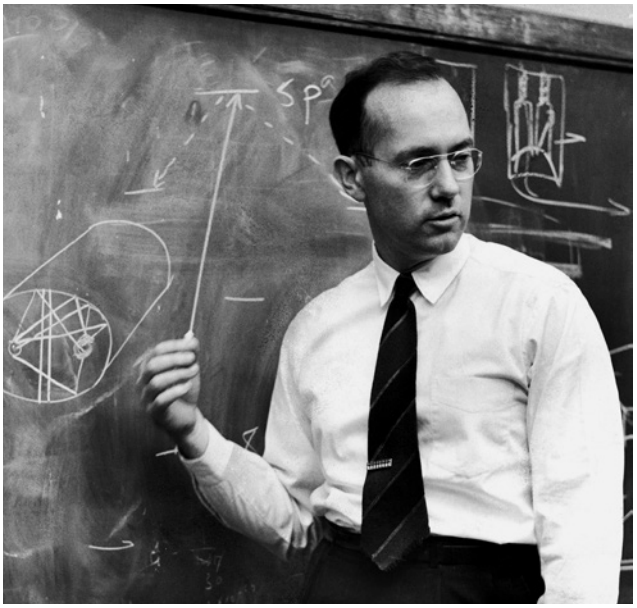
Charles H. Townes

(1915–2015)

Laser co-inventor, astrophysicist and US presidential adviser.



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Charles Hard Townes transformed modern society by helping to invent the laser. He also made crucial contributions to astrophysics and infrared astronomy, and served as a US presidential science adviser.

Townes, who died on 27 January in Oakland, California, was born in Greenville, South Carolina, in 1915. He attended Furman University in Greenville, and in 1935 received undergraduate degrees in both physics and modern languages.

He pursued graduate studies at Duke University in Durham, North Carolina, after being turned down from the California Institute of Technology (Caltech) in Pasadena. On receiving a master's degree in 1936, he again applied to Caltech, and this time was accepted. He completed his PhD in 1939 under physicist William Smythe on the process of isolating certain isotopes of a chemical element from others.

After graduating from Caltech, Townes joined the technical staff of Bell Telephone Laboratories in Murray Hill, New Jersey, where he worked on the development of radar methods as part of the Second World War effort. In 1948, he joined the faculty of Columbia University in New York City. His wartime work on radar had given him crucial knowledge in microwave methods, and in 1951 — while sitting on a park bench in Washington DC — he conceived of the maser (microwave amplification by stimulated emission of radiation).

This technique produces and amplifies microwave radiation by prompting atoms or molecules to make transitions from a high-energy state to a low-energy state, emitting a photon in the process. Energy is supplied to the maser by an electric discharge or another microwave field. Masers are notable for their high coherence — the emitted molecules within the maser beam oscillate with the same frequency and phase. The behaviour is a result of a chain reaction in which the emission from one molecule triggers that of its neighbours.

Townes and his group successfully demonstrated the maser in the laboratory in 1954 using ammonia gas. In 1958, along with Arthur Schawlow, his brother-in-law and a future Nobel prizewinner, Townes published a description of how to construct a version of the maser using visible light — a laser. Two years later, Theodore Maiman of Hughes Research Laboratories in Malibu, California, designed a functioning laser using an optically excited ruby crystal.

The influence of the laser has been extraordinary, with applications in telecommunications, medicine, law enforcement, the military, astronomy and in everyday life — it is used in just about everything from supermarket scanners to eye surgery. Townes shared the 1964 Nobel Prize in Physics for his work on the maser–laser principle.

In 1961, he left Columbia to become provost at the Massachusetts Institute of Technology (MIT) in Cambridge, Massachusetts. He maintained a small but productive research programme, which largely concentrated on lasers. He and his colleagues made measurements of the extremely narrow range of wavelengths associated with laser light, known as the Schawlow–Townes linewidth. (Its properties had previously been described theoretically by the pair.) Townes and his co-workers also began to explore nonlinear optics, discovering among other things a type of light scattering called stimulated Brillouin scattering.

In 1967, Townes moved to the University of California, Berkeley, where he spent the rest of his career. Here, he turned his attention to astrophysics, developing instrumentation for astronomy based on techniques drawn from the field of quantum electronics.

A breakthrough during this period was his discovery of water and ammonia molecules in interstellar clouds — accumulations of gas, plasma and dust in the interstellar medium. Astrophysicists knew that such clouds existed, but were surprised to learn that complex molecules, including those associated with life, could exist in the interstellar medium.

Townes also developed techniques for infrared astronomy. Infrared light penetrates much farther than visible light into cosmic dust clouds, which are intimately connected with the formation of stars. With his students, he probed the centre of our Galaxy, and obtained evidence for the presence of a supermassive black hole and measured its mass. He also monitored the diameter of the red-giant star Betelgeuse and made the remarkable discovery that the measured diameter decreased by 15% over a mere 15 years.

Townes was an adviser to US presidents Dwight D. Eisenhower, John F. Kennedy and Richard Nixon. Among other committees, he chaired the advisory panel for the first human landing on the Moon.

Townes firmly believed that religious faith was not incompatible with scientific exploration of the cosmos, and he was respectful of all religions. He argued for the "convergence of science and religion" — in his view, although each used very different methods, science and religion were similarly motivated by a desire to understand the mysteries of existence.

As my teacher, mentor, colleague and friend, Professor Townes had an enormous impact on my life. He was a kind and generous man, and gave much of himself as both a policy adviser and a teacher. ■

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