ized oscillation) a quantum of the localized oscillation. Thus, the spectrum of emitted γ quanta will consist of an unshifted line corresponding to the energy of the transition and of a continuous background corresponding to the emission and absorption simultaneously with the γ quantum of phonons from the continuous part of the spectrum of oscillations of the atom; on this background, there will be individual discrete peaks due to the emission and absorption of quanta of the localized oscillations.

These peaks can be observed in almost the same way as the unshifted line is observed. Namely, an absorber containing atoms in the ground state should be moved with such a velocity that the Doppler shift of its undisplaced absorption line will be equal to the frequency of the localized oscillation. One then will observe a stronger absorption than for neighboring frequencies. The velocity needed for this is obviously determined by the condition $\omega_L = v\omega/c$, where ω is the frequency of the γ line. If the energy of the transition is of the order of tens of kev, and $\hbar\omega_L \sim 0.01$ ev, $v \sim 10^3 - 10^4$ cm/sec. Such a velocity is not difficult to obtain by placing the absorber on the rim of a rotating disk.

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THE REALIZATION OF A MEDIUM WITH NEGATIVE ABSORPTION COEFFICIENT

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THE phenomenon of induced emission was predicted by Einstein.[1] The conditions for direct observation of this phenomenon were formulated by Fabrikant[2] and realized experimentally by Basov and Prokhorov,[3] Gordon, Zeiger, and Townes[4] in the microwave region of the spectrum, and by Butaev and Fabrikant[5] in the optical region of the spectrum.

In recent years there have appeared papers in which various means are proposed for realizing media with a negative absorption coefficient in the optical frequency range, but as yet there have been no reports of positive experimental realizations of these proposals.[6]

In the present work, it seems to us we have realized a medium which has a negative absorption coefficient in the visible region of the spectrum. For such a medium we use a gas discharge in a mixture of vapors of mercury and zinc.[7]

The negative absorption was studied at a temperature of the liquid electrodes of the gas discharge tube of 6 and 15° C, and the discharge current was varied from 8 to 15 amp. As a result of the measurements it was found that the transparency of the mercury-zinc discharge for the zinc line at 6362 A ($4^1P_1^0 - 4^1D_2$) is greater than unity and, under various conditions, changes from 1.5 to 10. Under these same conditions the transparency of the discharge for the 4722 A zinc line was less than unity and equal to ~ 0.9. The absolute value of the absorption coefficient k under the conditions of our experiments varied from 0.2 to 1.15. This makes it possible to estimate the concentration of excited atoms N_i in the 4^1D_2 level. In fact[2]

$$N_i = 8\pi |k| \Delta\nu/\lambda^2 A_{ik},$$

where $\Delta\nu$ is the half-width of the line, $\lambda = 6362$ A, A is the probability of spontaneous transition. For the 4^1D_2 level, $A_{ik} = 4 \times 10^7$ cm^{-1}.[8]

Setting $\Delta\nu = 10^{-2}$ cm^{-1} (the Doppler half-width), we obtain $N_i = 9 \times 10^9$ for $k = 0.2$, and $N_i = 5 \times 10^{10}$ for $k = 1.15$.

The estimate of N_i for the 4^1D_2 level made by us from measurements of the absolute intensity of the 6362-A line agree in order of magnitude with the computed values of N_i given above.

Let us state the physical reasons which in this case lead to such a break-down of the Boltzmann distribution of the atoms over the energy levels, so that one realizes a medium with a negative absorption in the optical frequency range.

According to Butaeva and Fabrikant,[5] $N_i/N_k = \alpha_i\tau_i/\alpha_k\tau_k$, where α_i and α_k are the numbers of acts of excitation per second to the levels E_i and E_k, while τ_i and τ_k are the lifetimes of atoms in these levels. In our case, the index i refers to the 4^1D_2 level, and k to the $4^1P_1^0$ level; then, if we disregard reabsorption of the 2138-A line, the ratio $\tau_i/\tau_k = 2.5 \times 10^{-8}/1.7 \times 10^{-9} \sim 15$.

Reabsorption of the 2138-A line can considerably reduce this ratio, but a rough estimate shows that this ratio remains ~ 1.

The ratio of the numbers of excitations, α_i/α_k, if we assume that the excitation occurs only because of electronic collisions, should be less than unity, but under the conditions we are considering there is a mechanism for selective excitation of the 4^1D_2 level which consists of the following: An atom of mercury has a 7^3S_1 level whose energy of excitation is only 133 cm^{-1} lower than the energy of the excited 4^1D_2 level of the zinc atom; i.e., the difference between the energies is of the order of the average energy of thermal motion of the atoms at room temperature. Therefore, we have very effective resonance collisions of the second kind between excited mercury atoms (7^3S_1) and unexcited zinc atoms, as a result of which there will occur an excitation of zinc atoms to the 4^1D_2 level. The number of mercury atoms in the discharge is very much greater than the number of zinc atoms, which guarantees a transfer of energy through collisions of the second kind.

It seems to us that this mechanism of excitation of approaching atoms by resonance collisions of the second kind in a gas discharge mixture can be extremely effective for producing a medium with a negative absorption coefficient. It seems that one can find a considerable number of examples of mixtures of atoms with nearby energy levels and with an asymmetry in the transfer of excitation by inelastic collisions of the second kind.

As an example, we may point to the mixture of cadmium and zinc atoms in which, in the diagram of energy terms, the interaction of the 5^3S_1 HgI and the 6^1S_0 CdI terms should produce a medium with a negative absorption coefficient for the infrared transition with $\lambda = 10394.7$ A and for the visible transition with $\lambda = 4413.06$ A.

The authors express their sincere gratitude to V. A. Fabrikant for valuable advice and useful discussion of the work.

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NUCLEAR ZEEMAN EFFECT IN Sn^{119}

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THE resonance absorption of 23.8-kev γ quanta by Sn^{119} nuclei, resulting from the emission and absorption of γ quanta without energy loss to recoil (Mössbauer effect[1]), has been observed earlier by Alikhanov and Lyubimov[2] and by Barloutaud et al.[3] Alikhanov and Lyubimov studied, in particular, the influence of an external magnetic field on the magnitude of the resonance absorption effect. In our previous work[4] we measured the dependence of the resonant absorption of 23.8-kev γ quanta emitted in the decay of Sn^{119m} on the velocity of the source with respect to the absorber; we detected a hyperfine structure of the γ rays due to the splitting of the excited state of the Sn^{119} nucleus in the electric field of the white tin crystal.

In the present work we have investigated the dependence of the resonance absorption of 23.8-kev γ quanta by Sn^{119} nuclei on the source velocity under conditions where the absorber is in an external constant magnetic field. In this case, there is a Zeeman splitting of the absorption line, and one observes in the absorption spectrum a