presented its 2001 Laboratory Director of the Year Award to **Rob Goldston,** director of the Princeton Plasma Physics Laboratory. The FLC gives the award annually to one or more lab directors who have made "maximum contributions to the overall enhancement of technology transfer for economic development." The citation noted that Goldston has "instituted or encouraged a number of activities that have the potential to lead to new technology transfer initiatives within [PPPL]."

On 1 September, **Haiyan Gao** will join Triangle Universities Nuclear Laboratory and Duke University as an associate professor of experimental nuclear physics. She will be taking a one-year leave of absence from her current position as an associate professor of physics at MIT.

During its annual meeting in Indianapolis, Indiana, this past March, the Association of Korean Physicists in America (AKPA) awarded its 2002 Outstanding Young Researcher Award to **Philip Kim**, assistant professor of physics at Columbia University, for his "pioneering research on high-temperature superconductivity and physics of carbon nanotubes." The 2002 AKPA President's Award was presented to **Yoonseok Lee** for "outstanding research in experimental low-temperature physics." Lee is an assistant professor in the physics department at the University of Florida, Gainesville.

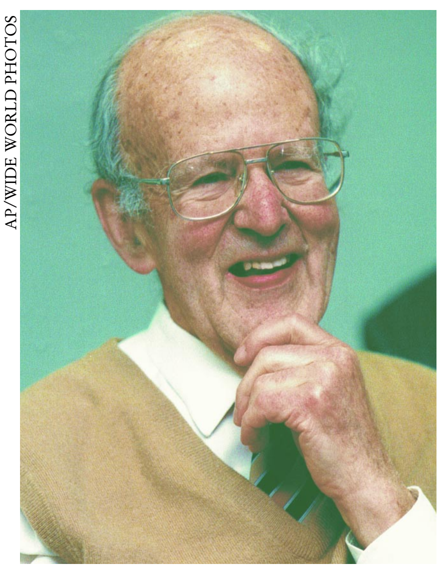
Case Western Reserve University in Cleveland, Ohio, awarded its Michelson Postdoctoral Prize Lectureship for 2002 to **Re'em Sari**, Sherman Fairchild Senior Research Fellow in Theoretical Astrophysics at Caltech. Sari was recognized for excellence in science and science communication and was invited to give three seminars and a colloquium at CWRU this past April. The physics department presents the award annually to an outstanding postdoctoral researcher in any field of physics.

Henric Krawczynski, research associate and instructor in the astronomy department at Yale University, moved to Washington University in St. Louis, Missouri, last month to take a position as an assistant professor of experimental physics.

At a banquet in Houston, Texas, this October, **Harden M. McConnell**, Robert Eckles Swain Professor of Chemistry Emeritus at Stanford University, will receive the 2002 Welch Award from the Welch Foundation in recognition of lifetime achievements in basic chemical research. The award consists of a gold medallion and a $300 000 cash prize.

OBITUARIES

Max Ferdinand Perutz


AP/WIDE WORLD PHOTOS

MAX FERDINAND PERUTZ

Max Ferdinand Perutz, a Nobel Prize winner in chemistry for his work on the three-dimensional structure of hemoglobin, died of cancer on 6 February 2002 in Cambridge, UK, where he had spent most of his career. He was one of the pioneers of molecular biology.

Born in Vienna, Austria, on 9 May 1914, Max studied chemistry at the University of Vienna, but he was especially interested in biochemistry. He had hoped to work with Gowland Hopkins in Cambridge, but instead was taken on by J. D. Bernal at the Cavendish Laboratory. Bernal and Dorothy Crowfoot (later Hodgkin) had earlier made the seminal discovery that protein crystals only gave highly ordered x-ray patterns if they were kept moist. Max found that hemoglobin crystals gave excellent diffraction patterns. He was especially intrigued to learn from his cousin, Felix Haurowitz, that oxy- and deoxy-hemoglobin crystallized in different crystal forms. He decided that he would try to work out the 3D structure of hemoglobin from the x-ray diffraction pattern of its various crystals so that he could "solve a great problem in biochemistry." He obtained his PhD from the University of Cambridge in 1940, and worked on the structure and function of various hemoglobins for most of his working life.

The boldness of this undertaking is astonishing. An x-ray diffraction pattern of a crystal produces only half the information needed to locate its atoms. This pattern provides the amplitude of the Fourier components of the electron density, but not their phases. Moreover, during the late 1930s, the largest organic molecule whose structure had been solved was minute compared to hemoglobin, which has a molecular weight of 64 500.

Max originally hoped that he could crack the structure by calculating the 3D Patterson function, the autocorrelation function of the electron density. This was a difficult and tedious task that involved measuring the intensities of thousands of x-ray spots. The calculations were performed on punch-card machines. The resulting Patterson function, published in 1949, appeared to show some interesting features, but those turned out to be misleading.

The impasse was broken by the realization, based on both theory and measurement, that the method of isomorphous replacement should work even for large molecules. As luck would have it, a mercury atom added to a cysteine side group did not change the crystal lattice structure of hemoglobin but did produce significant changes in some of the x-ray intensities. This coup enabled Max to solve, in 1953, a two-dimensional projection of the structure, which is centrosymmetric. For a 3D structure, several different heavy atoms are needed, so it took an additional five years of work to obtain the full structure at 5.5 Å resolution. Meanwhile John Kendrew had, by similar methods, solved the 3D structure of myoglobin, which is one-quarter the size of hemoglobin. The arrangement of the various α helices, and the essential heme groups, was broadly similar in both structures. For this work, Max and Kendrew shared the 1962 Nobel Prize in Chemistry. Once they became available, the amino acid sequences of hemoglobin and myoglobin fitted nicely with these (low-resolution) structures.

About 1950, Lawrence Bragg, Kendrew, and Max tried to build models of the α pattern that William Astbury had reported from hair and nails. Unfortunately, they assumed that the resulting helix had to have integral numbers of residues per turn to account for the 5.1 Å reflection on the meridian of the α pattern. They also failed to make the peptide bond planar. All their tentative models looked a mess. Linus Pauling, who tried the same approach, made neither of these mistakes. He discovered the α helix, which has about 3.6 residues per turn. Max realized that this structure should give a 1.5 Å repeat on the meridian and, by tilting the specimen, showed it was indeed there.

Over the years, Max and his coworkers determined the structure of many kinds of hemoglobin molecules, some to fairly high resolution. The thrust of this work was to determine how hemoglobin acts, a process that fascinated Max. Hemoglobin has evolved to take up oxygen avidly in the lungs and release it easily in the tissues. To do this efficiently, the curve of oxygen uptake versus oxygen pressure must be sigmoid. Moreover, that uptake curve can be altered by pH, carbon dioxide concentration, and other factors. Because hemoglobin is an allosteric protein (that is, it can reversibly switch between active and inactive structural forms), there must be some interaction between the four hemes that form the macromolecule and that lie at a considerable distance from each other.

The mechanism depends on two main factors. The first is that the attachment of the oxygen molecule to iron of the heme group produces a small displacement of the iron. This displacement was controversial for many years because the shift is so small. But eventually, by very careful measurements, Max proved his point. The second factor is the relative movement of the subunits. Hemoglobin consists of a dimer, about a twofold axis of symmetry, each monomer being made of one α chain and one β chain (encoded by different genes). It is because of this movement that crystals of deoxyhemoglobin break up if they combine with oxygen. It took Max 25 years to establish this basic mechanism. The arguments involved masses of observations, some of them wrong or misleading. Max gave a detailed account of these "hemoglobin battles" in his various comments to his collected papers entitled *Science Is Not a Quiet Life: Unravelling the Atomic Mechanism of Haemoglobin* (World Scientific, 1997).

Max also had an interest in the consequences of amino acid differences, either in the many known mutants of human hemoglobin or in different species, such as crocodiles and carp. In most cases, it is possible to explain the changes in behavior of hemoglobin if one knows the changes in sequence.

Max's career was interrupted by World War II, when for a time he was interred as an "enemy alien." He also worked on a fantastic project to construct a floating airfield out of ice. In 1947, Bragg persuaded the British Medical Research Council to support x-ray work on proteins. In 1961, the MRC built a new laboratory for that work, on the new site for Addenbrook's Hospital, to which Fred Sanger and his group were also relocated. Max was chairman of the lab, and unobtrusively led it to many successes, including a series of Nobel Prizes and four members of Britain's Order of Merit.

Max retired as chairman in 1979, but continued working in the laboratory until the year of his death. During this period, he wrote incisive articles and reviews, many of which were published in the *New York Review of Books*.

Max had a quiet personality, always friendly and encouraging to colleagues and students, yet he possessed a single-minded determination to stick to any problem he considered important. He was in some way the still center of the revolution in molecular biology that occupied the second half of the 20th century.

FRANCIS CRICK
The Salk Institute
La Jolla, California

George Dixon Rochester

GEORGE DIXON ROCHESTER

From blacksmith's son to famous elementary particle researcher and on to distinguished university administrator—such is a brief summary of the life of George Dixon Rochester, who died of heart failure on 26 December 2001 in Durham, UK.

Obituary writers commonly exaggerate the personal qualities of their subjects, but anyone who knew Rochester—"GDR" to his juniors—will testify that he was an extraordinarily gentle, helpful, and friendly person. His life revolved around his family, his physics, his university, and the Methodist Church.

To the physicist he will always be known as the codiscoverer, with Clifford Butler, of the so-called V particles in cosmic-ray experiments using a cloud chamber at Manchester University. This discovery, in 1946, followed by exhaustive analysis and publication in 1947, was a breakthrough in particle physics that led to great developments, particularly with the new accelerators.

Although the dearth of further examples of the two V particles (now known to be K mesons) made the Manchester camp uneasy until further examples were found on mountaintops, it is almost unbelievable that Rochester and Butler did not share a Nobel Prize for their seminal discovery. All the ingredients were there: reputations put firmly on the line, superb technical and interpretative skill, and a very big piece in the fundamental particle jigsaw puzzle put in place. Remarkable, indeed. Be that as it may, Rochester never, to my knowledge, mentioned the matter, or complained about it—and I was associated with him for 50 years.

Rochester was born on 4 February 1908 at Wallsend near Newcastle upon Tyne in northern England. His early experiences in his father's smithy gave him a feeling for the mechanical arts, and his later superb experimental techniques must owe a lot to his early life.

A scholarship took him to the Armstrong College of Durham University (now the University of Newcastle upon Tyne), where a keen researcher, W. E. Curtis, a noted spectroscopist, provided great stimulus. There, Rochester earned his BSc (1930), MSc (1932), and PhD (1937) degrees, all in physics. The last mentioned was on band spectra, done under the supervision of Curtis. While still working in spectroscopy, he spent 1934–35 as an