Active MHD Spectroscopy on the RWM in DIII-D and JET*

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Active MHD spectroscopy has been successfully applied to measure the damping rate and the rotation frequency of the resistive wall mode (RWM) in rapidly rotating DIII-D and JET plasmas above the conventional, no-wall pressure limit. In these plasmas toroidal plasma rotation in the order of a few percent of the Alfvén velocity is sufficient to stabilize the n=1 RWM. Plasma rotation in conjunction with dissipation such as sound wave damping or ion Landau damping can alter the stability of the RWM [1]. A reliable extrapolation of the stabilizing effect of plasma rotation in a future experiment such as ITER, however, requires a complete understanding of the underlying dissipative process.

In order to probe the RWM stability, the technique of MHD spectroscopy has been extended to frequencies of a few Hz [2]. Internal or external coils are used to apply a rotating or oscillating n=1 magnetic field. In both experiments the spectrum of the plasma response, measured as the perturbed magnetic field at the wall, can be fitted to a single mode model showing that such a model is applicable. The fit yields the damping rate and the rotation frequency of the RWM in the absence of external currents, which can be directly compared to predictions using the MARS code [3]. The fit also yields a geometrical coupling parameter, which depends on the resonant component of the applied field. Once the coupling parameter is known, the measurement of the plasma response at a single frequency is sufficient to determine the RWM stability allowing for a continuous measurement of ideal MHD stability. While the observed damping rate of the RWM in DIII-D is in qualitative agreement with predictions using the sound wave damping model, the observed natural rotation frequency is an order of magnitude too low, clearly indicating that further theoretical and experimental work is needed before results can be extrapolated with confidence to future experiments.

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*Work supported by the U.S. Department of Energy under DE-FG02-89ER53297, DE-FC02-04ER54698 and DE-AC02-76CH03073.