A CURRENT GRADIENT DRIVEN, HIGH MODE NUMBER KINK TEST OF GYROKINETIC SIMULATIONS

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The gyrokinetic simulations widely used to model turbulent tokamak plasmas normally assume the electron and ion distribution functions are Maxwellians with the same drift velocity. Therefore, the parallel electron current driven by the induced electric field in a tokamak that can drive unstable kink modes is not retained in standard gyrokinetic simulations. To retain kink modes the electrons must be allowed to have the proper self-consistent parallel flow with respect to the ions. When this electron flow becomes comparable to the ion thermal speed in an inhomogeneous, finite beta tokamak plasma the shear Alfvén wave solutions of the electromagnetic gyrokinetic equation can become nearly purely growing kink modes, but do so outside the regime of validity of both simple analysis and the simulation. Nonetheless, this kink mode can be used as a useful test of local gyrokinetic codes when a current gradient drive term is implemented as long as one is aware of the simplifications going into these models regarding magnetic geometry. To perform the study of the influence of the induced parallel electric field driven electron current on stability we use the new “low-flow” version of the gyrokinetic code GS2 developed for momentum transport studies [1]. We identify current gradient driven high mode number kink modes [2] in the GS2 simulations and make comparisons to analytical theory in sheared magnetic geometry. We find that the results are insensitive to whether we employ a parallel drifting Maxwellian or a full Spitzer function solution for the electron distribution function. Convincing agreement with analytical results both in terms of the parametric dependences of mode frequencies and growth rates, and regarding the radial mode structure is demonstrated [3]. As a result, we can say with certainty that GS2 is correct in the stable lower current gradient, weaker q variation limits where the theory and code are completely valid. Supported by US DoE at MIT PSFC and UT Austin (MB), EURATOM (IP), Vetenskapsrådet (IP), and Oxford U. (FIP)