IL'YA MIKHAILOVICH FRANK

(In honor of his Sixtieth Birthday)

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IL'YA Mikhaĭlovich Frank, a scientist widely known for his outstanding researches into physical optics and nuclear physics, will celebrate his 60th birthday on 23 October 1968.

Frank's interest in these domains of physics was conceived under the influence of his teacher S. I. Vavilov. While still a student, Frank began to work at Vavilov's laboratory in the Moscow State University, where under his direction he carried out an experimental study of luminescence quenching in fluids. Following his graduation from the University (in 1930) Frank joined the laboratory of A. N. Terenin at the Vavilov State Optical Institute where for several years he studied photochemical reactions by optical methods. His work in that direction was distinguished by procedural elegance and originality as well as by thoroughness of analysis of experimental data, and it served as the basis for awarding him, then 26 years old, his doctoral degree.

In 1934, on Vavilov's initiative, Frank transferred to the Lebedev Physics Institute, which had just then been separated from the Physics and Mathematics Institute, and has been working there to this day. As he was clearly aware of the significance of the "greater" nuclear physics that was coming into life just then, Vavilov suggested to a group of young scientists, including Frank, that they switch to the study of atomic nuclei. In collaboration with L. V. Groshev, Frank began to prepare himself to investigate the recently discovered phenomenon of the production of electron-positron pairs by gamma-quanta. It was roughly in that period that P. A. Cerenkov, then a graduate student of Vavilov, commenced his renowned studies of the glow of fluids in the presence of gamma-rays of radium. Frank stood very close to these experiments, in which the extraordinary properties of this glow had been discovered.

Vavilov demonstrated that this unusual glow is due to the electrons produced during the interaction between gamma rays and matter and is not a luminescence effect. The nature of this glow, now called Cerenkov radiation, had, however, remained mysterious until in 1937 I. E. Tamm and I. M. Frank in their now classical study provided an exhaustive explanation for it as the emission of electrons moving in a medium at velocities greater than the phase velocity of light. Frank's contribution to the solution of the problem by this brilliant teamwork of distinguished physicists consisted in his special insight into the deepest aspects of experiment and theory.

Later on the significance of Cerenkov radiation to physics had become widely recognized and a large number of applications was found for this effect. This recognition was, in particular, expressed in the awarding of the 1946 State Prize of the First Degree to S. I. Vavilov, I. E. Tamm, I. M. Frank and P. A. Cerenkov, the awarding of the 1958 Nobel Prize in Physics to Tamm, Frank and Cerenkov and Frank's election to Corresponding Membership in the USSR Academy of Sciences (1946).

Just as to the entire physics the Cerenkov effect became a point of departure for the development of an entire new domain of science, so to Frank the explanation of this effect became the starting point of his continuing active interest in the steadily broadening problem of the effect of optical properties of media on the radiation of a moving source. The radiation of the "faster-than-light" electron (i.e. the Cerenkov effect) in the elementary case (an isotropic medium, etc.) was essentially only the first of the problems engendered. Frank stated and thoroughly analyzed many other relevant problems. Some idea of them can be provided by the titles of certain of his studies: "The Doppler Effect in a Refractive Medium" (1942); "Interference Phenomena and Cerenkov Radiation" (1944); "Radiation of a Uniformly Moving Electron, Arising During its Transition from One Medium to Another" (co-authored with V. L. Ginzburg, 1945); "The Doppler Effect at Faster-

Than-Light Velocities'' (co-authored with V. L. Ginzburg, 1947); ''Cerenkov Radiation for Multipoles'' (1952); ''Flash Duration in the Cerenkov Effect'' (1956); ''Critical Velocity in Light Emission in Optically Anisotropic Media'' (1960); ''Transition Radiation of a Relativistic Charged Particle in the Optical Frequency Range'' (co-authored with V. E. Pafomov, 1965); ''Scattering of Light by Electrons Moving in a Refractive Medium'' (1968), etc.

These studies had predicted a number of new optical effects. The most famous of these at present is the so-called transition radiation, first investigated by Frank in collaboration with V. L. Ginzburg in the aforementioned 1945 study. In recent years a large number of experimental studies of this highly distinctive effect has been published (cf. reviews of I. M. Frank published in Usp. Fiz. Nauk in 1961 and 1965) and they have completely confirmed the existence of this effect and its predicted features. Experiments in this direction also are being carried out under Frank's guidance at Dubna. Transition radiation is beginning to be used as a method for investigating the optical properties of matter as well as the foundation for a new method of measuring the energy of relativistic particles.

Of no smaller significance than the applied results of the above group of studies is the unified physical picture of all these processes with their broadly varied manifestations. Such a unified physical interpretation, and particularly the concept of the formative zone of the radiation of a moving source enabled Frank and his numerous followers to arrive at clear and explicit conclusions regarding a multitude of particular problems.

It is probable that the other effects considered by Frank will attract greater attention as beams of high-energy particles become increasingly accessible. In this respect the last-named of the above studies may be of special interest: it showed that under definite conditions the process of the ''scattering'' of light on a fast electron is possible; at such a process the original photon not only does not become absorbed but even causes the formation of an induced photon and, in addition, then a photon of scattered light arises.

Although Frank has accomplished much in optics and continues his work in that domain, during the last quarter-century his main profession—if one may put it this way—has been nuclear physics. He was the organizer (1946) and head of the Laboratory of the Atomic Nucleus, Physics Institute of the Academy of Sciences, and the organizer (1957) and Director of the Laboratory of Neutron Physics at the United Institute of Nuclear Research in Dubna. Between 1946 and 1956 he also headed the Laboratory of Radioactive Radiation at the Scientific Research Physics Institute of the Moscow State University.

Apart from several experimental studies of cosmic rays, carried out on Mt. Elbruss, Frank's prewar research into nuclear physics dealt with the generation of electron-positron pairs. In an entire series of studies based on the use of a Wilson chamber and performed in collaboration with L. V. Groshev, he had very thoroughly investigated pair production by gamma rays in krypton and nitrogen and carried out the most valid and comprehensive contemporary comparison of the quantum theory and experiment concerning this phenomenon.

During the difficult wartime years when the Physics Institute of the Academy of Sciences was evacuated to Kazan', Frank, of course, concentrated directly on applied research. Thus, e.g., he worked on methods of measuring the variation in tube wall thickness with the aid of the gamma rays of radioactive preparations.

In the mid-1940's Frank energetically participated in the study of the problems confronting the Soviet nuclear physics in connection with the urgent need to solve the atomic problem. Together with a group of associates and disciples he carried out a broad program of theoretical and experimental research into the propagation and multiplication of neutrons in heterogeneous uranium-graphite systems, which were practically the most important systems of this kind at the time. In this case, too, Frank contributed his characteristic subtle comprehension of physical problems and this, of course, affected the development of research. Another major cycle of studies that he carried out dealt with the experimental investigation of light-nucleus reactions, during which neutrons are emitted, as well as with the interaction between fast neutrons and nuclei.

The orientations developed at the Physics Institute of the Academy of Sciences during those several years of intense work—neutron physics and light-nucleus reactions—have since remained basic to Frank.

It would take an inordinate amount of space to describe all the lines of research pursued by Frank and the teams working under his direction. We shall dwell on only a few of these.

The aforementioned research into neutron propagation in media was formerly carried out by conventional methods originating from the work of Fermi and his associates and based in one way or another on measurements of the spatial distribution of neutrons emitted by a stationary source. In certain respects these methods were inadequate. In 1952 Frank showed that the measurements of the time distribution of neutrons emitted by a pulsed source represent a superior method of investigating neutron moderation and diffusion. The pertinent experiments organized soon afterward not only confirmed this claim but also led to the discovery of a new phenomenon—the so-called diffusion cooling of neutrons—a consequence of the finite rate of the onset of a thermal equilibrium between the neutron gas and the ambient medium. Frank also provided a theoretical explanation of this new effect. This work has been followed up by numerous new studies both in the methodological and in the physical plane, which produced results of importance to reactor physics and geological exploration. At present the pulsed method of investigating neutron propagation has become commonly adopted; in 1965 a special international conference devoted to its various applications was held in West Germany.

In 1956, when the United Institute of Nuclear Research was organized, it was decided to build in Dubna a highly original facility, namely, a pulsed fast-neutron reactor designed for spectroscopic neutron studies based on the transit-time principle. Frank undertook the task of organizing at the above Institute a new laboratory for the purpose of constructing this reactor and using it for physics research. The reactor was put into operation in 1960 and since then it has been performing satisfactorily and is being continually improved. The international team of young scientists working in the laboratory headed by Frank have convincingly demonstrated all the advantages of this new principle, so that as a result projects for the construction of pulsed research reactors have appeared in a number of countries. Of the experiments performed with the aid of the pulsed fast-neutron reactor special mention is deserved by experiments with polarized neutrons and polarized nuclear targets, studies of neutron resonance and a series of studies of the physics of condensed media.

The Laboratory of Neutron Physics in Dubna and the Laboratory of the Atomic Nucleus at the Physics Institute of the Academy of Sciences also continue their research into light-nucleus reactions as well as into fast neutrons. In recent years Frank and B. A. Benetskii have carried out interesting experimental studies of correlations in the inelastic scattering of fast neutrons.

Frank's style as a scientist is characterized by depth and clarity of thought and ability to reveal the essence of a subject by the most elementary methods. He never accepts vagueness or ambiguity of understanding. This is characteristic of the school of L. I. Mandel'shtam, of which he is a follower, as he himself has observed more than once. As a supervisor he is not prone to excessive interference. Yet even his skeptical silence or a rare puzzled question often prevent straying from the path and hasty conclusions, while his restrained approval or advice assist in acquiring greater confidence, which is so important to the tyro researcher.

Lucidity and logical reasoning also distinguish many of the articles written by Frank as well as the lectures which for many years he had been giving at the Moscow State University, where also he was a department head. Many now full-pledged physicists consider themselves his disciples.

He also has been and is devoting a great deal of effort to his work as scientific organizer—to facilitating work with nuclear photoemulsions in the USSR, organizing conferences on nuclear physics, being active at the Party bureau of the Division of Nuclear Physics, USSR Academy of Sciences, etc. Frank's work and his accomplishments have more than once been rewarded by State prizes.

We wish him good health and further successes.

Translated by E. Bergman