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Abram Fedorovich Ioffe

(On his seventy-fifth birthday)

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OCTOBER 29, 1955 marked 75 years since the day of birth and 50 years of scientific activity of an outstanding Soviet physicist, Member of The Academy of Sciences, USSR, Abram Fedorovich Ioffe. All of the physicists and the learned world of the Soviet Union celebrate this famous jubilee and greet Abram Fedorovich Ioffe not only as an outstanding scientist, but also as one of the greatest organizers of science in the Soviet Union.

A. F. Ioffe was born in the cityof Romny (Poltav District) in 1880. After having completed the Real (Secondary) School in Romny, he entered the Petersburg Technological Institute.

Manifesting great interest in scientific investigation and experimental physics, Abram Fedorovich upon graduating from the Institute went to Munich to work with the great experimental physicist Roentgen. From 1902 to 1906 he worked with Roentgen, where he was occupied with the investigation of the electrical and elastic properties of quartz, He completed his studies at the Physics Institute of the University of Munich with great distinction and received the degree of Doctor of Philosophy.

In 1906, after having declined a proposal of Roentgen to remain and work in Munich, Ioffe returned to Petersburg and was appointed as a researcher to the chair of Physics in the Polytechnical Institute. Up to 1914 he still continued to collaborate with Roentgen. During this period, along with the investigation of the electrical and mechanical properties of crystals, Abram Fedorovich was studying the nature of light and the atomic structure of electricity. The investigations of the elementary photoeffect and of the magnetic field of cathode rays were the subject of his master's dissertation, which he defended in 1913. In the same year Ioffe was elected Professor of Physics of the Petersburg Polytechnical Institute. The continuing investigation of the electrical and elastic properties of quartz was the subject of his subsequent dissertation, for which the Petersburg University awarded him the degree of Doctor of Physics in 1915.

The real development of the scientific and organizational activity of A.F. Ioffe began after the great October Revolution. He was one of the great scientists who from the very first days of the establishment of Soviet rule fully supported it. In the difficult year of 1918 he was actively engaged in the organization of the State Roentgen (X-ray) and Radio Institute in Petrograd. Before long the Physics Department of this Institute, headed by Abram Fedorovich, was made into an independent State Physico- Technical Roentgen Institute.

From the very beginning of the foundation of the Physico- Technical Institute Ioffe considered that along with the investigation of the physical properties of matter, it is necessary to develop the trend of introducing the attainments of physics into industry. The name of the Institute itself emphasized that this course—the relationship between physics and technology—was the most important object of the Institute. The chief collaborators of the newly established Institute became the young physicists, students of Abram Fedorovich— participants in the physics seminar which he organized at the Polytechnical Institute in 1916. A great many of these first students of A. F. Ioffe became themselves great scientists: among them the Academicians N. N. Semenov, P. L. Kapitza, P. I. Lukirskii, associate member of the Academy of Sciences, USSR, Ia. I. Frenkel', and others. The

new Institute became for a long time the main center of the development of physics in the Soviet Union.

In 1920 Abram Fedorovich was elected Member of the Academy of Sciences, USSR (in terms of the date of his election A. F. Ioffe is at present the oldest Academician).

Having foreseen that the development of socialist industry would require the intensive development of physics and the creation of new factory laboratories, A. F. Ioffe advanced the question of the training of new cadres. In 1919 he organized at the Polytechnical Institute a Physico-Mechanical Faculty for training cadres of new engineers and engineer-physicists. For more than ten years he was the Dean of this Faculty, which was closely associated with the Physico-Technical Institute, and students of this Faculty were drawn by him to do scientific work at the Institute. Among the graduates of the faculty we see now many of the great scientists—Academician A. I. Alikhanov, I. K. Kikoin, V. N. Kondrat'ev, G. V. Kurdiumov, Iu. B. Khariton, associate members of the Academy of Sciences, USSR, G. A. Grinberg, I. Ia. Pomeranchuk, A. I. Shal'nikov, and others. When speaking of the Physico-Mechanical Faculty and of the work of Ioffe at the Polytechnical Institute one should note especially that during all of his pedagogical activity his lectures were very popular and attracted large audiences.

During the first period of the existence of the Physico-Technical Institute the trend of the work there was closely connected with the investigations of Abram Fedorovich himself, the most important of which at that time were devoted to the studies of the mechanical and the electrical properties of crystals. The investigations of A. I. Ioffe on the mechanical properties, plastic deformation and elastic properties of crystals became the basis for contemporary ideas on the strength of materials. The studies of Abram Fedorovich on the electrical properties of dielectrics explained the mechanism of the processes occurring in insulating materials and made it possible to set up and solve a number of important practical problems.

In 1924 A. F. Ioffe jointly with N. N. Semenov organized a Physico-Technical Laboratory in order to improve the link with industry and to work out practically important problems in technical physics (electro-technical, radio-physical, acoustic, thermo-technical, and others). The activity of this laboratory was so closely interlinked with the activity of the Physico-Technical Institute that in fact it was a single institute (and soon these were amalgamated).

A significant role in the development of Soviet Physics was played by the Allunion meetings and conferences of physicists, the initiator and leader of which was A. F. Ioffe. Taking into account the rapid tempo of the industrialization of the country and the need of the most rapid development of physics in the Soviet Union, Abram Fedorovich entered upon the organization of a number of institutes in various regions of the Union. His initiative was greatly supported by the Soviet Government and in the beginning of the thirties he undertook with great energy the organization of a number of new physico-technical institutes. From the staff of the Leningrad Physico-Technical Institute (LPTI) Ioffe appointed talented physicists, who formed the main nucleus in the institutes established in Kharkov', Sverdlovsk, Tomsk and Dnepropetrovsk.

Not limiting himself to the organization of such institutes, Abram Fedorovich interested himself greatly in the application of physics not only to industry, but also to other fields and, in particular, to agronomy. He showed that physical methods may be effective for the solution of such problems as the heat and moisture condition of soils, improvement of the composition of soils, etc. In 1932 he organized in Leningrad a Physico-Agronomical Institute, of which he is the director up to the present.

In 1930 when a number of well-defined scientific trends crystallized out at the LPTI and quantitatively the Institute developed greatly, Ioffe proposed to subdivide it; it was separated into the Institutes of Chemical Physics and Electrophysics. In the remaining Physico-Technical Institute A. F. Ioffe developed energetically four main directions: nuclear physics, physics of polymers, studies of the mechanical properties of metals and physics of semiconductors. The latter trend was a result of the personal investigations of Abram Fedorovich and under his direct guidance.

It would be difficult to separate the scientific activity of A. F. Ioffe from the work of the LPTI. Regardless of the fact that, beginning with 1930, the personal investigations of Abram Fedorovich were concentrated on the studies of semiconductors, it can be stated with certainty that also the other investigations owed much to his initiative. At his suggestion a strong group was set up for the study of nuclear physics headed by I. V. Kurchatov, A. I. Alikhanov and A. A. Artsimovich, and during this period the LPTI became the main center of studies of nuclear physics in the Soviet Union. A. F. Ioffe influenced greatly the study of the physical properties of polymers. The investi-

gation of the mechanical properties of metals was the direct result of his work on the mechanical properties of crystals. In a short article it would be impossible to enumerate all the investigations carried out at the LPTI. We will attempt only to describe briefly the studies of A. F. Ioffe and his coworkers in the field of semiconductors.

In the beginning of the thirties Abram Fedorovich stressed the importance of semiconductors and noted that for the practical use of semiconductors it will be necessary to have a profound knowledge of their physical properties and, in particular, to have the knowhow of effecting changes in these properties. The study of the electrical properties of semiconductors was started first. This permitted the understanding of the nature of impurity and specific conductivity, the electron and hole mechanism of conductivity and the effect of impurities and of deviations from stoichiometric composion. Detailed investigations were carried out on the internal photoeffect of cuprous oxide. The behavior of semiconductors in strong electric fields was studied. Great interest was aroused by the hypothesis on the mechanism of rectification on a contact with two semiconductors having a different type of conductivity (electron and hole). The studies on semiconductors which were carried out at the PTI in the prewar years beginning with 1930 were devoted not only to physical investigations, but also to a number of important industrial applications. New photoelements of high sensitivity were produced from thallium sulfide; new rectifiers using cuprous oxide with magnesium for high current densities were produced. By analyzing the thermoelectric and thermal properties of semiconductors, Ioffe pointed out a practical use of semiconductive thermoelements for the direct transformation of heat into electric energy.

At the beginning of World War II, the LPTI was evacuated from Leningrad to Kazan'. During this period the work of the institute was reorganized and directed towards the solution of problems important for defense. Some of these problems were already studied theoretically at the institute, and now individual groups of workers took an active part in their practical solution. Some problems produced by the war were successfully solved by the workers and students of A. F. Ioffe under his direct leadership. A group of workers of the institute, headed by P. P. Kobeko, one of the closest students of Ioffe, carried out, under the difficult conditions of the siege, the important work connected with the "ice road" over Lake Ladoga, and others.

At the end of the war the LPTI returned to Leningrad and under the leadership of A. F. Ioffe and owing to the untiring efforts of the whole staff it was reinstalled. After the war, the same as before the war, the work of the institute continued along the same lines, that is, nuclear physics, the physics of polymers, semiconductors, and metals. The personal interests of Abram Fedorovich were again concentrated on the studies of semiconductors and under his leadership the workers of the institute extended greatly the work in this field.

In 1951 A. F. Ioffe left the position of the director of LPTI and organized a separate laboratory of Semiconductors at the Academy of Sciences, USSR, and Abram Fedorovich was appointed director.

In the last decade, as was foreseen by A. F. Ioffe, semiconductors have become exceptionally important technically and the interest in the theory of semiconductors increased greatly. Simultaneously with essential improvements in the known industrial semiconductive devices, new, industrially valuable devices were also produced; it suffices to mention only semiconductive amplifiers as an example.

In the post war period Abram Fedorovich conducted thorough investigations of the physical properties of semiconductors. As a result of the work of Ioffe and his students, a number of problems connected with the actual control of the properties of semiconductors has been largely solved. These problems are of primary importance for industrial applications. As an example we may point out the solution of the problem of the actual control of the thermoelectromotive force and the thermal conductivity of semiconductors, which made it possible to construct batteries of high efficiency and thermoelectrocoolers. In order to coordinate all of the scientific investigations on semiconductors in the Union, a commission on semiconductors under the chairmanship of Ioffe was set up at the Academy of Sciences, USSR.

The achievements of A. F. Ioffe as a reknowned scientist are well known and highly valued not only in our country, but also abroad. A. F. Ioffe has been elected as honorary member of a number of foreign Academies.

The untiring, long, passionate scientific work of Abram Fedorovich, his service to the motherland, have long been acclaimed. On the day of his seventy-fifth birthday A. F. Ioffe received the title of Hero of Socialist Labor.

The importance of the role of A. F. Ioffe as an organizer of Soviet Physics is expressed best of all by the fact that he had established a whole network of physical and physico-technical institutes (16 institutes), by the organization of the first Physico-Mechanical Faculty—a forge for specialists of a

new type: engineer physicists,by his long and brilliant pedagogical and scientific activity. Abram Fedorovich is the teacher of several generations of Soviet physicists. He succeeded in instilling in his students a love for science and a desire to apply the results of their studies for the good of their country, that is, those features which are characteristic of all of his activity.

Now, in the days of his seventy-fifth anniversary Abram Fedorovich Ioffe is full of creative powers, full of ideas for new work and plans for wide practical applications of semiconductors.

All the physicists of the Soviet Union warmly congratulate Abram Fedorovich on his seventyfifth birthday and wish him great success in his future activity and many years of fruitfull work.

Translated by E. Rabkin
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Photoelectric Quantum Yield in Silver Bromide Crystals

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The quantum yield of the photoelectric effect in silver bromide was determined. It was shown that as one increases the concentration of electron emitting centers, one decreases the magnitude of the quantum yield.

A GREAT deal of work has been devoted to the study of the photoelectric effect in silver halides.[1] Only Lehfeld[2] and Hecht[3], however, actually measured the quantum yield of the reaction. The difficulty of determining this quantity, even in terms of the energy absorbed, is due to the fact that it depends on the quantum yield as well as on the "displacement" of the electrons. For this reason Lehfeld performed his experiments under saturation conditions when all electrons freed by the light quanta reach the anode. Measurements at such great field strengths (3000 v/cm) are hard to perform at room temperature, because of the presence of large and unsteady background (dark room) currents. For this reason Lehfeld and Hecht performed their experiments at liquid air temperatures. They found the quantum yield to be between 0.1 and 0.6 and the electron displacement per unit field strength was of the order of 4×10^{-4}cm/(volt/cm).

The literature contains no data on the above quantities at room temperature. It was this lack that inspired the present work.

EXPERIMENTAL METHOD

Silver bromide crystals were prepared by allowing the fused salt to flow between two glass discs, as was previously described by one of the authors.[4]

In order to measure the photoelectric current we built a special ac amplifier that was calibrated by means of an audio oscillator with a vacuum tube voltmeter as well as with a 50 cycle alternating current. In the latter case a known voltage was attenuated by means of a voltage divider. The silver bromide crystals were placed in a metal box in which the electrodes rested on insulated discs. The box was connected to the amplifier by means of a coaxial cable. The inner conductor applied the voltage from one of the electrodes

[1] E. A. Kirillov and A. S. Fomenko, Trudy Odessa Inst. 3, Odessa, 1951, p. 7.

[2] W. Lehfeldt, Nachr. Akad. Wiss. Göttingen Math.-physik. Kl I, 171 (1933).

[3] K. Hecht, Z. Physik 77, 235 (1932).

[4] P. V. Meikliar, J. Exper. Theoret. Phys. USSR 21, 42 (1951).