Linear global ITG solutions from local electrostatic gyrokinetic codes

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We employ a local gyrokinetic code, GS2, together with analytic theory [1] to investigate global ion temperature gradient, ITG, modes. We use a linear electrostatic model with adiabatic electrons and employ the high aspect ratio $s - \alpha$ tokamak equilibrium model with circular magnetic flux surfaces. We have used a quadratic radial profile for the drive source, namely $\eta_i$-profile. We performed local linear gyrokinetic calculation with GS2, across the full domain of interest in radius, $x$, and ballooning angle $-\pi \leq p \leq +\pi$. This procedure provides the local complex mode frequency $\Omega_0(x, p) = \omega_0(x, p) + i\gamma_0(x, p)$ which depends on $x$, due to the profile variation, and is periodic in $p$. The real frequency, $\omega_0(x, p)$, and the linear growth rate, $\gamma_0(x, p)$, are stationary at the same radial position, which implies the existence of a strongly growing mode that peaks at the outboard mid plane, $\theta = 0$, with maximum global growth rate, $\gamma_{\text{max}} = \max(\gamma_0(x, p))$. These results are consistent with the reduced fluid model of ITG modes [2]. Radial variation of the equilibrium safety factor ($q$) profile, with constant magnetic shear, moves the peak mode position slightly away from the outboard mid plane, see Fig.1 (left), $\theta \neq 0$, and reduces the growth rate. Finally, we have studied the effect of low rotation shear through a Doppler shift in the real frequency, $\Omega_0(x, p) \rightarrow (\omega_0(x, p) + nq'\Omega'x) + i\gamma_0(x, p)$, where $\Omega'$ describes sheared equilibrium flow. The profile variations introduce an asymmetry to the growth rate spectrum with respect to the sign of the flow shear, see Fig.1 (right). These results are in good qualitative agreement with the linear electrostatic global ITG calculations presented in reference [3].

References