high-energy physics operations was given to a third party, the Argonne Universities Association, newly formed by the Midwestern universities. But working within that contract, Crewe found it difficult to fix responsibilities, make workable plans, or escape endless, stressful meetings.

Nevertheless, the years of his administration were productive. For the first time, he pushed the basic research budget ahead of that for technical programs. In 1966, at the end of his five-year term, Crewe resigned as Argonne's director and returned to his professorship at the University of Chicago.

Crewe's major scientific achievement, taking almost four decades of effort, was to develop the STEM. The first requirement for his instrument was to produce a source of electrons, an "electron gun" with an effective size smaller than the desired resolution. To solve that problem, Crewe used field emission from the tip of a sharp needle.

The next requirement was to focus the electron beam to the same small source size onto an "image" plane, where it is used as a probe to scan across the sample. Given a sufficiently small source, the size of the image was determined by the magnitude of the spherical and chromatic aberrations in the focusing system. The solution to the problem of aberrations presented itself when Crewe gave a series of lectures on electron optics. One of his students pointed out at the end of the course that he had not mentioned sextupoles. Following up on the remark, Crewe wrote down the equations of motion and found that by incorporating two sextupoles, together with uniform magnetic and electrostatic fields, the aberrations could be eliminated.

The long effort to develop the electron gun and the much longer undertaking to produce an aberration-free focusing system resulted in a bright pointlike electron probe far superior to anything previously achieved. Crewe and his students applied the STEM to investigations in biology, metallurgy, and mineralogy, and in 1971 they used the STEM to produce images of single atoms. Thousands of STEMs are now in use at semiconductor fabrication facilities around the world.

Among his honors, Crewe received the 1976 Distinguished Physical Scientist award of the Microscopy Society of America, the 1977 Michelson Medal of the Franklin Institute, the 1979 Ernst Abbe Memorial Award of the New York Microscopical Society, and the 1980 Duddell Medal and Prize of the Institute of Physics. He was appointed to the University of Chicago's William E. Wrather Distinguished Service Professorship in 1977.

Crewe's outstanding contribution to science and his ever cheerful and optimistic disposition were deeply appreciated and will always be remembered by his colleagues and friends.

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Boris Peter Stoicheff

Boris Peter Stoicheff, the leading laser physicist in Canada and an eminent world figure in optical spectroscopy, died from multiple myeloma on 15 April 2010 in Toronto. He was beloved not only by his family but by his students, colleagues, and friends. He had an endearing nature and a charismatic personality that attracted people to him. Because of his broad perspective and sound judgment, he frequently was in demand as an adviser to the Canadian Association of Physicists, the Optical Society of America, and the Canadian government.

Born in Bitola, Macedonia, on 1 June 1924, Boris immigrated with his family to Toronto in 1931 because of political upheaval. In his formative years, he developed an interest in mathematics and critical thinking, which resulted in his going to the University of Toronto. He earned a BA Sc in engineering physics in 1947 and a PhD in experimental physics in 1950 under the direction of Harry Welsh. Boris's thesis was titled "Raman Spectroscopy of Gases at High Pressures."

HENRY M. VAN DRIEL

Boris Peter Stoicheff

At Welsh's suggestion, Boris moved to Ottawa to work in the laboratory of Gerhard Herzberg at the National Research Council Canada. He remained there for 14 years conducting high-resolution Raman and Brillouin experiments on gases and solids. In the Raman effect, light incident on a molecule generates a scattered component shifted from it by the molecular vibrational frequency. In Brillouin scattering, the scattered light is shifted by the acoustic frequency. The light source in those prelaser days was a high-pressure mercury lamp.

Optical spectroscopy changed dramatically in 1960 after Theodore Maiman's invention of the ruby laser. Boris entered the scene in 1963 by developing the first ruby laser in Canada. He then spent a year at MIT working with Charles Townes and his student Raymond Chiao. They studied the generation of stimulated Brillouin scattering and intense coherent hypersonic waves produced in quartz and sapphire following excitation by a pulsed ruby laser. In 1964 Boris participated in the Fermi Summer School in Varenna, Italy. He would comment later that the Italians considered that anyone wearing glasses must be a professor and that the idea went to his head, because at that juncture he accepted a professorship at the University of Toronto. In 1977 he was named University Professor, the school's highest honor. He was also a senior fellow of the university's Massey College.

At the Third International Conference on Laser Spectroscopy in Wyoming in 1977, Boris gave the keynote address, as he frequently did, and described the revolution taking place in laser spectroscopy. He was a colorful speaker with a commanding voice and a sense of humor. Once asked if he would like a microphone for his talk, he replied, "No, I don't need it. I have a built-in microphone."

Boris made several contributions to that revolution. For example, he used an argon-ion laser to make a precision Brillouin scattering measurement of a single crystal of the rare gas krypton. That work yielded elastic constants that for the first time could be compared with neutron scattering experiments.

In the past the resolution of optical

spectra in atomic or molecular gases was always limited by Doppler broadening, particularly for transitions to highly excited states with small level splittings. However, lasers provided the opportunity for developing new nonlinear techniques with Doppler-free spectra. Boris showed that highly excited states of the rubidium atom were accessible by a two-photon transition without Doppler broadening. The atoms were excited by two counter-propagating beams so that the Doppler frequency shifts canceled. In that way, the excited-state *D* doublet spacing of the Rb atom could be resolved for the first time up to principal quantum number $n = 32$.

In another area, he measured the ground-state dissociation energy of the simplest of all molecules, the hydrogen molecule. For that purpose, Boris and colleagues used a fluorescence technique employing a nonlinear multilaser scheme for generating tunable extreme UV radiation around 84.5 nm. The experimental result was $36\,118.11 \pm 0.08\ \mathrm{cm}^{-1}$, compared to a theoretical value of $36\,118.09 \pm 0.10\ \mathrm{cm}^{-1}$ based on a 249-term wavefunction that included relativistic, radiative, and nonadiabatic corrections.

Herzberg and Boris had a deep mutual respect and admiration for one another. While Boris was writing his mentor's biography, *Gerhard Herzberg: An Illustrious Life in Science* (NRC Press and McGill-Queen's University Press, 2002), he made numerous trips to Ottawa to interview Herzberg, whose health was failing. Boris pursued his task with great vigor and meticulousness, visiting the University of Chicago, the Yerkes Observatory, and all the places in Germany where Herzberg lived and taught.

Boris served as president of the Optical Society of America (OSA) from 1976 to 1977 and of the Canadian Association of Physicists from 1983 to 1984. Among the numerous honors he received were a 1982 appointment as an officer of the Order of Canada, the 1967 Centennial Medal of Canada, and, from OSA, its 1981 William F. Meggers Award and 1983 Frederic Ives Medal.

All who knew him will miss this kind gentleman who had a special talent for making people feel better just by being in his presence.

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