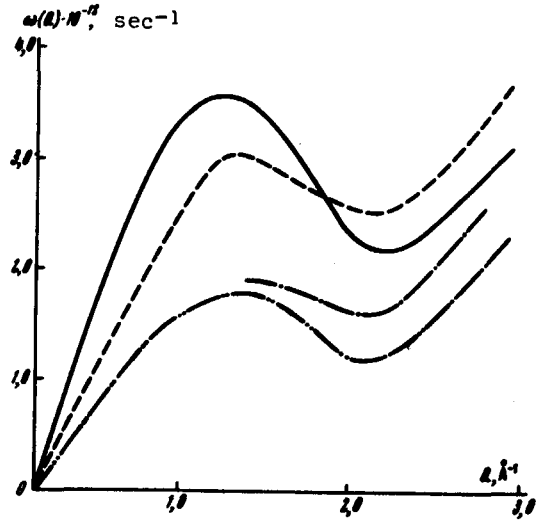

[10]. $\phi(r)$ is the (6 - 12) Lennard-Jones potential with parameters $\varepsilon = 10.22°K$ and $\sigma = 2.556$ Å, $1/\alpha^2 = \langle(\vec{u}(0) - \vec{u}(\vec{R}))^2\rangle$ is the rms relative displacement of the atoms from the equilibrium position, and is determined in a self-consistent manner from the frequency spectrum, and $f(r)$ is the solution of the Bethe-Goldstone equation [9], which makes it possible to take correlations of the hard-core type into account.

In calculating the elementary-excitation spectrum, α for $T = 0°K$ is determined from the condition of minimum energy of the ground state $E(\alpha)$. The calculations were made with a computer. The dispersion dependence for $T = 0°K$ is given in the figure (solid line), which shows for comparison the experimental curve of [5] (dotted) and the results of the calculations of [11] (dashed) and [12] (dash-dot). We see that the results are in satisfactory agreement with experiment, thereby evidencing the applicability of the quasicrystalline model of the liquid to the description of the elementary-excitation spectrum not only in classical liquids, [3, 4], but also in the quantum liquid ^{4}He when account is taken of appropriate corrections required by large-zero-point oscillations.

In conclusion, I consider it my pleasant duty to thank N.M. Plakida and V.B. Priezzhev for help and valuable discussions.

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TEMPERATURE DEPENDENCE OF THE PROBABILITY OF THE MOSSBAUER EFFECT IN YTTRIUM-IRON GARNETS

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The exchange interaction between octahedral (a) and tetrahedral (d) iron ions in ferrimagnets should exert an influence on the vibrational spectrum of the crystals [1]. We have investigated the temperature dependence of the Mossbauer-effect probability f' on Fe^{57} nuclei at temperatures 78 - 750°K in the iron garnet $Y_3Fe_5O_{12}$ and the substituted iron garnet $Y_3Fe_4Al_1O_{12}$, the physical

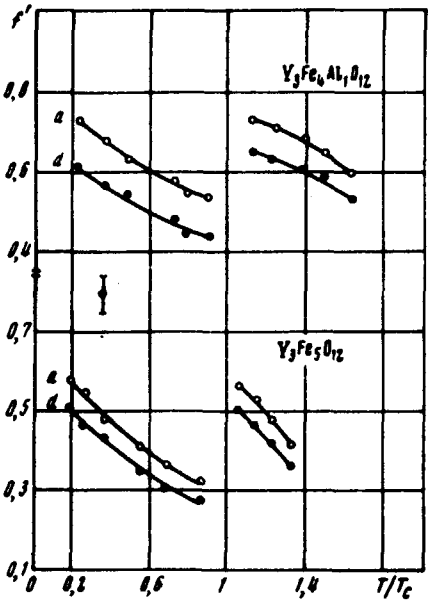

Fig. 1

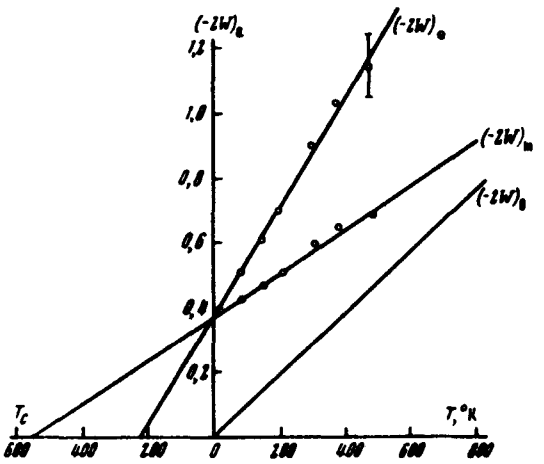

Fig. 2

Fig. 1. Temperature dependence of f' on Fe^{57} nuclei in $Y_3Fe_5O_{12}$ and $Y_3Fe_4Al_1O_{12}$. The solid curves (at $T < T_c$) were calculated from formula (1).

Fig. 2. Temperature dependence of the D-W factor for Fe^{57} in the $Y_3Fe_5O_{12}$ octahedra. $(-2W)_e$ - experimental values of the D-W factor; $(-2W)_m$ - magnetic contribution to the D-W factor; $(-2W)_0$ - D-W factor in the paramagnetic temperature region.

properties of which have been well investigated. These garnets are magnetically "loose" materials (Curie temperatures T_c = 548 and 415°K, respectively) compared with ferromagnets, whose Curie temperature is much higher. This contributes to a greater manifestation of the influence of magnetic order on the Debye-Waller (D-W) factor in ferrimagnets. There are still no experimental data on the absolute value of f' determined for the sublattices of iron garnets at temperatures below the Curie point, and only relative measurements of the quantity f'a/f'd have been made [2], where f'a and f'd are the probabilities of the Mossbauer effect on Fe^{57} nuclei in the octahedra and tetrahedra, respectively. To determine f', we used the modified method of Bykov and Pham Zuy Hien [3] and the standard-absorber method. The standard was Armco iron, for which f' = 0.84 at room temperature [4]. The procedure was tried on Fe_2O_3, for which a value f' = 0.44 ± 0.04 was obtained at T = 300°K, which agrees with the previously obtained value [5]. The data on f' for $Y_3Fe_5O_{12}$ at temperatures above T_c were taken from [6]. The x-ray diffraction analysis revealed no extraneous phase in the investigated samples; the cation distribution over the sublattices of the given garnets is as follows: $Y_3(Fe_2)^a[Fe_3]^dO_{12}$ and $Y_3(Fe_{1.84}Al_{0.16})^a[Fe_{2.16}Al_{0.84}]^dO_{12}$, and the lattice constants are 12.376 ± 0.002 Å and 12.305 ± 0.002 Å, respectively. The calculation of the ratio of the line intensities for the iron ions in the octahedra and tetrahedra was performed with a computer, with allowance for the expansion coefficients obtained for the well-resolved outermost lines of the resonance spectra at 78 and 300°K. This ratio remained in force also for higher temperatures. The experimental values of f' as a function of T/T_c for the octahedral and tetrahedral positions of the iron ions in the investigated garnets are shown in Fig. 1.

As seen from Fig. 1, the temperature dependence of f' is quite different in the region above and below T_c. The transition from the paramagnetic state to the ferrimagnetic state is accompanied by an appreciable increase of the experimentally observed Debye-Waller factor (-2W) for the iron ions in both the a- and d-positions. A plot of $(-2W)_a$ for the Fe^{57} nuclei in the $Y_3Fe_5O_{12}$ octahedra is shown in Fig. 2.

The temperature region above T_c is characterized by anharmonicity of the iron-ion oscillations in both garnets. The phonon-phonon interaction, which leads to the appearance of expansion terms of fourth and higher order in the D-W factor [7], apparently plays an important role in this region.

The temperature dependence of f' in the temperature region $T < T_c$ (Fig. 1) is well described by representing the experimentally observed D-W factor $(-2W)_e$ in the form

$$(-2W)_e = (-2W)_o + (-2W)_m, \quad (T \geqslant 200°K), \tag{1}$$

where $(-2W)_0$ is the D-W factor in the paramagnetic region ($T > T_c$) and $(-2W)_m$ is the magnetic contribution to the D-W factor ($T < T_c$).

For the temperatures $T > T_c$, the D-W factor is given by the usual formula

$$(-2W)_o = \frac{AT}{\theta_o^2}. \tag{2}$$

$A = 138$ for Fe^{57}; θ_0 is the characteristic temperature in the absence of magnetic order. Subtracting from $(-2W)_e$ the value of $(-2W)_0$ obtained from the temperature θ_0 (which we know from the paramagnetic temperature region), we obtain for the region $T < T_c$ (Fig. 2):

$$(-2W)_m = \frac{A(T + T_c)}{\theta_m^2}, \tag{3}$$

where T_c is the Curie temperature and θ_m is the partial characteristic temperature in the region $T < T_c$.

We note that the reduction of the experimental values of $(-2W)_e$ was carried out by least squares, using the known values of T_c and θ_0.

Values of the characteristic temperatures θ_0 and θ_m for iron ions in octahedra (a) and tetrahedra (d)

θ, °K	$Y_3Fe_5O_{12}$		$Y_3Fe_4Al_1O_{12}$	
	a	d	a	d
θ_o	378 ± 18	343 ± 18	467 ± 18	405 ± 18
θ_m	455 ± 18	416 ± 18	525 ± 18	450 ± 18

The values of θ_0 and θ_m obtained for the a- and d-positions of the iron ions are listed in the table. From (3) and (2) we obtain for the temperatures $T \geq 200°K$

$$2W_m/2W_o = \theta_o^2/\theta_m^2(1 + T_c/T). \tag{4}$$

In the first approximation, the ratio θ_m^2/θ_0^2 characterizes the ratio of the force constants ($\gamma = m\theta^2$, where m is the mass of the oscillating ion and γ is the force constant) in the magnetic and paramagnetic temperature regions.

We determined the ratios θ_m^2/θ_0^2 from the data in the table. They turned out to be the same for the two investigated iron garnets, 1.35 ± 0.06. From the θ_m^2/θ_0^2 ratio we determined the magnetic contribution $\overline{x_m^2}$ to the rms displacement of the Fe^{57} nuclei, $\overline{x_m^2} = 0.75\ \overline{x_0^2}$, i.e., the magnetic contribution to the rms displacements of the Fe^{57} nuclei amount, on the average, to 0.75 of the ordinary rms displacements of the iron ions in the paramagnetic temperature region. This estimate agrees well with the data of [8].

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NATURE OF THE ELECTRIC CONDUCTIVITY OF METALS IN THE TRANSCRITICAL STATE

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Recent papers report the measurement of the electric conductivity and of the equation of state of mercury [1 - 3] and cesium [4 - 9] at temperatures and pressures exceeding the critical values. The lack of information on the microstructure of matter in the transcritical state has made it difficult to understand the nature of the electric conductivity. On the basis of the experimental data, the transcritical state can be arbitrarily divided into three regions, in which the microstructure differs significantly [8, 10]. In the first region ($\rho > \rho_{crit}$) the dominant structure is the one characteristic of liquid metals, and therefore the electric conductivity in this region obeys laws governing liquid metals. In the next region the local density fluctuations increase to such an extent that ions falling in the rarefaction zone produce local force centers, and the conduction electrons are captured by these centers. As a result, the concentration of the conduction electrons is greatly reduced. In the upper limit, the metallic conductivity vanishes. The third region ($\rho < \rho_{crit}$) is one with an electric conductivity characteristic of dense ionized gases. It can be described by the methods developed for a dense plasma [11, 12].

To investigate the structure changes occurring when the density of a metal is decreased, an attempt was made to use as the first approximation an obviously oversimplified mechanical model. The real atoms were replaced by metallic spheres set in disordered ("thermal") motion by a special vibrating stand. The lowering of the real density was simulated by decreasing the number of spheres in a given volume. At the same time, the electric conductivity