Here $E^2 = 4\pi I/c$ and ν_i is the frequency of the Coulomb collisions between the electrons and the ions.

In order that the average electron energy in the field rise by several electron volts in the presence of elastic losses (as is required in order to accelerate noticeably the ionization acts), the required intensity is $I_1 \approx 10^3$ MW/cm^2, as gotten from the condition $d\varepsilon/dt = 0$. This value agrees with the experimental point where the strong nonlinearity begins, $(P_{inc}/P_t)_1 = I_1/I_t \approx 10^{-2}$. The subsequent course of the absorption curve is determined by the kinetics of the ionization development in the plasma and by the influence of the geometric factor - the taper of the beam. It is important, however, that at high intensities it is meaningless to speak of a local light absorption coefficient $\kappa(I)$, since hydrodynamic effects set in as a result of the large energy release [2].

We emphasize that at intensities larger than I_1 nonlinear absorption will take place not only in the focal region, but in the entire volume of the light cone where $I > I_1$, thus strongly influencing the optical thickness of the nonlinearly absorbing layer of the plasma.

The difference in the character of the curves 1 and 2 of Fig. 1 is partly connected with the fact that in breakdown of cold gas there can be born many ($n \approx 40$) generations of electrons [2]. If the multiplication time is, say, inversely proportional to I, halving I decreases the final ionization by a factor $2^{n/2} \approx 10^6$, which is tantamount to no absorption. In a plasma, on the other hand, only several generations are born, and halving I decreases the number of electrons and the absorption by only several times.

Another reason for the gradual growth of absorption with increasing I is the increase of the geometric thickness of the nonlinearly absorbing layer.

Bearing in mind the obtained results, great care should be exercised when using those laser plasma-diagnostics methods in which high-intensity light beams are employed.

Articles devoted to a detailed description of the experimental setup and results are being readied for publication.

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STIMULATED RAMAN SCATTERING AND GENERATION OF INFRARED RADIATION IN QUARTZ AT LOW TEMPERATURES

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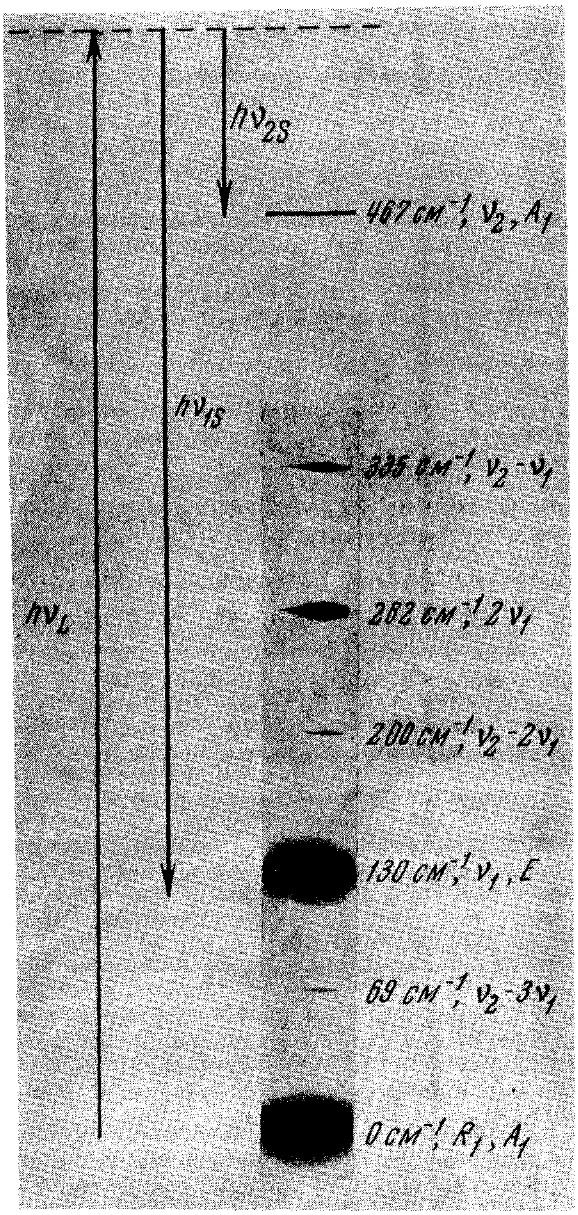
In this investigation we observed infrared (IR) radiation when stimulated Raman scattering (SRS) is produced in single-crystal quartz at a temperature close to 10°K. If the laser beam is directed along the crystal axis z and the scattering is registered forward in the same direction, then the SRS spectrum contains Stokes and anti-Stokes lines due to the fundamental quartz lattice vibrations, with $\nu_1 = 130$ and $\nu_2 = 467$ cm^{-1}. Some of the lines of this spectrum were observed earlier [1, 2].

The figure shows the Stokes part of the most detailed SRS spectrum in quartz at ~9°K near the exciting ruby-laser line R_1 = 6943 Å, obtained by us with a diffraction spectrometer having a linear dispersion 3.3 cm^{-1}/mm in the R_1 region. The figure shows the shifts of the observed lines, their interpretation, and the type of symmetry of the ground levels.

If the gain of the Stokes radiation is larger at 467 cm^{-1} than at 130 cm^{-1}, then IR generation is possible by the transition $A_1 \rightarrow E$, at a frequency (337 cm^{-1}) that does not coincide with the resonant frequency of quartz. IR generation is possible with transitions from the level A_1 (467 cm^{-1}) to other levels that do not appear in the SRS spectrum [3]. Such levels may be those of the fundamental vibrations of quartz, 266 cm^{-1} and near 400 cm^{-1} with symmetry E.

Estimates show that if the width of the spontaneous 130-cm^{-1} line is 0.1 cm^{-1} [2] it is possible to produce under the conditions of our experiment (see below) population inversion between the levels A_1 (0) and E (130 cm^{-1}) and obtain generation at this frequency in the quartz sample [4].

The conditions for IR generation become even more favorable as a result of repeated SRS (see the figure).



Spectrum of stimulated Raman scattering in quartz at temperature near 9°K

In our first experiments we registered the total IR radiation flux. A ruby-laser beam with 100 - 200 MW power and pulse duration 12 nsec was focused with a lens of 5 cm focal length inside a quartz crystal oriented in the manner indicated above. The investigated crystals were parallelepipeds 3 - 5 cm long with the long edge in the z direction. The crystals we mounted on a cold finger inside a helium cryostat with windows of fused quartz (3 mm thick) and their temperature was 8 - 14°K in the various experiments. Near the exit window of the cryostat there was installed a thermopile (time constant τ = 0.2 sec) with a window of crystalline quartz (2 mm thick), connected to a galvanometer having a sensitivity 0.02 μV. Visible, possible ultraviolet, and near infrared radiation was applied with the aid of filters made of black photographic paper, black polyethylene or teflon coated with turpentine lampblack. In conjunction with the windows of the cryostat and the thermopile, these filters passed radiation with wavelength shorter than approximately 40 microns. Signals up to 1 μV were registered with different crystals and filters, and with different laser powers. No signal was observed at a 90° scattering angle.

When a transparent glass plate opaque to IR radiation was added to the filter of black paper, no signal was observed. When a paraffin plate (2.5 mm thick), having a transmission in the visible less than 1%, was added to the same filter, the signal decreased to 30 - 40% of the initial value. This is in accord with the transmission of paraffin in the 40 - 100 μ region. When the black paper was replaced by black polyethylene, the singal increased by 3.5 times, this being close to the ratio of the transmission coefficients of these filters at a wavelength ~75 μ. These experiments confirm that long-wave IR radiation was registered.

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LINE SHAPE OF NONLINEAR FERROMAGNETIC RESONANCE OF SECOND ORDER

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The phenomenon of nonlinear ferromagnetic resonance (NFMR) was observed in [1] in the microwave band. A similar problem was solved using the phenomenological equation of motion for the magnetization vector, with a damping term in the combined Bloch-Wangsness form [2], for the concrete case of a ferrite sphere in a resonator (Fig. 1).

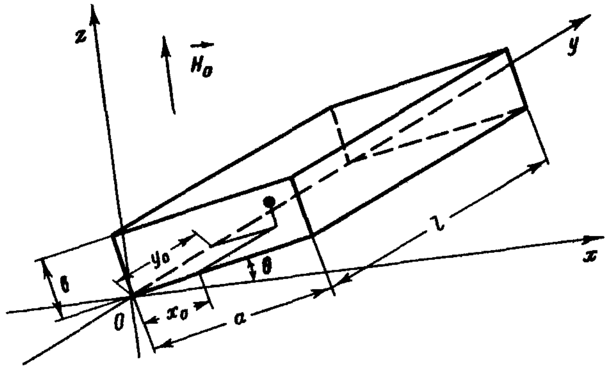

Fig. 1. Resonator with ferrite sphere

The absorbed power in NFMR of second order is given by

$$P_{\text{abs.}} = \frac{\gamma^2\mu_0 T_2}{\omega_0} V h_z^2 (h_x + h_y^2) \times$$
$$\times \frac{\gamma\mu_0 M_s\left(1 + \dfrac{4\pi\chi_{\text{st}}}{3\mu_0}\right) - \dfrac{\chi_{\text{st}}}{\mu_0}(\gamma\mu_0 H_0 - 2\omega_0)}{\left(1 + \dfrac{4\pi\chi_{\text{st}}}{3\mu_0}\right)^2 + T_2^2(\gamma\mu_0 H_0 - 2\omega_0)^2},$$

where γ is the gyromagnetic ratio, μ_0 the magnetic permeability of vaccum, h and ω_0 the amplitude and frequency of the microwave radiation, V the volume of the ferrite, χ_{st} the static magnetic susceptibility, T_2 the relaxation time, H_0 is the intensity of the slowly-varying magnetizing field, and M_s the saturation magnetization.