OPINION

International Mobility and US Mathematics

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ABSTRACT. United States mathematical history has been shaped by social, political, and religious flows around the world. Policies fostering international exchange and mobility are essential for a healthy mathematical community.

By any account, the United States is now a world superpower on the mathematical stage. In mathematics, as in many fields, the US rose to its current prominence on the strength of flows of ideas and of people across its borders in both directions. A special role was played by immigration, as people moved around the world on strong religious and political currents.

An immigrant arguably started it: J. J. Sylvester came to the United States because his advancement was limited in Britain: a brilliant Second Wrangler of the Cambridge Tripos, he was barred from receiving a Cambridge degree by the university's (Anglican) Articles of Faith. Neither Sylvester, being Jewish, nor his contemporary Augustus De Morgan, being a "Dissenter," could be fellows or professors at Oxford or Cambridge at the time. De Morgan went only as far afield as University College London, but Sylvester ultimately struck out for the United States on two separate occasions. Here he infused US mathematics with energy and ambition and founded the nation's first mathematical journal, the *American Journal of Mathematics*, still a top journal today.

Later, turmoil in Europe completely reshaped American mathematics. Hitler rose to power in February 1933, and by April an order was issued purging Jewish citizens from national service, which included university employment. In the months and years that followed, Jewish mathematicians and other scattered undesirables and malcontents fled the Fascists. American universities seized the opportunity to raise their level of mathematics to rival the traditional European powerhouses, and US mathematics has never looked back. Einstein may be the most famous scientific name to come to our shores in those years, but Gödel, Noether, Weyl, Artin, Siegel, Bers, Courant, and von Neumann all participated in the great transformation [1]. The reception of this new crop of mathematicians was uneven, but the indisputable long-term effect was the crystallization in the United States of the strongest mathematical community in the world.

Partly as a function of its new internationalism, post-WWII America continued to attract immigrants from all over the world at the highest levels of mathematics. New research centers like the Institute for Advanced Study (founded 1930) and the Courant Institute (founded 1935) were flourishing by midcentury with a rich mix of native-born and immigrant scholars. The postwar decades brought A. Borel, Calderón, Chern, Chow, Harish-Chandra, and Hironaka, among many others, and a constant flow of visitors.

Three brief profiles will help to illustrate both the attractive force of American mathematics across the twentieth century and the stultifying effects of nationalist insularity around the world.

Chinese mathematical immigration spanned the full century, building from a trickle to a rapid flow. In 1907 Teddy Roosevelt agreed to accept political reparation money from China for the bloody, anti-Christian, nativist Boxer Rebellion in the form of the Boxer Indemnity Scholarship program: educational scholarships for Chinese students to study in the United States. By the 1930s, Chern reports that this had become a natural place for the best Chinese students to come, though he himself chose

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Europe for his studies and only came to the States when his mathematical isolation in postwar China caused him to reach out for other options [3]. Chern returned continually to China in efforts to build up a strong tradition for mathematics, but his and many colleagues' hopes were dashed amidst the repression and anti-intellectualism of the Cultural Revolution, and the work had to be begun anew in the 1980s. Meanwhile, a generation of Chinese mathematicians, most notably S.-T. Yau, had set up in the US and helped establish the pipeline of Chinese talent that today accounts for more than one in ten students in the top tier of American doctoral programs.

The aftershocks of the 1917 Russian Revolution brought us refugees and other escapees who developed pure and applied mathematics in the States, including Lefschetz, Tamarkin, Timoshenko, and Zariski. Later, it became difficult to leave the Soviet Union or even to communicate freely with the outside mathematical world. Political efforts on behalf of Soviet colleagues grew in the US through the Cold War period. In the 1970s and 1980s came a vanguard of Soviet emigrants, including Bernstein, Gromov (first to the US and later to France), Kazhdan, Ratner, Margulis, and Zelmanov, who were allowed to leave the USSR under an ostensible policy of Jewish "repatriation" that only gestured towards Israel. After the collapse of the Soviet Union in 1992, hundreds of mathematicians flooded from the Soviet bloc into other countries, many of course coming to the United States. The effects were dramatic: according to an AMS survey, immigrants from Eastern Europe and the former USSR made up 10%–13% of all new faculty hires in mathematics in 1991–92 [2].

Iran has a storied mathematical tradition with ancient and medieval Persian antecedents, and the twentieth century saw the establishment of modern universities and renewed mathematical institutions. The 1979 Iranian Revolution was devastating for intellectuals, with its own Cultural Revolution purging academics and keeping universities closed for years in the early 1980s. In mathematics Iran rebuilt a global profile with a key role played by the International Mathematical Olympiad—Iran first formed a team in the mid-1980s and became a powerhouse by the 1990s, winning outright in 1998. IMO credentials and quietly relaxed US immigration rules have made it possible for a steady stream of preeminent Iranian mathematicians to come to the States for graduate study since the 1990s, including leading young figures in geometric topology, algebraic geometry, ergodic theory, number theory, dynamics, and many other fields. This wave included Maryam Mirzakhani—first as a graduate student, then a postdoc, and now a professor and one of two American immigrants to receive Fields Medals in 2014.

To quantify the global draw of United States mathematics, consider a recent demographic analysis of one of the field's top midcareer honors, a speaking invitation at the International Congress of Mathematicians. Martin Andler conducted a study of the global displacements of the 206 mathematicians so honored at the 2014 ICM in Seoul [4]; his report confirms the leading position of US mathematics and the vital role of immigration. Only 26 of 206 speakers were born in the United States, but 85 received a US PhD and 76 have permanent jobs here, where their research programs and their teaching and training activities are fundamental elements of our continued mathematical excellence.

Generations of immigrants have made American mathematics what it is today: a world-historical magnet for talent and innovation. Some people come to the United States fleeing authoritarianism and violence; others are simply looking to a stable, open society for intellectual opportunity. Not just immigration, but, more generally, *mobility* makes the scientific community stronger through collaboration and intellectual exchange. The lessons of 150 years teach us clearly that our mathematical leadership depends on our hard-won tradition of internationalism. Science withers in closed societies.

References

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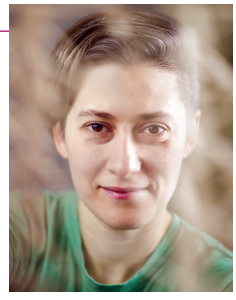

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