maxima in the electron spectrum can be interpreted as manifestations of autoionization states of sodium in the course of the (Na, Ne) collisions. In this case, the first maximum at E = 23.5 ± 0.5 eV can be ascribed, in analogy, to the lower autoionization doublet of states $(2p)^5 3s^2\ ^2P_{3/2,\ 1/2}$. The indicated auto-ionization states of Na were apparently observed for the first time.

Thus, the discrete electron groups observed in our investigation of the collisions of alkali-metal atoms with He and Ne atoms correspond to excitation of the same autoionization states as in the absorption of light. It should be noted that the corresponding maxima in the electron spectrum are very intense.

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GRAVITATIONAL EFFECT IN INTERFERENCE SPECTRA OF THE FINE STRUCTURE OF THE RAYLEIGH LINE

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We have obtained first results indicating an influence of the gravitational effect near critical stratification temperature of a binary solution on the magnitude of the speed of sound and on the refractive index of light. A new method, the gist of which is clear from Fig. 1, is proposed to observe this influence.

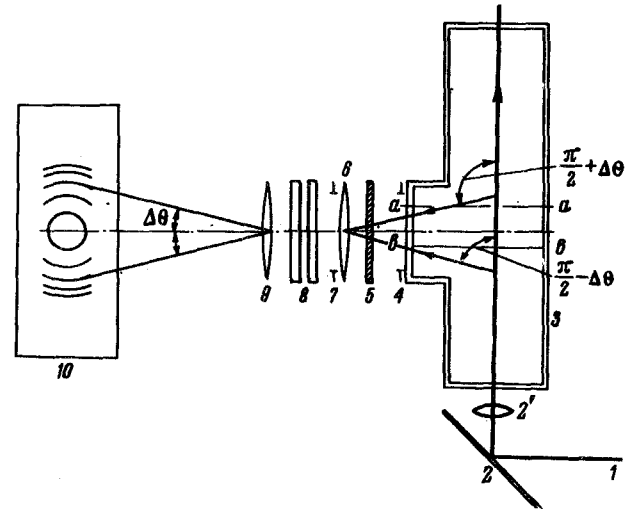

Fig. 1. Experimental setup: 1 - laser beam; 2 - flat mirror; 2' - long-focus lens; 3 - cell with solution, 140 mm high, 40 mm dia, diameter of side window 40 mm, aa - center of cell, bb - phase boundary after stratification; 4 - diaphragm; 5 - light filter; 6 - objective with focal distance f = 300 mm; 7 - diaphragm; 8 - Fabry-Perot interferometer, dispersion 0.5 cm^{-1}; 9 - objective, f = 500 mm; 10 - plane of spectrum.

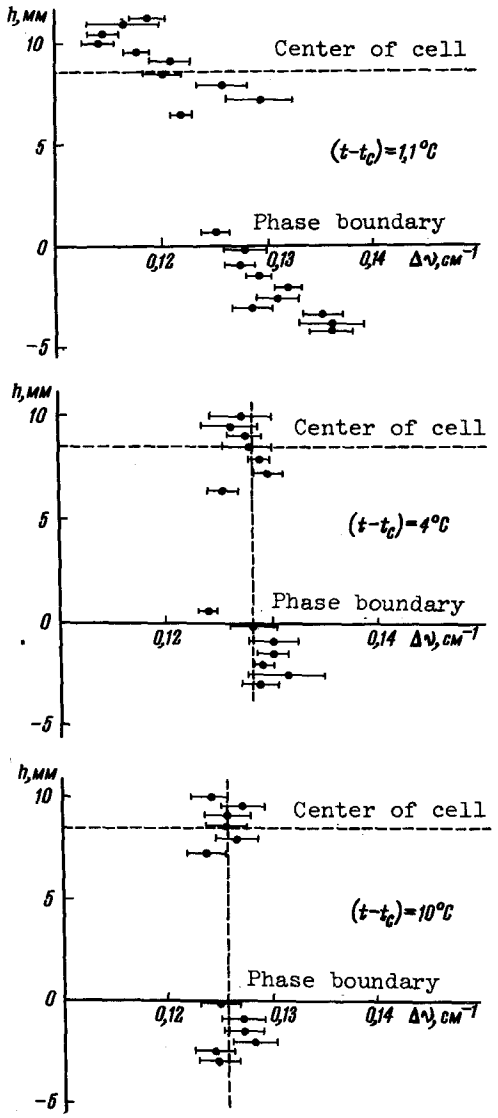

Fig. 2. Shift Δν of MB components vs. height h of the scattering volume at various temperatures.

The scattering-inducing laser beam passes through a solution-filled cell in an upward (or downward) direction. An image of the scattering volume is produced of the plane of the spectrum with the aid of a Fabry-Perot interferometer. The interference orders correspond to scattering volumes at different heights. The shift of the Mandel'shtam-Brillouin (MB) components Δν is equal to [1]:

$$\Delta\nu = 2n\nu(v/c)\sin\theta/2. \qquad (1)$$

Near the critical stratification point, the action of the gravitational force and the deceleration of the diffusion can produce various concentration gradients along the height of the cell (gravitational effect) [2]. Therefore scattering volumes of differing heights should have different refractive indices n, different sound speeds v, and consequently also different Δν.

We investigated a solution of nitrobenzene in normal hexane, with a near-critical nitrobenzene concentration c_1 = 0.4 molar fraction, having an upper stratification temperature t_c = 20 ± 0.05°C. Near t_c, prior to photography of the spectra, the solution was kept at the set temperature for 7 - 10 hours. The scattering was excited by the 6328 Å line of a 15 MW neon-helium laser. The other experimental condition and the spectrum reduction were the same as in [3].

As seen from Fig. 2, at 10 and 4°C above t_c the shift of the MB components is independent, within the limits of experimental accuracy, of the height of the scattering volume, and at $(t - t_c)$ = 1.1°C the shift Δν for the lower layers of the scattering volume is larger than for the upper layers. This indicates that a gravitational effect begins to appear in the given temperature interval. Assuming the solution to be ideal, we obtain $\delta(\Delta\nu)/\Delta\nu = 0.17\,\delta c_1/c_1$. Approximately 30% of Δν is then due to the change of n, and 70% to the change of v.

At $(t - t_c) < 1°$, the MB components became noticeably smeared out and their positions were difficult to measure against the growing background of the central component. It is possible that the smearing of the MB components is due to the large absorption of the hypersound propagating in the medium with variable density, inasmuch as in experiments with a horizontally oriented cell (laser beam perpendicular to the concentration gradient) we were able to obtain the fine structure of the Rayleigh line down to $(t - t_c)$ = 0.1°C.

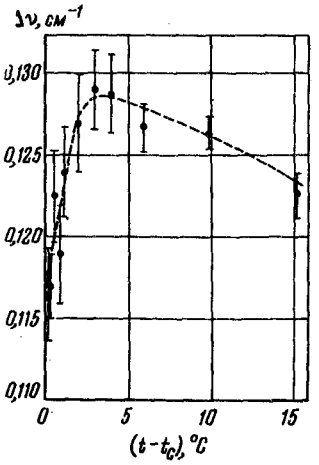

Fig. 3. Shift Δν of MB components vs. solution temperature at horizontal cell orientation.

The results of these measurements are shown in Fig. 3. We see that when t_c is approached the shift of the components first increases, then it begins to decreases at approximately 2.5°C, and when $(t - t_c) = 0.1°C$ the decrease is close to 10%.[1)]

We measured the refractive index n (6328 Å) of a thin layer of the solution with the IRF-22 refractometer. On approaching t_c, the value of n increased linearly from 1.4300 at $(t - t_c) = 15°C$ to 1.4387 at 0.1°C. If it is assumed that n remains practically unchanged, then the curve of Fig. 3 describes the temperature dependence of the speed of the hypersound.

D'Arrigo and Sette [5] measured the speed of 15-MHz ultrasound in the same solution. Their data on ultrasound absorption show that 15 MHz is higher than the critical relaxation frequency of the volume viscosity, if a single relaxation time is assumed. Consequently, the speeds of 15-MHz ultrasound and of hypersound should coincide, or else a weak positive dispersion of the speed of sound should take place.

Comparison of our data with those of [5] shows that at $(t - t_c) > 2.5°C$ the speeds of ultrasound and hypersound coincide within the limits of the measurement error. At $(t - t_c) < 2/5°C$ the speed of ultrasound continues to increase almost linearly, while the speed of hypersound decreases (see Fig. 3). The observed "negative" dispersion of the speed of sound does not follow from simple relaxation representations, which have explained quite successfully the results of the experiments of [3].

The decrease of Δν near t_c may be due to the increasing systematic error in the measurement of Δν, connected with the growth of the background due to the central line. Microphotometry of the spectra has shown that this error amounts to 2 - 3%. Allowance for the width of the MB components [4] leads to another ∿ 2% decrease of Δν. In accord with the results of experiments with a vertically oriented cell, since in experiments with a horizontal cell the scattering volume was 6 mm higher than the position of the phase boundary.

In conclusion, we are grateful to I. L. Fabelinskii for interest in the work, useful discussions, and hints.

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1) The obtained temperature dependence of Δν agrees qualitatively with recent results of Chen and Polonsky [4], who explained the temperature variation of Δν near t_c, but did not indicate that it is connected with the variation of n.

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LONGITUDINAL DISTANCES IN GAMMA QUANTUM SCATTERING AND ASYMPTOTIC ELECTROPRODUCTION CROSS SECTIONS

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1. It was shown in an earlier paper [1] that the question of the longitudinal distances that play a role in the scattering of virtual gamma quanta by nucleons at high energies can be clarified by analyzing the dependence of the imaginary part of the amplitude for the forward scattering of a virtual gamma quantum with mass q^2 by a nucleon, $\mathrm{Im}M_{\mu\nu}(\nu, q^2)$ on q^2 ($\nu = pq$, p and q are the momenta of the nucleon and of the gamma quantum). Namely, if $\mathrm{Im}M_{\mu\nu}(\nu, q^2)$ changes appreciably with changing q^2 at $\nu \gg m^2$ and $\nu \gg |q^2|$ and at a fixed ν, then large longitudinal distances, which increase linearly with increasing energy, play a role in the scattering of the gamma quanta by nucleons at high energy. But if $\mathrm{Im}M_{\mu\nu}(\nu, q^2)$ is independent of q^2 under the same conditions, then the principal role is played by finite longitudinal distances (or distances increasing more slowly than ν). When $q^2 < 0$, the value of $\mathrm{Im}M_{\mu\nu}(\nu, q^2$ averaged over the spins of the nucleon is expressed in the following manner in terms of the invariant functions $w_1(\nu, q^2)$ and $w_2(\nu, q^2)$, which determine the total cross section for the electroproduction of hadrons on nucleons:

$$\mathrm{Im}M_{\mu\nu}(\nu, q^2) = \frac{1}{m^2}\left(p_\mu - \frac{\nu q_\mu}{q^2}\right)\left(p_\nu - \frac{\nu q_\nu}{q^2}\right) w_2(\nu, q^2) - \left(\delta_{\mu\nu} - \frac{q_\mu q_\nu}{q^2}\right) w_1(\nu, q^2). \quad (1)$$

Hence

$$w_1 = \frac{1}{2}\mathrm{Im}M_T; \qquad w_2 = -\frac{q^2 m^2}{\nu^2 - m^2 q^2}\left(\frac{1}{2}\mathrm{Im}M_T - \frac{m^2 q^2}{\nu^2}\mathrm{Im}M_L\right) \quad (2)$$

where $M_T = M_{xx} + M_{yy}$, $M_L = M_{zz}$, and the z axis is directed along the gamma-quantum momentum. Experimental data on electroproduction on protons [2] show that in a certain interval of variation of q^2, at fixed ν satisfying the conditions $\nu \gg m^2$ and $\nu \gg |q^2|$, the function $w_2(\nu, q^2)$ does not depend on q^2, namely $w_2 \approx 0.3\ m/\nu$. By virtue of (2), this means that $\mathrm{Im}M_T$ and (or) $\mathrm{Im}M_L$ vary appreciably with varying q^2, i.e., large longitudinal distances play a role in the scattering of gamma quanta by nucleons.[1)]

Another argument in favor of the role of large longitudinal distances arises when the data on the energy dependence of the total cross sections for photoproduction on protons and for the absorption of neutrinos and antineutrinos by nucleons are compared. The total cross

[1)] In the author's paper [1], the behavior of $w_2(\nu, q^2)$ as a function of ν and q^2 was erroneously identified with the behavior of $\mathrm{Im}M_{\mu\nu}(\nu, q^2)$. As a result, in the absence of a dependence of w_2 on q^2, it was incorrectly concluded that the final states play the main role in the scattering of gamma quanta by nucleons.