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Tearing mode stability studies near ideal stability boundaries in DIII-D

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Abstract

For high β, highly shaped plasmas in the DIII-D tokamak [J.L. Luxon and L.G. Davis, Fusion Technol. **8**, 441 (1985)], the value of the tearing stability index $\triangle'$ calculated at a rational surface can be especially sensitive to the pressure and current profiles. Near marginal stability for a global ideal mode, a pole in $\triangle'$ exists in equilibrium parameter space, as predicted by analytic theory. The proximity of an equilibrium reconstruction to this pole in parameter space strongly decreases the accuracy of the $\triangle'$ calculations. Tearing stability calculations on kinetic equilibrium reconstructions of a series of times in three DIII-D discharges are presented, which indicate that the tearing modes in these discharges are classically unstable at the time of onset. The onset mechanism of two of these discharges (which are in H-mode) is related to the approach of ideal stability boundaries and the occurrence of

poles in $\triangle'$. Several ideal modes [sawteeth, edge localized modes (ELMs), and resistive wall modes (RWMs)] are thought to seed NTMs through forced reconnection, after the ideal mode is unstable. However, tearing modes often appear suddenly and grow quickly without an obvious ideal mode causing a seed island through forced reconnection, which could be explained by this mechanism. This is proposed as an alternative mechanism for the onset of neoclassical tearing modes (NTMs) in tokamaks, which is not incompatible with forced reconnection.

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