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ÉDUARD VLADIMIROVICH SHPOL'SKIĬ (On His Eightieth Birthday)

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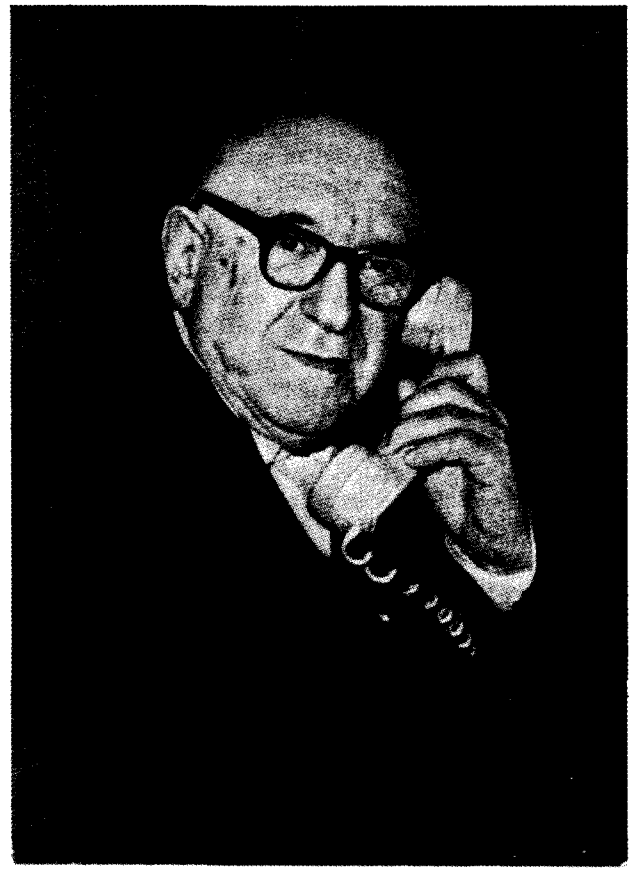
IN 1952, not long before Shpol'skiĭ's sixtieth birthday, he and his colleagues at the Optical Laboratory of the V. I. Lenin Moscow State Pedagogical Institute, where he had headed the Theoretical Physics Department and Laboratory for 40 years, discovered a new phenomenon that has since come to be known as the "Shpol'skiĭ effect." After a long and painstaking search, they established that at low temperatures, molecules of the aromatic hydrocarbon coronene, introduced into a specifically modified crystalline n-paraffin matrix, give luminescence spectra that consist of numerous surprisingly narrow lines instead of the usual few blurred bands. Such "quasiline" spectra were detected shortly thereafter in a number of other aromatic hydrocarbons, and in absorption as well as emission.

Since that day, which is already 20 years into the past, Shpol'skiĭ and his colleagues have diligently and successfully developed their research on the quasiline electron-vibrational spectra of the molecules of complex organic compounds.

Special studies carried out under Eduard Vladimirovich's supervision, both in his laboratory and at the Institute of Physics Problems of the USSR Academy of Sciences, where he was given wide latitude for experimentation, indicated that the width of the lines in the quasiline spectra reaches several reciprocal centimeters at 4°K, and that their relative positions, which are characteristic for each of the compounds studied, are determined by the energies of the electron levels and by the normal vibration frequencies of the molecules studied. At the same time, some features of the spectra—line width and multiplet structure—depend on the nature of the matrix and the method by which it is formed.

The Shpol'skiĭ effect and the quasiline spectra are of great scientific and applied importance. On the one hand, analysis of the conditions under which these spectra appear is important for understanding of the mechanism by which the discrete and diffuse electron-vibrational (vibronic) spectra of polyatomic molecules are formed. On the other hand, investigation of the properties of the narrow lines and the corresponding levels has become a tool for study of electron-phonon interactions in the corresponding impurity molecular crystals.

It must be stressed that the Shpol'skiĭ effect opens new paths that are inaccessible to other spectroscopic methods for study of the properties and structure of organic molecules. Among other things, Shpol'skiĭ spectra permit highly accurate determination of the system of electronic and vibrational levels of complex molecules and investigation of the various manifestations of subtle intra- and intermolecular interactions. Quasiline spectra of many compounds of various classes have now been obtained and studied in detail. Of great theoretical and practical interest among these compounds are condensed aromatic hydrocarbons and their various derivatives, heterocyclic compounds, chlorophyll and chlorophyll-like compounds, etc.



As a result of analysis of the fine structure of Shpol'skiĭ spectra, the exact positions of the electronic and vibrational levels of more than 200 complex organic molecules have been established. Vibrational structures have been established not only for the ground states, but also for the excited states, something that is practically impossible on the basis of infrared absorption and Raman scattering spectra. The high sensitivity of the quasiline spectrum to the intra- and intermolecular fields makes it possible to bring out extremely subtle effects. The influence of the hydrogen bond on the electron-vibrational spectra, the effects of the nature and position of substitutents on the energy-level system of the molecule, and other relationships have been established for many molecules.

The fine line structure of the Shpol'skiĭ spectra not only renders them uncommonly specific and different even for molecules with closely similar structures, but also predetermines the high strength of the lines.

Indeed, the usual broad bands are "pulled together" into narrow lines in Shpol'skiĭ spectra. These properties are responsible for the exceptional practical value of Shpol'skiĭ spectra as tools for qualitative and quantitative analysis of individual substances in complex organic mixtures. The technique of identifying individual organic compounds by their Shpol'skiĭ spectra is characterized by sensitivities up to 10^{-11} g per ml of solution, which is beyond the capabilities of other spectral analytical methods. The corresponding methods of investigating quasiline spectra have come into extensive use in detection of small quantities of organic matter in rocks, minerals and meteorites, and, in coal and petroleum, even small admixtures of certain organic compounds that are of great importance for geochemistry. Studies in which Shpol'skiĭ spectra have been used to detect and determine the quantity of one of the most common carcinogenic hydrocarbons—3,4-benzpyrene—in various natural and industrial products (tars, industrial soot, tobacco smoke, certain smoked foods, "food-grade" paraffins, polluted air, etc.) are widely known. The Shpol'skiĭ spectral method is now being adopted by the Soviet Union's public health and epidemiology stations to identify carcinogenic hydrocarbons with the purpose of preventing occupational malignancies.

The importance of Shpol'skiĭ's discovery goes far beyond molecular spectroscopy and spectral analysis. The effect has found important applications in study of a number of problems in solid-state physics.

During the past five years, Soviet and foreign investigators have given much attention to the problems of the actual physical nature of the Shpol'skiĭ effect and its distinctive properties. For example, experiments were performed to determine whether the basic conclusions of the theory of optical nonphonon transitions in the spectra of impurity crystals can be applied to Shpol'skiĭ systems. It was shown that the narrow lines in Shpol'skiĭ spectra have all of the basic attributes of nonphonon lines and are optical analogs of resonant Mossbauer γ lines. Detailed measurements of the basic parameters of lines in Shpol'skiĭ spectra (width, shape, and strength) and their temperature dependence have yielded valuable information on the nature of the electron-phonon interaction in molecular crystals. Work in this area is now being developed rapidly.

Work is being done on various aspects of the investigation and use of Shpol'skiĭ spectra in many laboratories in the USSR (the V. I. Lenin Moscow State Pedagogical Institute, the USSR Academy of Sciences Institute of Spectroscopy, the L. Ya. Karpov Physico-chemical Institute, the Belorussian Academy of Sciences Institute of Physics, the Ukrainian Academy of Sciences Institute of Physics, Moscow State University, the All-Union Geological Survey and Petroleum Institute, the USSR Academy of Medicine's Institutes of Experimental and Clinical Oncology at Moscow and Leningrad, and others), and also in foreign countries (at the University of Chicago in the USA, in England, and at the Paris University Laboratory at Orsay, the Radium Institute at Paris, and the University of Grenoble in France, etc.). The list of these organizations is growing steadily, and scientific publications on Shpol'skiĭ spectra are appearing in steadily and rapidly increasing numbers.

To this day, É. V. Shpol'skiĭ is the acknowledged leader of an independent trend in molecular spectroscopy—fine-structure electron-vibrational spectroscopy of complex organic compounds. For his work in this field, Shpol'skiĭ was awarded the S. I. Vavilov Gold Medal in 1962 and a USSR State Prize in 1971.

Needless to say, the discovery of the quasiline spectra came after many fruitful years of Shpol'skiĭ's work as a physicist. He is well known for his work on photochemistry, which began while he was still under the guidance of P. P. Lazarev, for his experimental work on the spectroscopy of biological specimens (here Shpol'skiĭ became a pioneer in the modern spectroscopy of light-scattering substances), and for an extensive cycle of research on the spectroscopy of polycyclic aromatic hydrocarbons.

But Soviet physicists are quite familiar with É. V. Shpol'skiĭ as more than an experimenter. A brilliant writer and teacher who always kept abreast of the most recent attainments in physics, he was prominent in shaping the scientific world-view of many generations of scientists. As he devoted much of his time and effort to his voluminous and varied publications, his penetrating and sensitive erudition, profound understanding of the processes that are the province of physics, his acute sense of timing, and his superb knowledge of people made Shpol'skiĭ an inseparable, necessary, and active participant in the entire process by which Soviet physics developed.

Broadmindedness, uncompromising standards, and exceptional tact won Shpol'skiĭ a high reputation as an authority. His participation in any scientific or scientific-administrative measure always contributed to adoption of a fundamental and correct solution.

Shpol'skiĭ authored a well-known two-volume textbook on atomic physics that has already been used for two decades by physics students not only in our country, but also in many others. He has written a long series of surveys of many physical problems and articles on the history of physics, as well as perceptive profiles of other well-known scientists.

He played an especially significant role in the activity of the scientific publishing houses. A member of several editorial staffs, he translates and edits study aids, monographs, and papers, manages production of a number of serial publications, participates actively in the creation of new scientific journals, and reviews and abstracts many new books and journal articles.

But Shpol'skiĭ has two "children" that are especially dear to him. A passionate reader and collector of books, whose attention is continually being drawn to new ideas not only in physics but also in related sciences, he committed himself more than half a century ago to the journal "Uspekhi Fizicheskikh Nauk," the intent of which was to report everything new and fundamental in the development of these sciences. Under his guiding hand, this journal has won worldwide recognition and become an extremely important factor in the training of all generations of Soviet physicists and a necessary everyday reference for any active investigator or teacher. This has been due in no small measure to the far-flung scientific and personal connections of Shpol'skiĭ among prominent Soviet physicists and to his personal charm and kindliness.

Also inseparably linked to Shpol'skiĭ's name are the inception and guidance, through nearly 20 years, of the abstract journal "Referatyvnyĭ Zhurnal Fizika," which won recognition even in its infancy as one of the leading publications of the type in the world's literature. It is thanks to his skill and effort that it was possible to solve the difficult problem of finding a convenient indexing system for the journal, assembling the necessary editorial and reviewer panels, maintaining high quality in the abstracts, and achieving exceptionally complete coverage of world literature.

Shpol'skiĭ's teaching activity has occupied a prominent place in his life. Many of his first-hand students are now physicists engaged actively in research and teaching work. A brilliant lecturer, he devoted his talents for many years to the important job of training teachers, thereby strongly influencing the level of physics instruction in the intermediate schools.

Although Shpol'skiĭ is 80 years old, he is, as before, among the pioneers in the development of physics, and, as before, his enthusiasm, his lively interest in science and its people have aided many. We wish him continued health and vigor.

Translated by R. W. Bowers