



SAMUEL L. MCCALL

semiconductor lasers and his important contributions to vertical-cavity surface-emitting lasers that may well find broad applications in optical data links. His analysis of Bragg reflectors typifies his approach to many problems. He wrote the forward and backward propagating wave amplitudes as a two-state spinor wavefunction and then showed that the coupling of these states in the grating is equivalent to a time-dependent Schrödinger equation with Pauli spin matrices in the Hamiltonian. This elegant analysis makes possible simple solutions to problems in which shifts are introduced into the gratings to stabilize the lasing mode frequency.

Sam will be remembered by his many friends for his deep and broad intellect. He was the source of wisdom one consulted to understand almost any problem. He would always start his explanations at the most fundamental level and expand them by using many examples. He was especially capable of carrying out theoretical calculations where rigor was appropriate, but in considering new phenomena, he could ignore the confines of mathematical rigor and quickly line up all kinds of possible mechanisms, discarding the improbable ones and homing in on the right one.

Sam will also be remembered for his wonderful baritone voice, his love of the outdoors and especially for his storytelling and sense of humor. He was an expert at castigating the arrogance and pretentiousness of this world with his sharp (often politically incorrect) humor. His critiques of physics research by both his colleagues and others outside Bell Labs made him famous (or infamous to some). But we all gained new insight from the sharp criticism. Sam was a sensitive human being and a wonderful

friend to many of us. We will miss this lovable genius.

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Lawrence C. Biedenharn Jr

Lawrence C. Biedenharn Jr, a well-known mathematical and theoretical nuclear physicist and James B. Duke Professor of Physics Emeritus, died on 12 February of cancer in Austin, Texas, where he lived after retirement from Duke University.

Biedenharn was born on 18 November 1922 in Vicksburg, Mississippi. His undergraduate studies at MIT were interrupted by World War II, which he spent in the US Army Signal Corps and in completing his bachelor's degree in absentia. Returning to MIT in 1946, he concentrated on theoretical nuclear physics, receiving his PhD in 1949 under John Blatt.

His lifelong pursuit of symmetries in nuclear (and later particle) physics began with his early publications. He extended Eugene Wigner's definition of time reversal to the realm of relativistic quantum mechanics. His work with Blatt and Murray E. Rose on the use of the rotation group in the theory of nuclear reactions and angular correlations in nuclear decays culminated in two review articles published in *Reviews of Modern Physics* in 1952–53; among that journal's most frequently cited articles, the two reviews are still standard texts.

After leaving MIT, Biedenharn spent two years at Oak Ridge National

Laboratory. In 1952 he became an assistant professor at Yale University, where he began his work on Coulomb excitation of nuclei. In 1954 he joined the faculty of Rice University, where he became an associate professor in 1956. Five years later, he moved to Duke University as a full professor. His work on the excitation of nuclear states by electrostatic forces led to a classic textbook, *Coulomb Excitation*, which he coauthored with Peter J. Brussard (Oxford U. P., 1965).

Biedenharn's interest next brought his formidable mathematical talent to bear on the role of symmetry groups in quantum physics. He and his collaborators generalized the Wigner–Racah calculus of tensor representations for the angular momentum group to other continuous symmetry groups, especially the unitary groups that play an important role in the classification of elementary particle states. This work culminated in two monographs, written with James Louck, *Angular Momentum in Quantum Physics* and *Racah–Wigner Algebra in Quantum Theory*, which were published as part of the *Encyclopedia of Mathematics and Its Applications* (Addison-Wesley, 1981).

Biedenharn's significant contributions to group theoretical methods in physics led to his worldwide recognition as one of the foremost leaders in modern theoretical physics. His research had a significant impact on both nuclear physics and condensed matter physics.

From 1985 until he retired from Duke in 1993, Biedenharn was the editor of the *Journal of Mathematical Physics*. In 1989 he published a widely cited paper about the quantum group $SU(2)_q$ in which he introduced the q -analog of the algebra of boson operators. In the following years, he contributed significantly to the popularization of the mathematics of quantum groups for theoretical physicists. His *Quantum Group Symmetry and q -Tensor Algebras* (World Scientific, 1995), coauthored with Max Lohe, appeared only a few months before he died.

Biedenharn was known to his colleagues and his many students as a man of erudition and manifold interests, which penetrated virtually every aspect of human life. His scientific productivity kept a steady pace throughout the years and even accelerated toward the end of his career.

He had a great love for music and was a devotee of chamber music in particular. His keen intellect will be remembered by his colleagues and coworkers.

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