spectral distribution of the photoconductivity.

The agreement between the spectral distributions of the silicon sample and the germanium photodiode, and also the fact that the photoresponse of the diode is produced only by simultaneous exposure of the silicon sample to the monochromatic radiation and the additional illumination, shows decisively that recombination radiation stimulated by long-wave IR light occurs in charge-exchanged silicon. The free electrons and holes produced by the IR radiation are captured by the charge-exchange recombination centers, the electrons by the neutral boron atoms, and the holes by the neutral antimony atoms. The energy of the photons emitted in this case (~1 eV) [2] corresponds to the region of photosensitivity of the germanium diode.

Thus, the long-wave radiation was transformed in this experiment into short-wave radiation with an appreciable gain (by a factor ~20) in the photon energy.

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1) The authors thank K. I. Svistunova for supplying this material.

CONVECTIVE INSTABILITY OF A PLASMA WHICH IS NOT UNIFORM ALONG THE MAGNETIC FIELD

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The stability of a plasma which is not uniform in a direction transverse to the magnetic field has been intensively investigated in recent years [1]. In practice, however, a plasma is quite frequently nonuniform also along the magnetic field. Axial plasma-density gradients are produced, for example, in the case of free diffusion of charged particles from a source to the side walls of the chamber (high-frequency discharge, cathode region of gas discharge, diffusion plasma decay, etc), in the case of volume recombination of a dense plasma, etc. We shall show that a weakly ionized plasma is subject to its own specific instability resulting from the presence of an axial density gradient.

We introduce a coordinate system with the z axis directed along H and x axis along the transverse density gradient. We then have for the electron velocity

$$\vec{v}_{e\perp} = \frac{c}{H}\left[h,\ \nabla\varphi - \frac{T_e}{en}\nabla n\right] - \frac{D_e}{(\Omega_e\tau_e)^2}\frac{\nabla_\perp n}{n} + \frac{b_e}{(\Omega_e\tau_e)^2}\nabla_\perp\varphi\,,$$

$$v_{ez} = b_e\frac{\partial\varphi}{\partial z} - D_e\frac{1}{n}\frac{\partial n}{\partial z}\,. \qquad (1)$$

Here $\vec{h} = \vec{H}/H$, b_e is the electron mobility, D_e the diffusion coefficient, φ the electric field potential, T_e the electron temperature (assumed constant), Ω_e the electron cyclotron frequency, and τ_e the time of collision of electrons with the neutral-gas molecules.

Frequently $T_e \gg T_i$ and the ion diffusion can be neglected. We then have for the average velocity

$$\vec{v}_{i\perp} = \frac{C}{H}\frac{(\Omega_i\tau_i)^2}{1+(\Omega_i\tau_i)^2}[\vec{h}\times\nabla\varphi] - \frac{b_i}{1+(\Omega_i\tau_i)^2}\nabla_\perp\varphi, \quad v_{iz} = -b_i\frac{\partial\varphi}{\partial z}, \tag{2}$$

where $\Omega_i = eH/MC$ is the ion cyclotron frequency, τ_i the time of collision of the ions with the neutral-gas molecules, and b_i the mobility. At equilibrium we have for ambipolar diffusion

$$E_x = D_e b_e^{-1}(1+y)^{-1}\frac{d\ln n}{dx}, \quad E_z = D_e b_e^{-1} q, \quad n = \bar{n}(x)e^{-qz}, \quad v_{ez} = 0,$$
$$y = \frac{b_i}{b_e}\frac{(\Omega_e\tau_e)^2}{1+(\Omega_i\tau_i)^2}.$$

Substituting (1) and (2) in the continuity equations for the electrons and the ions, and linearizing the latter, we obtain two equations for the density and potential perturbations, n' and φ'. In the quasiclassical approximation in x, we have $n' = n_0' \exp[-qz + i\vec{k}\cdot\vec{r} - i\omega t]$ and $\varphi' = \varphi_0' \exp[i\vec{k}\cdot\vec{r} - i\omega t]$, and we can obtain the increment from the corresponding dispersion relation. In the case of a very strong magnetic field, when the ions are also "magnetized," i.e., $(\Omega_i\tau_i)^2 \gg 1$, the increment is of the form

$$\mathrm{Im}\,\omega = -D_e q\sqrt{b_i/b_e}\frac{d\ln n}{dx}\frac{\kappa^3}{(q^2/K_z^2)+(1+\kappa^2)^2}\frac{K_y}{K_\perp} - D_e\frac{b_i}{b_e}\frac{K_\perp^2}{(\Omega_i\tau_i)^2}\frac{q^2/K_z^2+1+\kappa^2}{q^2/K_z^2+(1+\kappa^2)^2}.$$

Here $\kappa^2 = (b_i/b_e)[K_\perp^2/(K_z^2(\Omega_i\tau_i)^2]$ and $K_\perp^2 = K_x^2 + K_y^2$. The second term describes the damping of the disturbances by diffusion. The first term is positive for a suitable sign of K_y/K_z, and a plasma which is nonuniform in z may become unstable to certain disturbances.

In fact, it follows from the expression for the increment, first, that for a specified K_y the largest increment is possessed by the disturbance with $K_x \to 0$, i.e., $K_y/K_\perp = 1$, and second, that the largest increment is produced by a disturbance with minimum $K_\perp$. Further, in the case of free diffusion from the source to the walls, $q = (1/a\Omega_i\tau_i)(b_i/b_e)^{1/2}$ (a is the tube radius), and the first term reaches a maximum when $\kappa^2 = 3.8$. Then

$$\mathrm{Im}\,\omega = -0.3\,D_e\,q\sqrt{b_i/b_e}\frac{d\ln n}{dx} - 0.3\,D_e\frac{b_i}{b_e}\frac{K_\perp^2}{(\Omega_i\tau_i)^2}.$$

Putting $K_\perp \approx 1/a$, we have for $(\Omega_i\tau_i)^2 \gg 1$:

$$\max\,\mathrm{Im}\,\omega \approx D_e\frac{b_i}{b_e}\frac{1}{a^2\Omega_i\tau_i}.$$

The condition $\kappa^2 = 3.8$ means that for such disturbances $K_y/K_z = \Omega_i\tau_i\ (3.8\ b_e/b_i)^{1/2}$ = const, i.e., they all have the same slope. In addition, the wavelength of the disturbances along z is large.

In a second case of practical importance, that of a decaying plasma, $q \approx \pi/l$, where l is the length of the tube with the plasma. Then $q/K_0 < 1$ and the instability develops if $\text{Im}\,\omega > D_e(b_i/b_e)l^{-2}$ or

$$D_e \frac{\pi}{al} \sqrt{b_i/b_e}\ \frac{\kappa^3}{(1+\kappa^2)^2} - D_e \frac{b_i}{b_e} \frac{K_\perp^2}{(\Omega_i\tau_i)^2}\ \frac{1}{1+\kappa^2} > D_e \frac{b_i}{b_e}\ \frac{1}{l^2}\ .$$

This inequality is satisfied only when $(4\pi^2a^2/l^2)b_e/b_i < 1$, with $aK_\perp/\Omega_i\tau_i = 1/2$ on the boundary. Thus, instability is produced in a decaying plasma only in sufficiently long tubes, by disturbances with $K_\perp \sim 1/a$. It can be shown that the obtained criterion changes slightly when account is taken of the final ion temperature $T_i \lesssim T_e$. In case of helium, $b_e/b_i = 65$ and instability exists only if $l > 50a$. The critical magnetic field amounts to $H_{cr}/P \approx 10$ kOe/mm Hg. In extensive experiments on the decay of helium plasma [2], anomalously large coefficients of transverse diffusion were actually observed in tubes 60 - 70 cm long with diameters smaller than 3 cm, with fields $H/P \gtrsim 3$ kOe/mm Hg. In shorter tubes, the deionization followed the laws of classical diffusion.

Free diffusion of a longitudinal plasma produced on one end of a tube by a high-frequency generator was investigated in [3] by studying the dependence of q on the magnetic field. Starting with some critical value of the magnetic field H_{cr}, an anomalous escape of the charged particles to the side walls was observed, accompanied by the appearance of low frequency noise. The instability set in with the ions "not magnetized": $(\Omega_i\tau_i)^2 \ll 1$. The criterion for the occurrence of instability, obtained with the aid of Eqs. (1) and (2) (where we no longer neglect the transverse diffusion and the mobility of the electrons), is

$$x^4 + \left(2 + y + \frac{b_e}{b_i}\ \frac{y}{1+y}\ \frac{1}{a^2K_\perp^2}\right) x^2 + 1 + y + \frac{b_e}{b_i}\ \frac{y}{1+y}\ \frac{K_y^2\ \chi^2}{K_\perp^4} < \frac{b_e}{b_i}\ \frac{y(y+2)}{(1+y)^{3/2}}\ \frac{K_y\ \chi}{a\ K_\perp^3}\ x\ , \tag{3}$$

where

$$x = K_z\ \Omega_e\ \tau_e/\ K_\perp, \quad y = (b_i/\ b_e)\ (\Omega_e\ \tau_e)^2, \quad \chi = |d\ \ln\ n/dx|\ .$$

This criterion is very similar to the criterion obtained in [1] for the stability of a positive column, where an important role is played on the right-hand side by the longitudinal current. It is seen again from (3) that the first disturbance to develop should be one with minimum possible $K_\perp$, i.e., $K_\perp \sim \chi$. The corresponding disturbance is manifest by the bending of the pinch as a unit. In the case of hydrogen ($b_e/b_i = 40$) in a long tube (arbitrary values of x are possible), a minimum value $y_{min} = 2$ at which (3) is satisfied was observed. The corresponding critical field is $H_{cr}/P = 3$ kOe/mm Hg. The experimentally obtained value was $H_{cr}/P = 4$ kOe/mm Hg. In this case $x \sim 1$, i.e., $K_z \sim X(\Omega_e\tau_e)^{-1} \ll X$. In other words, the longitudinal wavelength of the disturbance is much larger than the tube radius.

Thus, the described instability of a plasma which is not uniform along the magentic field agrees well with the experimental data on the diffusion in a sufficiently broad range of experiments.

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MAGNETIC STRUCTURE OF THE COMPOUND FeGe

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The iron-germanium system has not been thoroughly investigated. It suffices to state that only recently have new compounds of this system become known. This includes the compound FeGe [1].

It is already known [2] that the iron-germanium compounds containing more than 50 at.% iron are ferromagnetic, and the only compound with a smaller iron content, $FeGe_2$, is antiferromagnetic. The published data on the magnetic properties of FeGe are contradictory. In [1], on the basis of measurements of the magnetic susceptibility X, it is suggested that this compound is an antiferromagnet with a Neel point at 410°K. In a later paper by the same authors [2], however, it is regarded as paramagnetic at room temperature (the authors of [2] refer in this case to unpublished results of neutron-diffraction studies of FeGe).

The question of existence of magnetic order in the FeGe compound can apparently be resolved with the aid of the Mossbauer effect, since the iron isotope Fe^{57} is very convenient for these purposes.

We have investigated the Mossbauer spectra of Fe^{57} nuclei in the compound FeGe, in the interval from 77 to 500°K. The investigated sample was prepared by a procedure described in [1]. The initial components were Armco iron and germanium. X-ray structure analysis has established that the sample produced contains a phase with hexagonal structure, having parameters a = 5.005 Å and c = 4.054 Å. Such a structure is possessed by the compound FeGe [1]. Investigations of the magnetization of the sample in the interval 300 - 500°K have shown that there are no ferromagnetic impurities with Curie points above room temperature.