the magnetic field intensity H.

We see from the figure that the oscillations begin at relatively weak magnetic fields, 2000 Oe, for the odd photomagnetic effect, and at 4000 Oe for the even effect.

The experimental data for the odd effect agree qualitatively with the theory of [1]. As to the even effect, in view of the absence of a quantitative theory, we regard its interpretation as premature. We plan to carry out in the nearest future investigations of the oscillations of the Hall effect and of the planar Hall effect with the same samples.

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POPULATION INVERSION IN ADIABATIC EXPANSION OF A GAS MIXTURE

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Several new methods of obtaining population inversion have been proposed recently [1-3]. We show in this article that in some mixtures of molecular gases, population inversion states in the vibrational levels are produced and exist for some time following the adiabatic expansion. To this end, the molecules of the mixture must differ appreciably in their vibrational relaxation times and be capable of exchanging vibrational-excitation energy.

Effective transfer of vibrational excitation between molecules of different species occurs when the energies of the vibrational levels of the molecules are close to each other. More accurately, for resonance exchange of vibrational-excitation energy it is necessary to satisfy the condition $|\Delta E| \ll kT$, where ΔE is the energy deficit.

By way of an example of resonant exchange of vibrational excitation we can cite mixtures of nitrogen with carbon dioxide or with nitrogen dioxide [4]. In the first mixture the exchange is between the level v = 1 of the N_2 molecule and the level $(0\ 0^0 1)$ of the CO_2 molecule. At room temperature the transfer probability in one molecule collision is $\alpha \sim 10^{-5}$.

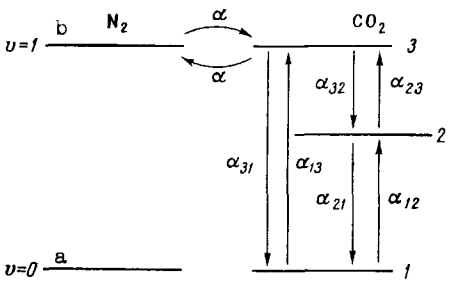
We assume for simplicity that the concentration of the molecules that carry the vibrational excitation in the mixture is much larger than the concentration of the working molecules at whose levels the population inversion takes place. We can then assume during the description of the relaxation processes that the concentration of the excited carrier molecules in the mixture remains constant in time.

The equations that describe the change in the number of molecules of the working gas at three vibrational levels, of which one (the third) can exchange vibrational excitation with the level b of the carrier molecule (see the figure) are written in the form

$$\frac{dn_3}{dt} = -w_{ab}n_3 + w_{ba}n_1 - w_{31}n_3 + w_{13}n_1 - w_{32}n_3 + w_{23}n_2,$$

$$\frac{dn_2}{dt} = w_{32}n_3 + w_{12}n_1 - w_{23}n_2 - w_{21}n_2; \quad n_1 + n_2 + n_3 = n.$$

Here w_{ba} is the probability of excitation of the working molecule by collisions with the carrier molecules, which are in the excited state; w_{ab} is the probability of the reverse transfer of excitation from the working molecule to the carrier molecules; w_{31}, w_{13}, w_{32}, etc. are the probabilities of the thermal relaxation of the working molecule between the corresponding vibrational levels.



Assume that the process of adiabatic expansion of the gas mixture is fast enough so that the time interval during which the gas is cooled from the initial temperature T_1 to the final one T_2 is much shorter than the proper vibrational relaxation time of the carrier-gas molecules. A stationary distribution over the vibrational levels of the working molecules is established in the gas within a short time interval following the end of the gas-mixture expansion.

The inversion between levels 3 and 2 is obtained as usual by equating to zero the right sides of the equations. Then

$$\frac{n_3 - n_2}{n_1} = \frac{\alpha(\alpha_{21} - \alpha_{32})}{\alpha_{21}(\alpha + \alpha_{32} + \alpha_{31})} \exp\left(-\frac{E_b - E_a}{kT_1}\right),$$

where α_{21}, α_{32}, and α_{31} are the probabilities of relaxation after one collision. It is assumed that the final temperature of the gas mixture T_2 is such that thermal excitation of the molecule (i.e., the probabilities w_{13}, w_{23}, and w_{12}) can be neglected, but the deactivating collisions cannot be neglected and $kT_2 \gg |\Delta E|$. We see from the formula that no inversion between the levels 3 and 2 is obtained if $\alpha_{32} > \alpha_{21}$. If the condition $\alpha_{21} \gg \alpha_{32}$ is satisfied and the probability α of transfering vibrational excitation is much larger than the probability of deactivation of level 3 for the working molecule, then the inversion reaches its maximum and is equal to the relative concentration of the excited molecules of the carrier gas at an initial temperature T_2.

Let us show, with the mixture of nitrogen and carbon dioxide as an example, that by adiabatic expansion it is possible to obtain a population inversion between the levels (0 $0^0$1) and ($10^0$0) of the CO_2 molecule, and let us determine its magnitude for T_1 = 1000°K and T_2 = 300°K. If the final temperature of the gas mixture is of the order of room temperature then $\alpha_{21} > \alpha_{32}$, since this is the optical transition of the CO_2 molecule at which a N_2 - CO_2 gas laser operates when excited with an electric discharge [5]. The probability of deactivation of the CO_2 molecule after one collision is $\sim 10^{-5}$ for the dry gas [6], and therefore $(n_3 - n_2)/n_1 \sim 1\%$ and the maximum is 3.5%.

It must be noted in conclusion that a continuous mode of adiabatic expansion of a gas mixture can be realized by passing the gas through a supersonic nozzle.

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MAXIMUM TEMPERATURE OF THERMAL RADIATION

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American investigators have recently observed cosmic radio emission with effective temperature 3.5°K at a wavelength 7.3 cm [1]. If the assumed thermal character of this radiation (maximum at 0.1 cm) is confirmed, then it will be most natural to regard it as the residual photon field remaining from the initial singular state of the expanding universe, which in this case must be assumed to possess an infinite entropy density ("hot" model of expanding universe; in this model it is necessary to postulate, besides the presence of the photon field, also the presence of a residual graviton gas and of gas made up of pairs of two species of neutrinos with approximately the same average energy and nonthermal spectrum).

In connection with these hypotheses it is of interest to consider the properties of hot matter at very high densities, including such that the gravitational interaction of the photons is significant (the number of photons per unit volume is of the order of the gravitational unit $n_0 = c^{3/2}\hbar^{3/2}G^{-3/2} = 2.4 \times 10^{+98}$ cm^{-3}; cf. paper [2] by the author, where cold matter is considered).

We denote the energy density by ϵ. The total energy in a sphere of radius R, separated in isotropic space, contains terms proportional to different powers of R

$$E = \frac{4\pi}{5} R^3 \dot{R}^2 \epsilon - \frac{32\pi^2 G R^5}{15} \epsilon^2 + \frac{4\pi}{3} \epsilon R^3$$

(we put c = 1).

The first two terms are $\sim R^5$ (their sum vanishes for flat space). To find the value of ϵ it is necessary to separate the terms proportional to the volume in the gravitational interaction between particles (correlation and exchange interactions).

Neglecting for simplicity all effects of production of baryon and lepton pairs, we have within the framework of gravitational perturbation theory the following power expansion

$$(n/n_0)^{2/3} = G\hbar^{-1}c^{-1}n^{2/3}$$

(we put below $\hbar = c = 1$, $n_0 = G^{-3/2}$) and

$$\epsilon = A n^{4/3} - B G n^2 - C G^2 n^{8/3}. \qquad (1)$$

The first term is the Stefan-Boltzmann expression; the second is an exchange correlation which decreases the energy for the attracted bosons. The next terms make up the correlation