Solomon Isaakovich Pekar (Obituary)

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Solomon Isaakovich Pekar, a member of the Ukrainian Academy of Sciences, a prominent theoretical physicist whose name is associated with outstanding achievements in solid state theory died on 8 July 1985 after a short serious illness.

S. I. Pekar was born on 16 March 1917 in Kiev into a lawyer's family. He entered Kiev University at the age of 16 and carried out his first scientific investigations already during his student years. One of them was reported at the Physics Institute of the Academy of Sciences at an All-Union conference on electron discharge in gases.

At that time there was no specialization in theoretical physics in Kiev University, and Pekar carried out his student practical work in Leningrad at the Physicotechnical Institute under the direction of Ya. I. Frenkel', and after graduating from the university continued to work in Kiev and successfully completed his graduate training under the direction of I. E. Tamm. In his candidate's dissertation he developed a general nonlinear monopolar theory of rectification at a semiconductor-metal contact. The most unexpected result of the theory—the transition in the barrier layer from depletion to enrichment—was immediately confirmed experimentally. At the defense of his dissertation in May 1941 V. E. Lashkarev, I. E. Tamm and Ya. I. Frenkel' proposed that the 24-year old Pekar should be immediately awarded the degree of doctor of physical-mathematical sciences. L. D. Landau in discussing this work at his seminar said: "In Kiev spontaneous generation of theoretical physics has taken place."

SOLOMON ISAAKOVICH
PEKAR
(1917–1985)

During the years of World War II Pekar devoted his knowledge and the accumulated experience to the development of semiconductor devices needed at the front.

A particularly fruitful period in Pekar's work began after the returned to Kiev in 1944: it is associated with the development of the theory of polarons. Already in the 1930's L. D. Landau proposed the idea of the possibility of "capture" (self-trapping) of an electron by a lattice under conditions of sufficiently strong interaction. Pekar first applied to the description of self-trapping a microscopic approach which enabled him to develop a very beautiful and original mathematical theory. Pekar gave the name of polaron to the self-trapped state itself, and this concept has become firmly established in subsequent years in the foundation of solid state theory and entered the vocabulary of physicists of the whole world.

Pekar's equation for the determination of the energy spectrum of the polaron and the Landau-Pekar formula for its effective mass formed the basis of the theory of strong coupled polarons. Developing this theory further Pekar constucted the quantum theory of polarons, established the mechanism of their formation without activation, investigated the properties of the polaron as a carrier of current, etc. Along with this as a working tool in the theory of polarons he founded the effective mass method—one of the most powerful methods in the electron theory of the solid state.

The papers of Pekar on polaron theory became classical practically immediately. The mathematical elegance of the theory has attracted the attention of many theoreticians: it turned out to be a convenient model for field theory. Pekar's polaron, apparently, became the first example of the classical solutions of the equations of nonlinear quantum field theory that are so prominent at present. In subsequent years such theoreticians as N. N. Bogolyubov, T. D. Lee, R. Feynman and others participated in the development of polaron theory. Because of this it became an effective channel for the penetration of field theory methods into solid state theory. In the course of time it became clear that equations closely

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related to the equations of polaron theory describe phenomena belonging to quite different fields of physics, and Pekar's results subsequently became widely used, and sometimes even rediscovered:

Others seeing the fresh tracks
Your path will follow step by step...

At present it is impossible to think of solid state theory without polaron theory.

During the same years Pekar created the theoretical department within the Institute of Physics of the Ukrainian Academy of Sciences, reestablished the chair of theoretical physics and then created the specialization in theoretical physics in Kiev University. His university classmates became his first graduate students. Thus Pekar's school began to be formed.

Together with his collaborators and students Pekar generalized the methods of polaron theory to the case of intermediate coupling and extended them to new objects: excitons, condensons—self-trapped states in nonpolar crystals (in doing so he introduced the method of the deformation potential simultaneously with Bardeen and Shockley!). The theory of the shape of impurity absorption and luminescence bands due to electron-phonon coupling acquired particular significance. The shape of the absorption curve corresponding to the simplest model has become established in the literature as a "pekarian." Already in 1953 Pekar predicted an extremely narrow phononless line in impurity spectra (the optical analog of the Mössbauer line).

Of fundamental significance is Pekar's series of papers on the theory of excitons and supplementary waves. He showed that a consistent taking into account of the dependence of exciton energy on the momentum leads to a radical restructuring of crystal optics in the region of exciton resonances. The central result turned out to be the discovery of supplementary waves which have the same frequency and polarization as the "ordinary" waves, but a different velocity of propagation. In the region of the spectrum which traditionally was regarded as the region of total reflection, the energy is carried only by the supplementary waves. The Kramers-Kronig relations do not hold in the neighborhood of exciton resonances. Pekar's results gave rise to a number of new problems and led to lively discussion which facilitated rapid development of research in this field. At present Pekar's supplementary waves have been discovered experimentally by different methods in many crystals and they have become a common concept in exciton spectroscopy.

Two pearls of Pekar's creative output—polarons and supplementary waves—have become the subjects of his two monographs: "Research in electron theory of crystals" (1951) and "Crystal optics and supplementary light waves" (1982).

It is neither necessary nor possible to enumerate Pekar's other specific results: electron-phonon interaction proportional to the external field, amplification of sound, thermodynamics of highly excited gases, photorecombination lasers, etc. A common trait characterizing Pekar's creative output is important: observing the development of modern physics he did not tend to follow the current fashion, but worked specifically on those problems where he could take a new, nontrivial and fundamental step. Therefore many of his papers themselves gave rise to new directions of research. His best work he carried out by himself, with painstaking thoroughness. His responsible attitude to his work served as an example for those surrounding him.

Pekar was excited by physics experiments and even by purely design problems as well as by theory.

Pekar's contributions to physics are not restricted to his personal results. He educated a large number of pupils who are now working not only in Kiev but also in other scientific centers of our country.

Pekar always strove to transmit to this students his own remarkable qualities: highly principled attitude and boldness in science, striving towards formulation of fundamental problems and their rigorous solution, towards carrying the work through to definite results, leading to comparison with experiment.

On Pekar's initiative and under his direction All-Union Conferences on the theory of semiconductors have been regularly held in the course of 30 years. Several generations of theoreticians have been brought up on these conferences. The XII conference prepared by Pekar took place in October 1985 already without him.

Pekar's scientific achievements were recognized by his being elected as an Academician of the Ukrainian Academy of Sciences (1961), by the State prize of the Ukrainian Academy of Sciences, by three Orders and by several medals.

In 1960 Pekar together with his whole department transferred to the Institute of Semiconductors of the Ukrainian Academy of Sciences organized by himself and V. E. Lashkarev. Pekar's remarkable scientific and human qualities played a tremendous role in the establishment of the new institute. They exerted an influence on the atmosphere not only in the theoretical department, but in the Institute as a whole. In the theoretical department he was always well informed in all matters, delved into controversial situations, and his "Solomon's decisions" have always been both just and delicate.

Many people often turned to Pekar for scientific advice, and strove to report their results at his seminar. To all those who turned to him "on scientific matters" Pekar was always an attentive, benevolent, and thoughtful critic, who always tried to be really helpful by giving practical advice. His opinion was unbiased and independent. His support enabled many young theoreticians to enter into science.

A penetrating mind and unique individuality were combined in Pekar with remarkable purely human qualities which to a full extent became apparent to those who had the good fortune to know him well.

The memory of a brilliant and complete human being—Solomon Isaakovich Pekar will be retained both in science into which his best results have entered as a component, and in the hearts of his colleagues, friends and pupils.

Translated by G. M. Volkoff