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Measured Improvement of Global MHD Mode Stability at High-beta, and in Reduced Collisionality Spherical Torus Plasmas[1]

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Global mode stability is studied in high-beta National Spherical Torus Experiment (NSTX) plasmas to avoid disruptions that must be kept to low probability in ITER and future tokamaks. Dedicated experiments using low frequency active magnetohydrodynamic (MHD) spectroscopy of applied, rotating $n = 1$ magnetic fields, which provides an experimental measurement of plasma stability, revealed key dependencies of stability on plasma parameters. Stability *increases* at the highest values of $\beta_{\mathrm{N}}/\mathrm{l_i}$ in high β_{N} plasmas, consistent with other resistive wall mode (RWM) active control experiments and the wider database. This behavior is shown to correlate with kinetic stabilization [1]. Kinetic theory stipulates that when the trapped thermal ion precession and ExB motions are in resonance, energy is most efficiently transferred between the mode and the particles. The measurements also indicate that plasma stability can benefit from reduced collisionality, in agreement with the expectation from kinetic theory that reduced collisionality can allow resonant effects to be stronger, and in contrast to collisional stabilization models. Full kinetic RWM stability calculations with the MISK code generally agree with the experimental results. Calculations support the understanding that RWM stability can be increased by kinetic effects at low rotation by precession drift resonance and at high rotation by bounce and transit resonances. A simplified kinetic resonance criterion is evaluated, and the related stable range of measured ExB frequency is identified. The results are being analyzed for use in real-time instability determination to guide future rotation profile control and to supplement active RWM control for disruption avoidance.

[1] J.W. Berkery, et al., Phys. Rev. Lett. **104**, 035003 (2010).

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