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SOLPS-ITER modelling of plasma rotation with co-rotating atoms in the Magnum-PSI beam

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SOLPS-ITER modelling of plasma rotation with co-rotating atoms in the Magnum-PSI beam.

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In the ITER divertor heat loads of 10 MWm-2 are expected in steady state. The linear plasma device Magnum-PSI [1] can achieve plasma parameters close to those expected in the ITER divertor. In particular, Magnum-PSI experiments have been made with detached plasma state. [2], a state important for the ITER-divertor by reducing heat and particle fluxes. With easier access for some plasma diagnostics in Magnum-PSI than in tokamak divertors, it is attractive to have accurate simulations of both linear and divertor plasmas with the same numerical models. The goal is to learn from the linear plasma simulations more about the atomic and molecular processes, such as reactions and excitations, relevant in detachment.

SOLPS-ITER [3] simulations of the plasma and neutral particles have been shown to be possible for the relevant regimes in Magnum-PSI [4], making use of Thomson Scattering radial profiles of electron density and temperature near the plasma source and near the target plate. The Magnum-PSI plasma source can generate significant currents throughout the plasma beam which impact the discharge through Ohmic heating. This work presents improved calculations of these currents in SOLPS-ITER by including the rotation velocity of the neutral atoms as a consequence of friction with the plasma, which rotates mainly through the ExB drift. This component of the plasma velocity, being in the ignorable (symmetry) direction and perpendicular to the magnetic field, in the standard SOLPS-ITER code is not passed on from the plasma model (B2.5) to the neutrals model (EIRENE). Including this interaction, we find that, typically, the average rotation speed of the neutral atom population is about half of the plasma rotation velocity. This co-rotation affects the entire plasma beam in two ways: by somewhat reducing the neutral density in the plasma beam centrifugally, and by reducing the radial electric resistivity through friction between the ions and neutrals.

Each simulation uses one profile of the radial electric field near the plasma source as boundary condition. This profile is based on spectroscopic measurement of the H-atom rotation velocity on 30 parallel lines of sight, using some assumptions about the kinetic neutral particle velocity distribution. This paper will verify those assumptions using information about the neutral particle velocity distribution extracted from EIRENE in a limited number of plasma locations.

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