Obituary

Lyman Spitzer Jr (1914–97)

Astrophysicist and founder of controlled nuclear fusion research

Lyman Spitzer, who died on 31 March, shaped four different fields of science. His theoretical work on star clusters, interstellar matter and laboratory plasmas is classic. He proposed, helped to design and nurtured the construction of the Hubble Space Telescope. And he proposed a method to control thermonuclear fusion for energy production in a magnetic field, and led a pioneering effort to do so at Princeton University.

Spitzer was born in Toledo, Ohio, the son of a businessman. At Yale he was drawn to physics, and went to Cambridge University to study astrophysics. Later, at Princeton, he studied with Henry Norris Russell, then the dean of American astronomy, and while a postdoctoral fellow at Harvard in 1938–39, he met the rising young astrophysicist Martin Schwarzschild* and they became lifelong close friends.

Spitzer undertook underwater sound research for the Navy in the Second World War, after which he returned briefly to Yale. It was there that he received the offer, in 1947, to succeed Russell at Princeton. Recruiting Schwarzschild as a colleague, he remained at Princeton as director of the observatory until 1979, and as professor until 1982.

In the 1940s, convinced that stars must be forming even today from the clouds of gas and dust that had been observed in interstellar space, Spitzer resolved to understand how. He conceived of an ultraviolet telescope in orbit, which could measure the spectra of atoms and molecules in interstellar space. In parallel, he worked on the theory of the heating and cooling of interstellar gases, and their response to the pressure of hot regions near luminous stars. His investigations established the study of interstellar matter as an independent and rich discipline, summarized in his books *Diffuse Matter in Space* (Wiley, New York, 1968) and *Physical Processes in the Interstellar Medium* (Wiley, New York, 1978).

His proposal for an orbiting telescope to study interstellar material was finally achieved with the launch of the Copernicus satellite in 1972. When a pre-launch test of the focusing mechanism revealed a failure in a crucial component, Spitzer saved the mission by calculating — on the night of the scheduled launch — the focus corrections due to the bending of the support-structure on Earth and the refraction caused by a beam of hot air present in the test environment.

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The Copernicus mission showed that much of the matter in space is in the previously unobserved form of hydrogen molecules. It also showed that most of the heavy elements are bound up in interstellar dust grains, and that one component of the medium had the unexpectedly high temperature of about a million degrees — unexpected, that is, by those who had not read Spitzer's prediction in 1956 of a hot gaseous corona of the galaxy, analogous to that of the Sun. Finally, deuterium atoms were observed for the first time in interstellar space, with an abundance that implies that we are living in an open Universe — unless there is a huge amount of dark matter in space.

Spitzer, together with H. Alfvén and a few other visionary pioneers, established the theoretical foundations of plasma physics in the 1950s. Recognizing the importance of the thermal, electrical and mechanical transport coefficients in a fully ionized gas, Spitzer made the initial calculations of their values, and also the first computations of containment, resistive heating and diffusion losses for a plasma confined in a torus. (The electrical conductivity of a fully ionized gas is still called the Spitzer conductivity.) This work was summarized in his book *Physics of Fully Ionized Gases* (Wiley, New York, 1962).

In 1951, Spitzer proposed to the Atomic Energy Commission the building of a reactor, which he called a 'stellarator', that would be "designed to obtain power from the thermonuclear reactions between deuterium and either deuterium or tritium". The idea came to him on a ski slope. Until 1967 he directed the resulting programme, Project Matterhorn (later the Princeton Plasma Physics Laboratory), and steady progress was made towards the goal of controlled thermonuclear fusion.

In stellar dynamics, Spitzer helped show how the process of 'relaxation' causes a stellar system to inexorably approach a singular state — that is, with an infinite central density (Spitzer, L. *Dynamical Evolution of Globular Clusters* (Princeton Univ. Press, Princeton, NJ, 1987)).

Spitzer's seminal contributions to space astronomy are known to schoolchildren and curious adults throughout the world. In 1946, he proposed the development of large space telescopes in a report called *Astronomical Advantages of an Extra-Terrestrial Observatory*. He outlined the advantages to be gained from greater angular resolution (overcoming the 'seeing' problems caused by the turbulent atmosphere), from the increased wavelength coverage available, and from the stability of a low-gravity environment. These goals have guided generations of space scientists and engineers, and have led to a succession of revolutionary discoveries made in space.

The large space telescope that Spitzer proposed in 1946, eventually called the Hubble Space Telescope, was launched in 1990, with Spitzer and his family observing the event. In the years between 1946 and 1990, and indeed afterwards, Spitzer provided gentle but perceptive scientific, technical and political guidance that helped lead to the extraordinary successes of the Hubble Telescope. The modest and somewhat humorous way he regarded his own eminence is typified by a remark he once made to Bahcall in the 1970s during one of their innumerable trips in support of what was to become the Hubble Space Telescope: "You know, all the objectives of this trip would be fulfilled and much effort and money would be saved if they would just allow us, instead of appearing directly, to send wax images of ourselves."

Together with Martin Schwarzschild, Spitzer established in Princeton an enduring cordial atmosphere of mutual support and encouragement for astrophysical research at the highest level. On the day of his death, Spitzer worked a full day in his beloved Peyton Hall, talking enthusiastically to colleagues and making progress on a research paper.

He was admired and loved by all who knew him, non-scientists and scientists alike. He once confessed to one of us that, "I suppose I have at least one serious fault as a scientist: I love to work on big problems". But he not only worked on big problems, he solved them.

George B. Field & John N. Bahcall

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*Martin Schwarzschild died on 10 April. An obituary will appear here shortly.