Equilibrium and stability of toroidal plasmas with poloidal sonic flow

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Equilibrium and stability of toroidal plasmas with flow in the order of poloidal sound velocity are studied. In toroidally confined plasmas, both of the poloidal and toroidal components of flow are important for improved confinement. Recently, a new reduced set of equilibrium equations has been derived for high-beta tokamaks with both toroidal and poloidal flows comparable to the poloidal-sound velocity [1]. This set of model equations includes the effect of poloidal flow on both the magnetic flux and the pressure as higher-order terms of asymptotic expansions in terms of the inverse aspect ratio. We have found analytical solutions for this reduced set of equations for linear profiles of the lowest order free functions and performed qualitative studies of equilibria with sub- and super-poloidal-sonic flow [2]. In this presentation, we will show stability analysis of these analytical equilibria. The reduced MHD equations that include higher order terms and give above equilibrium solutions are similar to those in Ref. [3] but allow non-uniform density. Equations for linear stability are derived by exploiting the Lagrangian displacement [4]. This system includes the shear Alfven and the slow magnetosonic waves and the geodesic acoustic mode (GAM). We will discuss the stability of these branches in the presence of both of the toroidal and the poloidal flows.

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