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Emigration of Mathematicians and Transmission of Mathematics: Historical Lessons and Consequences of the Third Reich

Organised by
June Barrow-Green, Milton-Keynes
Della Fenster, Richmond
Joachim Schwermer, Wien
Reinhard Siegmund-Schultze, Kristiansand

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Abstract. This conference provided a focused venue to explore the intellectual migration of mathematicians and mathematics spurred by the Nazis and still influential today. The week of talks and discussions (both formal and informal) created a rich opportunity for the cross-fertilization of ideas among almost 50 mathematicians, historians of mathematics, general historians, and curators.

Mathematics Subject Classification (2000): 01A60.

Introduction by the Organisers

The talks at this conference tended to fall into the two categories of lists of sources and historical arguments built from collections of sources. This combination yielded an unexpected richness as new archival materials and new angles of investigation of those archival materials came together to forge a deeper understanding of the migration of mathematicians and mathematics during the Nazi era.

The idea of measurement, for example, emerged as a critical idea of the conference. The conference called attention to and, in fact, relied on, the seemingly standard approach to measuring emigration and immigration by counting emigrants and/or immigrants and their host or departing countries. Looking further than this numerical approach, however, the conference participants learned the value of measuring emigration/immigration via other less obvious forms of measurement.

Forms completed by individuals on religious beliefs and other personal attributes provided an interesting cartography of Italian society in the 1930s and early 1940s. Observing the length of time a Minister of Education in Spain remained in office over three-quarters of a century provided a unique assessment of the educational and scholarly values (or lack thereof) in Spain before, during and after World War II. Mapping the geographical paths followed by refugees on a single globe and looking for patterns offered still further insight into how mathematicians and mathematics traveled. For all these proactive forms of measurement, one speaker urged participants to use caution when measuring emigration and immigration in terms of gain and loss.

Measuring the anguish of physical emigration in the form of a painting, such as Frans Henriques' "Travel to Sweden. October 1943," provided a distinctly human evaluation of this moment in history and highlighted another meaningful insight from the conference.[1] As one speaker put it, "this was an intensely personal moment in history." In the words of a Jewish mathematician of the time, "sudden and arbitrary unemployment was the first step to serious personal catastrophe." At this "moment in history," personal and professional lives were inextricably linked.

The talks and discussions underscored the role of choice in emigration and immigration. Here again, the conference called attention to more obvious forms of choice in the form of, say, the choices of Karl Menger to leave Austria or Emil Artin to leave Germany. Those individual choices, however, depended on institutional choices in the host countries. Other talks pointed out the more subtle choices of Arnold Scholz that ultimately prevented his emigration from Germany or the lingering choices of university officials that resulted in disastrous consequences for mathematicians hoping to immigrate. Economic interests sometimes motivated these administrative choices and yielded their own consequences.

From the outset, the conference organizers placed an especial emphasis on gaining a better understanding of refugees from countries other than Germany. A collection of talks on issues related to emigration and immigration in Czechoslovakia, Hungary, Poland, Spain and Denmark ("a temporary refuge") helped achieve this aim. Even better, many of these talks were prepared and presented by young scholars in the field.

The 46 conference participants came mainly from Europe and North America, among them five young researchers who participated as Oberwolfach Leibniz Graduate Students. The organizers are very grateful to the Leibniz-Gemeinschaft for this support. The staff of the Mathematische Forschungsinstitut Oberwolfach was—as always—extremely supportive and helpful. We thank them for providing excellent working conditions.

The conference participants especially appreciated the interesting mix of people and talks we enjoyed during our week at the MFO. The last talk of the conference discussed the difference between one grain, one pile, and one heap of rice and raised

[1]The Danish title of Henriques' 1952 painting is "Rejsen til Sverige. Oktober 1943." The organizers would like to thank Henrik Kragh Sörensen for calling attention to this painting in his talk and for providing a translation of the title.

the critical question of how one moves from the pile to the heap. This conference allowed participants to add to the pile, but not quite reach the heap, in terms of our understanding of migration and immigration in the Nazi era. Continued conversations and investigations will add to this perpetual progress.

Finally, the organizers would like to thank the reporter, Craig Stephenson, for his excellent work with the abstracts which is evident in the coherence of the report and which was much appreciated by the authors.

Workshop: Emigration of Mathematicians and Transmission of Mathematics: Historical Lessons and Consequences of the Third Reich

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Abstracts

Forced migration and scientific change in the Nazi era

Mitchell G. Ash

The so-called 'Law for the Reconstitution of the Professional Civil Service' (7 April 1933), the Nuremberg racial laws (1935), the takeover of Austria (March 1938) and the murderous pogroms of 9 November 1938 led to mass migrations, not only of scientists and scholars, but of leftists and people of Jewish descent from many walks of life. The forced migrations of the Nazi era were qualitatively new in history up to that time. In the ongoing effort to describe and analyse these migrations and their impacts, a shift has occurred from a focus on émigrés' contributions to science, scholarship and culture in the so-called receiving countries, that is from a products to a process perspective. Discussion has moved beyond a discourse of loss and gain to analyses of dynamics of cultural and scientific change [4, 5]. This paper is an effort to summarize the results and implications of this recent literature, focusing on four questions: Who must leave and why? Did a loss or gain of PEOPLE mean the same for SCIENCE? Who may work in new places, and why? Science and scholarship in new places: linear transfer or transformation?

In this discussion migration, emigration or immigration, and exile are distinguished from one another. Migration is defined as any change of location of people, things, practices or ideas. Emigration is described as out-migration and immigration as in-migration; both processes are driven by choices made by the migrants themselves, albeit under duress. Exile is defined as a state of mind focused on trauma and a desire to return to one's homeland, acculturation as the process of adaptation undertaken by émigrés who decide to remain in their new locations. Finally, scientific changes due to forced migration, particularly but not only in the Nazi era, are described as reconfigurations of social and cultural resources, or resource ensembles [2].

Who must leave and why? The Nazi civil service law that led to the ejection of hundreds of academics from their university positions was not itself a science policy measure, but a central component of the Nazi seizure of state power. In this connection two kinds of political dismissal can be distinguished. Socialists or leftist intellectuals understood why they were being driven out, but many scholars and scientists who were defined as Jews regardless of their actual religious beliefs or ethnic loyalties often did not grasp what had happened to them. They were assigned an identity by political powers without their consent, with deeply traumatic results.

Did loss or gain of PEOPLE mean the same for SCIENCE? Nazi-era dismissals varied widely across institutions, and also across disciplines. A recent overview [15] indicates that total dismissals from 15 of the 23 German universities before the annexation of Austria amounted to roughly 21 per cent of professors and Dozenten. According to older and more recent reports [14, 15], the universities of Berlin, Frankfurt and Breslau (later also Vienna), all places with large Jewish populations, had the highest dismissal rates, while the universities in Rostock, Tübingen and Erlangen (later Innsbruck) had very few. Variability across disciplines ranged from chemistry with more than 23 per cent [7, 8] to population science, history or German philology with very small numbers. Mathematics appears to place relatively high on this curve overall [28], though the data do not allow easy comparison with other data sets due to different listing criteria. Like other disciplines such as physics [11], mathematics also shows high numbers of dismissals at some universities and no dismissals at all in others. These variations cannot be indicators of the supposed ethnic content (Jewishness) of any field, but rather point to the relative openness of the universities, disciplines, institutes or individuals in question to appointments by scientific merit without regard to religious or ethnic prejudice before 1933.

It is incorrect to assume without investigation a necessary causal relation between loss of personnel and loss of scientific content. And it is a fundamental error to assume that later achievements by émigrés, such as Nobel prizes awarded to them in the 1940s or 1950s, should be regarded as losses to German-speaking or gifts to English-speaking culture [20]. Rather, such achievements were enabled by contingencies and opportunities resulting from forced migration itself (see below).

Who may work in new places, and why? Relevant here are shifting discriminatory immigration policies in major receiving countries, such as Great Britain, France (until 1940), Canada and the United States, from which academics could sometimes, but not always, be excepted. Important also is the presence or absence of infrastructure for science; opportunities were available for émigrés in Turkey, Palestine, or Latin America, but conditions there were much worse than in the United States. Whether a given field of knowledge was more or less internationalized affected the presence or absence of disciplinary and other aid networks in support of émigrés. Age and gender were of course relevant as well. Older men with fewer language skills and women of all ages were at a great disadvantage in a depressed labor market [25].

Sources of temporary support were academic aid organisations such as the Emergency Committee in Aid of Displaced Foreign Scholars in the US, which cooperated with the Rockefeller Foundation [12], and the Academic Assistance Council (later: Society for the Protection of Science and Learning) in England [17], but also political and religious organisations [29], as well as committees and individuals working at the disciplinary level (for mathematics, see [26, 27, 28]). The gate-keeping function of these organisations and key individuals was often decisive in the distribution of career chances. Thus there existed a basic tension between humanitarian motives and the opportunity to mobilize human resources. Officials of the Rockefeller Foundation asked whether a given scientist or scholar was a good investment, meaning whether they were likely to receive permanent positions after their temporary stipend expired. Such successes depended in turn upon academic and other social contacts, and thus on the networking abilities of the émigrés and their willingness to adapt to local cultures. In this respect social and disciplinary acculturation were not the same. Not only language skills, but also behavior was relevant at both levels.

In sum, we can speak here of a trick of (Nazi) unreason. The Nazi-era expulsions led on balance to unprecedented opportunities for the émigrés (usually, though not always in the U.S.), compared with the career chances that would have been open to them in German-speaking Europe. Unfortunately, however, we know far too little about those who failed to find positions (for the example of biologist Viktor Jollos, see [6, 9]).

Turning to the topic of scientific change itself, the literature shows a wide range of possibilities, including linear transfer of research programs and practices, complete breaks from the past, and more complex changes. An example of linear transfer is the work of embryologist Viktor Hamburger [6]. A case of continuity only partly rewarded appears to be that of biologist Richard Goldschmidt, who won a prestigious professorship in Berkeley but whose focus on development was not in line with the molecularization of genetics [6, 9]. Physicist James Franck's work on photosynthesis was well-funded by the Rockefeller Foundation due to his earlier success in physics, but did not lead to innovation [5].

In order to conceptualize this variation, two paradigmatic processes are proposed: (a) de- and re-localization of practices — instruments and skills relying on what émigré Michael Polanyi [22] called tacit knowledge [18, 19, 21]; (b) inter-, multi-, and transcultural syntheses via new resource constellations, most obvious in, but not limited to, technoscientific programs such as the Manhattan project. Here as in other military research (cf. [10]) the role of so called applied mathematics employing problem solving heuristics of the kind publicized by émigré Hungarian George Pólya [24] was significant. Perhaps this work could be more precisely described as science in contexts of application, since new basic science was also necessary in order to achieve the practical goals involved.

Siegmund-Schultze is surely right to point out that the Nazi era migrations led to the establishment of new centers in science, including mathematics [28]. But analyses that refer to influences of émigrés on their new colleagues or of the receiving culture on the work of the émigrés must take account of the fact that such processes are rarely as linear as terms like influence or transfer seem to suggest [3].

English had become the most frequently used language in natural scientific publications before 1933 [1]. Thus, contrary to often-stated claims, the Nazi-era persecution of scientists and scholars did not actually cause, though it surely accelerated the shift in scientific strength from Continental Europe (especially Germany) to the United States. In any case, many of the fundamental scientific changes of the twentieth century occurred independently of Nazism's impact. Thus, there is no necessary causal relationship between forced migration and scientific/scholarly change. However, the specific timing of changes and the resource constellations mobilized in specific cases can be explained historically. The contingencies that emerge from such accounts document yet again the fundamental openness of human affairs.

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Emigration of mathematicians and of mathematics: facts and open questions

Reinhard Siegmund-Schultze

1. New tendencies after the Nazi purge

We asked in the abstract for the workshop about the

> "Emigration of Mathematicians and Transmission of Mathematics: Historical Lessons and Consequences of the Third Reich".

Indeed, after the many deep changes in the communication structure of science and mathematics in recent decades, with globalization progressing and information technologies mushrooming, one is tempted to repeat the perennial question of the historian: what can we really learn from history and what does emigration 75 years ago teach us about the global mathematical research and the teaching of today?

Between World War II and today, of course, there have been any number of new phenomena leading to academic migration, including remigration, post-war migration for economic reasons, the 'brain drain', the fall of the Iron Curtain etc. In many of these instances of academic migration one finds the traits and consequences of the original explosive migration due to Nazi rule.

Now I would argue that there is indeed something special and historically specific to 'migrations' as compared with other phenomena of globalization such as the internet, or even frequent visits to international meetings. Migration is clearly intimately connected to the structures of the national and international scientific systems, to political decisions, as well as to the peculiar needs of oral communication. In fact, the importance of 'oral communication' in the sciences was already apparent in the 1920s and the foremost U.S.-American foundations took account of this by granting stipends on an international basis. (This leads us, by the way, also to the dimension of tacit knowledge, to be discussed at another workshop in Oberwolfach in January 2012.)

Of course much depends on the notion of emigration which one uses. In this respect I learned much from Mitch Ash's work dating back to the 1980s, then often focussing on psychology (Gestaltpsychologie etc.). One has, for instance, to differentiate even today between voluntary and forced migration; there are, after all, an abundance of repressive regimes. But also the bounderies between different types of migration are fluid. In order to find something historically relevant, not just for the individual in question but also with regard to the various scientific systems between which the practitioners are migrating, I found it useful to first restrict the notion of emigrant and then gradually to extend it in different directions.

2. Results from the time of the mass emigration after 1933

For my work on the first half of the 20th century, I therefore assumed a rather narrow notion of emigration in the sense that the émigré was required to have completed graduate studies (Ph.D.) in his/her home country (see [1]).

It is one of the most important results of research into the flight of German-speaking mathematicians to the U.S. during the Nazi-period that the American system was sufficiently mature and versatile to absorb the refugees. In other words, immigration added to tendencies in the U.S. which were at work anyway. There existed a tradition of research in pure mathematics. The refugees added, in particular, to the development of academic applied mathematics (Courant, Lewy, Mises, Prager, etc.). There existed research institutes (Princeton), teaching institutions and industrial enterprises (Bell etc.) which profited from the immigrants and guaranteed the continued flux of young talent between research, teaching and the applications. The war added to the interaction of these institutions.

Immigration was, however, largely unable to change those patterns in the American system which were so deeply entrenched in the social structure, such as the localized, tax-dependent and 'overdemocratic' school system.

The emigration of mathematicians from Europe after 1933 and the ensuing shift of the world centre of mathematics from Europe to the United States is arguably the most important historical result for mathematics of the Nazi rule. This result is at least comparable in importance with the reorientation towards the fields of applied mathematics due to the war, which, in part, was also promoted by emigration. Much of today's hotly-debated problems in American mathematics and in mathematics world-wide (such as the relative advantages and disadvantages of the various national educational and school systems, the need for the classical European background in analysis, and communication systems in research) cannot be discussed without reference to the very important historical event of emigration.

3. Lacunae in the research on emigration in mathematics

So far, research has been largely restricted to German-speaking emigration, with the focus being on the United States. Little has been done on Britain and even less on the emigration to the Soviet Union and Turkey. Existing analyses have concentrated more on global and descriptive levels; studies for individual disciplines are for the most part lacking, exceptions being combinatorial group theory and representation theory (Chandler/Magnus) and aerodynamics (Hanle).

4. Today's new, changed conditions for research on emigration in mathematics

- Both the generation of the refugees and that of their students have now died out or, at least, retired;
- Further unpublished papers by refugees and by mathematicians remaining in Germany have now become available (Rado, Blumenthal, Bernstein, Hasse, Bieberbach, Süss);
- Ever more material is available on the Internet;
- Opening of new archives in the East (Russia, Poland, Czech Republic);
- Research on emigration to the Soviet Union (Walfisz: researched by Lamm);
- New research on French émigrés (Weil: Audin, Loève: Simon/Mazliak);
- Opening and research of new archives in Italy (Volterra);
- Beginnings of research on mathematics under Franco (Pacheco);
- Beginning of a systematic study of the SPSL archives in Oxford (Nossum);
- Recent interest by Turkish colleagues (Eden, Irzik), although the archival situation there is still deplorable;
- New research on remigration to Germany (Krauss, Remmert).

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Persecution and emigration of mathematicians: the case of Fascist Italy

Annalisa Capristo

In my talk I focused on the Fascist anti-Semitic persecution and its effects on the Italian mathematical world, with special consideration to the fate of those Jewish mathematicians, both Italian and foreign, who fled the country between 1938 and 1945. I also referred to the Jewish remigration after World War II. Finally, I considered the case of some non-Jewish mathematicians who opposed Fascism in different ways and were persecuted and/or forced to leave Italy after September 1943.

At the end of the 1930s the small community of Italian mathematicians was harshly struck by the Fascist regime. Mathematicians of international renown such as Guido Castelnuovo, Federigo Enriques, Gino Fano, Guido Fubini, Beppo Levi, Tullio Levi-Civita, Gino Loria, Beniamino Segre, Alessandro Terracini, Vito Volterra—to mention only a few names—were completely excluded from the Italian scientific world.

The scientists who were persecuted and/or forced to emigrate were predominantly Jewish. As such, they were strongly affected by the anti-Semitic legislation in force since late 1938.

Between 1938 and 1943 Jews who remained in Italy had to face a situation of 'civil death' in their own country; many of them also experienced worsening economic conditions, because only a few people among those who lost their jobs had the right to receive a pension.

Because of the persecutory politics set in motion by the Fascist government, many Italian Jews attempted the difficult path of emigration. The experience of exile—either temporary or for life—strongly influenced their lives and their scientific careers.

The emigration occurred under different conditions corresponding to the two distinct periods in which it took place, 1938–1943 and 1943–45. Before the political crisis of 25 July 1943, it took place under many restrictions and with many difficulties, above all of an economic and organizational character. After 8 September 1943, it meant fleeing from round-ups, arrests and deportation. In other words, it was a matter of saving one's own life and those of his family.

The Italian Jewish mathematicians who escaped from Italy in 1939 and took refuge abroad were Beniamino Segre (England), Guido Fubini (Paris, France; then Princeton and New York, United States), Beppo Levi (Rosario, Argentina), Alessandro Terracini (Tucumán, Argentina), Gino Fano (Lausanne, Switzerland). The actuary Pietro Smolensky can be included among the emigrating professionals. In 1938 he worked as *condirettore centrale* at the insurance company Assicurazioni Generali in Trieste. After his dismissal he went to Paris; then, in March 1939, he fled to Argentina with his family. Smolensky directed the life insurance company La Continental and taught actuarial mathematics at the University of Buenos Aires. He also served on the board of directors of the Instituto Actuarial Argentino.

Furthermore, the case of Mario Salvadori (both an engineer and a mathematician) should be considered. As a son of a 'mixed' marriage, in September 1938 "Salvadori was involved twice in racial queries[...]. An official notice of temporary suspension from the IAC [the Italian Institute for the Application of Calculation] pending verification of his racial status arrived in November 1938." At the beginning of January 1939 Salvadori fled Fascist Italy and settled in the United States with his wife, who was also of Jewish origin. They arrived in New York on 13 January. "The very next day, a wire reached him saying that his suspension due to racial reasons had been rescinded" [28, pp.173–178]. In 1959 Salvadori was appointed full professor at Columbia University.

If—at least until 1943—for Italian Jews (both Jews by faith and people who on the basis of the racist-biological criteria of the Fascist laws were considered to be of Jewish race') the emigrations were not imposed by law or by violence, the decision to leave was objectively provoked by the deprivation of the civil rights which had been won in the second half of the 1800s, and above all by the impossibility of carrying out studies and continuing one's professional activity in Italy.

Meanwhile, according to the law decrees of 7 September and 17 November 1938, for the foreign Jews (with few exceptions) it meant actual expulsion by 12 March 1939. The category of foreign Jew included even those who had acquired Italian citizenship after 1 January 1919 and who were unable to take advantage of the exemptions granted by the law. In the second half of 1938 their citizenship was revoked and many found themselves stateless. Among these were university professors and professionals who had arrived in Italy from Central and Eastern Europe in the 1920s and 30s either to find a job or to seek refuge. Now they had to emigrate for a second time, in much more difficult conditions. Although—after March 1939—the mass expulsion of foreign Jews had been delayed and then not enforced because of the war, the situation for those remaining in Italy without authorization or with residence permits worsened considerably. After Italy entered WWII foreign Jews were arrested and interned.

Among the foreign Jewish mathematicians forced to emigrate from Italy because of the Fascist anti-Semitic laws were Robert Frucht (who established himself in Chile), Izaak Opatowski and Wolfgang Wasow (both of whom emigrated to the United States).

During the period of the Italian Social Republic and the Nazi occupation of central-northern Italy, some Jewish mathematicians—such as Castelnuovo, Enriques and Loria—were forced into hiding. Bonaparte Colombo (a former adjunct professor of Mathematics at the University of Turin) fled Italy to Switzerland. Annetta Segre and Diana Jacchia, former high school teachers of mathematics, and Luigi Sinigallia, a former instructor at the University of Pavia and Parma, were arrested, deported to Auschwitz and killed.

Even for professors who were well-established in the scientific community and recognized internationally it was very difficult to secure a visa and a position in a foreign country. Many aspiring exiles turned to international organizations founded for the purpose of offering support to foreign displaced scholars, such as the Society for the Protection of Science and Learning in England and the Emergency Committee in Aid of Displaced Foreign Scholars in the United States. The majority of the exiles, however, found a position thanks to their own international academic contacts and with the recommendation of friends and colleagues.

After 1945, for Italian Jews the restoration of rights and the 'return to life' was a long journey fraught with obstacles, above all of a bureaucratic character. In academia, even tenured full professors encountered difficulties in regaining their former positions, which in the interim had been assigned to non-Jewish professors. Lecturers and adjunct professors encountered still more troubles. In addition, since the purge within the university was largely a failure, the victims of the persecution were again, after a few years, colleagues of those who were fully compromised by Fascism and who were more or less active supporters of the anti-Semitic politics. This was another reason that many university professors and professionals who had emigrated did not return to Italy after 1945. Others, however, reinserted themselves into the Italian academic environment. Among them were the mathematicians Beniamino Segre and Alessandro Terracini.

Even some non-Jewish mathematicians were punished by the regime for political reasons, as anti-Fascists, or they were induced to emigrate. At least three cases are worth noting.

The first is that of Lucio Lombardo Radice. Having graduated in Mathematics at the University of Rome in 1938, in 1939 he was arrested and imprisoned for his anti-Fascist activity as a member of the Communist Party. For this reason, he could not assume his post of adjunct professor of Geometry at the University of Rome. Lombardo Radice returned to teaching and to his scientific work after the end of the war.

The second case is that of Ada Rossi, the wife of the anti-Fascist leader Ernesto Rossi. With a degree in mathematics from the University of Pavia and a teaching post at a technical institute in Bergamo, Ada Rossi was forced to leave a public school because of the anti-Fascist activity she pursued in collaboration with her husband. Throughout the 1930s Ada Rossi was under police surveillance; in 1942 she was arrested and confined at various places in southern Italy. She obtained her freedom after 25 July 1943 and was able to rejoin her husband, with whom she participated in the founding of the European federalist movement in Milan. After 8 September 1943, Ernesto Rossi—again sought by the Nazi-fascist authorities and in very poor health on account of the deprivations suffered during his imprisonment—took refuge in Switzerland in order to flee arrest. His wife followed him into exile, which lasted until April of 1945.

The third case is that of Gustavo Colonnetti, engineer and mathematician, exponent of Catholic Action, who, after the war, was also a member of the Italian Constituent Assembly and president of the Italian National Council of Research. After 25 July 1943 and the collapse of Fascism, during the period of the 45-day Badoglio government, Colonnetti was nominated provost of the Polytechnic of Turin, a post he had already held from 1922 to 1925. After 8 September 1943, he decided to leave Italy to flee the Nazi-fascist reprisals and he sought refuge in Switzerland. He taught at the École des Ingenieurs at the University of Lausanne and directed the university campus for Italian refugee students. In exile he carried out an intense politico-cultural activity.

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Expelled female mathematicians in exile: working conditions, and the impact on pure and applied mathematics

Renate Tobies

Based on a survey of the career spans of the studied group, the lecture considered the working conditions in the immigration countries and the impact of female mathematicians' emigration on special fields.

1. Sources and statistics

We analyzed the career paths of several thousand individuals who successfully completed their studies of mathematics at the tertiary level in Germany during the 20$^{\text{th}}$ century and opted for a secondary teaching examination and/or a Ph.D.

- (a) a sample of individuals who passed a secondary teaching examination in mathematics, in the largest German federal state, Prussia, from 1902 to 1940, 15.2% of whom were women and 2.7% of whom were Jewish women [was based on newly discovered material, personal record cards, from the Archive for Historical Education Research (Archiv für bildungsgeschichtliche Forschung) in Berlin];
- (b) the entirety of mathematicians who gained a doctorate in Germany, from 1907 to 1945. Number of male mathematicians: 1347, of whom 131 were foreigners. Number of female mathematicians: 120, of whom 4 were foreigners. 13% of the German female mathematicians who completed a doctoral thesis had Jewish ancestry.

The only two female mathematicians who were able to obtain their postdoctoral degrees (Habilitation) in mathematics at a German university prior to 1933, Emmy Noether (1882–1935) in Göttingen and the Austrian Hilda Geiringer (1893–1973) in Berlin, were also Jewish. Geiringer had earned her doctorate at the University of Vienna.

2. Career spans and grounds for dismissal

The most usual career was to become a secondary school teacher.

Racist 'reasons':

There were 15 Jewish-born women who completed a doctoral thesis in mathematics at a German university. They lost their positions as secondary school teachers and as lecturers at universities (Emmy Noether).

A list of Jewish women who completed a mathematical thesis at a German university:

Erlangen	Noether, Emmy	(1919 devoid of) (PhD: 1908), Hab., Prof., **Exile U.S.A.**, algebra (denomination)

Breslau	Goldmann, Frieda	(1909), teacher, unknown, geometry
Breslau	Neumann (Courant), Nelly	(1909), teacher, concentration camp, geometry (ev.)
Göttingen	Kahn, Margarethe	(1909), teacher, concentration camp, topology
Göttingen	Löbenstein, Klara	(1909), teacher, **Exile Argentina**, topology
Königsberg	Hurwitz, Charlotte	(1915), teacher, concentration camp
Halle	Paderstein, Elisabeth (ev.)	(1918), teacher, unknown
Breslau	Weyl, Gertrud	(1921), teacher, unknown
Heidelberg	Wolfsohn, Hilde	(1924), unknown
Bonn	Fröhlich Cäcilie	(1925), Industry, **Exile U.S.A.**, appl. maths
Göttingen	Stern, Antonie	(1925), Kaiser Wilhelm Society, **Exile Palestine**, analysis
Frankfurt a.M.	Weil, Ilse (ev.) Half-Jewess	(1926), Stud.Ass. 1.10.28–1.4.34
Heidelberg	Leibowitz (née Winter), Grete	(1933), **Exile Palestine**, history of mathematics
Breslau	Silberberg (married Kober), Käthe	(1934), **Exile Great Britain**, differential geometry
Berlin	Peltesohn, Rose	(1936), **Exile Italy, Palestine**, algebra

Political reasons:

Margarete Hermann (1901–1984 Bremen), Emmy Noether's doctoral student (1925), and Adelheid Torhorst (1884–1968), who earned her doctoral title (under Eduard Study) at the University of Bonn in 1915, were politically active after World War I (Social Democracy). They went into exile and entered into marriages of convenience - Margarete Hermann in Great Britain, Adelheid Torhorst in the Netherlands. In addition, Emmy Noether was a member of the USPD and the SPD, and her dismissal in 1933 was also based on political reasons.

3. Immigrant countries and particular conditions faced by women in the labour market

We know from seven of the Jewish women who obtained a doctorate that they were able to find their way into exile: to the United States, Belgium, Italy, Turkey (Hilda Geiringer), Great Britain, Palestine, and Argentina. Two left Germany for political reasons; two other female mathematicians followed their Jewish partners: Hanna Neumann (b. Caemmerer) to Great Britain; Hildegard Rothe (b. Ille) to the United States.

In 1943, having had to flee Turkey for the United States, Hilda Geiringer wrote "I am certainly conscious of the fact that it is hard for a refugee + woman to find something." Nevertheless Emmy Noether's (Modern Algebra) and Hilda Geiringer's (Applied Mathematics) careers in the United States confirm that the

United States offered comparatively better career possibilities. Further examples of this from the German-speaking world are provided by the Austrian number theorist Olga Taussky-Todd (1906–1995) and the applied mathematician Irmgard Flügge-Lotz (1903–1974), who both obtained professorships in the United States after 1945.

There is another outstanding example from applied mathematics: Cäcilie Fröhlich (later: Cecilie Froehlich, 1900–1992), whose career path we were recently able to trace. She obtained her doctoral degree at the University of Bonn. From 1929 to 1937 she held a research position at the General Electrical Power Company (Allgemeine Elektrizitätsgesellschaft) in Berlin. In exile, she went on to have a good career, first in a similar position at an electrical engineering corporation in Charleroi, Belgium and, from 1941, at the Department of Electrical Engineering at City College, New York, where she finally became the first female professor and closely cooperated with industrial corporations as a mathematical consultant. Cecilie Froehlich, a member of the Society for Industrial and Applied Mathematics - in addition to many other societies - would become a recognized researcher, but she is widely unknown in the mathematical research community today. And it should be stressed that Emmy Noether again became, even during her short period of exile prior to her untimely death in 1935, the head of a school in modern algebra.

The lecture demonstrated the special impact of female mathematicians' emigration on applied mathematics and on modern algebra.

Emigration of mathematicians from Poland in the 20$^{\text{th}}$ century (roughly 1919–1989)

Roman Duda

Emigration of Polish mathematicians began in the 19$^{\text{th}}$ century, after the country had been erased from the political map of Europe and its territory partitioned between Prussia, Austria and Russia. It was a century of restraining native language and culture which first provoked several national uprisings against oppressors, and only in the last three decades of the 19$^{\text{th}}$ century there began a slow rebuilding of the national intellectual life. The 20$^{\text{th}}$ century saw a steady outflow of a great many good names (not only mathematicians), hardly compensated by an inflow due to assimilation processes. The net result was decisively negative. Emigration had thus already become a constant factor of the Polish history in the 19$^{\text{th}}$ century and continued well into the 20$^{\text{th}}$ century. Here are some names (chosen out of many) of Polish mathematicians who then made their careers abroad: W. Bortkiewicz (Berlin), J.-M. Hoene-Wroński (Paris), L. Lichtenstein (Leipzig), F. Mertens (Vienna), B. Młodziejewski (Moscow) and J. Sochocki (Petersburg).

After the country regained independence in 1918, in the two decades 1919–1939, there flourished a Polish school of mathematics, a sociological phenomenon in itself (cf. [3, 4, 5, 6]). However, the inadequate number of academic positions and the growing darkness of the political atmosphere towards the end of that period, including anti-Jewish sentiments, resulted in frequent decisions to leave the country and emigrate. Emigrants included: S. Bergman (Soviet Union, United States), Z. Birnbaum (United States), S. Eilenberg (United States), W. Hurewicz (Netherlands, United States), M. Kac (United States), S. Mandelbrojt (France), B. Mandelbrot (France, United States), A. Tarski (United States) and S. Ulam (United States).

Then came the catastrophe of WW II which halved the number of active Polish mathematicians including S. Banach (died 1945), A. Hoborski (died 1940 in Sachsenhausen), J. Marcinkiewicz (prisoner of war, murdered in Kharkov), S. Saks (perished 1943), J. Schauder (shot 1943), S. Zaremba (died 1942) and many others.[1]

After the war Poland became a different country. One third of its pre-war population had perished during the war. Its territory was diminished by approx. 70 000 km^2 and pushed approx. 200 km westwards (Soviets took its eastern part of approx. 180 000 km^2, including the university cities of Lvov and Vilnius, whilst the Allied Forces gave Poland approx. 110 000 km^2, including the university city of Breslau/Wrocław, at the cost of Germany). And the very existence of the country, to say nothing of a strong ideological and economical grip, depended on the Soviet whim which dominated over the country until 1989, thus for nearly half a century.

After the subordination of Poland to the Soviet Union, going abroad was a difficult and dangerous task. A mere application for a passport attracted the hostile attention of the authorities. Thus in practice there were only two ways to get out: to plead for family reunification (in this respect the Jews and Germans were privileged) or to go abroad in an official delegation and then refuse to return. The so-called "non-returners" were comparatively frequent but they paid highly for their freedom in the West: family members were not allowed to join them. In such cases reunification was hard to achieve and separation could last several years. Nevertheless, the emigration of mathematicians continued (cf. a detailed study [1]).

One way or another, during the first two decades of this satellite state approx. 20 mathematicians left Poland, among them: W. Bogdanowicz, S. Drobot, A. Ehrenfeucht, J. Jaworowski, S. Knapowski, S. Mrówka, J. Mycielski, S. Świerczkowski, J. Wloka and Z. Zieleźny. All (with the exception of J. Wloka, who settled in the Bundesrepublik) went to the United States.

In public life, anti-Semitism was nearly absent for more than two decades. However, in 1968 there came a shameful "anti-Zionist" campaign, initiated by the Party authorities in March 1968. The campaign was accompanied by pressure, sometimes quite brutal, upon people of Jewish origin to leave the country forever. A few resisted, but the majority of the remnants of the pre-war Jewish population in Poland left. Included among them are more than 26 mathematicians (my list comprises exactly 26 names, but some names could be missing and some "zionist" emigrants left somewhat later). Some names: brothers J. and P. Blass, S. Fajtlowicz, M. Jaegermann (husband and his wife Nicole Tomczak-Jaegermann), K. and

[1]For more names and details see [2].

W. Kuperbergs (married couple), brothers A. and R. Ramer, J. Strelcyn, brothers M. and W. Wojtkowski. And, after that, the emigration wave remained high.

In the shadow of this enforced emigration there developed a hardly visible "internal" emigration of those who had been dismissed from their university positions but refused to leave and took their jobs elsewhere. Some mathematicians who suffered in this way: S. Hartman, E. Marczewski and M. Stark.

The next period of about a decade, 1968–1976, was one of liberalization. The government contracted heavy debts abroad and invited foreign visitors. In those years it was easier to obtain a passport. Nearly 30 mathematicians profited from this unexpected chance and left for good. Among them: K. Apt, J. Bochnak, A. Granas, J. Mycielski and T. Przymusiński.

The next turning point was the year 1976 with mass protests against a drastic rise in prices, followed by mass persecutions of protesters, and the first open opposition movements. Economic conditions worsened rapidly and in the summer of 1980 strikes spread all over the country. To appease national expectations, authorities agreed to legalize the independent trade union "Solidarity". The union soon gained over 10 million members (in a 40-million country) and a clash with the communist regime became inevitable. It took the form of martial law, imposed by the regime on December 13, 1981. The "Solidarity" was crushed (temporarily) but the event marked the moral collapse of the regime.

General disillusionment and the lack of hope for a better future resulted then in a wide and strong tendency to seek a more promising place to live elsewhere. This time the tendency had some official support. For instance, all those interned (and their number exceeded 10 thousand) could immediately turn his/her certificate of internment into a passport and leave.

In total, in the years 1947–1989 among emigrants from Poland there were more than 230 well-trained mathematicians including 10 professors, 36 PhDs with habilitation and 134 PhDs (the last two figures could be even higher, because my lists may not be complete). That would suffice to organize 5 strong mathematics departments with 2 professors (one of whom gave a lecture at an ICM), 7 habilitated PhDs and 26 PhDs.

It seems like a miracle that, in spite of such prolonged and severe bloodshed, mathematics in Poland still exists.

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The role of collegial networks for the emigration of mathematicians and the transmission of mathematics

Gerhard Rammer

The paper presented a case study on migrating scientists in the field of applied mathematics and applied mechanics who were dismissed at the University of Göttingen. Ludwig Prandtl was the director of the Institute for Applied Mechanics between 1905 and 1934. This institute experienced the greatest transformation of all the Göttingen institutes in the period from 1930 to 1950. The institute had beside its experimental research in mechanics a distinctive mathematical tradition. This tradition was heavily damaged by the Nazis.

In addition to his directorship at the university, in the early 1930s Prandtl was also the director at the Aerodynamic Testing Station and the Kaiser-Wilhelm-Institute for Flow Research. Thus Prandtl's first assistant at the Institute for Applied Mechanics had the role of an unofficial acting director. In 1933 and 1934 Prandtl lost three of his assistants due to political actions and as a result of the struggle over this position he even lost his directorship to Max Schuler. In summary, the Nazi takeover of power had drastic consequences for the institute. Especially the active Nazi students at the institute persecuted Prandtl's assistants and thus destroyed a fruitful scientific and human atmosphere.

Two of these dismissed assistants were Willy Prager (1903–1980) and Kurt Hohenemser (1906–2001), whose migration paths show notable differences. Prager first found a job at the Fieseler airplane-manufacturing plant near Kassel and got a professorship at the University of Istanbul in late 1933. In 1941 he emigrated to Brown University in Providence, Rhode Island. There he made a successful career as the director of Advanced Instruction and Research in Mechanics, founding the journal the *Quarterly of Applied Mathematics* in 1943.

Hohenemser was dismissed a little later than Prager and was able to take over Prager's job at the Fieseler airplane-manufacturing plant when the latter left for Istanbul. His attempts to emigrate to Great Britain in 1933/34 failed. From 1935 to 1945 he worked for Anton Flettner, in Berlin, later in Silesia, as an advisor on helicopter development. Despite being a "half-Jew", he was able to survive the Nazi period in Germany. At the beginning of 1945 he fled the approaching Russian front and found refuge in a convent in Bildhausen, Unterfranken, in the south of Germany. In June 1945 he went to Göttingen in order to initiate his re-employment at the institute. His first meeting with the new director Schuler resulted in a harsh refusal by Schuler. Hohenemser then formally applied for the reconfirmation of his teaching permission and his re-employment as assistant, mentioning in his application the political circumstances of Schuler's career: "Prof. Prandtl then had the directorship of the Institute[...]. Through the arrangement of Mr. Gengler, then the assistant of Professor Schuler and later regional leader for Göttingen, the directorship of the Institute for Applied Mechanics was taken away from Prof. Prandtl and assigned to Professor Schuler, who is still actively the director at this time."

The university rejected Hohenemser's applications and considered him to be an intruder with whom a loyal collaboration seemed impossible. Prandtl, who cultivated a positive collegial relationship with Schuler before and during the Nazi period, backed Schuler and only partly supported Hohenemser's rehabilitation. The faculty saw in Hohenemser's hint over politically promoted careers a clear violation of the rules of collegial behaviour. Hohenemser's rehabilitation failed also because certain important scientists who would have been willing to support him without reservation were missing – some of those who had supported his career in the 1930s were missing because they had been forced to emigrate in 1933.

Feeling deeply disappointed, Hohenemser left Germany in 1947 for the United States where he immediately became chief aerodynamicist in the helicopter division of McDonnell Aircraft in St. Louis. His university career had been destroyed and could only later be regained: in 1957 he became a visiting professor at Washington University in St. Louis, in 1963 he was made full professor there.

The comparison of these two migration paths shows the influence of collegial networks on careers at this time. It also shows the influence of migration on the structure of collegial networks. Being forced to leave university in Germany seriously changed the possibilities of obtaining academic positions. The comparison also shows how migrating scientists took their knowledge and skills to foreign countries, thus transmitting mathematics.

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'Mixed feelings' - remigration or internationalization of science after World War II

Marita Krauss

If we look at the possibilities of remigration we have to look first at the 'mixed feelings', which Richard Courant observed after his first post war meeting with his former colleague Helmut Hasse. Very few mathematicians took the direct route back to Germany, others only came to teach or to visit. So it is necessary to look at visiting and guest professors and their role in re-establishing international scientific exchange for German scholars and students and, who were, in my view, one of the most important drivers of the internationalization of science.

Statistics about the remigration of mathematicians contain only eleven remigrants. Out of 145 emigrated mathematicians only eleven really did return: six of them were outstanding scholars: in 1958 Emil Artin went to Hamburg, where he had been a professor till 1937; Reinhold Baer went to Frankfurt in 1956; Hans Hamburger in 1953 to Cologne, where he had been a professor from 1924–35; Friedrich Levi to the Free University of Berlin; Carl L. Siegel to his old Alma Mater Göttingen in 1951; and in 1951 Hermann Weyl returned to Zürich, where he had taught before going to Göttingen in 1930. In addition there was Alfred Basch, born in Prague in 1882, who emigrated to the US where he did not reach the position as Associated Professor until 1946 and returned to Vienna in 1947; Karl Freudenberg, born in 1892, Doctor med. and professor of statistics, who emigrated to the Netherlands in 1938, returned to OMGUS Hessen in 1947 and attained the chair of medical statistics at the Free University of Berlin in 1949; Grete Hermann also remigrated to the Federal Republic, Wilhelm Hauser, a leftist who was born in 1883, emigrated to the United Kingdom, returned to Berlin in 1946 and became Professor in Potsdam; Ludwig Boll returned to the GDR. German universities did not encourage remigration in general. They only tried to get back the most famous of the scholars they had expelled and declared that the 'selection of the best'. Others, who had worked outside university for some years because of persecution, were said to be not 'sufficiently qualified'. In the fifties the Universities were forced by law to give their former colleagues their pension. And those who had been expelled then expected to become faculty members again. But in most cases this was denied, and they continued to be excluded from their old universities.

But remigration was not the only possibility. Internationalization of science did not start with Nazi persecution in 1933, but it was accelerated remarkably by it. There were also 13 visiting professors in the field of mathematics after World War II. There were German-born scientists who tried to take in their former German colleagues. The question is how these former Germans and sometimes their children managed to navigate Western Germany's path back into the international scientific community, by imparting new knowledge and a different style of teaching at German universities. In contrast to many of the permanent remigrants, most of these scientists had been able to become established in their new homeland and could then be expected to bring elements of a new scientific culture with them to Germany.

Visiting professorships, lecture tours and visits played a vital role in reintegrating Germany into the world community of scientists. The language of this country had changed and it had developed remarkably since the early thirties; nationalistic separatism was no longer acceptable. In short, it is necessary to change the perspective: The important subject of post war years was not the remigration of persecuted mathematicians into a 'German' mathematical world. The interesting point still today is the scientific exchange and communication in a global mathematical community. In this way, emigrants and remigrants may be seen as the forerunners of transnational hybrid cultures, as productive mediators of knowledge between many cultures.

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Otto Neugebauer and the historiography of the ancient exact sciences

David E. Rowe

Otto Neugebauer was one among several distinguished mathematicians in Weimar Germany who took a deep interest in ancient mathematics, astronomy, and related exact sciences. His personal relationship with Richard Courant reflects many of the broader mathematical and scientific interests the two men shared. As director of the Göttingen Mathematics Institute during the Weimar years, Courant faced numerous challenges and dealt with them brilliantly. Through his connections with Ferdinand Springer, he launched the famed "yellow series," one of several initiatives that enabled Springer to attain a pre-eminent position as a publisher in the fields of mathematics and theoretical physics. Not surprisingly, Neugebauer took an active part in preparing some of these volumes, including the Hurwitz-Courant lectures on function theory as well as the first volume of Felix Klein's lectures on nineteenth-century mathematics. For the history of the ancient exact sciences, Springer's short-lived *Quellen und Studien* series created a new standard for studies in this fast-breaking field. In 1934 Neugebauer left Göttingen for Copenhagen, where he continued his editorial work as well as his pioneering research and teaching activity. He also continued editing Springer's *Zentralblatt* until Nazi racial policies led to the removal of Jewish colleagues from its board. As is well known, this paved the way toward the founding of *Mathematical Reviews*, which Neugebauer managed from his new post at Brown University.

This lecture aims to shed light on Neugebauer's work as a historian during these politically turbulent times, especially its larger reception within the newly emergent community of historians of science in the United States. For many experts on ancient science, Neugebauer's views on Greek mathematics represented a fairly large-scale intrusion by mathematicians into a field that was formerly dominated by classical philologists. Within the latter field, the intruders—Neugebauer, van der Waerden, Reidemeister, et al.—could cite the work of Eva Sachs and Erich Frank in defending their arguments for recasting the early history of Greek mathematics. After the Second World War, this early work by so-called "hyper-critical" philologists came under strong attack in the pages of George Sarton's *Isis*. Although this explicit reaction appears to have been relatively brief, its implications were long-lasting. Thus, long before Sabetai Unguru mounted an even more sweeping assault on the historiography of ancient Greek mathematics in his 1975 article in *Archive for History of Exact Sciences*, there was a strong polarization among experts along sharply disciplinary lines. On a small scale, the picture suggests themes later made famous in C. P. Snow's essay on the sharp division separating the "Two Cultures."

Emil Artin: emigration, immigration and shared migration

Della D. Fenster
(joint work with Joachim Schwermer)

Solomon Lefschetz had two points in mind when he wrote to Father John F. O'Hara, President of Notre Dame University, in early January, 1937. After congratulating O'Hara on Notre Dame's recent appointment of Karl Menger to their faculty, Lefschetz offered a "constructive suggestion" about another European mathematician. "I permit myself," Lefschetz wrote to O'Hara

> to name for your strong consideration another absolutely first rate man, the algebraist E. Artin, at the present time Professor at the University of Hamburg. He is an Austrian Aryan, but his wife is one-half Jewish. They have a couple of small children and you know the rest. Like Menger, Artin is in the middle thirties, famous not only as a first rate scientist but also as a teacher, and inspirer of youth, and is a most attractive personality. Although still very young he was in 1930, runner-up for the post of successor to Professor David Hilbert at Gottingen, himself an outstanding mathematical genius of all times.[1]

Apparently, then, from his position within the AMS, Lefschetz learned of Artin's situation and took up his cause. Thus it was a personal letter and a commitment from an institution, and not one of the organized committees, that initially brought Artin to America.

[1]Lefschetz to O'Hara, 12 January 1937, Artin File, Notre Dame Archives.

For all of Lefschetz's (accurate) accolades, he did not mention that Artin had not published since 1932. In fact, this request and the subsequent move occurred during a time that a 'casual observer' might describe as 'ten years of silence' (roughly 1931–1941) in terms of written publications where, instead, "Artin spoke through his students and through the members of his mathematical circle" [5, p.36]. This talk explored these 'ten years of silence' and, in particular, how Artin emigrated from Germany, immigrated to America and disseminated ideas about class field theory during this time in a sort of shared migration collaboration with George Whaples, a young American mathematician who had just completed his Ph.D. at the University of Wisconsin.

Once Lefchetz had made his personal appeal on behalf of Artin, Father O'Hara "made a place for him on the [Notre Dame] faculty . . . in order to relieve his mind of the strain under which he labored in Germany".[2] In Artin's life, the temporary position at Notre Dame serves more as a starting point, an opportunity for steady income in that critical first year in a foreign country moved to with urgency.

Naturally, news of Artin's arrival at Notre Dame spread quickly among mathematicians. In particular, K.P. Williams, chair of the mathematics department at Indiana University in Bloomington (some 174 miles south of Notre Dame), recognized the value Artin could bring to their program. Williams must have made a convincing case since Indiana University offered Artin a permanent faculty position to begin the following academic year (1938–1939). In his seven years at Indiana, Artin oversaw the work of two Ph.D. students and published at least six papers and three books. In particular, Artin collaborated with George Whaples.

Whaples spent 1939–1941 at Indiana in a post-doctoral position where he learned class field theory and worked with Emil Artin. This collaboration with Artin ultimately resulted in the publication of three papers: *The Theory of Simple Rings* [1], *Axiomatic Characterization of Fields by the Product Formula for Valuations* [2], and *A Note on Axiomatic Characterization of Fields* [3]. In the first paper, Artin and Whaples dealt with the structure of simple rings and extended existing theorems for simple algebras to simple rings. In their second and third publications, Artin and Whaples provided an axiomatic characterization of what is nowadays called a global field by means of the product formula. The commitment to clarify the role played by the basic result in a theory was fundamental to Artin's approach to mathematics.

Whaples' work and association with Artin opened the door for him to visit the Institute for Advanced Study in Princeton (IAS). While at the IAS in 1941–1942, Whaples gave a course on class field theory and a series of lectures titled *Remarks on class field theory*. Thus what began at Indiana in a post-doctoral position now continued at the celebrated IAS. Artin left Indiana to join the faculty at Princeton in 1946. The Princeton opportunity seemed to revitalize Artin. His "exceptionally inspiring" teaching, as it was described by Hermann Weyl,[3] manifested itself in the

[2]O'Hara to H.B. Wells, 11 June 1938, Artin File, Indiana University Archives.
[3]Weyl to W.T. Martin, 15 January 1945, Artin File, Princeton University Archives.

form of 18 doctoral students, including John Tate and Serge Lang. Artin returned to Germany in 1958.

Artin's direct work with students calls attention to his natural inclination to exchange ideas freely. These exchanges were mutually beneficial. In one of his last conversations with Richard Brauer, reflecting on his students John Tate and Serge Lang, Artin remarked that "[t]his happens only once to a man. Not many mathematicians have been that lucky" [5, pp.28–29].

The mathematics discussed in this paper occurred during a time of tremendous upheaval in Artin's life. Artin immigrated to America in 1937 with his (then) two children and wife. They were a young family displaced by the Nazis. He initially held a (temporary) position at Notre Dame, then moved to Indiana University and finally to Princeton. Artin seemed to embody the quintessential attributes of 'scholarship and adaptability' which later scholars would designate as critical to an emigrant's success [4].

It was a confluence of critical events that shaped this moment in the history of mathematics. Artin had given a course on class field theory in Hamburg in the early 1930s that Chevalley, among others, had attended. The political situation in Germany forced Artin's departure for America not long after. The "for America" cannot be overstated. Had a similar political situation occurred even forty years earlier, a mathematical research community in America would not have existed for Artin to emigrate to. Whaples, a second-generation, American-trained mathematician, with an advisor who worked under the influential E.H. Moore at the University of Chicago, had the opportunity to work closely with Artin, a distinguished European mathematician. The published papers of Artin and Whaples show their advancements in algebraic number theory. Whaples' year at the IAS points to other benefits of this association, including the chance to work with Chevalley, another distinguished European mathematician.

This investigation of one sliver of Artin's work called attention to an ever-expanding, international mathematical circle that persisted, even flourished, in the most adverse of circumstances. It highlights the significance of Artin's migration "both for its consequences and for what it discloses about historical processes of human and intellectual transfer" [6, p.338]. Without intentionally setting out to explore the effects of 'forced migration' on Artin and his work, this broader study suggests a remarkably seamless 'human and intellectual transfer' in this particular case.

Robin Rider rightly points out that, behind the numerical count of mathematicians dismissed from their positions in Germany, were "individuals, each with a story, often a poignant one" [7, p.111]. Although Artin might account for one of these individuals, his work with Whaples and other young mathematicians shows that he worked best as an individual with a circle of mathematical friends surrounding him.

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The career of Arnold Scholz

Franz Lemmermeyer

The talk details the efforts made by Arnold Scholz to obtain a position in Germany or abroad. We have used the correspondence between Scholz and Helmut Hasse, Scholz and Olga Taussky, and F.K. Schmidt and Helmut Hasse.

During the 1930s, many scientists emigrated from Germany. Some of them who stayed behind tried in vain to go abroad, or thought seriously about doing so before it was too late. As an example of a 'failed' emigration, and to give an idea of the pulling of strings that went on behind the scenes, I presented the career of Arnold Scholz, a distinguished German number theorist who failed to get a position in Germany and eventually died (according to O.H. Keller, who was with Scholz during his last days, of tonsillitis; according to Taussky's obituary, of diabetes).

In Spring 1933, Scholz was Loewy's assistant at the University of Freiburg. After Loewy was fired, he became the assistant of Doetsch, who quickly established himself as a Nazi hardliner. Scholz quit his position as an assistant and was replaced by Schlotter, who was responsible (along with Doetsch) for the denunciation of Zermelo. Scholz left Freiburg for Kiel in 1934 at Hasse's suggestion, accompanied by negative reports from Doetsch and Schlotter.

When Scholz was not given the lectureship he had been promised, he began looking for other possibilities. In letters to Hasse and Olga Taussky, he contemplated going to the USA, Scandinavia, Yugoslavia, Holland or Switzerland, but quit his efforts when F.K. Schmidt offered him an assistant position at Jena. However, the University of Jena was ordered to drop its negotiations with Scholz and so he failed to obtain this lectureship. He continued to receive a regular payment from 1936 to 1939, was then drafted and sent as a teacher to the Marine Academy School in Flensburg, where he died in February 1942.

I discussed, in detail, three episodes in Scholz's career:

(1) Scholz's move from Freiburg to Kiel in 1934, and his (futile) attempt at getting the promised lectureship;
(2) Scholz's attempt at getting a position at Jena as F.K. Schmidt's assistant;
(3) Scholz's efforts at finding a position abroad.

Scholz in Kiel. After Loewy had been fired from the University of Freiburg, Scholz did not see any future for himself there and asked Hasse to find a position for him at Göttingen. Hasse thought this to be a bad idea for various reasons (mainly political) and, when Scholz applied there anyway, Tornier asked Doetsch for a report, and in this report Doetsch said that Scholz had a negative attitude towards the Nazis and was incompetent as a teacher. Hasse pulled strings to find Scholz a place at Kiel, although Tornier passed on Doetsch's report to Kaluza at Kiel. Although Scholz had been promised a lectureship (*bezahlter Lehrauftrag*) at Kiel, he did not get it. It seems plausible to assume that this was due to negative political reports on Scholz from Schlotter, Doetsch and Süss.

Scholz and Jena. Studying the Hasse correspondence reveals that it was Blaschke who informed F.K. Schmidt about the fate of Scholz at Kiel. F.K. Schmidt subsequently offered his assistant position to Scholz, but Berlin demanded that the negotiations be dropped because of several vacant positions at Kiel.

Scholz's emigration plans. When the lectureship at Kiel failed to materialize, Scholz seriously considered leaving Germany. In the correspondence, he mentions the impossibility of obtaining secure positions in Scandinavia, the Netherlands and Switzerland; among his options he mentions Zagreb (where Bohniček worked), Beograd and Ljubljana in Yugoslavia. He asked Hasse whether Ore had any financial means, and told Olga Taussky that he may ask Emmy Noether to find him something in the US. When, in April 1936, he received a regular payment limited to three years, he dropped all plans of leaving Germany and decided to stay in Kiel. His efforts to obtain a position at Erlangen, Vienna and Prague all failed.

Acknowledgement

The correspondence between Scholz, Hasse and Taussky was TeXed by Thomas Olschewski and made available to me by P. Roquette. The letters are currently being prepared for publication within the next few years.

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Felix Bernstein: a failure in emigration because he was old and difficult?

Norbert Schappacher

The title of this talk reflects the bottom line of Reinhard Siegmund-Schultze's treatment of Felix Bernstein's [1878–1956; we will refer to him as 'F.B.'] case in [1, pp.262–266]. My aim is to explore complementary lines of explanation. They cannot, however—nor are they meant to—replace Reinhard's wise way of dealing succinctly with a complicated case. My suggestions are mindful of the delicate position, between various disciplines and professional organizations, in which F.B. found himself as a result of his increasing interest in medical and anthropological applications of mathematical statistics. His hybrid domain of research could render professional integration all the more difficult as he, who had never passed a medical degree, could not simply claim to be part of the medical profession.

Yet how could it happen that F.B. was regarded in May 1934 at the Rockefeller Foundation as "the one definite misfit among the displaced scholars" [1, p.262] —even though he had been until 1932 the well-known director of the Göttingen *Institut für Mathematische Statistik*; had successfully deduced from statistical data the inheritance of the human A / B / AB / O blood groups in 1924; had already left Germany on 1 December 1932, for his third invited lecture trip to the USA; and even though he had excellent connections there? F.B. was, for example, in touch with Albert Einstein about an immediate boycott of Germany in reaction to the antisemitic actions.[1] And he participated for a while in discussions about plans for a Jewish University in the UK to absorb Jewish academics who had recently lost their jobs in Germany. This idea interacted with other more or less analogous initiatives, e.g. by Alvin Johnson, director of the New School for Social Research, with whom Bernstein corresponded. Albert Einstein wrote a letter of recommendation for F.B., dated 24 February 1933, to Nicholas Murray Butler, then President of Columbia University, New York. This letter was undoubtedly drafted by Bernstein himself; it briefly reviews F.B.'s scientific career up to 1933.

As a matter of fact, F.B. did obtain in 1933 an initial job as guest professor at Columbia University with aid from the Emergency Committee of the Rockefeller Foundation (RF); but the contract ended in 1935 in accordance with the Emergency Committee's rules. From 1936 to 1937 F.B. was Professor of Biostatistics at the Dental Medicine Faculty of NYU. Finally, from 1937 through 1950, all he could find was a miserable position as lecturer at Triple Cities College of Syracuse University at Endicott, NY. Attempts to get to Yale or Harvard came to nothing,

[1] He had expressed his political mind before—for instance in 1918, when he had been a co-founder of the left liberal *Deutsche Demokratische Partei* alongside with men like Hjalmar Schacht, Walter Rathenau, Theodor Heuss. F.B. was one of the few truly republican university professors in Weimar Germany.

despite the interest of colleagues like E.B. Wilson (Harvard) for just the kind of interdisciplinarity that Bernstein could offer.

The more immediate professional contacts that F.B. could try to exploit in the US naturally derived from his research since the 1920s. A central theme in this work was the search for racial markers. In 1924 for instance, with the backing of Albert Einstein, F.B. had asked the RF to sponsor a survey of the natural singing pitch of European children, which he believed to be a genetic racial marker. The request was turned down as being incompatible with the RF funding priorities at the time. In 1929, F.B. pursued a similar project, including what he labeled "West Indian" and "Negro" voices, in a field study at the James Russell Lowell School, Harlem, with the Long Island Biological Association. As of October 1928, he aroused Max Mason's (RF) personal interest in such projects. Although the RF could not offer direct funding to F.B. for field work in the US, their discussion (March 1929) apparently encouraged F.B. to approach Friedrich Glum, the director of *Kaiser-Wilhelm-Gesellschaft* (KWG) directly asking, if not for an institute created for him, at least for an official position in one of the existing structures of the KWG. Such a self-invitation strikes us as almost suicidal because an earlier research proposal drafted by F.B. in November 1927, for an extensive survey of the distribution of blood-groups in Germany[2] had been fatally rejected on 17 December 1927 at a crucial high-level meeting in Berlin about financing options for anthropological research projects. In this meeting, Eugen Fischer, the director of the new *Kaiser-Wilhelm-Institut für Anthropologie, menschliche Erblehre und Eugenik* in Berlin, had dismissed Bernstein's focus on a few discrete, clearly measurable hereditary traits like blood groups with the (antisemitic?) remark: *"... da könne man ebensogut eine 'Nasenforschung' fordern"* [2, p.115–116]. One may interpret this event as the beginning of Bernstein's increasing preclusion from the anthropological mainstream.[3]

In the US, at least the cultural anthropologist Franz Boas [1858–1942] was on F.B.'s side, and was quite skeptical with respect to Eugen Fischer's take on racial research and his institute; this is clearly brought out by a letter of May 1928 from Boas to the New York banker and patron Felix M. Warburg, to whom Boas recommended F.B. warmly. After 1933, F.B. seconded the 77 year old Boas in a project which involved anthropometric surveys of children from different races, in particular Jewish children in orphanages, schools, etc. This work was placed in a context of refuting simple anthropometric racist theories. When F.B.'s position at Columbia University was discontinued in 1935, Boas wrote to him: "I regret more than I can say that there seemed to be no way of establishing you as the center of scientific statistical work which is so badly needed."

[2]At least since Ludwik & Hanna Hirszfeld had surveyed the blood groups of soldiers from 16 nations at the end of World War I, blood groups were seen as discrete genetic properties whose distribution mirrored racial intermixtures brought about by historic migrations.

[3]Only in the UK, F.B.'s approach seems to have been taken up with more sympathy. Since F.B.'s emigration never led him to the UK, we leave this aspect aside for the present talk.

Through his research on blood groups, F.B. was in contact with Karl Landsteiner's [1868–1943; discoverer in Vienna in 1900 of what was later called the A / B / O blood groups] laboratory in New York and knew in particular Landsteiner's young and active collaborator Alexander S. Wiener. In 1931, F.B. had succeeded in obtaining a Rockefeller grant for his student Siegfried Koller to work there for a term.

F.B. also knew very well the eugenicist Charles B. Davenport [1866–1944] at Cold Spring Harbour, Long Island, who was less critical of Eugen Fischer, Otto Reche (for whom blood research in Germany was more of a *völkisch* cause) and others, than Franz Boas. At the same time, in a letter of 27 February 1936 to the anatomist G.J. Noback at NYU, Davenport wrote: "I have known Dr. Bernstein since before he came to this country, through his publications; and have been thrown rather intimately with him since... He is, as you know, the discoverer of the true genetical basis of the blood groups, and has made contributions ... to the difficult genetical analysis of the human pedigrees. He is an outstanding statistician and that and his great interest in human heredity make a very unique combination. ... Bernstein has been with us at Cold Spring Harbour for two or three summers and has always proven himself agreeable and cooperative. ... The only 'out' that I know of him is that he is of a somewhat nervous temperament, but that has not interfered with our contacts..."

It was not impossible to initiate a new centre for applied mathematical statistics in the US in the 1930s, as the example of Jerzy Neyman's [1894–1981] coming to UC Berkeley in 1938 shows. One may speculate that, apart from his younger age, Neyman's British experience helped him to get this opportunity. But in order to highlight the peculiar difficulties of the sort of applications of mathematical statistics that were F.B.'s specialty, I chose for the last part of my talk the example of the non-paternity tests based on the heredity patterns of blood groups. For them to become applied before court, the rules of heredity have to be accepted not only by the medical profession, but also by the law scholars and the judges as scientific proof. In Germany and most European countries, F.B.'s heredity rule for the A / B / AB / O blood groups made their way into courtrooms within about 4 years of their discovery—not the least because of the very active and persuasive work by the medical researcher Fritz Schiff in Berlin.

In the US however, Landsteiner's lab in New York, esp. the publications of Alexander S. Wiener, in spite of their quality and relevance, did not have the same impact; the admissibility of blood group based non-paternity test before American courts with a jury would continue to lag behind European standards by more than a decade. Searching through US law journals from the 1930s not only shows a few spectacular cases—like State v. Damm in South Dakota, or Berry v. Chaplin, 74 Cal.App. 2d 652—but one also discovers articles by American law scholars on what they call the American 'Culture lag', i.e., the unduly long way from a scientifically established method to its application in the courtroom. The traditional emphasis on the jury in American legal practice is certainly one of the reasons for this phenomenon. Still, it seems worhwhile to try to investigate more precisely the significant differences between the inertias of the medical and the legal profession on both sides of the Atlantic.

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Migrations of Hungarian mathematicians in the 20th century: some general trends and examples

Péter Gábor Szabó

"The two best Hungarian export goods are salami and mathematicians." The historian of mathematics László Filep (1941–2004) began with this funny remark in his article [2] on the emigration of Hungarian mathematicians in the 20th century. It is a fact that there are lots of excellent Hungarian mathematicians, and in the turbulent history of the 20th century Hungary gave many mathematicians to the world [3]. The "Hungarian secret" arose from the mathematical tradition in Hungary which dates back to the two Bolyai mathematicians [8]. Farkas Bolyai and his son, János Bolyai, were the first Hungarian mathematicians to achieve world fame. János Bolyai is a cultural hero in Hungary.

There were internal and external social and cultural reasons why several remarkable Hungarian mathematicians appeared at the beginning of the 20th century. One of them was a mathematical tradition in Hungary with excellent teachers, teaching institutes, journals and mathematical competitions. The *Középiskolai Mathematikai Lapok* (*KöMaL*, Mathematical Journal for Secondary Schools) [1] was founded by Dániel Arany in 1894. This journal played a very important role in the selection of the most talented mathematics students. In 1894 a mathematics competition of the Hungarian Mathematical and Physical Society was introduced for students just finishing high school. With the exception of a few small gaps during the world wars, this competition has been held every year. Thirty-five years later John von Neumann wrote to Lipót Fejér in a letter, saying "I have had several conversations with Leo Szilárd about the schoolchildren competitions organized by the math. phys. society, and about the fact that the first-ranking placeholders in these competitions virtually coincide with the set of those mathematicians and physicists that proved able afterwards." Indeed, we can read the names of many excellent scientists among the winners of the Eötvös Competitions (e.g. Lipót Fejér, Theodore von Kármán, Dénes Kőnig, Alfréd Haar, Marcel Riesz, Gábor Szegő, Tibor Radó, László Rédei, László Kalmár, Edward Teller).

We can discern three emigration waves of Hungarian mathematicians in the 20th century. The main reasons for the emigrations were social and political. Some people voted with their feet. Many received academic invitations, got better positions and grants. Unemployment was also a reason for emigration, and usually the first stop abroad was in Germany, but later, when the Nazis came into power, this changed to the US. Of course, some mathematicians went to other countries as well, but they were able to continue their special research topics.

The mathematicians who emigrated kept in contact with those who remained at home. They helped each other with food parcels, books, and with conference invitations abroad. There are many documents about the Hungarian mathematicians who emigrated. They are mostly letters stored in Hungarian archives. In the last few years I have published about a thousand letters of over thirty Hungarian mathematicians [4, 5, 6, 7]. These letters also contain many interesting details about the lives of the mathematicians who emigrated.

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Mobility and migration of Spanish mathematicians during the years around the Spanish Civil War and WWII

José M. Pacheco

This presentation aims to be a general overview of the mathematical scene in Spain before and after the Spanish Civil War (1936–1939). No attempt is made to dwell on particular cases or results, rather a description is offered of the way the mathematical endeavour was understood in Spain: the evolution of the mathematical sciences in Spain in the first half of the 20^{th} century contrasts sharply with that in Europe. While European mathematicians –and this includes those of a number of countries in Central and Northern Europe, as well as Italy– used to move from one place to another in a highly competitive environment, the centralised structure of Spanish universities, the rigid processes for obtaining tenured positions, and the complicated situation of the education system, hindered mobility and the updating of mathematics in Spain. On the other hand, there was no persecution of mathematicians on racial grounds: instead it occurred on political or even personal grounds during and after the Civil War in the framework of the general repression that swept the country between 1936 and 1945.

In the years considered, Spain had four different political regimes: a constitutional monarchy under Alfonso XIII (1902–1922), a dictatorial monarchy (1923–1931) under Alfonso XIII and General Primo de Rivera, a republic (1931–1939) with two presidents –Alcalá Zamora and Azaña–, and the dictatorship of General Franco from 1939 onwards. The Republic and Francoism coexisted during the Civil War period, each in their zone. During the period of the monarchy the average time in office at the education ministries was some seven and a half months, in the republican years it came down to less than four months and after the war the mood changed: only one minister was in office between 1939 and 1951.

Research policy and funding followed a different path, both before and after the Civil War. In the wake of the Nobel Prizes awarded to Santiago Ramón y Cajal (medicine, 1906) and to the mathematician and engineer José Echegaray (literature, 1905), a scientific policy agency –Junta de Ampliación de Estudios (JAE)– was created in 1907 and remained in operation until 1936. The JAE managed to survive the many ministry changes and even regime shifting. Cajal was its president until his death in 1934, and its actual decision-maker José Castillejo was in office until 1936. The JAE was a very active organization, channeling money from different official and private sources to a vast number of projects. One of them was the creation of the Laboratorio-Seminario Matemático (LSM, 1915–1939) under the guidance of Julio Rey Pastor, a very gifted mathematician and manager who is duly acknowledged as the founder of a Spanish Mathematical School from which most of today's Spanish mathematics and mathematicians descend.

The actual objectives of the LSM were manifold: first, a number of people were funded to study abroad in order to import into Spain new tendencies and developments in mathematics, as well as in the teaching techniques; second, two journals –*Revista Matemática Hispano Americana (RMHA)* and *Matemática Elemental*, as well as an internal bulletin– were edited for the output of the work produced by Spanish mathematicians, with an important number of invited papers from leading mathematicians, usually as a result of previous visits paid by the Spanish bursars; third, the LSM practically monopolised the access to tenured positions in universities and high schools.

With regard to mobility, the JAE and LSM activity amounts to: from 1908 to 1936, 27 grants were awarded to 23 people to study mathematics abroad, among them Rey Pastor himself, who went twice to Germany before WWI. The preferred destinations were Germany, France and Italy and the main topics of study were geometry (algebraic and differential), analysis (complex, foundations), mathematical physics and insurance theory. Chronologically ordered, Spanish mathematicians visited Hölder, Hausdorff, Mayer, Böhm, Hurwitz, Weyl, Pólya, Volterra, Levi-Civita, La Vallée-Poussin, Vessiot, Cartan, Hadamard, Caratheodory, Köppen, Julia, Blaschke, Fréchet and Menger. It must be stressed that it was common for bursars to have already obtained tenured positions. Nevertheless, a few completed dissertations abroad, e.g. Luis Santaló under Blaschke and Antonio Flores under Menger. Another 16 grants went to 12 people specialising in mathematics teaching, visiting Italy, Germany and Switzerland. Enriques, Castelnuovo and Severi were most visited by the Spaniards, but the trips to Germany insisted on the observation of organisational aspects.

The production of mathematics in Spain during the LSM period has also been traced in the *Jahrbuch über die Fortschritte der Mathematik*: between 1907 and 1939 some 190 publications by 10 Spanish mathematicians –79 of them by Rey Pastor– were reviewed. A few more, eight by three people, were reviewed between 1939 and 1942, the year the *Jahrbuch* disappeared. The large majority of the published works were in Spanish, and basically in the *RMHA*.

Another index of mathematical activity is provided by checking the PhD production and final destination of the awardees. In the pre-Rey years, 1905–1913, 24 PhDs, were obtained, but only 11 proceeded to university posts. The topics: geometry-flavoured exercises and introductions to some areas in analysis, like linear ODEs, elementary integral equations and the calculus of variations. The Rey Pastor years (1915–1920) show 8 PhDs and 7 proceeded to university posts: 4 of them had had JAE grants. The topics were more specialised and up-to-date: complex analysis, topology, and even one on the history of mathematics. During the 1920s Rey was travelling between Spain and Argentina and from 7 PhDs only 3 proceeded to university posts and 3 had had JAE grants. The topics: mathematical physics (due to the visit Einstein paid to Spain in 1922), differential geometry, series summation, and one more on the history of mathematics. In the so called *los años de los investigadores* (the epoch of researchers, 1930–1936) there were 6 PhDs and all 6 proceeded immediately to university posts, but only 1 had had a JAE grant. The topics were: series summation, topology, differential / integral geometry (Blaschke's school). No PhDs were ever awarded in the field of mathematics teaching.

The framework for the science policy –including mathematics– after the Civil War was modelled by the Franco regime on the previously existing JAE facilities: the JAE gave way to the Consejo Superior de Investigaciones Científicas (CSIC), which also adopted the functioning scheme of a long-lived tandem of President and General Secretary: José Ibáñez and José María Albareda were in office from 1939 to 1966. The LSM changed into the Instituto Jorge Juan de Matemáticas, and the mathematical journals were maintained. Indeed, the LSM strategy of immediately occupying tenured positions was enthusiastically adopted and enhanced by the new rulers. The direct mathematical and organisational influence of Rey drastically diminished: he had spent the war years in Argentina, and preferred to stay there until 1948, so his role was played by a former collaborator of his in the LSM, Tomás Rodríguez Bachiller. Though Bachiller had been sanctioned by the Franco regime in the early stages of the *depuración* process (a sort of reverse *Entnazifizierung*), already in 1939 we find him travelling to Rome, and before 1943 he had advised three theses to young candidates, helped them to secure their tenured positions and then sent them to Rome, Jena or Leipzig to complete their education. The contacts in Bachiller's agenda were many and he profited from them in the dark post-war years, both for himself and for the mathematical life in Spain. After the Potsdam Conference in August 1945, Spain was sanctioned and isolated from the international community: nevertheless, in early 1947 Bachiller started a 6 month stay at Princeton, promoting Spanish mathematics for the new international order. Since then, the U.S. has had a dominating influence on the Spanish mathematical scene.

Between 1939 and 1950, 17 PhDs in mathematics were awarded in Spain: four of which were advised by Bachiller. Another four dealt with topics which had not previously been present at the LSM. Eventually, all those who had been awarded PhDs obtained chairs at various universities, although some had to wait until the late 1950s. This is in contrast with the first-hour post-war students of Bachiller, all three of whom were full professors before the age of 30.

We may thus affirm that in mathematical affairs there existed a clear continuity across the Civil War, with only some difference being observed in the shy appearance of applied mathematics, due to the dream of Franco's regime in the mid-1940s of becoming a power in aircraft building. However, on the teaching side, the transfer after the Civil War of most secondary teaching to a number of religious orders deeply affected the mathematical culture in Spain because the efforts of the LSM were lost and forgotten, even though the few remaining official secondary schools did have well-trained mathematicians among their staff, but a number of them could be considered in some sense as 'interior exiles'. This leads us to consider the effect of the Francoist repression on mathematicians, where a distinction should be made between the 'exiles abroad' and the interior exiles. The latter category included both winners and losers from the War. We find the following exiles:

JAE bursars - abroad:[1] Lorente de Nó (1918) the Americas, Vinós (1925–6) Mexico, L. Santaló (1934) Argentina, M. Santaló (1934) Mexico, Gil (1934) Venezuela, Balanzat (1934) Argentina.

JAE bursars - interior: Alvarez Ude (1910), Eyaralar (1922), Carranza (1928), Paunero (1932), Ms. Martínez Sancho (1931), Ms. Capdevila (1933), Montáñez (1933), Flores (1933). Note here that only two women were funded by the LSM, María Capdevila and Carmen Martínez Sancho, the latter being the first woman ever to obtain a doctorate in mathematics in Spain. Both made a living as high school teachers.

Non-JAE bursars - abroad: the brothers Carrasco Garrorena, Mexico; Castro Bonel, Mexico; Vera, Argentina; Palacio Gros, Venezuela; Jiménez González, Mexico; a number of younger university auxiliary staff, the Americas.

Non-JAE bursars - interior: Barinaga, Pineda, Cuesta; a number of auxiliary faculty and secondary school teachers.

There were also people doing mathematics outside of the CSIC / Jorge Juan framework –but not too far from it. Here, for example, we find the sanctioned Barinaga and Flores, and Gallego-Díaz, all former members of the LSM, working

[1]Given beside each name is the year of the grant from the JAE.

privately for some years at a number of academies, in the preparation of entrance examinations for engineering schools and maintaining the journal *Euclides.* Let us cite only two special cases. First, Cuesta with his outstanding solitary mathematical trajectory, who only in 1957 obtained a chair at Salamanca –but before that had to spend a year as *colaborador*, the lower rank of the Institute's personnel, at the Jorge Juan. Second, the already-cited Gallego-Díaz, an example of a polymath who was finally appointed to a chair –in physics– in 1955, after having travelled on his own all around Europe visiting mathematicians and research centres. Then he left Spain for the Americas, but not as an exile: he was greeted as an outstanding mathematician, even by the Franco regime ...

End note: It is impossible to fit even a short sample of the literature on this topic into the abstract. Primary sources, such as the minutes of the JAE and the CSIC, as well as the *Boletín Oficial del Estado (BOE)* (the official gazette of the Government of Spain), are available on-line. The efforts of the history section of *La Gaceta de la Real Sociedad Matemática Española* and the journal *Llull* of the Sociedad Española de Historia de las Ciencias y de las Técnicas are most warmly acknowledged.

Emigration of mathematicians: sources, opportunities

Robin E. Rider

Historians who have explored the circumstances and consequences of the so-called intellectual migration of the 1930s have relied heavily on institutional archives and collections of personal correspondence, using them to construct compelling narratives and reveal important patterns. Aspects of the archival landscape have changed markedly over the past three decades, to the considerable advantage of historians investigating topics in 20$^{\text{th}}$-century science. In this paper I consider that landscape and its consequences for scholarship in history of science, with particular attention to the university and political circumstances that conditioned efforts at the University of Wisconsin [UW]-Madison in 1933 to find a place for a displaced mathematician. In exploring the university's actions and connections to the larger effort to secure positions for displaced scholars, I take the approach of reading the contents of one particularly rich folder from the UW Archives both for its own sake and against a background of related sources - I might call it a sort of deep reading.

From his appointment as UW president in 1925, Glenn Frank was surrounded by controversy, partly because of his lack of an advanced degree and university teaching experience, but also because of state and national circumstances. In the 1920s prominent Progressive politicians in Wisconsin had decried, and for five years blocked, grants for the UW from outside foundations like the Rockefeller Foundation, with its taint of oil; and the Great Depression of course took its toll on the university's budget, faculty, staff, and students. Events at Madison in 1933–1934 were also shaped by Frank's evident failure to engage with the Emergency Committee in Aid of Displaced German Scholars in its first few months, an endowment supporting the UW Carl Schurz Visiting Professorship, and the critical role of Warren Weaver, who had the year before stepped down as chair of the UW mathematics department to assume an influential position at the Rockefeller Foundation.

The story I tell attends to artifactual characteristics of archives, alert to multiple narratives and documentary practices encoded in the records of 20th-century academic institutions. I thus suggest that self-conscious consideration of archival collections for their own sake, including circumstances of their creation, their physical characteristics, organizational schemes, and archivists' practices for describing them — especially for collections rooted in political upheaval, economic hardship, personal trial, and reconsideration of academic norms and values — will help open up more opportunities for exploring and understanding the scholarly migration of the 1930s and its consequences.

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In addition to the growing literature on the displacement and emigration of mathematicians in the 1930s, this account relies upon numerous records and collections at the University Archives, University of Wisconsin–Madison, including budget volumes, records of UW president Glenn Frank (especially the folder "Weaver, Warren," for 1933–1934), records of Mark Ingraham and the mathematics department and (for the Schurz Professorship) those of the German department. Minutes of meetings of the UW Regents have been digitized as part of the University of Wisconsin Board of Regents Collection at `http://digital.library.wisc.edu/1711.dl/UWBoR`.

Additional sources concerning the UW include *The University of Wisconsin: A history* (Madison: University of Wisconsin Press, 1949–), esp. v. 2 (by Merle Curti and Vernon Carstensen) and v. 3 (by E. David Cronon & John W. Jenkins), available at `http://uwdc.library.wisc.edu/collections/UW/CurtiUWHist`; and Lawrence H. Larsen, *The president wore spats: A biography of Glenn Frank* (Madison: State Historical Society of Wisconsin, 1965). About records of academic institutions and of 20th-century science and technology, see such works as *Understanding progress as process: Documentation of the history of post-war science and technology in the United States: Final report of the Joint Committee on Archives of Science and Technology*, ed. Clark A. Elliott (Chicago: Society of American Archivists, 1983); William J. Maher, *The management of college and university archives* (Metuchen, NJ: Society of American Archivists and Scarecrow Press, 1992); and Helen W. Samuels, *Varsity letters: Documenting modern colleges and universities* (Lanham, MD: Scarecrow Press, 1998; Society of American Archivists, 1992). For reconsideration of archives and their functions, see such recent studies and essays as Eric Ketelaar, Tacit narratives: The meaning of archives, *Archival science* **1** (2001), 131–141.

The legacy of an exiled mathematician. The diffusion and generalization of Emmy Noether's work on invariant variational problems

Yvette Kosmann-Schwarzbach

From a study of the biographies of the many mathematicians and physicists who were forced to emigrate from the Third Reich, or to escape from the lands it conquered, one can observe a general pattern. Persecution led to forced emigration, from which followed the transmission of science created in Germany to the host countries, most notably to the United States, whence the further diffusion and development of the transmitted science. This view is confirmed by Oswald Veblen's opening address at the first International Congress of Mathematicians to be held after the war (Harvard, 1950), in which he expressed the hope that mathematics in Germany would regain its pre-war stature.

Emmy Noether (1882–1935) was deprived of her employment by the Nazis in 1933 and compelled to leave Göttingen. She found refuge and employment in the United States where, until her premature death following an operation, she taught at Bryn Mawr College, on the outskirts of Philadelphia, and also participated actively in the mathematical life of the Institute for Advanced Study at Princeton. Her fame rests mostly on her work in algebra, which she did whilst at Göttingen from 1920 until her emigration in 1933.[1] But she is also the author of *Invariante Variationsprobleme* ("Invariant variational problems"), published in the *Göttinger Nachrichten* in 1918 [3], in which she established the relationship between invariance and the conservation laws for variational problems.[2] The article contains two theorems which are now considered fundamental in both mathematics and physics, together with their proof and that of their converses, and the proof of a generalization of a conjecture of Hilbert (who had claimed that the absence of a proper law of energy was a characteristic of the general theory of relativity).

One can ask whether the transmission of Noether's work on variational problems was influenced by the fact that she emigrated in 1933 and whether this fits the general scheme which I have just outlined. I am inclined to answer that the diffusion of her *Invariante Variationsprobleme* did not follow that scheme, so it is really an exception to the general pattern. In fact, a study of the transmission of the contents of her article shows that no significant developments took place until long after her emigration to the United States and her subsequent death in 1935.

[1] For a study of the transmission of her fundamental work in this domain, see the book by Leo Corry on the history of 'modern algebra' and, in relation to the effect of emigration on the transmission of mathematics in general, the book by Reinhard Siegmund-Schultze [7].

[2] See Peter Olver's book [4] for a very complete account of Noether's results and many other developments. For historical studies, see [5] and see my book [2] (a thoroughly revised version of [1]), which contains an English translation of Noether's article followed by an essay both on the inception of these theorems and on their reception, especially the developments that occurred after 1970. See also the review articles by Reinhard Siegmund-Schultze [8] and Erhard Scholz [6], and the forthcoming review by Peter Olver (*Bull. Amer. Math. Soc.*).

What were the developments following the publication of the *Invariante Variationsprobleme*? Noether submitted it for her *Habilitation*, which she finally obtained in 1919, but she never referred to this article in any subsequent publication. At Göttingen, she had an immediate follower, Erich Bessel-Hagen (1898–1946) who was Klein's student. In his article on conservation laws in electrodynamics (*Mathematische Annalen*, 1921), he restated Noether's two theorems in a slightly more general form, an advance that he admitted he "owe[d] to an oral communication by Miss Emmy Noether herself". Thus, the invention of the 'symmetries up to divergence' introduced in that article should be attributed to Noether. While Bessel-Hagen referred very explicitly to her, there are some surprising omissions. For example, she is not mentioned in Hermann Weyl's summary of Bessel-Hagen's paper, nor in Wolfgang Pauli's article on relativity theory in the *Encyclopädie der mathematischen Wissenschaften*. Her work did figure in Roland Weitzenböck's treatise on differential invariants (1923) and particular cases of her theorems were summarized in Richard Courant and David Hilbert's *Methoden der mathematischen Physik* (1924, second edition 1931). However, I could find no other reference to Noether's article in books of, or on, mathematics prior to her departure for New York in 1933, nor, for that matter, in those published during the following quarter of a century.

In 1935, Bartel van der Waerden published a eulogy of Noether in the *Mathematische Annalen*. Given the fact that Noether was Jewish, this was by then a courageous act, even though it was not yet explicitly forbidden. It seems that the importance of Noether's mathematical legacy was such that a suitable tribute had to be published, even in Nazi Germany. Hermann Weyl composed a very generous eulogy, but he was then in Princeton, and his text was published outside of Germany. These eulogies contain only the briefest mention of Noether's work prior to the 1920s.

The diffusion of Noether's results was extremely slow, and took various forms, apparently independent of each other. By this I mean that her work was used in a very few books and papers between 1921 and 1951, but was eventually rediscovered in the 1950s and 1960s. Citations came later, in the 1970s, and in that same period genuine generalizations of her work began to be published. Until then the so-called 'generalizations' were all due to physicists and mathematicians whose knowledge of her theorems derived from the truncated versions which they had read in a 1951 article by Edward L. Hill published in the *Reviews of Modern Physics.* In fact, with very few exceptions, the transmission of Noether's theorems was not accomplished by members of the German diaspora, nor by mathematicians or physicists residing in Germany or writing in German. It was Andrzej Trautman at the University of Warsaw who, in 1967, was the first to introduce even a part of Noether's article using a more modern terminology, that of manifolds and jet bundles.

What is striking for the reader of Noether's article today is its generality. She dealt with a Lagrangian of arbitrary order with an arbitrary number of independent variables, as well as an arbitrary number of dependent variables. She considered the invariance of such Lagrangians under the action of 'groups of infinitesimal transformations'. Since she not only considered groups of global symmetries but also their infinitesimal generators in the sense of Sophus Lie, she could introduce a very general type of infinitesimal symmetry, one which was only rediscovered by mathematicians and mathematical physicists in the 1960s. Her theorems, whose importance remained obscure for decades, were eventually applied and generated important developments, e.g., the exact sequence of the calculus of variations and the variational bicomplex. The impact on the communities of mathematicians and physicists of the Noether correspondence between symmetries and conservation laws would be eventually felt, long after her emigration and death.

Other political upheavals have forced the emigration of mathematicians and of ordinary citizens, who had even fewer opportunities to reconstruct their lives abroad. The life stories of all the Jews who were persecuted and murdered, and of all the victims of the Nazis, are extremely moving, as are the life stories of those who survived far from their beloved Germany. In a world that has not yet rid itself of racism, they must serve us as a lesson, albeit an ambiguous lesson since not all exiles are analogous.

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Bringing an exhibition on German-Jewish mathematicians abroad: some experiences

Birgit Bergmann and Moritz Epple
(joint work with Ruti Ungar)

On 14 November 2011, the exhibition "Transcending Tradition: Jewish Mathematicians in German-Speaking Academic Culture" will open in the Museum Beit Hatfutsot in Tel Aviv (cf. http://www.gj-math.de). To produce an international version of the existing German exhibition "Jüdische Mathematiker in der deutschsprachigen akademischen Kultur" (cf. [1], [2]) involved various practical and intellectual challenges. How to stage a story about the participation of Jews in Science in Germany in countries that provided a new home to those fleeing the Nazis?

Objectives of the exhibition. In the decades before and after 1900, when mathematics was undergoing a deep intellectual and professional transformation, many Jewish mathematicians held professorships or other important positions in German academic life. Of the 94 full professorships in mathematics at German universities at the end of the Weimar Republic, twenty were held by Jewish mathematicians. In the years before, as many as twenty-eight of these chairs had at least temporarily been occupied by by Jewish scholars. The percentage of Jewish mathematicians among all professors was similar. If we add to this the number of scholars who as a result of anti-Semitism or other factors were not permitted to submit a habilitation thesis, and if we keep in mind, too, the many Jewish mathematicians at German-speaking universities in Zurich, Vienna, Prague and other cities, it becomes clear that mathematical life in pre-1933 Germany and neighboring German-speaking countries was to a considerable extent a German-Jewish mathematical life.

Our exhibition showcases the impressive technical and professional scope of the contribution of these mathematicians to German-speaking mathematical culture. The exhibition highlights two points in particular. First, there was no part of the academic culture of mathematics during the period in question in which Jewish mathematicians were not actively involved. In the German Empire and the Weimar Republic, Jewish mathematicians worked in research, teaching, and publishing, they were active in professional organizations like the German Mathematical Society, and they participated in the public discourse on mathematics. They contributed to shaping the German-speaking mathematical culture of their time. Second, their activities were so varied and multifaceted that any stereotype of a 'Jewish' style in mathematics is immediately disproved.

Every university mathematician in Germany has had occasion to see the exhibition. Several school classes saw it with their teachers. It is clear that to some extent, the German exhibition did indeed change the awareness and collective memory of the events it describes.

Structure of the exhibition. The exhibition (German and English) is divided into three areas. The first area treats the political and legal conditions for the emancipation of German Jews and the beginnings of academic activities in mathematics, including a prosopography of German-Jewish mathematicians between ca. 1800 and 1933.

The second, largest area is devoted to the flourishing participation of Jewish mathematicians in German academic culture — in major centers such as Berlin and Göttingen and in smaller cities such as Bonn and Frankfurt. Besides illustrating mathematical life in these places the exhibition displays 50 mathematical monographs containing a substantial part of the mathematical legacy of German-Jewish mathematicians. It also documents their engagement in professional infrastructure and general academic culture.

The third area briefly summarizes the impact of academic anti-Semitism throughout the period considered, and it recalls what is known about Nazi persecution and its consequences (cf. [3]). For the international version, a new section about the question of returning to Germany was added (see the talk given by Volker Remmert in this workshop).

Changes of perspective in going abroad. During the preparation of our exhibition, some problematic issues have been raised that required some reflection of what it means to bring the exhibition to the countries in which émigrés found new homes and positions.

1. Is 'Jewish Mathematicians in German Speaking Academic Culture' a meaningful sociological concept? Many mathematicians dealt with in the exhibition had no special affinity to Jewish religion or being Jewish. On the other hand, very few mathematicians had Zionist leanings. As with religion, so in other respects: There is no sociological coherence among Jewish mathematicians. Most probably, they were as diverse a group as each other academic group. However, the Nazis persecuted all of those our exhibition is devoted to, and they did so in a different way than with political opponents. Persecution was coupled to racist, anti-Semitic ideology. This did in fact create more affinities among Jews than used to be the case before the Nazi period.

2. The contribution of émigré mathematicians to the academic culture of mathematics. One of the issues that was well-received in the German version of the exhibition was the light thrown on cultural activities beyond mathematical research. These cultural contributions where often brought to the countries of exile and/or second academic career. Several activities highlighted in the exhibition can be mentioned here:

In Frankfurt, Max Dehn set up a famous seminar on the history of mathematics; in his exile, he continued to publish historical papers. Moreover, his interest in mathematics and arts also found expression in his later career: indeed it became dominant in his last position as a member of the reform college at Black Mountain in North Carolina. One might add more examples relating to the history of mathematics. In mathematics education, a similar story can be told about Otto Toeplitz's arguments for using a genetic method in mathematics teaching.

When it comes to institutional activities one of course has to point to Courant's Göttingen experience which he brought to the US. In an interview Birgit Bergmann conducted with Willi Jäger he reported that even in his later years Courant repeatedly expressed his wish to build a second Göttingen at his new institute.

Still, not all cultural activities of German-Jewish mathematicians could live on elsewhere, especially those strongly relying on the German language. Whereas the Nazis could not suppress Felix Hausdorff's contributions to set theory, they nearly achieved the deletion of all memories of Paul Mongré the writer.

3. Discriminated minority vs. members of a scientific elite? Telling the story of German-Jewish mathematicians in Germany, and now in Israel, may mean two rather different things. In the German context, we were telling the history of a discriminated minority. In today's Israel, those who were persecuted in Germany are memorized as celebrated members of a scientific elite. Thus the exhibition might be (mis-)understood as mainly celebrating this elite and the greatness of the Jewish scientific mind. In view of the present discrimination of the Arabic population in Israel such a message would be problematic, and it would run counter to the intentions of many of those portrayed in our exhibition. In preparing the exhibition for Israel we have tried to avoid such an interpretation. First of all, the main language chosen is English, as the story to be told is not one belonging to one country in particular. We have added several elements in the local languages Hebrew and Arabic. But the two languages are treated in a completely symmetrical way. Moreover, we have stressed the context of continuing discrimination. The short period of flourishing cooperation between Jewish and non-Jewish mathematicians in Germany before 1933 testifies to the possibilities that open up when discrimination against a minority weakens or disappears.

4. The new title "Transcending Tradition" emphasizes this point. Indeed, the period of flourishing of German-Jewish life was a period of transcending traditions in at least three senses. First, a long-standing tradition of social and religious discrimination was at least partially overcome. Second, this period saw a decisive reshaping of mathematics as a whole: traditional mathematics became modern mathematics. German-Jewish mathematicians most actively contributed to this modernization. Third, in engaging with a science beyond religious and national boundaries, also some limitations of traditional Jewish life in Germany may have been transcended — this, at least, was the view of many of those portrayed in our exhibition, including Richard Courant, Max Dehn, Hans Hahn, Felix Hausdorff, Emmy Noether, and many others.

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Refugee mathematicians from non-German academia assisted by the Society for the Protection of Science and Learning

Rolf Nossum

Thousands of academics were affected by anti-Semitic and political persecution in Europe from 1933 onwards. Aid organisations were set up in many European countries as well as in the USA to assist refugee scholars. In Britain, the Academic Assistance Council (AAC) was founded in 1933, reorganised as the Society for the Protection of Science and Learning (SPSL) in 1936, and in 1997 it was renamed the Council for Assisting Refugee Academics (CARA, `http://www.academic-refugees.org/`).

The archives of the SPSL, deposited at the Bodleian Library in Oxford,[1] are a rich source of information on the emigration of scientists from all parts of Europe, including those who did not come from German-speaking institutions. Earlier work on the activities of the SPSL, however, does not contain much information about mathematicians from outside German-speaking academia, except for a brief outline in Rider [2, pp.119–122].

The category "German-speaking mathematician" is circumscribed by Reinhard Siegmund-Schultze in his book on the emigration of mathematicians from Nazi Germany:

> "German-speaking" as used in this book means more than just fluency in the German language. It is related to the process of socialization of the respective mathematicians. Publications in German alone are definitely not the decisive criterion for calling a mathematician "German-speaking" as German was still the leading language in mathematics at that time. [3, p.2]

The scope of the present investigation is the set difference between the mathematicians represented in the SPSL archives and those considered in [3]. Of the 95 mathematicians in the SPSL files, 33 were non-German-speaking in this sense. In a few cases, there will be occasion to recall the reasons that a particular mathematician considered here was excluded from consideration in [3].

The purpose of the SPSL was twofold: to create a fund for the financial support of displaced scholars; and to act as a placement service, seeking to re-establish scientists in academic life in the UK or elsewhere. On initial contact, refugees were made to complete a questionnaire with details of their academic merits, and the SPSL had a network of correspondents from whom confidential opinions were solicited about the academic merits of the applicants. Some of these were themselves refugees from persecution, for instance, Harald Bohr, Richard Courant, Jacques Hadamard, and Hermann Weyl. Other frequent referees for mathematics were Selig Brodetsky, Godfrey H. Hardy, John E. Littlewood, Louis J. Mordell, and John Henry C. Whitehead. Of these, Hardy in particular was explicit about the

[1] I am grateful to CARA, the owner of the SPSL archives, for permission to access these files, and to the Bodleian Library for the opportunity to take photographs of them for use in my research.

goal of strengthening British mathematics by having the scientifically strongest of the refugees absorbed into British universities.

Refugee scholars with strong academic résumés stood the best chances of success with the SPSL. As would be expected, opinions about particular refugees sometimes diverged, complicating the task of prioritizing applicants. Personal contacts and recommendations also played a significant role, and occasionally the SPSL was invited to complement the financial support already established by supporters of particular refugees. In many cases, refugees who first arrived in Britain were later re-established in the United States.

A fuller account than is possible here is given in [1]. Of the 33 refugees considered there, at least 18 were of Jewish descent and the victims of discrimination and persecution in their countries of origin in the 1930s. Some lost their positions when their universities were closed due to nationalistic strife (notably the University of Vilnius and the Czech Universities in Prague and Brno). One was expelled from the USSR because of his British nationality.

Xenophobia was not confined to the countries of origin. One refugee reported being pessimistic about finding employment in Western Europe because he had perceived a strong dislike of foreigners there, especially of East Europeans. Another was even faced with the scepticism of the SPSL itself on account of his Russian appearance. Racism typical of the period was evident in the way a position at an American college established for the education of African Americans was presented to several refugee scholars, some of whom replied with finesse. Some of the refugees, who had come to Britain with the assistance of the SPSL before the war, were interned as enemy aliens due to government orders issued in May and June of 1940.

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Jewish émigré mathematicians and Germany

Volker R. Remmert

The talk was based on my contribution to the exhibition catalogue *Transcending Tradition. Jewish Mathematicians in German Speaking Academic Culture* [5]. It had three parts:

(1) Returning to Germany

(2) The German Mathematical Association (DMV) and Jewish mathematicians in the postwar period
(3) The Mathematisches Forschungsinstitut Oberwolfach as meeting point

1. Returning to Germany

Eventually only three Jewish émigré mathematicians returned to a German university:[1] Friedrich Wilhelm Levi went to Berlin in 1952 and was retired in 1956; Hans Hamburger (1889–1956) returned to Cologne in 1953 (where he had taught up to 1935); and Reinhold Baer accepted a professorship in Frankfurt in 1956, where he then had many prominent doctoral students and became an important part of the German mathematical community. While Hamburger succeeded in reclaiming his old position in Cologne, this was not an option for Baer and Levi who had not held permanent positions when they emigrated. They made their way back to Germany through visiting professorships and lecturing trips. Baer and his family had settled in the U.S., but felt drawn back to Germany. He was appointed at Frankfurt University in 1956. Levi was very unhappy with his unstable situation in India. He gave a series of talks in England, the Netherlands and Germany in 1950, and held visiting professorships in Freiburg (1951) and Berlin (1952). At the newly founded Freie Universität in Berlin the mathematician Alexander Dinghas (1908–1974) was determined to hire Levi and succeeded in doing this in 1952 in spite of the opposition of the administration.

2. The German Mathematical Association (DMV) and Jewish mathematicians in the postwar period

The DMV was newly founded in 1948 in the French occupation zone by the mathematician Erich Kamke (1890–1961) who had lost his professorship in 1937 because his wife was Jewish. After World War II, Kamke severed all ties to the “old” DMV and its leading personnel, pointing to its treatment of Jewish members in 1938.

Generally speaking, no systematic efforts were undertaken to open ways back into German universities for émigré academics. And only rarely were they invited to return to their old positions. Rather, the situation in German universities was cemented in 1951, when a law was passed that allowed most of those professors who had lost their jobs during the denazification process to be reinstated. Later that year, the Germany Ministry of the Interior started an initiative for academics who had been expelled during the Nazi period but had not held permanent positions, had since been teaching at universities, and did not have any pension rights outside Germany. While these restrictions (and the three-week deadline for replies) made the group in question quite small, this may be seen as a first step towards the so-called “Wiedergutmachung” [compensation] that took place in the mid-1950s.[2]

In the DMV, president Kamke immediately took action when he learned about this. Within four weeks he submitted a “List of mathematicians who had been compelled to leave Germany by the NS-regime”, at the same time pointing to the

[1] On the general context of remigration to Germany see [3].
[2] On the topic of compensation see [2].

fact that the amount of compensation being offered was not sufficient and was bound to create bad feelings among some of those concerned. Indeed, the question of compensation was a source of frustration to many.

3. The Mathematisches Forschungsinstitut Oberwolfach as meeting point

The MFO was founded in late 1944 as a National Institute for Mathematics ("Reichsinstitut für Mathematik") with the objective of conducting research important to the war effort. The moving force behind its foundation and the first director of the institute was Wilhelm Süss, DMV president between 1937 and 1945/46. In 1938, he had been instrumental in excluding Jewish members from the DMV. After the war, Süss quickly readjusted his policies. He now wanted to clear the Oberwolfach institute of its war-related history and transform it into an international meeting place for mathematicians (see [1]). Starting in 1948, he deliberately began approaching Jewish émigré mathematicians and inviting them to come to Oberwolfach.

Regular conferences took place in Oberwolfach from 1949 onwards. Of the three workshops held in 1949, two were centered around eminent Jewish mathematicians: the attraction of the topology workshop in April was Heinz Hopf (1894–1971), who had taught in Zürich since 1931 and first visited Oberwolfach in 1946. The meeting on mathematical logic was presided over by Paul Bernays (1888–1977), Hilbert's collaborator who had lost his position in Göttingen in 1933. These workshops, along with a Franco-German meeting in August 1949, were of great importance for the re-integration of German mathematicians into the international community.[3]

But Süss was also very interested in getting Reinhold Baer, Friedrich Wilhelm Levi and Bernard Neumann to Oberwolfach. Their reactions to his invitations were positive. Levi came to Oberwolfach in 1950 and Baer in 1952 (not having managed to incorporate it into his travel plans in 1950). In 1951 Bernard Neumann (1909–2002), who had emigrated to Great Britain in 1933, came with his wife Hanna (1914–1971), who was a group theorist as well. In the late 1940s the main obstacle for Baer and Neumann to travel to Oberwolfach was the lack of travel funds. For Baer and Levi, the early visits to Germany and Oberwolfach were first and important steps on their way back to Germany. Neumann organized his first conference on group theory in Oberwolfach in 1955. Beginning in 1954, Baer frequently organized workshops in Oberwolfach in the 1950s and 1960s. Both Baer and Neumann were instrumental in the remigration of mathematical ideas and theories, in particular in group theory, to Germany.

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Beyond the 'Magic Mountain' – some remarks on the development of Menger's 'small inductive dimension' definition and his emigration to the USA

Bernhard Beham

Karl Menger (1902–1985) left his trace in various scientific fields, among them mathematics, philosophy and economics. In my dissertation, I am mainly focusing on Menger's 'formative' years and his early contributions towards dimension theory. Thus, my dissertation should be seen in the light of a first step towards a scientific biography of Karl Menger, which is not at hand yet. In order to understand the impact that came from Menger's (and Urysohn's) 'small inductive dimension' definition, one has to look at the inner mathematical developments and discussions before the 1920s. Since the ancient Greeks, an unquestioned concept of dimension, based on quantity, meaning that a line would intuitively include fewer points than a square or a cube, can be traced within the history of mathematics up to the late 19$^{\text{th}}$ century. By then Georg Cantor (1845–1918) had brought this concept into doubt, while proving that a one-to-one mapping from a square/cube onto a line segment exists [2]. Whereas several mathematicians tried to 'save' the former concept, while proving the so-called invariance theorem of dimension,[1] Guiseppe Peano (1858–1932) and David Hilbert (1862–1943) had not only given with their counter-intuitive space-filling curves a serious blow to this somewhat intuitive concept of dimension but also opened an interesting research field [4, 17]. Later, in the 1930s, Hans Hahn (1879–1934) would call this situation the 'crisis of intuition' [3]. Although everybody has an intuitive idea of what a curve, square or cube is like, by the turn of the century the mathematical community was in need of exact definitions.

The end of this 'crisis' was first brought by L.E.J. Brouwer's (1881–1966) general proof in 1911 of the invariance theorem of dimension [1], which to some extent 'saved' the former concept of dimension. However, in the early 1920s Paul Urysohn (1898–1924) and Karl Menger (simultaneously and independently) presented a new concept of dimension – 'small inductive dimension' definition –, based on point-set topology. While looking at Menger's first attempts and contributions towards dimension theory one cannot neglect his fascinating biography. Although Menger had come to some kind of a 'solution' by Spring/Summer 1921, his results were

[1] A detailed analysis of the history of the invariance theorem can be found in [5, 6].

not published until the end of 1923. This delay resulted both from health as well as from mathematical problems that Menger had to face in the early 1920s. By February 1922 doctors had diagnosed tuberculosis, which forced Menger to leave Vienna for a 'Magic Mountain' at the so-called 'Austrian Davos' in Aflenz, Styria. On the other hand, his mentor Hahn had, by the end of 1921, raised an objection which hit the starting point of Menger's first recursive dimension definition, namely the zero dimensional sets which Menger had defined as non-connected sets [14, p.416]. This assumption of the young Menger (to his fate) by then already stood in contrast to a counterexample published by Sierpinski, who had shown in his paper *Sur les ensembles connexes et non connexes* [19], that two non-connected sets could (by his special construction) have one point in common. From his sickbed Menger made (with respect to the 'small inductive dimension') a successful change which based his dimension definition on the concept of neighbourhoods. Whereas Menger's reaction concerning Hahn's objection stands in contrast to the theoretical concept opposed by Lakatos, it seems that Urysohn had explicitly included Sierpinski's counterexample in his dimension definition, namely in the notion of ϵ-separation. This also reflects the difference in the level of mathematical education between Urysohn and Menger at the time when they were trying to develop a concept of curves and consequently of dimension. Whereas Menger was only in his second term at the University of Vienna, Urysohn had already received his doctorate from the University of Moscow. This has to be considered when talking about the issue of priority. According to the date of publication, Urysohn has clearly priority over Menger, whereas this is offset both by a manuscript written by Menger in the summer of 1921, and deposited at the Austrian Academy of Sciences by December of that year, and by Menger's level of mathematical education. During his stay at Sanatorium Aflenz, Menger was not totally isolated, as he later recounted in his memoirs. With the help of his friend and colleague from university, Otto Schreier (1901–1929), he could discuss his mathematical problems in letters and at private meetings in Aflenz. The existing correspondence of Menger and Schreier (to be found in the *Menger Papers* at Duke University, North Carolina) throw light on the unknown topological side of the famous group theorist Schreier.[2] Therefore, Menger could continue his work on dimension theory and soon obtained his doctorate after his recovery.

During his treatment in Aflenz, Menger tried to hand in another manuscript for publication, which had to be declined due to an objection by Hahn [14, p.422]. As a result of this second objection, Menger made a deeper survey of topological covering theorems that found its way into the press by Summer 1924 [10]. Due to a presentation of Urysohn, given at the Annual Meeting of the German Mathematical Society in September 1923, Menger was under pressure to publish and to promote the contributions which he had made to dimension theory during the past years. Thanks to this mentor Hahn he was able to hand in his first publication by the end of 1923 [9]. By Spring 1924 Menger sent preprints to European

[2]The author is working on an article which focuses on Schreier's topological works in the framework of the development of the small inductive dimension concept developed by Menger.

topologists in order to promote his work. Among them was L.E.J. Brouwer, who later became Menger's second mentor. With the help of Brouwer he published not only in the proceedings of the Dutch Royal Academy, but also in the *Mathematische Annalen*. In addition, due to Brouwer's work on the foundations of mathematics, Menger got more and more fascinated with 'intuitionism'. Just before gaining his doctorate – 13 November 1924 [11] – Menger was invited for the first time to the Schlick Circle, to present (probably for the first time) Brouwer's philosophical program.[3] Later, in 1925, Menger would meet Brouwer for the first time in person during a short research stay in Amsterdam. During his stay in Amsterdam, Brouwer invited Menger for the autumn term to work with him in Amsterdam; his stay should be financed with the help of the Rockefeller Foundation [18]. Back in Vienna, Menger suffered from a nervous breakdown following the death of his mother. Again he needed to rest on a 'Magic Mountain', where he wrote the first draft of his report on dimension theory for the German Mathematical Society [12] that became the basis for the first textbook on dimension theory, written by Menger in 1928 [13]. In this difficult phase, Brouwer strongly supported Menger, while offering him a position as his assistant at the University of Amsterdam. His leaving for Amsterdam marks the end of Menger's 'formative' years and the starting point of his academic career. At first Menger worked at the University of Amsterdam (1925–1927), before receiving a call to the University of Vienna, where he taught until his emigration in 1937. In the USA, Menger first held a professorship at Notre Dame University (1937–1946), where he not only tried to revitalize a mathematical colloquium in the spirit of his Viennese one, but also built up a PhD programme (thanks Della Fenster), and taught at the Navy Training Center. Due to his teaching experience, not only at Notre Dame but also later at the IIT in Chicago (1946–1971), he got interested in didactical matters. As a result he wrote in 1952 the textbook *Calculus. A modern Approach* [15]. During the 1950s and 1960s he taught as a visiting lecturer at various European and American universities, which can be seen as some kind of 're-emigration' in the light of scientific transfer (thanks Marita Krauss). In his later years as an emeritus professor, Menger tried to recount not only his own intellectual biography [16], but also that of his father, the famous Austrian economist Carl Menger (1840–1921). Unfortunately, Menger could not finish these two projects prior to his death on 5 October 1985.

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US probability and statistics circa World War II

Sandy L. Zabell

Immigration to the US before, during, and immediately after World War II had profound effects on both these fields. But despite the fact that statistics and probability are closed linked branches of mathematics, the impact of immigration on the two fields was very different. This was because of the very different standing the two fields had in the US prior to the war. The US already had a vigorous statistical profession, but immigrants such as Jerzy Neyman and Abraham Wald gave it a much more mathematical direction than it had had previously. In contrast, prior to World War II mathematical probability effectively *had no identity in the United States*; in this case the influx of a small number of refugee mathematicians, such as William Feller and Mark Kac, played a major role in the creation of a new and flourishing school, effectively transplanting an entire branch of mathematics to the shores of the US.

Statistics. According to its website, the American Statistical Association, founded in 1834, is the second-oldest professional organization in continuous existence in the US, and already had a sizable membership by the beginning of the 20^{th} century.

Statistics was also flourishing at the same time in the UK, especially after the rise of the the English biometric school (sporting such luminaries as Galton, Weldon, Yule, and Karl Pearson) and the founding by Pearson of the journal *Biometrika* in 1900. Following on this, in the 1920s UK statistics began to acquire a more mathematical tone with the advent of young Turks such as R.A.Fisher, Egon Pearson, and Jerzy Neyman. Such developments were followed with interest in the US, and this led in the 1930s to both a new journal (the *Annals of Mathematical Statistics* in 1930) and a new organization (the Institute of Mathematical Statistics [IMS] in 1935). In 1938 the *Annals* became the official publication of the IMS, and acquired a genuinely international editorial board (including Cramér, Darmois, Fisher, von Mises, and Egon Pearson); see generally [5].

These developments also led to a desire to import new talent to US shores, and as a result Jerzy Neyman was hired by the University of California at Berkeley in 1938 to lead its statistical efforts. This was a remarkably prescient decision on both sides: Neyman became an enormously influential figure in US statistics: founder of Berkeley's Department of Statistics (which quickly became one of the top departments in the US), Neyman supervised 40 Ph.D. students (including Dantzig, Hodges, Le Cam, and Lehmann), leading in turn to (according the Mathematical Genealogy Project) 1646 'descendants'.

Neyman's decision to come to the US was influenced by the ominous world developments he saw taking place. Four decades later Constance Reid reported that Neyman did not "think he would even have considered leaving London for Berkeley" save for one reason: "[I] did not want to be behind barbed wire again. It was clear to me – and many people – that war was coming, but it was not clear whether Poland will be on one side or another one. It came to my mind that when war comes I shall be an enemy alien again" [4, pp.151–152].

Nevertheless, Neyman was in no sense a refugee: he had voluntarily left Poland in 1934 for what soon became a permanent position in the University College London's Department of Applied Statistics (headed by Egon Pearson). Many other immigrants to the US, however, were genuine refugees, including Abraham Wald (students included Herman Chernoff, Charles Stein), Wassily Hoeffding (students included Donald Burkholder, Meyer Dwass, James Hannan), Z.W. Birnbaum (students included Albert Marshall, Ronald Pyke), and Erich Lehmann (students included Peter Bickel, Allan Birnbaum, Colin Blyth, Frank Hampel). These four alone had 1551 descendants.

These immigrants brought a more mathematical focus to US statistics. One (unwilling) witness to their success was Neyman's arch-enemy R.A. Fisher, who, Joan Fisher Box reports, was "shocked" during his visit to the US in 1957–1958 by "the developments in mathematical statistics" there [2, p.462].

It should be noted, however, that statistics in the US also benefited from the war not just by an infusion of mathematical talent from abroad, but also from a *redirection* of mathematical talent at home. In both the US and the UK a number of mathematicians who were not statisticians before the war, first became involved in serious statistical work because of the war, and then remained in the field after peace came. In the US, this included statisticians of the first rank such as John Tukey, Herbert Robbins and William Kruskal; in the UK, George Barnard, David Kendall (applied probability) and, very importantly, I.J Good.

Probability. Prior to 1939, there had been many famous mathematicians working in probability throughout Europe, including France (Laplace, Borel, Lévy, Fréchet, Haag, Doeblin), Russia (Chebyshev, Markov, Liapunov, Bernstein, Kolmogorov, Khinchin), Italy (Cantelli, Castelnuovo, de Finetti) and other parts of Europe (Czuber, von Mises, Lindeberg), to name only some of the best known. In contrast, there were virtually *none* in the US prior to the war! There was a similar dearth in the UK (see [1] for discussion). (This seems in turn to have acted to a certain extent as a disincentive: some immigrants to the UK and the US, who had previously worked both in probability and in other areas, effectively ceased working on probability after arriving in the UK or US; the cases of Besicovitch, Uspensky, and von Mises come to mind.) This absence of professional activity mirrored an absence of serious research literature in English on probability [3, p.516].

There are two exceptions that prove the rule. Norbert Wiener had done important work on Brownian motion in the 1920s, but most of his mathematical work was in other fields, and of his 19 students, only 2 were in probability or statistics. And of course there was Joseph Doob, who did pioneering work on martingales and stochastic processes, and was a major figure in postwar probability in the US. (He had 17 students, his first being David Blackwell, and 1106 "descendants".) But Doob was *sui generis*: his thesis was in a different area, supervised by someone who did not work in probability (J.L. Walsh), and he only gravitated to probability afterwards, thanks to the statistician Hotelling. All this was to change with the arrival of a stream of gifted immigrants associated with World War II and its immediate aftermath.

These US immigrants included (here $a; b \to c$ means the individual taught at a, had b students and c descendants):

- William Feller (Princeton; $18 \to 887$)
- Mark Kac (Cornell; $11 \to 252$)
- Kai Lai Chung (Stanford; $14 \to 137$)
- Michel Loève (Berkeley; $5 \to 385$)
- Wassily Hoeffding (Chapel Hill; $18 \to 236$)
- Z.W. Birnbaum (University of Washington; $8 \to 77$)
- Others: Bochner, Zygmund, Moyal

The total for the first four alone comes to 48 students and 1661 descendants. (Moyal is a complicated case, not discussed here.)

How can one quantify (or at least objectify) the concept of impact on a field? Merely counting students and descendants has obvious limitations. In some cases a mathematician may have few students but be highly influential via books, papers, lectures, even missionary zeal. In other cases someone may have many students, many or all of whom may be unproductive. Ultimately 'impact' would appear to be something requiring an inescapable element of subjective judgement.

Nevertheless, in the case of probability some quantitative measures suggest themselves. In 1973 the *Annals of Mathematical Statistics* split into the *Annals of Statistics* and the *Annals of Probability* (AP). From its inception, the AP has been the leading journal for US probabilists to publish in, and it can thus serve as one window into US probability. If one examine the papers in the first, 1973, volume of the AP, it turns out that nearly half were written by descendants of the nine individuals listed above.

Another measure of impact can be seen in the editorship of the AP over the first 21 years of its existence (editors serve three-year terms). The first seven editors of the AP were: 1973–75, Ronald Pyke (descended from Birnbaum); 1976–78, Patrick Billingsley (Feller); 1979–81, Richard M. Dudley (Bochner); 1982–84, Harry Kesten (Kac); 1985–87, Thomas M. Liggett (Bochner); 1988–90, Peter Ney (Moyal); 1991–93, Burgess Davis (Hoeffding). *All seven of these* are descended from the nine immigrant mathematicians listed earlier! In contrast, the subsequent editors of the *Annals* were for the most part either themselves immigrants to the US, or descendants of mathematicians in other fields. This reflected a changed landscape: thanks to a thriving school of probability, the US was now able to attract talented individuals from other countries or areas of mathematics.

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Emigration of mathematicians to, from and within former Czechoslovakia, with an emphasis on the Nazi period

Jan Kotůlek and Helena Durnová

Czechoslovakia as a state only existed from 1918 to 1939 and from 1945 to 1992. Czech and German universities and technical universities co-existed in Prague and Brno until the beginning of WWII, although relations between the Czech and German institutions were sometimes lukewarm [12]. Jewish scholars studied and taught at all of them, e.g. Emil Schönbaum at the Czech university in Prague and Richard von Mises at the German technical university in Brno. In March 1939, Czechoslovakia was divided into the Protectorate of Bohemia and Moravia and the Slovak Republic, a client state of Nazi Germany. On 17 November 1939, those universities in the Protectorate of Bohemia and Moravia which used Czech as the teaching language were closed. Regular professors were sent on paid leave. Most of the other university staff (i.e. the associate and assistant professors) were given appointments as secondary school professors. Non-Jewish mathematicians thus felt no urge to emigrate. However, many promising young intellectuals, including mathematicians, were forced to labour in Nazi Germany (as part of the so-called *Totaleinsatz* ["total deployment"] of people born between 1921–25), whilst others died during the war.[1] The professional organization of Czech mathematicians, the Union of Czech Mathematicians and Physicists, supported the writing of textbooks (self-study manuals) for those who were not able to study during the war. The Society's journal, however, was discontinued from 1940 until 1945.

Jewish mathematicians and mathematics teachers who, unlike E. Schönbaum and K. Löwner, were not successful with their attempts at emigration were transported to concentration camps, where most of them died (examples are L. Berwald, G.A. Pick and Schönbaum's pupils V. Havlík, R. Polák and J. Stránský). Two well-known exceptions are Štefan Schwarz, who survived his internment in the Sachsenhausen concentration camp, and Heinrich Löwig, who emigrated only in 1948. The situation of Jews with Czechoslovakian citizenship was extremely complicated: prior to September 1938 there was little reason to emigrate (Czechoslovakia was welcoming immigrants until the spring of that year), whereas only a year later emigration had become illegal. A sad example which demonstrates the consequences is provided by Walter Fröhlich: after the outbreak of WWII, Fröhlich was regarded as the citizen of an enemy country (he held a passport from the German Reich) and his exit visa for Great Britain was cancelled. Later, he was arrested and deported to Łódź, where he died on 29 November 1942.

In the post-war period there were two major waves of emigration [14]: after the Czechoslovak coup d'état in February 1948 (e.g. Václav Hlavatý and Emil Schönbaum), and after the Warsaw Pact invasion of Czechoslovakia in August 1968 (e.g. Jan Mařík). After 1968, forced migration within Czechoslovakia was also common, with scientists often being moved to less prestigious institutions or to positions without teaching duties. **Example careers** mentioned during the talk include:

Otakar Borůvka (1899–1995) earned his doctorate at Masaryk University in Brno in 1923. He studied with E. Cartan in Paris and with W. Blaschke in Hamburg. In 1934, he became extraordinary professor at Masaryk University. During WWII he wrote his textbook on algebra while in isolation on paid leave. He became ordinary professor at Masaryk University in 1946 (valid retroactively from May 1940) and worked in Brno until 1970. He started a seminar on differential equations and founded (in 1965) the *Archivum Mathematicum*, a mathematical journal published by the university in Brno (now Masaryk University).

Bedřich Pospíšil (1912–1944) was an active participant of the Brno topology seminar led by Eduard Čech, which ran from May 1936 until the beginning of

[1]These issues are dealt with by Antonín Kostlán in his project *Disappeared Elites: Scientists and Intellectuals from Bohemia and Moravia as victims of the Nazi persecution, 1939–1945.*

WWII.[2] Following the closure of the universities, the seminar basically ceased to exist, although three of its most active members — Eduard Čech, Josef Novák and Bedřich Pospíšil — continued to meet at Pospíšil's home. Although Pospíšil was later released from prison, he died from the consequences of the imprisonment. Topology in Czechoslovakia had lost a young and promising researcher.

Miloš Kössler (1884–1961) was the head of the Union of Czech Mathematicians and Physicists during WWII. The Union tried to compensate for the absence of taught classes by publishing papers in its membership journal *Časopis pro pěstování matematiky a fysiky* (Journal for the Cultivation of Mathematics and Physics), but this was marred by the journal's discontinuation in 1940.

Štefan Schwarz (1914–1996) left his post as assistant in Prague for Bratislava in 1939. He taught at the Slovak Technical University in Bratislava until 1944, when he was arrested. He survived his imprisonment in the Sachsenhausen concentration camp. After WWII, he became one of the leading mathematicians in Slovakia.

Emil Schönbaum (1882–1967) was professor of actuarial mathematics at Charles University in Prague from 1923. On 1 March 1939, he was sent on paid leave and was formally asked to either leave the public service voluntarily or to ask for early retirement. So he left for Latin America, where he then worked as a social insurance specialist for the International Labour Organization. In December 1945 he resumed his duties at Charles University. In early 1948 he received a sabbatical and, shortly after the communist coup d'état, left for Mexico. Failing to return to Prague, he was dismissed for having left the service and for "showing a hostile attitude towards the People's Republic of Czechoslovakia."

Václav Hlavatý (1894–1969) received his Ph.D. from Charles University in Prague in 1921. He studied in Delft, Paris and Rome, and was also a visiting professor at the IAS in Princeton during 1937–38, but later returned to Czechoslovakia. In 1940, he was sent on paid leave and worked throughout WWII in seclusion, using his leave from teaching to write books (two volumes of the textbook *Projective Geometry*). In 1947, he became a member of the Czechoslovakian parliament. He emigrated only in 1948, when he was invited to Indiana University, where he applied his knowledge of differential and projective geometry to Einstein's unified theory of relativity.

Historiographical note: The broader views which were presented in the talk were based on biographical articles and obituaries that appeared in the journals of the Union for Czechoslovak Mathematicians and Physicists and in handbooks issued by the Union of Slovak Mathematicians and Physicists [8] and [12, 13].

A number of publications deal with the phenomenon of scientific emigration in the 20th century, but without specifically looking at the impact on the development of mathematics [1, 4, 9, 3, 5, 14]. Some books, on the other hand, provide biographies of mathematicians who were active in the Czech lands and Slovakia, but these pay no special attention to the theme of emigration or exile [8, 12, 13].

[2] The idea for Čech's research team was stimulated by his trip to Princeton in 1935–1936.

After 1990, a Ph.D. programme in Prague on the history of mathematics concentrated on the biographies of Czech mathematicians. The following deal with the work of mathematicians who were still alive during WWII [2, 6, 10, 11], but the Nazi Period is often neglected with a modest silence. Lives of two outstanding Brno mathematicians living during WWII are described in [7] and [15].

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Confluences of agendas: German refugees and mathematics in Denmark, 1933–1945

Henrik Kragh Sørensen

In the midst of the dire situation for German mathematicians after Hitler's ascent to power in the Spring of 1933, the Danish mathematical milieu provided a refuge for a few — at least temporarily. Through the efforts of the Bohr-brothers (the physicist and Nobel laureate Niels and his younger brother, the mathematician Harald), German mathematicians, in particular in Göttingen, were aided. Most of the emigrants would eventually move on to the US, with Denmark serving as a hub of communication and a station of transit. Yet some returned to Denmark after an escape to Sweden in 1943 and acculturated themselves to become integral in Danish mathematics. During the interwar period, the mathematical community in Denmark was strongly centralized in Copenhagen. However, no mathematical department exited until 1934, and when it was established, emigrant mathematicians were involved both with forming its international outlook and running the daily operations.

Two important aspects of Danish politics during the 1930s and early 1940s require mentioning in the present context. First, Danish emigration policy during the 1930s was formed by contrasting concerns of humanitarian aid and domestic and foreign policy [6]. In 1933, four relief committees were established in Denmark to aid emigrants who were Jewish, social-democrat, Christian, or "intellectual laborers" (academics) [3]. These committees were given the tasks of assaying the emigrants and collecting and distributing aid. The Danish government was reluctant in issuing work-permits for the emigrants, partly for fear of importing a "Jew problem" and, in particular, due to domestic unemployment. In October 1933, the relief committee for emigrant academics issued a call for financial support to aid emigrant intellectuals and combined with subsequent support from the Danish state, Rockefeller Foundations' Research Aid Fund for European Scholars, and the Danish Rask-Ørsted Foundation, these provided for comparably good living conditions among emigrant academics.

Second, the German occupation of Denmark 1940–45 was a very peaceful one by comparison. The Danish government continued some of its functions as a policy of "collaboration" was pursued 1940–43. This meant, for instance, that the Jewish population in Denmark was not interned until the collaboration policy came to an end after strikes in 1943. In October, 1943 a raid was planned to intern the Danish Jews but due to intricate machinations among the Germans, the Jews were warned and, aided by Danish fishermen and the resistance movement, fled across Øresund to Sweden. This epic rescue of the Danish Jews also included the emigrant mathematicians Käte and Werner Fenchel and the Bohr family, including Harald. In May 1945, after the liberation of Denmark, Bohr and the Fenchels returned to Denmark pursuing the rest of their lives there.

Throughout the spring and summer of 1933, Harald Bohr was active in visiting German colleagues and looking for ways of aiding those affected by the Nazi legislation. Harald Bohr had, himself, formed strong professional and personal ties with mathematicians in Göttingen, and during 1933, one of his main concerns was to assist Richard Courant in getting out of Germany. Harald Bohr served as a personal intermediary towards the international relief organizations such as the SPSL in Britain and the Rockefeller Foundation in the US [5, 7]. And, through his contacts and those of his brother, Copenhagen came to function as a hub for some emigrant mathematicians.

In his comprehensive study, Reinhard Siegmund-Schultze has identified seven German mathematicians who came to Denmark as a result of Nazi persecution [8].

These include a subgroup with a relatively high affinity to and impact on Danish academic mathematics comprising Otto Neugebauer, Käte (née Sperling) and Werner Fenchel; together with the two other research mathematicians, Herbert Busemann and Willy Feller, these were described also in [4]. Siegmund-Schultze includes in his list also Paul Nemenyi and Grete Hermann who were less closely connected to the academic mathematicians in Copenhagen. Besides these, one additional mathematically trained emigrant, Paula Strelitz, has been identified [2]. The list in [8] also contains emigrants to other countries who passed through Denmark on their route; such was the case for Max Dehn. Thus, the relief offered to German emigrant mathematicians from Denmark can be said to fall into four categories: 1) Some few who found permanent shelter in Denmark and acculturated themselves there; 2) Bordering on the first category, some a long-term transit in Denmark before eventually moving on to primarily Britain or the US; 3) More people were transiting in Denmark for a much shorter period of time as they were already en route to other destinations; 4) A category of aid besides physical shelter affected a number of would-be emigrants who approached in particular Harald Bohr as a mediator for relief.

Of those who stayed in Denmark the longest and therefore could exert the greatest influence were Neugebauer and the Fenchels. The three of them had strong connections to Göttingen before they arrived in Denmark in early 1934 or late 1933. Other emigrants such as Busemann and Feller also had ties to Göttingen and to Courant, in particular. Neugebauer had been instrumental in running the Mathematical Institute in Göttingen as the protégé and assistant of Courant; and he took with him not only his expertise at organizing an institute but, as is well known, also the editorial office of the Zentralblatt. Neugebauer continued to edit this reviewing journal out of Copenhagen for the duration of his stay there and with the assistance of a number of the younger Danish mathematicians and fellow emigrants.

As indicated, for some of the emigrants, Denmark was only a temporary stop on their way to other destinations. Thus, Feller went to Sweden in 1934 before eventually going to the US; Busemann who had also likewise to Copenhagen in 1933 stayed there until he went to Princeton in 1936 and, similarly, Nemenyi remained in Copenhagen from 1933 until he moved on to Britain and eventually the US in 1936. Neugebauer, on the other hand, stayed in Denmark right until 1939 when he accepted a position at Brown Univeristy in the US. As was the case with Neugebauer, Werner Fenchel had received a stipend from the Danish Rask-Ørsted Foundation, and in December 1935, Fenchel had applied for aid from the SPSL in finding a job overseas listing the USSR, The Far East and South America as possible venues. Yet, The Fenchels remained in Denmark, even when faced with German occupation in 1940 but fled to Sweden in 1943.

What united the emigrant mathematicians in Denmark was primarily their origin in the Göttingen tradition; for instance, they cannot be said to have any dominant field in common, neither with each other nor with a larger group of the Danish colleagues. Nevertheless, research collaborations emerged, for instance betwen Fenchel and Jessen who in 1938 published joint work on convex bodies; later, Busemann also contributed to that theory. A different impact on Danish research is illustrated through the historian of mathematics Olaf Schmidt who followed Neugebauer to Brown in 1939 and stayed there for the duration of the War. When he returned to Denmark, he re-established research in history of mathematics. Nevertheless, such cases are isolated ones owing partly to the small size of the Danish mathematical community and the relatively short duration of the emigrant impact except for the Fenchels.

On the other hand, it is clear from both the correspondence of Harald Bohr and Børge Jessen and from newspapers, that the emigrants had a much bigger impact on organization and outlook of Danish mathematics. When the department was inaugurated in 1934, Harald Bohr became its first head, and among the 11 personal offices in the new building, Neugebauer and Fenchel were each given one and Käte Fenchel worked as a secretary. Moreover, Neugebauer's work with the Zentralblatt became a source for information about international research that extended the existing research library.

In his seminal study of new directions of physics in Copenhagen during the interwar years, Finn Aaserud has argued that a confluence of circumstances and agendas allowed the group centred on Niels Bohr to "redirect" research in physics to include a more experimental perspective and the interface to biology [1]. The confluent factors included the availability of highly qualified scientists, a support scheme including private and public research foundations in Denmark and abroad, an established scholarly base of international renown, and a scientific ambition to break new ground in physical science. It seems clear that although many of the ingredients of Aaserud's analysis of Niels Bohr's "redirection" of science were also available to his brother concerning mathematics, the impact on Danish academia was not as great in mathematics as in physics. The emigrants were certainly instrumental in modernizing the institutional settings, but their impact on research trajectories is less clear, possibly reflecting that Danish mathematical research was fairly individualistic and driven by interests of the professors.

In follow-up research, these points will be elaborated and detailed, and the biographical facts for the identified emigrants will be substantiated further through archival material now available. It is hoped that new prosopographical studies made possible by a database developed for [6] and providing an overview of the immigration authorities' archives will allow for a more precise and detailed assessment of the role of Denmark as a hub and transit for German emigrant mathematicians during the 1930s.

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A comparison between the development of number theory in the USA and the UK

Samuel J. Patterson

In this talk I considered to what extent, in the case of number theory, the emigration of mathematicians from Germany had on the development of this branch of mathematics in the USA and the UK, the purpose of the comparison being to help identify which causes were most significant. I argued that the effect was much less than is generally believed. The entire question has to be considered in the context of the development of mathematics in the nineteenth century and in particular of the changing role of the universities over this period.

We recall that the Prussian universities were reformed after the defeats of 1806. This process began around 1810 and around 1820 was becoming effective. The results impressed those responsible in other nations. In the UK there was a response from about 1830 onwards whereas in the USA this came rather later, after the Civil War. The roles and number of universities in both countries were expanded on the Prussian (Humboldt) model. In both cases, but especially in the case of the USA, a large number of students went in the latter part of the nineteenth and early twentieth centuries to Europe, especially to Germany, to expand their horizons. In the reverse direction many European mathematicians visited the USA for shorter or longer periods, some staying permanently. There were consequently contacts from a relatively early period on and there were active number–theorists (e.g. G.B. Mathews in the UK and H. Hancock in the USA) in both countries trying to interest students in this area. They were not overly successful.

What had not happened in either country were spectacular developments to compare with those in Berlin and Göttingen in the nineteenth century. Since the active research life of a mathematician is typically around perhaps 20 years an area of mathematics has continually to recruit young enthusiasts. They are attracted to those areas where there is clearly a good opportunity to do interesting work, quite often not in the same area as their supervisor. What one observes is that a major advance in one country will result in talented younger people being attracted to that area. A very clear example in the case of the UK is the discovery and development of the circle method by Hardy, Littlewood and Ramanujan around 1920. (The major mode of transmission has been the written word and it should here be added that the same development gave a major impulse to number theory in the Soviet Union, especially through the person of I.M. Vinogradov.) A second important impulse in the UK, which was inspired in part by the circle method, was the formulation of the Birch/Swinnerton–Dyer conjectures around 1960.

In the USA the first really important development by American mathematicians in the field of number theory was the introduction of the methods of homological algebra presaged by S. MacLane (who had studied in Göttingen) around 1940, but completed in the Artin–Tate Seminar around 1950 and followed up by Tate in several publications. Algebraic topology had been an American speciality in the years before and the algebraic techniques were known to some of the better students. Another historically important event was Stark's solution of the Gauss class-number one problem in 1966. These were not the only developments but each set the tone for several years into the future. One might argue that Artin was instrumental in the first of these two but on the principle that one swallow does not make a summer one cannot conclude that this case proves any rule. In Stark's case he had studied carefully all the papers relating to the class-number one problem and was especially inspired by Heegner's great paper.

A second point should be borne in mind. The USA was drawn into WWII - this was more or less inevitable. This war was very technological, not only in the sense of the armoury but also in logistics (linear programming), cryptography, communication theory (Shannon), electronics (e.g. radar) etc... Whereas before the war much of the scholarship in the USA had been financed by private individuals, after it the US military put a great deal of money into all kind of research, including very pure mathematics. This opened up many opportunities and is one of the major reasons for the explosion of mathematical research, including number theory, in the USA in the post-war period. This phase came to an end around 1975 following the protests about the Vietnam war and then the funding was taken over by the NSF, again generously. In the UK the situation was rather different. In the middle of the nineteenth century it was mainly a scientific elite (especially the British Association for the Advancement of Science) which was responsible for the development of the universities (in England, the Scottish case was different). The Government had, on reflection, followed their advice. In the post-war period the UK Government did support research but in a less extravagant fashion than in the USA and not through the military. This had as a consequence that the USA was not only more attractive in the post–war period for many young mathematicians but was often the only possibility to work in an academic environment. This was expressed in a further migration (known at the time as the “brain drain”), which amplified the effect of those developments that were already taking place. From these facts one can see, if one is going to concentrate on the mechanisms of transmission of mathematics, that economic factors are particularly important, and that this is very visible in the case of the USA in the post-WWII period.

Reporter: Craig Stephenson

Participants

Prof. Dr. Thomas Archibald
Department of Mathematics
Simon Fraser University
Burnaby , B.C. V5A 1S6
CANADA

Prof. Dr. Mitchell Ash
Universität Wien
FB Geschichtswissenschaften
Dr.-Karl-Lueger-Ring 1
A-1010 Wien

Prof. Dr. June E. Barrow-Green
Faculty of Mathematics & Computing
The Open University
Walton Hall
GB-Milton Keynes MK7 6AA

Bernhard Beham
Josefinengasse 10/11
A-1020 Wien

Birgit Bergmann
Goethe-Universität Frankfurt
Historisches Seminar
Wissenschaftsgeschichte
60629 Frankfurt am Main

Dr. Annalisa Capristo
Centro di Studi Americani
Via Michelangelo Caetani 32
I-00186 Roma

Prof. Dr. James W. Cogdell
Department of Mathematics
The Ohio State University
100 Mathematics Building
231 West 18th Avenue
Columbus , OH 43210-1174
USA

Dr. Hans-Joachim Dahms
Institut Wiener Kreis
c/o Universität Wien
Spitalgasse 2-4, Hof 1, Eingang 1.13
A-1090 Wien

Prof. Dr. Dirk van Dalen
Department of Philosophy
Utrecht University
P.O.Box 80.126
NL-3508 TC Utrecht

Prof. Dr. Roman Duda
Institute of Mathematics
Wroclaw University
pl. Grunwaldzki 2/4
50-384 Wroclaw
POLAND

Prof. Dr. Helena Durnova
Department of Mathematics
Faculty of Education
Masaryk University
Porici 31
603 00 Brno
CZECH REPUBLIC

Prof. Dr. Moritz Epple
Goethe-Universität Frankfurt
Historisches Seminar
Wissenschaftsgeschichte
60629 Frankfurt am Main

Prof. Dr. Della D. Fenster
Dept. of Mathematics & Computer Science
University of Richmond
Richmond , VA 23173
USA

Katalin Gosztonyi
Balzac utca 11
H-1136 Budapest

Prof. Dr. Otto H. Kegel
Mathematisches Institut
Universität Freiburg
Eckerstr. 1
79104 Freiburg

Prof. Dr. Stephen Kennedy
Mathematics Department
Carleton College
One North College Street
Northfield , MN 55057
USA

Prof. Dr. Yvette Kosmann-Schwarzbach
Centre de Mathematiques Laurent Schwartz
Ecole Polytechnique
F-91128 Palaiseau

Dr. Jan Kotulek
Department of Mathematics and
Descriptive Geometry
VSB - Technical University of Ostrava
17. Listopadu 15/2172
708 33 Ostrava
CZECH REPUBLIC

Philipp Kranz
Interdisziplinäres Zentrum für
Wissenschafts- und Technikforschung
Bergische Universität Wuppertal
Gaußstr. 20
42119 Wuppertal

Prof. Dr. Marita Krauss
Philologisch-Historische Fakultät
Universität Augsburg
Universitätsstr. 10
86135 Augsburg

Dr. Christoph Lamm
Rückertstr. 3
65187 Wiesbaden

Dr. Franz Lemmermeyer
Mädchenschule St. Gertrudis
Schönbornweg 8
73479 Ellwangen/Jagst

Prof. Dr. Andras Mate
Dept. of Logic, Institute of Philosophy
Eötvös Lorand University Budapest
Muzeum krt. 4/i, II226
H-1088 Budapest

Prof. Dr. Laurent Mazliak
Laboratoire de Probabilites-Tour 56
Universite P. et M. Curie
4, Place Jussieu
F-75252 Paris Cedex 05

Prof. Dr. Rolf T. Nossum
University of Agder
Gimlemoen 25 J, P.O.Box 422
N-4604 Kristiansand

Prof. Dr. Jose M. Pacheco
Departamento de Matematicas
Universidad de Las Palmas
Campus de Tafira Baja
E-35017 Las Palmas

Prof. Samuel James Patterson
Mathematisches Institut
Georg-August-Universität Göttingen
Bunsenstr. 3-5
37073 Göttingen

Prof. Dr. Volker Peckhaus
Universität Paderborn
Institut für Humanwissenschaften:
Philosophie
Warburger Str. 100
33098 Paderborn

Dr. Gerhard Rammer
Institut für Philosophie, Literatur-
Wissenschafts- u. Technikgeschichte
TU Berlin
Strasse des 17. Juni 135
10623 Berlin

Prof. Dr. Andrew A. Ranicki
School of Mathematics
University of Edinburgh
James Clerk Maxwell Bldg.
King's Buildings, Mayfield Road
GB-Edinburgh EH9 3JZ

Prof. Dr. Volker Remmert
Bergische Universität Wuppertal
Wissenschafts- und Technikgeschichte
Historisches Seminar, Fachbereich A
Gaußstr. 20
42119 Wuppertal

Dr. Robin Rider
Department of Special Collections
990 Memorial Library
728 State Street
Madison , WI 53706-1418
USA

Prof. Dr. David E. Rowe
Institut für Mathematik
Johannes-Gutenberg Universität Mainz
Staudingerweg 9
55128 Mainz

Prof. Dr. Norbert Schappacher
I.R.M.A.
Universite de Strasbourg
7, rue Rene Descartes
F-67084 Strasbourg Cedex

Dr. Karl-Heinz Schlote
Eli-Wiesel-Str. 55
04600 Altenburg

Dr. Martina Schneider
Geschichte der Mathematik und der
Naturwissenschaften
Universität Mainz
Staudingerweg 9
55099 Mainz

Prof. Dr. Joachim Schwermer
Institut für Mathematik
Universität Wien
Nordbergstr. 15
A-1090 Wien

Prof. Dr. Reinhard Siegmund-Schultze
University of Agder
Fakultet for teknologi og realfag
Gimlemoen 25 J
Serviceboks 422
N-4604 Kristiansand

Dr. Henrik Kragh Sorensen
Center for Science Studies
Aarhus University
Ny Munkegade
DK-8000 Aarhus C

Craig Stephenson
Via Lactea, 1C-3A
Aravaca
E-28023 Madrid

Dr. Peter Gabor Szabo
University of Szeged
Institute of Informatics
PO Box 652
H-6701 Szeged

Prof. Dr. Christian Thiel
Institut für Philosophie
Universität Erlangen
Bismarckstr. 1
91054 Erlangen

Prof. Dr. Renate Tobies
Laboratorium Aufklärung
Friedrich-Schiller-Universität
Jentower, 8. Etage
Leutragraben 1
07743 Jena

Witold Wieslaw
Institute of Mathematics
Wroclaw University
pl. Grunwaldzki 2/4
50-384 Wroclaw
POLAND

Prof. Dr. Heinrich Wefelscheid
Fachbereich Mathematik
Universität Duisburg-Essen
Lotharstr. 65
47057 Duisburg

Prof. Dr. Sandy L. Zabell
Department of Mathematics
Northwestern University
2033 Sheridan Road
Evanston , IL 60208-2730
USA