DPP14-2014-000593

Abstract for an Invited Paper
for the DPP14 Meeting of
the American Physical Society

Unification of Kinetic Resistive Wall Mode Stabilization Physics in Tokamaks[1]

S.A. SABBAGH[2], Columbia University

Joint experiments and analysis on the DIII-D tokamak and the NSTX spherical torus have led to a unification of understanding of resistive wall mode (RWM) stability physics between the devices. Unstable and/or marginally stable modes have been found at significant levels of plasma rotation in both devices, and share common dynamics observed during mode growth and rotation. Large collapses of plasma stored energy (up to 60 percent) limit performance in DIII-D high normalized beta plasmas at high minimum safety factor, q_{min}, at plasma normalized beta, β_N, near 3.5 and lead to full disruptions in NSTX. Kinetic RWM stabilization theory [1] implemented in the MISK code can quantitatively explain the observed destabilization, with the results having important complementarity between devices. DIII-D experimental high β_N plasmas are less stable at high q_{min} than at lower q_{min}, which is reproduced by MISK, including the marginal stability point in terms of plasma rotation profile, β_N, and q_{min}. Trapped ion bounce resonance stabilization is dominant compared to ion precession drift resonance stabilization at $q_{min} = 1.2$. As q_{min} is increased to 1.6 and 2.8 in the experiment, ion bounce resonance stabilization decreases significantly, while the ideal MHD instability drive increases, leading to the marginal stability condition. In NSTX, variations of plasma rotation profile and collisionality alter RWM stability, and reproduce marginal stability conditions, but with the ion precession drift stabilization dominant to the bounce resonance stabilization. This understanding is critical for future design and operation of magnetic fusion devices, including ITER high normalized beta steady-state scenarios, to minimize minor and major plasma disruptions.

[1] B. Hu and R. Betti, Phys. Rev. Lett. **93**, 1050002 (2004).

[1]Supported by the US DOE under DE-FG02-99ER54524, DE-FC02-04ER54698, and DE-AC02-09CH11466.

[2]In collaboration with J.W. Berkery, J.M. Hanson, C. Holcomb, and the DIII-D and NSTX Research Teams.