Effect of Equilibrium Properties on the Structure of the Edge MHD Modes in Tokamaks

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In H-mode tokamak plasmas, edge localized modes (ELMs) often constrain the maximum pressure gradient at the edge pedestal, and the so-called 'Type-I ELM', which is caused by destabilizing an ideal magnetohydrodynamic (MHD) mode localized near the edge pedestal, sometimes puts the heat load on the divertor. Though the amount of the ELM energy loss will be determined by the nonlinear evolution of the edge MHD modes, the structure of the linear eigenfunction of the edge MHD modes, called the peeling-ballooning mode, provides a rough indication of the region to be collapsed [1]. The linear MHD stability codes have been developed to analyze the edge MHD stability, and some of them are used in the ELM simulation with the integrated simulation code based on the 1.5D transport code [2, 3].

Recently, with the integrated code TOPICS-IB, Hayashi revealed that the pressure gradient inside the edge pedestal has an impact on the structure of the linear eigenfunction of the edge localized peeling-ballooning modes [3]. This result indicates that though the pressure driven ideal ballooning modes are stable inside the pedestal, the steep pressure gradient inside the pedestal increases the pressure driven component of the plasma potential energy, and makes the linear eigenfunction broaden. From this viewpoint, not only the pressure gradient but also the equilibrium properties inside the pedestal, which affect the ballooning mode stability, will determine the structure of the peeling-ballooning modes.

In the present paper, we investigate numerically the effects of the profiles of the pressure and the safety factor inside the pedestal and that of the plasma shape on the structure of the linear eigenfunction of the edge localized MHD modes. The MHD stability of tokamak edge plasmas is analyzed with the MARG2D code, which can identify the stability boundary of ideal MHD modes with a wide range of toroidal mode numbers [4]. Since the structure of the edge ballooning mode (not the peeling-ballooning mode) have been predicted theoretically [5], the numerical results in this paper will be compared qualitatively with this theoretical prediction, and also with the experimental results.

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