DPP11-2011-000303

Abstract for an Invited Paper
for the DPP11 Meeting of
the American Physical Society

Classical confinement and outward convection of impurity ions in the MST RFP[1]

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Impurity ion dynamics measured with simultaneous high spatial and temporal resolution reveal evidence of classical ion transport for the first time in the reversed field pinch (RFP). The boron, carbon, oxygen and aluminum impurity ion density profiles are obtained in MST using a fast, active charge-exchange recombination spectroscopy (CHERS) diagnostic. The impurity ion density profile evolution is measured during improved-confinement RFP plasmas obtained using inductive control of tearing instability to mitigate stochastic transport (PPCD technique). At the onset of the transition to improved confinement, the profiles become hollow, with a slow decay of the impurity density in the core region concurrent with an increase in impurity density in the outer region. The high electron temperature ($\sim$ 2 keV) attained with improved confinement implies that the impurities are fully stripped, and that the source is small in most of the plasma. Hence, an outward convection of impurities is implied. A hollow profile and outward convection are favorable for impurity removal in a fusion plasma. Impurity transport from Coulomb collisions in the RFP is "classical" for all collisionality cases, and analysis shows that the observed hollow profile can be explained by the classical "temperature screening" mechanism. The profiles agree well with classical expectations. "Neoclassical" corrections are small in the RFP because the safety factor is small (poloidal field dominates), even though the trapped particle fraction is similar to that in high toroidal field configurations. Experiments have also been performed with impurity pellet injection and provide further evidence for classical impurity ion confinement. This work further establishes good confinement characteristics for the RFP when tearing instabilities are suppressed.

[1]Work supported by U.S. DOE and NSF.