Gyrokinetic analysis of linear instabilities within the pedestal of experimental discharges

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The pedestal region of a tokamak is the area in which the pressure gradients are highest. This gradient serves as a source of free energy to a large group of instabilities, examples including the ion temperature gradient mode (ITG), trapped electron mode (TEM), kinetic ballooning mode (KB) and electron temperature gradient mode (ETG). Understanding the pedestal height and width is a key component to achieving high core temperatures in a steady state device, which has been a focus of Fusion Energy Science Joint Facilities and Theory Research Target 2011. Recent advances in GYRO [Belli et al, Physics of Plasmas **17**, 112314 (2010)] allow simulations to map out the linear stability of many eigenvalues and eigenvectors of the gyrokinetic equation (as opposed to only the most unstable) at low computational cost.

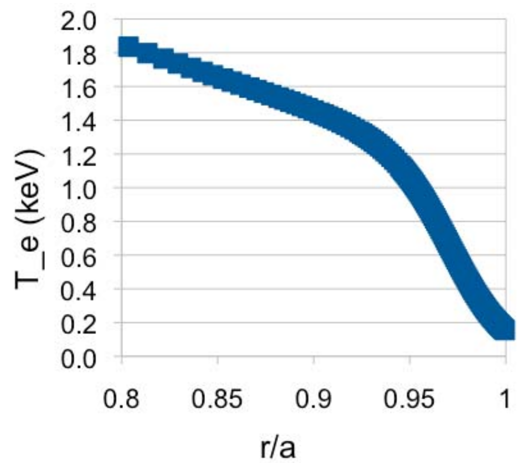

Fig.1 Temperature vs r/a. Pedestal is located between 0.92 < r/a < 1

In the present work, GYRO's new linear capabilities are applied to the pedestal region of experimental discharges (DIII-D shot 132016 in particular) to determine the nature of all instabilities present. The properties of these instabilities, from the frequency response to structure of the eigenfunctions, are explored in response to shifts in local parameters such as beta and collision frequency. We demonstrate the primary instability for radial locations inside the peak gradient is dominated by ITG for k_theta rho_i < 1, while at the peak gradient location (r/a=0.98) a group of modes compete. Electron modes are also unstable for higher values of k_theta rho_i. The impact of flow shear will be explored. The general trends will be discussed after investigating other similar discharges on DIII-D, NSTX and C-Mod.

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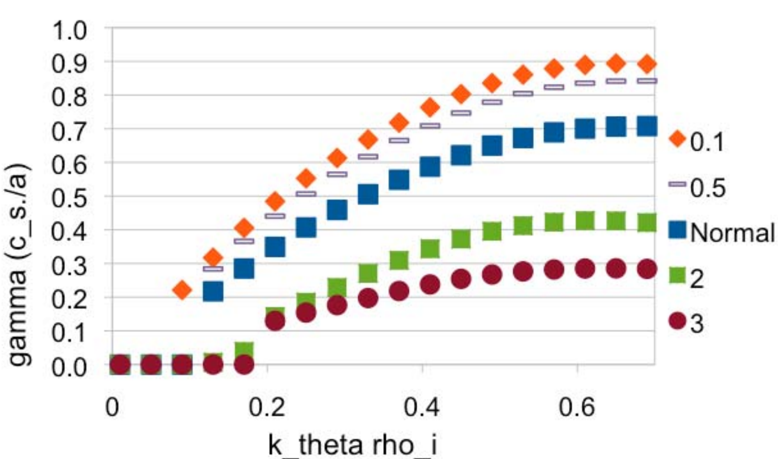

Fig.2 Collisionless growth rate for various k_θ and scales of β at r/a=0.92. Here 0.1 corresponds to 10% of experimental value. The decreasing growth rate with increasing β suggests mode is ITG.