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EX/P3-16: Classical Confinement of Impurity Ions and NBI-born Fast Ions in the Reversed Field Pinch

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Classical behavior of two types of ions (impurity and NBI-born fast bulk) has recently been observed in the MST RFP plasma. Both have positive implications, as NBI-born fast ions (with normalized Larmor radius similar to that of fusion alphas in a reactor-sized plasma) are well confined and transfer their energy to the background plasma. Classical transport of impurities in this specific collisionality regime leads to a decrease in core impurity density thereby reducing bremsstrahlung losses in the dense core plasma. The confinement time and radial transport properties of carbon impurity ions are determined by classical theory during periods of suppressed magnetic turbulence in MST. The measured density of fully stripped carbon rapidly evolves to a hollow profile due to outward convection, consistent with the temperature screening mechanism in classical transport modeling. A confinement time is deduced from the decay of core carbon ions sourced by methane pellet injection and agrees with classical modeling. Classical behavior of NBI-born fast ions is also observed. A new 1 MW injector sources 25 kV hydrogen (and roughly 3% deuterium) atoms in the core of MST. The measured fast H distribution and time decay of beam-target neutron flux both indicate classical slowing without enhanced radial transport, even in a stochastic magnetic field. This leads to a substantial population of fast ions and has several effects on the bulk plasma including enhanced rotation, electron heating, and stabilization of the core resonant tearing mode. Beam driven instabilities in the RFP are observed for the first time, as both continuum energetic particle modes and discrete toroidal Alfven eigenmodes are excited by inverse Landau damping.

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