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PAVEL ALEKSEEVICH BAZHULIN

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ON October 4th, 1965, Professor Pavel Alekseevich Bazhulin died. He was a doctor of physical-mathematical sciences, a distinguished specialist in the areas of physical optics and molecular spectroscopy.

Bazhulin was born on June 23rd, 1905, in Leningrad. In 1927 he was graduated from the Yaroslavl Pedagogical Institute, and at that time began his scientific and pedagogical activities. In 1931 he became a postgraduate student at the research institute of physics at the Moscow State University. As a candidate, from 1931 through 1934, Bazhulin carried out research in the areas of emission spectrum analysis and ultrasonics. His research into the attenuation of ultrasonic waves in liquids became the theme of his dissertation, which he defended in 1935.

From 1934 to the last days of his life, Bazhulin worked in the P. N. Lebedev Physics Institute of the Academy of Sciences (FIAN). He was the closest aide of G. S. Landsberg at the time of the organization of the optics laboratory of FIAN. For many years he was assistant to G. S. Landsberg in the FIAN optics laboratory. During this time he produced much new work in ultrasonics. Having summarized these experiments, P. A. Bazhulin in 1948 defended his doctoral thesis on the theme: "The Absorption of Ultrasonic Waves in Fluids." During that period he also had completed a large cycle of experiments in the area of the spectroscopy of the Raman scattering of light.

After the death of G. S. Landsberg, Bazhulin undertook the direction of the optics laboratory of FIAN. At that time, while continuing his research in molecular spectroscopy, he was also working productively in the field of quantum radiophysics.

Bazhulin paid much attention in his work to the training of scientific specialists. From 1932 to the end of his life, Bazhulin taught at the Moscow State University MGU. In 1951 he was appointed professor of the physics faculty. He directed the work of a great number of undergraduate and graduate students. Sixteen dissertations were completed under his direction. Many of the pupils of Pavel Alekseevich have become famous scientists.

Bazhulin published approximately 80 scientific papers and co-authored three monographs. The work of P. A. Bazhulin can be divided by subject into three groups.

ПАВЕЛ АЛЕКСЕЕВИЧ
БАЖУЛИН
(1905—1965)

I. RESEARCH ON ULTRASONIC WAVES IN LIQUIDS

By the time Bazhulin began his research it had been clear that statistical theory of the molecular scattering of light agreed well with experiments. According to this theory the scattering is produced by optical heterogeneities formed in the medium as a result of thermal fluctuations. The thermal motion can be regarded as an aggregate of elastic waves, which leads to the conclusion that there exists a fine structure of scattered light in crystals (the Mandel'shtam-Brillouin components). A fine structure was discovered by experiment to exist in liquids as well as in solids. In accord with statistical theory this meant that the attenuation of ultrasonic waves was comparatively small. But, on the other hand, in accordance with Stokes' theory of fluid viscosity, ultrasonic waves of a frequency of 10^9-10^{11} cps (responsible for the fine structure according to Bragg's rule) attenuate to

such an extent that the Mandel'shtam-Brillouin components should not appear.

In this situation, the question of experimental determination of the attenuation of ultrasonic waves of varying frequency in liquids and solids assumed the utmost importance and interest. The extensive and thorough research of P. A. Bazhulin led to the development of several optical methods of measuring the attenuation of ultrasonic waves in liquids. This made possible measurements over a wide range of attenuation coefficients at significant variations of ultrasonic frequencies under greatly varying physical conditions.

As a result of Bazhulin's research it was determined that the ultrasound attenuation is influenced not only by the first (customary) coefficient of viscosity corresponding to shear deformation, but also by the second coefficient of viscosity, connected with losses during volume deformations. Also, in many liquids the second coefficient can be much greater than the first. Bazhulin's measurements showed that in a wide range of frequencies up to 10^8 cps the coefficient of attenuation, in accordance with Stokes' theory, is proportional to the square of the frequency. For high frequencies, experiment showed variation from the square law. The experiments of Bazhulin appeared to be the proof of the relaxation theory of absorption and scattering of ultrasound of L. I. Mandel'shtam and M. A. Leontovich. In accordance with the simplest version of the theory, a liquid is characterized by one relaxation time τ. Then at $\omega\tau \ll 1$ the dependence of the viscosity on the frequency is quadratic as in the theory of Stokes, and at $\omega\tau \gg 1$ the viscosity does not depend on the frequency. Thus the complex of research by Bazhulin into the attenuation of ultrasonic waves in liquids significantly broadened our understanding of the viscosity of liquids and led to the confirmation of a new (relaxational) interpretation of the phenomenon of the propagation of high-frequency waves. Bazhulin's work pioneered in this direction, serving as a foundation for the analogous research of a whole series of other authors and gaining recognition both here and abroad.

II. RESEARCH IN MOLECULAR SPECTROSCOPY

The work of P. A. Bazhulin in the field of Raman scattering of light began with the study of the spectra of a series of the individual hydrocarbons which compose the benzenes. The resultant data were to serve as the basis for the development of methods for the analysis of a light motor fuel. This work was an important component of the joint research of a large collective of physicists (the Optics Laboratory of FIAN) and organic chemists under the direction of Academicians N. D. Zelinskiĭ and B. A. Kazanskiĭ. The work in this particular direction continued on the whole for about 20 years and was crowned with the creation of a composite method of investigation of the composition of benzenes. The results of the work were published in many magazine articles and two large monographs, with Bazhulin contributing.

There was also completed under Bazhulin's direction a large cycle of experiments in the area of infrared spectroscopy. Basic attention in this work was directed to working out rigorous quantitative methods of measurement of the intensity of infrared absorption bands. As a result of these experiments conditions of measurement were formulated and standards were set for apparatus, width of aperture, speed of scanning the spectrum, and others. As the final results of the work they formulated a special "set of instructions," in which were described in detail measurement methods ensuring reliable quantitative data on the intensity of the infrared bands.

The second trend of the Bazhulin's work in the field of molecular spectroscopy was connected with research into the effects of changes in the temperature and the aggregate state of a substance on the intensity and width of Raman-scattering and infrared-absorption spectral lines. Included in this work was a systematic investigation of the role of rotary Brownian motion of the liquid molecules in the broadening of the depolarized Raman scattering lines, which was carried out by Bazhulin and a group of co-workers and students in FIAN and MGU. Investigations of the temperature dependence of this broadening in liquids and during the transition to the solid stage produced many important results related to the kinetics of motion of molecules in liquids. Analogous experiments also were conducted with infrared-absorption spectral lines. Later, as a result of the development of highly sensitive methods of registration, Bazhulin and his co-workers were able to go on to experimenting with the broadening of vibrational-rotational and rotational lines of molecular spectra in the gaseous state. Many new and interesting results on the broadening mechanism were obtained here, too. In particular, we should point out his research into the role of various multipole interactions in the broadening of spectral lines of many molecules.

To this cycle belongs the investigation of the temperature dependence of the line intensity of Raman scattering in fluids. This research led to the disclosure of a very interesting anomalous temperature dependence (relative to the independent-molecule model) of the intensities of many lines. This phenomenon, closely connected with the very complex problem of the internal field of fluids, has not been satisfactorily explained to date. Without a doubt there will still be much work devoted to it.

III. WORK IN THE AREA OF QUANTUM RADIOPHYSICS

In the last years of his life P. A. Bazhulin devoted much attention to the development of quantum radiophysics. Under his direction a series of experiments

were carried out dealing with the pulsed gas lasers. He and his co-workers first achieved and investigated generation in molecular hydrogen and deuterium. These experiments also led to many other important results. In particular, they obtained the maximum power then feasible in pulsed molecular gas lasers (hydrogen and nitrogen). P. A. Bazhulin devoted much attention to the creation of quantum generators using rare-earth organic complexes (chelates). Under his direction, laser action with frozen europium-benzoylacetonate solutions was first achieved in the Soviet Union.

Bazhulin's activities in the area of quantum electronics were not confined to the foregoing experiments done under his direction. He did much for the development of this new area of science in the P. N. Lebedev Physics Institute, aiding in the reorganization of the institute's activities and in the coordination of the work of the various laboratories.

Bazhulin gave all of his life to the development of Soviet physics. His work represents a significant contribution to contemporary optics and spectroscopy. His scientific activity had a great influence on the development of these important divisions of contemporary physics in the Soviet Union. He also devoted much of his time and strength to social activities. For many years he was the head of the party organization of FIAN, and secretary of the party committee of FIAN.

He was a simple, sympathetic man, always ready to help his students and any others needing his help. His many students and co-workers and all who knew him personally will remember him well.

Translated by Janet Reich