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Role of NTV particle flux in density pumpout during ELM control by RMP

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Edge localized modes (ELMs) release large bursts of heat and particle flux to the plasma facing components in tokamaks, potentially causing significant material erosion in future devices such as ITER. Externally applied three-dimensional (3D) resonant magnetic perturbations (RMP) have been experimentally demonstrated to be effective in tailoring these ELM bursts. A significant yet not well understood phenomenon is the density pumpout effect caused by the RMP field. Understanding physics mechanisms associated with density pumpout is critical to: (i) understand the ELM control itself; (ii) understand RMP induced plasma performance degradation; (iii) provide guidance to ELM control design in ITER.

This contribution reports toroidal modelling results of RMP induced density pumpout, based on a self-consistent quasi-linear model implemented into the MARS-Q code. The model combines the resistive plasma response to 3D fields, with the axi-symmetric toroidal momentum and radial particle transport equations. In particular, the radial particle flux includes contributions from that associated with neoclassical toroidal viscosity (NTV). We found that the resonant NTV particle flux, which is significantly enhanced due to Landau resonance between the applied perturbation and the precessional drifts of trapped thermal particles, provides a significant outward particle flux near the pedestal top, where the ExB rotation velocity is small or even crossing zero. Initial value simulations, lasting longer than the momentum and particle confinement times, demonstrate the important role of the NTV particle flux in causing a large fraction of density pumpout.

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Author: Dr LIU, Yueqiang (General Atomics, PO Box 85608, San Diego, CA 92186-5608, USA)

Co-authors: Dr LOARTE, Alberto (ITER Organization); Dr KIRK, Andrew (Culham Centre for Fusion Energy); Dr PAZ-SOLDAN, Carlos (General Atomics); Dr LI, Li (College of Science, Donghua University, Shanghai 201620, People's Republic of China); PIOVESAN, Paolo (Consorzio RFX); Dr NAZIKIAN, Raffi (Princeton Plasma Physics Laboratory); Dr SUTTROP, Wolfgang (Max-Planck-Institut für Plasmaphysik); Dr SUN, Youwen (Institute of Plasma Physics, Chinese Academy of Scienses)

Presenter: Dr LIU, Yueqiang (General Atomics, PO Box 85608, San Diego, CA 92186-5608, USA)

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