The History of the Abel Prize and the Honorary Abel Prize

The History of the Abel Prize

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On the bicentennial of Niels Henrik Abel's birth in 2002, the Norwegian Government decided to establish a memorial fund of NOK 200 million. The chief purpose of the fund was to lay the financial groundwork for an annual international prize of NOK 6 million to one or more mathematicians for outstanding scientific work. The prize was awarded for the first time in 2003.

That is the history in brief of the Abel Prize as we know it today. Behind this government decision to commemorate and honor the country's great mathematician, however, lies a more than hundred year old wish and a short and intense period of activity.

Volumes of Abel's collected works were published in 1839 and 1881. The first was edited by Bernt Michael Holmboe (Abel's teacher), the second by Sophus Lie and Ludvig Sylow. Both editions were paid for with public funds and published to honor the famous scientist. The first time that there was a discussion in a broader context about honoring Niels Henrik Abel's memory, was at the meeting of Scandinavian natural scientists in Norway's capital in 1886. These meetings of natural scientists, which were held alternately in each of the Scandinavian capitals (with the exception of the very first meeting in 1839, which took place in Gothenburg, Sweden), were the most important fora for Scandinavian natural scientists. The meeting in 1886 in Oslo (called Christiania at the time) was the 13th in the series. At the meeting's farewell dinner, the Swedish mathematician Gösta Mittag-Leffler gave a toast in honor of Niels Henrik Abel, and he proposed starting a collection with the goal that in 16 years—in 1902, on the centennial of Abel's birth—a statue of the young genius could be erected. Money was collected during the meeting and national committees were appointed, but eventually the whole effort ran out of steam.

Mittag-Leffler, who had been publishing the Swedish mathematics journal, *Acta Mathematica*, since 1882, worked during these years to arrange and gather support for an international mathematics prize, namely King Oscar II's Mathematics Prize,

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H. Holden, R. Piene (eds.), *The Abel Prize*,
DOI 10.1007/978-3-642-01373-7_1,

a competition in which an answer was sought to one of four given questions. The prize was awarded on the King's 60th birthday in January 1889, and it was a tremendous success in every way. The prize winner was Henri Poincaré, who submitted a work that described chaos in space: a discovery that was only understood in its full breadth much later and that gradually developed into a major interdisciplinary research area. On the jury for the prize sat Charles Hermite and Karl Weierstrass together with Mittag-Leffler, and the latter discussed the possibility of establishing a permanent mathematics prize with King Oscar and various patrons and donors. Due to insufficient support, however, Mittag-Leffler initially tried to establish a smaller fund, and he proposed that money from this fund should be used for gold medals, which should be awarded to mathematicians who had published an exceptionally important work in *Acta Mathematica*. The gold medals were to be stamped with portraits of the greatest mathematicians, and he was of the opinion that it was suitable to begin with the greatest mathematician in the Nordic countries: Niels Henrik Abel.

These plans also came to naught. Instead, Mittag-Leffler managed to set up a fund that supported the editing of articles submitted to *Acta Mathematica* and that made it possible to invite great foreign mathematicians to Stockholm. When the content of Alfred Nobel's last will and testament became known in 1897, rumors abounded that Mittag-Leffler's financial antics and scientific plans and ideas might have dissuaded Nobel from providing funds for a prize in mathematics, in addition to those in physics, chemistry and medicine as well as literature and efforts to promote peace. It is true that Mittag-Leffler and Nobel discussed financial support for both Stockholm University College (now Stockholm University) and an extraordinary professorship for Sonja Kovalevsky and that they were in strong disagreement, but the reason why there was not any Nobel Prize in mathematics seems to clearly lie in Nobel's attitude to science and technology. He was a practical man and regarded mathematics in general as much too theoretical and having no practical applications.

The annual Nobel Prizes, awarded for the first time in 1901, quickly overshadowed other scientific prizes. At the academies of science in Paris and Berlin, mathematics prizes based on various problems, often in astronomy and navigation, had been awarded ever since the middle of the eighteenth century, and new prizes came into being in the nineteenth century [1]. Prizes were also announced in Leipzig, Göttingen and at other centers of learning. In 1897, the international Lobachevsky Prize was established at the University of Kazan. This prize was supposed to go to outstanding works in geometry, especially non-Euclidean geometry, and the first winner was Sophus Lie.

Sophus Lie, Norway's second world-class mathematician, died in 1899. One of the last things he used his international contact network for was to gather support for establishing a fund that would award an Abel Prize every fifth year for outstanding work in pure mathematics. Apparently, an inspiration in Lie's work was precisely the fact that Nobel's plans included no prize in mathematics. From leading centers of mathematical learning, Sophus Lie received overwhelming support for such an Abel Prize in the spring of 1898. From Rome and Pisa came assurances of support from Luigi Cremona and Luigi Bianchi; from Paris Émile Picard wrote that

both he and Hermite would donate money to the fund, and Picard, who otherwise would like to see a more frequent awarding of the prize than once every fifth year, reported that through its universities and lyceums France would also probably be able to contribute large sums; Gaston Darboux followed up with similar positive reactions and thought that all mathematicians in the Academy of Science in Paris would support an Abel Fund; Sophus Lie also received a warm declaration of support from A.R. Forsyth at Cambridge, who thought that Lord Kelvin would certainly lend his support to the fund; Felix Klein at Göttingen reported that he would obviously support the work, and he believed that David Hilbert would do so as well; Lazarus Fuchs was also supportive. The only mathematicians who expressed skepticism were Georg Frobenius and H.A. Schwarz in Berlin; they thought prizes in general often diverted younger talents away from the true scientific path.

Sophus Lie's contacts and promises of support, however, were related to him personally. When Sophus Lie died, there was no one else who could carry on the work.

At the celebration of the centennial of Abel's birth in 1902, three main tasks were formulated in Norwegian political and scientific circles: first, to arrange a broad cultural commemoration, second, to erect a worthy monument to the genius, and third, to establish an international Abel Prize. The first two tasks were achieved. The Abel commemoration in September 1902 was held with pomp and circumstance, and students, citizens, scientists, artists, the national assembly, the government and the Royal House all took part. A number of foreign mathematicians were present and were awarded honorary doctorates. Gustav Vigeland's great Abel Monument on the Royal Palace grounds (in Oslo) was unveiled six years later, but the plans for an Abel Prize were put on ice for reasons of national politics.

Gustav Vigeland's Abel Monument, Oslo

In the Norwegian capital it was regarded as important that the commemoration of Abel should put Norway on the map as a cultural nation, not least with a view to the conflict over the union (with Sweden), which many realized was imminent. However, King Oscar still sat on the Swedish–Norwegian throne, and after his mathematics prize (in 1889) and his support for *Acta Mathematica* (in 1882), he was regarded as having a special fondness for mathematics. The King himself also took active part in the Abel celebrations and arranged a big festivity at the Palace. Just after the conclusion of the official celebrations, Norwegian politicians and scientists were informed that King Oscar was considering having a gold medal created in memory of Niels Henrik Abel. The idea was that the medal should be awarded once every three years by the University of Oslo for top-flight mathematical work.

Two Norwegian scientists, Waldemar C. Brøgger and Fridtjof Nansen, and a representative from the Royal Court were delegated to draw up statutes, and Gustav Vigeland drew sketches for an Abel medal. When the proposal was presented on the King's birthday in January 1903, it was recommended that the prize be awarded every fifth year by the Scientific Society of Christiania (now the Norwegian Academy of Science and Letters in Oslo), and that the prize should go to the best mathematical work published during the last five years. However, decisions about the procedure, the prize committee, etc. were to be announced later.

In the ongoing work, many people were consulted for advice. Mittag-Leffler, who was well-informed about the establishment of the Bolyai Prize in Budapest, sent a copy of the statutes for that prize to Brøgger [5]. (The Bolyai Prize was awarded for the first time in 1905 to Henri Poincaré and the next time five years later to David Hilbert.) At that time, Mittag-Leffler was afraid that an Abel Prize, if there were to be one, would be overshadowed by the Nobel Prize. He did not think it was possible to find a new patron who could elevate an Abel Prize to the Nobel Prize level, and he was also of the opinion that it would be easier for a jury to make an irreproachable selection if there was a prize competition focused on a given problem or question, preferably related to Abel's work.

The mathematicians Ludvig Sylow and Carl Størmer were the key members of a committee that was supposed to draw up a set of rules for an Abel Prize. In the autumn of 1904, they submitted a memo, but the work had not been completed when the dramatic political events of June 1905 resulted in the dissolution of the union between Sweden and Norway. All further plans for an Abel Prize were set aside. The realities of the matter were expressed by Nansen in a letter to the mathematician Elling Holst: "The Abel Prize that we had been promised by good King Oscar went to heaven with the union."

In international circles of mathematicians, however, the lack of a prize in mathematics on the same level as the Nobel Prize was a frequent topic of discussion. This lack was a prime motivation for John Charles Fields in his efforts to establish the prize medal that would come to bear his name. The Fields Medal was awarded for the first time at the International Congress of Mathematicians in Oslo in 1936. Even though no money is awarded with the Fields Medal, and it is only awarded every fourth year at the International Congress of Mathematicians to two to four mathematicians under age 40, the Fields Medal rapidly gained the status of the most

eminent prize in mathematics, a kind of "Nobel Prize" in mathematics; a position it has held until the Abel Prize finally became a reality.

In Norway, Abel's name and memory were kept alive in various ways on into the twentieth century. On the occasion of the centennial of his death in 1929, Abel was commemorated on Norwegian stamps; aside from the royal family, only the playwright Henrik Ibsen had previously been so honored. In 1948, Norges Bank printed Abel's portrait on the obverse of the 500-kroner banknote. Abel has also been used in later banknote and stamp issues, and books have been written about his life and scientific efforts. When the International Mathematical Union, with UNESCO support, designated the year 2000 as the "World Mathematical Year", Abel was Norway's leading logo. Abel's international position and his life and work were also at the heart of the efforts leading up to the bicentennial of Abel's birth. The objective of a number of national and international efforts aimed at the profession, schools and society at large was to create a broader appreciation of the importance of mathematics and science for today's society.

In 1996, I published a biography of Niels Henrik Abel (an English edition was published in 2000 [3]), and in response to an initiative from the Department of Mathematics at the University of Oslo, I subsequently worked on a biography of Sophus Lie [4]. I was very familiar with Lie's contact network and efforts on behalf of an Abel Prize, and in lectures and conversations in academic circles of mathematicians, I brought up the old idea of such a prize. Most of the people I talked to thought the idea was fascinating, but extremely unrealistic. At a book signing in August of 2000, I met Tormod Hermansen, the President and CEO of Telenor at the time and a prominent Labor Party supporter. Hermansen showed immediate interest in an Abel Prize and argued in his political circles that funds should be allocated for such a prize. The reactions were positive, and at the Department of Mathematics at the University of Oslo, a working group was formed: the Working Group for the Abel Prize, consisting of Professors Jens Erik Fenstad, Arnfinn Laudal and Ragni Piene together with Administrative Head of Department Yngvar Reichelt, Assistant Professor Nils Voje Johansen and myself. With support from key figures in university, business and cultural circles, this working group had talks with the relevant Ministries and members of the Storting [the Norwegian Parliament]. Declarations of support were also received from the major international mathematics organizations—the *International Mathematical Union* and the *European Mathematical Society*. In May 2001, the working group submitted a proposal to the Prime Minister to establish an Abel Prize, and in August 2001, Prime Minister Jens Stoltenberg announced that the Norwegian Government would establish an Abel Fund worth NOK 200 million: a greater amount than the working group had proposed [2]. The Prime Minister emphasized the broad political consensus that the proposal had aroused and the hope that an annual Abel Prize would strengthen the research in and recruitment to mathematics and the natural sciences and raise international awareness of Norway as a knowledge-based nation.

The *Niels Henrik Abel Memorial Fund* is administered by the Norwegian Ministry of Education and Research, and the annual return on the fund is allocated to the Norwegian Academy of Science and Letters, which is entrusted with awarding

the prize and the management of other matters related to the funds. The Norwegian Academy of Science and Letters has established a board and a committee of mathematicians for the Abel Prize. The Abel Board shall be responsible for distributing the return on the fund and for events associated with the award ceremony, whereas the Abel Committee is responsible for reviewing candidates for the prize and make a recommendation to the Academy. This international committee consists of five persons who are outstanding researchers in the field of mathematics; both the International Mathematical Union and the European Mathematical Society nominate committee members.

As it is laid down in the statutes, the annual Abel Prize is a recognition of a scientific contribution of exceptional depth in and significance for the field of mathematics, including mathematical aspects of information technology, mathematical physics, probability theory, numerical analysis and computational science, statistics, and applications of mathematics in other sciences. One of the objectives for the prize is that it shall be awarded over the years in a broad range of areas in the field of mathematics.

As is also laid down in the statutes, the prize should contribute towards raising the status of mathematics in society and stimulate the interest of young people and children in mathematics. This objective was a very important argument for the creation of the prize, it was explicitly mentioned by the Prime Minister when he announced the establishment of the Fund, and it was most likely decisive for the Government's and the Parliament's acceptance.

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2002—an Honorary Abel Prize to Atle Selberg

Nils A. Baas

When the Abel Prize was established in 2002 it was decided to award an honorary prize to the renowned Norwegian mathematician Atle Selberg in recognition of his status as one of the world's leading mathematicians. His contributions to mathematics are so deep and original that his name will always be an important part of the history of mathematics. His special field in mathematics was number theory in a broad sense.

Selberg was born on June 14, 1917 in Langesund, Norway. He grew up near Bergen and went to high school at Gjøvik. His father was a high school teacher with a doctoral degree in mathematics, and two of his older brothers—Henrik and Sigmund—became professors of mathematics in Norway. He was studying mathematics at the university level at the age of 12. When he was 15 he published a little note in *Norsk Matematisk Tidsskrift*.

He studied at the University of Oslo where he obtained the *cand. real.* degree in 1939, and in the autumn of 1943 he defended his thesis which was about the Riemann Hypothesis. At that time there was little numerical evidence supporting the Riemann Hypothesis. He got the idea of studying the zeros of the Riemann zeta-function as a kind of moment problem, and this led to his famous estimate of the number of zeros. From this it followed that a positive fraction of the zeros must lie on the critical line. This result led to great international recognition.

When Carl Ludwig Siegel, who had stayed in the USA, asked Harald Bohr what had happened in mathematics in Europe during the war, Bohr answered with one word: Selberg.

During the summer of 1946 Selberg realized that his work on the Riemann zeta function could be applied to estimate the number of primes in an interval. This was the beginning of the development leading to the famous Selberg sieve method.

Selberg's collected works were published in [1], and an extensive interview appeared in [2].

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H. Holden, R. Piene (eds.), *The Abel Prize*,
DOI 10.1007/978-3-642-01373-7_2,

Photo by Herman Landshoff. Courtesy of the Institute for Advanced Study

In 1947 Selberg went to the Institute for Advanced Study in Princeton in USA where he continued the work on his sieve method. In the spring of 1948 he proved the Selberg Fundamental Formula which later in 1948 led to an elementary proof of the Prime Number Theorem. This was a sensation since even the possibility of an elementary proof had been questioned by G.H. Hardy and other mathematicians.

For these results he was awarded the Fields Medal in 1950—at the time the highest award in mathematics.

He became a permanent member of the Institute for Advanced Study in 1949 and a professor in 1951—a position he held until he retired in 1987.

In the early 1950s Selberg again produced a new and very deep result, namely what is now called the Selberg Trace Formula. Selberg was inspired by a paper by H. Maass on differential operators, and he realized that in this connection he could use some ideas from his Master Thesis. This result has had many important implications in mathematics and theoretical physics, but Selberg was never interested in the wide range of applications. In the Trace Formula Selberg combines many mathematical areas like automorphic forms, group representations, spectral theory and harmonic analysis in an intricate and profound manner. Selberg's Trace Formula is by many mathematicians considered as one of the most important mathematical result in the 20^{th} century. His later works on automorphic forms led to the rigidity results of lattices in higher rank Lie groups.

In his later years he continued to work on his favourite subjects: sieve methods, zeta-functions and the Trace Formula. In 2003 Selberg was asked whether he thought the Riemann Hypothesis was correct. His response was: "If anything at all in our universe is correct, it has to be the Riemann Hypothesis, if for no other reasons, so for purely esthetical reasons." He always emphasized the importance of

simplicity in mathematics and that "the simple ideas are the ones that will survive". His style was to work alone at his own pace without interference from others.

In addition to the Fields Medal in 1950, Selberg received the Wolf Prize in 1986 and then in 2002 the honorary Abel Prize prior to the regular awards. He was also a member of numerous academies.

Atle Selberg was highly respected in the international mathematical community. He possessed a natural and impressive authority that made everyone listen to him with the greatest attention.

He loved his home country Norway and always spoke affectionately about the Norwegian nature, language and literature. In 1987 he was named Commander with Star of the Royal Norwegian Order of St. Olav.

Atle Selberg died on August 6, 2007 in his home in Princeton.

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