Understanding Kinetic Plasma Transport in Proto-MPEX Lite

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The Material Plasma Exposure eXperiment (MPEX), under development at Oak Ridge National Laboratory (ORNL), is a steady-state linear plasma device designed to investigate plasma–material interactions under fusion-relevant conditions. To address remaining physics questions following the decommissioning of Proto-MPEX, a simplified facility, Proto-MPEX Lite, was constructed without the RF heating chambers. Previous studies of Proto-MPEX showed that resonance heating generated a temperature anisotropy, producing a magnetic mirror force that led to a significant reduction in plasma density at the target. In this work, the Particle-in-Cell code PICOS++ is used to investigate how the magnetic mirror force influences kinetic plasma transport in Proto-MPEX Lite by scanning the gas puff (particle source) rate to vary plasma collisionality and the magnetic coil currents to modify the axial magnetic-field gradient. The simulations demonstrate that magnetic mirror effects become significant only under low-collisionality conditions, where pressure anisotropy is sustained, substantially affecting plasma transport to the target.