Petr Leonidovich Kapitsa (Obituary)

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In July 1984 Soviet physicists were making plans to celebrate the ninetieth birthday of Petr Leonidovich Kapitsa and the fiftieth anniversary of the Institute of Physics Problems which he created; he died three months before that date.

The basic facts pertaining to the biography and activities of Petr Leonidovich are widely known in the world of physics—books and articles have been written about Kapitsa, including some on anniversary occasions in this journal. Now paying respects to the memory of the great physicist who has departed from us it appeared therefore to be appropriate not so much to repeat the same facts, but to attempt to emphasize those special characteristic features which made Kapitsa's personality unique, and to note his achievements, and his role in the development of Soviet and world physics.

Without any doubt the most prominent feature of Kapitsa's character and personality is his will power and the steadfastness in putting into practice his principles and convictions. Everything that refers to organization of scientific work, education of scientists, interrelationships between "pure" science and its applications-these principles were expounded by Petr Leonidovich himself in his well known book "Experiment. Theory. Practice". But his adherence to once and for all established principles by no means signified dogmatism. As years and decades go by the face of science inevitably changes, and together with this the concrete incarnation of the principles adopted by Kapitsa also changed. If in 1943 he wrote that "you will never accomplish good work with somebody else's hands", then in his pronouncements of the 1960's and 1970's he also emphasized the role of the scientific director and organizer-as a result of the increased complexity of experiments.

In his own scientific work Kapitsa followed these principles throughout his whole life and to the fullest extent. The great majority of his scientific papers has been published without coauthors (among the papers with coauthors there is a theoretical article together with Dirac (1933) on the reflection of electrons from a standing light wave). His principal scientific discoveries were made almost in a literal sense by his own hands. Moreover, he never carried out experiments the idea of which did not belong to himself; thus, if an experiment close to his own work was proposed by a theoretician the carrying out of such an experiment was assigned to one of his collaborators; but this, possibly, is not so much a consequence of general principles as it is of Kapitsa's own character. Probably it is these characteristics of Kapitsa's work



PETR LEONIDOVICH KAPITSA (1894-1984)

style that influenced the relatively not very large (according to today's standards!) number of scientific papers published by Kapitsa—a total of 78 (excluding pamphlets and popular articles). But then each of them contains a really new idea.

Kapitsa's constancy describes not only his convictions and principles, but also his character traits. His character is best of all described by the word "stern", and he did not mellow with the passage of years. But one should not even to the smallest degree identify this sternness with pomposity; pomposity—in the usual meaning of this word—was entirely absent to Kapitsa's character, as was manifested in his approchability; Petr Leonidovich was, possibly, for his collaborators one of the most approachable directors of institutes. Admittedly, it was not always easy to have a business discussion with the director; Petr Leonidovich always knew exactly what he did want and what he did not want, and in the latter case he said "no" directly. But, if he said "yes", then one could have confidence that he would do everything possible to fulfill his promise—and he knew how to attain goals that have been set.

Strictly speaking, Kapitsa did not have any direct pupils (in the literal sense of this word)-this also was a manifestation of the previously noted style of his own scientific work. But this does not diminish the colossal contribution made by him to the preparation of new generations of physicists. It is specifically towards this that the "cadre" type policy was directed which Kapitsa from the outset made a cornerstone of the Institute created by him: a significant fraction of the scientific personnel of the Institute should be nonpermanent, students, probationers, candidates for higher degrees, temporary visitors from other institutes should pass through the Institute; in this way the educational role of the Institute of Physical Problems spreads far beyond its walls. The whole scientific atmosphere created by Petr Leonidovich in the Institute has an educational significance, and in this sense all the members of the Institute are his pupils. In the course of the whole period during which Kapitsa directed the work of the Institute not a single paper based on the work in the Institute (in any case all experimental papers) was submitted for publication without being discussed with his participation. In the course of a number of years this took place at weekly meetings-seminars in the Director's office; as time went on with the inevitable (although constantly restrained) growth of the Institute, the discussions were transferred to the more widely based meetings of the Scientific Council.

Kapitsa's pedagogical aims were also extended to university education; he was one of the principal initiators and inspirers of the Physico-Technical Faculty of Moscow State University organized according to principles that were new at the time (1946). This Faculty was soon afterwards transformed into the Moscow Physico-Technical Institute. For some time he gave in this Faculty a general course in physics—together with L. D. Landau. Kapitsa's lectures were devoted to selected topics, outstanding experiments, while Landau gave a systematic course. It is regrettable that Kapitsa's lectures were not recorded at the time. However, there exists a remarkable collection of problems which for many years Kapitsa invented for oral examinations for graduate students which he always conducted personally.

Here is a list of Kapitsa's most fundamental scientific achievements:

A new method of producing very intense magnetic fields (1924).

The discovery of the linear dependence of electrical resistance on the magnetic field (1928–1929).

A new efficient method for the liquefaction of helium (1934).

Discovery of superfluidity of liquid helium (1938).

Discovery of two forms of motion in liquid helium (1941).

Discovery of a temperature discontinuity between liquid helium and a solid wall (1941).

Development of a turbo-expansion method of liquefaction of air and of new methods for industrial production of oxygen (1939–1946).

New types of high-power microwave generators (1950–1972).

Obtained a very high-power high-frequency filamentary discharge (1969).

This list does not require special comments—the essence of these discoveries and inventions are well-known to physicists. But this list demonstrates yet another unique feature of Kapitsa's scientific image—he is one of the very few (if not the only one) persons in whom an outstanding experimental physicist is united with a talented engineer; he himself repeatedly called himself an engineer and wrote about his engineering flair. It is this flair that prompted Petr Leonidovich not to restrict himself to the introduction (or, as he himself preferred to say assimilation) of his method of production of liquid oxygen along the usual administrative channels, but to undertake himself the further development of this method on an industrial scale.

The highest scientific achievement of Kapitsa, a discovery of unsurpassed significance, is undoubtedly the discovery of the superfluidity of liquid helium and the detailed study of its properties. These investigations carried out unusually completely, became the basis for the construction of the theory of superfluidity by L. D. Landau. Two papers by Kapitsa presenting his experimental investigations and a theoretical article by Landau were published in the same XI volume of the Journal of Experimental and Theoretical Physics in 1941 and, without doubt, must be included among the classical achievements of physics. They marked the birth of a new field of physical science—the physics of quantum liquids. At the same time the history of these discoveries is an example of what achievements can result from a close contact of a great experimentalist with a great theoretician.

The scientific, pedagogical and organization-of-science activities of P. L. Kapitsa was highly appreciated by the Communist Party and the Soviet State. He was twice awarded the title of Hero of Socialist Labor, received six Orders of Lenin, an Order of the Red Banner of Labor and other state awards. He is the recipient of state prizes of the USSR. He was given the highest award of the Academy of Sciences of the USSR—the M. V. Lomonosov gold medal.

For the "fundamental inventions and discoveries in the field of low temperature physics" Petr Leonidovich was awarded a Nobel Prize, even though it took the Nobel committee 40 years to do this. In this connection an event occurred which apparently is unique in the history of these prizes, when the laureate devoted his traditional lecture not to the reason for the award. Kapitsa began his speech with the statement that since the work for which he is being given the prize was completed a very long time ago, he had by now "basically forgotten" it and therefore would speak about the work with which he is occupied now; he then proceeded to lecture on his work on plasma physics.

Having mentioned the collaboration of Kapitsa and

Landau one must recall that physics is in Kapitsa's debt also by the fact that in his Institute, which became a real home for Landau, the latter could fully develop his talents. Landau experienced difficult times in his life, and Petr Leonidovich with his characteristic fearlessness helped him to overcome them. Landau never forgot this.

There were difficult years also in the life of Petr Leonidovich himself, and possibly in these years the firmness of his will and character have manifested themselves to the greatest extent. Deprived of the possibility to continue work in the field of low temperature physics he found strength within himself, decisiveness and the ability to create from practically nothing a small laboratory in which he occupied himself with the hydrodynamics of thin layers of liquid, and later with electronics at high power. To this same period also belongs a small article by Kapitsa (1951) which we want to mention not so much because of its importance, but as a demonstration of his interests and capabilities; this is a purely mathematical paper in which he succeeded in finding (in the course of his calculations related to electronics) something novel in such a field, which might appear to have been criss-crossed in every direction, as the theory of Bessel functions!

Since the end of 1955 Petr Leonidovich was the continuing chief editor of JETP. True to himself he began by developing basic principles by which the editorial board should be guided both in their general policy and in their daily work. These principles were formulated by him in specially prepared "Regulations concerning JETP". Having remained basically unchanged, they also have not become a dogma, and later underwent some alterations and were supplemented by numerous decisions made by the editorial board and carefully entered in the minutes of its meetings. In the course of many years Petr Leonidovich himself conducted (every two weeks) the meetings of the board and only with the passage of time found it possible to remove himself somewhat from current editorial duties.

Of course physics and his own work in it was the main interest in the life of Petr Leonidovich Kapitsa. But he by no means shut himself off in them. He was always interested, and with the passage of years even to an ever increasing measure, in general problems of humanity—the future of science in general, the problems of conserving the environment and natural resources, the energy crisis, even the problem of organizing the leisure of humanity in the future; but, of course, first of all—the problem of preserving peace on earth and removing the danger of nuclear catastrophe. The statements and the activities of Petr Leonidovich along these lines were all the more significant because they were based on the authority and the legendary aura surrounding his name.

We knew Petr Leonidovich as a man of iron decisiveness and will and the consequent toughness in business affairs. This toughness, however, was united in him with great responsiveness and good will. He many times said "yes" in reply to requests for all kinds of help, and many people are indebted to him for support in difficult times.

But only a few of those close to him knew of the human sensitivity and even vulnerability hidden in the depth of his soul. Those aspects which an attentive participant in conversation with him could only guess at now become evident from many hundreds of fortunately preserved letters written by Petr Leonidovich at different times to his mother Ol'ga Ieronimovna and to his wife Anna Alekseevna. These letters, as well as all his pamphlets, testify also to his truly not inconsiderable literary gift. It is to be hoped that his epistolary heritage, so rare in our hurried age, will eventually become accessible to a wide circle of readers as a memorial to the development of a personality of a great scientist and a remarkable man.

Translated by G. M. Volkoff