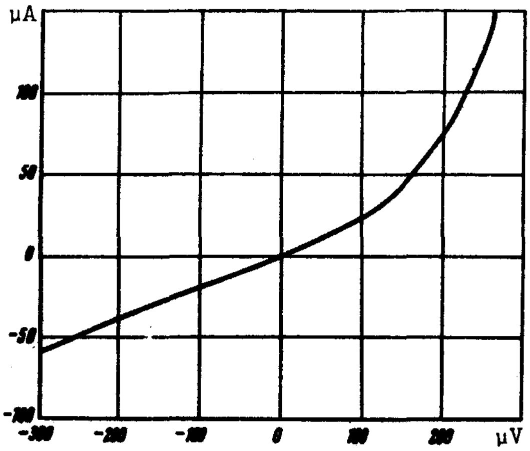

Current-voltage characteristic of contact.

the contact. The properties of the contact changed little when the needle was moved over the crystal, and therefore the sensitivity was determined primarily by the electrodynamic characteristics of the system. For comparison we indicate that the best detecting pairs used in detectors for the millimeter band, of the silicon-tungsten type, turned out to be less sensitive by two orders of magnitude when installed in our apparatus.

Cooling the contact with the indicated type of crystal to 77°K led to a sharp increase of the resistance and to a drop in the detecting properties, although the rectifying properties of the contact at low frequencies was considerably improved. A typical current-voltage characteristic of the contact is shown in the figure. The detection appears apparently at the Schottky barrier, through which considerable tunnel currents flow simultaneously in both directions. The opinion that detection is by the thermoelectric effect of the "heated" carriers in the region of the contact does not agree with the results of the measurement of the sensitivity upon cooling.

We are convinced that the metal-InSb contact is quite promising for video detectors and mixers for the submillimeter band, operating without cooling.

FIELDLESS TEMPERATURE RESONANCE IN RUBY (T-RESONANCE)

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The system of levels of the ground state of the Cr^{3+} ion in Al_2O_3 consists of two Kramers doublets separated by an energy gap 2D, where D is the constant of the axial crystal field in the spin Hamiltonian describing the behavior of these levels. The value of the constant D was determined many times at room temperature and below. We have found that above room temperature D depends on the temperature in the following manner:

$$2|D(T)| = 2|D_0| + D'T,$$

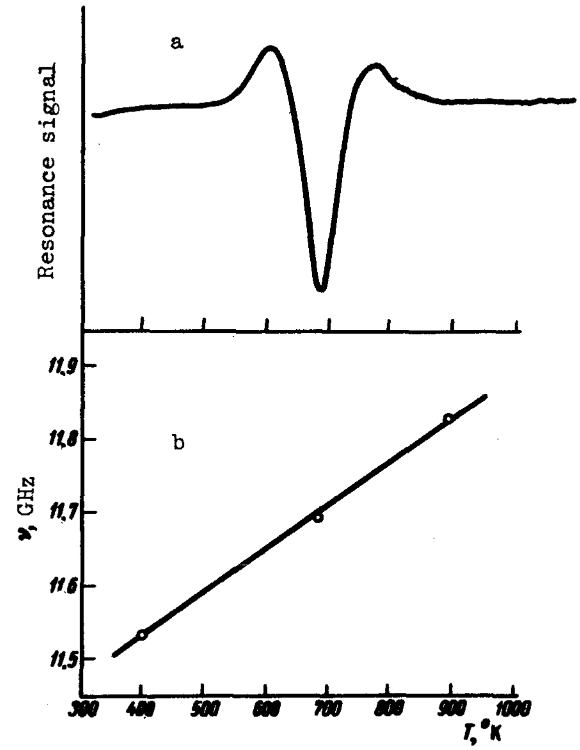
where D_0 = -5735 MHz is the known value of D at 300°K; D' = 0.6 MHz/deg.

The dependence of D on T makes it possible to observe in a paramagnetic crystal (ruby) a new form of fieldless resonance, under conditions when the frequency of the microwave radiation is fixed, and the "passage" through resonance is realized by slow variation of the temperature.

Experiments on temperature resonance were made on a sample with a chromium concentration 0.05%. The sample was placed in the resonator of a microwave spectrometer, where it could be heated up to 1000°K by means of a platinum oven. The resonator was tuned to a frequency exceeding $2|D_0|$ by several hundred MHz. The temperature of the sample was then slowly varied by varying the current heating the platinum oven.

As the sample became heated, the natural frequency and the Q of the resonator changed, making it difficult to employ a system of direct amplification of the absorption signal. We used a system of magnetic modulation of the absorption signal. Rods were inserted in the resonator, and alternating current of 5 kHz frequency was made to flow through the rods to produce an alternating magnetic field of several gauss.

Each of the two ground-state levels, between which the quantum transitions were observed when the resonance condition was satisfied, is doubly degenerate in the spin. Superposition of a weak external alternating magnetic field leads to a splitting of each of the levels into two, and this splitting occurs twice during each modulation period. In this case the resonance absorption signal occurs at double the frequency (relative to the modulation), and the form of the absorption signal is the second derivative of the envelope of the distribution of the density of states at the levels between which the transition is observed.



a - T-resonance absorption signal in ruby at the output of a microwave spectrometer, b - frequency of resonant transitions vs. resonance temperature.

Figure a shows one of the absorption signals observed by us at a klystron frequency 11.69 GHz. The temperature was varied from 300 to 1000°K. At the absorption maximum, the temperature was 680°K. The absorption line width at the point corresponding to the maximum slope of the integral curve is 80°.

Figure b shows a plot of the frequency ν, at which the absorption is observed, against the resonant value of the temperature.

In a number of cases, investigations of the fieldless resonance in ruby offer advantages over investigations of electron paramagnetic resonance (EPR). Thus, investigations of spin-lattice relaxation in ruby in a zero magnetic field [1 - 3] have shown that theoretical calculations greatly simplify, and comparison of theory with experiment becomes easier. In [4] there was investigated resonance in ruby in a zero magnetic field and in a scanning external electric field. (It was proposed in [5] to call this type of resonance E-resonance.) In the latter case it is necessary to take into account in the calculation the external magnetic field. The temperature resonance considered here makes it possible to solve in some paramagnetic crystals a number of problems under conditions when the system of levels of the ground state of a paramagnetic ion is extremely simple, and the absence of external magnetic and electric fields greatly simplifies the theoretical calculations. Among these problems are the investigation of spin-lattice relaxation at high temperatures, of the inhomogeneities of the intracrystalline electric field, of magnetic dipole-dipole interactions of paramagnetic ions, of the temperature variations of the spin-Hamiltonian constant, etc. Information can be obtained from the resonant values of the temperature (e.g., the plot of Fig. b is the temperature dependence of the value of 2D) and from the shape and width of the T-resonance signal.

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 $T_{eff} \simeq 180°K$ 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 $T_{eff} \simeq 150°K$. 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