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TH/P3-02: An Investigation of Coupling of the Internal Kink Mode to Error Field Correction Coils in Tokamaks

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The coupling of the internal kink to an external m/n=1/1 perturbation is studied for profiles that are known to result in a saturated internal mode in the limit of a cylindrical tokamak (Rosenbluth, Dagazian & Rutherford [Phys,Fluids 14(1973)1895]). 3D equilibria are calculated with thr VMEC code.
If a small m/n=1/1 perturbation is applied to the boundary, it is found that for aspect ratios A=30 circular plasmas and A=3 elliptical shapes that the coupling is strong. That is, the magnitude of the perturbation at q=1 is much larger than the edge perturmation for edge perturbations in the range deltaR/R_0 $\approx$ 10−3 $\longrightarrow$ 10−4. Without the edge perturbation the saturated mode is not observed in toroidal geometry, even at very large aspect ratio.
Plasma shapes that are favorable for MHD stability tend to have large sawtooth crashes. These crashes can be problematic in that they can trigger neoclassical tearing modes, they can interfere with ELM-suppression produced by RMP, and in the most severe cases can result in a prompt loss of 15% of total stored energy beyond the last closed flux surface.
Typically, modern shaped tokamaks have error field correction coils. These coils are often needed during the plasma current ramp to prevent locked modes. However, once the nominal operating point is achieved, they are no longer needed. It is proposed that this m/m=1/1 excitation could readily be applied with these error field correction coils. This should be explored as a mechanism for controlling sawtooth amplitudes in high performance tokamak discharges.

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