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AWARD OF THE BRUCE GOLD MEDAL TO PROFESSOR FRED HOYLE

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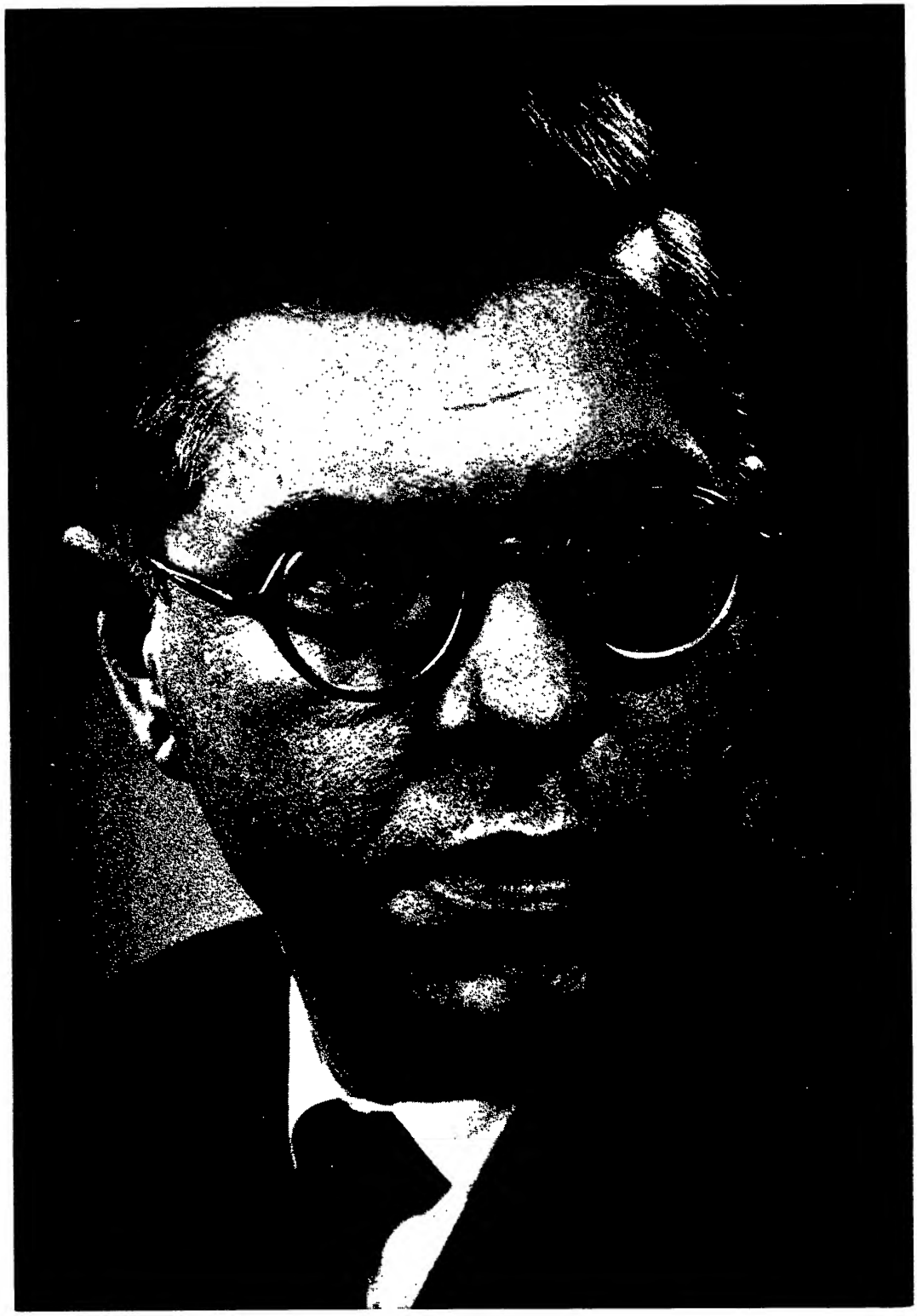
I first met Fred Hoyle when I was still a graduate student at the California Institute of Technology, where he came as a visiting professor in the early 1950's. Hoyle had had a mixed reputation among us students; he was well known for his interest in the steady-state cosmology, and for his popularization of astronomy. We also knew that he had an immensely fertile imagination and many new ideas. Some, if not most, of his ideas were controversial; several of us wondered if perhaps they were not overly speculative. It took very few weeks, however, for Hoyle to win the enthusiastic respect of all of us. He demonstrated a thorough knowledge of physics and astronomy; he is a brilliant lecturer and a wonderful teacher. He is also a warm human being who always found time to talk with students; his enthusiasm about almost everything is extremely contagious. And he did, indeed, turn out to be a man of ideas; he simply is the kind of person that things occur to, during almost any kind of conversation, under almost any circumstance. Of course, his ideas are too numerous for a large fraction to gain general acceptance; and of course many are speculative, but they are always sound in that they are consistent with the physical laws, as we understand them, that describe the universe. It is from such a wealth of ideas, some of which are wrong, others of which are wrong but brilliant, and still others of which are brilliant and right, that scientific progress is made.

In many respects, Fred Hoyle's wrong ideas have been almost as important as his right ones, because they have served to focus



PROFESSOR FRED HOYLE

attention on problems that await solution; and as a result of this delineation of problems many have subsequently been solved. Hoyle's right ideas alone, however, and the work they have inspired both by him and by others, are a far greater contribution than necessary to earn him the highest honor that is bestowed by the Astronomical Society of the Pacific, the award of the Catherine Wolfe Bruce Gold Medal.

Hoyle was born in Yorkshire, England, on June 24, 1915, the son of Benjamin and Mabel Hoyle. He obtained his Master's degree at Emmanuel College, Cambridge University, in 1939. As a student, he was Mayhew Prizeman in mathematics, tripos 1936, and Smith Prizeman in 1938. He married Barbara Clark in December of 1939 and has two children, Geoffrey and Elizabeth Jeanne.

Hoyle has been a Fellow at St. John's College, Cambridge, since 1939. He was a University lecturer in mathematics from 1945 to 1956, and since 1956 has been Plumian Professor of Astronomy. He now heads the new Institute of Theoretical Astronomy at Cambridge, an active center that has attracted top young astronomers from all over the world. He has been a frequent visitor to the United States, and particularly to the California Institute of Technology, and has been listed as a staff member of the Hale Observatories since 1956.

Hoyle was elected to the Royal Society in 1957 and is now Vice President of the Society. He is also a member of the American Academy of Arts and Sciences and has recently been elected Foreign Associate of the National Academy of Sciences. He received the Gold Medal of the Royal Astronomical Society in 1958.

Hoyle's interests are so broad that a discussion of all of his contributions to astronomy is impossible here. At best, we can briefly mention some of the areas where his work has had an important impact. Hoyle's investigations in stellar evolution date back to the early 1940's. With Lyttleton, he investigated the idea that stars might enrich themselves by accretion of material from interstellar space. The accretion idea has since proved wrong, but it was fruitful in that it encouraged further research. In the years from 1942 to 1947, Hoyle and Lyttleton attempted to account theoretically for the mass-luminosity relation of stars in light of what was then known about nuclear energy sources in stars. Their work led them to suggest that heavy elements account for only about one

percent of the mass of stellar material. In 1949 they provided the beginning of an understanding of the evolution of stars to red giants in terms of chemical inhomogeneities. In 1955, Hoyle collaborated with Martin Schwarzschild in their now famous investigation of the evolution of stars of 1.1 to 1.2 solar masses from the main sequence to red giants. They also accounted for the differences in the luminosities of Population I and Population II red giants as being due to differences in chemical composition.

Perhaps Hoyle's most influential contribution has been his pioneering work on nucleogenesis in stars. Hoyle recognized that if heavy elements are to be built up by nuclear reactions in stellar interiors, carbon must have a low-energy excited state—a prediction later confirmed by experiment. The collaboration of Hoyle with Fowler and the Burbidges at the California Institute of Technology led to the exhaustive and classic paper in 1957 that demonstrated the possibility that the heavy elements in the universe can have been produced by nucleogenesis in stellar interiors, and that in any case an enrichment of the heavy-element content in the universe must certainly be taking place in stars.

In 1948 Hoyle became interested in the steady-state model of cosmology suggested by Bondi and Gold. The symmetry of a universe infinite in time and extent, with the evolution of matter in continuous creation had a philosophical appeal that may have been as important to Hoyle as was the concept of the steady state as a scientific hypothesis. In any event, he provided a mathematical description for the theory that was within the framework of general relativity. Whereas modern observations of the distribution of quasars and of the cosmic microwave background radiation are hard to reconcile with the steady-state theory, still the concept was a noble one and has probably inspired more interest in the universe at large and more investigations in observational cosmology than any other idea in recent times.

Other research interests of Hoyle have involved the origin of clusters of galaxies, galaxies, star clusters, and stars as gravitational instabilities in successive stages; the origin of galactic magnetic fields (with Ireland); the origin of interstellar graphite grains (with Wickramasinghe); the studies of radio galaxies and quasars; the origin of cosmic rays; and the possibility of gravitational collapse (in collaboration with the Burbidges). Currently, Hoyle is working

on field theory with Narlikar, on the nucleii of galaxies, and on quasi-stellar objects with the Burbidges.

In addition to being an inspiration to his professional colleagues, Hoyle has excited and attracted a great number of students, many of whom have subsequently become first-class astronomers themselves. Moreover, Hoyle has probably done more than any other living astronomer to popularize our science. His famous series of lectures for the BBC led to his first book, *The Nature of the Universe*, in 1950. Other popular and semipopular books in astronomy include *Frontiers of Astronomy* (1955) and *Astronomy* (1962).

Hoyle also has an unusual talent as a fiction writer and is very well known for his science fiction stories, which include *The Black Cloud* (1957), *Ossian's Ride* (1959), *The Fifth Planet* (1963), and *October First Is Too Late* (1966). He has written a play, *Rockets and Ursa Major* (1962) and a special television play, *A for Andromeda* (1962). He has collaborated in the production of an opera. He lectured on ecology and population control 15 years before the subject became the popular vogue. The breadth of his interests and curiosity is further demonstrated by his expertise in the game of baseball. Hoyle learned about the game during his visits to southern California and became an avid fan of the Los Angeles Dodgers. He followed the game and the Dodgers so closely and so enthusiastically that he came to Los Angeles from England in order to attend the World Series.

By now it should be apparent that it is impossible to describe Fred Hoyle the man and his varied contributions to astronomy, let alone his creative activities in other areas, and do the description any justice. Suffice it to say that he has been and continues to be an extremely prolific producer in a wide range of activities, as well as one of the world's great astronomers. We are proud to name him among the Bruce Medalists.

Bruce Medalists

1898	Simon Newcomb	1835–1909	U. S. Naval Observatory
1899	Arthur Auwers	1838–1915	Berlin
1900	David Gill	1843–1914	Cape Observatory
1902	G. V. Schiaparelli	1835–1910	Milan Observatory
1904	William Huggins	1824–1910	London
1906	H. Carl Vogel	1841–1907	Potsdam Observatory

1908	E. C. Pickering	1846–1919	Harvard College Observatory
1909	G. W. Hill	1838–1914	West Nyack, New York
1911	Henri Poincaré	1854–1912	University of Paris
1913	J. C. Kapteyn	1851–1922	Groningen Astronomical Lab.
1914	Oskar Backlund	1846–1916	Pulkovo Observatory
1915	W. W. Campbell	1862–1938	Lick Observatory
1916	G. E. Hale	1868–1938	Mount Wilson Observatory
1917	E. E. Barnard	1857–1923	Yerkes Observatory
1920	E. W. Brown	1866–1938	Yale University
1921	H. A. Deslandres	1854–1948	Meudon Observatory
1922	F. W. Dyson	1866–1939	Greenwich Observatory
1923	Benjamin Baillaud	1848–1934	Paris Observatory
1924	A. S. Eddington	1882–1944	Cambridge University
1925	Henry Norris Russell	1877–1957	Princeton University Observatory
1926	R. G. Aitken	1864–1951	Lick Observatory
1927	H. H. Turner	1861–1930	Oxford University
1928	W. S. Adams	1876–1956	Mount Wilson Observatory
1929	Frank Schlesinger	1871–1943	Yale University Observatory
1930	Max Wolf	1863–1932	Heidelberg Observatory
1931	W. de Sitter	1872–1934	Leiden Observatory
1932	J. S. Plaskett	1865–1941	Dominion Astrophysical Observ.
1933	C. V. L. Charlier	1862–1934	Lund Observatory
1934	Alfred Fowler	1868–1940	University of London
1935	V. M. Slipher	1875–1969	Lowell Observatory
1936	A. O. Leuschner	1868–1953	University of California
1937	Ejnar Hertzsprung	1873–1967	Leiden Observatory
1938	E. P. Hubble	1899–1953	Mount Wilson Observatory
1939	Harlow Shapley		Harvard College Observatory
1940	F. H. Seares	1873–1963	Mount Wilson Observatory
1941	Joel Stebbins	1878–1966	Washburn Observatory
1942	J. H. Oort		Leiden Observatory
1945	E. A. Milne	1896–1950	Oxford University
1946	P. W. Merrill	1887–1961	Mount Wilson Observatory
1947	Bernard Lyot	1897–1952	Paris Observatory
1948	Otto Struve	1897–1963	Yerkes Observatory
1949	H. Spencer Jones	1890–1960	Greenwich Observatory
1950	A. H. Joy		Mount Wilson Observatory
1951	M. Minnaert		Utrecht Observatory
1952	S. Chandrasekhar		Yerkes Observatory
1953	H. D. Babcock	1882–1968	Mount Wilson Observatory
1954	Bertil Lindblad	1895–1965	Stockholm Observatory
1955	Walter Baade	1893–1960	Mount Wilson and Palomar Observatories
1956	Albrecht Unsöld		University of Kiel
1957	Ira S. Bowen		Mount Wilson and Palomar Observatories
1958	W. W. Morgan		Yerkes Observatory
1959	Bengt Strömgren		Institute for Advanced Study
1960	V. A. Ambartsumian		Biurakan Observatory
1961	Rudolph Minkowski		Mount Wilson and Palomar Observatories

1962	Grote Reber		National Radio Astronomy Observatory
1963	Seth B. Nicholson	1891–1963	Mount Wilson and Palomar Observatories
1964	Otto Heckmann		Hamburg Observatory
1965	Martin Schwarzschild		Princeton University Observatory
1966	Dirk Brouwer	1902–1966	Yale University Observatory
1967	Ludwig Biermann		Max-Planck-Institut für Physik und Astrophysik
1968	Willem J. Luyten		University of Minnesota
1969	H. W. Babcock		Mount Wilson and Palomar Observatories
1970	Fred Hoyle		Institute of Theoretical Astronomy at Cambridge