Mapping the RWM Stability Dependence on Rotation, Fast Particle Distribution, Magnetic Field and Normalized Beta in DIII-D Plasmas and MARS-K Benchmarking

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This paper describes a series of DIII-D experiments aimed at isolating the physics of non-ideal effects on resistive wall mode (RWM) stability. The plasma response amplitude and phase were measured by active MHD spectroscopy, as a proxy for the RWM stability level, and they are compared to the theoretical predictions of the MARS-K model [1]. In contrast to a previous study [2], the effect of fast beam ions on the RWM stability of a set of DIII-D plasmas is found to be small when using the full kinetic model. Moreover, the off-axis neutral beam injection (OA-NBI) system was used to change the fast-ion distribution during a subset of the discharges, and this method modified the thermal kinetic profiles and thus the ideal MHD stability limits, which accounts for part of the RWM stability characteristics. Rotation scans were performed, adding higher values to the rotation map obtained in previous years [2], and showing that the response trend weakens for rotation values above the 40–50 km/s peak observed in [2]. A magnetic field scan, performed for different β_N levels kept constant by NBI feedback, showed a roughly proportional trend in the plasma response amplitude with B_t. The discharges produced in the scans mentioned previously were analyzed with the ideal MHD code DCON [3], as well as with the full kinetic MARS-K model, in order to benchmark the latter for rotation and magnetic field trends, fast particle effects, and proximity to the ideal no-wall limit. New results for a β_N scan of one experimental equilibrium, scaled to values above the no-wall limit, indicate that the inclusion of plasma rotation (which in previous studies was neglected [4]) to the ideal MHD model contributes to part of the damping of the plasma response observed in the experiments (red trace, Fig. 1). When the full kinetic model is used instead of the MHD only model, including the fast-ions effects (black curve), the results show better agreement with the measured phase, as well as the amplitude, in the approach to the no-wall limit.

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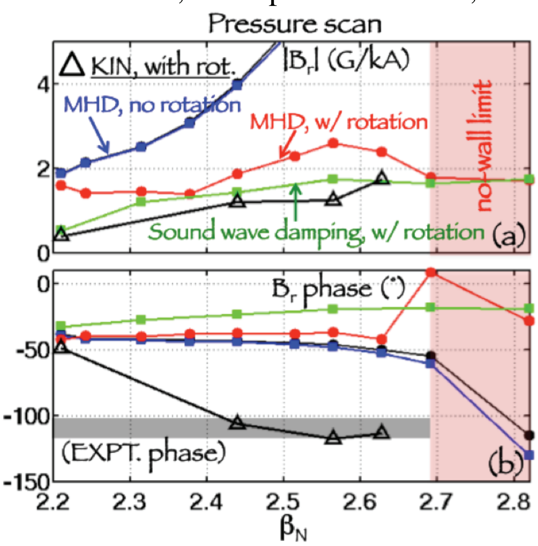

Figure 1. β_N scaling of an experimental equilibrium and MARS-K results: plasma response amplitude (a) and phase (b) with the inclusion of fast-ions to the kinetic model (black trace), or of rotation in the MHD model (red).

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