

WE HEAR THAT

## TAYLOR, POPE RECEIVE 1992 WOLF PRIZES IN PHYSICS, CHEMISTRY

The 1992 Wolf Prize in Physics has gone to Joseph H. Taylor Jr, the James S. McDonnell Distinguished University Professor of Physics at Princeton University. John A. Pople, the John Christian Warner Professor of Natural Sciences at Carnegie Mellon University, has won the 1992 Wolf Prize in Chemistry.

The Wolf Foundation, in Herzliyya, Israel, bestows annual awards in five subjects, each of which includes a \$100 000 prize. The president of Israel, Chaim Herzog, gave the recipients their awards in a ceremony in Jerusalem on 17 May.

The foundation cited Taylor for his "discovery of an orbiting radio pulsar and its exploitation to verify the general theory of relativity to high precision." Pople's citation recognized his "outstanding contributions to theoretical chemistry, particularly in developing effective modern quantum chemical methods."

In 1974 Taylor and his graduate student Russell Hulse discovered the pulsar PSR 1913+16, which was detectable at radio frequencies. Not

only was the pulsar the first found to be in a binary system, but both companions turned out to be neutron stars. Since then a few dozen binary pulsars have been found.

Taylor told us that he and Hulse quickly realized the system would exhibit special and general relativistic effects that could be observed and tested: The pulsar was clearly part of a high-velocity, high-mass system with much higher velocities and gravitational fields than are present in the solar system. Taylor and his coworkers had to refine existing pulsar timing techniques to achieve the precision needed to measure accurately the arrival times of signals from the pulsar. Eighteen years of observations with the large radiotelescope at Arecibo have provided them with a large amount of data with remarkably small experimental errors.

Taylor's group measured the precession of the pulsar's periastron (or point of closest approach), its gravitational redshift and the delay in the pulsar's signal due to the relativistic time dilation. The precession of the pulsar's periastron is similar to the precession of Mercury's orbit around the Sun except that it is greatly magnified in the binary's much higher gravitational field. From the data Taylor calculated the masses of the companions precisely. It turned out that both neutron stars have masses of about 1.4 solar masses, just over the Chandrasekhar limit for a star to become a neutron star after going supernova. From the masses, Taylor predicted the amount of energy the system would lose to gravitational radiation according to relativity theory.

The results of measurement of the orbital decay turned out to agree with the predictions made from general relativity. The data provided conclusive quantitative evidence that the binaries give off gravitational radiation that is quadrupolar in

nature and that propagates at the speed of light, in agreement with the theory. This is perhaps the best evidence to date for the existence of gravity waves.

The binary system turned out to be the first of a class of pulsars known as recycled pulsars, which are useful not just for tests of relativity but for other applications requiring precise timing. In a recycled-pulsar system the faster-spinning neutron star is a remnant of the first of the original orbiting stars to go supernova. When the second one evolves off the stellar main sequence, it ejects gas, which carries angular momentum. This material accretes onto the first pulsar, spinning it up to a faster rate. Recycled pulsars have been used to study stellar evolution in close binary systems and to place limits on the gravitational radiation background left over from the Big Bang.

Taylor graduated from Haverford College with a BA in physics in 1963. He earned his PhD in astronomy from Harvard University in 1968. The next year he joined the astronomy

John A. Pople



faculty of the University of Massachusetts, Amherst, where he remained until 1981. From 1977 to 1981 he was the associate director of the Five College Radio Astronomy Observatory. Since 1980 he has been a member of the physics faculty at Princeton.

In 1953 Pople and, independently, Rudolph Pariser, then of Du Pont, and Robert Parr, then of the Carnegie Institute of Technology, developed a semiempirical model of molecular orbitals that accounted only for the electrons in  $\pi$  orbitals. The Pariser-Parr-Pople model applied only to planar conjugated molecules, because their delocalized electrons are easier to handle than the electrons of other types, Pople told us.

In the 1960s Pople and various collaborators set forth more sophisticated molecular orbital models that included the  $\sigma$ -orbital electron interactions: the complete neglect of differential overlap, or CNDO, and intermediate neglect of differential overlap, or INDO, models. These models generalized the PPP model to three-dimensional molecules. As such they allowed better calculations of molecular properties such as structures; bond lengths and angles; harmonic frequencies and force constants; and the energies of excited electron states.

By the late 1960s Pople began to work on *ab initio* methods that determined molecular orbitals directly from the laws of quantum mechanics and the fundamental physical constants. Such calculations do not require empirical parameters, which were chosen somewhat arbitrarily when used in the earlier semiempirical methods. As a result, the *ab initio* methods have greater power to predict molecular properties, as well as a

firmer epistemological basis.

Pople was among the early developers of minimal basis sets—that is, linear combinations of ground-state atomic orbitals—to get a single determinant for a molecule's Hartree-Fock wavefunction. The basis sets enabled him to calculate the wavefunction for polyatomic molecules. Pople then developed larger basis sets that included the d and f orbitals. Pople and coworkers were instrumental in the systematic development of many-body perturbation methods for incorporating specific electron interactions, which Hartree-Fock theory neglects. Such methods allow one to predict molecular wavefunctions with even greater accuracy.

Pople's use of computers since 1970 has enabled him and many coworkers to speed up the calculation of molecular energies and properties. He and his team wrote a computer program called Gaussian to perform the required mathematical operations. The program is widely used, particularly by quantum and organic chemists. It is updated and revised every few years; its current version is Gaussian 92.

Pople received his BA (1946), MA (1950) and PhD (1951) in mathematics from Cambridge University. After that he was first a research fellow and subsequently a lecturer at Trinity College, Cambridge, until 1958. From then until 1964 he was superintendent of the basic physics division of the National Physics Laboratory in Teddington, England. He was Carnegie Professor of Chemical Physics at Carnegie Mellon from 1964 to 1974, when he was named to his present chair. Since 1986 he has also been a chemistry professor at Northwestern University.

four years, he joined the Michigan State faculty in 1958. He is currently the University Distinguished Professor of Physics there.

Pollock was director of Indiana's cyclotron facility from 1972 to 1979, during which time he oversaw construction of the cyclotron and developed pion and light-particle spectrometers and other measurement devices. The cooling ring he designed has been used to study the production of mesons near threshold. Pollock earned a PhD in physics from Princeton in 1963 and was a member of the physics faculty there from 1964 to 1969. He went to Indiana in 1970 and is now the Distinguished Professor of Physics there.

The Dannie Heineman Prize for Mathematical Physics, awarded by APS and the American Institute of Physics, was given to Stanley Mandelstam of the University of California, Berkeley. He was cited for "his fundamental contributions to elementary-particle physics, including the Mandelstam representation—which displays the analyticity properties of scattering amplitudes—the formulation of the relativistic string as a unitary theory of interacting particles and his influential work on gauge theories." His representation of the analytic properties of scattering amplitudes in the form of double dispersion relations is basic to the modern understanding of relativistic particle scattering, and he was among the first to apply path-integral quantization methods to string theory.

Mandelstam earned a PhD in mathematical physics from the University of Birmingham (England) in 1956. He was a professor of mathematical physics there from 1960 to 1963 and then became a professor of physics at Berkeley.

Claude N. Cohen-Tannoudji of the Collège de France and Alan H. Guth of MIT were this year's recipients of the Lilienfeld Prize. Cohen-Tannoudji was cited for "his unique contributions to the understanding of atomic systems in electromagnetic fields and for his expository skills. He has made singular contributions to the theory of 'dressed atoms,' optical pumping and cooling, and resonance fluorescence and has experimentally verified some of his predictions." Most recently Cohen-Tannoudji has demonstrated new, more efficient optical cooling processes that contradict previous predictions of a theoretical lower limit to the temperature achievable by radiative cooling.

Cohen-Tannoudji earned a DSc in atomic and molecular physics from

## APS PRIZES AND AWARDS ARE HIGHLIGHTS OF APRIL MEETING

One of the highlights of the American Physical Society meeting held in Washington, DC, in April was the presentation of a number of prizes and awards in recognition of achievements in physics.

The 1992 Tom W. Bonner Prize, given for contributions to nuclear physics, was presented to Henry G. Blosser of Michigan State University and Robert E. Pollock of Indiana University. The two were cited for "their pioneering development of innovative accelerator configurations, which have allowed new levels of precision and flexibility for nuclear

physics research."

As director of Michigan State's cyclotron laboratory from 1958 to 1989, Blosser supervised the construction of the first precision cyclotron, and he later developed techniques for combining its particle beams with magnetic spectrographs to permit unprecedented time and energy resolution in studying the products of nuclear reactions. He led the design and construction of the first superconducting cyclotron. Blosser received a PhD in physics from the University of Virginia in 1954. After working at Oak Ridge National Laboratory for