four orders than ν_{ei}. $\overline{\nu_{eff}}$ varies like E_0^2 with increasing E_0, and perhaps even more rapidly.

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INVESTIGATION OF THE CATAPHORESIS EFFECT IN A CADMIUM-VAPOR LASER

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When a dc discharge is excited in a mixture of gases having different atomic numbers and ionization potential, separation of the components - cataphoresis - is observed [1]. Goldsborough [2] used this effect to introduce cadmium vapor into the discharge gap in an He-Cd laser. The cadmium ions move in this case in the discharge gap from the anode to the cathode. Owing to the Doppler effect, the spectral emission lines of the ions, when observed in the direction of their motion and in the opposite direction, are shifted by an amount

$$\Delta\nu = 2\nu_0 \frac{V}{C}.$$

We have investigated experimentally the cataphoresis effect when an He-Cd dc discharge tube is placed in a traveling-wave generator.

The experimental setup is shown in Fig. 1. The resonator, made up of one spherical and two flat mirrors, has the form of an equilateral triangle of 50 cm on each side. The spectral composition of the laser radiation was analyzed with a ring scanning interferometer 2, placed past the photomixer 3. The use of a ring interferometer eliminates completely the influence exerted on the laser by the radiation reflected from the input mirror of the interferometer. The resonator length can be adjusted with the aid of an electrostrictor in a range ±1 μ.

The gas-discharge tube 1 has a discharge-gap length 200 mm and a channel diameter 1.8 mm. Cadmium (the isotope Cd^{114}) is placed near the anode. The tube was sealed off at a pressure 3 mm Hg.

Figure 2 shows and explains the spectrum obtained with a scanning interferometer, of oscillations produced in two opposing beams. When the perimeter of the ring resonator is rearranged and the pump level is suitably chosen, generation is observed in the first beam (a), then in two beams simultaneously (b), and eventually in the second beam (c). The distance between the frequencies of the generated oscillations equals 3C/L (600 MHz). The magnitude of the observed frequency shift between the generated oscillations is determined by the velocity of the ions along the tube axis and by the natural frequencies of the resonator. Distances of 600 MHz between the centers of the amplification curves corresponds to an average velocity of 132 m/sec for ions at the $4d^9 5S^2\,{}^2D_{5/2}$ level.

If we assume that the mean ion velocities at the $4d^9 5S^2\,{}^2D_{5/2}$ level and at the ground state are equal, then we can obtain from the measured ion velocity and rate of cadmium consumption (1 mg/hr in our case), using the expression $m/t = MNSV$, where m/t is the rate of cadmium consumption, M the mass of the atom in grams, N the ion concentration, S the cross section area of the tube, and V the average cadmium-ion velocity along the tube axis, a value of 4×10^{12} cm^{-3} for the cadmium ion concentration.

We have performed experiments with a three-electrode gas-discharge tube, in two arms of which the cadmium ions moved in opposite direction. The length of each discharge channel was 1.4 mm, and the helium pressure was 3 mm Hg.

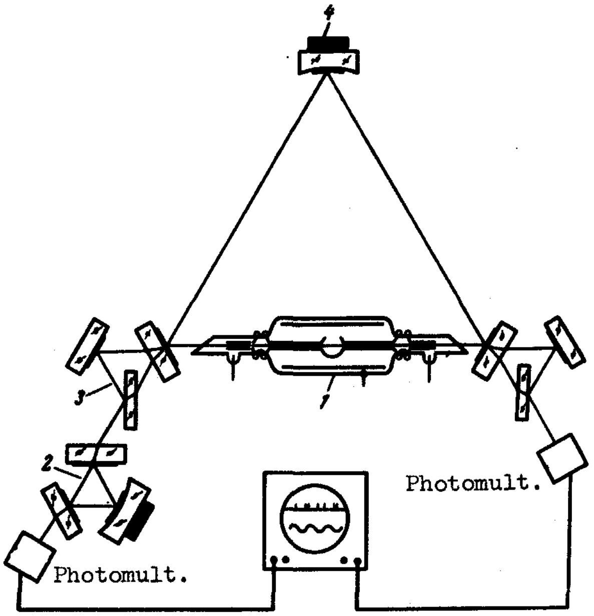

Fig. 1

At equal currents and cadmium vapor pressures in the discharge gaps, there was no frequency difference between the opposing waves. When the currents or cadmium vapor pressures became unequal, producing a relative shift smaller than C/2L = 100 MHz between the centers of the amplification curves, and the oscillation frequencies at the output of the scanning interferometer were equal at a definite pump level. As a result of the pulling of each of the frequencies towards the center of its own amplification contour, the frequencies of the opposing waves can differ in this case by an amount

$$\Delta f = \Delta\nu'_{\text{cat}} \frac{\Delta\nu_p}{\Delta\nu_D} + \Delta\nu''_{\text{cat}} \frac{\Delta\nu_p}{\Delta\nu_D} \,,$$

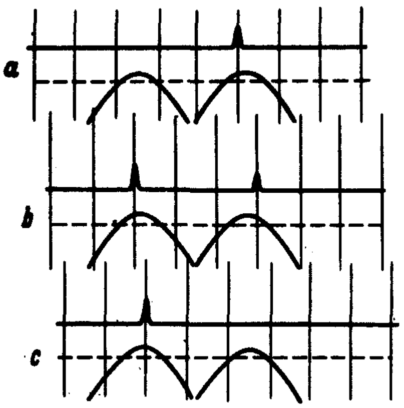

Fig. 2

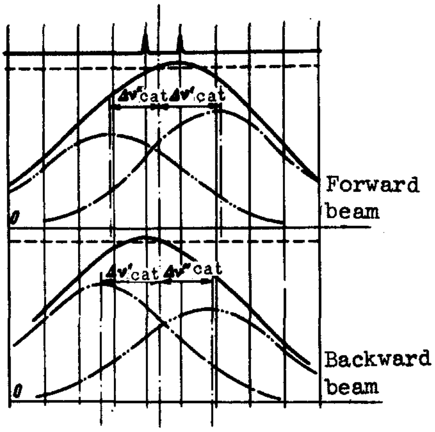

Fig. 3

where $\Delta\nu'_{cat}$ and $\Delta\nu''_{cat}$ are the deviations of the first and second waves, respectively, from the center of the amplification line, $\Delta\nu_p$ is the width of the resonator bandwidth, and $\Delta\nu_D$ is the Doppler width.

This frequency shift does not exceed several hundred kHz and cannot be resolved by the scanning interferometer (its resolution is of the order of 50 MHz).

When the excitation conditions are changed in one of the gaps (by decreasing the cadmium vapor pressure), generation of oscillations with a shift C/L (200 MHz) is observed (Fig. 3). When the cadmium vapor pressure is decreased in one of the arms, a transition is observed towards generation of oscillations with a shift 2C/L (400 MHz).

Thus, under the indicated experimental conditions the mean ion velocity, determined by the cataphoresis, lies in the range 110 - 150 m/sec, and the cadmium ion concentration, determined from the average ion velocity and from the cadmium consumption, is 4×10^{12} cm^{-3}.

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CORRELATION BETWEEN THE TRANSVERSE AND LONGITUDINAL MOMENTA IN MULTIPLE GENERATION

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In recent investigations of inelastic interactions of hadrons, either with accelerators or at cosmic energies, particular attention has been paid to the correlation between the transverse and longitudinal momenta of the secondary particles. This problem is of interest because it is assumed in most theoretical researches that these two variables are either entirely independent of each other or only very weakly connected. On the other hand, experiments have shown that the differential cross section of the interaction cannot be factorized in terms of p_t and p_ℓ [1]:

$$\frac{d^2\sigma}{dp_t\,dp_\ell} \neq f(p_t)\phi(p_\ell) .$$

The latter becomes manifest in two facts. The mean value $\langle p_t \rangle$ turns out to be a function of p_ℓ [2 - 5]. In addition, the slope of the p_ℓ spectrum in a semilog scale turns out to be a decreasing function

$$\ln\frac{d\sigma}{d|p_\ell|} = -b(p_t)|p_\ell| . \qquad (1)$$

We obtained the corresponding relations at $\sim 5 \times 10^{11}$ eV using apparatus consisting of a cloud chamber in a magnetic field and an ionization calorimeter [6]. Figure 1 shows the correlations between $\langle p_t \rangle$ and p_ℓ, and Fig. 2 shows the dependence of the p_ℓ spectra on p_t. These data agree with the results observed at accelerator energies not only qualitatively but also quantitatively.