DPP16-2016-001442

Abstract for an Invited Paper
for the DPP16 Meeting of
the American Physical Society

Core Radial Electric Field and Transport in Wendelstein 7-X Plasmas

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Results from the investigation of core transport and the role of the radial electric field profile (E_r) in the first operational phase of the Wendelstein 7-X (W7-X) stellarator are presented. In stellarator plasmas, the details of the E_r profile are expected to have a strong effect on both the particle and heat fluxes. Neoclassical particle fluxes are not intrinsically ambipolar, which leads to the formation of a radial electric field that enforces ambipolarity. The radial electric field is closely related to the perpendicular plasma flow ($u_\perp$) through the force balance equation. This allows the radial electric field to be inferred from measurements of the perpendicular flow velocity from the x-ray imaging crystal spectrometer (XICS) and correlation reflectometry diagnostics. Large changes in the perpendicular rotation, on the order of $\Delta u_\perp \sim 5km/s$ ($\Delta E_r \sim 12kV/m$), have been observed within a set of experiments where the heating power was stepped down from $2MW$ to $0.6MW$. These experiments are examined in detail to explore the relationship between, heating power, response of the temperature and density profiles and the response of the radial electric field. Estimations of the core transport are based on power balance and utilize electron temperature (T_e) profiles from the ECE and Thomson scattering, electron density profiles (n_e) from interferometry and Thomson scattering, ion temperature (T_i) profiles from XICS, along with measurements of the total stored energy and radiated power. Also described are a set core impurity confinement experiments and results. Impurity confinement has been investigated through the injection of trace amount of argon impurity gas at the plasma edge in conjunction with measurements of the density of various ionization states of argon from the XICS and High Efficiency eXtreme-UV Overview Spectrometer (HEXOS) diagnostics. Finally the inferred E_r and heat flux profiles are compared to initial neoclassical calculations using measured plasma profiles.

[1]On behalf of the W7-X Team.