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Michael Atiyah, Mathematician in Newton's Footsteps, Dies at 89

By Julie Rehmeyer

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Michael Atiyah, a British mathematician who united mathematics and physics during the 1960s in a way not seen since the days of Isaac Newton, died on Friday. He was 89.

The Royal Society in London, of which he was president in the 1990s, confirmed the death but gave no details. Dr. Atiyah, who was retired, had been an honorary professor in the School of Mathematics at the University of Edinburgh.

Dr. Atiyah, who spent many years at Oxford and Cambridge universities, revealed an unforeseen connection between mathematics and physics through a theorem he proved in collaboration with Isadore Singer, one of the most important mathematicians of the last half of the 20th century.

His work with Dr. Singer, of the Massachusetts Institute of Technology, led to the flowering of string theory and gauge theory as ways to understand the structure and dynamics of the universe, and has provided powerful tools for both mathematicians and theoretical physicists.

"He has heavily influenced the whole contemporary development of how math and physics have interacted," the physicist Edward Witten, of the Institute for Advanced Study in Princeton, N.J., said in an interview for this obituary in 2015.

Dr. Atiyah spent a good part of his career at the institute.

Newton and his contemporary Gottfried Wilhelm von Leibniz established the first major bridge between mathematics and physics by creating calculus and showing that it could describe physical attributes like velocity and acceleration. Dr. Atiyah and Dr. Singer discovered a similar but far more subtle connection.

Dr. Atiyah was also active among scientists in promoting peace. From 1997 to 2002 he was president of the Pugwash Conferences on Science and World Affairs, an organization that brings together scholars and public figures with the aim of curtailing armed conflicts around the world. (It takes its name from the site of its first meeting, in 1957, in the village of Pugwash, Nova Scotia. In 1995, the group and its founder, Joseph Rotblat, were awarded the Nobel Peace Prize.)

During his tenure at Pugwash Dr. Atiyah worked to defuse a nuclear standoff between India and Pakistan and to reduce tensions in the Middle East. Earlier, as president of the Royal Society (1990-1995), he publicly criticized the British nuclear program, arguing that it was a dangerous waste of scientific resources.

Dr. Atiyah received the two highest honors in mathematics: the Fields Medal, in 1966, and the Abel Prize, in 2004. Several colleagues of his have received Fields Medals for discoveries building on his work as well. He was knighted in 1983 and made a grand officer of the French Legion of Honor in 2011.

Dr. Atiyah, a relatively short and jolly man who had gone mostly bald as a young man, was renowned for his energy and a commanding voice, most notably in his lectures.

“He could hypnotize you into believing you understood something,” said Graeme Segal, a former student of his and now an emeritus fellow in mathematics at Oxford. “He would make you think that everything was possible, and there were all these wonderful ideas, and you could put them together and do something with them.”

Michael Francis Atiyah was born on April 22, 1929, in London to the former Jean Levens, a Scot, and Edward Atiyah, a Lebanese. His parents had met while his father was a student at Oxford. The family moved to Sudan, where Edward Atiyah was a diplomatic liaison officer for the British colonial authorities.

Mr. Atiyah in 2008. “He would make you think that everything was possible,” said Graeme Segal, a former student. Basso Cannarsa/Agence Opale, via Alamy

Even with the father's Arab ancestry and dedication to the Arab people, the Atiyah family identified culturally as British. Michael Atiyah spoke English at home and at school, and Arabic with extended family. (Written Arabic was the only class he ever failed, he said.)

At 12, he went to the Victoria School in Cairo, a well-known English boarding school, and at 16 he and his family moved back to England. At Cambridge, Dr. Atiyah did his undergraduate and graduate studies at Trinity College, where he received his doctorate in 1955. That same year he married Lily Brown, who was also a mathematician. She died at 90 in March in Edinburgh. Dr. Atiyah was master of Trinity College from 1990 to 1997.

Dr. Atiyah's early work was in topology, a field of mathematics that studies shape, including that of mathematical objects with many more than three dimensions. Though such objects can't be visualized, topology provides tools to figure out how many holes they have and how different parts of an object are connected to one another. Topology considers shapes to be elastic and malleable — able to be stretched or squished without their fundamental nature being changed, as long as no new holes are punched and no pieces are newly joined together. Working with the German mathematician Friedrich Hirzebruch, Dr. Atiyah developed a topological tool called K-theory.

Dr. Atiyah teamed up with Dr. Singer in the early 1960s. Dr. Singer is a specialist in mathematical analysis, the study of differential equations, which are used to describe physical phenomena in the language of calculus.

The equations are extremely useful for describing real-world situations, but they have a wicked problem: No one knows how to solve them precisely. Dr. Atiyah and Dr. Singer set out to see if Dr. Atiyah's topological tools might help find the solutions.

Although they couldn't find the exact solutions to any differential equation, they did manage to use topology to reveal the number of solutions such an equation

has. This became their famous Atiyah-Singer Index Theorem, which they developed into an entire field, called index theory.

“It’s a bit of black magic,” Dr. Atiyah said in 2015, “to figure things out about differential equations even though you can’t solve them.”

But that was just the beginning of the connections that the index theory would make. In the mid-1970s, in the middle of this work, Dr. Atiyah learned something surprising: Physicists had been creating their own, less formal version of index theory in parallel with the mathematicians. They were using it to try to understand quantum field theory.

Dr. Atiyah and Dr. Singer teamed up with the mathematician Raoul Bott and Dr. Witten, who was then barely out of graduate school. The team (and soon many others) used index theory to see how discoveries in mathematics revealed truths about physics, and how physical facts revealed mathematical insights. In the process, they transformed both fields.

“It gives the whole landscape on which theoretical physics is constructed now,” Dr. Atiyah said.

Dr. Atiyah’s survivors include his sons David and Robin and three grandchildren. His eldest son, John, died while mountain climbing in 2002.

Dr. Atiyah continued to influence young mathematicians to the end of his life, and to experiment with his own mathematical ideas. In October, he created a stir when he claimed to have solved the Riemann Hypothesis, one of the most famous unsolved problems in mathematics, but the proof did not hold up.

Dr. Atiyah described himself as an optimist. In 2013 he told an online interviewer: “I believe in new ideas, in progress. It’s faith. I’ve recently been thinking about faith. If you’re a religious person, which I’m not, you believe God created the universe. That’s why it works, and you’re trying to understand God’s works. There are many scientists who work in that framework.

“Scientists, outside of religion, have their own faith,” he went on. “They believe the universe is rational. They’re trying to find the laws of nature. But why are there laws? That’s the article of faith for scientists. It’s not rational. It’s useful. It’s practical. There’s evidence in its favor: The sun does rise every day. But nevertheless, at the end of the day, it’s an article of faith.”

A correction was made on Jan. 11, 2019*: An earlier version of this obituary misstated the year Dr. Atiyah received the Fields Medal, one of the highest honors in mathematics. It was 1966, not 1996.*

When we learn of a mistake, we acknowledge it with a correction. If you spot an error, please let us know at corrections@nytimes.com. Learn more

Ana Fota contributed reporting.

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