Heat equilibrium and stability of impurity seeded tokamak plasmas

D.Kh. Morozov¹,², A.A. Mavrin¹

¹NRC «Kurchatov Institute», Moscow, Russia
²NINU MEPHI, Moscow, Russia
E-mail: morozov@nfi.kiae.ru

The density limit problem for L-mode in tokamaks is discussed. The thermal equilibrium and stability of axially symmetric thermal perturbations is analyzed. The boundary condition at the last closed magnetic surface is shown to be of great interest in order to find the density limit. Two versions of the boundary conditions [1-3] were used in different papers with different results. Both of them are investigated in the present paper. It is shown that the boundary condition \( T(a) = \text{const} \) [1] is more adequate than the boundary condition of the third type \( \frac{dT}{dr} = -\alpha T(a) \) [2,3]. The condition of the thermal equilibrium is found. The critical density obtained under the condition of the thermal equilibrium existence has been found. For the Ohmic regime it takes the form \( n_c \sim I_p^{1.1} \). Here \( I_p \) is the plasma current. It coincides with Greenwald’s criterion [4] \( n_c \sim I_p \) with an acceptable accuracy. It is shown that the radiation mode \( m=0, n=0 \) is stable. The influence of the neutral flow from the wall is not able to destabilize the mode despite the significant rise of the radiation from the edge.

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