OBITUARY

Edwin Salpeter (1924–2008)

Multi-talented astrophysicist and public servant.

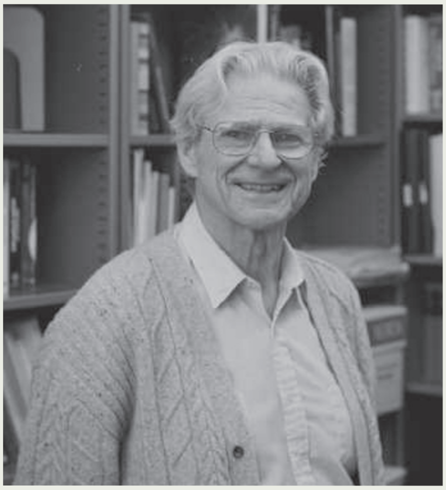
Edwin Ernest Salpeter, who perhaps more than anyone put the physics into astrophysics, died on 26 November 2008 at the age of 83. Among his many accomplishments was figuring out how giant stars burn helium to form carbon in the 'triple-alpha process' (named after the three helium nuclei — alpha particles — that fuse together in the process). Before this discovery, the origin of the elements beyond helium in the periodic table was a mystery.

Salpeter was born on 3 December 1924 in Vienna. In 1939 his family fled to Australia after the Nazi takeover of Austria the previous year. He earned bachelor's and master's degrees at the University of Sydney, and then went to the University of Birmingham, UK, where he earned his doctorate in theoretical physics under the supervision of Rudolf Peierls in 1948. On Peierls' advice, he went to Cornell University in New York to work with fellow theoretical physicist Hans Bethe. He stayed at Cornell for nearly 60 years, and for most of this time occupied the same office assigned to him on his arrival.

Salpeter's most important work from his early years at Cornell led to the Bethe–Salpeter equation, which describes bound states of particles in quantum field theory. But despite his success in theoretical particle physics, Salpeter felt that he did not have the right talents or temperament for the subject. He started to look for a field that, in his own words, "was more controversial, more open-ended and new, where quick was useful and sloppy did not matter too much because it would all change soon anyway". He found it in astrophysics.

In 1939, Bethe published his Nobel-prizewinning work showing how the conversion of hydrogen to helium powers main-sequence stars such as the Sun. He subsequently received much correspondence on the subject. When Salpeter became the most junior of Bethe's postdocs, he was often delegated to respond to this correspondence, sparking his interest in nuclear astrophysics. Beginning in 1951, Salpeter started spending summers at the Kellogg Radiation Laboratory of the California Institute of Technology in Pasadena, working with Bethe's friend, the nuclear experimentalist Willy Fowler.

One of the key problems at the time was working out how elements heavier than helium (^{4}He) are generated in giant stars that have finished fusing hydrogen (^{1}H) to form helium. It was already known that there were no stable nuclei of atomic mass 5 or 8, and so there was no way that nuclei could form through the fusion of ^{1}H and ^{4}He, or through the fusion of two ^{4}He nuclei. Furthermore, the probability of three helium nuclei coming together directly to produce ^{12}C was much too low to be feasible.



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While studying Fowler's experimental data, Salpeter realized that the beryllium nucleus ^{8}Be — the fusion product of two helium nuclei — is actually metastable, and would exist in low concentrations inside red-giant stars. The ^{8}Be nucleus could therefore capture another helium nucleus to make ^{12}C. In 1997, Salpeter won the Royal Swedish Academy of Sciences' Crafoord prize for his discovery of this triple-alpha process. He shared the award with the astronomer Fred Hoyle, who predicted that ^{12}C must have a specific energy-level structure for the rate of the process to correspond to the known temperature of giant stars.

As the new field of nuclear astrophysics burgeoned, a vital question was how much heavy-element enrichment of the interstellar gas occurs when massive stars die. The answer hinges on how many stars of a given mass have been born — the 'initial mass function'. In 1955, Salpeter provided an answer to this crucial question as a simple power-law distribution. This "sloppy" treatment has turned out to be remarkably good, and is still widely used today. Salpeter also showed how electron screening affects both thermonuclear reaction rates in stars and the equation describing the state of dense matter, such as in white dwarfs and planetary interiors.

Whereas Salpeter's early research in astrophysics focused on questions related to stars, in the 1960s he began to study larger-scale problems in astronomy. Some of his most important work concerned the physical chemistry of interstellar gases, especially the condensation of the gases into dust grains, and the pivotal role of these grains as sites of chemical reactions. In the 1970s and 1980s, Salpeter turned towards still-larger scales of galaxies and the Universe, writing crucial papers on dark matter, on the rotational velocities of galaxies, and on the development of galaxy clusters and superclusters.

Salpeter's work in astrophysics was characterized by a combination of 'broad-brush' semi-quantitative estimates, theoretical rigour and, always, attention to unexplained observations — some of which he, his students and his collaborators made themselves. But he often predicted new and unexpected phenomena while thinking about what might become observable. Perhaps his most famous prediction (also made independently by Yakov Zel'dovich in the Soviet Union) was made in 1964, when he predicted that black holes could be detected indirectly by the radiation emitted by gas accreting onto them. This has become a standard method for detecting black holes.

Among his numerous contributions to public service, Salpeter's most important role was in the rigorous technical studies of anti-ballistic missile defence systems, starting in the 1960s. This impressed on him the limitations of such systems, and in the 1980s he participated in an influential study by the American Physical Society that debunked the feasibility of the 'Star Wars' Strategic Defense Initiative. Salpeter sparked some controversy by referring to the "dishonesty without outright lies" that pervaded the anti-ballistic missile defence community, then and now.

Late in his career, Salpeter became increasingly interested in neurobiology, collaborating with his wife, Miriam (Mika, then professor of neurobiology and behaviour at Cornell University), on research into the interactions between nerves and muscle fibres. He also worked on epidemiology and the statistical analysis of clinical trials, both in collaboration with his daughter Shelley Salpeter, a physician, and recently with his grandson, Nicholas Buckley. Of this work, Salpeter said, "My switch to epidemiology was not as radical a change as you might think. Humans coughing tuberculosis mycobacteria into the air at different ages required similar mathematical treatment to stars of different lifetimes disbursing heavy elements into the interstellar medium."

Salpeter trained many students during his magnificent career, including numerous faculty members at leading universities worldwide. And yet, no matter how eminent he became, Salpeter retained his modesty and sense of fun.

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