

Hoyle, who now lives in Bourne-mouth, England, is the former Plumian Professor of astronomy and experimental philosophy at Cambridge University and the founder and former director of what is now the Institute of Astronomy in Cambridge. Salpeter is the James Gilbert White Distinguished Professor in the Physical Sciences at Cornell University. The two are to share the prize for "their pioneering contributions to the study of nuclear processes in stars and stellar evolution." According to the academy's announcement, Hoyle should be "remembered as a pioneer and leading representative during the 1940s and 1950s for the study of the formation of chemical elements in stars." The academy goes on to note that "later very important work by Hoyle dealt with the dating of the Solar System and the Galaxy by nuclear methods, the structure of so-called super-massive stars and production of light elements in those and in the Big Bang."

Salpeter is cited by the academy for contributing "very essentially to the understanding of nuclear reactions in interiors of stars during the 1950s," especially for identifying the reaction chain, now called the Salpeter process, that "burns" helium to carbon. Among the other contributions mentioned in the academy's announcement are Salpeter's study during the 1960s of how matter is accreted around black holes and his investigations in the 1980s of stellar evolution in the early universe.

APS Prizes Given at Summer Meetings

Several awards of the American Physical Society are being presented during meetings this summer. At the Topical Conference on Shock Compression of Condensed Matter, held in Amherst, Massachusetts, at the end of July, the Shock Compression Science Award was presented to **Arthur C. Mitchell** and **William J. Nellis** "in recognition of their pioneering experimental investigations of molecular and planetary fluids using shock compression." Mitchell and Nellis are both physicists at Lawrence Livermore National Laboratory.

This month's International Conference on Computational Physics, in Santa Cruz, California, will be the setting for the presentation of the Aneesur Rahman Prize for Computational Physics, given to **Donald H. Weingarten** of IBM Corp's Thomas J. Watson Research Center in Yorktown Heights, New York. Weingarten is

cited for "his seminal work on lattice quantum chromodynamics including algorithmic innovations, massively parallel computer software development and hardware implementation that led to calculations of hadron masses and the mass and decay couplings of the scalar glueball."

IN BRIEF

Two prizes were awarded at the February 1997 meeting in Beijing of an international conference entitled "Materials and Mechanisms of Superconductivity-High Temperature Superconductivity" and sponsored by the International Union of Pure and Applied Physics. The John Bardeen Prize went to **Philip Anderson**, Joseph Henry Professor of Physics at Princeton University, for his "contributions to the understanding of broken symmetry, the order parameter in the A and B phases of superfluid helium three and the role of impurities in metallic superconductors." The Bernd Matthias Prize was shared by **Robert Cava**, of both the chemistry department and the Materials Institute at Princeton University, and **Bertram Batlogg**, head of the material physics research department at Bell Laboratories, Lucent Technologies. The two were recognized for "creative use of solid state

chemistry and physics in the discovery of new superconducting materials."

Peter Galison, Mallinckrodt Professor of the History of Science and of Physics at Harvard University, has received a 1997 MacArthur Fellowship worth \$265 000. According to the MacArthur Foundation's announcement, Galison "focuses on the role of scientific instruments, which not only represent the epistemological center of experimental physicists' work, but also serve as a focal point of social organization for scientists."

John Hopfield became a professor of molecular biology at Princeton University in April. Through the end of 1996 he had been a professor of chemistry and of biology at Caltech.

The Institute of Electrical and Electronics Engineers presented its Edison Medal to **Esther M. Conwell**. According to IEEE, Conwell is the first woman to receive one of the institute's medals. Conwell, a research fellow at Xerox Corp in Webster, New York, was cited for "her fundamental contributions to transport theory in semiconductors and organic conductors, and for their application to the semiconductor, electronic copying and printing industries."

OBITUARIES

Abdus Salam

Abdus Salam died at age 70 on 21 November 1996, at his home in Oxford, England. He was best known for his pioneering work on electroweak unification, for which he shared the Nobel Prize in Physics in 1979 with Sheldon Glashow and Steven Weinberg. Salam will be remembered also for his invaluable contributions to the propagation of science in the third world. He founded the International Center for Theoretical Physics (ICTP) in Trieste, Italy, and directed it for over 30 years; he also helped create other international research centers, several international foundations, such as the Third World Academy of Science, and a number of international prizes.

Salam was born in Jhang, a district in the part of British India that is now Pakistan. Known at an early age for his sharp intellect, he completed his undergraduate education at the University of the Punjab in 1946, and won a scholarship to continue his graduate studies at the University of Cambridge's St. John's College. He excelled there, securing a first (top honors) in both physics and mathematics. While



ABDUS SALAM

seeking a research problem for his thesis, he asked the advice of Paul Matthews, who was about to finish his PhD. Matthews had been attempting to extend to meson theories, which describe the nuclear forces, the renormalization techniques that had recently been applied so successfully to avoid the infinities in quantum electrodynamics. Matthews challenged

Salam to solve the problem of the so-called overlapping divergences, which arise in meson theories in higher orders of perturbation theory. To Matthews's great surprise, Salam arrived at a complete solution to the problem in just a few months. This thesis made Salam well known at the very beginning of his career.

After finishing his PhD at Cambridge in 1951, Salam returned to Pakistan as a professor of mathematics at the University of the Punjab, hoping to build research groups in theoretical physics in his own country. However, he was frustrated in achieving his goals by both the lack of official support and the acute isolation in physics that he faced in Pakistan. He felt that he could serve his country better by staying abroad, so he returned to Cambridge in 1954 as a lecturer and fellow of St. John's College. Three years later, he accepted a professorship at what is now the University of London's Imperial College of Science, Technology and Medicine, where he succeeded in establishing one of the best theoretical physics groups in the world, well known for its contributions to the role of symmetries in particle physics. He maintained his professorship at Imperial College to the end of his career, despite spending most of his time after 1964 at the ICTP.

From 1957 to 1967, Salam, initially in collaboration with John Ward, attempted to unify the radioactive weak and electromagnetic forces—an idea introduced by Julian Schwinger in 1957. Following a suggestion by Glashow on the usefulness of the gauge symmetry $SU(2) \times U(1)$ and a crucial observation made by Peter Higgs and independently by F. Englert and R. Brout and (earlier) by Philip Anderson on how massless gauge particles can acquire masses through spontaneous breaking of symmetries, Weinberg (in 1967) and, independently, Salam (in 1968) proposed a model for electroweak unification based on the idea of a spontaneously broken $SU(2) \times U(1)$ gauge symmetry. The model gained great impetus in 1971, when Gerhard 't Hooft showed that such a model is renormalizable. Thus, it permitted reliable predictions of the masses of the W and Z particles, as well as dozens of neutral-current weak processes, all of which have turned out to be in spectacular agreement with experiment.

During 1974 and 1975, Salam collaborated with John Strathdee on the superspace–superfield formalism for dealing with a new type of symmetry—supersymmetry—which has the novel property that it can transform spin- $\frac{1}{2}$ fermions into spin-0 bosons and vice versa. The Salam–Strathdee formalism

has turned out to be an indispensable tool for dealing with the quantum behavior of supersymmetric field theories.

My personal collaboration with Salam started in the summer of 1972 and remained intense for over ten years. Together, we introduced the idea of an underlying unity of quarks and leptons and, simultaneously, of their weak, electromagnetic and strong gauge forces. Believing in $SU(4)$ color symmetry for quark–lepton unification and seeking a compelling reason for quantization of electric charge, we introduced the concept of left–right symmetry. This in turn led us to predict the existence of right-handed neutrinos accompanying the observed left-handed ones—a prediction that now plays a role in proposed solutions to the solar neutrino puzzle and in theories of dark matter.

In 1973, despite the skepticism of the physics community at the time, Salam and I noted that a gauge unification of quarks and leptons would inevitably lead to nonconservation of baryon and lepton numbers and thereby naturally to an unstable proton. These ideas have matured and evolved considerably. Salam had hoped to see a more final chapter of this story of unification in his lifetime. We were both encouraged, however, to see that the search for proton decay was continuing with the recent completion of the Superkamiokande detector in Japan.

During our collaboration, Salam always reacted to our occasional disagreements with a good-natured spirit. If he were greatly excited about an idea that I did not like, he would impatiently ask, “My dear sir, what do you want? Blood?” I would reply, “No, Professor Salam. I would like something better.” Whether I was right or wrong, he never took it ill.

While Salam was moving forward in his research, he never lost sight of his ardent desire to help the growth of science and technology in the third world. Determined to help, he approached the International Atomic Energy Agency (IAEA) of the United Nations in 1960 for support of what was to become the ICTP. Salam's proposal met with great resistance, with one delegate from a developed nation saying, “Theoretical physics is the Rolls Royce of sciences—the developing countries need only bullock carts.” After Salam and several colleagues lobbied intensely for four years, Salam finally succeeded in creating the center in 1964, with partial support from the IAEA (now taken over by UNESCO) and primary support from the government of Italy.

Thanks to Salam's tireless efforts,

the ICTP has emerged as one of the finest research-cum-training institutions in the world, not only producing high-quality science but also providing opportunities for scientists from the developing and developed nations to interact regularly through annual workshops and summer schools. In its 33 years, the ICTP has hosted some 60 000 visits by experimental and theoretical research physicists, about half of whom are from the developing countries.

Salam dreamed of creating 20 international centers like the ICTP, spread throughout the world and emphasizing different areas of science and technology. He appealed vigorously to the developed as well as many developing countries and to the World Bank for funds to create the centers. Meanwhile, Salam also dreamed of creating a “World University,” which would be funded internationally and would be linked for its functioning to a consortium of universities worldwide.

Salam's efforts in these directions in the last eight years of his life were unfortunately severely hampered by a crippling neurological illness, attributed to a variant of Parkinson's disease. Thanks to his own initiative and that of several others, he nevertheless succeeded in creating the International Center for Genetic Engineering and Biotechnology, with components in Trieste and Delhi, and the International Center for Science and High Technology in Trieste.

Salam will surely be remembered as one of the great scientists of the 20th century and as a humanitarian who devoted much of his life to uplifting the status of science and technology in the third world. Salam may have been somewhat ahead of his time in dreaming of 20 international centers and a world university. It remains for the present generation of scientists and world leaders to fulfill this dream.

JOGESH C. PATI

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Edward Mills Purcell

Edward Mills Purcell, who shared the Nobel Prize for Physics with the late Felix Bloch in 1952 for their independent roles as founders of nuclear magnetic resonance (NMR), died of respiratory failure in Cambridge, Massachusetts, on 7 March 1997.

Ed was born 30 August 1912 and grew up in Taylorville and Mattoon, Illinois, where his father managed an independent telephone company. Reading articles in the *Bell System Technical Journal* during his boyhood contributed to Ed's decision to enter