

CONFERENCES AND SYMPOSIA

PACS numbers: 01.10.Fv, **01.60.+q**, **01.65.+g**, 03.75.Be,
28.20.–v, **28.41.–i**,41.60.Bq, 41.60.Dk

Commemoration of the centenary of the birth of Academician I M Frank
(Scientific session of the Physical Sciences Division of the Russian Academy of Sciences, 22 October 2008)

G A Mesyats; B M Bolotovskii; A N Sissakian, M G Itkis;
B A Benetskii; A I Frank; V L Aksenov

DOI: 10.3367/UFNe.0179.200904g.0403

To commemorate the centenary of the birth of the Nobel Prize Laureate in Physics 1958 Academician I M Frank, a scientific session of the Physical Sciences Division of the Russian Academy of Sciences (RAS) took place on October 22, 2008 in the Conference Hall of the P N Lebedev Physical Institute. The following reports were presented at the session:

(1) **Mesyats G A** (P N Lebedev Physical Institute, RAS, Moscow) "Il'ya Mikhailovich Frank (opening address)";

(2) **Krokhin O N** (P N Lebedev Physical Institute, RAS, Moscow) "I M Frank and research in optics";

(3) **Bolotovskii B M** (P N Lebedev Physical Institute, RAS, Moscow) "I M Frank's papers on the radiation of sources moving in refractive media (the 'optics of moving sources')";

(4) **Sissakian A N, Itkis M G** (Joint Institute for Nuclear Research, Dubna, Moscow region) "I M Frank and the development of the Joint Institute for Nuclear Research";

(5) **Benetskii B A** (Institute for Nuclear Research, RAS, Moscow) "I M Frank: founder and leader of FIAN's Laboratory of Atomic Nucleus";

(6) **Frank A I** (Joint Institute for Nuclear Research, Dubna, Moscow region) "I M Frank and the optics of ultracold neutrons";

(7) **Aksenov V L** (Joint Institute for Nuclear Research, Dubna, Moscow region) "Pulsed nuclear reactors in neutron physics".

An abridge version of the opening address and reports 3–7 is given below.

PACS numbers: **01.60.+q**, **01.65.+g**, 41.60.Bq
DOI: 10.3367/UFNe.0179.200904h.0403

Il'ya Mikhailovich Frank
(opening address)

G A Mesyats

On October 23, 2008, Il'ya Mikhailovich Frank — an outstanding physicist, Full Member of the Academy, Nobel Prize Laureate — would have celebrated his 100th anniversary of the birth. Il'ya Mikhailovich was born in Saint Petersburg into a family of intelligentsia. His father, a talented mathematician and teacher of mathematics, greatly influenced the futures of his sons (Il'ya Mikhailovich's brother Gleb became a well-known specialist in biophysics). At the beginning of the 1920s, the Franks moved to the Crimea. Il'ya attended secondary school in Yalta, then attended lectures at the Crimea University in Simferopol', without enrolling as a student; his father was a professor there. Il'ya Mikhailovich worked in the physics laboratory and attended a mathematics hobby group. In 1926, he enrolled in the Physics and Mathematics Department of Moscow State University (MGU) and graduated from there

Il'ya Mikhailovich Frank
(23.10.1908 – 22.06.1990)

Uspekhi Fizicheskikh Nauk **179** (4) 403 – 441 (2009)
DOI: 10.3367/UFNr.0179.200904g.0403
Translated by V I Kisin, G Pontecorvo, E N Ragozin;
edited by A Radzig

in 1930, having majored in two subjects: physics (at the Chair of Theoretical Physics under L I Mandel'shtam) and mathematics. In his sophomore year he began working in S I Vavilov's laboratory; they published a joint paper on luminescence in 1931. In 1930–1934, he studied photochemical processes at the State Optical Institute in which S I Vavilov was deputy director for research; in 1932, Vavilov became head of the Physics Department of the Physicomathematical Institute. The Physics Department was the place where work had started on studying the properties of the newly discovered neutrons, luminescence of liquids under ionizing radiation, the coloring of crystals, the microstructure of liquids, electric breakdown in gases, and the catalysts of chemical reactions.

This was the period when, together with I M Frank, a number of brilliant scientists were working under S I Vavilov's guidance: G A Gamow, L V Mysovskii, N A Dobrotin, P A Cherenkov, L V Groshev, and some others. More laboratory equipment was acquired, various seminars opened up. The department grew familiar with new physics and was rapidly opening a new efficacious phase in its life. Even though S I Vavilov's specialty per se was physical optics, the range of his interests in science was much broader. At that particular moment, Vavilov's goal was to create a new 'polyphysics' institute that would combine the main avenues of research in the present-day physics, dictated by the logic of progress in science; each field was to be headed by a first-class specialist. S I Vavilov discussed the future structure of the Physical Institute with his colleagues. He clearly recognized the importance of the physics of the atomic nucleus that was just emerging then and understood the compelling need to support the 'new physics' born at the start of the 20th century — the theory of relativity and quantum mechanics. He also understood very clearly that theory is just as important for modern physics as experimentation is and that these two components of physics as a science are inseparably tied together.

The general meeting of the USSR Academy of Sciences on 28 April 1934 decided to split the Physicomathematical Institute in two: the Mathematical Institute, and the Physical Institute. Soon after, in summer 1934, the USSR Government decreed that both institutes and the Academy of Sciences itself should move to Moscow into the building on 3rd Miusskaya Street, already built in 1912; the money for the building was donations for the laboratory of Petr Nikolaevich Lebedev. This step completed a more than 200 years' evolution of a small department of the Kunstkamera, followed by the transformation (started by A N Krylov and accomplished by S I Vavilov) of the Physicomathematical Institute to the Physical Institute of the Academy of Sciences (FIAN in *Russ. abbr.*, or the Lebedev Physical Institute). This event also symbolized the merger of the older Petersburg academic physics with the younger Moscow university physics. This is the right place to mention the friendship between B B Golitsyn and P N Lebedev, which began in their student days at Strasbourg University and continued until the death of P N Lebedev. The new Physical Institute thus combined the traditions of the Golitsyn and Lebedev scientific schools. The first head of the Physical Institute was, incidentally, a student of P P Lazarev, Academician S I Vavilov (Lazarev was an assistant professor and P N Lebedev's closest assistant).

When S I Vavilov looked for coworkers, he invariably tried to identify the most talented researchers and thus laid the foundation for the growth of strong scientific schools in the future. Academician A N Krylov is known to have quipped that Sergei Ivanovich tried to hire only people stronger than himself.

In fact, 1934 was the year when the new history of FIAN began. Soon to appear here were the Laboratory of Atomic Nucleus headed by D V Skobel'tsyn, whose staff included V I Veksler, S N Vernov, L V Groshev, N A Dobrotin, I M Frank, P A Cherenkov, and others; the Laboratory of the Physics of Oscillations headed by N D Papaleksi (A A Andronov, B A Vvedenskii, L I Mandel'shtam, G S Gorelik, S M Rytov, P A Ryazin, E Ya Shchegolev, and others); the Laboratory of Physical Optics led by G S Landsberg; the Laboratory of Luminescence headed by S I Vavilov (V V Antonov-Romanovskii, V L Levshin, M A Konstantinova, L A Tumerman, and others); the Laboratory of Spectral Analysis led by S L Mandel'shtam; the Laboratory of the Physics of Dielectrics under B M Vul; the Laboratory of Theoretical Physics headed by I E Tamm (D I Blokhintsev, V L Ginzburg, M A Markov, K V Nikol'skii, E L Feinberg, V A Fock, and others), and the Laboratory of Acoustics headed by A A Andreev (S N Rzhevkin, L D Rozenberg, Yu M Sukharevskii, and others). From 1934 till 1937 the Institute also included the Laboratory of Surface Phenomena headed by P A Rebinder. In the pre-WWII period, FIAN organized annually an expedition to Mount Elbrus to record cosmic rays and observe certain atmospheric optics phenomena. I M Frank went on two Elbrus expeditions, where he used the Wilson chamber to study cosmic rays.

I M Frank worked at FIAN from 1934 to 1970. In 1935 (at 26 years of age!), Il'ya Mikhailovich submitted and viva voce defended his DSc thesis. In 1940, he became a professor at Moscow State University, and between 1946 and 1956 headed the Laboratory of Radioactive Radiation at the Research Institute of Nuclear Physics at Moscow State University. In 1957, I M Frank became Director of the Laboratory of Neutron Physics at the Joint Institute for Nuclear Research (JINR) at Dubna, and in 1971 headed a laboratory at the Institute for Nuclear Research of the USSR Academy of Sciences. I M Frank's main publications were devoted to physical optics, neutron physics, and low-energy nuclear physics.

Vavilov insisted that, having transferred to FIAN, Frank should switch to nuclear physics. From 1937 to 1940 Frank (together with L V Groshev) published a series of papers concerning the creation of electron–positron pairs in a Wilson chamber filled with krypton and irradiated by gamma quanta.

At about this time, Pavel Cherenkov, one of Vavilov's postgraduates at the Lebedev Physical Institute, began studying blue-color glow (later named Cherenkov or Vavilov–Cherenkov radiation) which was caused by gamma rays in refracting media. Cherenkov was able to show that this radiation was not just another form of luminescence, but he was unable to explain it in theoretical terms. In 1937, I M Frank and I E Tamm succeeded in calculating the properties of an electron moving uniformly through a medium with a velocity exceeding the speed of light in this medium. They disclosed that energy must be emitted in this situation, with the angle at which the generated wave propagates expressed in a simple way in terms of the speed of the electron and the speed of light in a given medium and in a vacuum. One of the first results of the new theory was the explanation of the polarization of Cherenkov radiation. The theory proved to be so successful that Frank, Tamm, and

Cherenkov were able to check some of its predictions experimentally, such as the presence of energy threshold for the incident gamma radiation, the dependence of this threshold on the refractive index of the medium, and the characteristic geometric shape of the emerging radiation (a hollow cone with the axis along the direction of the incident radiation).

In 1946, I M Frank was elected Corresponding Member of the USSR Academy of Sciences, and the team-work by Tamm, Frank, Cherenkov, and Vavilov was awarded the USSR State Prize. In 1958, Cherenkov, Frank, and Tamm won the Nobel Prize in Physics "for the discovery and the interpretation of the Cherenkov effect." In his Nobel lecture Frank said that the "Cherenkov effect had found numerous applications in the physics of high-energy particles. A connection between this phenomenon and many other problems has also been found, as for example, the physics of plasma, astrophysics, the problem of radio wave generation, the problem of acceleration of particles, etc." The discovery of Vavilov–Cherenkov radiation resulted in the development of a new method of detection and measurement of the velocity of high-energy nuclear particles. This method plays an enormously important role in current experimental nuclear physics.

This particular work started the whole series of I M Frank's theoretical publications treating light sources moving in a refracting medium. He developed the theory of the so-called complex Doppler effect — that is, the Doppler effect in a refracting medium, and of the anomalous Doppler effect for a source moving with superluminal speed (in 1947, together with V L Ginzburg). In 1946, Frank and Ginzburg predicted the transition radiation emitted when a moving charge crosses a planar interface between two media. This type of radiation is emitted due to the restructuring of the electric field of a uniformly moving particle when it crosses the interface between two media possessing different optical properties. Even though this theory was later experimentally verified, some of its important implications continued to resist laboratory tests for more than a decade.

In the mid-1940s, I M Frank conducted theoretical and experimental studies of neutron multiplication in heterogeneous uranium–graphite systems. This work helped in understanding the laws of neutron transfer in nuclear reactors; for example, it was possible to determine with high accuracy the critical dimensions and the neutron multiplication factor in an infinitely large system and to study how these parameters depend on the properties of the uranium–graphite lattice. Il'ya Mikhailovich suggested and developed a pulse technique for studying the diffusion of thermal neutrons, and discovered in 1954 how the mean diffusion coefficient depends on the geometric parameter (the diffusion cooling effect). He also developed a new method of neutron spectrometry — by the time of neutron slowing-down in lead.

I M Frank supervised a series of experimental studies of reactions involving light nuclei in which neutrons are emitted, the interaction between fast neutrons and the nuclei of tritium, lithium, and uranium, and the process of fission in the nucleus; he launched studies of short-lived quasistationary states and the fission of nuclei bombarded by mesons and high-energy particles. In 1957, I M Frank supervised the establishment of the Laboratory of Neutron Physics at JINR. Here he was one of the leaders of the program of developing fast periodic pulse reactors for spectroscopic neutron studies: IBR-1 (1960) and IBR-2 (1981). From 1970, Frank worked exclusively for JINR.

In 1954 and 1971, I M Frank's work was rewarded by USSR State Prizes, and in 1968 he was elected Full Member of the USSR Academy of Sciences.

I M Frank was convinced that a scientist absolutely must be widely educated and a person of the intelligentsia. His scientific papers are perfectly designed and written in clear style. Colleagues always appreciated his exceptional intuition in the arrangement of experiments and in searching for solutions to theoretical problems. All his life I M Frank deeply respected his beloved teacher — S I Vavilov. He prepared a volume of collected reminiscences about Sergei Ivanovich, which went through two editions. Il'ya Mikhailovich died (in Moscow on 22 June 1990) several days after he had completed work on the third edition. Until the very end, Il'ya Mikhailovich was unflinchingly faithful to his optimistic attitude to creative work and to life in general, most of all because fate gave him the possibility of always being able to do the job he loved.

PACS numbers: **01.65.+g**, 41.60.Bq, 41.60.Dk
DOI: 10.3367/UFNe.0179.200904i.0405

I M Frank's papers on the radiation of sources moving in refractive media (the 'optics of moving sources')

B M Bolotovskii

A charged particle which travels through a refractive medium, i.e., a medium whose properties are defined by specifying its permittivity and permeability, becomes a source of electromagnetic waves. At the present time, the radiation of moving sources in different kinds of refractive media has become a rather vast field of physics. Extensive experimental and theoretical data have been accumulated in this field, and the results of investigators have led to significant application in physics.

This branch appeared in the 1930s, when the Vavilov–Cherenkov effect was discovered and interpreted. In this case, the emergence and progress of the electrodynamics of moving sources (or the optics of moving sources) are intimately related to I M Frank's name. He deserves the credit for the underlying contributions to this field of physics, which define the level of achievements and the present state of the problem. By the way, the term 'optics of moving sources' owes its origin to I M Frank and implies precisely the same meaning as the 'electrodynamics of moving sources'.

I M Frank studied at the Physics Department of Moscow State University (MGU in *Russ. abbr.*). When it was time to choose a specialty, he opted for optics. The supervisor of his degree research was Professor Sergei Ivanovich Vavilov, the founder-to-be of the P N Lebedev Physical Institute and the president-to-be of the USSR Academy of Sciences. S I Vavilov made a substantial contribution to several branches of optics, to the nature of luminescence in particular. During the student years of I M Frank, optics at the Physics Department of MGU was embodied in world-famous physicists like G S Landsberg and L I Mandel'shtam. They were outstanding scientists and wonderful teachers.

The lectures on electromagnetic theory were delivered by Igor' Evgen'evich Tamm. At that time, he was writing the course *Osnovy Teorii Elektrichestva* (Foundations of Electric