radiation, we note only that its angular distribution is strongly anisotropic and depends on the orientation of the screen. In the experiment [1], such an anisotropy was not observed apparently, since the surface of the employed screen was not flat with an accuracy to within the wavelength of the light.

In conclusion, we call attention to the need for further experimental study of the modulation of an electron beam at optical frequencies. It would be quite interesting to observe the aforementioned quantum singularities of this phenomenon.

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POSSIBILITY OF STABILIZING FLUTE INSTABILITY OF A PLASMA WITH THE AID OF CONTROLLED ELECTRON BEAMS

V.A. Chuyanov
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Experiments have shown [1, 2] that the first mode of flute instability of a plasma in a trap with a straight mirror field can be suppressed with the aid of external electrodes, the potentials of which are controlled by a feedback system in accordance with the fluctuations on the surface of the plasma [3]. Such a stabilization system, however, cannot act in principle on the internal modes, which are not sensitive to the boundary conditions. To stabilize such oscillations, it is necessary to find a method of introducing the feedback signal directly into the volume of the plasma. Since in flute oscillations the phase of the perturbation is constant on the force lines of the magnetic field, it is possible to use for this purpose a system of electron beams injected into the plasma from the space outside the mirrors. The intensity of these beams should change in accordance with the fluctuations of the potential on the corresponding force lines. (Methods of stabilizing drift oscillations with the aid of controlled sources of electrons placed inside the plasma and with the aid of beams of neutral atoms were considered in [4, 5].)

The problem of flute oscillations of a rarefied plasma in a strong magnetic field was considered many times. Our case differs only in the fact that it is necessary to take into account the change of electron-beam density in the continuity equation for the electrons, i.e., to introduce a term of the form $(1/ev_b)(\partial j/\partial t)$, where v_b is the velocity of the electrons in the beam, e is the electron charge, and j is the density of the electron current. Since we are particularly interested in stabilization of short-wave oscillations, it is convenient to carry out the analysis in the quasiclassical approximation. Let a cold plasma, homogeneous in the directions of y and z, be placed in a strong magnetic field parallel to the z axis. Let the plasma density decrease in the direction of the x axis. To simulate the effect of curvature of the force lines, we introduce a gravitational force directed along the x axis and leading to drift of the ions along the y axis with velocity v*. Then, for small potential perturbations of the form $f_0 \exp i(k_x x + k_y y = \omega t)$, the dispersion equation will take the form (cf., e.g., [6]):

$$-(k_x^2 + k_y^2)\left(1 + \frac{\omega_{0i}^2}{\omega_{Bi}^2}\right) - \frac{i4\pi}{\omega v_b}\left(\frac{\partial j/\partial t}{f}\right) = \frac{\omega_{0i}^2}{\omega_{Bi}}\kappa k_y\left(\frac{1}{\omega} - \frac{1}{\omega + k_y v^*}\right), \quad (1)$$

where k_x and k_y are the components of the wave vector, ω is the frequency, ω_{0i} is the ion plasma frequency, ω_{Bi} is the ion cyclotron frequency, $\kappa = (1/n_0)|dn_0/dx|$, n_0 is the plasma density, and f is the perturbed potential. To solve (1) it is necessary to specify the ratio $(\partial j/\partial t)/f$. In principle, the feedback system can control the quantity $j(x, y, t)$ in accordance with the measurements of the fluctuations of any plasma characteristic such as ion density, electron density, potential, or electric fields, since the perturbations of all the quantities are uniquely connected with each other and can be "calculated" by the stabilization system on the basis of measurements of one of them. In practice, however, such signal transformations may entail considerable technical difficulties. In this paper we consider the simplest example. Let the stabilization system measure the perturbations of the potential and set the electron current in accordance with

$$j(x, y, t) = j_0 + \alpha f_0 \exp i(k_x x + k_y y - \omega t), \tag{2}$$

where α has the dimension of conductivity and depends on the gain in the measuring system, and j_0 is a constant. If α does not depend on the frequency, then the solution (1), which is a quadratic equation with respect to the frequency, is obvious. There are two stability regions: for negative feedback ($\alpha > 0$) if

$$\alpha > \left[\frac{4\omega_{0i}^2 \kappa}{\omega_{Bi} v^*} - (k_x^2 + k_y^2)\left(1 + \frac{\omega_{0i}^2}{\omega_{Bi}^2}\right)\right] \frac{v_b}{4\pi} \tag{3}$$

and for positive feedback ($\alpha < 0$) if

$$|\alpha| > (k_x^2 + k_y^2)\left(1 + \frac{\omega_{0i}^2}{\omega_{Bi}^2}\right) \frac{v_b}{4\pi}. \tag{4}$$

We note that the stabilizing effect of the negative feedback is analogous to the known effect of short-circuiting the perturbation potential through a plasma outside the mirror along the force lines of the magnetic field.

If α depends on the frequency ω, the order of Eq. (1) increases. We shall not consider this case, however, since Eq. (1) with condition (2) coincides exactly with the dispersion equation for a stabilization system with external electrodes, and consequently all the theoretical and experimental results [1 - 3] obtained for such systems, including the case when $\partial\alpha/\partial\omega \neq 0$, are applicable in our case.

The current needed for the stabilization (j_0) is determined by the noise level in the system. For a typical experimental setup (e.g., for the Phoenix-II setup [2, 7]), an estimate based on formula (4) for the first mode at a plasma density 3×10^9 cm^{-3} and $v_b \simeq 4 \times 10^9$ cm/sec yields the following relation between the total electron current through the entire system and the amplitude of the fluctuations of the potential

$$j\ (\text{amperes}) = 10^{-1} f_0\ (\text{volts}). \tag{5}$$

The question of the stability of the electron beam itself is not considered here. We note, however, that the appearance of a thermal scatter in the electron velocities, either as a result of instability or purposely introduced, is not a limiting factor in the present case.

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INTERACTION OF NEUTRINO WITH NUCLEI AT HIGH ENERGIES

M.G. Ryskin
A.F. Ioffe Physico-technical Institute, USSR Academy of Sciences
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In [1], Gribov considered the scattering of high-energy electrons by heavy nuclei, assuming that large distances x are involved in the integral (1) for the amplitude of the forward Compton effect

$$F_{\mu\mu} = i\int e^{iqx} < A|\,T j_\mu\left(-\frac{x}{2}\right) j_\mu\left(\frac{x}{2}\right)|\,A> d^4x\,, \tag{1}$$

i.e., the process proceeds in two stages. At first the photon decays into virtual hadrons, and then these hadrons interact with the nucleus.

Let us consider, under the same assumptions, the interaction between high-energy neutrinos and nuclei. Neglecting the lepton mass, we obtain [2]

$$\frac{d\sigma}{dq^2 d\nu} = \frac{k_{20}G^2}{k_{10}2\pi}\left[\cos^2\frac{\theta}{2}\,W_2(\nu, q^2) + 2\sin^2\frac{\theta}{2}\,W_1(\nu, q^2) + \right. \\ \left. + \frac{k_{10}+k_{20}}{M}\sin^2\frac{\theta}{2}\,W_3(\nu, q^2)\right], \tag{2}$$

$$M_{\mu\nu}(\nu, q^2) = \int \sum_\beta < A|\,l_\mu^+\,|\,\beta > < \beta\,|\,l_\nu^-\,|\,A > (2\pi)^3\delta^4(k_\beta + k_2 - k_1 - p) \times \\ \times\frac{d^3k_\beta}{4k_{\beta 0}M(2\pi)^3} = -\delta_{\mu\nu}W_1 + \frac{p_\mu p_\nu}{M^2}W_2 + i\,\epsilon_{\mu\nu k\ell}\,p_k\,q_\ell\frac{W_3}{M^2} + \frac{p_\mu q_\nu + q_\mu p_\nu}{M^2}W_4 \\ + \frac{q_\mu q_\nu}{M^2}W_5\,. \tag{3}$$

Here k_1 and k_2 are the 4-momenta of the incident and scattered leptons, p is the 4-momentum of the nucleus, M is the nuclear mass, θ is the scattering angle in the lab system, and

$$q = k_1 - k_2\,,\quad \nu = q_0 = (pq)/M\,.$$