with the wavelength λ, then it is necessary to take into account the transformation of the waves in regions where geometrical optics is applicable in the first approximation in λ/L [2]. When the foregoing remark is taken into account, it becomes clear that when the beam (and consequently also the perturbation) moves in a direction of increasing density (i.e., when N^2 decreases), an appreciable fraction of the energy is transformed into waves that "flow out" from the plasma chamber to the outside. Such a transition is possible also when $N^2 > 1$. We note that when the beam moves in a direction of increasing density the quasilinear regime observed in [6] can lead only to an increase of the effect considered here, since the energy should go back to the beam in this case. In our case, owing to the strong inhomogeneity ($\lambda/L \lesssim 1$), this circumstance is apparently immaterial.

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DEPENDENCE OF THE ENERGY LOSS FROM A TOKAMAK PLASMA ON THE EFFECTIVE ELECTRON COLLISION FREQUENCY

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The current flowing through the plasma column in Tokamak devices performs the functions of heating and containing the plasma. Therefore the electron density n_e, the temperature T_e, and the current I are connected by a definite relation [1] and cannot always be varied in independent fashion. Such a possibility exists, for example, in a discharge with a relatively large initial hydrogen pressure, when the electron temperature at a given current is practically independent of the density in a wide interval [1]. Such a weak $T_e(n_e)$ dependence makes it possible to trace the variation of the transport coefficients with varying density or effective collision frequency ν_{eff}. The value of ν_{eff} is calculated from measurements of the electric conductivity of the plasma column and is nearly proportional to n_e, but unlike n_e this value takes into account the existence in the plasma of an uncontrolled amount of impurities or the development of collective processes.

Figures 1 and 2 show plots of $\beta_I = 8\pi n_e T_e / H_I^2$ (H_I - magnetic field of the current) and of the energy lifetime $\tau_E = (3/2)n_e T_e/(jE - Q)$ (j - current density, E - intensity of the longitudinal electric field, Q - power radiated

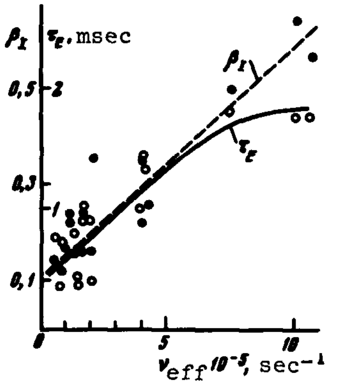

Fig. 1

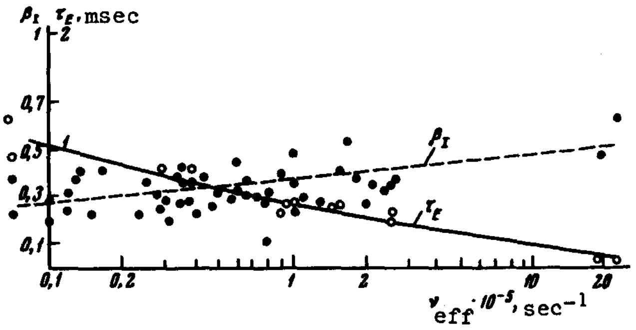

Fig. 2

from the plasma) against ν_{eff}, obtained with the Tokamak TM-3 installation for two fixed values of the current, 35 and 12 kA. Both quantities β_I and τ_E characterize the containment of the energy in the plasma column. Figure 1 illustrates discharge regimes ($I = 35$ kA, $H_z = 27$ kOe) in which the transport coefficients exceed the neoclassical values only by 3 - 5 times, but their dependence on ν_{eff} patently contradicts the theory developed by Galeev and Sagdeev [2]. In contrast to these predictions, both τ_E and β_I increase strongly with increasing frequency. Since the transport coefficients apparently cannot be smaller than the neoclassical ones, it is natural to expect "saturation" of the $\tau_E(\nu_{eff})$ curve, as is indeed observed in Fig. 1.

The dependence of β_I and τ_E on ν_{eff} has an entirely different character in the case of small discharge current (Fig. 2, $I = 12$ kA, $H_z = 14$ kOe), where the $\tau_E(\nu_{eff})$ dependence does not contradict qualitatively the theoretically predicted one. However, the transport coefficients are larger than the theoretical ones by one order of magnitude.

A similar result was obtained by Artsimovich in the interpretaton of experiments with the T-3a installation, performed at the same current densities: $\tau_E \sim a^2/30\nu_{eff}\rho_I^2$ (a is the minor radius of the plasma loop, and ρ_I the Larmor radius of the electron in the field H_I) [3]. Under such conditions, β_I is practically independent of ν_{eff}.

Summarizing, we can state that at the present-day parameters, the coefficient of thermal conductivity of the Tokamak plasma exceeds the neoclassical value [2] by 3 - 10 times, but the role of the processes leading to anomalously high thermal conductivity decreases with increasing current and electron density.

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