A Two-Dimensional Kinetic Model of the Scrape-Off Layer of a Diverted Plasma with a Private Flux Region

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Abstract

Earlier two dimensional (radial and poloidal angle), analytically tractable ion kinetic models of the scrape-off layer (SOL) in which a steady state is achieved by balancing the streaming loss of ions to the divertor target plates with the radial diffusion of ions from the core are unable to distinguish between limited and diverted plasmas. The model presented here removes this limitation while still remaining amenable to a similar Wiener-Hopf solution procedure. The boundary conditions employed at the divertor plates allow for partial reflection in order to model ion recycling. The diffusion into the private flux region and the extended divertor channels (all of normalized length d), as well as the rest of the SOL, is evaluated. The SOL is shown to be asymmetric about the separatrix because ions from the core must stream by the X point before diffusing into the private flux region. The SOL in the private flux region is narrower (by \(2d/(1+2d)^{1/2}\)) with a stronger poloidal dependence and a lower density (by \(2d/(1+2d)\)) than the region beyond the separatrix.

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