



*Caltech's newest Nobel Prize-winner proudly displays another award — a sweat shirt awarded him this week by colleagues at Yerkes Observatory in Wisconsin.*

# William A. Fowler

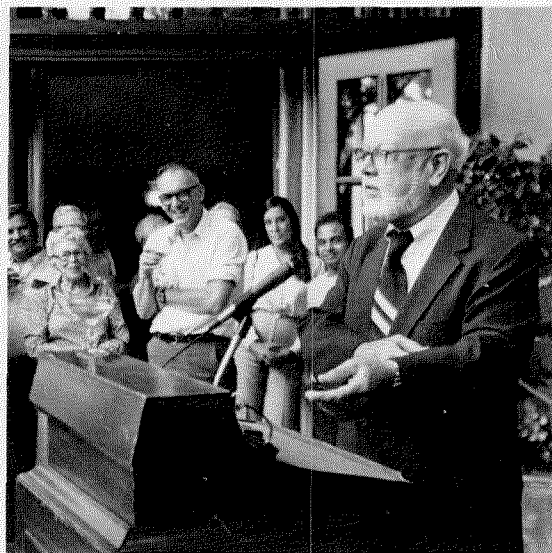
## Nobel Laureate 1983

FOR HIS “theoretical and experimental studies of the nuclear reactions of importance in the formation of the chemical elements in the universe,” William A. Fowler received the Nobel Prize in Physics on October 19. He is considered the driving genius behind the present theory of nucleosynthesis — the origin of the elements and their isotopes mainly in the nuclear furnaces in the core regions of stars.

The importance of Fowler’s contribution lies in his recognition toward the end of the 1930s that “with the growing knowledge and understanding of nuclear physics, it should be possible to make quantitative statements about the

rate at which nuclear reactions occur in stars,” according to his colleague Charles Barnes, professor of physics. “He had the wisdom to foresee that the depth of our theoretical knowledge of nuclear physics would for a very long time remain insufficient to predict the rates of nuclear reactions purely from theory, and so he set up a program with his colleagues to measure accurately the rates of astrophysically important nuclear reactions in the laboratory. This was the beginning of a whole sub-branch of physics that has had an impact on studies of every aspect of stellar evolution and the synthesis of the chemical elements.”

*Champagne and smiles were the order of the day in Dabney Garden on October 21 — with his wife, Ardiane, and at the podium to tell his colleagues (including Provost Rochus Vogt) how it happened.*



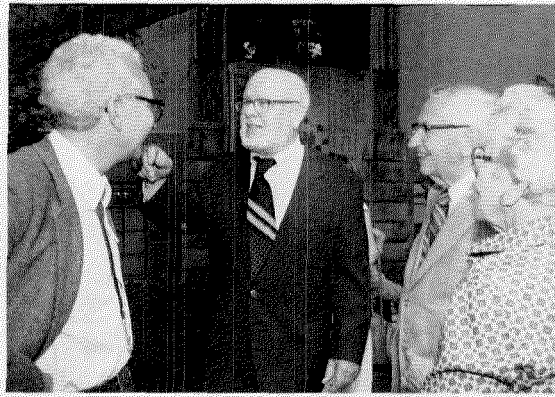
Fowler becomes the 20th Caltech faculty member or alumnus (and the 12th physicist) to win the Nobel Prize, and he is, as Provost Rochus Vogt described him, “the archetype of the Caltech citizen.” His Caltech career spans 50 years. He came here after receiving his bachelor of engineering physics from Ohio State University in 1933, immediately following what Fowler calls “the golden year of classical nuclear physics,” 1932, when Urey discovered deuterium, Chadwick discovered the neutron, Anderson discovered the positron, and Cockcroft and Walton succeeded in producing nuclear reactions far below the Coulomb barrier — work that served as the foundation for the growing body of new ideas of nuclear structure. Fowler joined Charles Lauritsen’s team in the newly established W. K. Kellogg Radiation Laboratory and earned his PhD in physics in 1936 with a dissertation on radioactive elements of low atomic number. Between 1936 and 1946 he climbed the academic ranks from research fellow to full professor and in 1970 was named the first Institute Professor of Physics. He became emeritus in 1982 — a few months after the 50th anniversary of Kellogg Lab.

Fowler identifies his career and work closely with the history of the laboratory and said on receiving the Nobel Prize that “it’s really a prize for Kellogg in my book.” He drew a distinct contrast between his own research and that of Barbara McClintock, who had won the Nobel Prize in Medicine the previous week. McClintock did her work entirely by herself, while Fowler sees himself as part of a group of “many, many people who have made major contributions in the field of astrophysics.” He singled out Barnes and Ralph Kavanagh, also

professor of physics, as current and long-term Kellogg co-workers. He also cited physics professors Ward Whaling and Thomas Tombrello as former colleagues and Steven Koonin, professor of theoretical physics, as one of his more recent collaborators. (The close-knit Kellogg group has also long been known for its parties, and Fowler, affectionately known around campus as “Willy,” is a treasured collaborator in this respect as well.)

Lauritsen’s discovery (in Kellogg) in the 1930s of the radiative capture of protons, as well as other work by Fowler with both Charles and Thomas Lauritsen, set the stage for later studies of nucleosynthesis. And by 1939 it was clear, at least to Fowler, after Hans Bethe and Carl von Weizsäcker’s suggestion that hydrogen was converted to helium by the capture of protons (fusion) in stars, that “problems in the application of nuclear physics to astronomy could only be solved by detailed and accurate measurements of nuclear reaction rates.”

All of this was put on hold during World War II, when the Kellogg Lab, and Fowler with it, was drawn into defense work, first on proximity fuses for anti-aircraft shells and later on the development of rocket ordnance. After the war Kellogg returned to the field of low-energy, light-element nuclear physics — particularly those reactions thought to take place in the hot interiors of stars. Although the first problem attempted was figuring out how hydrogen burns to form helium, by the mid-1950s the question was: How does helium burn? The arrival at Caltech of British astronomer Sir Fred Hoyle in 1953 and of Geoffrey and Margaret Burbidge in 1955 produced a collaboration with Fowler that resulted in 1957 in the



*Faculty-student collaboration led to the sign atop Millikan Library (far left), the faculty being physicist Robert Christy and his wife, Juliana Sackmann, and the students being members of Ruddock House, who managed the logistics of getting it into place.*

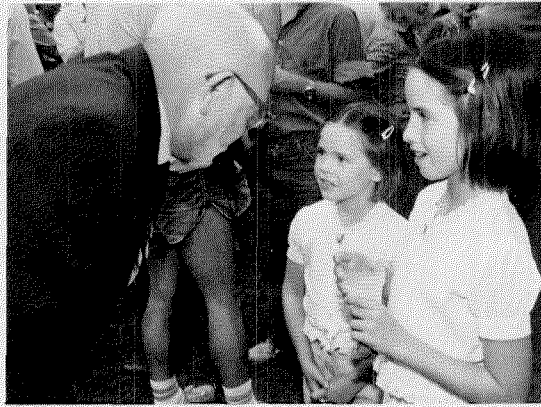


*Two long-time Nobel laureates welcome a new one — top, Murray Gell-Mann, bottom, Richard Feynman. With Gell-Mann and Fowler are President Emeritus and Mrs. DuBridge.*



*They worked together and were happy to toast the results together. On either side of Fowler are Ralph Kavanagh (left) and Charles Barnes, long-term Kellogg collaborators. Jerry Wasserburg's (right) work on meteorites is also strongly identified with the Kellogg group.*

From left to right, two more sets of Fowler friends, Alexa and Ilia Christy; and Evaline Gibbs, who was on the staff at Kellogg for 26 years, and Marty Watson, who replaced her as administrative aide for the lab in 1979.



classic summary paper in the *Review of Modern Physics*, "Synthesis of the Elements in Stars."

In the paper, which was based on the experimental measurements of Barnes, Kavanagh, Whaling, and physicists at other institutions, the four authors detailed the processes by which nuclei could combine to form the elements up to the iron group by successive burning of heavier and heavier nuclei through charged-particle (proton and alpha-particle) reactions. This is currently taking place in stars more evolved than the sun, which is still in the hydrogen-burning stage. Beyond the iron group, however, neutron capture processes have played the major role in the synthesis of the heavier elements and their isotopes. Not all of the elements were formed, therefore, by a single process in a single primordial event, such as the big bang; except for helium, they have mainly been synthesized by a succession of different processes during the evolution of stars. The neutron-capture reactions take place through a *slow* process in red giants (younger stars composed of light elements previously synthesized by other stars) and through a *rapid* process in supernovae. These elements are constantly being ejected into interstellar space, providing building materials for new stars. Some of the matter that has been through this long chain of nuclear processes has been incorporated into the meteorites that are the objects of study of Gerald Wasserburg, the John D. MacArthur Professor of Geology and Geophysics, and long-time collaborator of the Kellogg research group.

Trying to sort out the nuclear physics of what happens in supernovae — how the capture of electrons by protons and other nuclei to form neutrons contributes to the gravitational collapse of the interior of a star and its eventual explosion — still occupies Fowler, who has continued to be active in research in his new

emeritus status. In fact, when the Nobel Prize was announced, he was attending a conference at Yerkes Observatory in Williams Bay, Wisconsin, on "Challenges and Opportunities in Nucleosynthesis in Stars," where he was invited to deliver the opening paper. (He was not actually *at* the conference when the phone call came, but in the shower — when the phone always rings.)

The Caltech physicist shares the 1983 Nobel Prize in Physics with Subrahmanyan Chandrasekhar of the University of Chicago, who has studied stellar structure and stellar evolution in theoretical research with important links to Fowler's work in nuclear astrophysics.

Fowler has always been insistent on the basic nature of his research work, which has also included nuclear cosmochronology, the origin of isotopic anomalies in meteorites, synthesis of helium in the big bang, the emission of neutrinos by the sun, and general relativistic effects in quasar and pulsar models. In 1946, in the laboratory's first proposal to the Office of Research and Innovations (which later became the Office of Naval Research) for Kellogg's postwar funding, it was specifically stated that, "It is also essential that it be clearly understood that these studies are primarily fundamental in nature and that the possibility of applications is of secondary importance."

And again, on receipt of the Nobel Prize, when queried repeatedly about the practical applications of his work, Fowler reiterated that practical applications had never been his principal motivation. "What we're doing is mainly a cultural and intellectual contribution to the sum total of human knowledge, and that's why we do it," he said. "If there happen to turn out to be practical applications, that's fine and dandy. But we think it's important that the human race understands where sunlight comes from." □ — JD