PLACZEK, GEORGE (*b.* Brünn, Moravia [now Brno, Czechoslovakia], 26 September 1905; *d.* Zurich, Switzerland, 16 October 1955), *molecular spectroscopy, nuclear physics.*

Placzek was the oldest of three children born to Alexander Placzek and Marianne Pollack. His father owned a factory in Brünn, and the family was quite well-to-do. Placzek apparently attended primary and secondary schools in Brünn, displaying abilities in both science and languages. Later known for his classical erudition, he particularly enjoyed reading Renaissance science treatises in their original languages. Placzek and his family were Jewish but did not practice the religion. His parents and sister were killed and died and his brother committed suicide during World War II. Placzek was twice married, the second time, in 1943, to Els Halban. He suffered for many years from pernicious high blood pressure, which caused considerable pain in later years. He became an American citizen in 1945.

Placzek studied physics at the universities of Prague and Vienna, receiving his doctorate under Hasenöhrl in 1928. His dissertation involved an experimental study of the electrodynamics of moving particles. His subsequent work, pursued at leading research centers in Europe and America, concerned the scattering of electromagnetic radiation and neutrons in matter. He was regarded as a foremost authority on both subjects.

Electromagnetic waves entering matter are reflected, refracted, or dispersed in various directions at various frequencies. Working with H. A. Kramers and L. S. Ornstein at Utrecht (1928–1931), Placzek began applying the newly established quantum mechanics to the equally recent discovery of the Raman effect, a type of inelastic scattering of light by molecules. Unlike elastic (Rayleigh) scattering, the emitted frequency differs from the incident frequency, since the scattering molecule is left in an excited vibrational or rotational state. The frequencies of such states, which yield infrared electron spectra, appear in the Raman effect as shifts in the visible or ultraviolet spectra. Both the infrared and the Raman spectra depend on the symmetry of the molecular configuration, but in different ways. Valuable symmetry information can be extracted from a comparison of the two types of observations. This is now a standard procedure in molecular chemistry, but it relies upon relating the properties of Raman spectra to molecular symmetry.

Placzek was the founder of this important line of research. Taking a phenomenological approach, he related the amplitudes and polarizations of the observed Raman lines to the matrix elements of the polarization tensor of the scattering molecule, taken between vibrational and rotational quantum states. While the infrared spectra derive from the electric dipole moment of the molecule, the Raman spectra depend upon more complex configurations and symmetries. In 1932 Placzek wrote the then definitive treatise on the Raman effect while at Fermi's institute in Rome.

During the period 1932–1939 Placzek worked intermittently at Bohr's institute in Copenhagen and with Lev Landau in Kharkov. During the 1934–1935 academic year he taught at the Hebrew University in Jerusalem; in 1938 he worked with Hans von Halban, Jr., in Joliot's institute in Paris; and in 1939 he was appointed research associate at Cornell University. During these travels Placzek's research turned increasingly to experimental and theoretical studies of neutron absorption and neutron-induced reactions, topics inspired by the discovery of the neutron in 1932.

Placzek's work in Copenhagen rendered him a leading authority on neutron scattering and absorption in matter. In a series of experiments, Placzek and Otto Frisch demonstrated that the absorption of neutrons in matter is strongly dependent upon the atomic mass of the material and the velocity of the neutrons, but for slow neutrons and light elements, such as boron 10, the neutron-capture cross section is inversely proportional to the velocity, v. They used boron 10 as a velocity "indicator" to study neutron absorption in heavier elements, for which they observed absorption resonances. Placzek and H. A. Bethe provided a fundamental theory of neutron absorption resonances by analogy to the Raman effect, from which they derived the $1/v$ law and selection rules for various forms of inelastic scattering. Using the optical theorem and Bohr's liquid-drop model of the nucleus, Placzek, Bohr, and Peierls offered a fundamental theory of neutron-

induced nuclear reactions. These works proved essential to the subsequent development of nuclear theory and to development of nuclear reactor design.

Placzek's critical skepticism of any work, including his own, sometimes hindered his publications but it stimulated others to clarify and to expand upon their ideas. This was evident after the discovery of nuclear fission late in 1938. Placzek's initial skepticism induced Frisch, then in Copenhagen, to search for fission fragments. It also encouraged Bohr's realization of the crucial isotope effect for natural uranium: uranium 235 is fissionable by slow neutrons, uranium 238 by fast; intermediate-velocity neutrons have no effect.

After conceding the existence of fission, Placzek worked at Cornell, and in collaboration with Fermi's group at Columbia University, on problems of neutron propagation in nuclear chain reactions. In 1943 Halban appointed Placzek head of the Theoretical Physics Division of the Canadian Nuclear Research Laboratory at Chalk River, near Montreal. In 1945 he joined the staff of the Los Alamos Scientific Laboratory; in 1946 he transferred to the laboratories of the General Electric Company; and in 1948 he became a member of the Institute for Advanced Study at Princeton. His research after 1942 concerned methods for the treatment of the slowing down and diffusion of neutrons in matter for application to reactor design. His lectures at Los Alamos on neutron diffusion became a standard textbook on the subject.

Much of Placzek's work during his last years remains unpublished, just as his contributions as a communicator and critic of ideas remain little appreciated. His work at Princeton, supported in part by the Atomic Energy Commission, continued to concern the relationship of neutron diffusion to material structure. His pioneering studies of the inelastic scattering of high-energy neutrons in dense crystals contributed both to crystallography and to reactor design, and opened a new field of interdisciplinary research. In the midst of this research Placzek suffered a fatal heart attack shortly after arriving in Europe to begin a Guggenheim Fellowship in Rome.

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