and the asymmetry of the spectrum is opposite to the asymmetry observed in low reflection orders [2]. With increasing temperature, the asymmetry in the Mossbauer scattering spectra is much less pronounced.

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ON THE POSSIBILITY OF POLARIZING NUCLEI WITH ULTRASOUND

L.L. Buishvili and N.P. Giorgadze
Research Institute for Semiconductor Physics
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It is well known that in diamagnets the relaxation of the nuclear spin is due to dipole-dipole interaction of the nuclei with the paramagnetic impurities. The main contribution is made here by the part of the dipole-dipole interaction leading to the flipping of only the nuclear spin [1].

$$H_{IS} = \frac{1}{2} \sum_{in} (v_{in}^{+z} I_i^- + v_{in}^{-z} I_i^+) S_n^z , \qquad (1)$$

where I and S are the nuclear and electron spins, respectively.

If the concentration of the paramagnetic impurities is sufficiently low and the dipole-dipole interaction between the impurities can be neglected, then the change of the electron spin is determined by its interaction with the lattice. For simplicity, this interaction can be represented in the form [2]

$$H_{LS} = \sum_n \mathbf{L}_n \mathbf{S}_n , \qquad (2)$$

and under conditions when the single-phonon relaxation mechanism is decisive, the lattice operator L_n is linear in the phonon production and annihilation operators.

The interactions (1) and (2) lead in second-order perturbation theory to the so-called flip-flip and flip-flop transitions, accompanied by emission or absorption of phonons of frequency $\omega_S \pm \omega_I$ [3]. If the rate $1/T_0$ of the relaxation of the phonons with the thermostat is large compared with the rate of spectral diffusion in the frequency interval $2\omega_I$ about the frequency ω_S of the phonon spectrum, i.e., if $T_0 \ll (2\omega_I)^2/D$, where D is the coefficient of spectral diffusion, then the phonon frequencies $\omega_S \pm \omega_I$ in the relaxation process can be regarded as subsystems characterized by reciprocal temperatures $\beta^{\pm}$.

Introducing, in addition, the Zeeman electronic and nuclear subsystems with reciprocal temperatures β_S and β_I, respectively, and using the method of non-equilibrium statistical operator [4], we obtain for the evolution of the nuclear Zeeman temperature in second approximation of perturbation theory

$$\frac{d\beta_I}{dt} = -\frac{1}{T^+}\left(\beta_I - \frac{\omega_S + \omega_I}{\omega_I}\beta^+ + \frac{\omega_S}{\omega_I}\beta_S\right) - \frac{1}{T^-}\left(\beta_I + \frac{\omega_S - \omega_I}{\omega_I}\beta^- - \frac{\omega_S}{\omega_I}\beta_S\right), \tag{3}$$

where the kinetic coefficient $T^{\pm}$ is defined by the relation

$$\frac{1}{T^{\pm}} = \frac{\pi}{\hbar\omega_S^2}\sum_n |v_{In}^{+z}|^2 L^{+-}(\omega_S \pm \omega_I), \tag{4}$$

and $L^{+-}(\omega)$ is the Fourier transform of the correlator $\langle L_n^+ L_n^-(t)\rangle$.

In the case of single-phonon relaxation we have

$$L^{+-}(\omega_S \pm \omega_I) \sim \frac{(\omega_S \pm \omega_I)^2}{\beta^{\pm}}.$$

Confining ourselves in addition, to the terms of lowest power in the parameter $\omega_I/\omega_S \ll 1$, we obtain from (3) for the stationary value of β_I

$$\beta_I^{(st)} = \frac{\beta^+\beta^-}{\beta^+ + \beta^-} + \frac{\omega_S}{\omega_I}\beta_S\frac{\beta^+ - \beta^-}{\beta^+ + \beta^-}. \tag{5}$$

Assume now that a strong ultrasonic excitation of sufficiently small width (smaller than ω_I) has upset the equilibrium between the phonons of frequency $\omega_S - \omega_I$ and the lattice ($\beta^- \ll \beta_0$). The phonons of frequency $\omega_S + \omega_I$, and also the Zeeman subsystem of the electrons, which is strongly coupled with the phonons of frequency ω_S, remain in equilibrium with the thermostat ($\beta^+ \approx \beta_S \approx \beta_0$). We then obtain for $\beta_I^{(st)}$ from (5)

$$\beta_I^{(st)} \approx \frac{\omega_S}{\omega_I}\beta_0. \tag{6}$$

Inasmuch as $\omega_S/\omega_I \sim 10^3$, this means that the polarization of the nuclei has been greatly increased. On the other hand, when the phonons of frequency $\omega_S + \omega_I$ are excited, the polarization of the nuclei, determined by relation (6), reverses sign and its magnitude remains unchanged.

The effect can become manifest in an increase of the NMR signal.

Two-phonon processes of electron-spin relaxation, and also the relaxation of nuclei via the electron dipole-dipole reservoir, prevent polarization of the nuclei. Nonetheless, if the ultrasound signal has sufficiently high intensity, a noticeable effect can be attained.

We note finally that under conditions when the spectral diffusion in the phonon spectrum is appreciable, or when the frequency width of the ultrasound signal is comparable with ω_I, no polarization of the nuclei may take place, since the ultrasound excitation causes simultaneous heating of the phonons of both frequencies and of the Zeeman reservoir.

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PENETRATION OF NEUTRAL ATOMS INTO A CYLINDRICAL PLASMA PINCH

L.F. Isaenko, L.V. Maiorov, and D.A. Shcheglov

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The penetration of neutral atoms into a hot highly-ionized plasma exerts an appreciable influence on the processes occurring in them. In fact, we are dealing with an entire set of problems, such as the role of these neutral atoms in the material balance of the plasma and its energy balance, the feasibility of plasma diagnostics by using the spectrum of the neutral charge-exchange atoms, etc.

It is therefore necessary to calculate, for configurations close to the geometries of real installations, the distribution of the plasma concentration over the plasma cross section, the albedo of the plasma relative to the incident atoms, and the energy spectrum of the atoms escaping from the plasma. In this paper we present a Monte Carlo calculation of these quantities for a cylindrical geometry. The results are compared with the approximate analytic solution and with the experimental data obtained in investigations of several regimes of the T-3 installation.

The Monte Carlo calculations were made under the following assumptions: 1) We considered a cylindrical plasma pinch, inside which the ion temperature T_i,

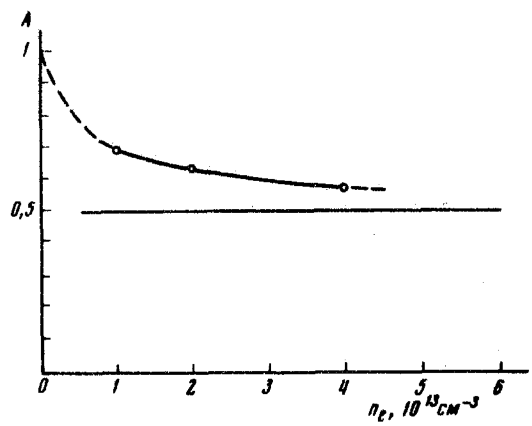

Fig. 1

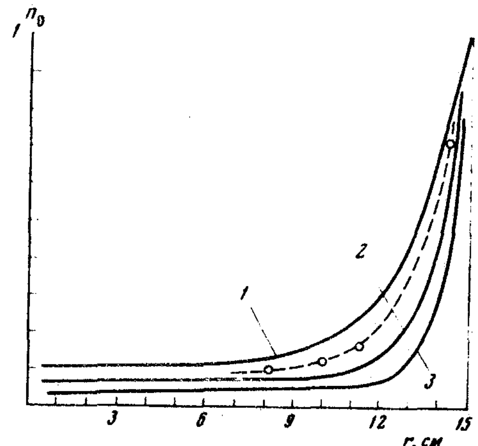

Fig. 2

Fig. 1. Albedo of plasma as a function of n_e; dashed curve - asymptote as $N_e \to \infty$ (cf. [2, 3]).

Fig. 2. Distribution of the concentration of the neutral atoms over the radius of the pinch at different densities. Curves 1, 2, and 3 correspond to n_i = (1, 2, and 4) × 10^{13} cm^{-3}. Dashed - experimental curve (T-3 setup, current 60 kA, field H_z = 17 kOe).