Multi-branch resistive wall instabilities in a resistive plasma

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Most of the theory and the modelling efforts on the resistive wall mode (RWM) instability are based on the ideal plasma assumption (i.e., without plasma resistivity). Previous works shown that toroidal favorable average curvature (i.e. GGJ) effect associated with the resistive layer has a stabilization effect on the RWM [1]. In this work, we apply the full toroidal stability code MARS-F to investigate the GGJ effect on the RWM stability in a toroidal resistive plasma. An important conclusion is that there are two instability branches of the RWM, when the GGJ effect is taken into account as shown in Fig. 1. The behavior of these two branches (both mode growth rate and mode real frequency) rather different while varying both the Lundquist number and the toroidal plasma rotation frequency. However, only one branch can be found when GGJ effect is excluded. Qualitatively similar results can be obtained by numerically solving the RWM dispersion relation, which includes the resistive layer physics associated with the GGJ effect.

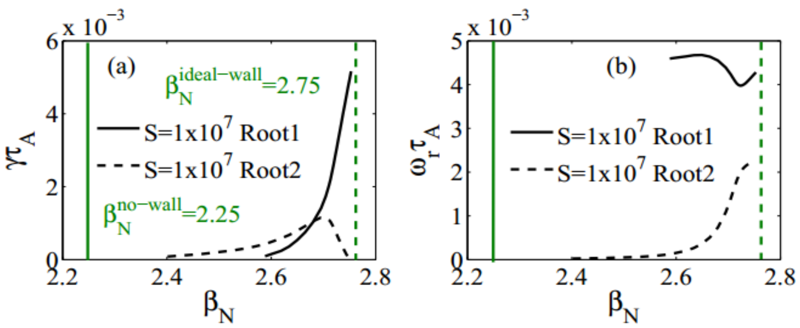

Fig.1 The normalized growth rate (a) and real frequency (b) of resistive wall mode versus the normalized plasma pressure β_N with different choices of Lundquist number S.

In order to successfully control RWM instability in high performance plasmas such as in ITER, the possible multi-branches of RWM induced by non-ideal effects (e.g. resistivity discussed in this work and the kinetic effect from thermal particles [3]) should be considered.

References

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