In Memoriam Martin J. Berger (1922 - 2004)

Martin J. Berger died on November 6, 2004, at Suburban Hospital in Bethesda from the effects of a hematoma after a fall in which he struck his head. He lived in Bethesda, MD.

The radiation-physics community knows well Martin’s seminal contributions in the development of Monte Carlo methods for the transport of photons and charged-particles in extended media, and for his extensive body of critically evaluated radiation-interaction data. These data were not only necessary for the transport calculations but have become standard reference data for the radiological sciences. The use of electron/photon Monte Carlo calculations is now widespread, and the field has matured so much that in many disciplines heavy reliance is placed on the results of the better-known Monte Carlo codes in preference to much more difficult measurements. In fact, the medical-physics community has so thoroughly embraced Monte Carlo that calculated results are used extensively in medical radiation-dosimetry research, development, protocols and therapy planning. Martin Berger, with his 1963 paper, quite literally established the Monte Carlo calculation of charged-particle transport at the energies of interest in medical and radiation-protection physics; he is generally credited as being the father of modern electron and proton Monte Carlo methods. The methods he developed and the cross-section data for which he was largely responsible are imbedded in nearly all of today’s coupled photon/charged-particle Monte Carlo codes.

Martin Berger was born in Vienna, Austria on July 12, 1922. At the time of the annexation of Austria by Germany in March 1938, Martin’s parents, whom he was never to see again, sent him to England to escape. He spent 18 months in England living in a refugee camp for boys and with various English families, going to school and working. In early 1940 Martin immigrated to the United States, living in Pennsylvania, where he attended high school. He didn’t finish high school, but was encouraged to study physics on his own by an older cousin who was a scientist. He learned that the University of Chicago would accept students who passed the college-entrance examinations; he did so with a high score, which earned him a scholarship there. In three years, he earned a B.S. degree with a major in physics, graduating from the University of Chicago in 1943. Shortly after graduation, in 1944, Martin became a U.S. citizen and joined the Army, serving in the Aleutian Islands from 1944 to 1946. Shortly after his discharge, Martin spent a few months at Columbia University in New York City, and then returned to the University of Chicago, earning a M.S. in physics in 1948 and his Ph.D. in physics in 1951; his thesis was “Multiple Scattering of Fast Protons in Photographic Emulsions” under Marcel Schein. He then held a one-year post-doctoral fellowship there in mathematical statistics.

Martin had heard of the work being done in ionizing radiation by Ugo Fano and Lew Spencer at the National Bureau of Standards (NBS), and so he wrote to them, was invited for an interview, and was hired. He joined the Radiation Theory Section, headed by Fano, within the Atomic and Radiation Physics Division headed by Laurie Taylor at NBS, in September 1952. In 1964, Martin became Chief of the Radiation Theory Section and later, as well, Director of the Photon and Charged-Particle Data Center at NBS, in
charge of as many as 12 physicists, positions he held (through various reorganizations and re-naming) until his retirement in 1988.

At NBS in the 1950s, Martin concentrated first on the transport of gamma rays and developing photon Monte Carlo methods. He pioneered the applications of Monte Carlo calculations in complex media, extending calculations to realistic configurations involving boundaries and inhomogeneities. This work led to the comprehensive treatise in the Handbuch der Physik, with Fano and Spencer, on the penetration and diffusion of x rays (1959). His work on photon transport involved Berger in collaborations with Radiation Theory Section colleagues, working on cross-section information. One in particular was Rosemary McGinnies, the author of a number of important early evaluations. In 1960 Martin married Rosemary; they had three children and six grandchildren. Over the years, Martin retained his interest in photon-interaction cross sections, collaborating on critically evaluated databases that have become a standard for radiation-transport calculations.

Soon after the early work on photon transport, he began to focus on charged-particle transport, with emphasis on electrons and protons. His 1963 monograph “Monte Carlo Calculation of the Penetration and Diffusion of Fast Charged Particles,” in Methods in Computational Physics, thoroughly delineated the taxonomy, the methods, the underlying single- and multiple-scattering distributions, and the algorithms used in charged-particle Monte Carlo codes. This work was a departure from the few earlier papers of other authors done mostly for calculations of showers in high-energy approximations. In his study Martin developed a comprehensive approach based on the use of the most accurate distributions available to describe the transport of radiation. Because of the vastly larger number of charged-particle interactions than for photons, Martin refined and exploited a method that treats groups of successive collisions collectively in a single step of a random walk. Together with accurate analytical multiple-scattering theory, this reduced the problem to a manageable size, making possible the solution of a large class of radiation-transport problems. Perhaps the most telling compliment is that this early pioneering work is still remarkably relevant today, some 40 years later. Much of Martin’s work is incorporated in the Monte Carlo code packages the development of which he is responsible. His ETRAN code, first published in the 1960s, became the industry standard for coupled electron-photon transport. It has since evolved through many improvements and incorporation into other packages, such as the SANDYL code, the Integrated Tiger Series (ITS), and MCNP. More recently, he returned to proton transport, developing the PTRAN code (1993) to address the accuracy needed for the clinical proton-therapy beams that have come into increasing use.

In parallel with the development of charged-particle Monte Carlo calculations, Martin embarked on the development of critically evaluated cross-section data for electron and heavy-charged-particle interactions, information crucial for transport calculations. Martin was a member of the NCRP task group who prepared NBS Handbook 79 / NCRP Report 27 (1961) on Stopping Powers for Use with Cavity Chambers. In 1964 he published extensive tables of stopping powers and ranges for electrons and positrons and for heavy charged particles in the National Academy of Science - National Research Council Publication 1133 and in NASA special publications. His work on stopping powers continued, culminating in the publication of ICRU Report 37 (1984) for electrons and positrons, and of ICRU Report 49 (1993) for protons and
alpha particles. He was chairman of both report committees and contributed most of the analytical work. Martin’s work in this area directly contributed also to a number of other ICRU publications, such as Reports 14, 16, 21, 28, 35, 44, 46, 56, and the report of the ICRP-ICRU Joint Task Group on Dose Related Quantities for Radiological Protection Against External Radiation. His work included also the application of Spencer-Attix cavity theory to the evaluation of stopping-power ratios for use in radiation dosimetry, work that has been used, for example, in the dosimetry protocols for North America.

Critical to reliable electron-photon Monte Carlo calculations for a large and important class of problems is the use of accurate electron-bremsstrahlung production cross sections, a requirement particularly difficult at electron energies below some 10’s of MeV where the high-energy approximation is no longer valid. Early in his work on electron transport, Martin developed and demonstrated a synthesis of analytical theory and empirical corrections that formed the basis for the evaluation of the radiative stopping power as well as for the Monte Carlo calculations. Significant improvements were made in the 1980s with a new synthesis, this one of high-energy analytical theory with newly available exact results from phase-shift calculations at lower energies. A similar story holds for Martin’s work in the development of accurate cross-section information on the elastic scattering of electrons: evolving from complete reliance on analytical theory, justified at high energies, to the incorporation at lower energies of exact results from phase-shift calculations as they became available. More recently, Martin contributed his careful, expert approach to the work of the ICRU Report Committee on Elastic Scattering of Electrons and Positrons, of which Martin was a member until his death.

During the more than four decades of his Monte Carlo development work, Martin was busy also in applying these methods to important problems in radiological physics. Among these efforts are his work in providing point kernels for the absorbed dose from both photon- and electron-emitting sources (re: ICRU Report 32); in calculations of detector response functions for radiation spectroscopy (re: ICRU Report 53); in microdosimetric calculations (re: ICRU Report 36), and in numerous studies of the absorbed dose and the penetration of photons, electrons, bremsstrahlung and protons in materials of interest in medical dosimetry, radiation protection, radiation shielding, auroral physics, and radioactivity standardization. These contributions were reflected also in his invitation to participate in the writing of NCRP Reports 83 and 108 that provide definitive examinations of the basis for calculations of absorbed dose.

Martin continued this work after retirement, participating in the work of the ICRU and consulting for NIST and other agencies. In fact, of his nearly 150 publications, his last paper, “X-rays from thick tungsten targets irradiated by 500 – 50 keV electrons,” appeared in the November 2004 issue of Nuclear Instruments and Methods in Physics Research B just before his untimely death.

Martin made major contributions to the improvement, the standardization, and the promulgation of the best practices in many areas of radiological physics, both through his published work and through his service to the ICRU, the NCRP and the IAEA. His impact has been extensive and enduring. During his career at NBS, Martin received several awards for distinguished service, including the Silver and Gold medals of the U.S. Department of Commerce and the 1990 Radiation Science and Technology Award from the American Nuclear Society. His contributions are well recognized by the international
radiation-physics community, particularly in medical and health physics. In August of 2003 Martin received the L.H. Gray Medal from the ICRU, in recognition of his seminal contributions in the development of Monte Carlo methods for the transport of photons and charged-particles in extended media, and for his extensive body of critically evaluated radiation interaction data. However, perhaps the honor most valued by Martin was the Symposium on the Physics of Electron Transport held at the National Institute of Standards and Technology (which NBS has become) on 23 April 1990, where more than 60 of his friends and colleagues from around the world gathered to celebrate Martin Berger’s work and career. Please note that much of the material presented here has been taken from the tribute prepared for that meeting, which can be found in Appl. Radiat. Isot. 42 (10), XIII-XIV (1991).

Martin’s work has been scientifically impeccable. He looked carefully into all physical effects that are important in his calculations, he paid attention to all the details, and he checked thoroughly. He attacked each problem in his own way, which later usually became the standard way. He picked problems often not worked on by others and solved them in a correct, straightforward, useful manner. He was a pioneer. The radiological sciences have lost an important scientist.

Martin Berger is survived by his wife Rosemary of Bethesda; three children, Noah Berger of Sudbury MA, Michael Berger of San Francisco, Susan Berger Hanson of Issaquah WA; and six grandchildren.

Stephen M. Seltzer
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