Report on the ICHM Co-Sponsored 30th Novembertagung on the History and Philosophy of Mathematics

Dates 31st October - 2nd November 2019

Venue Institut de Recherche Mathématique Avancée (IRMA), Strasbourg, France

Theme Mathematical Cultures, Values and Norms

Invited speakers June Barrow-Green (Open University) and Roy Wagner (ETH Zurich)

Organising Committee Paul Hasselkuß (Düsseldorf), Tiago Hirth (Lisbon), Deborah Kant (Konstanz), Rosie Lev-Halutz (Tel Aviv), Nicolas Michel (Paris, Sphere), Gatien Ricotier (Strasbourg) and Benjamin Wilck (HU Berlin)

Website https://novembertagung.wordpress.com/

The 30th Novembertagung on the History and Philosophy of Mathematics took place at the Institut de Recherche Mathématique Avancée (IRMA), Strasbourg, France. 40 early career scholars (from master to post-doctoral students) attended the 25 talks distributed in two parallel sessions and the 5 joint sessions (the opening session, the two talks by the invited speakers, a walking tour of historical Strasbourg architecture for the sciences by Norbert Schappacher, and the discussion about the future of the Novembertagung, see the program and abstracts below).

Participation at the Novembertagung was free of charge. The costs for accommodation and all meals were covered by the organization (including the dinner on 31st October to the lunch on 2nd November). The generous funding of the ICHM and the other co-sponsors allowed us to offer grants to subsidize the travel costs for those participants with a limited or no travel budget. As a result, 12 different countries were represented : France, Germany, United Kingdom, Portugal, Switzerland, Austria, Czech Republic, Bulgaria, Russia, Israel, United States of America, and Brazil. The international stature and the wide diffusion of the Novembertagung are growing with every year, but some issues arise, such as the lack of early resources for the funding of those who had to travel long distances (such as, for this edition, from Ecuador or South Africa).

The 30th Novembertagung was a success. For several participants, this was their first participation to an international conference, and their first opportunity to present and discuss their research in front of an international audience. The ample time allotted to breaks and meals allowed for informal exchanges, networking, and free discussion of some of the difficulties or tacit problems encountered by several early career scholars. These traditional aspects of the Novembertagung and the issues raised by the wider diffusion of the event were openly addressed in the last session.

Program – 30th Novembertagung

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Day 2 - November 1st		
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	Tobias Schütz — Albert Einstein and Projective Geometry	Arilès Remaki — Series of combinatorial numbers' inverses in the middle of the 17th century: three proofs, three styles.
11h Break		
11h30 (Conférence)	Roy Wagner — Cultures of mathematical consensus	
13h Break		
14h	Walking tour of historical Strasbourg architecture for the sciences (by Norbert Schappacher)	
15h30 Break		
16h	Session A (Conférence) Chair: Paul Hasselkuß	Session B (Séminaire) Chair: Tiago Hirth
	Sandra Bella — First readings of the Leibniz Calculus: the Malebranchist Group Case (1691-1706)	Jan Makovský — Learning mathematics in XVIIIth and early XIXth century Bohemia: Bolzano's exam
	Pierrot Seban — How many mathematical practices? Can infinity help us answer?	Chopra Murtaza — The numbers of the sky
17h30 End day 2		
Day 3 - November 2nd		
9h30	Session A (Conférence) Chair: Rosie Lev-Halutz	Session B (Séminaire) Chair: Paul Hasselkuß
	Petra Bušková — Dispute over Infinity	Matías Osta-Vélez and Guillermo Nigro — Grounding mathematical concepts in practices
	Tatiana Levina — Grasping Absolute Infinity: Symbol in Georg Cantor	Benjamin Wilck — Euclid's Philosophical Commitments
11h Break		
11h30 (Conférence)	Discussion: the future of the Novembertagung	
13h End day 3		

30th Novembertagung on the History and Philosophy of Mathematics

Mathematical Cultures, Values and Norms

31/10 – 02/11, Strasbourg

1 Day 1 – 31st October

1.1 9h : Conference opening (GAM)

1.2 9h30 – 11h : Session A (GAM)

1.2.1 David Dunning — Notational Norms in Charles Sanders Peirce's Circle of Logicians

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Keywords : logic, notation, Peirce, pedagogy

Abstract : From 1879 to 1884, the American philosopher and Coast Survey computer Charles Sanders Peirce (1839 — 1914) taught logic at the recently founded Johns Hopkins University in Baltimore, where he and a small circle of graduate students collaboratively published influential research in mathematical logic, forming a local community of a size and vibrancy unprecedented in that fledgling field. Early British discourse around the algebra of logic had operated largely at a distance through the published contributions of a few pioneers, and several independently developed mathematical studies of logic had recently appeared in Germany. No university on either side of the channel had yet seen a coherent pedagogical community form around this new subject matter. I propose to explore the local culture of mathematical logic Peirce and his students developed, focusing on the norms they adopted around notation. We might expect a community working in close collaboration to share a single symbolic system ; in fact the logicians working in 1880s Baltimore tended to develop individual variations on existing notations. Unlike British and European authors who engaged in bitter polemics pitting one symbolism against another, notational differences appear not to have corresponded to intellectual or social conflict at Peirce's Hopkins. Rather the Baltimore logicians assimilated notational difference as an acceptable, even productive form of communal diversity. They revised, extended, and remade Boole's symbolism without ever settling on a final shared system of their own. While earlier mathematical logicians stubbornly defended their individual systems, Peirce and his circle of graduate students took a more flexible approach to notation, finding intellectual interest precisely in the range of inscriptive possibilities presented by the new mathematical logic.

1.2.2 Henning Heller — From group concept to group theory

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Keywords : group theory, Klein, axiomatization

Abstract : The history of abstract group theory is usually told in two parts : First was the formation of the concept of groups, culminating in the first purely abstract definition of a group by Dyck (1882). Second was the development of an autonomous theory of groups, arguably starting with the first monograph on the topic by de Séguier (1904). But what happened in the 20 years of "transition", between these two events ? We will examine that question in this presentation.

By taking the mathematical work of Felix Klein as an example, we will argue that during the "transition period" 1880-1900, the success of special, "pre-abstract" theories of groups (Lie groups, linear substitutions, discrete groups ?) was decisive for making abstract group theory an interesting endeavor in the first place. Further, many important theorems of abstract group theory could readily be imported from its predecessor theories.

While mathematicians of the early 20th century univocally praised Klein's group-theoretic contributions (Loewy 1910, Miller 1935), he is today mostly known for his previous "Erlangen Programm" of 1872. As we want to argue, this shift of reception of Klein's work is due to (1) a change of mathematical style and language that makes Klein's results (although still important for group theory) unintelligible to modern readers ; (2) an over-emphasis on the concrete-abstract distinction and on the axiomatic method. The axiomatic definition of groups was surely important to establish the group concept, but no decisive step in the development of group theory. Rather, it was a witness of a change that happened anyways.

1.3 9h30 – 11h : Session B (PAM)

1.3.1 Deborah Kant — How does a qualitative interview study inform the philosophy of set theory ?

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Keywords : set-theoretic independence, interview study, mathematical truth

Abstract : In the philosophy of mathematics of today, scholars show more and more interest in the practices of mathematicians. Following this attitude, a qualitative interview study was set up to investigate how set-theoretic practices look like, in particular the mathematical work on set-theoretic independence. We tackle here the following methodological question : How does a qualitative interview study with professional set theorists inform the philosophy of set theory ?

Our answer is a systematisation of the interplay of the different disciplines. We, first, distinguish the kind of questions and the languages. Since philosophers mostly ask non-empirical questions, but in Social Science, only empirical questions can be approached, we have to relate non-empirical questions to empirical ones. Moreover, the languages in which the disciplines are practised are distinct.

Second, we retrace the path from the philosophical question to the interview study, and back from the results of the study to their integration in the philosophy of set theory. Our philosophical question we start with is : Is it possible that there are mathematical statements that are neither true nor false ? An answer to that question depends on the explication of the concept of truth. The interview study provides an empirical account of the concept of truth in mathematics, which can be integrated in the philosophy of set theory as one additional account of mathematical truth. The empirical work can then inform the philosophy in that we are able to determine which account correspond best to the practices. However, the empirical work cannot help us in general to single out the right account.

1.3.2 Karl Heuer — How do we decide which mathematics is valuable : Empirical findings and philosophical thoughts.

University Affiliation : Technical University of Berlin

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Keywords : Philosophy of Mathematical Practice, Mathematical Beauty, Mixed Methods, Sociology of Mathematics

Abstract : Freely paraphrased G. H. Hardy said only beautiful mathematics will stand the test of time and Paul Erdos bantered God has a book of the most beautiful proofs.

The question what kind of mathematics is valuable can be debated in two senses :

(1) there are (or should be) objective criteria which distinguish good math from bad math, or

(2) pure mathematics is a cultural phenomenon where the value is decided by its community.

It is important to undermine any debate with empirical data. Unfortunately, there is still a lack of empirical data on these topics. Philosophers and sociologists of science often ignored mathematics. Bettina Heintz, for instance, wrote about her profession that "Sociology meets mathematics with an idiosyncratic mixture of devotion and disinterest." [1]

We want to show results from a first qualitative interview series on the question which problems mathematicians choose to work on. Embedded in a mixed methods approach, these interviews rather work as an exploratory endeavour, looking for right categories to include in a planned, bigger quantitative work. Questions include : Do mathematicians look for problems fitting to their techniques, or vice versa ? What makes a problem/result prestigious, interesting or aesthetic ? Is it important how long it was unsolved, is price-money an important factor ?

This is work in progress and both authors are not trained in methods used in social sciences. This talk is joint work with , we would like to give this talk together if possible.

[1] (Heintz 2000, 9) (Translated by the applicants) ; German original : ?Die Soziologie begegnet der Mathematik mit einer eigentümlichen Mischung aus Devotion und Desinteresse."

1.4 11h30 – 13h : Session A (GAM)

1.4.1 Brigitte Stenhouse — Mr Mary Somerville, Husband and Secretary

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Keywords : Decline, reform, community

Abstract : As a nineteenth-century British woman, Mary Somerville's engagement with learned academies and polite scientific society was neither consistent nor straightforward. Whilst she was 88 before being elected a full member of any institution (the American Philosophical Institution, 1869), Somerville benefitted from the resources and social networks cultivated in such spaces from as early as 1812.

Dr William Somerville, her husband, was a key mediator between herself, her scientific contemporaries, and the institutions of which he was a member. Indeed William provided Somerville with vital access to both actors and knowledge. Using the extensive correspondence held in the Somerville Collection, at the Bodleian Library in Oxford, we will investigate how William took on the roles of chaperone, secretary, and later literary agent for his wife. Moreover, we will consider how Somerville actively used her husband to liberate knowledge from behind the closed doors of learned societies, and to pursue a successful career publishing mathematical and scientific books.

1.4.2 Rosie Lev-Halutz — Mathematics in Victorian London - Non-Euclidean Geometry as a Case Study

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Keywords : History of mathematics ; non-Euclidean geometry ; mathematics in Victorian London

Abstract : The history of mathematics in Victorian Britain is by now a widely studied area within the field of history of mathematics. While we have vast literature that scrutinizes the mathematical culture that developed in Cambridge, I am not aware of any research which attempted to investigate the distinctive characteristics of the mathematical community which developed in London in the 19th century, and this is the purpose of my research. The celebrated mathematicians of the capital (whether in their days or those whose names we still celebrate today) did get the attention of historians ? but mostly as individuals and not as a group. I study the so called "London based mathematicians" as a community, examine their shared values, goals and views, their mathematical works and achievements, and identify both the key aspects that were unique to London and those that they shared with their Cambridge peers.

I use non-Euclidean geometry as a case study, and this will be the main theme of my lecture. Existing research shows that for the most part, the confident dominant authority of Cambridge held rather conservative views and approaches in regards to non-Euclidean geometry and particularly to its physical implications. The most meaningful British opposition to this conservative stance came from London. I hold that the "radical" views that were set forth by some of London's mathematicians were not sporadic or singular phenomena, but rather a part of an entire intellectual scheme. That is, I analyze the underlying cultural and professional framework which enabled (or encouraged) the innovative approaches that were set forth by those mathematicians.

1.5 11h30 – 13h : Session B (PAM)

1.5.1 Deniz Sarikaya — How to choose the right definition : a normative endevour ?

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Keywords : Philosophy of mathematical practice, axiomatisations, epistemic objects, conceptual engineering

Abstract : This talk investigates the selection of axioms/definitions for (newly formed) mathematical disciplines and argues that the vocabulary developed within the ?conceptual engineering'-debate offers fruitful concepts for a finer philosophical analysis of the selection-process. This debate shifted to the metalevel, stressing the normative aspect of conceptual engineering.

We argue that both, values and pragmatic considerations, come into play when we suggest axiomatisations/definitions in our way starting from vague notions towards precise definitions. Usually, there are competing axiomatisations and it is not clear which of them captures the intuitive notion the best and which one yields to a fruitful new field.

Informal notions preceding axiomatised fields can deliver data. Hence axiomatisations need to fit to informally proved crucial results of the new field, including those results which deliver fruitful techniques. This process can be iterated several times and we might change our intuitions about these informal notion within this process.

We analyse our ideas in a case-study, focusing on the shift from finite to infinite combinatorics.

This talk is joint work with , we would like to give this talk together if possible.

1.5.2 Paul Hasselkuß — Are Computer-Assited-Proofs Really Complex ?

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Keywords : Philosophy of Mathematical Practice, Experimental Philosophy, Computer-Assited-Proofs

Abstract : Computer-assisted proofs (CAPs) have produced outstanding results in mathematics, yet mathematicians often regard them as complex, messy and error-prone and refuse to use CAPs on these

grounds. My talk will analyse and question this behaviour : Building upon examples from the controversy on Appel and Haken's (1989) proof of the four-color conjecture, I will argue that two often made objections against CAPs are in fact made using two distinct concepts of complexity : The first claims that CAPs are too complex insofar they are messy and error-prone, the second claims that CAPs are too complex insofar they do not give us insight into why a theorem is true. Then, I will question whether both objections are actually correct. The first objection may hold with regard to Appel and Haken's initial proof, but not with regard to later improvements, e.g., Gonthier's (2008) fully formalized proof. Dealing with the second objection, I argue that the notion of being too-complex-to-provide-insight presupposes that a proof's ?insight ? could be judged in an (at least) intersubjectively stable way. However, this assumption can be questioned on the basis of recent empirical studies of mathematicians' proof appraisals by Inglis and Aberdein (2014, 2016) who were able to show that proof appraisals involve multiple different dimensions. Mathematicians disagree in their judgements on any quantity that can be represented as a combination of these dimensions. Based on the study's data I argue that insight can be represented as a linear combination of two of these factors ; thus, the notion of being too-complex-to-provide-insight is subjective : It cannot warrant the exclusion of CAPs from mathematics.

1.6 14h – 16h15 : Session A (GAM)

1.6.1 Nicolas Michel — Naturalizing Mathematical Knowledge : Algebra in the Industrial Revolution

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Keywords : Algebra, Naturality, Virtue, France, England

Abstract : From Leibniz to Grothendieck, and including Chasles or Dedekind, mathematicians across centuries and disciplines have mobilized the epistemic virtue of naturality to describe and value certain definitions, notions or methods. These are alternatively deemed natural if they're sufficiently elementary, wide-encompassing, simple, or capturing an essential feature of a mathematical theory.. While recent attempts by historians and philosophers of mathematics to tackle this multi-faceted epistemic virtue have focused on the rise of so-called ?conceptual mathematics' in the late 19th century (and in particular on a genealogy starting with Riemann), in this talk, I set out to describe ambivalent dispositions towards algebraic methods in early 19th century France and Great-Britain, in which the value of naturality features prominently. Many authors of this period regularly drew a contrast between the ingenious, human, locomotive-like instruments which analytical methods yield, to other, more natural, pedestrian methods. In this context, the defense or rejection of naturality, we suggest, was a crucial norm for the mathematicians choice of conceptual tools, and definitional and notational practices. Furthermore, by placing these recourses to naturality meant in the context of the Industrial Revolution, we claim that a focus on naturality allows for a richer description of the way mathematicians envisioned their own activity, its rules and its goals. In so doing, we wish to provide a characterization of competing mathematical practices which ties into cultural and social history at large, without doing away with a technical and fine-tuned reading of the mathematical knowledge they produced.

1.6.2 Anna Kiel Steensen — Textual proof practices in Dedekind's early theory of ideals

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Keywords : Notation, proof practice, Dedekind

Abstract : How can we use mathematical texts to describe practices of proving ? What is the relation between concrete notation used in the text and the proof practices that the author carries out ? In this talk, I will address these questions in the case of proof practices in the early version of Dedekind's ideal

theory [1871].
Specifically, I focus on Dedekind's power notation, which includes the expression p^n, where p denotes a set of numbers (rather than just a number) and n denotes a positive integer. As for example Ehrhardt [2016, 2017] argues, changing the notation can enable new practices of proving ; in the case of Dedekind, my study shows an interesting connection between, on the one hand, how the meaning of the notational expression p^n changes as the text progresses and, on the other hand, how Dedekind uses p^n to write proofs. The study thus suggests a relation between the semiotic behavior of the power notation and the proof practices that this notation allows.
To describe how the meaning of the expression p^n changes, I apply a semiotic-analytical framework, which in particular does not presuppose the meaning of the expressions but instead constructs it as part of the analysis. This approach thus enriches our understanding of how the local semiotic processes that produce meaning within a text also shape textual practices of proving and vice versa.
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Ehrhardt, C. (2016). Notations, proof practices and the circulation of mathematical objects. The example of groups (1800-1860). Khronos. Revista De História Da Ciência, (3), Khronos. Revista de História da Ciência, 2016, Issue 3.
Ehrhardt, C. (2017). E uno plures ? Unity and diversity in Galois Theory (1832-1900). In Culture without culturalism in the making of scientific knowledge. Duke University Press.

1.6.3 Tiago Hirth — Towards a Genealogy of Recreational Mathematics Problems

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Keywords : Recreational Mathematics ; Genealogy of Problems

Abstract : David Singmaster called Recreational Mathematics the folklore of Mathematics. It is by definition mathematics that is accessible to the layperson be it due to its simplified form or basis for mathematical inquiry. It has accompanied both the cultural, and subsequently underlying, mathematical developments oftentimes being the very root of development of a mathematical branch or theory, i.e. (combinatorial) game theory, probability theory or graph theory. It holds in it, and as an object of historic analysis, the opportunity to grasp an understanding of intuitive notions, development of norms of rigor and resolution techniques,a strong insight into ludic activities of various populations, as well as the opportunity to see trends of propagation and migration of knowledge.
In this presentation I'd like to share and update my work on a lineage of recreational mathematical problems and give two or three examples of less well known problems and their lives.

1.7 14h – 16h15 : Session B (PAM)

1.7.1 Ellen Lehet — Understanding as the Aim of Mathematics

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Keywords : Understanding, Explanation, Cultures

Abstract : In this talk I will argue that the aim of mathematics is understanding. That is, understanding is of more value and interest to mathematicians than
mere knowledge. This has become apparent with the development of mathematics in the past century. In his well-known paper, Proof and Progress in Mathematics, Thurston says the following of mathematical practice : what we are doing is finding ways for people to understand and think about mathematics. This remark clearly suggests that understanding plays an important role in mathematical practice,

but is somewhat enigmatic in that it does not make clear how or why understanding is so important for mathematics. My goal will be to unpack this claim in order to give a more precise account of the importance of understanding. I will first give an account of how mathematical understanding is more valuable than knowledge, and then will argue that understanding is necessary for mathematical progress and development.

After establishing the importance of understanding, a natural follow-up question is how it is that mathematicians obtain understanding.

In the interest of providing a partial answer to this question, I will consider how mathematical cultures contribute to understanding and how understanding is transferred between cultures. In short, I will argue that mathematical cultures are crucial for facilitating wide-spread mathematical understanding.

1.7.2 Milan Mosse — Are Inductive Mathematical Arguments Thereby Explanatory ?

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Keywords : inductive arguments, social explanation

Abstract : Arguments by mathematical induction are rather common and have been in use for some time (Acerbi (2000) finds a candidate example in Plato !). Due in large part to Lange (2009), the philosophy of mathematical practice has recently concerned itself with the question that gives this talk its title — that is, with whether arguments by induction are explanatory because they proceed by induction. Supposing we aren't skeptics about the very possibility of mathematical explanation (Zelcer (2013) offers a more recent example of such skepticism), it's natural to think that proofs by induction aren't always explanatory, and that when they are, they aren't always thereby explanatory. After a brief overview of the relevant literature, we offer examples to motivate principles distinguishing these cases, and discuss some possible replies. Our suggestion is that one of the relevant distinctions turns on the fact that arguments by induction can be helpfully used to make arguments by analogy in particular social contexts.

1.8 16h45 – 18h15 : June Barrow-Green — Characterising the diverse world of Olaus Henrici (Conférence)

University Affiliation : The Open University

Abstract : Olaus Henrici was born in Denmark, educated in Germany, and made his career in England. He worked as an engineer, held chairs in pure mathematics, in applied mathematics, and in mechanics and mathematics. Amongst his writings are books on building bridges and on projective geometry, and articles on algebraic geometry and on planimeters ; and he constructed geometric surface models and a harmonic analyser.

This diversity in Henrici's life prompts a consideration of movements between technical, scientific and national cultures, and problems of mutual visibility. In my talk I shall use Henrici as an example to consider such movements, both spatially and temporally.

2 Day 2 – 1st November

2.1 9h30 – 11h : Session A (Conférence)

2.1.1 Gatien Ricotier — At the beginning of Bourbaki's project : Henri Cartan's teaching of Calculus between 1931 and 1940

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Keywords : Bourbaki, calculus, teaching, Henri Cartan

Abstract : Nicolas Bourbaki is the pseudonym of a group of mathematicians who started to gather at the end of 1934. This collective project changed the shaping and practice of mathematics during the twentieth century. Nowadays, the name Bourbaki refers to a treatise of mathematics (the "Eléments de mathématique"), a famous seminar, and a more or less well-defined style of writing and practicing mathematics.

The starting point of this project is a well-known myth : André Weil, after being questioned a lot by his Strasbourg colleague Henri Cartan about how to teach Calculus, suggested to gather with other former students of the Ecole Normale Supérieure to settle these questions once and for all. The adequate treatment of Stokes's theorem is often mentioned as a central problem. Indeed, Henri Cartan claimed he could not find a satisfactory answer in the classical textbook of Goursat.

The study of drafts of his lectures sheds a new light on the beginning of the Bourbaki project. In reconstructing Henri Cartan's teaching from 1931 to 1940, three main questions arise about the beginning of the Bourbaki project :

- Which difficulties can be found in Henri Cartan's drafts before the beginning of the Bourbaki project ?
- How does the Bourbaki project interact with Henri Cartan's teaching ?
- How did the Bourbaki project influence Henri Cartan's Calculus lectures of 1940 ?

In my communication, I will attempt to give satisfactory answers to these questions.

2.1.2 Tobias Schütz — Albert Einstein and Projective Geometry

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Keywords : Albert Einstein, Projective Geometry

Abstract : Albert Einstein is certainly one of the most famous scientists that has ever lived. Although he is almost exclusively known as a physicist, he had a broad knowledge of mathematics, as well. This is demonstrated not only by him attending courses and receiving good grades at the *Federal Polytechnic School* (ETH), but also by almost entirely unidentified and unknown documents. These documents are part of a manuscript containing some 1750 pages which were found a long time after Einstein's death when they were discovered behind a filing cabinet in the 1980s. We are currently analyzing four sheets of this manuscript in which Einstein drew sketches that can be identified with projective geometry. We can date these pages to the year 1938 when he worked on finding a *unified field theory.* Astonishingly, we have also found two pages in one of his notebooks that, too, deal with projective geometry - but from the years between 1912 and 1915. This was the time period when he worked on formulating his *general theory of relativity*, together with his good friend and former class mate Marcel Grossmann who is well known for his mathematical contributions to the general theory of relativity and was a lecturer in projective geometry.

My talk will present the pages dealing with projective geometry, will discuss what knowledge Einstein had regarding projective geometry, and will link the late pages from 1938 with the early ones. The questions arising are : why did Einstein consider projective geometry at all, why do very similar sketches appear in notes more than 20 years apart, and if there is a connection to Marcel Grossmann.

2.2 9h30 – 11h : Session B (Séminaire)

2.2.1 Matteo De Benedetto — Game-theoretic frameworks for conceptual evolution in mathematics

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Keywords : Conceptual evolution, Lakatos, evolutionary theory, game theory

Abstract : Lakatos is rightfully praised for being one of the first philosophers of mathematics that stressed how mathematical concepts change throughout time. Despite the vast consensus in seeing ?Proofs and Refutations' (Lakatos 1976) as foreseeing the need of considering mathematical concepts as cultural products of mathematical activity, few attempts have been made to build on Lakatos' conceptual framework. Amongst them, Mormann (Mormann 2002) proposed a quasi-Lakatosian evolutionary approach to conceptual evolution in mathematics. Generalizing Lakatos' method of concept- stretching to various forms of concept formation in formal and informal mathematics, he proposed a modified Darwinian selection theory for mathematical concepts, where conceptual variants compete in a proof-problems world.

The main aim of this work is then to propose a family of game-theoretic frameworks for modeling different kinds of conceptual evolution in informal mathematics. I will first change Mormann's evolutionary background theory, using Godfrey-Smith's recent version of the Darwinian selection theory (Godfrey-Smith 2009) as a conceptual basis for a general evolutionary theory of mathematical concepts centered around the notion of a Lakatosian population. Then, I will show how this refined evolutionary approach can be made precise into a family of evolutionary game-theoretic models (Weibull 1995). With the help of toy-examples reconstructions of different cases of conceptual evolution from the history of mathematics, I will show how my framework is able to account for the richness and variety of evolutionary patterns of mathematical concepts in different areas and cultures.

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2.2.2 Arilès Remaki — Series of combinatorial numbers' inverses in the middle of the 17th century : three proofs, three styles.

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Keywords : Series 17th Leibniz Style

Abstract : In 1665, an infinite series emerged spontaneously within Christiaan Huygens' works on games of chance : the series of the triangular numbers' inverses. Seven years later, when the Dutch mathematician first met Gottfried Wilhelm Leibniz in Paris, he challenged the young philosopher who was eager to prouve himself, to find the value of this infinite series. Leibniz did calculate not only this particular series but the general formula of the sums of series of combinatorial numbers's inverses, which deeply impressed Huygens. That encouraged Leibniz to make his discovery known by the members of the Royal Society within which he desired to be. But they answered him that this result had been already demonstrated by the Italian mathematician Pietro Mengoli in 1650.

This little story gives us three works of three contemporary mathematicians about this very similar problem : find the limit value of the infinite series of some figurate numbers' inverses. The three approaches are very different regarding sizes or shapes of the textual sources, nature of the tools they used but also contextual backgrounds from where terms of the series came : the long euclidean book of Mengoli, the short algebraic proof of Huygens and the patient combinatorial construction of Leibniz. These elements have crucial impacts on the way the mathematician conceives proofs, rigor and reliability of results. But it shows us also more philosophical or metaphysical considerations, by discussing the roles played by infinite, space or time in those mathematical materials.

2.3 11h30 – 13h : Roy Wagner – Cultures of mathematical consensus (Conférence)

University Affiliation : ETH Zürich

Abstract : One of the distinguishing features of mathematical practice is the exceptional level of consensus among professional mathematicians. While this fact is brought up quite often, and some practical or metaphysical explanations have been suggested, the literature is poor in detailed analyses of what precisely it is that mathematicians actually agree on, how, and under what conditions.

It is commonplace to say that mathematicians agree on the validity of arguments (rather than, say, their importance, elegance, or truth in senses not reducible to provability). But even if we restrict attention to the validity perspective, mathematicians often fail to reach agreement. In practice, a rather complex "negotiation" is required to reach agreement whereby the contested argument may be reformulated. At the end of this process the parties may still not agree whether the renegotiated proof and the original proof are the same.

Moreover, this agreement is not an a-historic phenomenon. I will argue that the current level of consensus emerged, in fact, in the 20th century, and was much weaker before (Euclid's Elements is a notable exception, and I will address it in my talk). During the talk I will consider various historical case studies in order to compare consensus in different mathematical cultures and analyze the conditions that allow for consensus to emerge in the way it does in contemporary mathematics.

2.4 14h – 15h30 : Walking tour of historical Strasbourg architecture for sciences (by Noverbert Schappacher)

2.5 16h – 18h15 : Session A (Conférence)

2.5.1 Sandra Bella — First readings of the Leibniz Calculus : the Malebranchist Group Case (1691-1706)

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Keywords : Appropriation, Differential calculus, Leibniz, Integral calculus

Abstract : The 1680s, Leibniz's inaugural articles on the calculus (Nova methodus in 1684 and Geometria recondita in 1686) circulate rather slowly and concern very few mathematicians, apart from the brothers Jean and Jacques Bernoulli and obviously Leibniz.

The Leibnizian calculus is first received in France within a group of savants gathering around the philosopher Nicolas Malebranche, Guillaume de l'Hospital being one of its flagship members. Their mathematical training is based on the knowledge of ancient geometry but is also strongly influenced by the French methods of Descartes, Fermat and Pascal. From 1690 on, European mathematical methods and, in particular John Wallis' and Isaac Barrow' writings circulate within this group.

Their understanding of the Leibnizian calculus is in the beginning shaped by these texts, although it's also mediated by their reading of Newton's texts and methods.

My contribution, based on manuscript sources, highlights different steps in the appropriation processes taking place within this group, such as different translations to new symbolisms or such as figurative representation of new notions.

The ways in which these mathematicians receive the Leibnizian calculus show that the notions involved in the calculus (differential space, continuously variable quantity, curve) take root in their practice by shaping the notions they had previously taken out of other authors.

We will argue that the Malebranchist group's appropriation of the Leibnizian calculus is an example of an original mathematical production resulting from different mathematical cultures.

2.5.2 Pierrot Seban — How many mathematical practices ? Can infinity help us answer ?

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Keywords : Infinity, Mathematical Styles, Euclid

Abstract : How and why is a procedure deemed acceptable in a given community ? How important is rigor, and which rigor ? Conceptual, philosophical rigor (according to certain principles), or demonstrative rigor (obtained through, for example, explicitness) ? Finally, are we able to assess these questions in the case of a culture we can only study through a limited extant corpus, almost devoid of metamathematical considerations ? We would like to contribute to these questions by returning to the Euclidean Elements, to study one aspect in particular : the treatment of infinity, arbitrary largeness and arbitrary iteration. It is often said that the Elements compile results and techniques from several older traditions. If one conducts a systematic survey, one is indeed struck by the apparent absence of overall consistency in the text on this subject, and the possibility to distinguish several techniques or treatments in different places. "Infinity" (apeiron) occurs, for example, in 3 different kind of contexts, with very different conceptual and inferential implications : 2 of them in book I, where we can see a kind of "casual" approach to both potential and actual infinity, and 1 in book X, where infinite multiplicity are adopted without qualms ? the only other occurrence being inside of the famous "infinite descent" of VII, 31. Arbitrary large iterations also take several different forms, from the very explicit and careful elaboration of IX, 9, to the purely implicit use of II, 27 ? that apparently bothered even ancient copyists. We would like to consider whether it is possible to link such a diversity of styles to a diversity of ancient practices, but also to consider whether the question of informal vs. formal techniques might be surfacing in some aspects of this methodological problem.

2.6 16h – 18h15 : Session B (Séminaire)

2.6.1 Jan Makovský — Learning mathematics in XVIIIth and early XIXth century Bohemia : Bolzano's exam

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Keywords : Jesuits, Prague, Calculus, Bolzano

Abstract : The general aim of our talk is to explore the interplay between institutional changes and changes in the teaching and learning of science, especially mathematics. In particular, we are interested in the effects that the suppression of the Society of Jesus in the Habsburg empire, in 1773, had on the teaching and learning of mathematics in Bohemia and in Prague, where the Jesuits had monopolized a segment of the university teaching for more than a century. Until the half of the 18th century the Jesuit teaching of mathematics in Bohemia was traditionally organized around the ratio studiorum, the curriculum of studies developed by the Jesuits at the end of 16th century. However, from mid- 18th century, the traditional Jesuit curriculum yielded to the pressure of internal and external factors, and was eventually modified on several occasions. All changes aimed at increasing the role of empirical sciences to the detriment of Aristotle, and at stressing the importance of mathematics in the curriculum by increasing the number of university chairs devoted to different branches of mathematics. This process, however, was by no means linear and orderly. Until the suppression of the order, for instance, modern scientific disciplines, such as the infinitesimal calculus, were included in the more traditional architecture of the ratio studiorum, while new textbooks were written, which aimed to present a balance between modernity and classicism. By exploring this rich, but little known literature, as well as other types of documents, such as a manuscript containing the written exams for the chair of elementary mathematics which took place in 1804, we aim to assess whether the official death of an institution such as the Society of Jesus actually implied that the forms and contents of the education it imparted were also disestablished.

2.6.2 Chopra Murtaza — The numbers of the sky

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Keywords : anki moon astronomy norms

Abstract : I specially would like to present for discussion the hypothesis that constitutes a part of my dissertation and with the clarification of which I'm struggling.

The hypothesis is that a strongly normative purpose and contents underlies the mathematical procedures or schemes [none of these terms is completely satisfactory] of the cuneiform astronomy, and that this norm is, so to say, the world itself. But, precisely there is no concept of world in this literature and the expression we find is anki, heaven-earth.

And so, the mathematical procedures do, together describe the astronomical events, and also have a performative function by showing how the norming , eg. limitating, element and the determined elements - the course of the astronomical events - is always renewed and occurs again and again.

My presentation should consist in three parts :

1 The sexagisemal system is not only a tool among others but it represents and accomplishes a correspondence scales of numbers which can have the same sexagismal value and always reports them to the multiples of 60. There are clear elements that show that this symbolic function is in harmony with other practices, like texts' interpretation or theology. Among others, the heaven-earth relation will appear between different levels and between the one-sixty... and the other elements.

2 This relation implies a special kind of determination of the earth by the heavens, namely that, whatever the course be, it should at the end be determined by unity, and show this determination all along its steps. This is quite manifest in the rising schemes that were republished and well-studied by John Steelle that give the distance between sunrise place and the part of the sky that is at the meridian.

3 Another determination is thoroughly expressed in late period system b's account of moon's velocity through the number 18, that determines the saros cycle, the relation between anomalistic and synodic month and the daily difference for the moon's velocity. This is a very appealing feature of those methods but it is not easy at all to give a serious account of it.

In conclusion, I will propose to consider this character of determination through values [numerical and, so to say, cosmological] as axiomata for non propositional methods.

3 Day 3 – 2nd November

3.1 9h30 – 11h : Session A (Conférence)

3.1.1 Petra Bušková — Dispute over Infinity

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Keywords : Poincaré, Cantor, Infinity

Abstract : The paper deals with the dispute of two prominent personalities - French mathematician, physicist and philosopher Henri Poincaré and German mathematician and logician Georg Cantor. Their dispute was related to set theory created by Cantor, especially conception of infinity. The actual infinity on which Cantor based his set theory, Poincaré, as well as other representatives of intuitionism, could not accept. Intuitionists relied exclusively on potential infinite.

The introduction shows how this dispute appeared in Czech literature and influenced Czech mathematical environment. After that there comes a short introduction of both mathematicians, including the fields they were dealing with, their crucial opinions as well as their life stories.

It is followed by a brief look at the evolution of understanding infinity. There is outlined the way to conception of infinity, as we understand it today. In particular, the paper deals with the difference between potential infinity and actual infinity, among which are many years of development and many thought-turns.

As a representative of the Czech Republic, I have to mention the crucial Czech personality dealing with

infinity ? Bernard Bolzano. He advocated the existence of infinity and infinite sets hundred years before Cantor and Poincaré. His work Paradoxes of the Infinite was the significant inspiration for George Cantor's set theory.

In the final part, the essence of the dispute between George Cantor and the intuitionists, represented by Henri Poincare, is presented. There are also mentioned other mathematical personalities who have sided with Poincaré or Cantor, such as Leopold Kronecker and David Hilbert.

3.1.2 Tatiana Levina — Grasping ?Absolute Infinity' : Symbol in Georg ?antor

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Keywords : Georg Cantor, Pavel Florensky, symbol, absolute infinity

Abstract : Is it possible to comprehend the ?Absolute Infinite' and could a world contain a symbol that helps people ? philosophers or mathematicians ? understand the absolute ? For Georg Cantor an absolutely infinite sequence of numbers was the "appropriate symbol of the absolute". In the Foundations of a General Theory of Manifolds" (1883) he adds that the absolute can only be acknowledged but never known. As Cantor's set theory has become the foundation of contemporary mathematics, it is essential to clarify the philosophical background that Cantor associated with it in order to elucidate his interpretation of the problem of infinite.

Russian philosopher Pavel Florensky was influenced by Cantor's ideas and wrote the article "On the symbols of infinity" in 1904. In this paper he says that the transfinite mathematics of Georg Cantor is an example of a symbolic vision of God. Symbol, as Florensky wrote in his memoirs, was the most important concept in his own philosophy throughout his life. Symbol has a distinctive ontological mode of existence and its primary property is to be the reference for the higher being, namely God.

Contemporary theologian Christian Tapp, who researched Cantor's interest in theology, doesn't consider the notion of symbol as important in Cantor's works. For Tapp, Cantor is saying that symbolic vision means ?not direct', therefore God cannot be understood and transfinite numbers cannot be connected with knowledge of the Absolute Infinite.

Therefore, the first question of the research is the following : Did Georg Cantor really associate transfinite numbers with the knowledge of God and in what sense ? I will examine Johanna van der Veen and Leon Horsten's paper, which represents Georg Cantor's conception in the context of European philosophers whom Cantor read.

The second research question resulted from the first one : What does Cantor mean by ?symbol' ? I hypothesize that Georg Cantor and his interpreters have different understanding of the symbol, from which follows different kinds of epistemological consequences. For the Novembertagung conference concise explanation of how Cantor's ladder of number-classes with layers of infinities leading out endlessly to an unreachable Absolute and why the notion of symbol is important along with Cantor's understanding of the symbol will be presented.

3.2 9h30 – 11h : Session B (Séminaire)

3.2.1 Matías Osta-Vélez and Guillermo Nigro — Grounding mathematical concepts in practices

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Keywords : Mathematical practices ; Concepts ; Wittgenstein ; Projective geometry

Abstract : During the last few decades, philosophy of mathematics has turned to the notion of practice for developing an analysis of mathematics as a social and historically situated activity. Despite the progress

made in this direction, philosophers have not yet agreed on how to relate mathematical concepts to actual practices.

Building on Wittgenstein's use theory of meaning and Toulmin's theory of concepts ; we propose a semantic framework that could solve this problem. The "later" Wittgenstein famously argued that concepts gain their meaning embedded in (rule-governed) language games which are "grounded" in different behavioral and practical contexts (forms of life). Following these ideas, Toulmin claimed that scientific concepts cannot be analyzed in abstracto, because they have a stratified nature. That is, their contents are the product of the evolution of sequences of language games, which are, at the same time, associated with different (culturally situated) collective behaviors. In this sense, analyzing the content of scientific concepts imply to look into their developmental history and, more specifically, to look into the collective practices that constitute the language games in which they were involved.

We will apply these ideas to mathematics, taking as a case study the mathematization of perspective in the 16th century. In particular, we will show how Guidobaldo del Monte and his colleagues used different language games from art and pictorial technique in order to construct some precise mathematical notions that will later play an important role in the development of projective geometry.

3.2.2 Benjamin Wilck — Euclid's Philosophical Commitments

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Keywords : Euclid's Elements ; definitions ; implicit metaphysical commitments ; ; Aristotle

Abstract : My paper argues that Euclid's Elements is committed to philosophical views about definition that partially coincide with Plato's and Aristotle's theories of definition, and partially do not. Although Euclid was a mathematician, commentators have tried since antiquity to present Euclid as a philosopher. However, while scholars have engaged either in cosmological speculations about Euclid's Elements (Proclus in Eucl. 68.20 ?25, 70.19 ?71.5, 71.22 ?24, 74.11 ?13 Friedlein ; Hahn 2017) or in reconstructing the logical framework of Euclid's mathematical proofs (Mueller 1981 ; Acerbi 2011 ; Acerbi forthcoming), my paper provides the first self-contained study of Euclid's theory of definition.

While Euclid nowhere talks about his mathematical works, Euclid's treatise nonetheless contains sufficient evidence for his implicit philosophical commitments and meta-mathematical background assumptions. I unveil aspects of Euclid's logic, Euclid's theory of science, and Euclid's metaphysics. In particular, I argue that Euclid is committed to the following :

-

a sharp distinction between species and differentiae ; and

-

priority in definition.

For instance, Euclid rigidly defines the differentiae of mathematical species (such as ?even' and ?odd' for numbers) in a way that is syntactically different from the way in which he defines the mathematical species (such as the number) themselves. Therefore, we can infer that Euclid systematically distinguishes between species and differentiae. Moreover, since Euclid always introduces or defines terms prior in definition prior to terms posterior in definition, we can attribute the notion of ?priority in definition' to Euclid. These philosophical commitments are shared by pre-Euclidean philosophers such as Plato and Aristotle. Euclid also however appears to be committed to more recalcitrant views, such as multiple definition, which are not shared by either Plato or Aristotle.

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3.3 11h30 – 12h30 : Discussion : the futur of the Novembertagung (Conférence)

We will discuss about what happened during this and the previous Novembertagung, and decide where the next one will be held.