Linear Stability Analysis of an EDA H-mode Edge Plasma: A Quest for the Quasi-Coherent Mode

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Enhanced D-Alpha (EDA) H-modes observed in Alcator C-Mod[1] are of interest because they combine good energy confinement with quasi-steady ELM-free operation. It is thought that the EDA is enabled by the quasi-coherent mode (QCM), observed in these discharges,[2] which might regulate the pedestal gradient and particle transport. Here, we employ the 2DX edge eigenvalue code[3] to determine whether a linear stability analysis of the edge plasma using realistic C-Mod X-point/divertor geometry and EDA experimental plasma profiles, can produce a candidate for the QCM.

2DX solves linearized eigenvalue equations in the R-Z plane for a given toroidal mode number, and has been successfully benchmarked on various linear plasma instabilities in full X-point geometry. Use of a specialized equation parser permits a high degree of flexibility in the equations. We exploit this feature to study the unstable spectrum in a variety of physics models ranging from electrostatic resistive ballooning to drift-resistive-inertial models which include Kelvin-Helmholtz, E_r-shear, ion diamagnetic drift effects, and electromagnetic physics.

We find that the unstable spectrum is somewhat insensitive to the physics model. No unambiguous candidates for the QCM have emerged so far, although a resistive-ballooning model with ion diamagnetic drifts gives peak growth rates at a wavenumber close to observations. When drift waves are present in the model, growth rates and frequencies tend to increase more or less linearly with toroidal mode number (and hence poloidal wavenumber) in the regime of interest. While some linear drives remain to be investigated (e.g. edge current gradients), the present results tend to suggest a role for nonlinear effects such as the inverse cascade.

[1] M. Greenwald, et al., Phys. Plasmas **6**, 1943 (1999).
[2] J.L. Terry, et al., Nucl. Fusion **45**, 1321 (2005).
[3] D. A. Baver, J. R. Myra and M. Umansky, Lodestar Report #LRC-10-137 (2010) http://www.lodestar.com/LRCreports/LRC-137_2DX.pdf.

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