Transient Excitation of RWM in DIII-D by Energetic Particle Losses and Plasma Rotation Decrease Due to Off-axis Fishbone Modes*

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A recent series of experimental studies of kinetic effects in the resistive wall mode (RWM) stabilization is consistent with a model prediction that RWM stability can be achieved with kinetic effects [including the Energetic particle (EP) precession drift resonance] and by the plasma rotation near the $q = 2$ surface [1,2]. On the other hand, an EP-driven "off-axis-fishbone mode (OFM)" often triggers a RWM, preventing long-duration high-β_N discharges. In the DIII-D experiments, the EP-driven bursting events not only reduce the EP density, but also simultaneously lower the plasma rotation by some process associated with EP radial losses, presumably due to non-ambipolar electric field buildup. Analysis of these effects on stability with a self-consistent perturbation to the mode structure by the MARS-K code showed that the impact of EP losses together with rotation drop is sufficient to destabilize the RWM in low rotation plasmas, when the plasma rotation normalized by Alfvén frequency is only a few tenths of a percent near the $q = 2$ surface. The OFMs grow initially like a classical fishbone, and then the mode structure becomes strongly distorted. The dynamic response of the OFM to an applied $n = 1$ external field with feedback mode implies that the mode retains its external kink character. This narrow window of stability between off-axis fishbone mode and the external kink mode (namely RWM in wall-stabilized plasmas) is analogous to the relationship of the classical fishbone to the internal kink mode.

[1] E.J. Strait, *et al.*, Phys. Plasmas **14**, 056101 (2007).
[2] H. Reimerdes et al., "Evidence for the Importance of Trapped Particle Resonances for Resistive Wall Mode Stability in High Beta Tokamak Plasmas," submitted to Phys. Rev. Lett. (2010).

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