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P1.1029 Verification of neoclassical toroidal viscosity due to energetic particles

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The strength of neoclassical toroidal viscosity (NTV) induced by energetic particles (EPs) is investigated with DIII-D experiments and MARS-K simulations [1]. Tokamak plasma confinement is sensitive to a low level of intrinsically existing or externally applied threedimensional (3-D) magnetic field perturbations. These 3-D fields generate toroidal NTV torque which can greatly affect the plasma momentum confinement. This NTV is a result of drift kinetic non-ambipolar transport in the presence of 3D fields [2], where both thermal particles (the focus of most current research [3]) and EPs can play a contributing role. In present day tokamaks, the EP population from NBI and ICRH can contribute up to half the stored energy, and in future fusion reactors the alpha particles will take up ~15% of the plasma energy, which motivated new experiments on DIII-D to validate the NTV torque due to trapped EPs. In theory and modeling, the NTV torque due to trapped EPs is derived and computed based on the equivalence between NTV and the imaginary part of the drift kinetic energy perturbation [4]. A sophisticated DIII-D experiment, utilizing the full duty cycle neutral beam with varying injection angle and beam energy in the presence of the n=2 magnetic perturbations, measured the induced NTV from these EPs. The plasma response [5] and NTV torque are compared between the experimental measurements and MARS-K kinetic simulation, to carefully verify the existence and parametric dependence of EP induced NTV. This proof of principle experiment and model validation is the first step towards predicting the EP NTV for future devices such as ITER, where the NTV is expected to play an important role in the momentum balance. This work is supported by US DOE under DE-FC02-04ER54698, DE-AC02-09CH11466.

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