EXCITATION OF RESONANT ELASTIC OSCILLATIONS IN NONLINEAR FERROMAGNETIC RESONANCE

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It is known that magnetoacoustic resonance (MAR), namely oscillations at the frequency of the mechanical resonance of the sample, can be excited in a ferrite at nonlinear ferromagnetic resonance (NFMR). An excitation of this kind was observed experimentally in the region of the fundamental [1-3] and supplementary [4-6] ferromagnetic resonance in samples of single-crystal yttrium ferrite under transverse pumping.

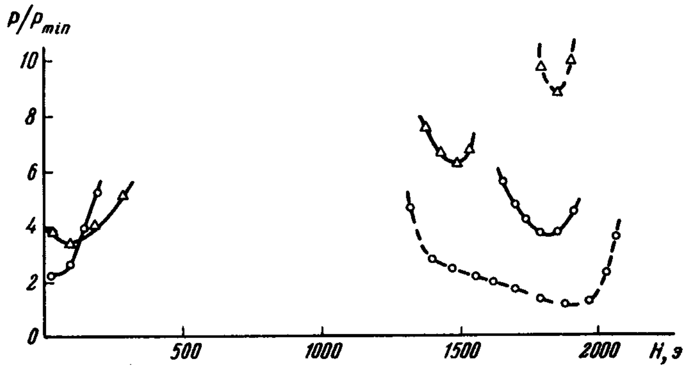
We report here excitation of MAR under longitudinal and transverse pumping in samples made of single-crystal yttrium, yttrium-gallium, yttrium-gadolinium, lithium, and lithium-gallium ferrites.

The experiments were made at 9300 MHz in a resonator, using spherical samples with diameters from 0.8 to 2 mm; the samples were in a free state in a quartz tube closed on both ends.

The envelope of the microwave signal reflected from the resonator was observed on the screen of the S4-8 spectrum analyzer. Upon excitation of the MAR, a spectral line having the frequency of the mechanical resonance of the sample (on the order of several MHz) appeared on the spectrum-analyzer screen. The frequency position of this line was practically independent of the magnetizing field and of the pump power, making it possible to distinguish it clearly against the background of the NFMR auto-modulation oscillations. The excitation of the MAR was additionally monitored by measuring the voltage in a loop wound around the tube at the location of the sample.

The MAR excitation had a threshold character; its amplitude increased rapidly to a maximum value, which then remained constant with further increase of the pump power.

The figure shows the MAR excitation threshold curves. We call attention to the following: 1) In longitudinally and transversely pumped yttrium ferrite, the minima of the MAR excitation thresholds occur at approximately the same magnetizing field. We recall that the minima of the NFMR excitation thresholds occur at different magnetizing fields under the in dicated pumping conditions [7,8]. In lithium ferrite, the positions of the minima of the



MAR excitation threshold curves in single-crystal yttrium (———) and lithium (-----) ferrites, o - transverse pumping, Δ - longitudinal pumping.

MAR and NFMR excitation thresholds coincide. 2) In transversely pumped yttrium ferrite, the region of MAR excitation is much broader than under longitudinal pumping; in the lithium ferrite the width is approximately the same in both cases. In addition, in the lithium ferrite MAR excitation is observed in a weak magnetizing field. 3) The MAR excitation threshold under longitudinaly pumping is always higher than under transverse pumping.

Similar relations were observed in yttrium-gallium, yttrium-gadolinium, and lithium-gallium ferrites.

In all the experiments, the MAR frequency corresponded to the transverse S_1 oscillation mode of the spherical sample [9]:

$$F = 0.848 \frac{V_t}{d},$$

where V_t is the velocity of propagation of the transverse elastic oscillations and d is the sample diameter.

At certain values of the magnetizing field, the MAR was excited at several frequencies close to the S_1-mode frequency. Calculation has shown that the observed difference between the resonant frequencies corresponds to the difference between the transverse propagation velocities of the elastic oscillations, due to the crystallographic anisotropy of the sample. The propagation velocity of the transverse elastic oscillations deviates from the average value $V_t = 3.865 \times 10^5$ cm/sec by approximately ±2% in yttrium ferrite and approximately ±20% in lithium ferrite. It was also observed that when MAR is excited the excitation threshold of the NFMR auto-modulation increases and its intensity decreases strongly. This effect is particularly noticeable in yttrium ferrites.

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DYNAMICS OF LOW FREQUENCY OSCILLATIONS OF GUNN DIODES

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Simultaneous generation of high-frequency oscillations at 17.8 GHz and low-frequency oscillations at ~12 MHz by a Gunn diode was observed experimentally in [1]. The low-frequency oscillations were sinusoidal and their amplitude increased with increasing voltage applied to the sample.

We observed low-frequency oscillations of frequency 5.9 - 9.8 MHz in five Gunn diodes with Gunn-oscillation frequencies 0.8 - 1.2 GHz. The dynamics of these oscillations had a complicated character and depended on the voltage applied to the sample.