Impact of Ion Temperature Anisotropy on 2D Edge-Plasma Transport

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The effect of ion temperature anisotropy on the parallel plasma transport in the scrape-off layer (SOL) of tokamaks is implemented using a generalization to the fluid transport model now implemented in UEDGE. Two ion energy equations are used that evolve the separate parallel and perpendicular ion temperatures. The temperature anisotropy generates viscous forces in both the parallel and perpendicular directions that modify the parallel force balance equation and add an additional cross-field drift. These equations have been described and used in 1D simulations of the tokamak SOL in Refs. [1,2], and an earlier application of similar temperature anisotropy equations was used to describe the closely related process of warm plasma flowing through a magnetic mirror machine in Ref. [3]. In the present work, the model is implemented and applied in the full 2D version of UEDGE, including cross-field drifts and recycled neutrals. Evidence for strong ion temperature anisotropy in the SOL comes from gyrokinetic edge simulations using the XG1a [4] and COGENT [5] codes. Thus, part of the motivation of the present work is to represent anisotropies in the much simpler 2D fluid transport codes that can then be compared to results from 4D kinetic codes. Comparisons of poloidal electron pressure profiles in the DIII-D divertor leg for helium plasmas have been fit reasonably well using SOLPS with fitted radial transport coefficients, but the electron pressure between the X-point region and the midplane could not be matched [6], which could be attributed to effects of the ion temperature anisotropy. It is precisely in this region where the temperature anisotropy is expected to play a significant role, which is part of the present analysis. A second specific comparison given here is to assess the role of ion temperature anisotropy on simulations of DIII-D radiative divertor discharges including cross-field drift effects presented in another paper [7].

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