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TH/P4-22: Coarse Grained Transport Model for Neutrals in Turbulent SOL Plasmas

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Edge plasmas of magnetic fusion devices exhibit strong intermittent turbulence, which governs perpendicular transport of particles and heat. Turbulent fluxes result from the coarse graining procedure used to derive the transport equation, which entails time averaging of the underlying equations governing the turbulent evolution of the electron and ion fluids. In previous works, we have pointed out that this averaging is not carried out on the Boltzmann equation that describes the transport of neutral particles (atoms, molecules) in current edge code suites (such as SOLPS). Since fluctuations in the far SOL are of order unity, calculating the transport of neutral particles, hence the source terms in plasma fluid equations, in the average plasma background might lead to misleading results. In particular, retaining the effects of fluctuations could affect the estimation of the importance of main chamber recycling, hence first wall sputtering by charge exchange atoms, as well as main chamber impurity contamination and transport. In this contribution, we obtain an exact coarse-grained equation for the average neutral density, assuming that density fluctuations are described by multivariate Gamma statistics. This equation is a scattering free Boltzmann equation, where the ionization rate has been renormalized to account for fluctuations. The coarse grained transport model for neutrals has been implemented in the EIRENE code, and applications in 2D geometry with ITER relevant plasma parameters are presented. Our results open the way for the implementation of the effects of turbulent fluctuations on the transport of neutral particles in coupled plasma/neutral edge codes like B2-EIRENE.

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