the Performing Arts, an Urban League Studies Program and, most significantly, the Center for Biomedical Education.

All these acts of creation were carried out in an atmosphere of ethnic strife and agitation, as well as political and economic assaults against City College. (Free tuition was abolished in 1975.) Motivated by his social conscience and sympathies, Bob was extraordinarily responsive to all demands, striving mightily and in part successfully to supplement and replace lost public funds with funding from private sources. Nevertheless frustration and bouts of ill health took their toll, as did undoubtedly the deprivation of not doing physics. So at the age of 63 Marshak again became a full-time physicist.

In 1979 Marshak accepted a position as a Distinguished Professor at the Virginia Polytechnic Institute and State University. He resumed research in particle physics, working on various modern subjects such as the preon model (involving possible substructures of leptons and quarks), grand unified theory with possible neutron–antineutron oscillations, consequences of both local and global gauge anomalies in the gauge field theory, and the strong *CP* problem in quantum chromodynamics. Just before his death he completed the manuscript of *Conceptual Foundations of Modern Particle Physics*.

Pursuing physics full-time never stopped Marshak from doing other public service work that for most people would itself have been full-time. In the early 1980s the principal beneficiary of Bob's energy and activism was the American Physical Society. He had been on the APS council and the executive committee in the 1960s, and soon after his retirement from CCNY he was elected APS vice president; he became president in 1983.

One of Marshak's accomplishments was the design and approval of the Cooperative Chinese–American Program in Condensed Matter, Atomic and Optical Physics, which is now seen by those familiar with it as a major achievement and contribution of APS. He also led APS in statements on nuclear arms control.

Other leadership roles played by Marshak included his initiatives in the reestablishment of relations with scientists in the Soviet Union and Eastern Europe, the founding of the Rochester Conference and the seminal role he played in the creation of the International Centre for Theoretical Physics in Trieste, Italy.

With Bob Marshak's death, one of our time's great physicists and practical dreamers is no longer with us.

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Dawon Kahng

Dawon Kahng, a physicist, electrical engineer and research leader, died on 13 May 1992 at the age of 61. He was internationally known for his semiconductor device research and inventions, including the first demonstration of the basic element of today's metal oxide–semiconductor integrated circuit technology, the silicon–silicon dioxide MOS field-effect transistor. At the time of his death he was president of the NEC Research Institute in Princeton, New Jersey.

Dawon was born on 4 May 1931 in Seoul, Korea. He graduated from Seoul National University and entered Ohio State University in 1955. As part of his PhD research under Milton Boone and Marlin Thurston, Dawon investigated physical phenomena related to oxide masking, including the diffusion of impurities into silicon through SiO_2. He received his PhD and joined Bell Telephone Laboratories in 1959.

This was a period of intense effort on silicon surfaces and interfaces, both to improve the existing bipolar transistor technology and to make possible a practical FET device. Although the principles of a MOSFET and inversion-channel (enhancement mode) operation were largely understood, still missing, despite considerable searching, was an ideal insulator of sufficiently low interface state density and dielectric loss, with high enough dielectric strength to allow control of the channel with feasible gate voltages.

Dawon, in collaboration with Martin Atalla, fabricated a MOSFET using a gate insulator formed from high-quality SiO_2 grown *in situ* by a new, high-pressure steam oxidation process. They demonstrated transistor action, operated the device in several modes and reported the results in June 1960. Dawon later confirmed that the performance was consistent with first-order theory. This was the first successful operation of the modern MOS transistor and a major milestone in semiconductor technology.

Dawon made numerous other contributions to semiconductor physics and devices. In 1962–64 he demonstrated for the first time that Schottky barriers obeying the Bethe thermionic emission law could be reproducibly fabricated from Si and GaAs, and he verified the image-force lowering of the barrier. In collaboration with Martin Lepselter, Dawon showed that one could make practical and reliable Schottky junctions with many choices of metallurgy—for example, silicide–silicon junctions. In 1967 Dawon invented a field-effect memory device in which charges were injected across an insulator from silicon onto an isolated gate. This floating-gate memory, which Dawon demonstrated the same year in collaboration with Simon Sze, was the first nonvolatile silicon memory device and opened the way to read-only memory technology. In 1967 he and his colleagues demonstrated efficient electroluminescence from thin-film, wide-bandgap semiconductors in which rare earth ions were impact-ionized by hot electrons, a process they called Lumocen. Dawon continued research on the Lumocen concept throughout his life. As supervisor of a ferroelectric semiconductor group, he contributed to the understanding of field-dependent dielectric properties of ferroelectric semiconductors. His subsequent research was in the area of electronically reprogrammable memory cells, silicon MOS device physics and high-performance silicon VLSI circuits.

In 1987–88, after joining NEC as a consultant, Dawon played a central role in organizing the NEC Research Institute, which conducts long-term basic research in the physical and computer sciences. His plans for the institute included innovative policies encouraging collegiality, collaboration and invention. He served the institute as president from its founding in 1988 and lived to see his plans become a reality.

Dawon envisioned computers with powers of inference and cognition approaching human capabilities. A demanding research leader, he insisted that research be unconventional and that it combine scientific excellence with the potential for pointing the way toward applications. His strategic view of research was coupled with a remarkable intuition in evaluating individual projects. He made an indelible personal impression on his colleagues. Dawon continued creative scientific work and invention to the end of his life.

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