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Cross-Machine Comparison of Resonant Field Amplification and Resistive Wall Mode (RWM) Stabilization by Plasma Rotation[1]

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Dedicated experiments in the DIII-D and JET tokamaks and the NSTX spherical torus reveal an aspect ratio A and safety factor q dependence of the stabilizing effect of plasma rotation on the RWM, which is used to discriminate among theories and improve stabilization strategies in future devices including ITER. Despite the different distance of the DIII-D and JET walls, the critical rotation for RWM stabilization normalized to the inverse Alfven time is the same. Similar NSTX plasmas at lower A, however, yield a significantly higher critical rotation. A decrease of the critical rotation with increasing q_{95} in DIII-D and JET is consistent with the $1/q^2$ dependence observed in NSTX. This increase of rotational stabilization with increasing q is predicted by a kinetic damping model [Bondeson, Phys. Plasmas **3** (1996) 3013] and can be derived from a viscous damping model [Fitzpatrick, Phys. Plasmas **9** (2002) 3459] when taking into account neoclassical viscosity [Shaing, Phys. Plasmas **11** (2004) 5525]. The observed A dependence of the critical rotation follows from this theory. In each device the weakly damped n=1 mode manifests itself in resonant field amplification (RFA) above the no-wall stability limit. Applying n=1 fields in similar DIII-D and JET plasmas yields the same amplification confirming that the damping process is independent of the wall properties. The RFA is well described by a single weakly damped mode and can be used to infer the RWM damping rate and rotation frequency. Measurements of RFA induced rotation damping in DIII-D will be compared to NSTX observations that agree with neoclassical toroidal viscosity induced drag.

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