The Early History of the Fields Medal

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Although all mathematicians know about the Fields Medal, the early history of the medal is less well known. This article is a brief account of its birth and the international mathematical events leading up to it.

John Charles Fields

Fields was born in Hamilton, Ontario (then Upper Canada), in 1863. His father operated a leather shop at 32 King Street West, and the family lived nearby at 150 King Street East. (Both of these buildings have long since disappeared; the site of the shop is now occupied by Jackson Square (a shopping complex) and the site of the house by a Ramada Inn.) Fields graduated from the University of Toronto in 1884 and then left to study at Johns Hopkins University, probably attracted by the fact that Johns Hopkins apparently was the North American university that stressed research most strongly at that time. Its mathematics program had been set up by J. J. Sylvester during the years that he spent there (1876–83). Fields was awarded a Ph.D. in 1887. His thesis was entitled *Symbolic finite solutions and solutions by definite integrals of the equation* $d^n y/dx^n = x^m y$ and was published in the *American Journal of Mathematics* in 1886. After teaching at Johns Hopkins for two years, he joined the faculty of Allegheny College in Pennsylvania.

Fields was understandably dissatisfied with the state of mathematics in North America at that time, and in 1891 he left for Europe to spend the next ten years there, combining a modest inheritance from his parents with economical living habits.

Fields's years in Europe, mainly in Berlin but also in Göttingen and Paris, influenced him deeply and reinforced his convictions about the importance of mathematical research. He mingled with many of the greatest mathematicians of that time—Klein, Frobenius, Weierstrass, Fuchs, Hensel—and changed his mathematical interests to algebraic functions, in which he published many papers during the rest of his mathematical career. He also developed there a lifelong friendship with the Swedish mathematician Gösta Mittag-Leffler.

Fields returned to Canada in 1902 as a special lecturer at the University of Toronto, where he remained for the rest of his life. He became a Fellow of the Royal Society of Canada in 1909 and of the Royal Society of London in 1913. He spent much of his leisure time in Europe, and it is claimed that he was a personal acquaintance of several reigning monarchs. He attended a dinner party in 1912 given by the King of Sweden and had a personal audience with Mussolini during the International Congress of 1928 in Bologna.

Fields worked tirelessly to promote mathematical research. Soon after his return from Europe, he lobbied the Ontario legislature for support for research. He persuaded the government to provide the University of Toronto with a special annual research grant of $75,000, a significant sum at a time when professors earned less than $1,000 per year. He also devoted his efforts to the establishment of the National Research Council (from which the National Science and Engineering Research Council of Canada, the Canadian counterpart of the National Science Foundation in the U.S.A., later developed) and the Ontario Research Foundation. It is possible that his strong support

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of research was also related to his friendship with Mittag-Leffler, who was the head of a faction at the Stockholms Högskola that was of "the view that the Högskola should be devoted to free learning and research at the highest level and not concern itself with exam or degree requirements" (p. 51, [Crawford]).

The Royal Canadian Institute (RCI), founded in 1849 by Sandford Fleming, was another of Fields's endeavors. He served as its president between 1919 and 1925 and attempted to transform it into an instrument for the promulgation of scientific thought as well as a center for actual research. To that end he spent much time and money in persuading distinguished scientists to lecture to the membership of the institute and to the public—its Saturday evening lectures became very popular during his tenure in office. Fields's vision of the RCI as a center of research did not materialize, but perhaps The Fields Institute is a worthy realization of his dreams. The RCI is still active in its mission to enhance public awareness of science in several ways and continues to be known best for its public lectures, now held on Sunday afternoons.

Portrait of John Charles Fields (left). Below, a photograph of his gravestone in Hamilton, Ontario.

The International Congress of Mathematicians (ICM) and the International Mathematical Union

The international mathematics community has held ICMs every four years since 1897—the first in Zürich—except for interruptions due to the two world wars.

The Zürich meeting was critical in initiating international cooperation in mathematics. The congresses were subsequently self-perpetuating: at each congress, the decision about the format and organizers for the next would be made. This arrangement worked very well until the First World War, and even after, the ICMs managed to survive in spite of all the troubles that beset them after 1919.

In that year in Brussels a scientific umbrella organization called the "International Research Council" came into being, with the French mathematician Émile Picard as its president. Its initial membership excluded the "central powers" of Germany, Austro-Hungary, Bulgaria, and Turkey, and this exclusion was carried over to the International Mathematical Union (IMU), which was born in 1920 at the first postwar ICM, held in Strasbourg. (Thus the IMU was a child of the ICM, not the other way around!) There were voices raised in protest, but they did not prevail. G. H. Hardy said that "All scientific relationships should go back precisely to where they were before.…This seems to me worth saying on account of the many imbecilities printed during the last year [1918] by preeminent men of science in England and France." Mittag-Leffler also strongly condemned the policy of exclusion but was practical enough to realize that it was "advisable not to invite the central powers…until the worst passions had cooled" (p. 32, [Lehto]).

There was as well a great deal of controversy about whether or not the central powers would be allowed to attend the next meeting in 1924 in New York. L. E. Dickson and L. P. Eisenhart were the delegates of the American section of the IMU to the Strasbourg Congress. They invited the congress to hold its next meeting in New York, although they did so without having consulted the AMS. By 1922 it was clear that financial backing for the New York meeting was not forthcoming in the United States because of the exclusionary policies of the IMU, and the AMS withdrew its support for that meeting shortly thereafter (p. 19, [Archibald]).

Through Fields's efforts Toronto was chosen in 1922 as the venue of the 1924 Congress. Fields evidently had mixed feelings about holding the

Mittag-Leffler and Nobel

The persistent rumor that Nobel did not establish a prize in mathematics because Mittag-Leffler had an affair with his wife is certainly incorrect. Nobel never married. But the other version of this rumor, founded on hostility between Nobel and Mittag-Leffler, may be correct though there is no documentation to support it. Certainly there appear to have been ill feelings between the two men: according to a letter from J. L. Synge to H. S. Tropp [Tropp], Fields told Synge that this was the case, and Synge remarks that he later confirmed this himself in Sweden. There is no doubt that Nobel and Mittag-Leffler knew each other. Mittag-Leffler was one of the most prominent Swedish scientists at the time. In 1890 Nobel turned down Mittag-Leffler's proposal to fund a professorship for Sonya Kovalevsky at the Stockholms Högskola (later Stockholm University), where Mittag-Leffler was a professor and one of its most powerful members [p. 251, Crawford]; Kovalevsky was on the faculty there from 1884 until her death in 1891. The Högskola was named as a beneficiary in Nobel's first will (1883), but not in his final will (1896). According to [p. 53, Crawford], the rector of the Högskola, a chemist named Otto Pettersson, and Svante Arrhenius, a physicist, let it be known "that Nobel's dislike for Mittag-Leffler had brought about what Pettersson called the 'Nobel flop'" (the term he used to describe the dropping of the Högskola from Nobel's will). There seems little doubt too that Mittag-Leffler had many detractors: "Mittag-Leffler had a great ambition to succeed in the many endeavors to which he applied his organizational skills. The judgments of many of his contemporaries about his person were not positive" (p. 334, [Lehto]). One wonders whether the hostility between Nobel and Mittag-Leffler and the friendship between Fields and Mittag-Leffler were factors in Fields's establishment of his award.

Ironically, Mittag-Leffler (as well as Arrhenius) was, in the first few years after Nobel's death in 1896, of "decisive importance…in shaping the decisions and hence the international standing of the [Nobel] prizes" [p. 8, Crawford].

—C. R.

meeting with the central powers excluded but decided that it was important to hold the congress in any case. He almost single-handedly organized the congress himself and worked steadily during the next two years to ensure its success, far from assured at the time because of the political controversy.

The 1924 Toronto Congress was in fact very successful, with 444 mathematicians in attendance, more than twice the number at Strasbourg, though fewer than at prewar congresses. The meeting was followed by an organized rail excursion to British Columbia accompanied by Fields. For many nights he got no sleep, and on his return to Toronto his health broke down. From that time on he never regained the vigor of his former years. With the help of his colleague J. Chapelon, he nevertheless managed to complete the proceedings of the congress, which appeared in two large volumes in 1928.

It was not until 1928 in Bologna that mathematicians from the central powers rejoined the international community, after IMU president Salvatore Pincherle of Italy decided to ignore the restrictions which other influential members of the IMU (mainly Picard and the IMU's secretary general Gabriel Koenigs) wished to perpetuate. When the German delegation, led by David Hilbert, then an old man, entered the hall, the audience rose and cheered wildly. As Hilbert said of the occasion, "All limits, especially national ones, are contrary to the nature of mathematics."

These conflicting views within the IMU inflicted heavy damage on it, causing it to virtually disappear by the time of the 1936 Congress in Oslo, with few tears shed. The IMU was reborn in 1950 and finally in 1962 came to play its present role through its involvement in the structural details of the Stockholm Congress.

The Fields Medal

The history of the Fields Medal itself begins in the Committee of the International Congress, set up by the University of Toronto in November of 1923. Fields was the chairman, and his colleague J. L. Synge the secretary. Although Fields probably conceived of such an award at some earlier time, the first recorded mention of it is in the minutes of a meeting of that committee on February 24, 1931, where it is "resolved that the sum of $2,500 should be set apart for two medals to be awarded in connection with successive International Mathematical Congresses through an international committee appointed for such purpose initially by the executive of the International Mathematical Congress, but later by the International Mathematical Union." The $2,500 was evidently more or less the balance on hand after all expenses of the 1924 Congress had been met. At the next meeting of the committee, in January 1932, Fields indicated that the idea of the medal had the support of the major mathematical societies of France, Germany, Italy, Switzerland, and the United States.

At the same meeting he outlined the principles behind the proposed medal. The genesis of the rule that it be awarded only to mathematicians no older than forty is evidently the statement that "…while it was in recognition of work already done, it was at the same time intended to be an encouragement for further achievement on the part of the recipients and a stimulus to renewed effort on the part of others." Then he continued, "In commenting on the work of the medalists it might be well to be conservative in one's statements, to avoid invidious comparisons explicit or implied. The Committee might ease matters by saying that they had decided to make the awards along certain lines not alone because of the outstanding character of the achievement but also with a view to encouraging further development along these lines." And mindful of the turmoil of ten years earlier, he added, "[T]he medals should be of a character as purely international and impersonal as possible.

There should not be attached to them in any way the name of any country, institution or person." Of course, in spite of Fields's intentions, the medal became known as the Fields Medal when it was awarded for the first time in Oslo in 1936. It is interesting to note that, at the same meeting, it was decided that "the Chairman should see the Prime Minister of Canada to arrange if possible how permanence of capital and of interest of the fund might be assured." Such an arrangement was apparently never made, and the monetary value of the Fields Prize is presently Canadian $15,000 (about U.S. $9,500), hardly commensurate with its stature in mathematics.

Fields then proceeded with the planning of the awarding of the first medals, but fell ill in May of 1932 and died in August. Just before his death, with Synge at his bedside, he made his will. It included an amount of $47,000 to be added to the funds for the medal. Fields is buried in the Hamilton cemetery overlooking the western end of Lake Ontario. His gravestone could not be more modest, short of not being there at all. It is set flat into the ground, is about 22 inches by 16 inches, and simply says "John Charles Fields. Born May 14, 1863. Died August 9, 1932."

Synge carried Fields's proposal to the congress in Zürich in September of that year. It was accepted, and a committee consisting of G. D. Birkhoff, Carathéodory, E. Cartan, Severi, and Takagi was formed to make the first awards at the Oslo Congress in 1936. They chose Lars Ahlfors, a Finn, and Jesse Douglas, an American. Unfortunately, war again intervened, and the next ICM was not held until 1950, in Cambridge, Massachusetts, when the French mathematician Laurent Schwartz and the Norwegian mathematician Atle Selberg were selected as Fields Medalists. A list of all Fields Medal winners (with short descriptions of their work) can be found at `http://elib.zib.de/IMU/medals/`. An analysis by Michael Monastyrsky of the effect of Fields Medalists on twentieth-century mathematics and physics, delivered in a lecture at the Fields symposium "The Legacy of John Charles Fields" held in Toronto in June 2000, is available at `http://www.fields.utoronto.ca/aboutus/FieldsMedal_Monastyrsky.pdf`. See also [Monastyrsky].

The Medal Itself

Fields specified that the medals should "each contain at least 200 dollars worth of gold and be of a fair size, probably 7.5 centimeters in diameter. Because of their international character the language to be employed it would seem should be Latin or Greek." The medal does in fact meet these specifications (in 1933 dollars!). Its monetary value has at least on one occasion been of critical importance: in the turmoil at the end of World War II, Ahlfors became separated from his wife and was allowed to leave Finland with only 10 crowns. He smuggled out his Fields Medal and pawned it, enabling him to reach his wife in Zürich. (He later retrieved it with the help of some Swiss friends.)

The medal, struck every four years in the Royal Canadian Mint, was designed by the Canadian sculptor R. Tait McKenzie. For the obverse, he chose a picture of Archimedes from a collection at

Columbia University. The Latin inscription from the Roman poet Manilius surrounding the image may be translated "To pass beyond your understanding and make yourself master of the universe." The phrase comes from Manilius's *Astronomica* 4.392 from the first century A.D. The complete passage is:

> *The object of your quest is God; you are seeking to scale the skies and though born beneath the rule of fate, to gain knowledge of that fate; you are seeking to pass beyond your understanding and make yourself master of the universe. The toil involved matches the reward to be won, nor are such high attainments secured without a price…*

(from the translation by G. P. Goold, Loeb Classical Library, Harvard University Press, 1977).

The inscription on the reverse may be translated "Mathematicians having congregated from the whole world awarded (this medal) because of outstanding writings." Behind the inscription are a laurel branch and a diagram of a sphere contained in a cylinder from an engraving thought to have been on Archimedes' tomb.

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I have also used material from the following documents: an article in *Saturday Night,* published in 1934, announcing the launching of the Fields Medal; an obituary of Fields by Synge in the *Journal of the London Mathematical Society* in 1933; a lecture by T. Archibald at the symposium "The Legacy of John Charles Fields" in June 2000 at The Fields Institute; an article by Lars Gårding and Lars Hörmander in the *Mathematical Intelligencer*, vol. 7, no. 3; and unpublished articles by Frances Hoffman and Elaine Riehm. I would also like to thank Allyn Jackson, Elaine Riehm, and William J. Slater for their help.