Detailed Comparison of MHD Stability Theory with Measurements in DIII-D*

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Magnetohydrodynamic (MHD) stability theory can make predictions for tokamak experiments on three levels. Historically, predictions of the scaling of stability limits with key parameters has provided guidance for improving tokamak performance, as exemplified by the Troyon scaling. More recently, with the advent of accurate equilibrium reconstructions utilizing internal profile measurements, it became possible to successfully reproduce the experimental stability limits of specific tokamak discharges. In the past few years, the predictive capability of MHD stability has entered a new phase in which, not only can the stability limits be predicted accurately, but also the predicted growth rates and mode structures can be quantitatively tested against experimentally measured diagnostic fluctuations such as electron cyclotron emission (ECE), soft X-ray (SXR), and Mirnov signals [1]. This has led to an acceleration in both the scientific understanding of tokamak plasmas and the performance of tokamak discharges. It is now possible to test the importance of competing non-ideal effects in setting the stability limits. For fast-growing global, ideal-like instabilities, linear theory can explain the dominant features of the observed growth and fluctuation signals. Detailed comparisons between predicted resistive wall modes (RWMs) with discharge behavior has resulted in the identification of a definite correlation between observed rotation slowdown and wall stabilization [2]. Predictions of unstable edge localized modes (ELMs) can also be compared with measured signals. For slower, resistive modes, comparisons of the predictions with diagnostic measurements have enabled identification of resistive interchange modes, classically destabilized tearing modes, and nonlinearly destabilized neoclassical tearing modes.

[1] A.D. Turnbull, D.P. Brennan, M.s. Chu, et al "Predictive Capability of MHD Stability Limits in High Performance DIII–D Discharges," to be published in Nucl. Fusion (2002).
[2] A.M. Garofalo, A.D. Turnbull, et al, Phys, Rev. Lett. **82** 3811 (1999).

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