

## REPORT OF THE ICHM-SPONSORED SYMPOSIUM GLOBAL MATHEMATICS

at the 2017 International Congress for the History of Science and Technology  
Rio de Janeiro, 25-26 July

The “Global Mathematics” symposium, organized by Michael J. Barany (Dartmouth College, USA), Rogério Monteiro (University of São Paulo, Brazil), and Anne-Sandrine Paumier (Institut des Hautes Études Scientifiques, France), featured 15 presentations (plus a 2 formal comments, in addition to general discussion) over the course of six symposium sessions during two days of the 2017 International Congress for the History of Science and Technology, with per-session attendance ranging from 18 to 33. The Symposium was highly successful in its aims for assembling a global community of researchers interested in historical and sociological questions arising from the global transformation of mathematics since the late nineteenth century, and for catalyzing an integrated discussion of historical, conceptual, and methodological foundations for ongoing study on this emerging topic of scholarly interest.

The ICHM contributed a total of US\$3000 to subsidize travel and attendance costs for six graduate students and recent doctorates who faced financial barriers to attendance, with individual grants ranging from \$250-800 according to need.

### SYMPOSIUM ABSTRACT

Mathematics today is presented as a global discipline. Mathematicians regularly travel thousands of miles to present their work and to collaborate. They share ideas and findings in an interconnected community that spans nations, languages, and continents. Our symposium on “Global Mathematics” assembles a range of historical and ethnographic perspectives on the emergence and consequences of this global system of mathematics from the late nineteenth century to the present. While the preceding period of “internationalization” in mathematics has received considerable scholarly attention over the last few decades, historians have only recently begun systematically to scrutinize later developments that saw mathematicians joined on an significantly broader scale. We examine mathematics “between the Global and the Local” through analyses of the individual and institutional circumstances that made global mathematics possible, situating them in their social, economic, cultural, political, technological, and scientific contexts. With these analyses, we situate mathematics in an emerging literature on global science while also marking where the story for mathematics departs from recent findings concerning other fields.

Speakers will relate changing mathematical theories and images of mathematics as a discipline in the period of globalization to the changing professional contexts of mathematical work and collaboration, as well as the changing values and infrastructures of mathematics education. These changes are evident in the shifting relations between national and regional mathematical communities, in the emergence and effects of new transnational institutions, as well as in particular communities’ responses to new global connections. We trace an arc through the two World Wars and the Cold War and its aftermath, showing how new geographies of power and prestige were manifested through new modes of communication and travel as well as new ideas about the nature and content of mathematics and their relation to the goals of state and society. The symposium will combine new historical accounts with new historiographical approaches to understanding the distinctive phenomena of global mathematics. With speakers and subjects-matter ranging across continents and hemispheres— principally focused on, but not limited to, the Americas (South and North), Europe (West and East), and East Asia—we aim to foster productive comparisons and to recognize connections and convergences not immediately visible in individual studies. Such encounters will shed new light on the effects of scale, place, ideals, and practices in constituting professional mathematical communities and mathematically-literate societies that became interconnected, in the last century and a half, as never before.

Les mathématiques sont présentées aujourd’hui comme une discipline mondiale. Les mathématiciens parcourent régulièrement des milliers de kilomètres pour présenter et collaborer. Ils partagent leurs idées au sein d’une communauté interconnectée qui réunit les nations, les langues et les continents. Notre symposium sur les « Mathématiques mondiales » rassemble une palette de perspectives historiques et ethnographiques sur l’émergence et les effets de cette mondialisation des mathématiques depuis la fin du 19<sup>ème</sup> siècle jusqu’à aujourd’hui. Alors que la période précédente d’ « internationalisation » a été étudiée fréquemment, les historiens ont commencé seulement

récemment à regarder systématiquement les développements plus récents qui unissent les mathématiciens à une échelle beaucoup plus large. Nous examinons les mathématiques « entre le global et le local » à travers les analyses des circonstances individuelles et institutionnelles qui ont rendu la mondialisation des mathématiques possible, en les replaçant dans leur contexte social, économique, cultural, politique, technologique et scientifique. Nous situons les mathématiques dans la littérature émergente sur la mondialisation des sciences en même temps que nous mettons en évidence les points de différence entre les histoires des mathématiques et des autres disciplines.

Les orateurs mettront en perspective les théories et les images des mathématiques à l'heure de la mondialisation avec les changements de contexte professionnel du travail, ainsi que des valeurs et des infrastructures pour l'enseignement. Ces changements sont évidents dans le décalage des relations entre les communautés nationales et régionales, dans leurs réponses à de nouvelles connexions globales, ainsi que dans l'émergence de nouvelles institutions transnationales. Nous dessinons un arc à travers les deux guerres mondiales et la guerre froide, montrant comme de nouvelles cartes de pouvoir se sont manifestées à travers de nouveaux modes de communication ainsi que de nouvelles conceptions sur la nature et le contenu des mathématiques et leur rapport aux objectifs des états et de la société. Le symposium comblera de nouveaux comptes-rendus avec de nouvelles approches historiographiques afin de mieux saisir les phénomènes distincts à l'œuvre dans la mondialisation des mathématiques. Avec des orateurs et des exposés traversant les continents et les hémisphères – concentrés sur les Amériques (du Sud et du Nord), l'Europe (de l'Ouest et de l'Est), et l'Asie de l'Est, sans s'y limiter – nous cherchons à reconnaître des liens et des convergences qui ne seraient pas visibles dans des études isolées. De telles rencontres donneront un nouvel éclairage sur les effets d'échelle, de lieux, de conceptions et de pratiques qui constituent les communautés mathématiques et leurs sociétés qui sont devenues interconnectées dans le dernier siècle et demi, telles qu'elles ne l'avaient jamais été jusqu'alors.

## PRESENTATIONS

### Session 1: The Stakes of Global Mathematics for Past, Present, and Future

*Welcome and introduction from the symposium organizers.*

Michael J. Barany, "Problems and Prospects in the History and Historiography of Global Mathematics"

My talk will offer a thematic survey to guide discussions within the "Global Mathematics" symposium, with a focus on the historical and historiographical questions that arise in studying global mathematics, as distinct from other areas of global history or the history of mathematics. In addition to material from the current historical literature, I will use findings from my own research on the history of the theory of distributions and the 1950 International Congress of Mathematicians to raise and complicate different points of the historiography. Developing the perspective articulated in the symposium description, I will define global mathematics and indicate some guideposts to its geography and periodization. Among a range of relevant historiographies, I will position global mathematics with respect to recent scholarship on international, transnational, and global technoscience, as well as on the transmission, communication, and institutionalization of mathematics. I will identify several themes---including scale, translation, materiality, and knowledge-politics---that have been well studied under other rubrics but demand renewed attention in view of the particular contexts and dynamics of global mathematics. These give rise to a number of methodological challenges for historians of global mathematics, as well as a number of vital avenues for research and collaboration.

Ursula Martin, "The impact of mathematics on a global scale"

Our social policy approach complements historical analysis to understand how, as countries around the world increasingly ask a return on research investment, universities use impact to demonstrate global influence. In the US and Europe, the traditional view of mathematics as an intellectual endeavour pursued for its own sake, has been increasingly challenged by an instrumental view. Vannevar Bush's forceful argument for funding science - that unfettered intellectual curiosity gives rise to unpredictable and useful discoveries - endures in present day advocacy for mathematics funding.

A 2010 UK government study by Deloitte used a top-down methodology to argue that mathematics research underpins 10 % of all UK jobs and 16 % of UK GVA. The availability of 209 standardised case studies of the impact of mathematics, collected across 52 universities as part of the UK's 2014 research assessment, allowed us to conduct a bottom-up multi-method study of how research in mathematics gives rise to impact. We used a categorisation developed for social science research,

classifying impacts as Instrumental, Conceptual, Capacity-building, Culture Change and Enduring Connectivity. This variety of impact types, going beyond more usual patents or start-up companies, was found to fit the impact of mathematics, in particular to capture impacts on policy, and thus to capture more completely the global impact of UK mathematics research.

The study also identified significant impact mechanisms, in particular long term relationships, interdisciplinarity, and impact via other academic disciplines. Though often not explicitly recognised, a variety of knowledge intermediaries, bridging the gap between researchers and users, are important: skilled individuals, readily available software, and specialist networks, for example through learned societies. The increasing globalisation of research through exchange of people and ideas, enabled by the internet, increases the reach of impacts.

Mathematicians often favour rigid linear narratives of intellectual influence, while also arguing that requirements to produce such linear narratives distort the reporting of impacts. Drilling into research themes finds complex international ecosystems of impact: papers, people, research users, knowledge intermediaries, with enduring links and fluid boundaries. Ironically, the more complex the ecosystem, the easier it is to extract such linear narratives: but the less representative they seem to be.

## **Session 2: The Recent and Contemporary Political Economy of Global Mathematics**

Ellen Abrams, "Backwards Graphs: Negotiating the Local and the Global at the Nesin Mathematics Village"

Recent findings in Leavitt path algebras and graph  $C^*$ -algebras have brought mathematicians together to explore a "mysterious" connection between the two fields. Researchers interested in either field, however, practice distinct forms of mathematics: Leavitt path algebras are primarily studied as a specialty in algebra, whereas graph  $C^*$ -algebras are a topic of analysis. In general, algebraists and analysts belong to distinct communities that differ in terms of norms, conventions, styles, and approaches. Yet in June-July 2015, representatives of both groups from ten different countries across five continents came together for a joint CIMPA (Centre International de Mathématiques Pures et Appliquées) Research School held at the Nesin Mathematics Village near Şirince, Turkey. While Science Studies scholars have characterized the coordination of diverse communities in terms of "trading zones," the coordination between algebraists and analysts at the Nesin Mathematics Village was directed instead toward the cultivation of a trading community. For the duration of the Research School, representatives of both groups took turns presenting to an audience of graduate students in a way that suggests a process of "training for trade." This process of training highlights the multi-sited production of mathematics between the imagined globalism of formal publications and the grounded production of knowledge at local institutions.

Lorenzo Lane, "Show you're working: Exploring visibility, productivity and competition in mathematics institutes"

I relate the local practices involved in producing mathematics in mathematics research institutes to the global field of discourse within which such practices are valued and oriented. Using ethnographic observations, interviews, and textual materials collected over 6 months of ethnographic fieldwork at 4 leading European mathematics research institutes, I study how knowledge and identity are presented, produced and performed within different social settings. I show how knowledge is transformed as it moves from private, informal settings to public, formal stages of presentation, demonstrating how the processes of "working-out", "writing up" and "writing out" serve to select, sort, and sanitise knowledge, so that it conforms to certain aesthetic criteria. These different presentations of knowledge and self, I explain, are influenced by the wider field of discourse within which mathematicians are situated. Using Bourdieu's (1980) notion of field, habitus and practice, as well as Goffman's (1959) work on theatres of performance, I describe the social mechanisms by which productivity, visibility and competitiveness relate public discourse to private practice, and allow us to understand how the idea of a "global" mathematics can be realised on multiple local scales.

Milena Kremakova, "The 'Schrödinger Postdoc': Work and careers of mathematicians in the global neoliberal academy"

PhD in mathematics: what next? This paper will discuss what pathways postdoc mathematicians take on today's global scientific job market, how their personal and professional biographies unfold in parallel, and what the challenges of combining a career in mathematics with personal life. I call today's typical PhD-graduate the "Schrödinger postdoc": an aspiring scientist whose career is a patchwork of short-term, insecure postdoctoral positions, often across institutions and countries.

Work and careers in science are framed by profound transformations in the structure and role of the contemporary university. These have often been described as a move away from the traditional Humboldtian “knowledge community” and towards a neoliberal “academic capitalism”. As universities become more like firms, jobs in higher education and research are ever more precarious.

Governments increasingly favour applied sciences at the expense of theoretical fields. Academic work and academic careers both increasingly international, but also pervaded by global inequalities. The organisation of teaching and research is increasingly fast-paced, bureaucratic and dependent on performance metrics. The number of academic fields and publications growing faster than ever. The “technocratic” time of the university clashes with the “thinking time” required to do good science. The internationalisation of science, precarious jobs, and the acceleration and marketisation of academic life create the conditions in which the working lives of men and women mathematicians unfold. They also shape science itself, by influencing which problems are tackled, how teaching is organized, how collaborations are structured, and how universities are run.

While academia, science careers and knowledge labour have been attracting more attention by sociologists and anthropologists of work, mathematics has largely evaded scrutiny. Aiming to fill some of this gap, the paper presents findings from a new three-year ethnographic study of work, labour and careers in the mathematical sciences. The research included ethnographic participant observation in mathematics departments, a comparison of the UK and German academic systems in a global context, and 105 life-course interviews with men and women mathematicians at all career stages, mathematicians no longer in academia, and university administrators.

### **Session 3: The Origins of an "American Century" of Global Mathematics**

Karen Parshall, "Reaching beyond National Boundaries: American Mathematicians Abroad in the 1920s"

The revival of the International Congresses of Mathematicians (ICMs) in the 1920s reflected a partial resumption of international mathematical contacts in the aftermath of World War I, but mathematicians in the United States wanted more. They had a sense of destiny. They saw it playing out at home with the success of their efforts to strengthen the infrastructure for their mathematical endeavors, but they also aspired to see it play out much more broadly. American Mathematical Society Secretary (AMS), Roland Richardson fully captured that spirit in a 1924 letter to Princeton geometer and then AMS President, Oswald Veblen. “America has in the past quarter-century made great strides in both pure and applied science,” he stated, “and it is hoped that by this move ... new forces will be let loose which will contribute toward putting America in the front rank which should be hers.” The “front” of that “rank” was clearly measured by an international yardstick.

One way to begin to achieve that broader recognition was for American mathematicians personally to represent their maturing community---as well as directly to share the fruits of their mathematical labors---abroad. Algebraist Leonard Dickson and others had done exactly that at the Strasbourg and Toronto ICMs in 1920 and 1924, respectively. The Americans, however, capitalized on other opportunities over the course of the 1920s in Europe as well as in Latin America. This talk will explore some of those contexts as it analyzes some of the nationalistic motivations that drove early efforts toward the globalization of mathematics.

Samson Duran, "L'American Mathematical Society comme actrice de la promotion des géométries étatsuniennes sur la scène internationale"

Dans les premières années suivant la création de l'American Mathematical Society, en 1888, la rhétorique des mathématicien-ne-s étatsuniennes les place comme étant d'un niveau mathématique en deçà de ceux des grands pays que représente l'Allemagne ou la France. Par ailleurs, des études historiques sur la formation des doctorant-e-s à l'étranger et le développement des institutions sur le sol étatsunien ont montré la constitution d'une communauté de recherche en mathématique solide dans le pays, lors du dernier quart du 19e siècle.

La situation étatsunienne va continuer à évoluer lors des vingt premières années du 20e siècle. Pourtant l'historiographie n'a pas proposé d'études sur les géométries dans ce pays pour ces deux décennies, et les constats passent donc souvent d'une communauté en formation sur la fin du 19e siècle à des travaux géométriques bien connus et influents à partir des années 20. Une étude des travaux géométriques portés par l'AMS montrera que ce moment constitue pourtant justement celui d'une évolution

pour passer du discours d'une nation élève du modèle allemand à celui d'une grande nation mathématique sur la scène nationale, et dont le niveau en recherche mathématique n'a plus rien à envier à celui des autres grandes nations européennes.

Mon étude s'appuiera sur l'étude d'un ensemble de marqueurs variés apportant différents éclairages sur l'évolution des travaux liés à la Géométrie aux États-Unis d'Amérique. J'aborderai ainsi la question du regard porté sur la scène internationale par la société, via les recensions de géométries dans le Bulletin de l'AMS, mais aussi dans les rencontres organisées par la société. De plus nous verrons que la création d'un journal dont les articles sont destinés à s'insérer dans la recherche internationale en portant haut les positions étatsuniennes sur la géométrie et l'évolution des enseignements universitaires dans le pays montre les volontés d'un développement fort qui est là aussi porté par la société.

J'essaierai ainsi de montrer comment les acteur-ric-e-s de l'AMS ont cherché à placer leur pays comme une nation importante en Géométrie sur la scène nationale lors des deux premières décennies du 20e siècle.

#### **Session 4: National Mathematics in a Global Scene**

Jenny Boucard, "Examples of géométrie de situation in the second half of the nineteenth century: between local practices et global circulations"

During the XIXth century, the expression « Géométrie de situation » is linked to very different mathematical practices even if it refers initially to some geometry focusing on situation or qualitative rather than quantitative properties. Here I focus especially on two main authors - Louis Poinsoot and Edouard Lucas - who promote a « Géométrie de situation » linked with number theory and mathematical recreations. In 1810, "géométrie de situation" is defined by Louis Poinsoot as a geometry where one "sees less the magnitude and proportion of the figures, than the order and location of the various elements that compose it." Poinsoot also indicates some important figures in the development of it, including Leibniz, Euler and Vandermonde and his work is then devoted to polygons and polyhedra. In 1891, a chapter of Edouard Lucas' *Théorie des nombres* is entitled "géométrie de situation". It comprises a set of problems including chess, polygons, polyhedra or lattices. For both authors, the "géométrie de situation" is a domain linking number theory, geometry and combinatorics. In this paper, I analyze the circulation of problems associated with the "géométrie de situation" and linked with polyhedra and chess boards by focusing on the media the different authors used to spread their work and how they were received in local, national and international scales. I show that these problems can be integrated in various disciplinary configurations according to different times and institutional spaces and I study the local and global aspects involved in terms of goals, values, practices, institutions.

Jiri Hudecek, "Mathematics, National Culture and Class in 1930s Japan and China"

China entered global mathematical mainstream after 1905, when new schools started teaching Western curricula and Chinese students went abroad to receive advanced education. By the mid- 1930s, a dynamic mathematical community had been established with ties to research centers all over the world. At the same time, traditional Chinese mathematics was being studied by firstgeneration historians of mathematics such as Li Yan (1892-1963) and Qian Baocong (1892-1974) as a revealing probe into the Chinese culture. These historians were motivated in their effort by developments in the history of mathematics abroad, especially in Japan. The Japanese historian Yoshio Mikami (1875-1950) understood mathematics as a particular offshoot of a holistic national culture, constructed from the culture of the Edo-period samurais. His Chinese counterparts argued that achievements of premodern Chinese mathematics meant that Chinese culture as a whole had a potential to embrace science and modernity.

Cultural nationalism was challenged by Marxists. Japanese historian Kinnosuke Ogura (1885-1962), influenced by G. Plekhanov, developed a class analysis of mathematics to reject cultural essentialism. Many of his articles were translated into Chinese, including a detailed criticism of Ludwig Bieberbach's (1886-1982) racist classification of mathematicians used to promote his ideas about "German mathematics". This article also warned against Japanese "Bieberbachs" and attempts to define a racially pure Japanese mathematics. In this paper, I will show that the interest Ogura's articles generated in China was not a reflection of Chinese mathematicians' belief in the universalism of mathematics, but rather of the

power of Marxist social theories and the utility of Ogura's arguments in the struggle against cultural imperialism.

Catherine Radtka, "Between national traditions and international debates: French mathematics teaching in search of modernization in the 1950s and 1960s"

After the World War II, many countries reformed mathematics education in relationships to the "New Math" movement. In France, new approaches and contents found their way to textbooks and classrooms in the late 1950s, and the reform culminated in the 1960s. Changes in the curriculum were linked to the changing professional practices of mathematicians, to a renewed social role of mathematics and mathematicians, and to changing values and aims of education. Many of these aspects and their consequences on mathematics education were discussed in international meetings organized with the help of the OEEC (later OECD), the UNESCO, the ICMI or the International Commission for the Study and Improvement of Mathematics Teaching. French mathematicians and mathematics teachers actively participated to the movement, while on the national scene the French association of mathematics teacher (APMEP) strongly advocated the modernization of mathematics teaching in a way which, progressively, put forward the implementation of "new math" curricula. The paper will come back to the debates regarding mathematics teaching in France during the 1950s and the 1960s, and link them to discussions held in international bodies. The purpose will be to investigate the international influence with regards to French specificities and to consider their possible survival after the reform. In particular, I will argue that, even though the actual experience of teaching new math in schools might have been relatively short, this reform changed for long the image of mathematics, not only because it resulted in the implementation of an axiomatic and structural conception of Mathematics which remains presents in the collective memory, but also because it unraveled the cultures and infrastructures of mathematics education. By comparing the situation of mathematics teaching in France and in England after the World War II, I will show that the "New Math" reform fostered the disappearance of a culture proper to the primary order of education and of entire branches of mathematics, such as cosmography, which characterized French mathematics teaching up to the late 1950s. Together with contemporary structural changes that affected the entire educational system, the "new math" movement would then be seen as a driving force towards globalization during decades marked by competing traditions and opposed understandings of the relationships between mathematics and pupils.

### **Session 5: Books Across Borders**

Luciana Vieira Souza da Silva, "Italian culture and the education of Brazilian mathematicians and physicists: the books adopted by University of São Paulo"

This talk explores the circulation of Italian text-books at the University of São Paulo, Brazil, in the 30s. During the Italian Fascist Government of Benito Mussolini, several cultural products were sent to foreign countries, such as movies, photographs, books, and even teachers and intellectuals, in order to diffuse Italian culture and spread positive propaganda of the Fascist Government. In the year 1934, attending these cultural policies, a group of Italian teachers known as Italian Mission was invited to teach at the Faculty of Philosophy, Sciences and Letters of the University of São Paulo, in Brazil. The point of this talk is to explore the diffusion of Italian culture in Mathematics and Physics courses during the classes of Luigi Fantappiè and Gleb Wataghin. In a history of books perspective, according Robert Darnton and Roger Chartier studies, books and text-books are significant vehicles to diffuse a culture (specially a dominant culture), thanks to their writing, production, and circulation. In this sense, we will analyze the lists of physics' and mathematics' Italian books bought to the Departments of Mathematics and Physics in the 1930 decade, as well as the text-book written by Gleb Wataghin in 1934 November, focused on his Brazilian students, in order to bring to light the authors, the publishers and the buyers of these books. In preliminary analyses, we observe authors such as Tullio Levi-Civita, Guido Castelnuovo and Francesco Severi, and different publishers, such as Vallecchi, Zanichelli and Società Italiana di Fisica. This study is supported by the grant 2015/20490-8, from the São Paulo Research Foundation (FAPESP).

Rogério Monteiro, "The Librarie Scientifique Albert Blanchard and the international market of scientific books"

The circulation of students, mathematicians, books and journals was a fundamental element in the homogenization process that mathematics underwent in the 20th century. From a local point of view, the development of national communities of professional mathematicians depended on the economic capacity

of local elites to send their students to study abroad, but also on the capacity of these communities to keep up to date with the new theories and methods developed in others centers of research. In this respect, a preexisting book market with librarians and editors capable of offering imported materials was an essential and precondition for the process of homogenization. Far from assuming a diffusionist perspective, these agents from the world of books translated and edited foreign authors, imported volumes, and sent their catalogs abroad, assuming a cosmopolitan strategy in order to reach their customers. In this context, the role of publishing houses in the circulation of mathematical sciences should not be disregarded. The editorial strategies of the Librarie Albert Blanchard richly illustrate this issue. Located near the Sorbonne, in Paris, the library was well known as a bookseller for the exact sciences and an editor of occasional brochures and doctoral theses, taking advantage of the Sorbonne's large student population. In addition, Albert Blanchard specialized in publishing foreign books in mathematics and physics, both in their original languages and in French translation.

Analyzing his long list of publications, it seems that the editor assembled his catalog by mixing translations of a few known figures like Sommerfeld, Herman Weyl, Ricci and Levi-Civita with works by unknown, young scholars and outsiders of the French community of mathematicians. His commercial formula offered a perfect occasion for foreign engineers and mathematicians to publish original works in France, thereby achieving some international visibility. Their ranks included the Swiss Gustave Juvet, from the University of Neuchatel, the Brazilian engineer Theodoro Ramos, from the Polytechnic School of São Paulo, and the French naturalized Belgian François Bouny, professor at the Technical Faculty of Hanover.

In my communication, I will explore the long list of authors edited by the publishing house Librarie Albert Blanchard, connecting his dual editorial strategy with the problem of the emergence of an international network of mathematicians.

Harald Kümmerle, "The role of foreign languages in the institutionalization of mathematics as a science in Japan during its buildup phase 1870-1930: practices in the university instruction and the publication market"

The Meiji government which came to power in 1868 early after started to build the first compulsory formal education system in the history of Japan. The import of Western technology and – as its foundation – Western science was given a very high priority in the government's policy in order to avoid colonization by the Western powers. While the founding of Tōkyō University in 1877 is often given as an epoch-making date in the history of Japanese higher education, overemphasizing this shadows that there were much more continuities than discontinuities. Although most of the foreign teachers at the Faculty of Science were replaced by Japanese ones in the next decade, lecture notes in mathematics and natural sciences were taken in foreign languages (mostly English) for decades to come regardless of the possibility to communicate in Japanese colloquially. While this can be considered a natural example of institutional inertia, examining the reasons which contributed to this choice gives much insight into import strategies of scientific knowledge.

Likewise, the language of research published by the university staff did not change to Japanese once the teaching staff had become Japanese. While this is connected to the preference of foreign languages in class, there were also political reasons: the journals were by and large funded by the government, for which having research institutions gain a good reputation abroad was an issue of national prestige. Correspondingly, the fact that for people without a connection to academia it was difficult to publish in Japanese Western-language journals guaranteed a minimum standard for research by Japanese that was recognized internationally.

At the junction of academic teaching and academic research, textbooks can fill an important gap by giving comprehensive and streamlined presentations of single topics. But in respect to the publishing of textbooks, economic calculations played a much bigger role than practical considerations in class or political priorities for obtaining a high reputation. Because the field of mathematics had rather low enrollment numbers for a long time, it was not until the 1920ies that Japanese language textbooks began to appear.

Tatiana Roque, discussant

## **Session 6: Algebra at the Boundaries of Languages and Disciplines**

Frédéric Brechenmacher, "On the universalization of linear algebra: the emergence of a global discipline from local mathematical cultures (1900-1960)"

The emergence of linear algebra as an international discipline highlights a complex phenomenon of globalization of a specific organization of knowledge aiming at universality, both in mathematical research and education. Although this phenomenon took place within a decade, in the 1930s, it involves the long-term interrelations of various local mathematical cultures, involving specific practices, forms of representations, values, and ideals. This phenomenon challenges not only the usual description of the history of algebra as a progress toward more and more abstraction, but also the importance that has usually been given to a few specific mathematical theories, individuals, and social environments. For instance, while the historiography of algebra has tended to lay the emphasis on German developments in algebraic number theory, the universalization of matrix decomposition highlights the key role played by circulations of specific practices within a network of texts involving mostly French and American mathematicians. Investigating such circulations between the local and the global raises the issue of the relevant categories for describing collective organizations of knowledge or the social identities of groups of actors.

Ryan Dahn, "An Unlikely Collaboration: The Geopolitical Context of Pascual Jordan's Eponymous Algebra"

Historians have rightfully identified the Nazi takeover of Germany in 1933 as a turning point in global scientific history. With the near-instantaneous dismissal of Jewish and left-leaning scholars that same year, German science lost many of its brightest lights; the ensuing wave of emigration dispersed this formerly-local community across the world. Meanwhile, those who remained in the Nazi state became increasingly isolated from their colleagues abroad in the face of official suspicion of foreign contacts and resulting restrictions on international travel.

Against that backdrop, this paper presents the story of a highly unlikely mathematical collaboration that managed to bridge that divide. In late 1932, physicist Pascual Jordan stumbled onto the idea that non-associative algebras might be the path forward for quantum electrodynamics, just as noncommutative algebras—in the form of matrix multiplication—had been the key to understanding the quantum revolution of the 1920s. During early 1933, this interest developed into an intense collaboration with John von Neumann and Eugene Wigner, culminating in a famous ‘three-man paper’ that outlined what are now termed ‘Jordan algebras’.

This collaboration would not be surprising under normal circumstances, as the three had long been friendly. Yet under the political conditions it is exceptional: as the paper was being written in spring 1933, Wigner and Neumann fell victim to the Nazi purge of Jewish scholars and made plans to permanently emigrate to the United States. At the same time, Jordan was professing his allegiance to the new regime in a series of articles under his political pseudonym; he ultimately joined the Nazi Party on May 1. Amazingly, these events had no impact on the collaborative spirit of the three, and Jordan eagerly agreed to the suggestion of Wigner and Neumann that the article—drafted and conceived in German—be published in English, in the American journal "Annals of Mathematics". The ultimate appearance of the three-man-paper in 1934 cemented a friendship that managed to survive the war years; the present paper examines this unlikely collaboration as a microcosm of global mathematics in the 20th century.

Christopher Hollings, "A Language of its Own? Communicating Mathematics across Language Barriers"

During the years of the Cold War, Western mathematicians developed a great interest in Soviet mathematics, which they perceived as world-leading, and therefore engaged in many efforts to gain greater access to the relevant work. On the language side, these ranged from the teaching of courses in mathematical Russian to the cover-to-cover translation of major Soviet journals. Indeed, where Western resources for accessing Russian-language materials were concerned, mathematics was one of the best-served disciplines. I believe that this enthusiasm was due, at least in part, to the nature of mathematical Russian: that a knowledge of mathematics enables the reader to glean some small amount of understanding, even if they know no Russian. In this talk, I will extend this suggestion to other languages, and argue that the near-universal nature of mathematical notation, terminology and writing style (certainly in recent centuries) has given mathematics a privileged position in the communication of scientific ideas across language barriers.

Leo Corry, discussant