Personalia

ÉDUARD VLADIMIROVICH SHPOL'SKIĬ

(On the occasion of his seventieth birthday)

G. ROZENBERG

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HIS seventieth birthday finds É. V. Shpol'skiĭ at the peak of his creative powers and brimming with energy. Only a year ago the Presidium of the Academy of Sciences of the USSR awarded to him the S. I. Vavilov Gold Medal for his research on the line luminescence spectra of frozen crystalline solutions. The subject of his investigations, which have gained wide recognition, was a phenomenon he had discovered jointly with L. A. Klimova and A. A. Il'ina in 1952, now known as the "Shpol'skiĭ effect." In the course of the next ten years, thanks to the varied and persistent experiments of Shpol'skiĭ and his students, this peculiar phenomenon not only was convincingly explained, but led to the development of an entirely new and extremely effective line of spectroscopic investigation of complex molecules.

Long before this, however, Shpol'skiĭ's name had become a byword in broad circles of Soviet physicists of several generations, including thousands of university students and teachers.

Shpol'skiĭ's first scientific work, carried out under the supervision of his teacher, P. P. Lazarev, was in the field of photochemistry.

The object of this work was to study the mechanism of the chemical action of x-rays. In comparing the kinetics of reactions induced by visible or ultraviolet light on the one hand and x-radiation on the other, he discovered and explained a number of peculiar features which are present in the latter case. The most interesting result was obtained in studying the variation of reactions in the presence of optical sensitizers. In particular, he investigated minutely the so-called Eder reaction between mercuric chloride and potassium oxalate in water solutions. He found that the introduction of fluorescin-type dyes sensitizes the reaction to visible light, but hinders it greatly where the activating influence of x-rays is concerned.

Shpol'skiĭ continued his investigations of the action of sensitizers in the case of the reaction between sodium sulfite and oxygen. In the early thirties it was assumed that the sensitizing action of dyes is due to quenching of their fluorescence. Shpol'skiĭ's experiments showed, however, that the components involved in the reactions he studied did not quench the fluorescence of the sensitizer. It followed that sensitization can occur only through utilization of the energy that is not manifested in fluorescence.

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Further research carried out by Shpol'skiĭ and his collaborators showed beyond all doubt that there participates in the process of sensitization, at an intermediate stage, a persistent excited state, with a lifetime millions of times greater than the normal excited lifetime of fluorescent molecules.

Subsequently, a state presenting these properties was discovered independently by A. N. Terenin and G. A. Lewis. This is the triplet state (biradical) which plays an important part in many molecular processes.

The study of sensitized photochemical reactions initiated by Shpol'skiĭ in the twenties at the Institute of Physics and Biophysics of the People's Commissariat of Public Health was continued by him and his students in the admirably equipped Optical Laboratory which he organized at the V. I. Lenin Moscow State Pedagogical Institute. After the war this laboratory became one of the major centers specializing in the development and

applications of absorption spectrophotometry, and later luminescence analysis of complex organic substances. During this period, the direction of Shpol'skiĭ's own work changed: he was becoming increasingly interested in applications of spectroscopy to biological problems.

As a rule, biological objects are not homogeneous from the optical standpoint, so that scattering of light in them may be a significant factor. Hence in undertaking optical investigations of biological objects, great care must be exercised to allow for the fact that scattering may result in significant alteration of the interaction of light with the material.

At this point Shpol'skiĭ became interested in a problem which for a number of years had been actively discussed in the biochemical literature. According to measurements carried out by a group of Canadian biochemists, there is a significant difference between the absorption spectrum of haemoglobin in a transparent solution and that of the compound in red blood corpuscles. It was conjectured that this difference is due to change in the structure of the haemoglobin molecule when it enters into the erythrocyte. Through a series of simple but convincing experiments, Shpol'skiĭ and his students demonstrated that this is not the case. They showed that the reason for the misapprehension was methodological errors resulting from uncritical extension of the standard methods of spectrophotometry to an optically inhomogeneous medium.

In addition to solving the biologically important problem of the identity of haemoglobin in erythrocytes and in a transparent solution, these studies were also of general significance. They showed the importance in spectroscopy of allowing for the distinctive characteristics of propagation and scattering of light in inhomogeneous media. They also indicated a simple and effective means of obtaining the absorption spectra of dispersed substances, thus making possible investigation of many other objects of different origin. Subsequent studies carried out by Shpol'skiĭ and his collaborators were devoted to application of this procedure to the investigation of the absorption spectra of chlorophyll in solutions and in a natural state, and the absorption spectra of different pigments in turbid media.

At about the same time, Shpol'skiĭ and his coworkers initiated a series of optical investigations of polycyclic aromatic hydrocarbons. These included not only relatively simple compounds, such as anthracene and its derivatives, but also much more complex polynuclear molecules, particularly carcinogenic substances, primarily derivatives of pyrene. Work in Shpol'skiĭ's laboratory was devoted both to investigation of these interesting substances and to the development of procedures for fluorescence analysis. In view of the contact maintained with the Laboratory of Experimental Oncology of the Academy of Medical Sciences, the developed techniques were immediately put to use for analysis of different natural substances (resins, etc.) and foodstuffs for carcinogenic materials. At the same time, they could be used to develop effective procedures for animal experiments. Subsequently these investigation were continued by L. M. Shabad and P. P. Dikun at the Leningrad Institute of Oncology.

The first studies in the above-mentioned series were carried out at room temperature. Soon, however, Shpol'skiĭ began to use frozen solutions and study the spectra of a number of polycyclic hydrocarbons at liquid nitrogen temperature. These were the investigations in the course of which he discovered the effect that now bears his name.

Shpol'skiĭ and his co-workers established that the spectra of a number of polycyclic aromatic hydrocarbons dissolved in normal paraffins exhibit distinctive attributes at low temperatures. Upon freezing of the solution, the luminescence spectra display pronounced line structure; under favorable conditions the line width does not exceed 2—3 cm^{-1}, that is, it is close to the line width in the radiation of gases and vapors in discharge tubes. Subsequently it was found that the luminescence spectra obtained in this way (and, as was discovered later, the absorption spectra as well) are particular to the dissolved molecules and are essentially electronic-vibrational spectra. Analysis of the spectra showed that the frequencies of the several hundred lines appearing in them can readily be reduced to a few (10—15) fundamental frequencies, the values of which agree with the fundamental frequencies determined by independent means (observation of infra-red or Raman spectra).

Thus investigation of the quasi-line luminescence and absorption spectra of complex organic compounds is joining Raman and infra-red absorption spectroscopy as a powerful means for investigating the structure of molecules. Of particular value is the fact that these spectra have exceptionally clear properties in many cases when investigation of the infra-red and Raman spectra of the substances is difficult or impossible. Such investigations are now being actively carried out in a number of laboratories in the USSR and abroad.

As Shpol'skiĭ demonstrated, chemical analysis using line spectra provides a means of identifying individual compounds (including isomers) and of realizing a high analytic sensitivity. For the case of the important carcinogenic hydrocarbon, 3,4-benzpyrene, extremely sensitive techniques of quantitative and qualitative analysis were developed in Shpol'skiĭ's and other laboratories. Also significant were the studies on spectroscopic identification of heavy aromatic compounds in natural bitumens. Lastly, the sensitivity of Shpol'skiĭ's spectra to the location of molecules in the crystal lattice of the solvent and to inhomogeneities of the crystal field (evinced in changes of the multiplet structure and the intensity distribution between the multiplet components) opens up new and as yet unrealized potentialities for the investigation of the internal structure of solids.

The beginning of Shpol'skiĭ's scientific career (1918) came at a time when the young Soviet State needed desperately to train its own scientific workers conversant with the latest achievements of modern science and capable of independently posing and solving major scientific problems. On the other hand, this was also a period when many long accepted concepts were being discarded and modern theories of physics being formed. There was great need, for years to come, for consistent propaganda in defense of the new ideas, and for the painstaking and noble task of bringing up an army of creative scientific workers in these ideas. This educational activity required not only a vast erudition and a profound understanding of the changes that physics was undergoing, but also a feeling for the spirit of the times and outstanding literary and pedagogical ability. Shpol'skiĭ, who had been trained in the best traditions of the P. N. Lebedev school, was a student of P. P. Lazarev and a close friend of S. I. Vavilov and other leading members of what was then the younger generation of physicists, plunged enthusiastically into this activity, devoting much of his time and energy to it.

Shpol'skiĭ's name is indissolubly linked with the journal Uspekhi Fizicheskikh Nauk, which has played an outstanding part in training generations of Soviet physicists and has become one of the foremost physics journals in the world.

Shpol'skiĭ joined the staff of this journal, which had been founded by P. P. Lazarev in 1918, after the publication of the first few issues. He soon became co-editor with Lazarev, and later editor-in-chief, a post which he still holds. With consummate mastery and understanding of the changing needs of the times, for four decades he has guided the destinies of this periodical, the 78 volumes of which published to date are a record of the development of world and Soviet physics.

The writer had the opportunity, for a number of years, to observe Shpol'skiĭ in his role as editor-in-chief of the Uspekhi. Shpol'skiĭ has rare tact, great integrity, high standards and broad views. He has never confined himself to his own special field, but has allowed his interests to range far and wide. He is responsive to new ideas not only in physics, but in related disciplines as well—biophysics, geophysics, astrophysics, physical chemistry—and he is invariably capable of assimilating them, in itself no mean achievement in a century when all these sciences are undergoing such rapid and revolutionary development. The ability to note what is new, evaluate its scientific significance and gauge its future possibilities is what has enabled Shpol'skiĭ to transform a modest journal which devoted half its space to abstracts into a universally respected vehicle of the most advanced scientific ideas and the inevitable companion of serious research workers in all branches of physics.

Naturally, such an activity could not be carried on in isolation. Shpol'skiĭ's vocation became the training of succeeding generations of physicists. He has translated and edited countless textbooks, monographs and articles, organized and edited several series of scientific publications ("Contemporary Problems of Natural Science," "Classics of Natural Science," and "Newest Trends in Scientific Thought"), taken part in the establishment of new scientific journals (including the Journal of Physical Chemistry and the Acta Physicochimica URSS), served on a great many editorial boards, and reviewed and abstracted a vast number of new books and papers on the most diverse physics topics. In 1953, without abandoning his post on the Uspekhi, he became editor-in-chief of the first Soviet abstracts journal Physics, and took an active part in organizing a nation-wide system of dissemination of scientific information.

Scientific writing occupies a prominent place in Shpol'skiĭ's activities. In addition to original research reports, he is the author of 15 fundamental reviews. In a class by themselves are his lengthy and highly influential reviews of the current problems of, and methods of organizing, Soviet physics. He has also taken a keen interest in the history of physics. Among his many articles on that subject, mention must be made of his brilliant survey of the history of spectroscopy over the past 100 years, and his gallery of colorful portraits of outstanding scientists of the past (N. A. Umov, P. Curie) and of the present (T. K. Molodoĭ, P. P. Lazarev, S. I. Vavilov, P. L. Kapitsa, A. Einstein and M. Planck).

The two-volume course on atomic physics, which Shpol'skiĭ compiled in 1944-50, represents a monumental contribution to the training of the rising generation of Soviet physicists. This course, which has had four large printings, has been used by hundreds of thousands of our students. It has been translated into a number of languages: German, Polish, Czech, Hungarian, Rumanian, Chinese, Japanese, Serbian, Ukrainian, Armenian and Azerbaidjan, in all of which it has had from two to four printings, and it has become a standard physics manual in many countries.

The production of such a textbook, which the author has revised a number of times to take the latest findings into account, was made possible by Shpol'skiĭ's enormous teaching experience. For over 30 years (since 1932) he has been head of the physics department (later theoretical physics) in one of the capital's largest institutions of higher learning, the V. I. Lenin Moscow State Pedagogical Institute. During this time he has trained, through graduate work, over 25 specialists who now occupy responsible positions on the faculties of institutions of higher learning and in research institutes, to say nothing of a whole contingent of teachers who are indebted to him both for their high level of specialized knowledge and for their intelligent approach to teaching. Shpol'skiĭ has been greatly concerned with improving the quality of teaching and has taken an active part in solving many problems of methodology and organization of curricula, in particular as regards courses in theoretical physics.

The intensive scientific activity of Shpol'skiĭ himself—much of which took place within the Pedagogical Institute system—and of the laboratory he heads affords a splendid example of the scientific work performed within the department of an institution of higher learning, work which combines the training of scientists and teachers with important independent research.

A remarkable trait of É. V. Shpol'skiĭ is that his scientific activity and his keen interest in science have not flagged with the years. Not many men reach the age of seventy with such an inexhaustible store of energy and scientific initiative. A scientist who at seventy continues to advance so rapidly and to work so productively in so many different fields still has a great deal to give. We can only wish him continued success in his varied and tireless efforts, which have already made so valuable a contribution to our great country and to modern science.

Translated by Mrs. Valentine S. Rosen