Assessing ion-electron equilibration in the scrape-off layer in tokamak fusion devices

A. Holm and M. Groth

Department of Applied Physics, Aalto University School of Science, P.O.B 11100, FIN-00076 AALTO
email: andreas.holm@aalto.fi

The validity of an analytic model of the *scrape-off layer* (SOL) in fusion devices to predict the plasma conditions in a simplified geometry has been assessed using the fluid code *UEDGE*. The studies show that the agreement between the analytic *two-point model* (2PM) and UEDGE is sensitive to the choice of *flux tube* considered and that ion-electron thermal equilibration is rarely achieved.

Simulations of the SOL are critical in understanding and controlling the power exhaust of fusion plasmas. Simple, analytic models of the SOL, such as the 2PM, are preferred over time- and resource consuming full-geometry, numerical codes when identifying fusion-relevant operating regimes and for detailed analysis of such plasmas. Therefore, the capabilities of analytic models to adequately predict plasma behaviour is paramount.

The 2PM is an analytic model relating plasma parameters at an upstream SOL position to those at the divertor target. Due to the dimensionless character of the 2PM, volumetric and geometric effects which occur in fusion plasmas are neglected. When deriving the 2PM, basic assumptions are made regarding plasma behaviour, including but not exclusive to, ion-electron thermal equilibration, pressure-, and power conservation. Correction factors were introduced to the basic 2PM to alleviate the shortcomings of these assumptions, resulting in the extended 2PM [1]. This work considers the momentum balance, power balance, and thermal conduction in the SOL.

Two-dimensional fusion plasmas in an orthogonal *slab* model were simulated using the multi-fluid plasma code UEDGE. The 2PM correction factors were determined from these simulations. The basic and corrected 2PM predictions were compared to the UEDGE predictions to determine whether the introduction of the correction factors improved the 2PM-UEDGE agreement. Our studies show that the 2PM predictions significantly deviate from the UEDGE predictions, regardless of the inclusion of correction factors determined by UEDGE simulations, calling the application of the 2PM into question.

[1] P. Stangeby, The Plasma Boundary of Magnetic Fusion Devices, Institute of Physics Publishing (2000).