Preliminary analysis of isotopic effect on edge instability for tokamak L-H transition

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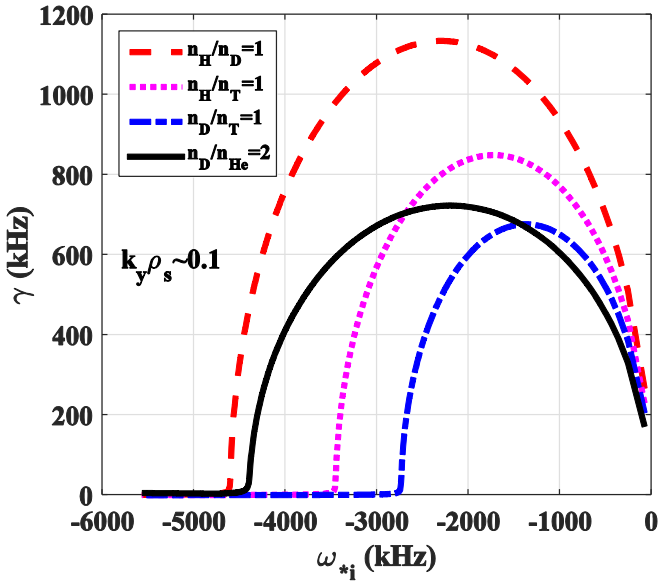
The fast turbulence suppression during the low-to-high (L-H) confinement transition has attracted significant attention for a long term, stimulated by the ITER requirement for H-mode operation in the initial phase with only limited power available. The L–H transition requires a certain heating power, known as H-mode power threshold. However, this power threshold has been shown to depend in a complex manner on plasma conditions and parameters[1]. Especially, for the future burning plasma with different ion components, the isotopic effects could be the non-negligible factor for the H-mode power threshold.

If the saturated turbulence intensity would be the balance between the effective growth rate and the nonlinear damping rate, there are theories indicate the sheared ExB flow has effect both on growth rate[2] and damping rate[3] to induce the turbulence suppression. Inspired by the recent observation on EAST that a turbulence radial wave number spectral shift and turbulence structure tilting prior to the L-H transition[4], a simplified model based on Edge-Instability Stabilization by ExB flow shear has been developed[5], which reveal that the threshold power is inversely proportional to the isotopic mass. According to this clue, a more comprehensive fluid model with multi-ion components is developing to investigate the dominant instability of edge turbulence in L-mode and the internal relationship with isotopes. Here the preliminary analysis shown in the figure as follows gives the maximum linear growth rate of different ion combinations varing with the ion diamagnetic frequency, which implies that the mode growth rate decrease with increasing the isotopic mass. Also the model has capability to deal with the helium ions and other impurities. Briefly, based on the interaction between the radial electric field and the stabilization of plasma micro-instability of the multi-component magnetic fluid theory, it is aimed to develop a turbulence dynamic model of L-H transition to explore the effects of isotopes and impurities on the H-mode threshold power



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