. Münch, New York 2016, S. 211-242.

Law, J.: On the Social Explanation of Technical Change: The Case of the Portuguese Maritime Expansion, in: Technology and Culture, Jg. 28, Heft 2, 1987, S. 227–252.
Law, J.: The Materials of STS, in: The Oxford Handbook of Material Culture Studies, hrsg. v. Hicks; Beaudry, Oxford u.a. 2012, S. 173–190 (https://doi.org/10.1093/oxfordhb/9780199218714.013.0006).
Law, J.; Lin, W.Y.: Provincializing STS: Postcoloniality, symmetry, and method, in: East Asian Science, Technology and Society, Jg. 11, Heft 2, 2017, S. 211-227 (https://doi.org/10.1215/18752160-3823859).
Lepori, B.; Geuna, A.; Mira, A.: Scientific output scales with resources. A comparison of US and European universities, in: PLoS ONE, Jg. 14, Heft 10, 2019, e0223415.
Leuschner, A.; Lindemann, A.: On Minor Publications, Thematic Divisions, and Biases in Philosophy: Insights from the Book Review Sections, in: APA Newsletter on Feminism and Philosophy, Jg. 17, Heft 2, 2018, S. 20–24.
Longino, H.: The Fate of Knowledge, Princeton 2002.
Lucier, P.: The Professional and the Scientist in Nineteenth-Century America, in: ISIS, Jg. 100, Heft 4, 2009, S. 699-732.
Lundgreen, P.: Das Personal an den Hochschulen in der Bundesrepublik Deutschland 1953–2005 (Datenhandbuch zur deutschen Bildungs¬geschichte. Band X.), Göttingen 2009.
Lyons, K. et. al: Engagements with Decolonization, and Decoloniality in and at the Interfaces of STS, in: Catalyst: Feminism, Theory, Technoscience, Jg. 3, Heft 1, 2017, S. 1–47.
Mahoney, J.; Thelen, K.: A Theory of Gradual Institutional Change, in: Explaining Institutional Change: Ambiguity, Agency, and Power, hrsg. v. J. Mahoney; K. Thelen, Cambridge 2010, S. 1-37.
McAllister, J.W.: Beauty and revolution in science, Cornell 1999.
Mehrtens, H.: Moderne Sprache Mathematik, Frankfurt a. M. 1990.
Meyer, J. W.; Rowan, B.: Institutionalized Organizations: Formal Structure as Myth and Ceremony, in: The American Journal of Sociology, Jg. 83, Heft 2, 1977, S. 340-363, Retrieved from http://www.jstor.org/stable/2778293.
Mody, C.: How Probe Microscopists Became Nanotechnologists, in: Discovering the Nanoscale, hrsg. v. Baird, A.N.D.; Schummer, J., Amsterdam 2004, S. 1-133.
Mody, C.; Cawas, M.: Corporations, Universities, and Instrumental Communities. Commercializing Probe Microscopy, 1981-1996, in: Technology and Culture, Jg. 47, Heft 1, 2006, S. 56 80.
Mody, C.: Instrumental Community. Probe Microscopy and the Path to Nanotechnology, Cambridge/MA 2011.
Mody, C.: The Long Arm of Moore’s Law, Cambridge/MA 2016.
Mol, A.: The Body Multiple: Ontology in Medical Practice, Durham 2002.
Motzkin, G.: Das Ende der Meistererzählungen, in: Kompass der Geschichtswissenschaft. Ein Handbuch, hrsg. v. Eibach; Lottes, Göttingen 2002, S. 371–387.
Nordmann, A.: The Age of Technoscience. In: Science Transformed? Debating Claims of an Epochal Break, hrsg. v. A. Nordmann; H. Radder; G. Schiemann, Pittsburgh 2011, S. 19 30.
Nordmann, A.: Im Blickwinkel der Technik: Neue Verhältnisse von Wissenschaftstheorie und Wissenschaftsgeschichte, in: Berichte zur Wissenschaftsgeschichte, Jg. 35, Heft 3, 2012, S. 200–216.
North, M.: Novelty. A History of the New, Chicago 2013.
Nye, M.J. (Hrsg.): The Modern Physical and Mathematical Sciences (The Cambridge History of Science V), Cambridge et al. 2003.
Oreskes, N.; Conway, E.: Merchants of Doubt: How a Handful of Scientists Obscured the Truth on Issues from Tobacco Smoke to Global Warming, New York 2010
Okruhlik, K.: Gender in the Biological Sciences, in: Canadian Journal of Philosophy, Suppl. Vol. 20: Biology and Society, 1994, S. 21–42.
Oudshoorn, N.E.J.; Pinch, T.: How users matter: The co-construction of users and technologies, Cambridge/MA 2003.
Paletschek, S.: Die permanente Erfindung einer Tradition: Die Universität Tübingen im Kaiserreich und in der Weimarer Republik, Stuttgart 2001.

Parshall, K.H.: The 100th Anniversary of the Death of Invariant Theory?, in: The Mathematical Intelligencer, Jg. 12, Heft 4, 1990, S. 10–16.
Piaget, J.: Le Structuralisme, Paris 1968.
Pickering, A.: Constructing quarks, Edinburgh/Chicago 1984.
Pickering, A. (Hrsg.): Science as Practice and Culture, Chicago 1992.
Pickering, A.: The mangle of practice: Agency and emergence in the sociology of science, in: American Journal of Sociology, Jg. 99, Heft 3, 1993, S. 559–589.
Pithan, D.: The Discursive Legitimation of New Ideas. Emergence and Diffusion of the Industrial Research Laboratory in the United States, 1870-1930, PhD Thesis, University of Wuppertal 2019.
Plennert, M.: The social construction of technological stasis: The stagnating data structure in OpenStreetMap, in: Big Data & Society, Jg. 5, Heft 2, 2018, S. 1–18, (2053951718790591. doi:10.1177/2053951718790591).
Pollock, A.; Subramaniam, B.: Resisting Power, Retooling Justice. Promises of Feminist Postcolonial Technosciences, in: Science, Technology & Human Values, Jg. 41, Heft 6, 2016, S. 951–966.
Proctor, R.; Schiebinger, L. (Hrsg.): Agnotology: The Making and Unmaking of Ignorance, Stanford 2008.
Remmert, V.: Ariadnefäden im Wissenschaftslabyrinth. Studien zu Galilei: Historiographie - Mathematik – Wirkung, Bern 1998.
Rheinberger, H.J.: Toward a History of Epistemic Things: Synthesizing Proteins in the Test Tube, Stanford 1997.
Richter, H.: Aufbruch in die Moderne. Reform und Massenpolitisierung im Kaiserreich, Frankfurt a.M. 2021.
Rickles, D.A.: A Brief History of String Theory. A Brief History of String Theory: From Dual Models to M-Theory, Berlin et al. 2014.
Riordan, M.; Hoddeson, L.; Kolb, A.W.: Tunnel Visions: The Rise and Fall of the Superconducting Super Collider, Chicago 2015.
Ritson, S.; Camilleri: Contested boundaries: The string theory debates and ideologies of science, in: Perspectives on Science, Jg. 23, Heft 2, 2015, S. 192-227.
Rose, U.: Thomas S. Kuhn: Verständnis und Mißverständnis. Zur Geschichte seiner Rezeption, Dissertation, Universität Göttingen 2004.
Ruegg, W.: Geschichte der Universität in Europa (Bd. 3., Vom 19. Jahrhundert zum Zweiten Weltkrieg, 1800 - 1945) München 2004.
Ruegg, W.: Geschichte der Universität in Europa (Bd. 4., Vom Zweiten Weltkrieg bis zum Ende des 20. Jahrhunderts), München 2010.
Rump, H.H.: Bäume und Zeiten: Eine Geschichte der Jahrringforschung, Berlin 2018.
Schickore, J.: Vom Nutzen der Historie für die Wissenschaftsphilosophie, in: Berichte zur Wissenschaftsgeschichte, Jg. 36, Heft 1, 2013, S. 83–95.
Schmaltz, T.; Mauskopf, S. (Hrsg.): Integrating History and Philosophy of Science: Problems and Prospects, New York et al. 2011.
Schurz, G.; Carrier, M. (Hrsg.): Werte in den Wissenschaften. Neue Ansätze zum Werturteilsstreit, Frankfurt a.M. 2013
Scott, R.W.: Institutions and Organizations – Ideas, Interests, and Identities, London 2013.
Servos, J.W.: Physical Chemistry from Ostwald to Pauling. The Making of a Science in America, Princeton 1990.
Shinn, T.; Joerges, B.: The Transverse Science and Technology Culture: Dynamics and Roles of Research-Technology, in: Social Science Information, Jg. 41, Heft 2, 2002, S. 207–251.
Smolin, L.: The trouble with physics: the rise of string theory, the fall of a science, and what comes next, London 2008.
Soler, L.; Trizio, E.; Pickering, A. (Hrsg.): Science as it Could Have Been. Discussing the Contingency/Inevitability Problem, Pittsburgh 2016.
Sonnert, G.; Holton, G.: Who Succeeds in Science? The Gender Dimension, New Brunswick (NJ) 1995.
Staley, K.: The evidence for the top quark, Cambridge 2004.

Stichweh, R.: Zur Entstehung des modernen Systems wissenschaftlicher Disziplinen, Frankfurt a. M. 1984.
Streeck, W.; Thelen, K.: Introduction: Institutional Change in Advanced Political Economies, in: Beyond Continuity. Institutional Change in Advanced Political Economies, hrsg. v. W. Streeck; K. Thelen, Cambridge 2005, S. 1–39.
Streeck, W.: Re-Forming Capitalism. Institutional Change in the German Political Economy, Oxford 2009.
Szöllösi-Janze, M.: Wissensgesellschaft in Deutschland. Überlegungen zur Neubestimmung der deutschen Zeitgeschichte über Verwissenschaftlichungsprozesse, in: Geschichte und Gesellschaft, Jg. 30, Heft 2, 2004, S. 277–313.
Thelen, K.: Historical Institutionalism in Comparative Politics, in: Annual Review of Political Science, Jg. 2, 1999, S. 369-404.
Thelen, K.: The Explanatory Power of Historical Institutionalism, in: Akteure - Mechanismen - Modelle. Zur Theoriefähigkeit makro-sozialer Analysen, hrsg. v. R. Mayntz, Frankfurt a.M. 2002, S. 91-107.
Thelen, K.: How Institutions Evolve. Insights from Comparative Historical Analysis, in: Comparative Historical Analysis in the Social Sciences, hrsg. v. J. Mahoney; D. Rueschemeyer, New York 2003, S. 208-240.
Thelen, K.: Contemporary Challenges to the German Vocational Training System, in: Regulation & Governance, Jg.1, Heft 3, 2007, S. 247-260.
Thelen, K.: Varieties of Liberalization: The New Politics of Social Solidarity, New York 2014.
Thelen, K.; Mahoney, J. (Hrsg.): Advances in Comparative Historical Analysis, New York 2015.
Titze, H.: Wachstum und Differenzierung der deutschen Universitäten 1830-1945 (Datenhandbuch zur deutschen Bildungsgeschichte, Bd. I, 2. Teil), Göttingen 1995.
Valian, V.: Why So Slow? The Advancement of Women, Cambridge (MA) 1998.
Weart, S.: Rise of interdisciplinary research on climate, in: Proceedings of the National Academy of Sciences of the United States of America, Jg. 110, 2013, (Fostering Advances in Interdisciplinary Climate Science), 3657-3364.
Wehling, P.: The situated materiality of scientific practices: postconstructivism–a new theoretical perspective in science studies, in: Science, Technology & Innovation Studies, Special Issue, Jg. 1, Heft 1, 2006, S. 81–100.
Weingart, P.: Die Stunde der Wahrheit? Zum Verhältnis der Wissenschaft zu Politik, Wirtschaft und Medien in der Wissensgesellschaft, Weilerswist 2001.
Wengel, R.: Die Zyklographie von Wilhelm Fiedler, Dissertation, Bergische Universität Wuppertal 2020.
White, H.: Metahistory. Die historische Einbildungskraft im 19. Jahrhundert in Europa, aus dem Amerikanischen von Peter Kohlhaas, Frankfurt am Main 19912.
Woit, P.: Not even wrong: The failure of string theory and the search for unity in physical law, New York 2006.
Ziman, J.: Prometheus Bound. Science in a Dynamic Steady State, Cambridge/MA 1994.
Zwiebach, B.: A first course in string theory, Cambridge 2004.