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TH/P4-16: Parallel Transport and Profile of Boundary Plasma with a Low Recycling Wall

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Reduction of wall recycling by, for example, a flowing liquid surface at the divertor and first wall, holds the promise of accessing the distinct tokamak reactor operational mode with boundary plasmas of high temperature and low density. Earlier work has indicated that such a boundary plasma would reduce the temperature gradient across the entire plasma and hence remove the primary micro-instability drive responsibly for anomalous particle and energy transport. Here we present a systematic study solving the kinetic equations both analytically and numerically, with and without Coulomb collision. The distinct roles of magnetic field strength modulation and the ambipolar electric field on the electron and ion distribution functions are clarified. The resulting behavior on plasma profile and parallel heat flux, which are often surprising and counter the expectations from the collisional fluid models, on which previous work were based, are explained both intuitively and with a contrast between analytical calculation and numerical simulations.

The transport-induced plasma instabilities, and their essential role in maintaining ambipolarity, are clarified, along with the subtle effect of Coulomb collision on electron temperature and wall potential as small but finite collisionality is taken into account.

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