nucleon coupling constant g^2 is also taken into account, a fully satisfactory description of the same experimental data is obtained in the case of the second phase-shift set and even more so in the case of the first. At the same time, the coefficient $C_{nn}(90°)$, calculated from the new phase shifts, was found to be approximately 0.41 for either set. In this connection, MacGregor et al.[9] believe that to solve the problem of the two phase-shift sets it is necessary to measure the value of C_{kp} at 45°, which determines the correlation between the spin components in the plane of the main scattering.

However, the new analysis with the nine phase shifts and with the constant g^2 has led not only to the disappearance of the difference between the coefficients $C_{nn}(90°)$ corresponding to the first and second sets, but also to a value that contradicts the available experimental data. In our opinion, this discrepancy should be considered as an indication that nine phase shifts are not enough. If the analysis were to include the experimental values of $C_{nn}(90°)$ in the procedure with the nine phase shifts, then an excessive value would be obtained for the parameter χ^2 for both sets, similar to what takes place in the analysis of the experimental data in which the quantity C_{nn} is not included and only seven phase-shifts are taken into account.

While analyses with seven and nine phase shifts give preference to the first set of phase shifts over the second,[9] the inclusion of the larger experimentally-obtained value of the coefficient $C_{nn}(90°)$, with account of 14 phase shifts and the constant g^2, makes the two phase-shift sets equally probable, as indicated by Allaby et al.[10] For an unambiguous determination of the phase shift it is obviously necessary to carry out more exact measurements of several of the quantities included in the analysis.

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ON THE USE OF THE MÖSSBAUER EFFECT FOR STUDYING LOCALIZED OSCILLATIONS OF ATOMS IN SOLIDS

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THE Mössbauer effect consists in the emission (or resonant absorption) by a nucleus in a solid of a γ quantum with an energy which is precisely equal to the energy of the transition, because of the fact that the recoil momentum is transferred to the crystal as a whole.

Usually the nucleus which radiates the γ quantum is formed by the decay of some other nucleus. As a result of this process, the nucleus can with a very high probability leave its place in the lattice and get stuck somewhere at an interstitial position. But, even if the nucleus does not move about, if it should change its atomic number as a result of the decay the forces holding it in the lattice will change. Thus the nucleus emitting the Mössbauer quantum must be a lattice defect.

On the other hand it is well known (cf. reference 1) that the spectrum of oscillations of a defect atom in a lattice consists of a continuous spectrum, coinciding with the spectrum of oscillations of the ideal lattice, and of discrete frequencies which do not coincide with any of the frequencies of normal vibrations of the atoms of the ideal lattice. Vibrations with such frequencies (localized oscillations) cannot propagate through the lattice over any sizeable distance.

At the same time there is a finite probability that in the emission of a γ quantum there is simultaneously emitted or absorbed (the latter, naturally, only for sufficiently high temperatures, $T \gtrsim \hbar\omega_L$, where ω_L is the frequency of the local-

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 $\tau_i/\tau_k = 2.5 \times 10^{-8}/1.7 \times 10^{-9} \sim 15$.