# Momentum transport by neutrals: effect of kinetic coupling

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Neutral particles play an important role in tokamak edge plasmas, influencing edge flow shear and the L-H transition. Through a series of charge exchange interactions, edge neutrals result in a non-negligible population of hot neutrals inside the separatrix. We investigate the effect of this population on the transport of toroidal angular momentum: it dominates the neoclassical flux carried by the bulk even at low relative neutral density.

Codes conventionally used to model the behaviour of neutrals couple to a drifting-Maxwellian bulk plasma [1]. In contrast it has been shown analytically [2] that non-Maxwellian moments of the bulk distribution function can induce a significant radial flux of toroidal angular momentum through neutrals. We therefore couple a solution of the neutral kinetic equation to numerical solutions from PERFECT [3] of the bulk drift-kinetic equation, thus avoiding the restriction to asymptotic collisionality regimes of the analytical solutions. A simplified (Krook) charge-exchange operator makes full coupling of kinetic ions and kinetic neutrals tractable.

Including the full kinetic ion distribution function is crucial in cases with low external momentum input, allowing the neutrals to regulate the flow, driving as well as damping it. We have quantified this in the limit of the short mean-free-path regime of the neutrals, explicitly exploring the impact of flux surface shaping and X-point position. We have also modelled an ASDEX Upgrade L-mode discharge in the presence of an NBI torque, comparing the angular momentum flux driven through the neutrals under the assumption of a drifting-Maxwellian bulk and retaining fully kinetic ions. The difference observed, in the presence of the modest plasma gradients, indicates this will be an important effect in low-torque H-modes.

An extension to arbitrary neutral mean-free-path is therefore under development, using a solver based on the method of characteristics [4], which will allow modelling of neutrals in the H-mode pedestal.

## References

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