# MHD Instabilities Occurring Near/At the Transport Barrier, Including Loss of Confinement in H Modes*

L.L. Lao

*General Atomics, P.O. Box 85608, San Diego, CA 92138-5608*

One of the major objectives of advanced tokamak research is to develop plasma configurations with high confinement and improved stability at high $\beta$. Two of the more promising enhanced confinement regimes are the H– and VH–mode configuration which exhibits improved confinement in the plasma edge and the negative-central/optimized shear configuration which shows improved confinement in the plasma core. The improved edge and core confinement leads to large pressure gradient and large edge bootstrap current density which often drive magnetohydrodynamic (MHD) instabilities terminating the discharge or reducing the discharge performance. The edge and the core transport barriers are deteriorated or completely lost. In this presentation, recent experimental and theoretical developments concerning MHD instabilities occurring near/at the edge and the core transport barriers are summarized emphasizing the dominant instabilities and the comparison with theory.

In the area of edge instabilities, recent developments include characterization and modification of edge instabilities using methods such as plasma shaping and impurity injection. Despite its simplicity and various simplifying assumptions, predictions from high *n* ideal ballooning theory are consistent with observed changes in pressure gradients and ELM character when second regime access is included. Detailed low *n* ideal stability analyses using simulated and accurately reconstructed experimental equilibria suggest that $n > 1$ modes with a large peeling component are more unstable as often observed experimentally. These recent theoretical and experimental results provide further support to the working hypothesis that edge-instabilities/ELMs are ballooning/kink/peeling modes arising from a complex interaction among MHD modes with various *n* and the evolution and growth of the edge pressure gradient and the edge bootstrap current. Other important effects such as diamagnetic stabilization and coupled high *n* peeling-ballooning modes are also being addressed.

In the area of core instabilities, the $n = 1$ ideal instabilities often terminating negative-central/optimized shear discharges are relatively well understood and can be avoided by reducing the peakedness of the pressure profiles as theoretically suggested. Various resistive instabilities such as resistive interchange and tearing modes are also observed, particularly when $q_{min}$ passes through a rational value or when rotational shear is weak. These resistive modes are less well understood than the ideal instabilities.

---

*Work supported by the U.S. Department of Energy under Contract No. DE-AC03-99ER54463.