charge from z + 1 to z_{max} (z_{max} is the maximum ionization multiplicity at the given laser-emission parameters).

Let us consider the concrete case corresponding to Fig. 1a, where ions with z = 1 and energy 150 eV expand in an angle ∿78°, and ions with energy 300 eV in a smaller angle ∿72°, exactly equal to the angle of expansion of the doubly-charged ions. This is explained by the fact that the singly-charged ions with E = 300 eV are produced by recombination from the more strongly accelerated doubly-charged ones, and have the same energy and angular distribution as the latter.

Figure 1b also demonstrates the formation of the angular distribution of the spectrum of the singly-charged ions as a result of the described process. For example, the maximum number of singly-charged ions is registered in the direction along which the minimum number of doubly-charged ions is observed. If we sum the number of particles moving in a given direction (curve Σ on Figs. 1a and 1b), then the angular distribution becomes smoothed out, as it should. The anisotropy of the curve Σ is due to the preferred expansion of the ions with larger charges along the normal to the target. This is confirmed by the form of the curves Σ corresponding to the larger densities of the radiation flux q. Other experimental results on the angular distributions are explained similarly.

The important role of recombination is manifest also in the fact that the slow ions are not registered at all observation angles (Fig. 2), and the energy spectrum corresponding to each value of the charge begins with a certain minimal value $E_{min}(z)$. On the other hand, recombination of the accelerated ions leads to the appearance of several maxima on the energy spectra (Fig. 2 and [4]).

Thus, the character of the angular and energy distributions of the ions of a laser plasma is well explained as being due to processes of acceleration and recombination.

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FEATURES OF THE RESONANCE OF DOMAIN-BOUNDARY DISPLACEMENT IN A DISK

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Theoretical and experimental investigations [1, 2] of magnetic resonances in spherical single-crystal ferrites in the presence of a domain structure have shown the demagnetizing fields are among the main factors determining the resonant frequencies and the coupling of various oscillation modes.

From this point of view, interest attaches to investigations of ferromagnetic resonance (FMR) and domain-boundary displacement resonance in samples in the form of disks, in which the demagnetizing fields have a sharply pronounced anisotropy. In the calculation of the conditions for FMR and domain-boundary oscillations, we consider an ellipsoidal sample (Fig. 1) of a single crystal with cubic symmetry and negative anisotropy, the principal axis of which

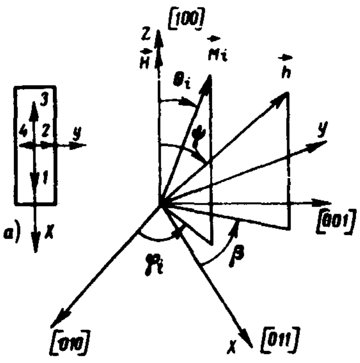

Fig. 1

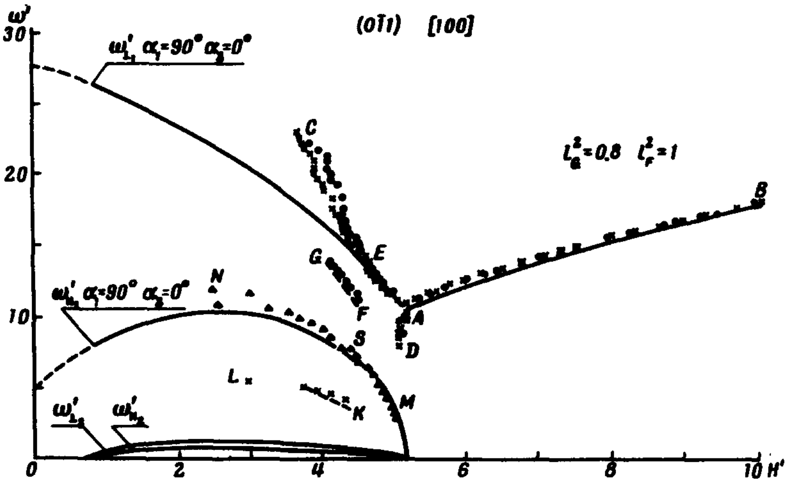

Fig. 2

Fig. 1. Coordinate system and (a) the mutual arrangement of the magnetization vectors in a disk cut in the (0$\bar{1}$1) plane.

Fig. 2. Dependence of the reduced resonant frequencies on the reduced constant magnetic field. Solid curves - theory ($N_x = N_z = 0.078$, $N_y = 0.844$, $N_{Y\perp} = N_{Y\parallel} = 2\pi$). Points - experiment. ● - $h = h_y$ (antisymmetrical excitation relative to the domain group 2 - 4), × - $h = h_x$ (antisymmetrical excitation relative to the domain group 1 - 3), Δ - $\vec{h} \parallel \vec{H}$, ℓ_G^2 and ℓ_F^2 are the values of the parameter ℓ^2 at the points G and F.

coincides with the [100] axis of the crystal, in an external constant magnetic field $\vec{H}$. It is assumed that the sample has a mixed domain structure consisting of two groups of domains with different volumes [2]. In the first group 1 - 3 (Fig. 1a) the domain boundaries make an angle 90° with the external field $\vec{H}$, and in the second 2 - 4 the boundaries are parallel to the field.

A calculation analogous to that in [2] has made it possible to obtain the equilibrium conditions and the equations of motion, according to which there exist six types of coupled oscillations. Four of them describe the precession of the magnetization in the domain following longitudinal (+, two) and transverse (-, two) excitation, and two (Δν) correspond to the displacement of the domain boundaries, which are excited only by a transverse field that is antisymmetrical with respect to the given group of domains.

The coupling between the transverse oscillation modes (-), and also between (-) and (Δν) of different groups of domains, is determined only by the demagnetizing fields of the sample. The coupling of the oscillations (-) with the domain-boundary oscillations (Δν) in each group of domains is effected by the demagnetizing fields of the sample and the domains.

Figure 2 shows the dependence of the reduced resonant frequencies of the transverse ($\omega'_{\perp 1,2}$) and longitudinal ($\omega'_{\parallel 1,2}$) modes on the reduced external field in the absence of coupling between (-) and (Δν).

The eigenfrequencies of the domain-boundary oscillations are determined in this case by the demagnetizing fields of the sample, and for a disk cut in the (0$\bar{1}$1) plane, the resonant frequencies of the first and second will differ strongly from each other because of the difference between the demagnetizing factors of the sample. As a result, the coupling between the domain-boundary oscillations and the oscillations of the magnetization in the domain will also be different. From an analysis of the theoretical data it follows, in particular, that for a given sample such a coupling will be much stronger for the second group of domains than for the first.

The experiments were performed on single-crystal disks of yttrium garnet with parameters $4\pi M = 1750$ G and $|K/M| = 43$ Oe. The results of the experiment for a disk with 2 mm diameter and 0.2 mm thickness are shown in Fig. 2 (similar results were obtained for disks with other dimensions). As follows from Fig. 2, besides the branches AC, AB, and NN, corresponding to magnetization precession, there were obtained two additional branches GF and KL. The resonance-absorption curves of the latter occur only for antisymmetrical excitation relative to domains 2 - 4 (h_y) for the GF branch and relative to domains 1 - 3 (h_x) for KL. Such excitation conditions give grounds for assuming that the branches GF and KL correspond to the resonant domain-boundary displacement frequencies. In the field range $4.6 < H' < 5.2$ there is good agreement between the experimental (sections AE and MS) and the theoretical curves. It can consequently be assumed that the domain structure in the sample is close to the theoretically chosen model. For fields $H' < 4.6$ the experimental deviate from the theoretical curve for $\omega'_{\perp 1}$ (section EC), apparently because of coupling with the strongly pronounced boundary-displacement boundary (branch GF) in this field region. As indicated above, the coupling of the magnetization oscillations in the domains with the boundary displacement is strongest for the domains 2 - 4. Therefore, taking only this coupling into account, we can estimate the parameter ℓ^2 by the procedure proposed in [1]. Using the experimental and theoretical values of the frequencies of the EC branch, we calculated the values of the parameter ℓ^2 and used **two formulas** for the frequencies of the coupled oscillations to determine the resonant boundary-oscillation frequencies for the group of domains 2 - 4. The results of this calculation are presented by the dashed line GF. The same values of the parameter ℓ^2 were used to calculate the resonant frequencies of the domain group 1 - 3 without allowance for the coupling (the dashed line KL).

It should be noted that the values of the parameter ℓ^2 for the disk agree with the values obtained for a sphere [1]. The strong difference between the experimental values of the resonant frequencies of boundary oscillations of the first and second domain groups show that, at least for yttrium garnet, the demagnetizing field of the sample is the main "elastic force" determining the resonant frequency of the domain-boundary displacement.

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ERRATUM

In the article by A. I. Pil'shchikov and N. E. Syr'ev, Vol. 14, No. 4, on page 160, third line of the text from the top, read "....with equal volumes [2]." and not "... with different volumes [2]."