[1] A.A. Kaminskii, Phys. Stat. Sol. (a) 1, 573 (1970).
[2] L.A. Riseberg and H.W. Moos, Phys. Rev. 174, 429 (1968).
[3] G.A. Slaek, D.W. Oliver, R.M. Chrenko, ans S. Roberts, Phys. Rev. 177, 1308 (1969).
[4] T. Kushida, Phys. Rev. 185, 500 (1969).

INTERACTION OF LASER RADIATION WITH YTTRIUM IRON GARNET IN PARAMETRIC EXCITATION OF SPIN WAVES

I.A. Deryugin, V.I. Mykityuk, A.A. Solomko, and V.N. Radchik
Kiev State University
Submitted 21 April 1970
ZhETF Pis. Red. 11, No. 12, 573 - 576 (20 June 1970)

We report the results of an investigation of spin waves excited parametrically by parallel pumping in an yttrium iron garnet using laser radiation (λ = 1.15 μ).

It is known that in alternating fields h $\parallel$ H_0 exceeding the critical value, the longitudinal magnetization decreases by an amount ΔM_z and an alternating component of the magnetization appears, having double the pump frequency [1]. In our experiments we investigated the rotation change, proportional to ΔM_z, of the plane of polarization of laser radiation by the Faraday effect.

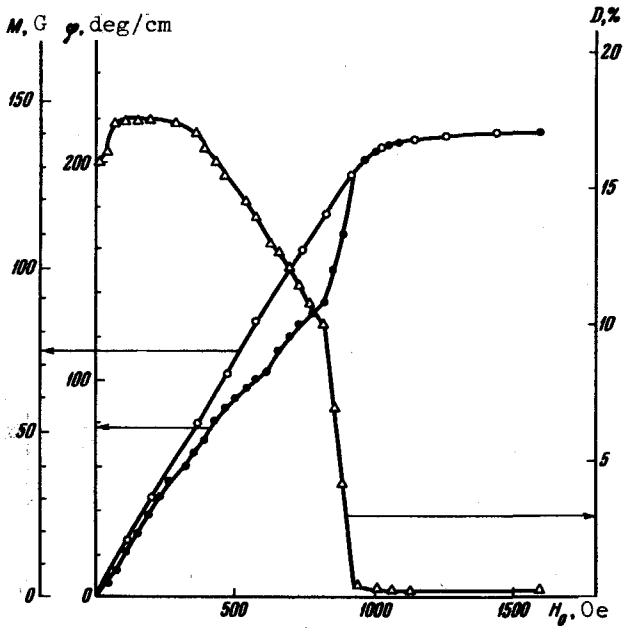

Fig. 1

The sample was a disc of 4.1 mm diameter and 1.6 mm thickness and was placed in the antinode of the magnetic field of a resonator operating in the H_{102} mode (ν_H = 9470 MHz). A constant field $H_0 \parallel h$ was applied along the disc axis. The laser beam propagated parallel to the applied external field. We measured in the experiment the magnetization-induced rotation of the plane of polarization of the laser beam, averaged over a central area of the sample with dimensions 0.4 × 0.7 mm, and determined by the dimensions of the photosensitive area of the receiver.

In the absence of pumping, we measured the dependence of the rotation of the plane of polarization of the laser beam ϕ and its depolarization D on the constant field (Fig. 1). We note that the $\phi(H_0)$ dependence does not coincide with the results obtained in [2], or with the results of our measurements of the magnetization of the sample $M(H_0)$ with the magnetometer (Fig. 1). In constant fields weaker than the saturation fields, two regions are seen on the $\phi(H_0)$ plot, characterized by different slopes of the $\phi(H_0)$ curve. This is also clearly seen on the plot of the depolarization vs. the constant field. Such a $\phi(H_0)$ plot can be attributed to the fact that the internal field in the sample is inhomogeneous (the sample is a disc).

The results of the investigation of the decrease of the rotation of the plane of polarization $\phi_s(H_0)$ of the laser beam, determined by the value of ΔM_z,

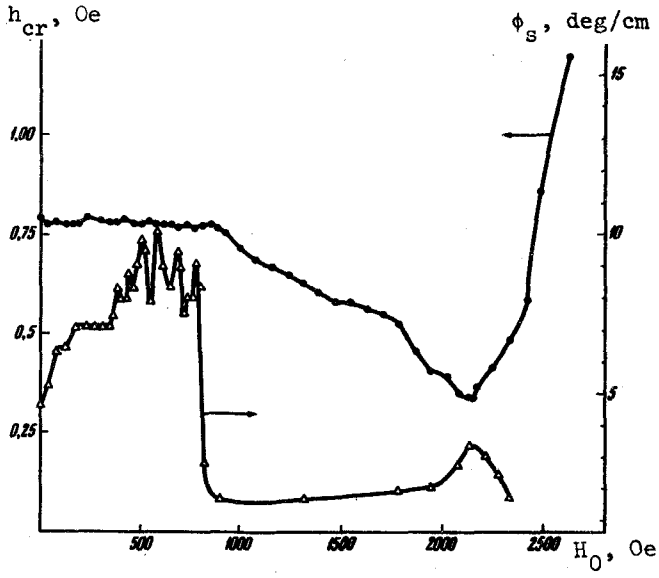

Fig. 2

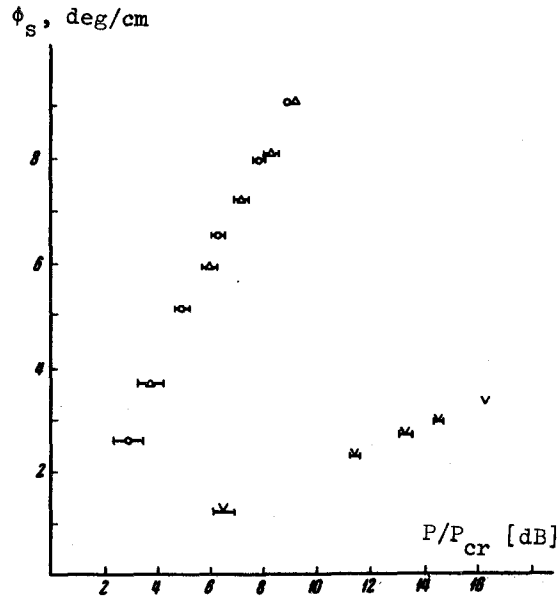

Fig. 3

are shown in Fig. 2. The same figure shows the dependence of the threshold field h_{cr} on the constant field H_0. In the measurement of $\phi_s(H_0)$, the power of the microwave signal was maintained constant and exceeded by 16 dB the minimum threshold power corresponding to the minimum of the $h_{cr}(H_0)$ curve. In a constant field corresponding to the minimum value of h_{cr}, the rotation of the plane of polarization decreases by $\phi_s \approx 3.5$ deg/cm. This corresponds to $\Delta M_z/M_0 = 1.67 \times 10^{-2}$, where M_0 is the saturation magnetization.

In addition, we registered an anomalously large decrease of the rotation of the plane of polarization $\phi_s \approx 10$ deg/cm in constant fields weaker than the saturation fields, with a spiked structure. The values of these peaks and their positions relative to the magnetic field change when the magnetization of the sample is reversed. The peaks in the variation of the rotation ϕ_s, of the polarization plane, in constant fields weaker than the saturation fields, can be interpreted as the consequence of the resonance of the spin waves in the domains, since in these fields the spin wavelength is commensurate with the domain dimensions.

In conclusion we note that in both cases -- at fields weaker and stronger than the saturation fields -- the decrease of the rotation of the plane of polarization ϕ_s is connected with parametric excitation of the spin waves and was observed in alternating fields stronger than critical (Fig. 3).

[1] J.J. Green and E. Schlomann, J. Appl. Phys. 32, 2, 535 (1962).
[2] G.S. Krinchik and S.A. Gushchina, Zh. Eksp. Teor. Fiz. 55, 490 (1968) [Sov. Phys.-JETP 28, 257 (1969)].