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Total-f gyrokinetic turbulent-neoclassical simulation of global impurity transport and its effect on the main-plasma confinement

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First-principles-based multiscale neoclassical-and-turbulent understanding of the impurity transport and its effect on the main plasma confinement is one of the most important subjects in magnetic fusion research. Seeding of impurity particles was found to improve the plasma confinement in the so-called "RI-mode"of operation [Weynants et al., Nucl. Fusion 39 (1999)]. More recently tungsten (W) impurities have been found to degrade the pedestal confinement of JET ILW H-mode plasma while a seeding of nitrogen (N) impurities reduces the degradation [Litaudon et al., 2017 Nucl. Fusion 57 (2017)]. In the present study, the total-f gyrokinetic code XGC1 [Chang et al., Phys. Rev. Lett. 118 (2017)] is used to understand the impurity transport in the whole-volume plasma and its effect on the main plasma confinement.

Recent total-f simulation by XGC1 [Kim et al., Phys. Plasmas 24 (2017)] showed that carbon (C) impurity can improve the main-ion confinement by reducing the ITG turbulence amplitude. In the presence of C+6 impurities, the self-organized deuteron temperature and its gradient were found to increase by up to 20

On-going research on the tungsten-nitrogen impurity transport and its impact on the H-mode pedestal in JET plasmas in realistic divertor geometry will also be presented. Starting with the impact of W-impurity on the neoclassical ExB shearing profile in a JET pedestal. Transport of the W and N particles into the central core will be included in the discussion. For whole-volume simulations, we will use new core-edge coupling technique developed in the High-fidelity Whole-Device-Modeling program of the Exascale Computing Project.

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