

# Ahmed Zewail

## Nobel prizewinning scientist known for his revolutionary work on femtochemistry

**B**efore 1990, all students of chemistry and adjacent sciences were taught that it was impossible to determine the precise atomic rearrangements that occurred during the course of any chemical reaction at the instant when some chemical bonds are ruptured and others formed. The timescale for such events is around femtoseconds, and one femtosecond is a millionth of a billionth of a second.

The major contribution made by Ahmed Zewail, who has died aged 70, was to break through this barrier. At the California Institute of Technology (Caltech), he developed ultrafast lasers that delivered pulses of femtosecond duration, thus making it possible to “photograph” the fundamental process of bond rupture and bond formation. For this outstanding work, he was awarded the Nobel prize for chemistry in 1999.

Bengt Nordén, a member of the Nobel committee, presenting Zewail to the King of Sweden at the prize ceremony, remarked: “Zewail’s use of the fast laser technique can be likened to Galileo’s use of his telescope, which he directed towards everything that lit up the vault of heaven. Zewail tried his femtosecond laser on literally everything that moved in the world of molecules.” The prize

recognised that Zewail had brought about a revolution in chemical science.

In 1991 Zewail embarked on another major venture. He designed a new type of electron microscope – by judicious use of ultrafast laser pulses and the photoelectric effect – in which a stream of individual electrons, repeated on a femtosecond scale, could be used to probe the dynamics of atoms in solids and their surfaces, as well as to interrogate biological materials.

All this he could do over a thousand million times as fast as had been done by electron microscopists hitherto. His so-called 4D electron microscope – three dimensions of space and one of time – is now contributing to advances in physical, biological, medical and engineering science. The Nobel laureate Roger Kornberg described Zewail’s recent book *The 4D Visualization of Matter* (2014) as “a chronicle of an extraordinary journey of invention and discovery”.

Ahmed was born in Damanhur, a town in the Nile Delta, the son of Hassan, a government official, and his wife Rawhia Dar. He liked exploring the hamlets and settlements of his beloved Egypt before embarking as a student of chemistry at the University of Alexandria. He took his bachelor and master’s degrees there and was an instructor at the same university for two years from 1967.

He then joined the group of Professor Robin Hochstrasser at the University of Pennsylvania. For two years, after his PhD in Philadelphia, he worked as an IBM fellow in Charles B Harris’s group at the University of California, Berkeley. In 1976 he was appointed assistant professor of chemical physics at Caltech, where he remained for the rest of his



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career. From 1982 to 1989 he was professor of chemical physics, and in 1995 he was appointed Linus Pauling professor of chemistry and professor of physics, positions he held until his death. From 1996 to 2007 he was the director of the National Science Foundation’s laboratory for molecular sciences at Caltech; and from 2005 onwards the director of the Center for Physical Biology, also at Caltech.

He was the recipient of numerous honours and an honorary doctor of 46 universities – he was one of the few (along with Dmitri Mendeleev, Marie Curie and Michael Faraday) to hold honorary doctorates from both Oxford and

Cambridge. He was a foreign member of the Royal Society and of most other national academies. In 2009 the US president, Barack Obama, appointed Zewail to his Council of Advisors on Science and Technology and in the same year he became the first US science envoy to the Middle East. In 2013, the secretary general of the United Nations, Ban Ki-moon, invited Zewail to join the UN Scientific Advisory Board.

Zewail was passionately concerned for the “have-nots”, especially the millions of children in various parts of the world who receive no education; and he made great efforts to foster education and the establishment of centres of excellence in the Arab world, especially in Egypt. The Zewail City of Science and Technology on the outskirts of Cairo was created in 2000 and its completion demanded a lot of energy on his part. He believed that Zewail City could raise the hopes of his compatriots, just as the creation of the Aswan Dam had done in the 1960s. Zewail was decorated with the Order of the Grand Collar of the Nile, Egypt’s highest state honour. For several years, he played a key role in the L’Oréal/Unesco prize for women in science.

Author of some 600 papers and 14 books (one of which, *4D Electron Microscopy: Imaging in Space and Time*, 2010, I co-authored), Zewail has left a lasting legacy. In the summer of 2009, I spent four weeks with him at Caltech and a week on “holiday” in Yosemite national park. During that frenetic period of work, I grew to learn more about Zewail’s unique qualities.

In addition to his technical virtuosity and the profundity of his intellectual understanding, he had a prodigality of

output and a general celerity of action. His passion for new knowledge was insatiable. To an almost punctilious degree he endeavoured to do things in memorable ways – in his writing, in his lectures and in the elegant illustrations that characterised his scientific papers and books.

Zewail also had a profound sense of history in general, but the history of science in particular. My eurocentric views of who had discovered what were often corrected by Zewail, who frequently reminded me that, for 700 years, the language of science was Arabic.

He pointed out that, in around AD1000, Alhazen had invented the camera obscura, and that this Arab scientist’s *Book of Optics* greatly influenced later European natural philosophers, including Galileo. He also drew to my attention that, in his native city, Alexandria, Hero had invented the principle of the jet engine (long before Frank Whittle); and that Aristarchus had suggested that the Earth circulates the sun some 19 centuries before Copernicus.

In 1991, Zewail enthralled members of the Royal Institution of Great Britain with his scintillating account of his laser femtochemistry work. During the course of it he showed a spectacular image of Akhenaton (the father of monotheism, 14th century BC) and drew attention to “the first known image that depicts that light travels in a straight line”.

He is survived by his wife, Dema (nee Faham), a doctor, whom he married in 1989, and four children, Maha, Amani, Nabeel and Hani.

**John Meurig Thomas**

*Ahmed Hassan Zewail, scientist, born 26 February 1946; died 2 August 2016*