DRIFT INSTABILITY STABILISATION BY ION-NEUTRAL COLLISIONS IN A STELLARATOR

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Experiments performed in low density, weakly ionised plasma in 1968 on the stellarator of the Institute of Nuclear Physics in Novosibirsk show that in the case that the mean free path λ of charged particles in the plasma is equal the length of stellarator stabilisation of drift instabilities takes place and decay time of the plasma increases. An empirical relation for the decay time τ in this case is $\tau \cong K \cdot \varepsilon^2 H^2 F(p)$ where ε - is a dimensionless parameter, giving the ratio of helical magnetic field to longitudinal field; H - is longitudinal field and p - pressure of neutral gases /1/. The results of new experiments carried out on the same stellarator are given below. The uniformity of the longitudinal magnetic field here was improved in comparison with the previous experiments.

Since the observed stabilisation is connected with the presence of neutral gas, measurements were made of the varitionion of plasma decay time as a function of neutral gas pressure in Helium, Neon, Aron. (Fig.1.) The average energy of electrons during the decay time was held constant at about 5eV. by means of low level stochastic heating (amplitude h.f. voltage at the gap 1-2 V, frequency 10 MHz). Estimates show that this heating does not give additional diffusion of the plasma. The temperature was measured by the following method. It has been shown /2-3/ that the shift in floating potential of a probe which has a high frequency voltage applied to it is a function of the electron temperature $\Delta V \cong \tilde{V}^2/4T_e$ where ΔV is the shift of floating potential and $\tilde{V}$ is the amplitude of the h.f. (in our experiments $\tilde{V} \approx 1$-2 volt and f = 1 MHz).

The decay times in Argon are about 3-4 time bigger than in Helium at equal neutral densities; this difference can be interpreted as scaling with $\sqrt{M}$, where M is the atomic mass, or by differences in the cross-sections for charge exchange.

Theory /4/ predicts that stabilisation of drift instabilities collisions occurs according to the following condition:

$$\lambda_{in} K_{\parallel} \leqslant {}^{v_{Te}}/_{v_{Ti}} (a K_{\parallel})^2$$

where a - transverse dimension of plasma. This condition can be expressed in the following form if $v_{Ti} \approx c\,U/Ha$, where $U \approx T_e \cdot \alpha$ - potential of plasma and α - constant of the order of unity

$$\sigma_{in} \cdot n_0 \cdot a^3 H \geqslant const$$

In Fig.1 the points at which there are a change of slope of the τ from p curves are in satisfactory agreement with this criterion.

The dependence of the plasma decay time on average electron energy, which is held constant during the decay, is shown in Fig.2. These experiments show definitely, that the decay time decreased as the mean electron energy increased; the decay time varies approximetly as $T_e^{-1/2}$, but allowence has to be made for the spread in the data.

A series of experiments was performed in which the plasma diameter was varied by means of a metal aperture limiter(Fig.3). These experiments indicate that the confinement of plasma is largely realised in the outer layer of the plasma.

The effect of impurites on the decay time of plasma was investigated experimentally; it was found that 1 % concentration of diatomic gases (N_2 or O_2) increased the electron cooling rate by a factor two if the electron temperature was more than 2-3 eV. but produced no change for lower temperatures.

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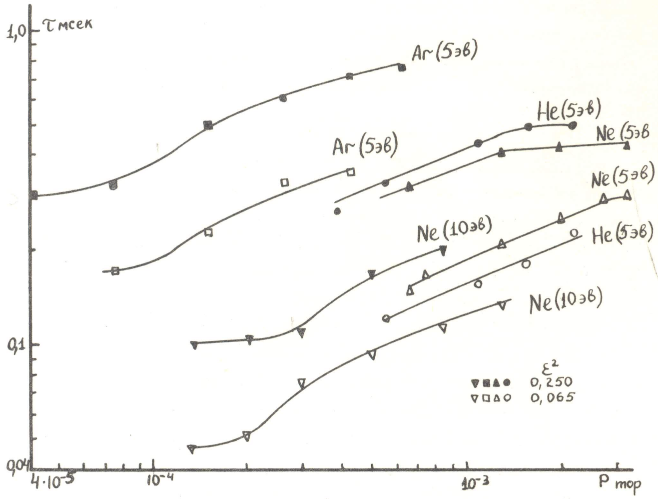

Рис. 1

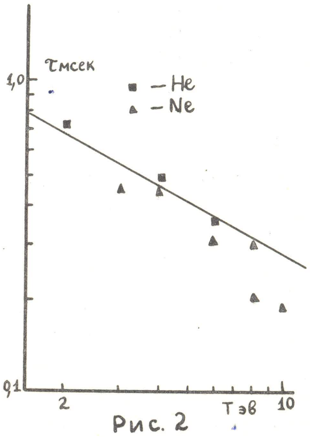

Рис. 2

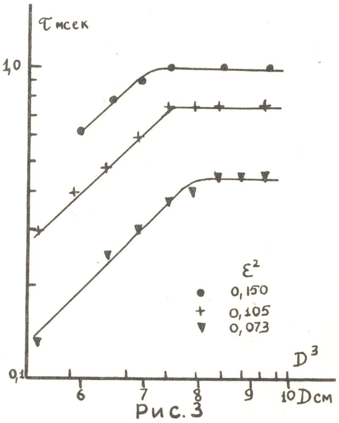

Рис. 3