JOINT SCIENTIFIC SESSION OF THE DIVISION OF GENERAL PHYSICS AND ASTRONOMY, USSR ACADEMY OF SCIENCES WITH THE DIVISION OF PHYSICO-TECHNICAL AND CHEMICAL SCIENCES, TURKMENAIN ACADEMY OF SCIENCES

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A scientific session of the Division of General Physics and Astronomy of the USSR Academy of Sciences of the Turkmenian Academy of Sciences was held on April 20, 21, and 22, 1971, at the Conference Hall of the Presidium of the Turkmenian Academy of Sciences (Ashkhabad). The following papers were delivered at the session:

1. A. A. Berdyev, Present State and Development of Physical Research at the Turkmenian Academy of Sciences.
2. V. A. Baum, Research Under Way in the Solar-energy Department of the Physico-technical Institute of the Turkmenian Academy of Sciences.
3. N. B. Lezhnev, Acoustic Investigations of Liquids at Microwave Frequencies.
4. Ya. A. Agaev, Research in the Field of Semiconductor Physics at the Physico-technical Institute of the Turkmenian Academy of Sciences.
5. M. Berkeliev, G. G. Dzhemilev, A. Muradov, O. Ovezgel'dyev, and M. Shirmamedov, Certain Results from Study of the Physics of the Ionosphere.
6. Kh. Gul'medov and A. P. Savrukhin, Research in Astrophysics and the Physics of the Upper Atmosphere in the Turkmenian SSR.
7. A. Ashirov, A. V. Anikin, O. Gandymov, and A. S. Vasilevskaya, Results of X-ray Structural and X-ray Spectral Investigations of Certain Compounds.
8. V. M. Agranovich and V. L. Ginzburg, Scattering of Light with Formation of Excitons.
9. G. A. Smolenskiĭ, Certain Problems in the Physics of Nonmetals.
10. Ya. B. Zel'dovich, Production of Particles in Electric and Gravitational Fields.
11. U. Kh. Kopvillem, V. N. Osipov, B. P. Smolyakov, and R. Z. Sharipov, Analogs of Electron Spin Echo in Ferroelectrics and Glasses.

We publish below brief contents or expositions of some of the papers.

N. V. Lezhnev. Acoustic Investigations of Liquids at Microwave Frequencies.

Acoustic experiments have a well-known role in solving problems of the liquid state of matter, and are conducted in a broad range of experimental conditions. In physical interpretation of these studies, acoustic relaxation, which reflects various processes taking place in the liquid, is a highly important effect of the sound-matter interaction. These nonequilibrium effects vary in nature, and their physics can be studied by varying the period of the perturbations over a broad range. The technique of artificial generation and registration of sound is now so advanced that the experimentor's arsenal includes frequencies $\sim 3 \times 10^9$ Hz, which corresponds to a sound wavelength $\sim 0.3\ \mu$ in a liquid. Quite recently, these frequencies were accessible only with optical hypersonic apparatus using the scattering of light by incoherent Debye waves.

The Molecular Acoustics Laboratory of the Physico-technical Institute of the Turkmenian Academy of Sciences was the first to solve the broad range of problems relating to microwave acoustic research. Thus, pulsed apparatus was built for measurement of the velocity and absorption of sound in liquids at frequencies of 1—3 GHz. Longitudinal hypersound was generated and received with lithium niobate single crystals placed in coaxial resonators. The velocity of microwave sound was measured by coherent mixing of a delayed radio-frequency signal and an acoustic signal that had passed through a thin layer of liquid. Simultaneous registration of acoustic and optical (He-Ne laser) interference effects and the use of computer techniques have made it possible to perform dispersion acoustic experiments at microwave frequencies with high accuracy: $\sim 0.1-0.5\%$.

Individual liquids whose vibrational spectra are well known were investigated. Relaxation effects were observed in thiophene, benzene, chloroform, and in a score of other substances, in which they are nicely explained by the Mandel'shtam-Leontovich phenomenological theory. The molecular mechanism of absorption and of the dispersion of the sonic velocity is explained by relaxation of the vibrational heat capacity in full agreement with the theoretical notions of Knezer, Gertsfel'd, and others.

Relaxation effects were observed in the high-frequency range in studies of a large group of aqueous solutions of electrolytes, including cadmium halides and sulfates of di- and trivalent metals. The behavior of the relaxation time as a function of concentration and temperature was ascertained.

In cadmium halides, relaxation is explained by violation of the equilibrium between the complexes and free ions. In sulfates, chemical relaxation and, to an insignificant degree, relaxation of the ionic atmospheres are responsible for the high-frequency relaxation.

In many viscous substances, the temperature dependence of sound absorption passes through a maximum whose magnitude decreases with increasing frequency. Examination of the results within the framework of relaxation theory with a single relaxation time indicates that it cannot satisfactorily explain the experimental data. The results of a broad range of experiments in highly viscous substances agree well with the nonlocal theory of Isakovich and Chaban. Interestingly, the behavior of a viscous substance in acoustic experiments resembles, in many cases, the behavior of a solution whose component concentrations are strongly influenced by temperature.

The propagation of transverse sound waves was studied in low-viscosity liquids, in which Fabelinskiĭ had observed fine structure in the wing of the Rayleigh line. Acoustic information on liquids was obtained by the impedance method: the transverse sound was artificially generated by quartz and lithium niobate crystals. Comparison of the optical and acoustic results provides a basis for certain hypotheses pertaining to the "anomalous" branch of the temperature curve of the distance between the doublet components in liquid salol and benzophenone. This branch is probably not a continuation of the temperature dependence of transverse-wave velocity at high viscosities, but essentially a manifestation of some new, not yet understood effect. This is suggested by our experiments in which the velocity of the transverse sound diminished with increasing temperature at low viscosities and, so to speak, continued the "normal" branch into the high-temperature region.

[1] A. A. Berdyev and N. B. Lezhnev, ZhETF Pis. Red. **13**, 49 (1971) [JETP Lett. **13**, 32 (1971)].

[2] A. A. Berdyev, V. V. Lapkin, and N. B. Lezhnev, Izv. Akad. Nauk Turkm. SSR, Ser. Fiz. Tekh. Khim. Geol. Nauk No. 2, 115 (1969).

[3] A. A. Berdyev, N. B. Lezhnev, and G. A. Nazarova, ibid. No. 1, 110 (1969).

[4] A. A. Berdyev, N. B. Lezhnev, G. A. Nazarova, and M. G. Shubina, ibid. No. 2, 114 (1969).

[5] A. A. Berdyev, N. B. Lezhnev, and V. V. Lapkin, ibid. No. 2, 111 (1968).

[6] A. A. Berdyev and B. Khemraev, ibid. No. 4, 94 (1970).

[7] A. A. Berdyev, B. Khemraev, and M. G. Shubina, Akust. Zh. **17**, 459 (1971) [Sov. Phys.-Acoust. **17**, 383 (1972)].

Ya. A. Agaev. Research in the Field of Semiconductor Physics at the Physico-technical Institute of the Turkmenian Academy of Sciences.

Over the past decade, the Physico-technical Institute of the Turkmenian Academy of Sciences has been engaged in work toward the development of new semiconductor materials of the types A^3B^5, $A^2B^4C_2^5$, and $A_2^1B^4C_3^6$ and solid solutions based on them.

Both p- and n-type $CdSnAs_2$ single crystals have been prepared (n, p $\sim 10^{17}$ cm^{-3}, $\mu_n \sim 22\,000$ cm^2/V-sec).

The gas-transport reaction method was used to prepare single-crystals based on $2GaAs-ZnGeAs_2$ and $2GaAs-ZnSiAs_2$ in a broad range of GaAs concentrations (n $\sim 10^{18}$ cm^{-3}, $\mu_n \approx 2500$ cm^2/V-sec).

Work was done in the preparation of the compounds Cu_2GeSe_3, Cu_2SnSe_3, Cu_2GeTe_3, Cu_2SnTe_3, Ag_2GeSe_3, Ag_2SnSe_3 and others, and some of their properties were investigated.

A coordinated study was made of the electrical, thermoelectric, galvanothermomagnetic, optical, and photoelectric properties of GaP, InP, AlSb, InSb crystals and InSb—AlSb and InP—InAs solid solutions.

An impurity photo-emf was detected in single-crystal acicular specimens of GaP; it is a result of direct electron transitions from the valence band to the 0.1- and 0.4-eV levels or of double optical transitions.

The Keldysh-Franz effect, which is related to indirect transitions in GaP with

$$\Gamma_{15}^{v} \to X_3 \quad \text{and} \quad \Gamma_{15}^{v} \to X_1$$

was observed.

Investigation of the Keldysh-Franz effect and the spectral photosensitivity in the shortwave region made it possible to propose a possible structure of the fundamental bands.

Mechanisms of carrier scattering were established in InP crystals on the basis of an analysis of the temperature dependence of mobility, the transverse Nernst-Ettingshausen effect, and the thermal emf: mobility is limited basically by Raman scattering on impurity ions and neutral atoms at low temperatures and by Raman scattering on optical and acoustic lattice vibrations at high temperatures.

High-resistance InP crystals (n $\sim 10^{11}-10^{12}$ cm^{-3}) were prepared by diffusion of copper and were used to make p-n junctions, and the electrical and photoelectric properties were studied in a broad range of temperatures. In the impurity-conductivity range of the high-resistance InP crystals, negative photoconductivity was observed at low temperatures with $h\nu \approx 0.9-0.55$ eV and can be explained on the basis of the energy spectrum of the impurities. At room temperatures, impurity photosensitivity was observed in the same region of the spectrum with external intrinsic illumination.

The absorption spectra of InP crystals showed a number of bands in the region $h\nu < E_g$, belonging in all probability to impurity levels; similar values were found for the impurity levels on the basis of the electrical and photoelectric properties.