Neoclassical transport in the edge plasma in the limit of low collisional and anomalous transport

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The understanding of heat transport mechanisms in the edge plasma is a major issue of the physics of tokamaks as it determines Scrape-Off Layer (SOL) decay lengths and consequently power loads on the divertor targets. In L-mode, turbulence in the outboard mid-plane region is known to dominate the cross-field transport of particles. Although mechanisms of heat transport are not yet fully understood, turbulence is likely to play a role. Nevertheless in H-mode turbulence is strongly reduced in the pedestal and near-SOL. It is thus not clear which is the main mechanism driving the transport through the separatrix. Recently a heuristic model \cite{1} proposed that the curvature drift of particles is the main mechanism driving the cross-field transport across the separatrix in H-mode, determining entirely the SOL power width. This model has been compared with a recent scaling law \cite{2}, showing a good agreement, and has also been pointed out as potential candidate to explain narrow heat flux profile in L-mode \cite{3}. Yet the assumptions made in this model call for a better understanding of the edge plasma equilibrium in the limit of weak collisional and anomalous transport.

In this work, we use the 3D fluid code TOKAM3X \cite{4} to study the role played by curvature drift in the transport of particles in the limit of weak collisional and anomalous transport. A 2D reduced version of the complete TOKAM3X model is used in which turbulence does not contribute to transport. Both limiter and divertor geometries are studied and compared. In limiter configuration, SOL density width ($\lambda_N$) scales as the square root of the diffusion for high diffusion coefficient, but saturates at a non-zero value for low diffusion coefficient. This value is significantly lower than the one predicted by the heuristic model. However it is not clear whether the stagnation is due to curvature-drift transport or to a numerical artificial diffusion. Moreover the particles flux through the separatrix is never dominated by the curvature drift even at very low diffusion coefficients, which seems to rule out a role of the curvature drift as the main driver of heat transport. Besides, at low diffusion coefficient, a complex neoclassical equilibrium appears, presenting strong poloidal asymmetry. In extreme cases one can even observe the formation of stationary shocks. In divertor configuration, the results are qualitatively similar but of a different order of magnitude due to modification of the flux expansion. In the tested configurations (JET-like shape), the SOL width is found 2 times smaller than in comparable limiter cases. This leads us to discuss the influence of the magnetic configuration on the cross-field transport and parallel equilibrium based on simulations run in specifically designed geometries.

\begin{thebibliography}{99}
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