In conclusion, we are grateful to M.F. Deigen and A.B. Roitsin for a discussion of the results.

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OBSERVATION OF PHONON CASCADE BY THE METHOD OF MANDEL'SHTAM-BRILLOUIN LIGHT SCATTERING IN PULSED SATURATION OF PARAMAGNETIC RESONANCE

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We have previously reported the use of Mandel'shtam-Brillouin light scattering (MBS) by longitudinal phonons in single-crystal cerium magnesium nitrate (CeMN) upon saturation of the EPR of Ce^{3+} ions under the conditions of the phonon "bottleneck" [1, 2]. We observed heating of the resonance phonons to an effective temperature $T_{\text{eff}} \approx 180$°K at an initial temperature $T = 1.5$°K, and measured the width of the spectral distribution and the lifetime of the hot phonons. This method of detecting hot phonons was employed independently and somewhat earlier in [3].

In the present article we present the results of a study of MBS by transverse phonons in the CeMN crystal with saturation of EPR both at the absorption center and on its wings.

An optically-finished sample measuring 4 × 4 × 8 mm was placed in a rectangular microwave resonator cooled to 1.5°K. The constant magnetic field was perpendicular to the crystallographic axis. A saturating field close to 6.8 GHz was generated by a 150-mW klystron. The saturation was in the stationary regime and with periodic rectangular pulses of 15 msec duration. The light source was an He-Ne laser of 80 mW power at wavelength 0.63 μ. The light scattered by the phonons propagating near the $(\bar{1}01)$ direction, in accordance with the setting of the crystal assumed in [4], was observed at 90° using a scanning Fabry-Perot interferrometer and an electronic registration method. A multichannel analyzer was used to accumulate the periodic signals of the intensity of the scattered light under pulsed saturation. The spectral distribution of the effective temperature of the phonons was investigated by varying the scattering angle, and the narrowing of the band widths of the optical receiver (to 30 MHz) was attained by greatly reducing the aperture angles of the incident and scattered light.

In stationary saturation of the EPR at the center of the line, the general MBS picture coincided qualitatively with that observed earlier for longitudinal phonons [1, 2]. The largest MBS intensity corresponded to phonon scattering at the resonance frequency, with $T_{\text{eff}} \approx 150$°K. In the case of stationary saturation of the EPR on the wing of the line, the character of the MBS was qualitatively altered. The maximum heating of the phonons was observed at a frequency that did not coincide with either the resonant frequency or with the pump

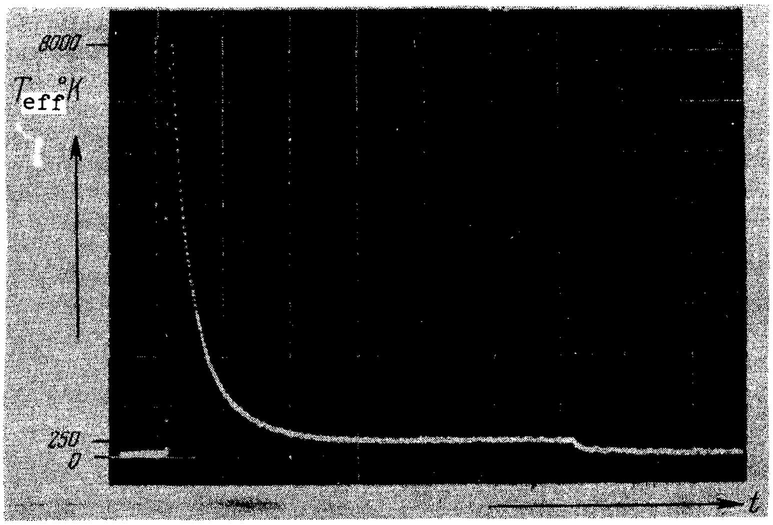

Fig. 1. Temporal dependence of the intensity of scattered light in pulsed saturation on the wing of the EPR line of Ce^{3+} ions in cerium-magnesium nitrate (each horizontal division equals 2.5 msec).

frequency, and was shifted even farther along the wing. The spectral width of the hot phonons was much narrower than the EPR line width, and the effective temperature rose to 250°K.

On going over to pulsed saturation, we observed new very interesting features in the behavior of the hot phonons. In pulsed saturation on the line wing, following the leading front of the pulse, a cascade-like growth of the effective temperature of the phonons appeared (Fig. 1), and its maximum was shifted in frequency in approximately the same manner as in the stationary regime. The intensity of the phonon burst depended on the exact value of the detuning $\Delta\nu$ and reached a maximum at the value $T_{eff} = 8000°K$ at $\Delta\nu = \pm 100$ MHz, corresponding to approximately half the width of the unsaturated EPR line. It is seen from Fig. 1 that the effective temperature of the phonons decreases by a factor e within a time on the order of 1 msec, and the greater part of the pulse corresponds to the stationary regime at $T_{eff} = 250°K$. An attempt to measure the distribution of the frequency of the hot phonons in the cascade has shown that the width of the distribution lies within the band width of the optical receiver, i.e., it does not exceed 1/7 of the EPR line width. A

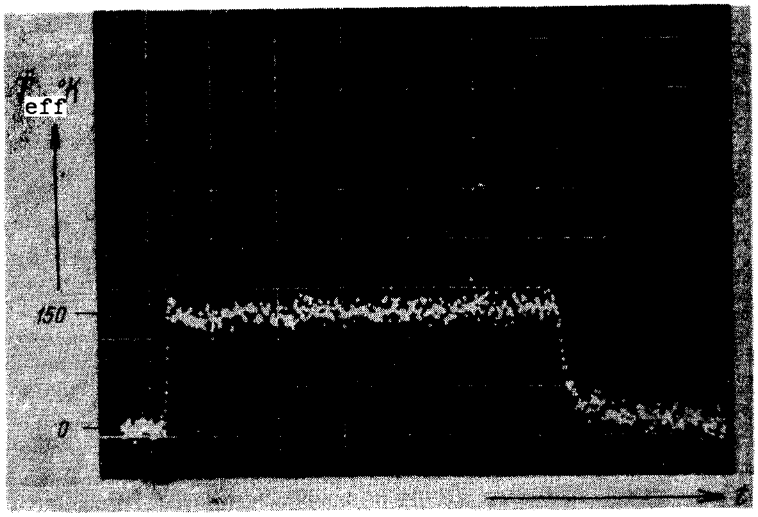

Fig. 2. The same as in Fig. 1, with saturation at the center of the EPR line.

feature of pulsed saturation at the line center is the vanishing of the phonon avalanche as can be clearly seen in Fig. 2.

An avalanche-like growth of the number of phonons was observed for the first time (by another method) in inversion of the populations of the Zeeman levels of the Fe^{2+} ion in a MgO crystal by adiabatic fast passage [5]. It may seem strange at first glance that the occurrence of a phonon avalanche was observed by us in simple saturation. On the other hand, it was shown theoretically and experimentally [6, 7] that in the case of saturation on the wing of a homogeneously broadened line there arises a region of stimulated emission, the maximum of which lies beyond the saturation point, this being due to the appreciable difference between the temperatures of the dipole-dipole reservoir and the Zeeman system [8]. The presence of such a region of stimulated emission leads apparently to the appearance of the phonon avalanche observed by us. This is confirmed also by the fact that there is no phonon avalanche in the case of saturation of the line center, when the dipole-dipole reservoir is disconnected from the Zeeman system.

A more detailed exposition of the experimental results and of their theoretical analysis will be published elsewhere.

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RESONANCES OF ANOMALOUS MICROWAVE HEATING OF ELECTRONS IN A MAGNETIZED PLASMA

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So far, no one has succeeded in relating the mechanism of anomalous heating of electrons in a magnetized plasma with some plasma instability in a microwave field [1]. To ascertain the nature of this phenomenon, we have studied the dependence of the effectiveness of the heating on the value of the magnetic field and the concentration of charged particles.

The experimental setup was similar to that used [1], but the round waveguide was replaced by a rectangular one. Plasma with $T_e = 6$ eV was generated by a spark gun and moved along a homogeneous magnetic field, flowing in and out through the narrow walls of the waveguide. A TE_{10} wave was excited in the waveguide, with the electric-field vector perpendicular to the constant magnetic field. The plasma density, the fast-electron current, and their radial