Michael and Lily Atiyah Portrait Gallery of Mathematicians

Level 3, James Clerk Maxwell Building
The King's Buildings
The University of Edinburgh

22nd April 2013


Archimedes
Ibn Abdallah Muhammad ibn Musa al-Khwarizmi
Isaac Newton
Ernestine Noether
Carl Friedrich Gauss
Bernhard Riemann
Grace Chisholm / William Henry Young
William Rowan Hamilton
Nils Henrik Abel
Évariste Galois
Sophus Lie
Henri Poincaré
David Hilbert
Felix Klein
Albert Einstein
Élie Cartan
Hermann Weyl
Emmy Noether
Jean Leray
André Weil
Hermann Weyl
Johannes Gfoellner
Kurt Gödel
Johann Neumann
Alan Turing
Israel Gelfand
Lars Gårding
Vladimir Arnold
Sergei Novikov
Bryan Birch / Peter Swinnerton-Dyer
Jean-Pierre Serre
Alexander Grothendieck
Lars Hörmander
Alan Baker
Edward Witten
Field medallists
Michael Michael Atiyah
James Mackay
Mary Somerville
Philippa Fawcett
Sofya Kovalevskaya
Sammy Barber
John Milnor and Dusa McDuff
Edmund Whittaker
Alexander Aitken
Robert Alagić
William Edge
Arthur Eddyn
Nicholas Kemmer
Paul Dirac
G. H. Hardy
J. A. Littlewood
Mary Cartwright
Abram Besicovitch
William Hodge
John Todd
Bertha M Harold Jeffreys
Sammy Whitehead
Frank Kline
Ian Macdonald
Graeme Boyd
Virgil Mickle
Simon Donaldson
Frances Kirwan
Shing-Tung Yau / James Simons
Roger Penrose
Stephen Hawking
Friedrich Hirzebruch
Raoul Bott
Vijay Patodi
Sadath Sayed (left) & Michael Atiyah (centre)

Michael and Lily Atiyah Gallery

Introduction

The portraits of mathematicians displayed in this collection have been personally selected by us.

They have been chosen for many different reasons, but all have been involved in our mathematical lives in one way or another; many of the individual texts to the gallery portraits explain how they are related to us.

First, there are famous names from the past – starting with Archimedes – who have built the great edifice of mathematics which we inhabit. This early list could have been more numerous, but it has been restricted to those whose style is most appealing to us.

Next there are the many teachers, both in Edinburgh and in Cambridge, who taught us at various stages, and who directly influenced our careers.

The bulk of the portraits are those of our contemporaries, including some close collaborators and many Fields Medallists.

Lily has a special interest in women mathematicians: they are well represented, both past and present.

Finally we come to the next generation: our students. Of course, many of the categories overlap, with students later becoming collaborators and friends.

It was hardest to keep the overall number down to seventy, to fit the gallery constraints!

Edinburgh, 22nd April 2013

Michael and Lily Atiyah Gallery

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Archimedes

Syracuse 287 – 212 BC

The greatest mathematical figure of antiquity. The story of his shouting *"Eureka!"* in the bath compares with that of Newton's falling apple.

Archimedes calculated areas and volumes by successive polyhedral approximations, a rudimentary form of the integral calculus.

He was also a brilliant engineer, with the Archimedes screw for pumping water still in use on the Nile when Michael was a boy. The story of his focusing light by giant mirrors to burn the Roman boats is legendary.

The Archimedean Society – the Cambridge University student mathematical society – is aptly named after him. Lily was President in 1951 and Michael in 1952. The Archimedeans' magazine is called *Eureka*, and is still going strong. Michael's article on Besicovitch was published in the October 1952 issue.

Al-Khwarizmi

Baghdad 780 – 850 AD

One of the outstanding figures of Arab civilisation.

The title of his famous book "*Hisab al-jabr w'al-muqabala*" can be translated as *"The compendium of calculation by completion and balancing"*. The book laid the foundations of algebra (the word being derived from the title) and his name gave rise to the word *algorithm*.

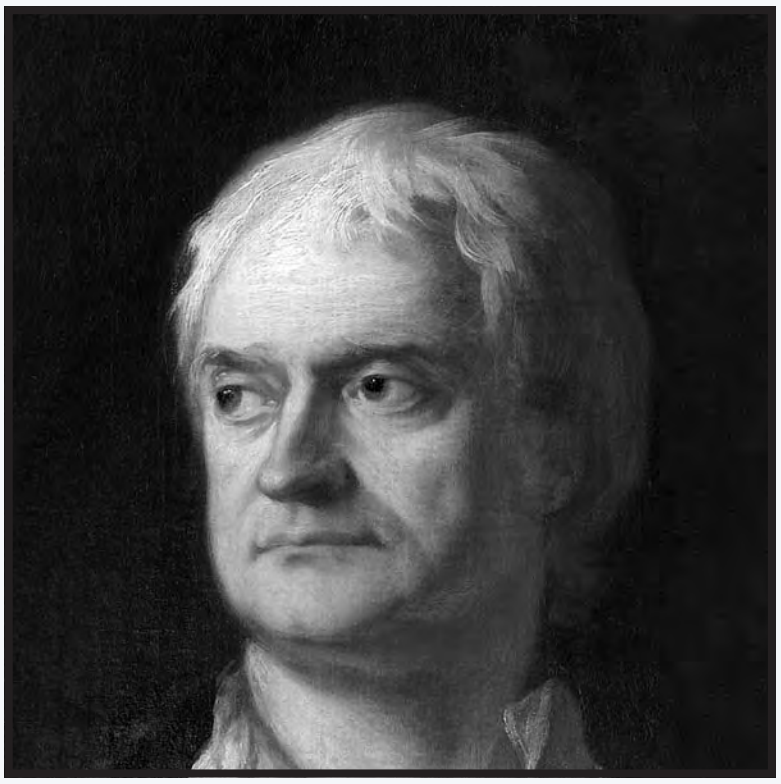
It was through the Arab world that Greek mathematics, as expanded and developed by men such as Al-Khwarizmi and Omar Khayyam, moved through Spain into western Europe in the Renaissance.

The decimal system of numbers 0, 1, 2, 3,... was introduced into Europe via his works.

His appearance on a Soviet era postage stamp recognizes both his fame and his Persian origins.

Isaac Newton

Woolsthorpe 1642 – London 1727



The greatest mathematician and physicist of all time.

Newton was born in the year in which Galileo died. Studied and worked at Trinity College, Cambridge. Lucasian Professor of Mathematics at Cambridge 1669–1702.

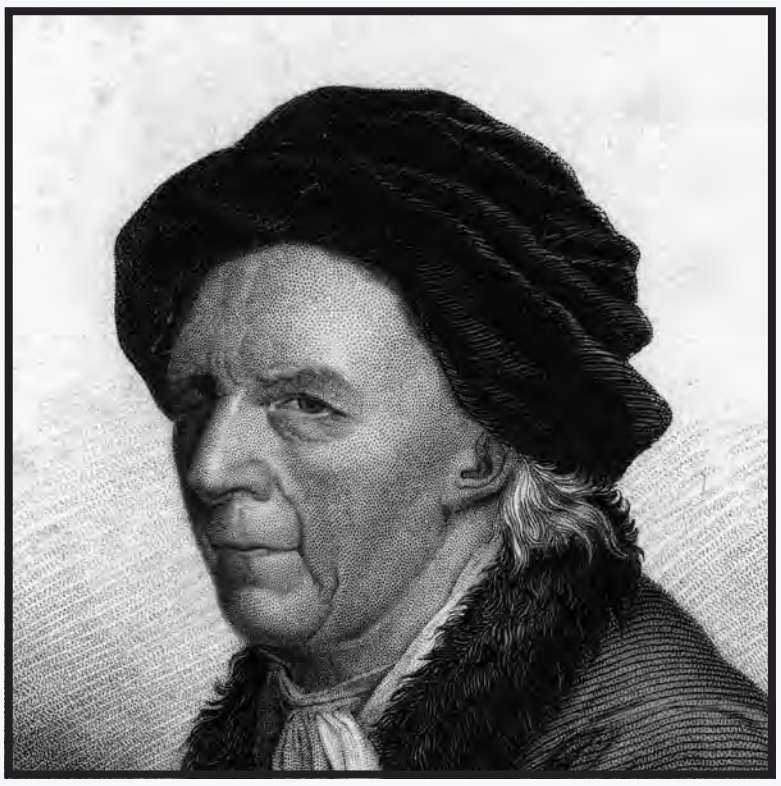
A younger portrait heads the list on the parallel Max Born Collection of Physicists. His calculus was in geometric form, unlike the algebraic version of Leibniz, because he thought in physical terms and geometry was where physics took place.

Newton holds special interest for Michael because of his strong connections with Trinity, and with the Royal Society in London. Newton was President of the Royal Society for 24 years, and firmly established it as a major national institution for the support of science. Trinity and the Royal Society between them have innumerable portraits, busts and even a fine statue.

Michael once gave a lecture to the National Portrait Gallery in London on *Portraits of Isaac Newton*.

Leonhard Euler

Basel 1707 – St. Petersburg 1783



The most prolific mathematician of any period. His collected works in more than 73 volumes are still in the course of publication.

Studied in Basel. Worked in St. Petersburg and Berlin. FRS.

His name appears in all branches of mathematics: Euler characteristic, Euler–Lagrange equations, Euler's constant. He gave the symbols to various important constants that we all use, such as e and π.

Euler's solution of the Königsberg bridge problem was the beginning of topology.

Euler introduced the famous infinite product that embodies the unique factorization of integers into prime factors, found the beautiful formula $\sum 1/n^2 = \pi^2/6$ and the fundamental relation $e^{i\theta} = \cos(\theta)+i\sin(\theta)$ between the exponential function and trigonometry.

Blind towards the end of his life, Euler continued to work until the very end – an encouragement to the older generation of the present time.

Carl Friedrich Gauss

Brunswick 1777 – Göttingen 1855

The mathematical giant who ushered mathematics into the modern era.

Officially an astronomer at the observatory in Göttingen. FRS, FRSE.

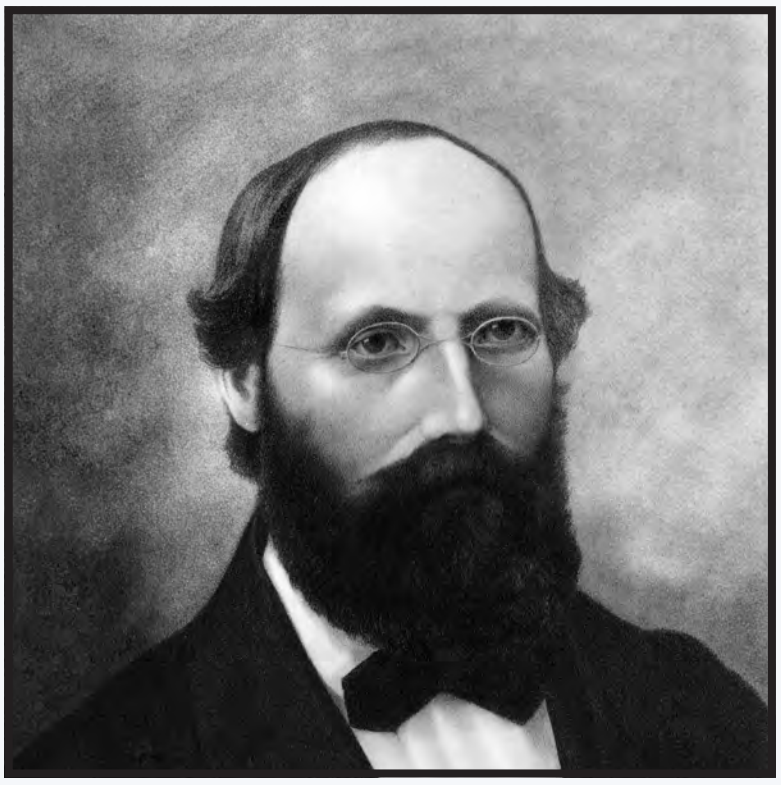
Gauss pioneered statistics (the Gaussian distribution) and geodesy (triangulation of the earth). His *Disquisitiones Arithemeticae* is still the bible for number theorists: it requires genius or divine backing to have integers named after you. In differential geometry, Gaussian curvature remains the foundation stone of the subject and has had far-reaching generalizations.

He gave the first rigorous treatment of complex numbers, writing that he had "shed a bright new light on the true metaphysics of the imaginary numbers".

His young contemporaries such as Bolyai (co-discoverer of hyperbolic geometry) and Abel thought him overpowering. But after the death of Abel, Gauss was more charitable and conceded that Abel had gone far beyond what Gauss himself had done.

Bernhard Riemann

Breselenz, Hanover 1826 – Selasca, Italy 1866



Riemann's name is attached to many fundamental ideas of our time.

A student of Gauss, Riemann worked in Göttingen, and was a foreign member of the Royal Society.

His name and work live on in Riemannian geometry, Riemann surfaces, the Riemann Hypothesis, the Riemann–Roch Theorem, the Riemann–Hilbert problem, and many more.

His foundational work on differential geometry was created as a sideline, to impress his doctoral examiners.

Unlike Euler his collected works take up only one modest volume, but each chapter opens a new door in mathematics.

Riemann died of tuberculosis at the height of his powers, aged just 39.

Évariste Galois

Bourg-la-Reine 1811 – Paris 1832

The French counterpart of Abel who pioneered the abstract study of symmetry (group theory) and made "Galois theory" a key part of modern mathematics.

Coming a few years after Abel, continued aspects of Abel's work on equations. He used the abstract symmetry of the roots of an equation as his main tool.

Galois theory, the use of group theory in this context, has been one of the key ideas of modern algebra.

Together with Abel he can be regarded as one of the founders of modern mathematics.

Galois had an unhappy relation with the French Académie des Sciences, whose Secretary Baron Augustin-Louis Cauchy lost the famous paper that Galois had submitted. For having triumphed posthumously over all his misfortunes Galois has become an iconic figure in the history of mathematics.

Galois died in a mysterious duel, aged just 20.

Grace Chisholm
William Henry Young

Haslemere 1868 – Croydon 1944 / London 1863 – Lausanne 1942

Grace Chisholm was, in 1895, the first female student at Göttingen to be awarded a Ph.D.

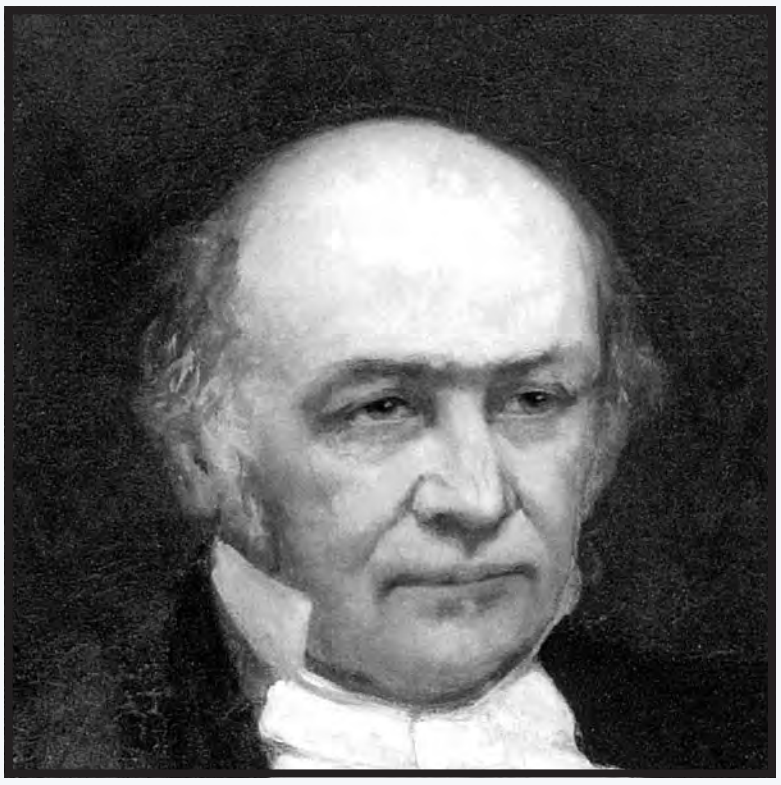
Grace attended Girton College Cambridge as an undergraduate, and then became a graduate student of Felix Klein in Göttingen. In 1896 she married William Henry Young, who had been her tutor at Girton College.

She worked closely with him on analytic topics, publishing many papers, though some appeared solely under his name so as to improve prospects of getting a job. This was essential since the couple had a full family life, raising six children.

One of their children, Laurence Chisholm Young, became a well-known mathematician and Fellow of Trinity from 1931 until 1935. Michael, as Master, met Young when he returned to Trinity for a Feast at the age of 91. Michael also met his daughter Sylvia Wiegand when he visited the University of Nebraska at Lincoln where Sylvia and her husband were both professors of mathematics.

William Rowan Hamilton

Dublin 1805 – 1865



Hamilton was an infant prodigy who spoke many languages at an early age.

At 21, he was appointed Royal Astronomer of Ireland, while still an undergraduate at Trinity College Dublin. Honorary FRSE.

He made his name early by predicting conical refraction, experimentally confirmed a short while later. Now famous for Hamiltonian mechanics, which became the paradigm for quantum mechanics a century later.

Hamilton is famous in mathematics for his discovery of the quaternions, carving the equations on Broom Bridge in Dublin where he had his brainwave in 1843. He opened the door to non-commutative algebra and, in physics, to the role of the group SU(2).

In one famous passage in an 1846 paper, Hamilton notes that a first order differential operator arising naturally in quaternions is the square root of the Laplace operator. He opines that this must have deep applications in physics. His forecast was fully justified since his operator was what Dirac rediscovered some 80 years later.

Niels Henrik Abel

Frindoe 1802 – Froland 1829

Abel was the first great figure to emerge in the new Norway when it freed itself from Denmark.

His story of young genius, with a few years of creative life followed by an early death from tuberculosis, is iconic and is why the Abel Prize was founded in 2002.

His ideas on algebraic integrals were far in advance of his time, going well beyond the known theory of elliptic functions. The general view-point he adopted is at the foundation of modern mathematics. He was the first to show that the general equation of degree 5 is not soluble by radicals.

The brevity and euphony of his name has widened his appeal, with abelian functions, integrals, groups, varieties and categories. Having your name become an adjective – without a capital – is the mark of real fame, as exemplified earlier by the terms *euclidean* and *newtonian*.

Évariste Galois

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Sophus Lie

Nordfjordeid 1842 – Christiania 1899

After Abel, Lie is the most famous Norwegian mathematician.

Professor at Christiania (Oslo) and Leipzig. Foreign Member RS.

He pioneered the field of what we now call *Lie groups*, one of the most important parts of mathematics and physics. He also dealt with more general situations in differential geometry, not far removed from the geometric structures that have emerged from new ideas in physics.

Lie felt that he had not been given the recognition that his work deserved. That may have been true at the time, but posterity has more than made up for it.

Henri Poincaré

Nancy 1854 – Paris 1912

One of the last of the universal mathematicians.

Professor in Paris. Foreign Member RS. Honorary FRSE.

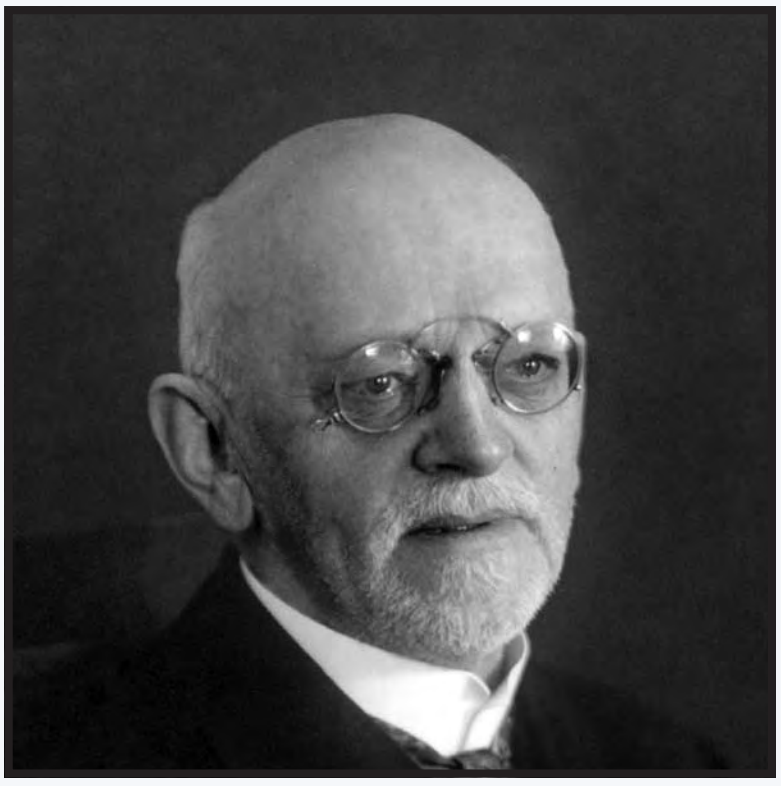
The conjecture he made on 3-dimensional manifolds was an unsolved challenge for a century until it was finally solved by Perelman in 2006.

Poincaré did fundamental work on dynamical systems (such as the many-body problem of celestial mechanics), hyperbolic geometry, automorphic functions, topology (with the duality theorem named after him) and much else. He was also seriously interested in physics and a precursor of Einstein in special relativity.

Poincaré can be regarded as someone in the newtonian tradition, where geometry and physics meet. This was certainly the view held strongly by Vladimir Arnold.

David Hilbert

Königsberg 1862 – Göttingen 1943



A near contemporary of Poincaré and also a universalist.

Professor at Königsberg and Göttingen. Foreign Member RS.

His name is everywhere in modern mathematics, indicating his importance and scope: Hilbert space, the Hilbert basis theorem, Hilbert syzygies etc.

But his name is especially attached to the list of 23 problems he spoke about at the 1900 International Congress of Mathematicians in Paris. These Hilbert problems drove much of the mathematics of the 20th century.

If Poincaré was in the mould of Newton then Hilbert was in the mould of Leibniz and Gauss and (according to Arnold) led to Bourbaki!

Felix Klein

Düsseldorf 1849 – Göttingen 1925

Klein was a powerful figure in German mathematics at the end of the 19th century.

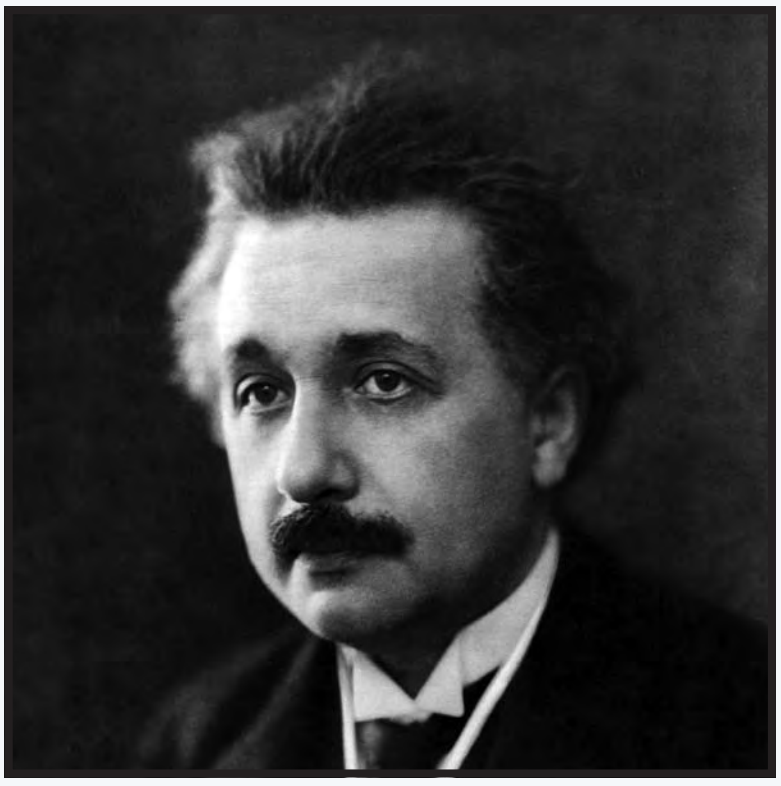
Professor at Erlangen and Göttingen. Foreign Member RS.

His main interest was in combining geometry and Lie group theory, as expounded in his famous Erlangen programme. Discovered the Klein bottle. He also worked with automorphic functions in competition with Poincaré. His book on the icosahedron has had a long-lasting influence, and is still highly regarded and much used.

He was a brilliant lecturer with an imposing presence and a somewhat domineering personality.

Albert Einstein

Ulm 1879 – Princeton 1955



The most famous physicist of the 20th century.

Professor in Berlin and at the Institute for Advanced Study, Princeton. Foreign Member RS. Honorary FRSE. Nobel Prize.

Although he was not a mathematician, his physical insight led him to beautiful mathematical ideas.

His most spectacular achievement was the General Theory of Relativity. Although one of the originators of the new quantum theory he never accepted the Copenhagen interpretation.

He constantly searched for a "Unified Field Theory" that would combine gravity, electro-magnetism and nuclear forces. Gauge theories have partly justified his view, but the final theory (if there is one) remains to be discovered and the Einstein-Bohr debate continues.

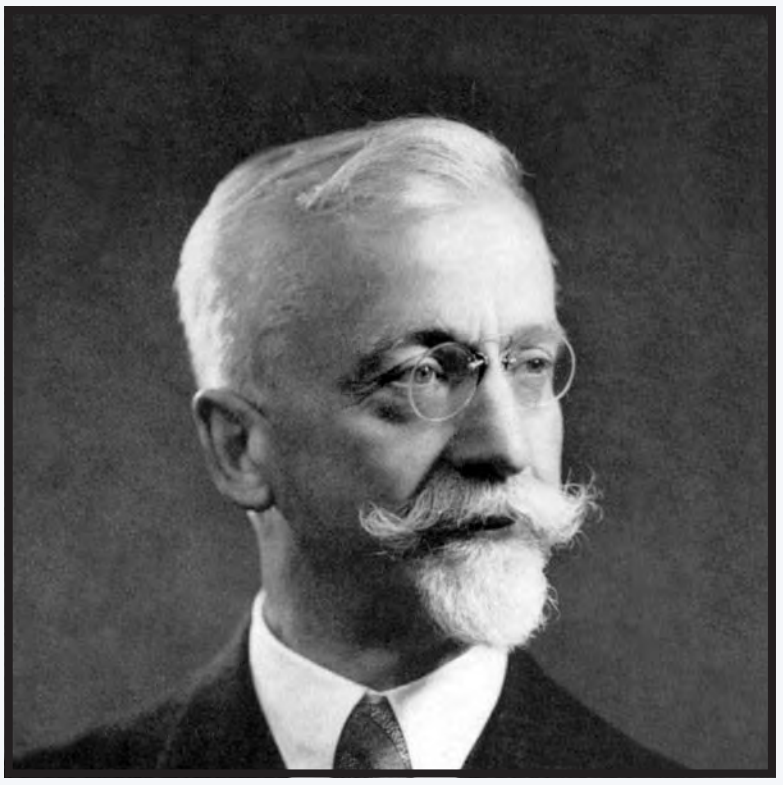
Nobel Prize 1921

His fame encouraged him to give sound bites to the journalists. Perhaps his most mordant was:

"The most incomprehensible thing about the universe is that it is comprehensible."

Élie Cartan

Dolomieu 1869 – Paris 1951



The first modern differential geometer, Cartan provided the right framework (moving frames) for all subsequent work.

Professor in Nancy and Paris. Foreign Member RS.

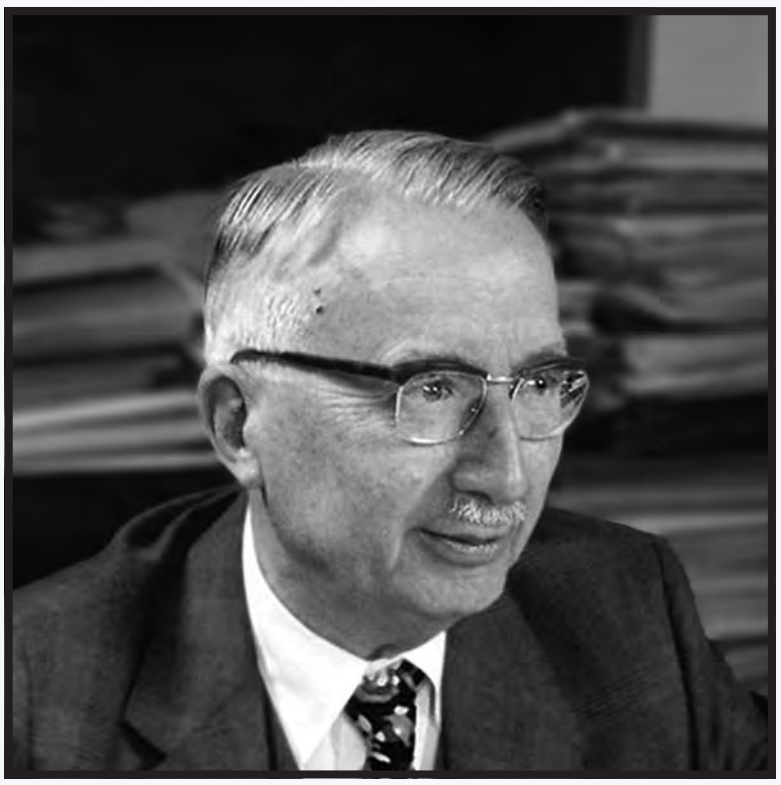
Cartan introduced differential forms and the exterior derivative, extending calculus to manifolds. These are key ingredients in modern differential geometry, and of de Rham cohomology. His work was particularly concerned with the geometric applications of Lie groups, which are manifolds with a group structure. He contributed to the definitive classification of simple Lie groups.

His work had a major influence on mathematical physics.

Father of Henri Cartan.

Henri Cartan

Nancy 1904 – Paris 2008



One of the sons of Élie Cartan, he equalled his father's reputation, being the driving force in Paris after 1945.

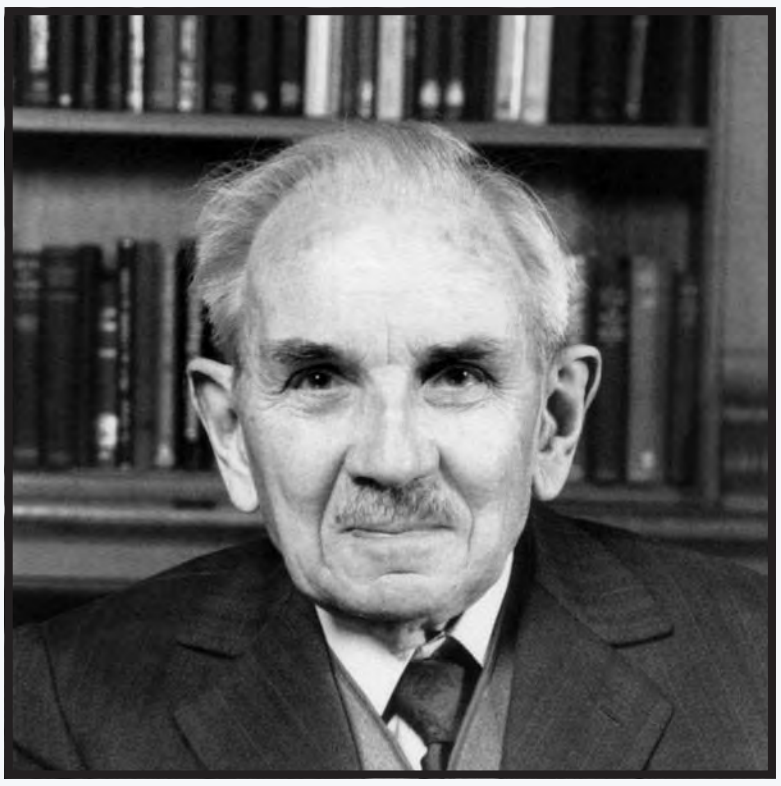
Professor in Strasbourg and Paris. Foreign Member RS.

His contributions were in the global theory that became possible after the pioneering work of Leray. Sheaf theory and cohomology were combined into a powerful tool for the global theory of several complex variables. The purely formal side, developed in conjunction with Eilenberg, gave birth to "homological algebra".

Cartan had many brilliant students at the École Normale Supérieure, notably René Thom and Jean-Pierre Serre, both Fields Medallists. He was also active internationally, becoming the President of the International Mathematical Union. Cartan was the first French mathematician in contact with German colleagues after World War II, in contrast to the ostracism shown after World War I.

Jean Leray

Chantenay 1906 – La Baule 1998



Leray was primarily an analyst who was interested in the differential equations of importance in the physical world.

Professor in Paris, Collège de France. Foreign Member RS.

He started off with significant contributions to the Navier–Stokes equations of fluid dynamics. But a quirk of fate diverted him in a different direction.

During the war he was held in a German prisoner of war camp in Silesia. The camp contained many scientists who were allowed to hold seminars. Leray was afraid that, if the Germans realized he was an expert on fluid dynamics, they might put him to military use. So he turned himself into “a useless topologist”. He then developed both spectral sequences and sheaves, the two most powerful techniques of 20th century topology.

André Weil

Paris 1906 – Princeton 1998

Weil was one of the most influential mathematicians of the post war period.

Professor at Chicago 1947–1958 and the Institute for Advanced Study, Princeton 1958–1976. Foreign Member RS.

Best known for his conjectures on the number of points in an algebraic variety over a finite field, formulated as an analogue of the Riemann Conjecture. This was one of the main stimuli for Serre and subsequently Grothendieck, and was finally proved by Deligne.

A key figure in Bourbaki, he exercised wide influence and set the tone for mathematics in our time. He encouraged both de Rham and Chern in their use of differential forms and introduced the "Weil algebra" into Lie theory. In 1954, while visiting Cambridge, he almost dissuaded Michael from pursuing his graduate studies.

He had a less than illustrious career in the war. In 1939 he was expelled from Finland on the suspicion of being a Soviet spy, mythically escaping a firing squad. On his return to France, he was jailed for deserting the French Army.

Hermann Weyl

Elmshorn 1885 – Zürich 1955

A mathematician with wide interests and an elegant style.

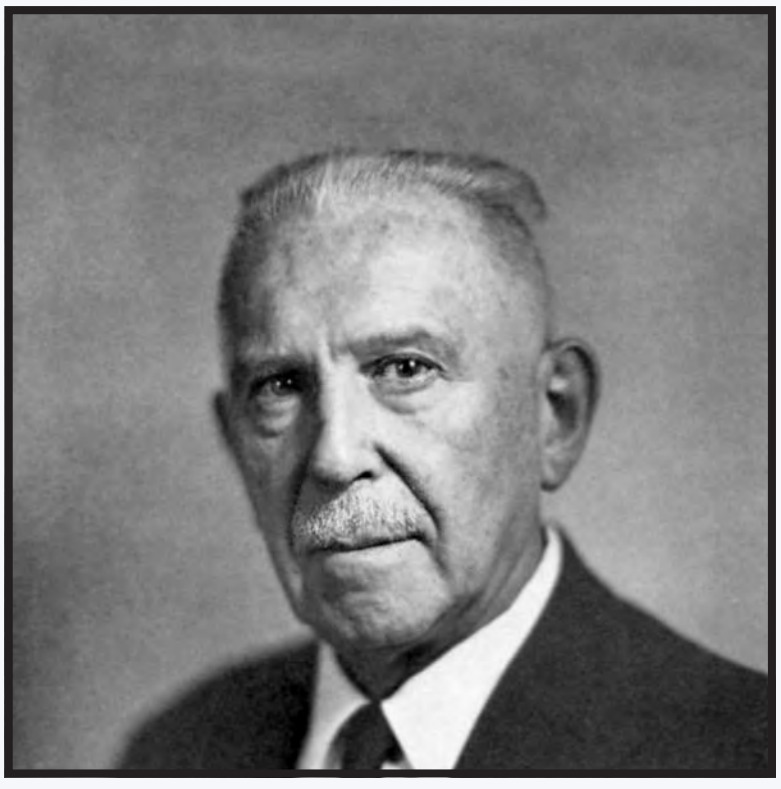
Professor at Göttingen, Zürich and the Institute for Advanced Study, Princeton. Foreign Member RS.

His work on the representation theory of compact Lie groups is well-known and his 1913 book on Riemann surfaces laid the foundations for all later analytic geometry. He was interested in physics, particularly in the role of symmetry. He introduced gauge theory in an effort to combine the equations of Einstein and Maxwell. He proved rigorously what physicists intuited, that the high frequencies of a quantum system converge to the classical limit.

He was a supporter of Hodge in his work on Harmonic Forms (correcting a technical error), and later of Kodaira, whom he brought from Japan to Princeton. Michael heard him at the 1954 International Congress of Mathematicians in Amsterdam when he presented the Fields Medals to Kodaira and Serre. Michael had the unusual opportunity of writing the biographical memoir for Weyl (for the US National Academy) 50 years after his death, rectifying an oversight.

Solomon Lefschetz

Moscow 1884 – Princeton 1972



Lefschetz became a mathematician quite literally by accident.

Educated in France, moved to the United States in 1905. Professor in Kansas and Princeton. Foreign Member RS.

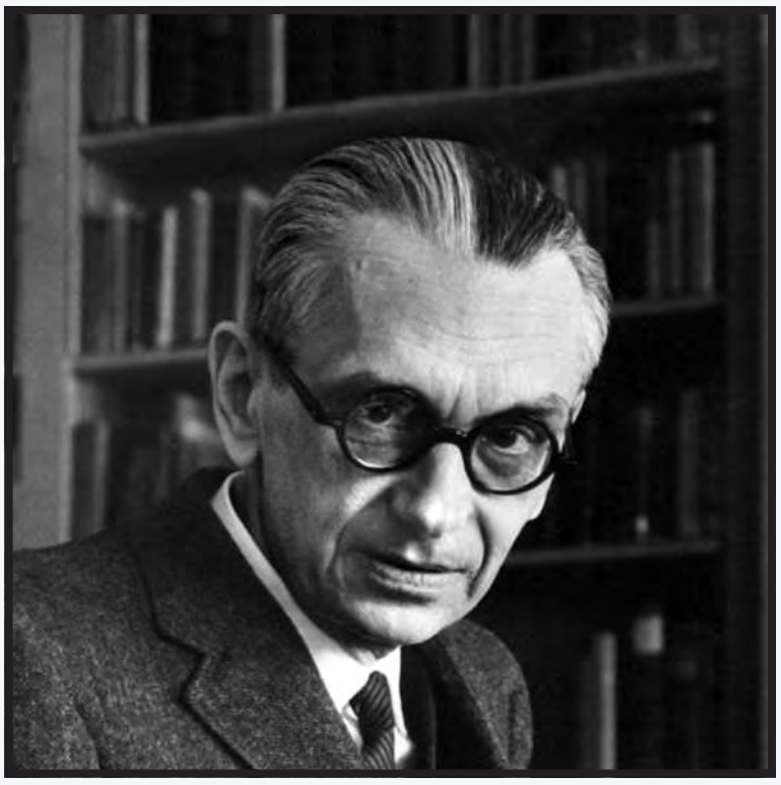
Trained as an electrical engineer, he lost both his hands in a lab accident in 1907. He became interested in the theory of higher dimensional algebraic varieties, following in the footsteps of Émile Picard.

He developed the topological tools needed for the purpose and proved some fundamental theorems (later taken up by Hodge and others). In particular he developed intersection theory on manifolds as a basis for algebraic geometry. The Lefschetz fixed point theorem became famous and led to many applications and generalizations, including the Weil conjectures and the Atiyah–Bott theorem for elliptic complexes.

A towering presence in Princeton and great rival of another Solomon (Bochner). Always claimed that his many years of isolation in Kansas had been ideal for his mathematics – no interruptions.

Kurt Gödel

Brünn 1906 – Princeton 1978



The most famous logician of all time.

Professor at the Institute for Advanced Study, Princeton. Foreign Member RS.

His results showed that mathematical certainty is a mirage. He demolished the great Hilbert plans to provide solid foundations for mathematics. His work greatly influenced both von Neumann and Turing whose theories underpinned the development of computers.

Gödel was a close friend of Einstein at the Institute in Princeton. He even wrote an interesting paper on general relativity.

Michael was a colleague at the the Institute for Advanced Study and remembers a dinner-table comment when Gödel said:

> *"The trouble with physicists today is that they have given up trying to explain and only describe".*

John von Neumann

Budapest 1903 – Washington 1957

He made fundamental contributions to many parts of mathematics and physics, including quantum mechanics, functional analysis, meteorology, economics, and computer science.

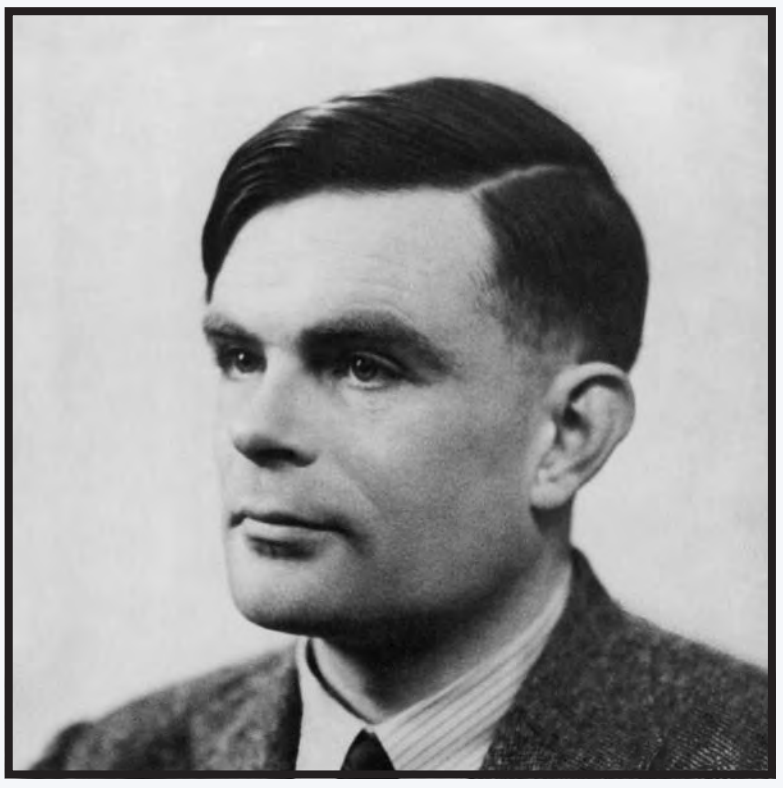
Von Neumann helped build an early computer at the the Institute for Advanced Study, and was a top adviser to US government and military.

He was the ultimate whizz-kid, whose brain worked faster than that of anyone else. Hermann Weyl, when he was a young professor at the ETH in Zürich, said that he approached each lecture in trepidation. He feared that the young von Neumann might be in the audience and that he would be certain to ask questions that Weyl could not answer!

While von Neumann's influence in the applications of mathematics was exceptionally broad, his contributions to pure mathematics were also profound. Von Neumann algebras have proved of lasting significance, particularly in the hands of Alain Connes.

Alan Turing

London 1912 – Wilmslow 1954



Turing has become famous over the past decades because his centenary has reminded the world of his pioneering impact on the development of computing.

Worked at Cambridge, Princeton, Bletchley Park and Manchester. FRS.

In 1936 he proved that it is not possible to solve Hilbert's *Entscheidungsproblem,* which asked for an algorithm to decide if any statement in logic is true or false.

The universal Turing machine was both a logical device and the theoretical basis of the digital computer.

He was also the key figure at Bletchley Park, the deciphering centre whose success with the German Enigma Machine played a major part in the Second World War.

Committed suicide in tragic circumstances, having been prosecuted on account of his homosexuality.

Israel Gelfand

Krasnya 1913 – New Brunswick 2009

One of the outstanding figures of 20th century mathematics.

Professor in Moscow and Rutgers. Foreign Member of RS.

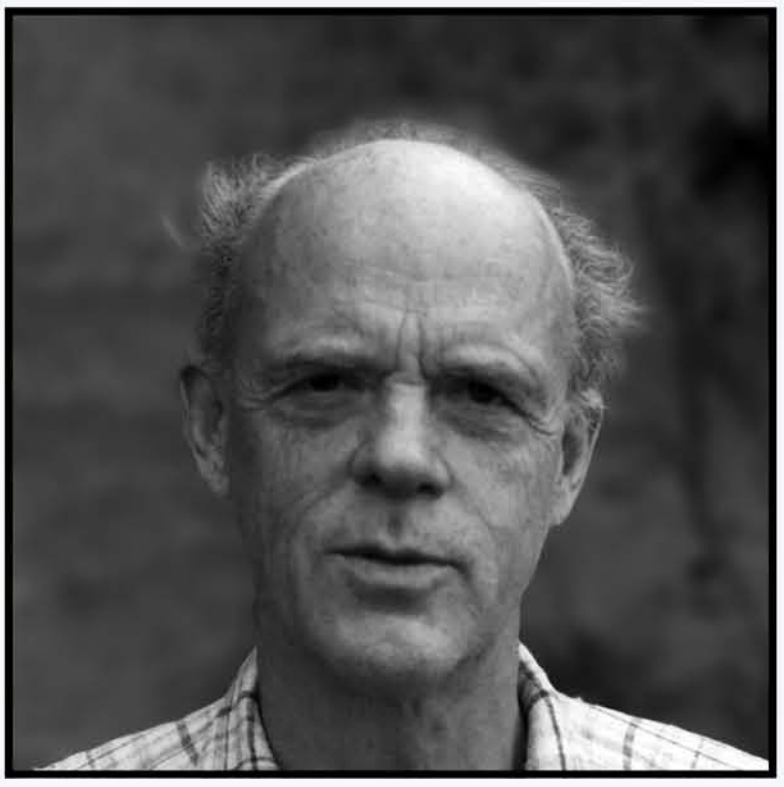
His most famous work was in identifying the algebra of continuous functions on a compact space in terms of normed Banach algebras. He then worked on a very wide range of topics in analysis, physics and geometry, notably on the representations of non-compact Lie groups. Henri Cartan compared him with Poincaré.

His Moscow seminar became world famous and his influence on the next generation was unique.

Banned from travelling abroad on the grounds of his secret work, he was eventually permitted to go to Oxford in 1973 to receive an honorary degree. Even so he arrived late and Michael had to interrupt a cricket match to go to Heathrow to collect Gelfand (who received his degree the next day).

Lars Gårding

Hedemora, Sweden 1919 – Lund 2014



A famous Swedish mathematician who analysed birdsong.

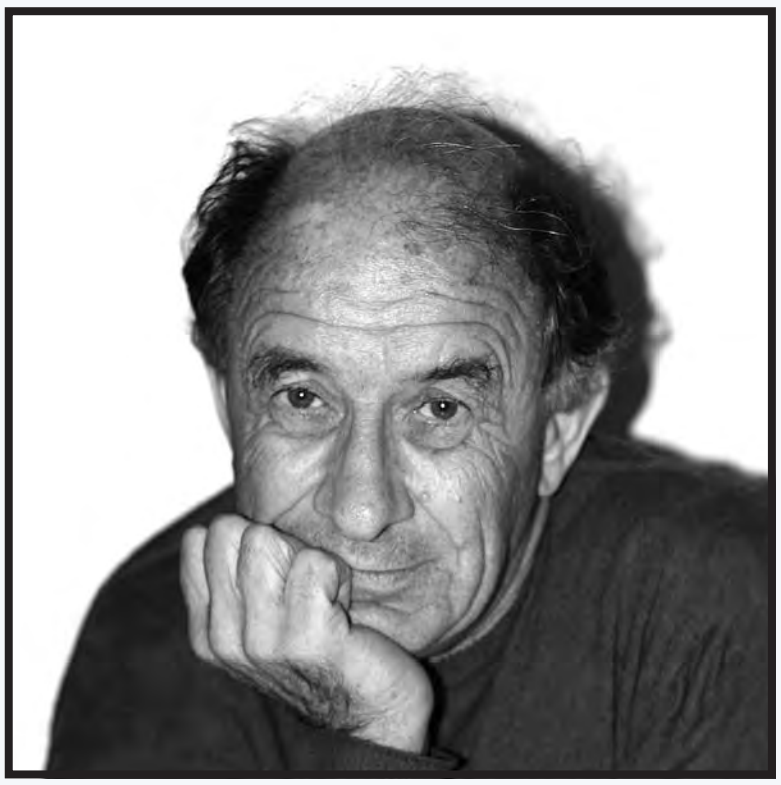
Part of the traditional Swedish school of analysts with special interest in partial differential equations, he worked with Leray on hyperbolic equations, and was the mentor of Lars Hörmander.

In the late 1960's Gårding visited Atiyah and Bott at St. Catherine's College, Oxford and persuaded them to take an interest in the theory of lacunas, as pioneered by Petrovsky. This led to a series of papers in which modern algebraic geometry was applied to hyperbolic equations.

Gårding was also a keen ornithologist and studied the "harmonic analysis" of Swedish birds.

Vladimir Arnold

Odessa 1937 – Paris 2010



Arnold was one of the few mathematicians of modern times who was equally admired in both pure and applied mathematics.

Studied and worked in Moscow, moved to Paris in 1986. Ph.D. with Kolmogorov. He became famous for the KAM (Kolmogorov–Arnold–Moser) theory of dynamical systems and for his study of the Euler equations of hydrodynamics.

His ideas in symplectic geometry opened up the field and were extremely fruitful. His interests were very broad and his views strong and frequently controversial.

He was a visiting Fellow of Trinity College, Cambridge during the time Michael was Master and he served with him on the Scientific Committee of the European Congress of Mathematics at Barcelona.

Sergey Novikov

Gorki 1938 –

Novikov is the most brilliant Russian topologist of the younger generation.

Studied and worked in Moscow. Ph.D. with Postnikov. Novikov proved the topological invariance of the Pontrjagin classes, and formulated the far-reaching Novikov conjecture relating characteristic classes and signatures of manifolds to the fundamental group.

Novikov was awarded a Fields Medal at the 1970 International Congress of Mathematicians in Nice. He was not allowed to attend for political reasons, but received the medal when the International Mathematical Union executive committee, chaired by Henri Cartan, and including Michael, met in Moscow.

He later moved into theoretical physics and did important work on periodic integrable systems.

Fields Medal 1970

Bryan Birch
Peter Swinnerton-Dyer

Burton-on-Trent 1931 - / Ponteland, Northumberland 1927 -

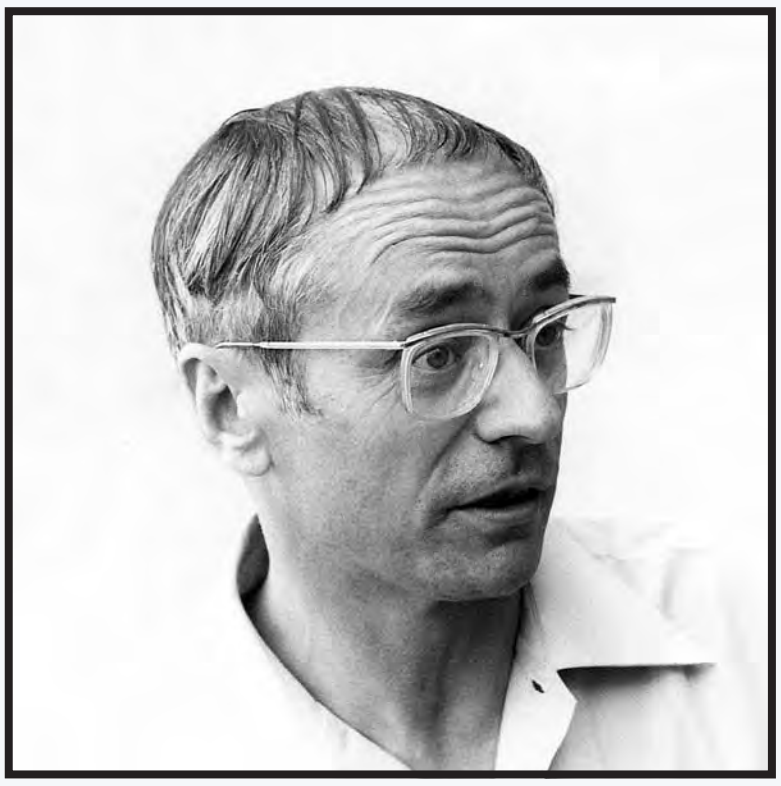
Trinity mathematicians who formulated one of the million dollar Millenium Prize conjectures.

Bryan Birch, two years behind Michael at Trinity, Fellow of Trinity, Reader then Professor at Oxford. FRS. Student of Cassels. Made many contributions to algebraic number theory, but famous for his joint conjecture with Swinnerton-Dyer relating the rank of the group of rational points of an elliptic curve over a number field to the behaviour of its ζ-function at $s=1$. This is one of the $1 million Millenium Prize problems.

Peter Swinnerton-Dyer, two years ahead of Michael at Trinity, Fellow of Trinity then Master of St. Catharine's College, Cambridge 1973-1984 and Vice Chancellor of Cambridge University 1979-1981. FRS. Analyst and number theorist who worked in the Cambridge Computer Laboratory. His skills in this field helped provide extensive numerical evidence for his conjecture with Birch. Chairman of the University Grants Committee 1983-1989, and Chief Executive of the Universities Funding Council 1989-1992, which set up the present framework for government support of universities. A high-level chess and bridge player, he was at one time the non-playing captain of the British women's bridge team.

Jean-Pierre Serre

Bages, France 1926 –



The outstanding mathematician of the post-war era. Hermann Weyl said that "never before have I witnessed such a brilliant ascension of a star in the mathematical sky as yours."

Studied at the École Normale Supérieure in Paris under Henri Cartan. Professor at the Collège de France for 38 years, from 1956 on. Foreign Member RS.

He revolutionized both algebraic topology and algebraic geometry by using sheaf theory and spectral sequences, both invented by Leray. He provided techniques to calculate the homotopy groups of spheres and successfully used the Zariski topology as the basis for the cohomology groups of coherent sheaves, following the analytic approach of Henri Cartan.

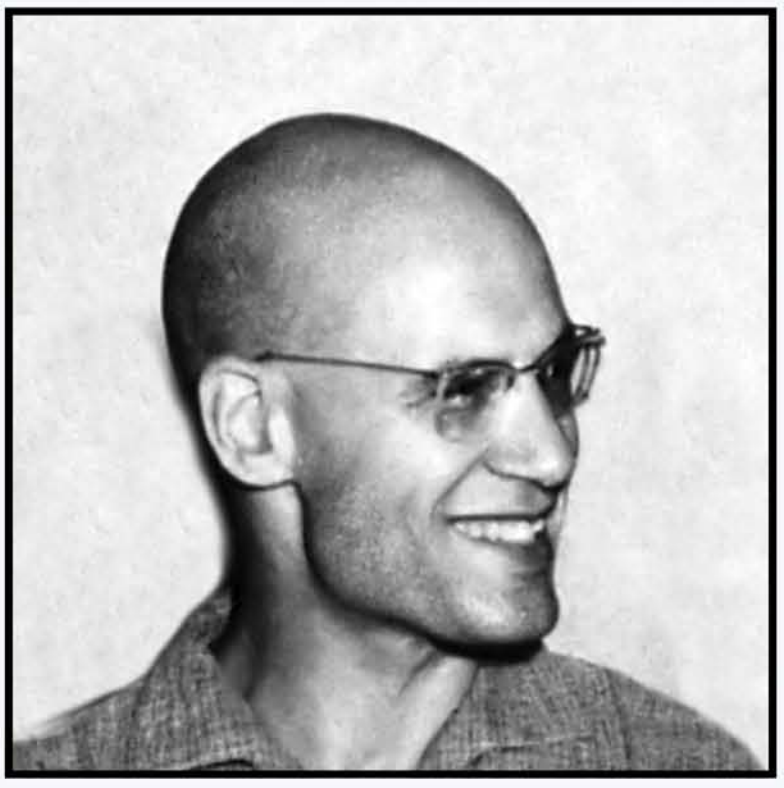
Serre worked subsequently in number theory and was very influential, with many fruitful ideas and conjectures.

Fields Medal 1954

Abel Prize 2003

Alexander Grothendieck

Berlin 1928 – Saint-Girons (Ariège) 2014



The whirlwind who tore through algebraic geometry and then vanished.

Started research in functional analysis and solved many hard problems proposed by Dieudonné and Schwartz. He then moved into algebraic geometry, in the wake of Serre, and transformed the subject completely. He produced a new and elegant proof of the Hirzebruch-Riemann-Roch theorem, which was purely algebraic. For this he introduced K-theory, which has had an extensive life in other fields. Michael heard his first lectures on the subject in Bonn in 1957 and this motivated the use of K-theory in topology.

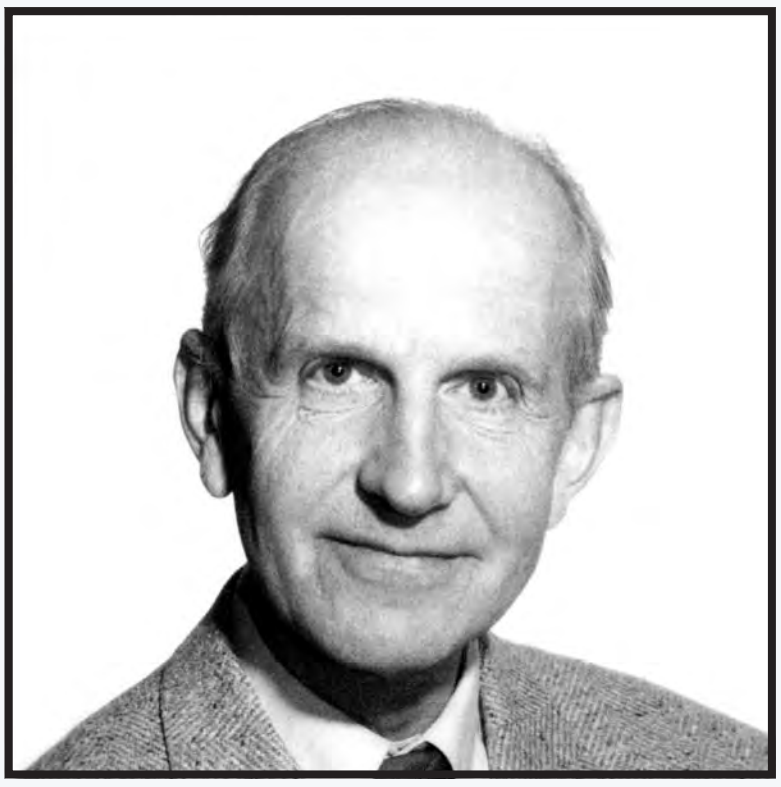
His introduction of étale cohomology groups paved the way for the eventual proof by Deligne of the famous Weil conjectures concerning the number of rational points of varieties over finite fields.

An intense, powerful and eccentric personality, he gave up mathematics in 1970, and devoted himself to idealistic causes.

Fields Medal 1966

Lars Hörmander

Mjalby 1931 – Lund 2012



The most brilliant Swedish mathematician of our time.

Mentored by Gårding in Lund, he then became Professor at the Institute for Advanced Study in Princeton, but returned after a few years to Lund.

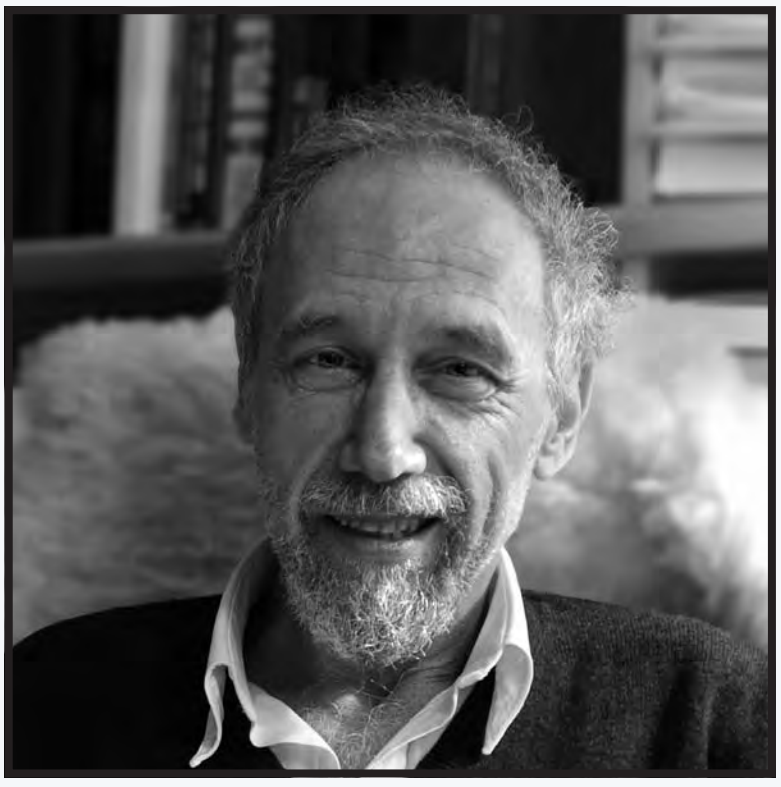
As a young man he contributed to the solution of Hilbert's fifth problem. He then worked with tremendous power and insight on the general theory of partial differential equations. He systematically developed micro-local analysis, which became a standard tool, and wrote a monumental four-volume treatise on linear PDE.

Michael learnt much of the analysis he needed from Hörmander and his books. They overlapped in Princeton for one year.

Fields Medal 1962

Alain Connes

Draguignan 1947 –



Analyst turned geometer. Creator of non-commutative geometry.

Connes first made his name by fundamental advances in the theory of von Neumann algebras. He then moved on to introduce Non-Commutative Geometry, where the measure theory of von Neumann is refined to a differentiable theory. This enabled him to introduce Riemanian metrics, connections and curvature into the non-commutative world. His theory of cyclic homology was a key technical tool.

In particular index theory lent itself to this new framework leading to many interesting applications. There are also fascinating, but only partially understood, links with theoretical physics.

Fields Medal 1982

Edward Witten

Baltimore 1951 –

Outstanding theoretical physicist whose work has had a profound influence on mathematics.

Studied History as an undergraduate. Then took a year off to campaign for George McGovern in the American Presidential election of 1972. Graduate student under David Gross at Princeton, then Junior Fellow at Harvard.

Professor at Princeton University 1980–1987, since 1987 at the Institute for Advanced Study, Princeton. Foreign Member RS.

Witten has generated a vast output of brilliant ideas on gauge theories and string theory. Some of his work was of direct mathematical interest and led to extensive direct contact between physicists and geometers (including Atiyah, Bott and Singer). Notable for geometers was the Chern–Simons interpretation of the Jones polynomials of knots, the use of spinors to prove the positive energy theorem and Seiberg–Witten theory.

Fields Medal 1990

UK Fields Medallists

The Fields Medal, awarded every four years to mathematicians under 40, is regarded as the mathematicial equivalent of the Nobel Prize.

There have so far been seven Fields Medallists in the UK. They were photographed together at the opening of the headquarters of the London Mathematical Society in De Morgan House on 23 October 1998.

They are, from left to right:

Tim Gowers, 1998; Karl Roth, 1958; Simon Donaldson, 1986; Michael Atiyah, 1966; Alan Baker, 1970; Richard Borcherds, 1998; Dan Quillen, 1978.

All are still alive (as of 2013), except for Quillen, who died in 2011.

Fields Medal

Michael & Lily Atiyah

London 1929 – / Edinburgh 1928 –

Originators of this portrait gallery of mathematicians.

Lily: born in Edinburgh 1928, studied at Edinburgh University, Ph.D. under Mary Cartwright at Girton College, Cambridge. Lecturer at Bedford College London 1954–55. Taught at various Oxford & Cambridge colleges and at Headington School, Oxford.

Michael: born London 1929, went to school at Victoria College, Egypt and Manchester Grammar School. Military service REME. Trinity College Cambridge (Master 1990–97) Ph.D. under Hodge. Professor at Oxford and the Institute for Advanced Study Princeton. Developed K-theory with Hirzebruch, index theory with Singer and Bott. Contributed to new links between geometry and physics. Knight Bachelor, OM, FRS and FRSE. Honorary degrees from Edinburgh and Heriot-Watt. President of the Royal Society 1990–1995. President of the Royal Society of Edinburgh 2005–2008.

Fields Medal 1966

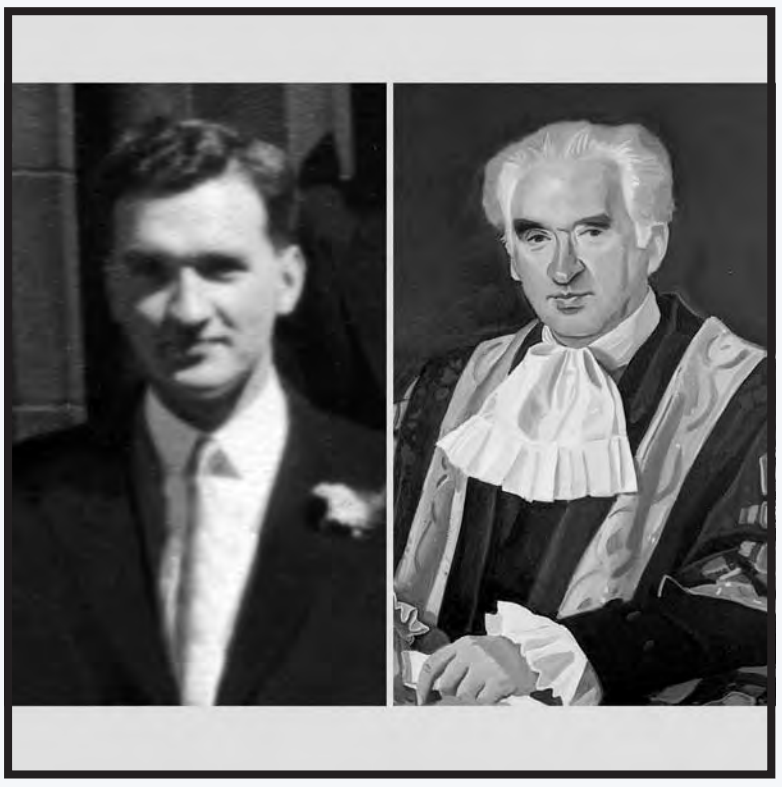
Abel Prize 2004

Michael and Lily were married in Edinburgh in 1955, with James Mackay as best man.

James Mackay

Edinburgh 1927 –

Scottish mathematician turned lawyer who ended up as Lord Chancellor.



Studied mathematics at Edinburgh University 1944–1948, and Trinity College, Cambridge 1950–1952, Lecturer in Mathematics, St. Andrews 1948–1950. FRSE.

Studied Law at Edinburgh, rose rapidly in the legal profession, becoming Dean of the Faculty of Advocates. Lord Advocate and then Lord Chancellor 1987–1997. Chancellor of Heriot-Watt University 1991–2005.

Best man at the wedding of Michael and Lily in Edinburgh in 1955. He gave Michael an Honorary Doctorate at Heriot-Watt, and received the Royal Medal of the Royal Society of Edinburgh, with Michael, in 2003.

Mary Somerville

Jedburgh 1780 – Naples 1872

Scottish female mathematician after whom Somerville College Oxford is named.

Daughter of Irish Vice-Admiral Sir William George Fairfax. Educated in Edinburgh. Married in 1804 to Captain Samuel Greig, son of Admiral Samuel Greig of the Russian Navy, then in 1812 to Dr. William Somerville.

She worked in mathematical physics, notably on the magnetic properties of solar rays. Laplace told her, "There have been only three women who have understood me. These are yourself, Mrs Somerville, Caroline Herschel and a Mrs Greig of whom I know nothing". Of course, Somerville was first and third of these three. She achieved fame through her translation of Laplace's *Traité de mécanique céleste*.

Moved in high scientific circles in London, with William and John Herschel, and Charles Babbage.

The Royal Society in London has a fine bust of her on prominent display.

Philippa Fawcett

Cambridge 1868 – London 1948

The woman who beat the men at their own game.

The daughter of Henry and Millicent Garrett Fawcett, pioneers in women's education. The Fawcett Society is named after her mother. Studied at Newnham College Cambridge at a time when women were not officially members of the University, but could attend lectures and sit examinations. In the final Mathematical Tripos examinations, where the names were read out in order of merit, the women were slotted in at the appropriate place. In 1890 the name of Phillipa Fawcett was placed above the Senior Wrangler, normally the top position. This became a world-wide sensation with front page photographs in London and New York.

She went on to have a distinguished career in education, as principal assistant to the Director of Education of London County Council.

Sofia Kovalevskaya

Moscow 1850 – Stockholm 1891

Most famous female mathematician of the 19th century.

She married Vladimir Kovalevsky in 1868, in order to be allowed to study. She studied in Heidelberg and Berlin, staunchly supported in her studies by Weierstrass. In 1874 she was granted a doctorate *summa cum laude* by the University of Göttingen, the first woman ever to be awarded this degree. However, she was not able to get a university position on account of being a woman.

After the suicide of Kovalevsky in 1883 Kovalevskaya moved to Stockholm with the help of Mittag-Leffler, another influential friend. She obtained a position at Stockholm University, first as *privat-docent* and then as *Professor Extraordinarius*. She is famous for her discovery of the 'Kovalevskaya top', the only completely integrable rigid body motion besides those of the Lagrange and Euler tops.

Emmy Noether

Erlangen 1882 – Bryn Mawr 1935

One of the founders of modern algebra, revolutionizing the theory of rings and fields. Has rings named after her.

Daughter of the well-known algebraic geometer Max Noether and sister of Fritz.

Her lectures on modern
algebra were expanded into the classic book by van der Waerden. Hilbert supported her in Göttingen, upbraiding his conservative colleagues by telling them that Göttingen was a university not a bathing establishment.

Hilbert interested her in physics and this led to her famous theorem explaining how symmetry led to conservation laws. With the increasing role of symmetry in fundamental physics her theorem acquired celebrity status.

Dismissed from Göttingen University in 1933 on account of being Jewish, she spent her last two years at Bryn Mawr College in Pennsylvania.

Dusa McDuff
John Milnor

Edinburgh 1945 – / Orange, New Jersey 1931 –

A celebrated mathematical pair.

Dusa McDuff grew up in Edinburgh, the daughter of the famous biologist C.H. Waddington. An undergraduate at Edinburgh, and a graduate student at Cambridge, worked on von Neumann algebras under George Reid. During a year in Moscow she came under the influence of Gelfand. In the United States since 1977, for many years at Stony Brook and now at Barnard College, part of Columbia University. Has made extensive and important contributions to symplectic topology. A leading figure supporting women in mathematics. FRS and FRSE.

John Milnor was Professor at Princeton University, MIT, the Institute for Advanced Study, Princeton, and Stony Brook. He made his name very young with work on the topology of knots. He hit the headlines with his discovery of exotic spheres, manifolds that are topologically equivalent but not differentiably equivalent to spheres, opening up a whole new field of differential topology. Famous for the clarity of his writing, he wrote many influential monographs.

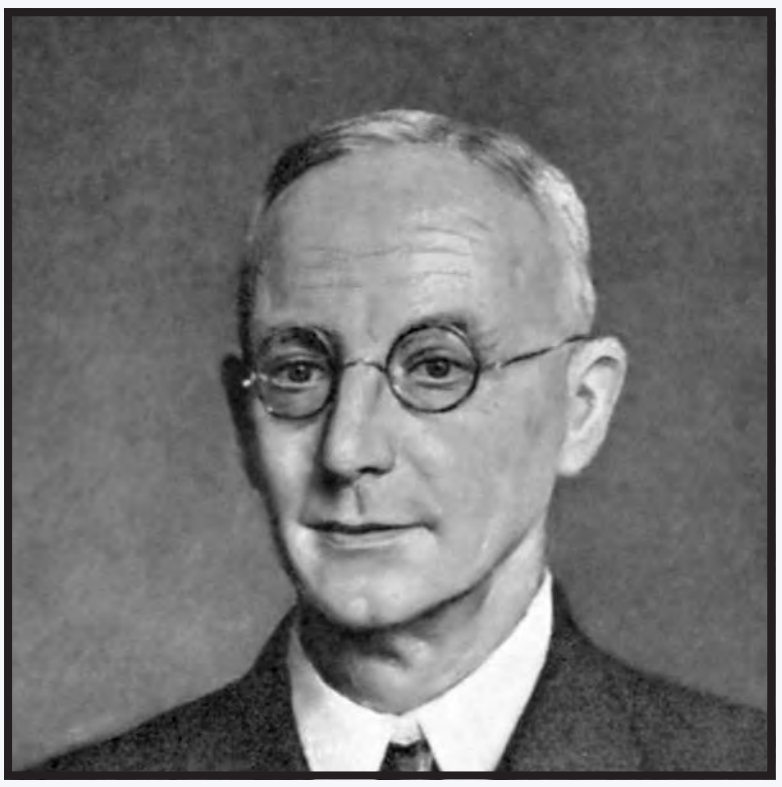
Fields Medal 1962

Abel Prize 2011

Edmund Whittaker

Southport 1873 – Edinburgh 1956

Head of Mathematics at Edinburgh during the pre-war period.



Fellow of Trinity, 1896–1906; Royal Astronomer of Ireland, 1906–1911; Professor at Edinburgh, 1911–1946; FRS. FRSE; President RSE, 1939–1944.

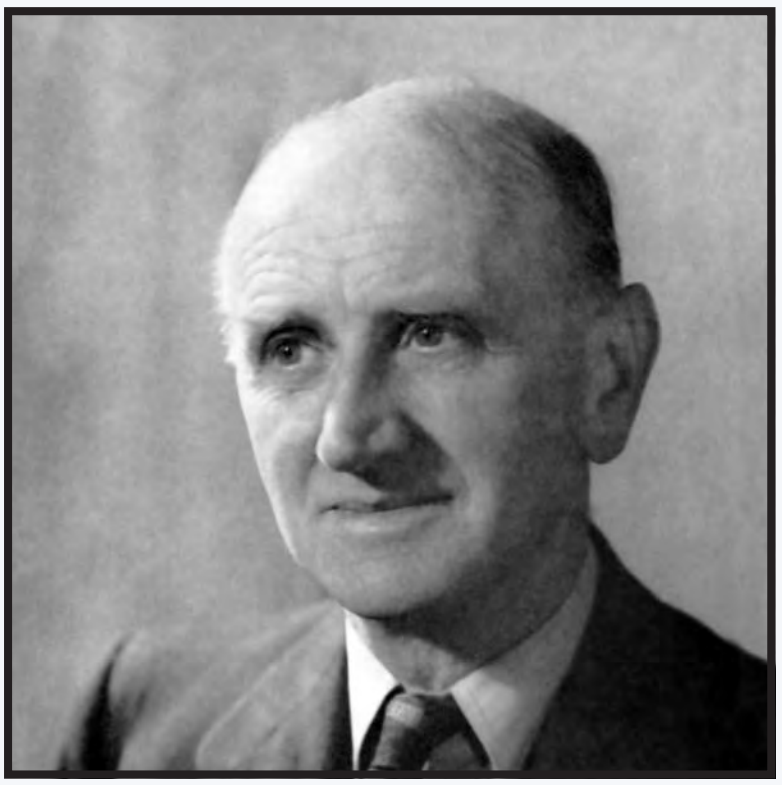
Whittaker was an analyst and applied mathematician; his textbook with Watson – *A Course of Modern Analysis* – became essential reading. It contained vast numbers of example problems lifted from the Tripos examinations. Whittaker was responsible for bringing Max Born to Edinburgh.

In 1945 Lily attended the last set of lectures he gave to first year students, covering philosophy and astronomy.

In 1955 Whittaker attended the St. Andrews Colloquium where Michael gave a course of lectures.

Alexander Aitken

Dunedin, New Zealand 1895 – Edinburgh 1967



The man who knew π.

Lecturer, Reader and Professor of Mathematics, Edinburgh University, 1925–1965. FRS. FRSE.

A statistician, a numerical analyst, and an algebraist skilled with determinants.

Famous for his lectures, which Lily attended, where he displayed his arithmetical virtuosity. He knew the decimal expansion of π to several hundred places and could recite it spontaneously starting from any point. Like many of the Edinburgh faculty he was a keen musician, and was a skilled violinist.

In the First World War he served with the New Zealand forces at Gallipoli, Egypt and France. The experience affected him deeply for the rest of his life.

Robin Schlapp

Edinburgh 1899 – Ashford 1991

A much loved Edinburgh teacher.

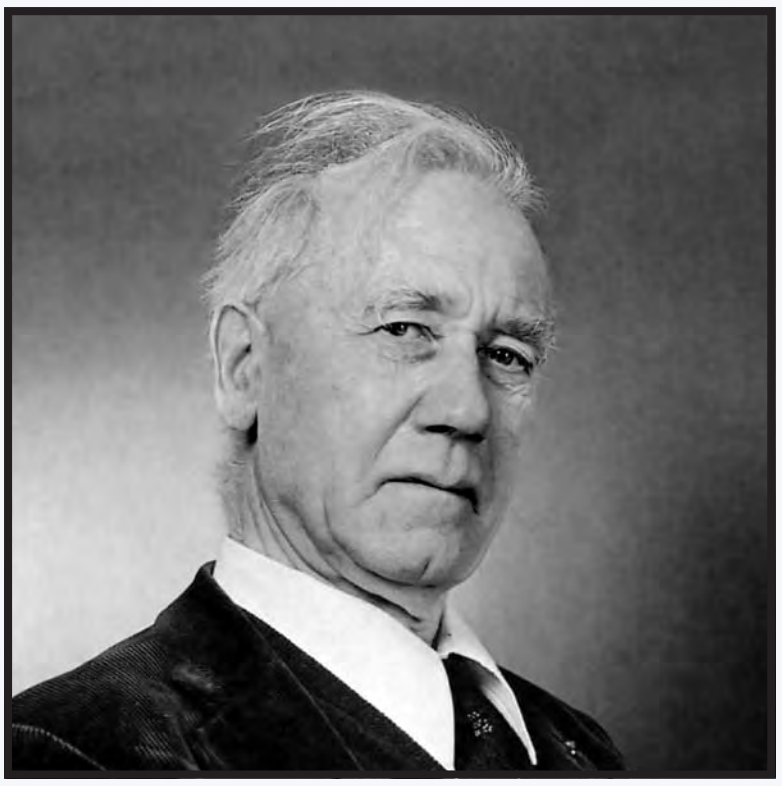
Ph.D. in Cambridge under Sir John Larmor. Lecturer and Senior Lecturer in Applied Mathematics at Edinburgh University 1925–1969. FRSE.

His father was an immigrant from Germany but Robin was brought up in Edinburgh. He studied quantum mechanics in Göttingen where he met Max Born, but subsequently focused on his teaching.

A kind man popular with students (of which Lily was one) he was a keen musician and had quartets performed in his house.

William Edge

Stockport 1904 – Bonnyrigg 1997



A great performer on the Edinburgh stage.

A Fellow (and devoted son) of Trinity who spent his entire career at Edinburgh. FRSE.

A magnificent lecturer modelled on his hero Felix Klein, he was a geometer of the old school. He had a fine voice for Schubert Lieder as well as in the classroom.

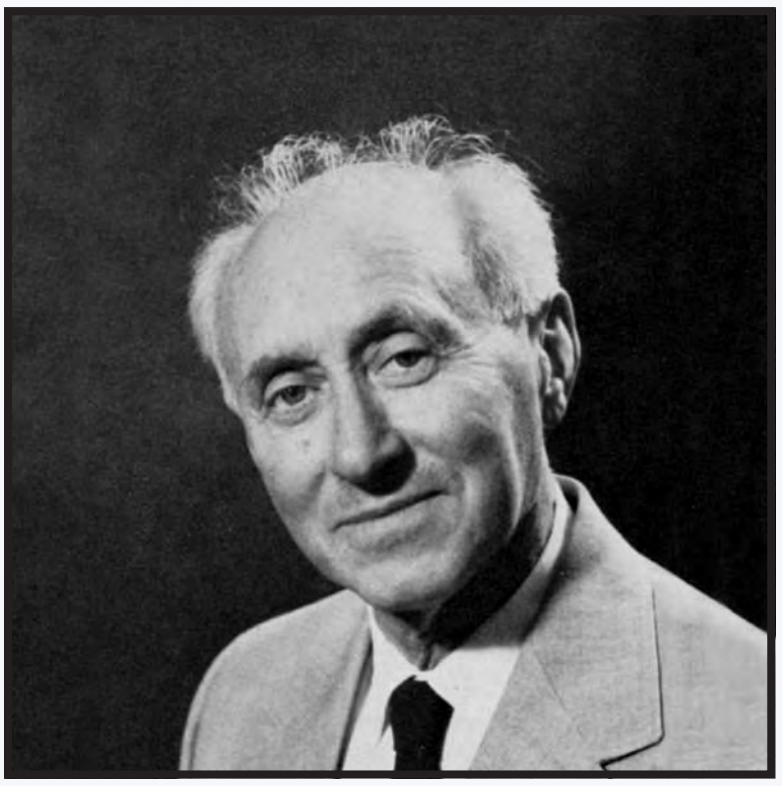
Edge was a keen hill walker who regularly took (male) students up the Scottish hills. Despite his apparent misogyny, he greatly encouraged Lily to go to Cambridge for her Ph.D. Dusa McDuff was inspired as an undergraduate by his lectures on algebraic geometry.

Michael met him during the frequent sabbaticals he took at Cambridge. Edge gave the speech of thanks for Michael's St. Andrews lectures but backhandedly said that it was not geometry as he understood it!

Arthur Erdélyi

Budapest 1902 – Edinburgh 1977

The Hungarian who became a Scot.



Whittaker rescued Erdélyi (who was Jewish), by arranging for him to come to Edinburgh in 1939, just before the outbreak of the Second World War.

A young and inspiring lecturer at Edinburgh when Lily was a student, he then went off to the California Institute of Technology to edit the Bateman Manuscript Project 1949–1964. Erdélyi was an analyst who focused on special functions.

He returned to Edinburgh in 1964 as Professor, where, as violinist, he rejoined the quartets with whom he had previously played. Erdélyi was a fellow of both the RS and RSE.

Nicholas Kemmer

St. Petersburg 1911 – Edinburgh 1998

A pioneering physicist from Russia.

Brought up in Russia and Germany, in UK since 1936.

Fellow of Trinity and Tait Professor of Natural Philosophy at Edinburgh 1953–1979 as successor of Max Born. He supervised Michael at Trinity. FRS. FRSE.

Kemmer's main claim to fame was the prediction of pions as mediating the nuclear interaction. This was done in 1935, independently of the simultaneous work by Yukawa which earned a Nobel Prize. Many think that Kemmer deserved similar recognition.

Kemmer was the mentor of Freeman Dyson and Abdus Salam.

At the end of Kemmer's life he became an Honorary Fellow of Trinity, while Michael was Master there.

Paul Dirac

Bristol 1902 – Tallahassee, Florida 1984

The outstanding theoretical physicist of the 20th century after Einstein.

Lucasian Professor of Mathematics at Cambridge 1932–1969. FRS, Honorary FRSE and Nobel Prize.

He discovered how to make quantum mechanics relativistic, by introducing spin and the Dirac operator. He also outlined the programme developed in detail by Feynman and known as the Feynman path integral.

A great believer in the necessity for physical laws to be embodied in beautiful equations, he forecast, in a lecture to the Royal Society of Edinburgh in 1939, that the future of physics would rely on more sophisticated mathematics. Michael attended his Cambridge lectures on quantum mechanics.

Nobel Prize 1933

A man of few words, his silences were legendary. Despite being a close colleague of Hodge for over thirty years the two do not seem to have had any mathematical exchanges. This left the field between Hodge theory and the Dirac operator open for the next generation (Atiyah–Singer) to exploit.

G. H. Hardy

Cranleigh 1877 – Cambridge 1947

Together with Littlewood he was the outstanding analyst of his time in Britain.

At Cambridge 1896–1919.
Savilian Professor of Geometry at Oxford 1919–1931.
Sadleirian Professor of Mathematics at Cambridge 1931–1942. FRS.
Honorary FRSE.

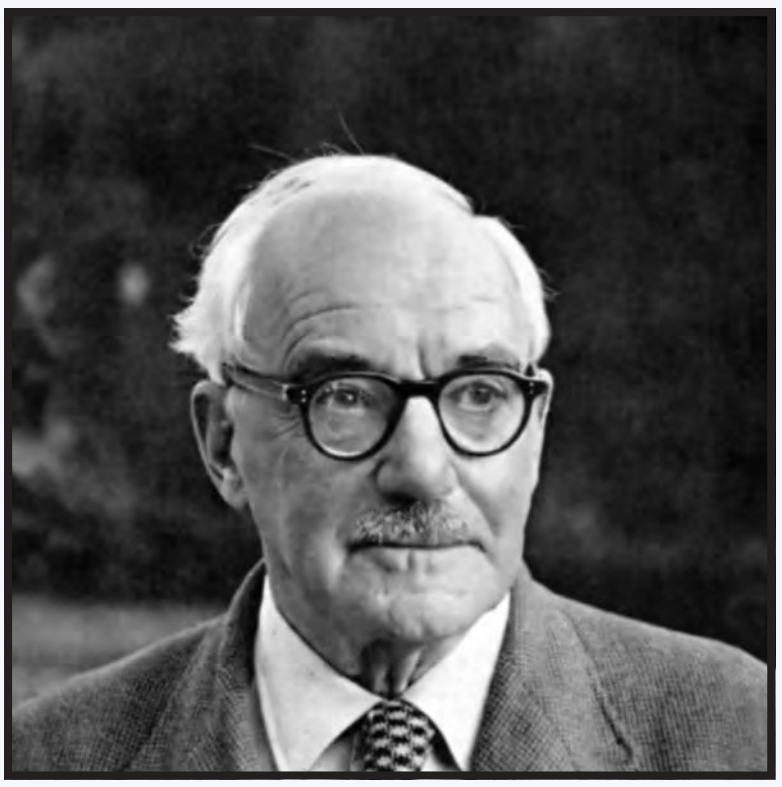
In 1913 Hardy "discovered" the Indian genius Ramanujan and brought him to Trinity.

Hardy collaborated with Littlewood for 35 years, and wrote many excellent books, such as *Pure Mathematics* and *Introduction to Number Theory* jointly with E.M.Wright, read and enjoyed by Michael while at school and in the Army. Littlewood liked *Pure Mathematics* but said that Hardy wrote like a missionary preaching to cannibals.

Hardy was an enthusiastic games player, and inaugurated an annual cricket match in Oxford between the Fellows of New College and the boys of the choir school. As a subsequent Savilian Professor, Michael had to play in these matches.

J. E. Littlewood

Rochester 1885 – Cambridge 1977



The South African who held his own with Hardy.

Fellow of Trinity and Rouse Ball Professor of Mathematics at Cambridge 1928–1950. FRS.

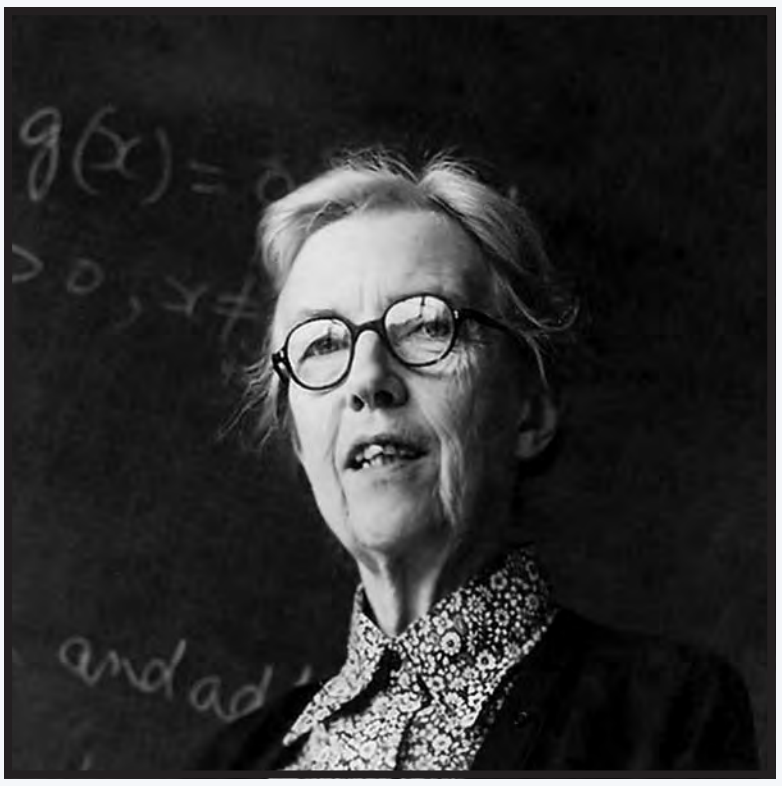
Analyst, and legendary collaborator of Hardy who exchanged letters with him but rarely words. A bon viveur and keen hiker, he survived into his nineties, frequently to be seen walking across the College in his bathrobes. Ran an analysis seminar which Lily attended.

As President of the Trinity Mathematical Society Michael invited Littlewood to give a talk. This had to be late in the evening since Littlewood was known to be at his best after claret. Littlewood had a “niece” who subsequently turned out to be his daughter.

Mary Cartwright

Aynho, Northamptonshire 1900 – Cambridge 1998

First female mathematician to become an FRS.



Student at St. Hugh's College, Oxford 1919–1923. At the time she was only one of five women at Oxford studying mathematics. Oxford Ph.D. 1930. At Cambridge from 1930 onwards.

Honorary FRSE. Sylvester Medal of the Royal Society. Dame of the British Empire.

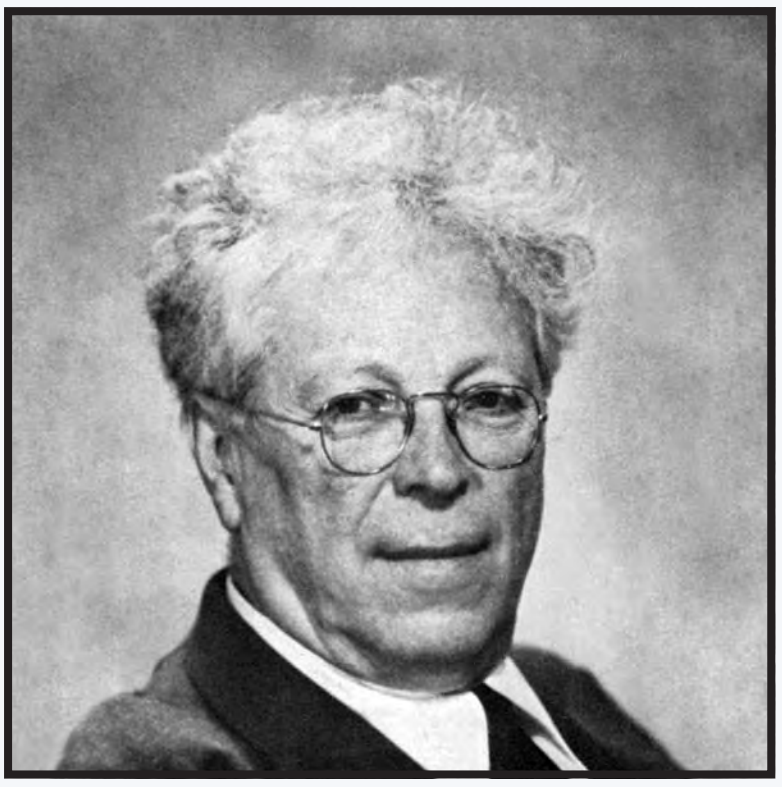
Mentored by Hardy but famous for her collaboration with Littlewood. Their joint paper, arising from the wartime needs of research on radar, is now recognized as pioneering work on chaos in a dynamical system. She also worked on complex variable theory and supervised Lily for her Ph.D. on "prime ends".

Was Mistress of Girton during Lily's time there.

Abram Besicovitch

Berdyansk 1891 – Cambridge 1970

The eccentric Russian who charmed Trinity.



Fellow of Trinity College from 1929 until his death. Rouse Ball Professor in Cambridge from 1950 until 1958. FRS.

Early work with Harald Bohr on almost periodic functions. Later he worked on the Kakeya needle problem (now in fashion) and difficult problems of geometric measure theory. Had one student who made his mark, Peter (E.R.) Reifenberg.

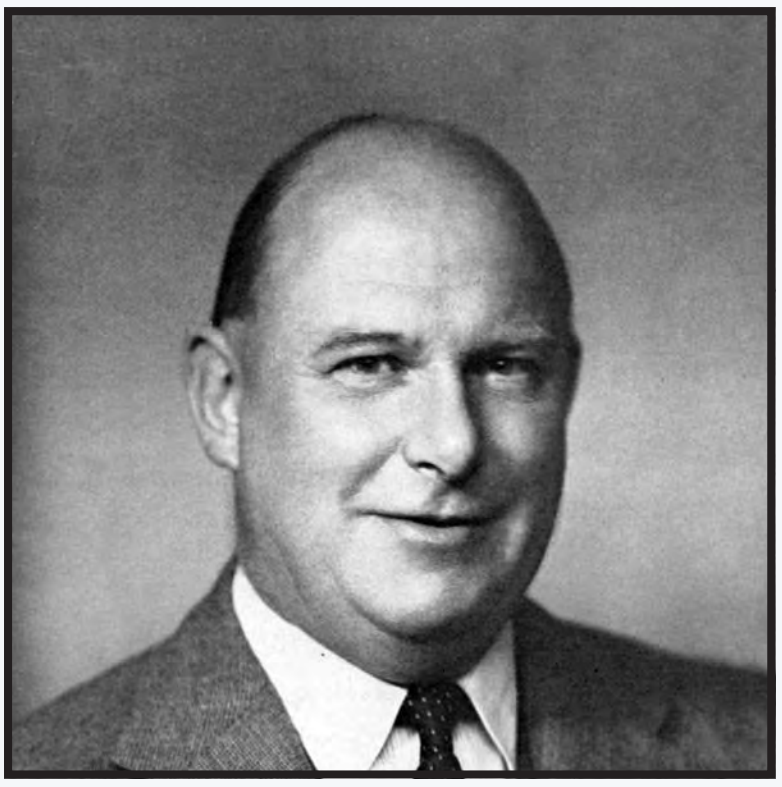
Taught many Trinity students (including Michael) and left a strong impression because of his eccentric personality and Russian accent. Was interviewed by Michael for the undergraduate magazine *Eureka*.

Periodically "Besi" would introduce Trinity mathematicians to a subtle card game said to be played by Russian peasants, but this tended to endanger Tripos results.

William Hodge

Edinburgh 1903 – Cambridge 1975

Creator of Hodge Theory – the foundation stone of modern algebraic geometry.



Undergraduate studies at Edinburgh University and St. John's College, Cambridge. Lecturer at the University of Bristol and subsequently Lowndean Professor of Astronomy and Geometry at Cambridge, 1936–1970. FRS, FRSE.

Hodge's major work, inspired at a distance by Lefschetz, was his theory of harmonic integrals which laid the foundations for future progress in algebraic geometry.

Became Master of Pembroke College, Cambridge and Physical Secretary of the Royal Society. Responsible for bringing the 1958 International Congress of Mathematicians to Edinburgh.

Supervised Michael for his Ph.D. and appointed him as Tutorial Fellow of Pembroke.

John Todd

Liverpool 1908 – Croydon 1994

Famous for the Todd polynomials in algebraic geometry.

Part of the large Cambridge school of algebraic geometers under H.F. Baker, he developed the underlying topological invariants and discovered what are now called the Todd polynomials, which play a key part in the Hirzebruch–Riemann–Roch Theorem. Lecturer and Reader at Cambridge 1937–1973. FRS.

Supervised Michael as an undergraduate and oversaw his first publication. Todd was a virtuoso algebraist and put his skills to good use in a joint paper with Michael. Despite teaching Trinity undergraduates for many years Todd was never elected a Fellow of the College, being considered socially gauche. Late in life he became a Fellow of Downing College, where he blossomed.

Harold & Bertha Jeffreys

Fatfield 1891 – Cambridge 1989 / Northampton 1903 – Cambridge 1999

A famous Cambridge mathematical pair.

Harold was Plumian Professor of Astronomy at Cambridge, having made great contributions both to Bayesian probability and geophysics. FRS. Honorary FRSE.

Bertha studied quantum mechanics under Max Born and Werner Heisenberg at Göttingen in 1925–27. She was for many years Director of Studies in Mathematics at Girton College and one of Lily's teachers.

Harold and Bertha wrote the extremely influential textbook *Methods of Mathematical Physics*, universally known simply as "J&J".

Harold was a common Cambridge sight on his bicycle until his last years. He always looked the same age (around 60).

Henry Whitehead

Madras 1904 – Princeton 1960

Farmer and cricketer who was also a famous topologist.

Undergraduate at Oxford. Studied with Veblen in Princeton on the foundations of differential geometry. Waynflete Professor at Oxford 1947–1960. FRS.

Whitehead founded a substantial school of topology at Oxford. A pioneer in homotopy theory, he was one of the leading figures of his time.

During the second World War, he worked as a codebreaker at Bletchley Park.

Nephew of the famous philosopher A.N. Whitehead (collaborator of Bertrand Russell) he inherited a herd of cows and set himself up as a gentleman farmer outside Oxford. An enthusiastic cricketer, he enjoyed the traditional pint after a keen match. He also liked to demonstrate how to remove your waistcoat while keeping your jacket on.

Frank Adams

Woolwich 1931 – Huntingdon 1989

The climbing topologist with a powerful algebraic punch.

Exact contemporary of Michael at Trinity.

Ph.D student of Shaun Wylie.

Fellow of Trinity, then Fielden Professor at Manchester (1964–1970) and Lowndean Professor of Astronomy and Geometry at Cambridge (1970–1989). FRS.

Leading homotopy theorist of his time. Developed the Adams spectral sequence, and solved outstanding famous problems such as finding the maximum number of independent vector fields on spheres of any dimension, and the Hopf invariant 1 problem.

Adams was killed in a car accident in 1989; the brass memorial plaque to him in the Trinity College Chapel states: *Vir recti iustique tenacissimus aspera montium loca superare nodosque rei topologicae difficiles expedire pari studio pari diligentia gaudebat.* Translation: He was devoted to the truth and to justice. With equal zeal and perseverance he delighted in overcoming the challenges of rock-climbing and in untangling difficult problems in topology.

Ian Macdonald

London 1928 –

An algebraic virtuoso and a master of beautiful formulae.

Undergraduate at Trinity College, Cambridge 1949–1952, where he was an exact contemporary of Michael Atiyah, James Mackay and Frank Adams. Spent five years in the civil service before returning to mathematics as a lecturer at Manchester University.

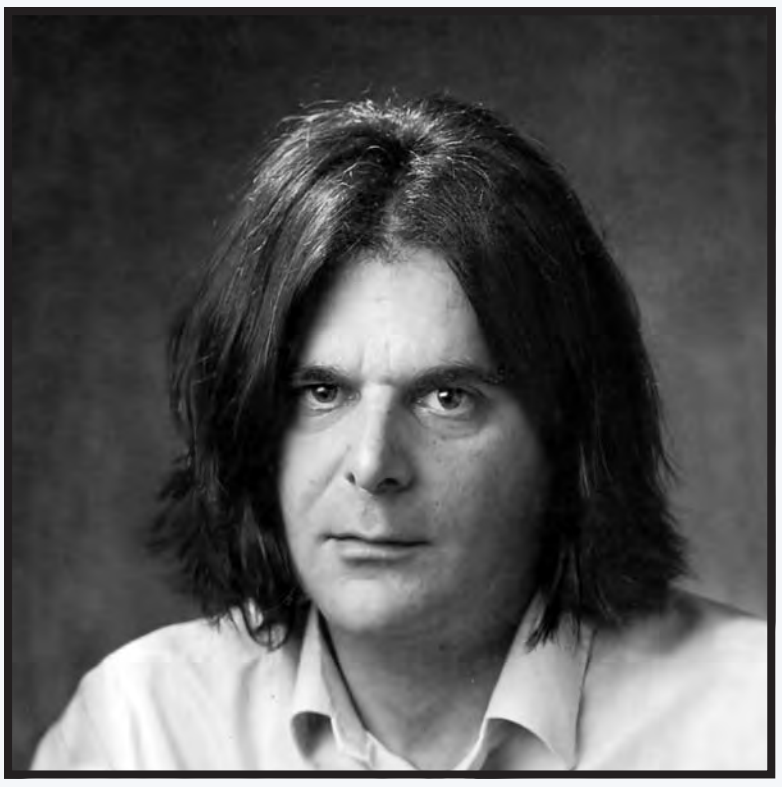
Fellow of Magdalen College, Oxford, then Professor at Queen Mary College, London. FRS.

Famous for discovering many remarkable identities which are now understood as extending the theory of Lie groups to the case of the infinite-dimensional loop groups. Wrote influential book on symmetric functions. Co-author with Michael of the popular textbook *Commutative Algebra*.

The lecture notes he took as a student were examples of beautiful calligraphy, in Indian ink on high class paper – irrespective of the lecturer's messy presentation.

Graeme Segal

Sydney 1941 –



The most distinguished of Michael's many Australian students.

Studied at Sydney, Cambridge and Oxford Universities. Ph.D. supervised by Hodge and Michael.

Fellow of St. Catherine's College Oxford 1969–1990, Lowndean Professor at Cambridge 1990–1999, Fellow of All Souls Oxford 1999–2009. FRS.

Worked on equivariant K–theory, loop groups and homotopy theory. Formulated the "Segal Conjecture" for the Burnside ring of a finite group. Wrote many joint papers with Michael on K–theory.

Has a deep interest in theoretical physics. His ideas on conformal field theory have been very influential.

President of the London Mathematical Society 2011–2013.

Nigel Hitchin

Holbrook 1946 –

A geometer productive with ideas and with graduate students.

Undergraduate at Jesus College, Oxford 1965–1968, Fellow of St. Catherine's College, Oxford 1979–1990, Professor at Warwick 1990–1994, Rouse Ball Professor, Cambridge 1994–1997, Savilian Professor, Oxford 1997–. FRS.

Worked closely with Michael, and was his assistant at the Institute for Advanced Study 1971–1973.

Made many contributions to differential geometry, particularly via twistor theory. Influential papers on gravitational instantons, Higgs bundles and generalized complex structure. Wrote a book with Michael on moduli spaces of magnetic monopoles.

Had many students: some, like Donaldson and Kronheimer, shared with Michael. President of the London Mathematical Society 1994–1996.

Simon Donaldson

Cambridge 1957 –

The man who opened up four dimensions.

Pembroke College, Cambridge, graduate student at Oxford under Nigel Hitchin and then Michael. He applied instanton moduli spaces to make phenomenal discoveries about four-dimensional manifolds. Opened up a whole new field which continues to be very fruitful and has deep connections with physics. Donaldson also extended the classical Lefschetz results on pencils in algebraic geometry to a symplectic context.

Fellow of All Souls College, Oxford 1983–1985, thenWallis Professor at Oxford 1985–1998. FRS. Since 1998 Royal Society Research Professor at Imperial College, London.

Fields Medal 1986

Frances Kirwan

Oxford 1959 –

A role model for female mathematicians.

Clare College, Cambridge and Magdalen College, Oxford. Obtained a Ph.D in 1983 in two years (under Michael) then Junior Fellow at Harvard. Since 1985 Fellow of Balliol College. University Professor of Mathematics at Oxford since 1996. FRS.

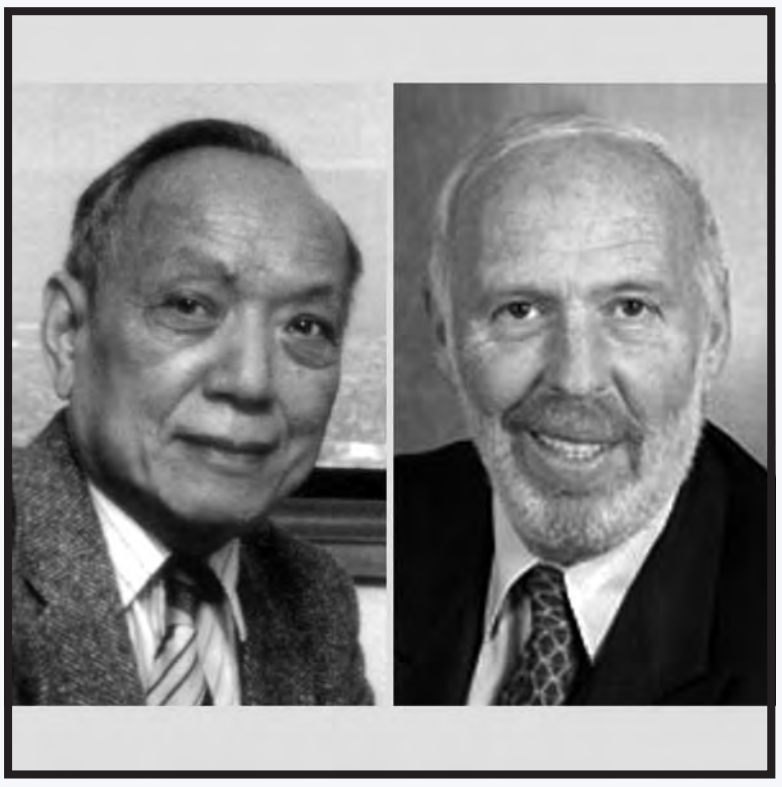
Worked on geometric invariant theory and in particular on moduli spaces of bundles on algebraic curves. President of the London Mathematical Society 2004–2006.

Married Michael Pennington, another of Michael's students, now in finance. She has been prominent in encouraging women in mathematics.

Shiing-Shen Chern
James Simons

Jiaxing 1911 – Tianjin 2004 / Newton, Massachussetts 1938 –

A productive partnership for geometry and finance.



Chern: Nankai University, Chicago, Berkeley. Director of MSRI Berkeley, Director of Mathematical Institute Nankai (now named the Chern Institute). Foreign Member RS.

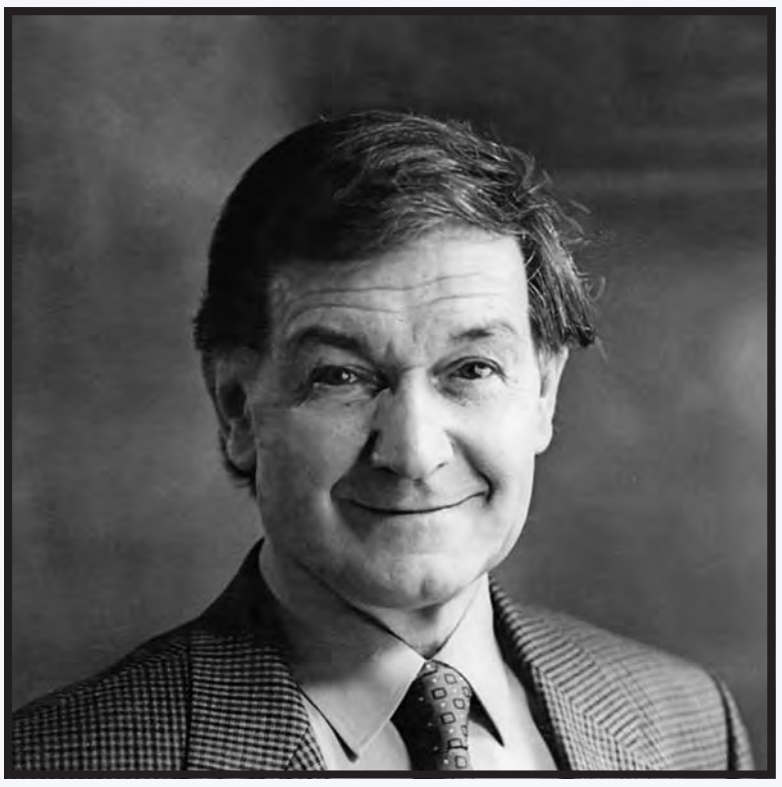
Many contributions to
differential geometry, but famous for his Chern classes and for his work with Simons.

Simons: studied with Chern and developed together what is now called the Chern–Simons action, much used in physics and at the basis of the knot invariants discovered by Vaughan Jones. Professor at Princeton then at Stony Brook.

In 1982 Simons set up the hedge fund investment company Renaissance Technologies, enabling him to become a generous philanthropist through the Simons Foundation. This has supported the Institute for Advanced Study, Princeton, MSRI, IHES and established the Simons Center for Geometry and Physics at Stony Brook. It also supports an extensive fellowship programme.

Roger Penrose

Colchester 1931 –



Cosmologist, original thinker and writer.

Studied at University College, London, then did graduate studies under Todd in Cambridge, as a contemporary of Michael.

Lecturer at Bedford College London 1956–1957. Reader at Birkbeck College London 1964–1973. Rouse Ball Professor at Oxford, 1973–1998. OM, FRS.

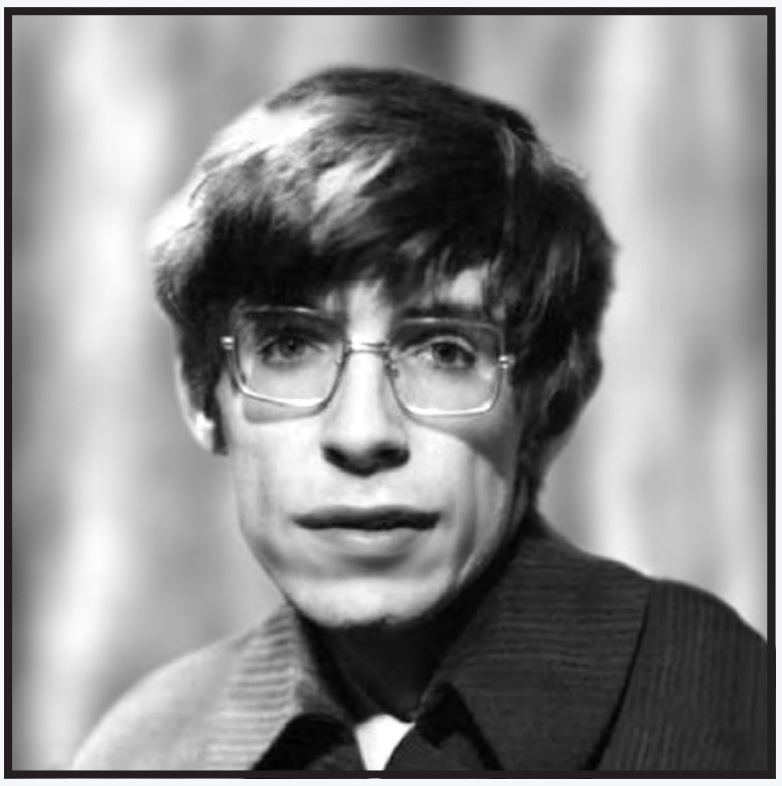
Moved from algebraic geometry into theoretical physics. Did important work with Hawking on black holes and subsequently developed twistor theory. This found significant applications in algebraic and differential geometry. As a side-line he produced non-periodic tilings of the plane, which are relevant to quasi-crystals.

Prolific author of books on physics and consciousness for the general public.

Stephen Hawking

Oxford 1942 –

Probably the best known physicist of our time.



Studied under Dennis Sciama in Cambridge.

Lucasian Professor at Cambridge 1979–2009. FRS.

Together with Roger Penrose he worked on black holes as classical solutions of the Einstein equations. His most famous discovery was that although no information could emerge classically from black holes they did produce quantum radiation.

Hawking suffers from a degenerative neurological illness which confines him to a wheelchair, and only enables him to speak via a computer.

His book *A Brief History of Time* became a world-wide best-seller and was translated into many languages.

Friedrich Hirzebruch

Hamm 1927 – Bonn 2012

The biggest figure in mathematics in post-war Germany.

Studied in Münster under Heinrich Behnke and in Zürich under Heinz Hopf. Professor at Princeton University and then at University of Bonn. Founder and first director of the Max Planck Institute for Mathematics at Bonn. Foreign Member RS. Honorary FRSE.

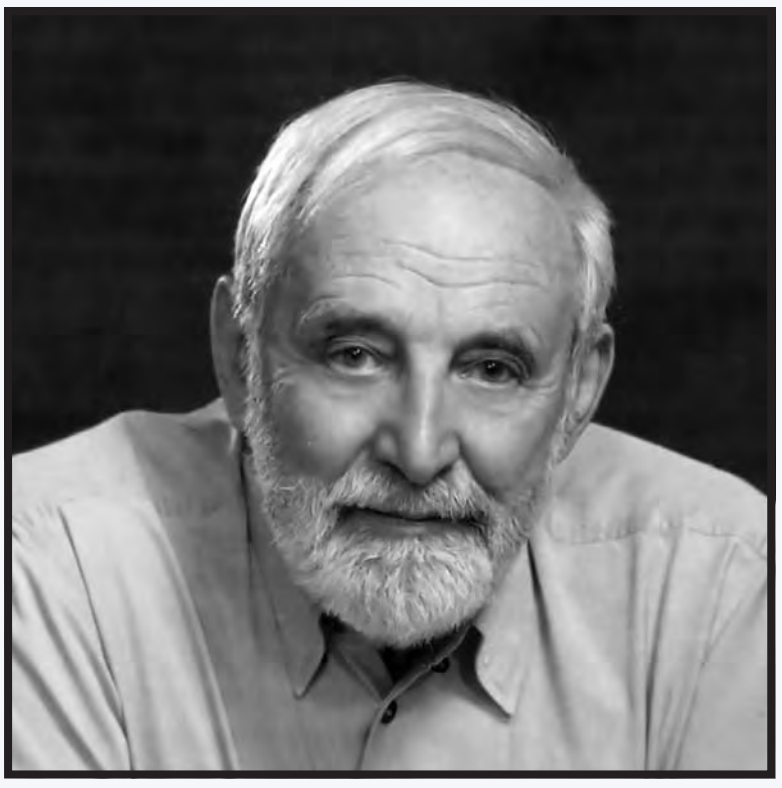
Contributed widely to many aspects of geometry, including the theory of Chern classes. He proved the explicit formula for the signature theorem of manifolds given by his L-genus. Famous for his extension of the classical Riemann-Roch theorem. Developed topological K-theory with Michael and made (with Zagier) extensive studies relating topology to number theory.

As initiator of the famous Bonn Arbeitstagung he had a major influence on mathematics in his time. Played a unique role in German mathematics and was a member of the order *Pour le Mérite,* the German equivalent of the Order of Merit.

Raoul Bott

Budapest 1923 – California 2005

A charismatic figure, everyone's favourite geometer.



Emigrated from Hungary to England 1938, and then to Canada 1940. Graduated in electrical engineering at McGill University 1945. Studied at Carnegie Institute of Technology under J.L. Synge. Professor first at University of Michigan and then at Harvard.

Together with Hans Samelson he applied Morse theory to Lie groups and later discovered his famous periodicity theorems for the homotopy of the classical groups. Subsequently collaborated at length with Michael on index theory, and established the Lefschetz fixed point theorem for elliptic complexes, and (with Patodi) the local index formula.

A larger than life personality, he had many students, including two Fields Medallists (Smale and Quillen).

Vijay Patodi

Guna, India 1945 – Bombay 1976

A brilliant and original young Indian who died tragically early.

He received his Ph.D. in 1971 from the University of Bombay under the guidance of M. S. Narasimhan and S. Ramanan at the Tata Institute of Fundamental Research in Bombay.

From 1971 until 1973 Patodi was at the Institute for Advanced Study in Princeton, where he worked with Atiyah, Bott and Singer. Wrote joint papers with all of them and in particular on spectral asymmetry in relation to the index problem for manifolds with boundary.

Patodi returned to the Tata Institute in Bombay but developed serious medical problems which led to his untimely death at the early age of 32. His career had parallels with that of Ramanujan.

Michael Atiyah
Isadore Singer

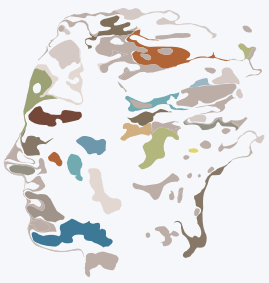
London 1929 – / Detroit 1924 –

Shared the Abel Prize in 2004.

Worked together on index theory, culminating in the Atiyah–Singer Index Theorem. The work was published in many papers and over several years. It has found unexpected applications in theoretical physics and opened the door to continuing connections between geometry and physics.

Awarded the second Abel Prize, presented by King Harald of Norway (above). The Prize was founded in 2002, and now rivals the Fields Medal, but without the under 40 age restriction.

In 2009 Singer attended Michael's 80th birthday conference in Edinburgh and, a few months later, Michael reciprocated by attending Singer's 85th birthday conference at MIT.



Abel Prize 2004

Michael and Lily Atiyah Gallery

Credits

The portraits in this gallery have been produced with the assistance and permission of many different bodies, listed below.

Niedersächsische Staats- und Universitätsbibliothek Göttingen:

Gauss, **Hilbert**, **Klein**, **Noether**, **Riemann**

Royal Society Biographical Memoirs:

Aitken (14, 1968), **Adams** (36, 1990), **Besicovitch** (17, 1971), **Bott** (53, 2007) **Cartan, E.** (8, 1952), **Cartwright** (46, 2000), **Dirac** (32, 1986), **Erdélyi** (25, 1979), **Hardy** (6, 1949), **Hodge** (22, 1976), **Kemmer** (57, 2011), **Leray** (52, 2006), **Lefschetz** (19, 1973), **Littlewood** (24, 1978), **Todd** (42, 1996), **Turing** (1, 1955), **Whittaker** (2, 1956), **Whitehead** (7, 1961)

London Mathematical Society:

Hitchin, Penrose, Segal, UK Fields Medallists (Atiyah, Baker, Borcherds, Donaldson, Gowers, Quillen, Roth)

Other sources:

Abel – Norwegian 500 Krone banknote
Arnold – Moscow Center for Continuing Education
Birch – Brian Birch
Bott – Candace Bott (daughter)
Al-Khwarizmi – from a Soviet postage stamp
Archimedes – image taken from the Fields Medal
Atiyah, M. / Atiyah, L. – Michael Atiyah
Atiyah, M. / Singer – The Norwegian Academy of Science and Letters
Cartan, H. – Société Mathématique de France
Cartwright – South Wales Evening Post
Chern – Chern Institute
Chisholm / Young – Sylvia Wiegand (granddaughter)
Connes – Alain Connes
Donaldson – Simon Donaldson
Edge – Edinburgh Mathematical Society 41 (1998)
Einstein – Public domain (Ferdinand Schmutzer)
Euler – Frontispiece from the Collected Works
Fawcett – Newnham College, Cambridge
Galois – Public domain
Gelfand – Michael Atiyah
Gårding – Paul Halmos
Gödel – Alfred Eisenstaedt
Grothendieck – Public domain
Hamilton – Royal Irish Academy
Hawking – Edward Leigh
Hirzebruch – G. W. Bachert
Hörmander – Lund University
Jeffreys – The Mistress and Fellows, Girton College, Cambridge
Kirwan – Andrew Ranicki
Kovalevskaya – Public domain
Lie – Public domain (Ludwik Szacinski)
Mackay – Estate of Alexander Goudie
Macdonald – American Mathematical Society
McDuff / Milnor – Anna McDuff
von Neumann – Marina von Neumann Whitman (daughter)
Newton – Trinity College, Cambridge
Novikov – Sergei Novikov
Patodi – Frontispiece of Collected Papers
Penrose – Jerry Bauer
Poincaré – H. Manuel
Schlapp – Edinburgh Mathematical Society 35 (1992)
Serre – Winfried Scharlau
Simons – Simons Foundation
Somerville – Somerville College, Oxford
Swinnerton-Dyer – Cambridge University
Weil – Sylvie Weil (daughter)
Weyl – ETH Bildarchiv
Witten – Institute for Advanced Study, Princeton

The gallery was designed and constructed for Sir Michael Atiyah and the School of Mathematics at the University of Edinburgh by Peter Reid and Mark Reynolds from the College of Science and Engineering's FUSION team, and Professor Andrew Ranicki FRSE from the School of Mathematics.

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April 2013

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