

bury 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 differ-

ences, 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.

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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



GEORGE DIXON ROCHESTER

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

Earl Grey Fellow at Stockholm University and the next two years at the University of California, Berkeley, as a Commonwealth Fellow. He moved in 1937 to take an assistant lectureship in physics at Manchester. His early experiences in spectroscopy led him, years later when designing a new laboratory at the University of Durham, to ensure that a high-current arc could be operated in every laboratory!

At Manchester, he came under the spell of the impressive Patrick Blackett (himself an experimenter par excellence) and soon transferred to cosmic-ray physics. Cloud chamber expertise led to a number of interesting results, culminating in the V particle work.

Following a spell as acting director of the physics department at Manchester, and after Blackett had departed for Imperial College, London, Rochester moved to the University of Durham in 1955 and took John Major and me with him. Using nuclear emulsions and, later, bubble chambers, Major spearheaded research at the accelerators and contributed to cosmic-ray work, too. I continued cosmic-ray research using electronic techniques, and eventually discovered, with Indian and Japanese research groups, the cosmic-ray neutrino in the Kolar Gold Fields in India. The cosmic-ray work led to astrophysics and the creation of the now most impressive astronomy group at Durham. Parallel developments in particle physics theory have led to a similarly prestigious particle theory group, currently led by James Stirling.

In all this, Rochester was at the helm in the sense of inspired choices of staff and the provision of facilities. Furthermore, he was a fine sounding board for his staff's discoveries, real and imagined. In his early days at Durham, when he read and commented on every paper before submission, one could rely on the English being corrected, as well as the physics being queried. The English corrections, in fact, came from his wife, Ida! His companion and strength for more than 60 years, Ida was an English graduate.

Rochester spent the rest of his career at Durham, where he became the first pro-vice chancellor (deputy vice-chancellor) in 1969. His contributions to university administration were legion; he was much in demand for his logical, quiet, sensible, non-partisan approach. He was deeply involved in the design of the department's new main building. Opened in 1997 on the 50th anniversary of his

discovery of kaons, it was named the Rochester Building by the university's chancellor, the actor Peter Ustinov.

In the early years of his long retirement beginning in 1973, Rochester took an interest in the history of astronomy at Durham. He was fascinated by events in the 19th century, not least by the university's first professor of mathematics, Temple Chevallier. That man was also a professor of astronomy, reader in Hebrew, deputy principal, part-time registrar, and parish priest of Esh, a village near Durham! Rochester unearthed the story of Chevallier's "observer" in the 1850s, Richard Carrington, whose work led to the discovery of the differential rotation of the Sun and thus to the fact that the Sun is not a rigid body. Carrington threw in the towel when the university declined to upgrade the observatory's telescopes, and he moved south, where he constructed his own observatory! Rochester loved the story.

He is remembered with fond affection by all who knew him and he is further remembered at Durham by the annual Rochester Lecture, in which leading scientists from the UK and abroad present the latest developments in physics. In addition, the universities of Durham and Newcastle jointly award the annual Rochester Prize to the best undergraduate in first-year science.

Rochester's wife, who, with him, was a pillar of the local Methodist Church, from which they gained much inner strength, survived him by only six days.

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Bo Andersson

Bo Andersson, an unconventional strong-interaction theorist with close relations to the experimental particle physics community, died unexpectedly from a heart attack on 4 March 2002. He was returning home from the winter school in St. Petersburg, Russia, and collapsed while changing trains in Malmö, Sweden.

Bo was born in Kristianstad, Sweden, on 8 June 1937. He attended Lund University, earning his BSc in 1961, and joined the lively circle of young physicists around professor Gunnar Källén. In 1967, he defended his PhD thesis on singularities in Feynman amplitudes, which he researched under the guidance of Källén. Bo remained affiliated with Lund throughout his career. He became a

professor in the theoretical physics department in 1984 and had intended on retiring in June 2002 and remaining as active as ever in research.

During his postdoctoral years, Bo continued formal studies of singularities in Feynman amplitudes, but in the early 1970s, he drastically changed his field of research. Collaborating with the nuclear emulsion experimental group at Lund, Bo worked on understanding heavy-ion reactions and became involved in the preparations for a charm-search experiment at Fermilab. Continuing along the phenomenological road, he and one of us (Gustafson) started up a close-knit collaboration at Lund for the study of strong interactions, work that continued until Bo's death. The group that was formed fostered some 30 PhD students over the years. The coffee room at Lund was filled with lively discussions among the group's members, blended with the rich smoke from Bo's pipe.

Bo's most famous contribution, in collaboration with Gustafson, was the development of what has become known as the Lund model for high-energy reactions. The model describes these reactions as a two-step process: (1) hard interactions between quarks and gluons in the initial phase of a high-energy collision, in which the effective coupling is small and the emission of gluons can be treated by perturbative calculations, and (2) the subsequent soft hadronization process, in which the coupling becomes large and nonperturbative models are needed. The description of this second step is the hallmark of the Lund model. It assumes that a stringlike confining force field is established between quark-antiquark pairs formed in the first step. Transverse excitations on the string kinks are identified as gluons. Concepts from quantum chromodynamics, such as infrared stability and color coherence, have constituted important guidelines in developing the model.

The way quarks and gluons are ordered along the string influences the color structure of events and provides unique predictions for the energy and particle flow in high-energy collisions. These features were first observed in 1980 by the JADE collaboration in three-jet events produced in electron-positron annihilation at the PETRA machine at the German Electron Synchrotron (DESY) in Hamburg, Germany, and have later been observed in multiparticle production at all kinds of high-energy events.