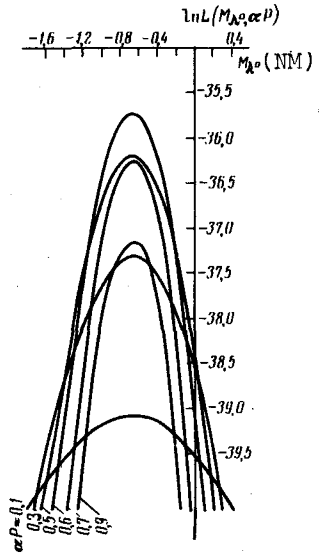
We have thus processed 25% of the obtained experimental material. From 57 events of the $\Lambda^0 \rightarrow p + \pi^-$ decay, satisfying all the selection criteria of [1], we determined by the maximum-likelihood method the value of the magnetic moment of the Λ^0 hyperon. The likelihood function is written in the form

$$L(\mu, aP) = \prod_i \left\{ \frac{1 + aP\cos\Theta_i(\mu)}{2} \right\},$$

where $\Theta_i(\mu)$ is the angle in the c.m.s. of the Λ^0 hyperon between the direction of the emission of the π^- meson of the decay and the direction of the polarization vector at the instant of the decay, calculated under the assumption that the magnetic moment of the Λ^0 hyperon is equal to μ. It follows from the figure that

$$\mu_{\Lambda^0} = (-0.65 \pm 0.28)\ \text{NM}$$

The indicated error corresponds to a decrease of the logarithm of the likelihood function by 0.5.



Logarithm of the maximum-likelihood function.

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[1] L.M. Barkov, I.I. Gurevich, et al., ZhETF Pis. Red. 14, 93 (1971) [JETP Lett. 14, 60 (1971)].
[2] R.L. Cool et al., Phys. Rev. 127, 2223 (1962).
[3] W. Kernan et al., Phys. Rev. 129, 870 (1962).
[4] Jared A. Anderson et al., Phys. Rev. Lett. 13, 167 (1964).
[5] G. Charriere et al., Phys. Lett. 15, 66 (1965).
[6] D.A. Hiell et al., Phys. Rev. Lett. 15, 85 (1965).
[7] E. Dahl - Jensen et al., Nuovo Cim. 3A, 1 (1971).

STIMULATED RAMAN SCATTERING OF MICROWAVES IN A LAYER OF COLLISIONLESS PLASMA

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An important role can be played in the interaction of microwave radiation with a plasma even at sufficiently low field intensities (compared with the plasma field), by nonlinear processes and particularly by parametric instability [1, 2]. The occurrence of instability leads to an increase in the field dissipation, since the oscillating electrons begin to be scattered by density pulsations; this mechanism is important also when it comes to explaining why the plasma layer becomes transparent at relatively small field intensities [3]. Parametric excitation of Langmuir and acoustic waves were first observed by Stern and Tzoar [4]. They have shown, however, that in order for the effect to occur it is necessary to direct the electric field of the wave perpendicular to the generatrix of the plasma cylinder. As a result it can be assumed that an

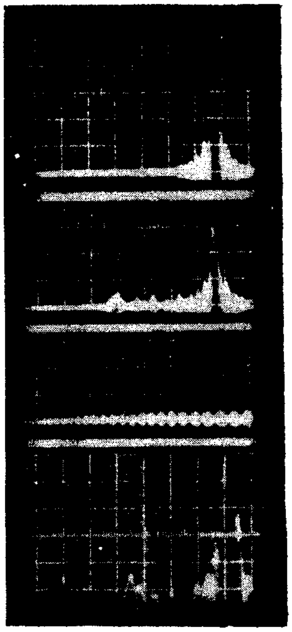

Fig. 1. Spectrograms of microwave radiation pulses. 1 - Spectrum of microwave generator, 2 - spectrum of radiation in the plasma layer, 3 - calibration with period 1 MHz, 4 - spectrum of radiation in plasma with increasing gain. p_0 = 60 dB-W.

important role was played in [4] by the presence of a sharp plasma boundary and by the linear transformation of the transverse wave into a longitudinal one on this boundary.

In the present study our aim was to investigate the emission spectrum of a plasma layer having a freely expanding boundary with a characteristic dimension on the order of the radiation wavelength λ_0 at normal incident of the wave on the layer (with the electric vector $\bar{E}_0$ of the wave perpendicular to ∇n). The measurements were performed under the same conditions as in the experiment on the self-action of microwaves [3]. Electromagnetic radiation of the 10-cm band was guided by a horn-lens antenna to a layer of collisionless plasma produced by four spark sources. The maximum electron concentration in the layer was n_m = (2 - 3)n_c ($4\pi n_c e^2/m = \omega_0^2$, where ω_0 is the circular frequency of the field). The electron temperature measured with the aid of the multigrid probe was about 10 eV at the instant when the microwave pulse was turned on. The measurements were performed in the single-pulse mode (repetition frequency 0.033 Hz). The spectra were investigated with an S4-14 microwave heterodyne analyzer. The spectral analysis was the result of applying the signal of the second intermediate frequency to a delay line with a frequency dispersion. Naturally, only the spectra of sufficiently short pulses can be analyzed by this method, since the frequency scale is transformed in the measurements into a time scale. In our measurements we used strobing of the intermediate frequency amplifier by a pulse of approximate duration 2 μsec, and the delay was set in such a way that we analyzed the spectrum of the section of the microwave pulse penetrating into the layer in the region from the second to the fourth microsecond from its start. The microwave pulse was turned on at the instant when the electron concentration in the plasma layer reached its maximum value.

After passing through the plasma layer, the radiation was received by the open end of a rectangular waveguide mounted at the center of the layer on the axis of the vacuum chamber. The measurements were performed in the following manner: we registered the spectrum of the pulse entering the receiving device without the plasma; during the next pulse, at the same values of the gain and coupling coefficients, we turned on the plasma injectors. As seen from Fig. 1, the radiation intensity in the plasma at the fundamental frequency decreases in comparison with the generator spectrum, and additional lines appear. The decrease of the amplitude of the fundamental frequency (due to the partial reflection of the microwave energy and its dissipation) confirms that the additional spectrum is due to the nonlinearity of the plasma and not to possible overloads of the crystal mixer at the input of the measuring circuit. The additional spectrum extends approximately 10 - 12 MHz towards lower frequencies. No changes in the spectrum were registered on the high frequency side within the limits of the capabilities of the measuring circuit (-30 dB). It should be noted that in the spectrograms of Fig. 1 the amplitude scale of the spectral components is nonlinear, and the measurements show that the maximum intensity of the registered shifted lines is 16 dB lower than ω_0.

The dependence of the radiation intensity at the combination frequencies (Fig. 2) on the power of the incident wave has a sharply pronounced nonlinear character, and the intensity of the satellites reaches a level sufficient for their reliable registration only at a value $v_E/v_{Te} = eE_0/m\omega_0 v_{Te} = 0.2$ (E_0 is the field intensity in vacuum in the plane where the radiation is received, and v_{Te} is the initial thermal velocity of the electrons). This field value corresponds to an incident-wave power at which the layer becomes transparent at approximately 2 μsec after turning on the microwave generator.

Similar changes of the spectrum are registered in the reflected signal, but in this case the level of the satellites reaches -(10 - 12) dB of the fundamental frequency. It is important to note that the satellite registration threshold likewise coincides in this case with the threshold of layer transparency.

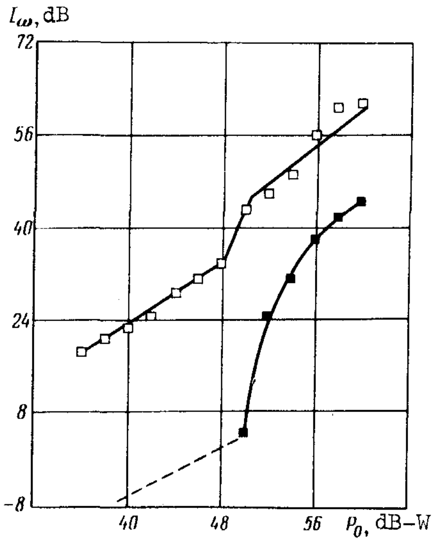

Fig. 2. Spectral component intensity I_ω vs. power of the incident wave: light squares - radiation at the frequency f_0, dark squares - radiation at the frequency (f_0 - 10) MHz; the dashed line corresponds to the level of reliable measurements.

The region of the spectrum near the second harmonic of the frequency of the incident radiation was investigated with the aid of a P5-7B measuring receiver. It was established that the second harmonic intensity is 60 dB lower than the fundamental (ω_0). In the presence of plasma, the intensity of the radiation at $2\omega_0$ increases by 3 - 5 dB (in the transmitted signal), and this can be attributed to refraction of the radiation in the plasma layer. At the same time, a radiation peak is registered at the frequency ($2f_0$ - 10) MHz, i.e., shifted by the same amount as the red satellite near the fundamental frequency. The appearance of this peak corresponds in time with the onset of transparency of the plasma layer.

The occurrence of radiation at the combination frequencies with a shift $\omega < \omega_{Li}$ can be interpreted as the result of instability with formation of a Langmuir wave and an ion-acoustic wave, and in this case it must be borne in mind that the ℓ-wave at shifted frequency can be converted into a t-wave registered by the analyzer. A comparison of the obtained experimental data ($\omega = 6.3 \times 10^7$ sec^{-1}, $\gamma > 10^7$ sec^{-1}) with the theory of parametric resonance in a homogeneous plasma shows that at $v_E/v_{Te} = 0.2 - 0.6$ the increment of the low-frequency oscillations is, in accordance with formula (3.18) of [5],

$$\gamma_{max} = \sqrt{\frac{3}{5}}\,\omega = 0.34\left(k_m r_{De}\frac{\omega_{Li}}{\omega_p}\,\frac{v_E}{v_{Te}}\right)^{2/3}\omega_p = (0.8 \div 1.6)\cdot 10^8\ \mathrm{sec}^{-1}.$$

This estimate is close enough to the experimental value, but according to the theory one should expect also blue satellites comparable in intensity with the red satellites.

Another explanation is also possible and is connected with the instability of the non-potential and acoustic wave [6]. In this case only a red satellite is produced and

$$\gamma_{max} = \sqrt{3}\omega = 0.87\omega_0\left(\frac{v_E}{c}\ \frac{\omega_{Li}}{\omega_0}\right)^{2/3} = (2-4)\cdot 10^7\ \mathrm{sec}^{-1}.$$

The frequency turns out to be underestimated by several times in comparison with the observed one.

Such a difference is apparently due to the fact that the employed theory does not take into account the influence of the inhomogeneity of the plasma layer.

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[1] V.P. Silin, A Survey of Phen. in Ionized Gases, Vienna, 1961, p. 205; FIAN Preprint No. 138, 1967.
[2] D.F. DuBois and M.V. Goldman, Phys. Rev. Lett. 14, 544 (1965).
[3] G.M. Batanov and V.S. Silin, ZhETF Pis. Red. 14, 445 (1971) [JETP Lett. 14, 303 (1971)].
[4] R.A. Stern and N. Tzoar, Phys. Rev. Lett. 17, 903 (1966).
[5] N.E. Andreev, A.Yu. Kirii, and V.P. Silin, Zh. Eksp. Teor. Fiz. 57, 1024 (1969) [Sov. Phys.-JETP 30, 559 (1970)].
[6] L.M. Gorbunov, ibid. 55, 2298 (1968) [28, 1220 (1969)].

SEARCH FOR GRAVITATIONAL RADIATION OF EXTRATERRESTRIAL ORIGIN

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I. We present here the results of the first series of measurements performed with two gravitational antennas, with the aim of observing simultaneous responses produced by gravitational radiation from extraterrestrial sources against the background of Brownian oscillations. The antennas had the same parameters as those of J. Weber [1] ($m = 1.3 \times 10^6$ g, $f_{quad} = 1640$ Hz, $Q = 10^5$, relaxation time $\tau^* = 20$ sec) were placed in evacuated chambers ($p < 1 \times 10^{-4}$ Torr) located 20 km apart. The anti-seismic insulation of the antennas was the same as in [1]. Unlike in [1], the small quadrupole vibrations of the antennas were measured with modulated capacitive displacement pickups, whereas in [1] piezoelectric pickups were used to record stresses. The capacitive pickup transformed a vibration amplitude of $\sim 4.5 \times 10^{-14}$ cm (corresponding to the rms amplitude σ_{Brown} of the Brownian oscillations) into a radio-frequency signal of amplitude $\sim 4 \times 10^{-7}$ V. The construction of the pickup and the system for the absolute ponderomotive calibration of the antenna are described in detail in [2]. We note that in Weber's experiments the Brownian fluctuations corresponded to a piezoelectric-pickup signal level of 5×10^{-10} V [1]. The amplitude of the vibrations are photographed on film with an oscillograph (film speed 0.6 mm/sec, beam spot diameter less than 0.2 mm). This made it possible, without using an electronic coincidence circuit, to discern on the film changes in the oscillation amplitude with a resolution time not worse than 0.3 sec. The recording apparatus for each of the antennas was located at the antenna itself, unlike in [1]. The plots were synchronized with the aid of the time-service radio signals, and with chronometers in the intervals between the hourly radio signals.