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methods of radiofrequency spectroscopy to the study of excited atoms. Brossel and Bitter, with the guidance and advice of Kastler, soon carried out the first optical double-resonance experiment on mercury atoms. This new experimental method and variants of it were subsequently used in many laboratories to measure hyperfine structures of excited atomic states and to deduce many new nuclear quadrupole moments. The optical double-resonance method had two important advantages: It overcame the limitation that Doppler broadening imposed on the measurements' resolution, because radiofrequency and microwave fields were used to induce transitions between closely spaced energy levels; it also allowed one to use, as signals, changes in the polarization and direction of the easily detectable optical photons that were triggered by the much less energetic radiofrequency photons.

In 1950 Kastler published an important paper in which he showed that it was possible to transfer the angular momentum of circularly polarized resonance light to atoms in their ground states, an idea that was pursued independently at Princeton by Robert Dicke and his collaborators. Kastler received the Nobel prize in physics "for the discovery and development of optical methods for studying Hertzian resonances in atoms" in 1966.

Not the least of Kastler's achievements was the collection of a brilliant group of young scientists at the École Normale to exploit the fertile new experimental methods stimulated by his work. Always eager to help young scientists, he once wrote an article on the age of admission of candidates to the French Academy of Sciences: He pointed out that on the basis of his extrapolations of recent trends it was clear that only posthumous members would be admitted by the year 2000. He maintained a lifelong committment to his ideals of peace and social justice.

William Happer
Princeton University

Kurt Symanzik

On 25 October 1983 Kurt Symanzik died in Hamburg, Germany, of cancer. In 1981 the German Physical Society had awarded him the Max Planck Medal, its highest honor, for his many fundamental contributions to quantum field theory and for the impulse he had given to the development of quantum chromodynamics (QCD), the currently accepted theory of strong interactions between elementary particles.

Symanzik was born on 21 November 1923 in Lyck and grew up in Königsberg (Germany, now in the USSR). He

SYMANZIK

began his studies of physics in 1947, in Munich. He later became a student of Werner Heisenberg in Göttingen and received his PhD in 1954, with a thesis on the Schwinger functional in quantum field theory. He continued to work in Göttingen in collaboration with Harry Lehmann and Wolfhart Zimmermann. They formed the legendary "*Feldverein*," in the name given to them by Wolfgang Pauli. From 1955 until 1968, Symanzik worked in the US: at the Institute for Advanced Study in Princeton, at the University of Chicago, and, starting in 1962, as a professor of mathematical physics at the Courant Institute of New York University. In 1968 he returned to Germany, as a leading scientist at the Deutsches Elektronen-Synchrotron (DESY) in Hamburg.

One of the best known of Symanzik's many contributions to quantum field theory and elementary-particle physics resulted from his collaboration with Lehmann and Zimmermann in Göttingen. The LSZ formula, which is now in all the textbooks on elementary particle physics, expresses scattering cross sections, such as those measured at accelerator laboratories like DESY, in terms of quantum-mechanical expectation values of products of field operators.

While at the Courant Institute, Symanzik discovered that quantum field theory admitted a mathematical transformation into classical statistical mechanics. This discovery was basic for the rigorous mathematical construction of quantum field theoretical models and has become used in almost all the present numerical and analytical work on nonperturbative effects in quantum chromodynamics (confinement, masses of elementary particles). He also introduced random-walk representations, whose applications range from studies of quark confinement to localization properties of electron states in amorphous materials.

A central theme in Symanzik's work over the last 15 years was extending the applicability of perturbation theory. His studies of the breaking of scale invariance by renormalization in quantum field theory led him (and independently Curt Callan) to the discovery of the Callan–Symanzik equation, which expresses renormalization group properties of the above-mentioned expectation values. It provided the impulse for the development of asymptotically free quantum field theory such as QCD and led to a resummation of perturbation theory, which makes it applicable to strong interactions of elementary particles at short distances. Symanzik also found a first model of an asymptotically free quantum field theory. His last activities were concerned with construction of improved lattice approximations for QCD, to enhance calculational capabilities. He remained as productive and innovative as ever until his untimely death.

For his colleagues in Hamburg, Symanzik's death is a grievous loss. While his papers were very difficult to read—he refused to publish anything that he would have considered trivial or repetitive—he was easy to communicate with and always ready to share his enormous treasure of knowledge.

GERHARD MACK
Universität Hamburg

John M. Wilcox

John Marsh Wilcox, Director of the Stanford Solar Observatory, died on 14 October 1983. He was 58 years old.

Wilcox specialized in the study of magnetic fields at the solar surface and in the interplanetary medium. He wrote or co-authored more than 100 articles on waves in laboratory plasmas, solar magnetism, solar oscillations, solar rotation, coronal and interplanetary magnetic fields, the solar wind, geomagnetic responses to the solar wind, and the influence of solar activity on terrestrial weather.

He did innovative studies of the global solar structure, including large-scale solar phenomena such as magnetic sectors and polar magnetic regions. Working with Norman Ness, he discovered that during times of moderate solar activity, the interplanetary medium is ordered into the large-scale magnetic structures he called sectors. Together with Robert Howard of Mount Wilson, he then showed that these structures could be mapped back onto the Sun.

Wilcox was a graduate of Iowa State College (BS 1948) and the University of California at Berkeley (PhD 1954). He was a physicist with the Lawrence Radiation Laboratory from 1951 to 1961. After spending 1961–62 as a visiting physicist at the Royal Institute of Technology in Stockholm, he returned to the University of California to work at the Space Sciences Laboratory from 1964 to 1971.

In 1971 he joined the faculty of Stanford University as an adjunct professor, a position he held until his death. There, together with Philip Scherrer, he designed and directed the construction of the Stanford Solar Observatory. Originally designed to permit measurements of the mean magnetic field of the entire Sun, observed as though it were a distant star, the facility has enabled researchers to make extremely accurate observations of the Sun's magnetic field, rotation and oscillations. The observatory also provides daily magnetic maps of the Sun for a systematic study of the evolution of the large-scale structure of magnetic fields. Observations of solar oscillations have played an important part in the work at the observatory. The solar 160.01-minute oscillation, discovered by observers in the USSR, was confirmed at Stanford in 1977, and recently both acoustic-mode and gravity-mode oscillations have been observed there.

Wilcox developed many innovative techniques to extract signals from the variety of noisy data that often plague researchers in solar–terrestrial physics. He had perception in attacking fruitful problems and persistence to devote himself to difficult physical puzzles from which others might shy away. Over the past decade, he and his associates established the connection between the sector boundaries of the interplanetary magnetic field and areas of strong vorticity at the lower boundary of the Earth's stratosphere. The effect, though small and of variable magnitude, has been independently confirmed and may be of great importance in weather and climate models.

Wilcox played an important role in the American Geophysical Union. He served as secretary of the Section on Interplanetary Physics 1970–74, and as associate editor of the *Journal of Geophysical Research* 1973–75.

Among his efforts to promote international cooperation and exchanges, Wilcox arranged extended visits to Stanford by researchers from many countries, including the USSR, China, Japan, England, France, Italy, Denmark and Sweden. The collaborations led to exciting and enlightening cultural exchanges, as well as important scientific results.

Wilcox was known to his scientific associates not only for his research accomplishments and stimulating ideas, but for his gentle manner of giving help. He was a talented clarinet player, and deeply loved chamber mu-

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