resonant process. An analysis of the hydrogen-molecule spectrum shows that there is no resonance with the vibrational levels of the ground state. Parity-allowed resonant electronic transitions can occur upon absorption of 11 quanta ($1^1\Sigma_g \rightarrow 2^1\Pi_u$) or 12 quanta ($1^1\Sigma_g \rightarrow 3^1\Pi_g$) of the neodymium-laser radiation. The presence of rotational and vibrational degrees of freedom of the excited electronic states increases the number of possible resonant transitions, a fact which also makes the interpretation of the experimental data difficult, but does not contradict the hypothesis advanced above. For a further investigation of this effect it is necessary to increase the interval of frequency variation, to decrease the width of the radiation line, and to measure the resonant dependence of the probability of multiphoton ionization on the frequency.

It should be noted that the strong frequency dependence of the character of the multiphoton ionization process points to difficulties in interpreting the experimental data obtained earlier [4] at a fixed radiation frequency, and in the case of a neodymium laser, at a broad ($\gtrsim 10$ cm^{-1}) generation spectrum.

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INFLUENCE OF MAGNETIC FIELD ON THE SPECIFIC HEAT ON GADOLINIUM IRON GARNET IN THE VICINITY OF THE MAGNETIC COMPENSATION POINT

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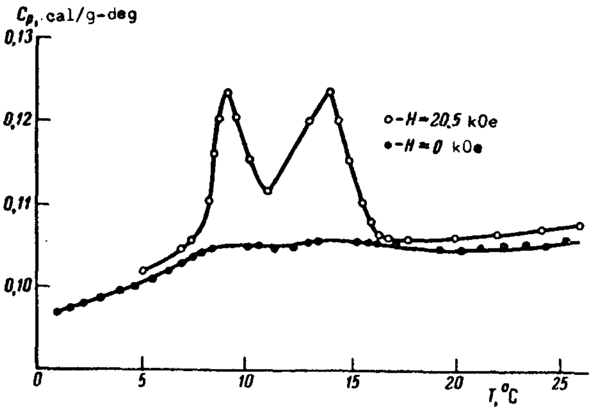
We report here on the possibility of experimentally observing the rotation of magnetic sublattices of rare-earth iron garnets in the vicinity of their magnetic compensation point, on the basis of measurements of the temperature dependence of the specific heat in a constant magnetic field.

It is known that the magnetic structure of rare-earth iron garnets (RIG) consists of three magnetic sublattices. Two sublattices consist of Fe^{3+} ions in an octahedral and tetrahedral surrounding of oxygen ions. The ions in tetrahedral positions constitute the {a} sublattice, and the ions of the octahedral site the {d} sublattice. The third magnetic sublattice consists of ions



of the rare-earth element. When RIG are considered in an external field $\vec{H} \ll \vec{H}^a_{eff}$, sublattices {a} and {d} combine into one "summary" {a-d} sublattice. As a result we deal with two magnetic sublattices. It is indicated in a number of theoretical papers that noncollinear magnetic structures can arise in two-sublattice ferromagnets of this type. The existence of a noncollinear magnetic structure in a definite interval of magnetic fields $\vec{H}_{1\ cr} \ll \vec{H} \ll \vec{H}_{2\ cr}$ and at temperatures near the compensation point follows from an analysis of the (H, T) magnetic phase diagrams of the RIG [3 - 5]. In a given magnetic field, collinear magnetic phases exist above and below this temperature interval. On going through the separation boundary between the corresponding magnetic phases, anomalies of the physical properties should occur. Such anomalies were observed in investigations of optical [7], magnetic, and other properties of RIG [8]. The region of weak fields was considered in [9]. Important information concerning this, namely the character of the (H, T) phase diagram, the nature of the phase transitions, and the role of the fluctuations of the magnetization in the region of the induced magnetic orientational transitions between the different phases, can be obtained from investigations of the specific heat in a magnetic field in the vicinity of the compensation point; no such investigations have been performed to date. We therefore deemed it of interest to investigate the character of variation of the specific heat of gadolinium iron garnet, which has a readily accessible compensation point at ∿287°K.

The vacuum adiabatic calorimeter method was used to measure the specific heat. The calorimeter proper was the sample itself, surrounded by thermal baffles used for thermal screening of the investigated sample. The adiabatic conditions were maintained automatically. Near the compensation temperature T_c, the temperature rise following the heat pulses did not exceed 0.2 - 0.4°C. The sample, with a homogeneous heater, had a sperical shape. The result of the measurement of the specific heat of $Gd_3Fe_5O_{12}$ are shown in the figure. The plot of the specific heat in a magnetic field H = 20.5 kOe differs strongly from the specific-heat curve in the absence of the field. In a magnetic field, the specific heat increases rapidly at T ≈ 280°K. This is followed by a minimum with subsequent growth of C_p to T ≈ 287°K. Starting with this temperature, the specific heat again decreases sharply. Thus, two specific heat peaks ∿4.2°K apart are observed in the magnetic field and reveal distinct features of a second-order phase transition. The jumps of the specific heat at the indicated temperatures amount to approximately 12% of the total specific heat. It is natural to assume that the anomalous behavior of the specific heat in a magnetic field H = 20.5 kOe in the vicinity of the compensation point is connected with the fact that a noncollinear magnetic structure is produced inside the temperature interval ΔT ≈ 4.2°K. Thus, our investigations show that from the data on the specific heat it is possible not only to construct the H-T phase diagram, but also to establish the character of the magnetic phase transitions.

In the noncollinear magnetic phase, the magnetic moment and the field H are inclined to each other, and one can therefore introduce the angle θ between the vectors M_{Fe} and H. On successively crossing the boundaries separating the collinear ferromagnetic, noncollinear ferromagnetic, and collinear ferromagnetic phases, the angle θ between the vectors M_{Fe} and H changes from 0 to π. Consequently a phase transition of the order-order type takes place during each passage through the phase curve and leads to a λ-type anomaly in the specific heat. The thermodynamic potential is thus a function of T, H, and θ. By expanding the thermodynamic potential near the interphase boundary in powers of the ordering parameter θ on going from the collinear phase ($\theta = 0$) to the angle phase:

$$\Phi(T, H, \theta) = \Phi_0(T, H, \theta) + a(T, H)\theta^2 + b(T, H)\theta^4 + \dots ,$$

we can establish the character of the transition from the values of the coefficients a(T, H) and b(T, H). As shown in [5], on the phase curve we have $a(T, H) = 0$ and $b(T, H) > 0$. According to the Landau-Ginzburg-Vonsovskii classification this corresponds to a second-order phase transition. A similar situation will be observed also on going from the collinear phase $\theta = \pi$ into the phase with the angle configuration. In this case the even powers of $\pi - \theta$ remain in the expansion of the thermodynamic potential. Just as in the preceding case, the coefficients are $a'(T, H) = 0$ and $b'(T, H) > 0$. Thus, two induced second-order phase transitions should exist at a specified value of the magnetic field and in a definite temperature interval. We can assume with sufficient justification that the two peaks of the specific heat in the magnetic field belong precisely to the case considered above. Since the temperatures of the magnetic phase transitions are insufficiently far apart, $\Delta T = 4.2°K$, an overlap of the two λ anomalies of the specific heat takes place, and this leads to a shallow minimum between the peaks. It is of interest to compare the obtained values with certain results of the theory and with data on the measurement of other parameters in the region of the compensation point. Zvezdin et al. [5] give the calculated values of the minimum temperature interval within which an angle-type magnetic structure exists. Thus, $\Delta T_{min} \approx 3°K$ for gadolinium garnet in a field H = 23 kOe. According to data on the magnetocaloric effect [8], such an interval is observed in a field H = 15 kOe. According to our measurements, which are shown in the figure for a field H = 20.5 kOe, the interval of the noncollinear magnetic structure extends over $\Delta T \approx 4.2°K$.

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