Electric Field-Induced Plasma Convection in Tokamak Divertors

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Measurements of the electric fields in the DIII-D tokamak divertor region are quantitatively consistent with recent computational modeling establishing that $\mathbf{E}\times\mathbf{B}_T$ circulation is the main cause of changes in divertor plasmas with the direction of $\mathbf{B}_T$.. Comprehensive two-dimensional measurements of plasma potential in the DIII–D tokamak divertor region are reported for the first time. The electric field $\mathbf{E}$ and the resulting $\mathbf{E}\times\mathbf{B}_T/B^2$ drift particle flux are calculated ($\mathbf{B}_T$ is toroidal magnetic field) for standard (anti-parallel to the plasma current $\mathbf{I}_P$) and reversed $\mathbf{B}_T$ direction and for low (L) and high (H) confinement modes. Perpendicular field strengths of up to $\mathbf{E}$~5 kV/m are observed at the separatrix between the divertor private region and the scrape-off layer (SOL). The $\mathbf{E}\times\mathbf{B}_T$ drift, which reverses with reversal of $\mathbf{B}_T$., creates a poloidal circulation pattern in the divertor that convects about 10^{22} ion/s, i.e. about 30%–40% of the total ion flow to a divertor target. The circulation strongly couples the various regions of the divertor and SOL and fuels the X-point region. An outward shift of the profiles is seen in reversed $\mathbf{B}_T$.

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