Parallel and Perpendicular Flows Associated with Stochastic Magnetic Field Driven Transport in MST

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Both parallel and perpendicular plasma flow can arise from stochastic magnetic field induced transport. Radial momentum flux due to stochastic field is defined as the correlated product of parallel ion pressure fluctuations and radial magnetic field fluctuations ($\frac{<\delta p_{//}\delta b_r>}{B}$), which can act to alter parallel plasma flow. In addition, particle transport due to stochastic magnetic field is not intrinsically ambipolar. Slight imbalance between ion flux and electron flux, referred to as charge flux ($\Gamma_q = \Gamma_i - \Gamma_e = \frac{<\delta j_{//}\delta b_r>}{eB}$), where $\delta j_{//}$ is parallel current density fluctuation, can generate a large radial electric field and $E \times B$ perpendicular flow.

In this paper, core measurements of magnetic fluctuation-induced radial momentum flux (associated with density fluctuations) and charge flux are made during magnetic reconnection events. These magnetic reconnection events are characterized by discrete sawtooth-like bursts in many high-temperature toroidal plasmas such as the Reversed Field Pinch (RFP) and tokamak. Radial momentum flux can be separated into two terms by taking $\delta p_{//} = n\delta T_{//,ion} + T_{//,ion}\delta n$, where [$T_{//,ion}\delta n$] corresponds to the convective part which is experimentally determined. A differential interferometer allows us to measure the density fluctuations and their gradient $(\delta n, \nabla\delta n)$ with high spatial resolution while Faraday rotation is used to measure core magnetic and current density fluctuations $(\delta j_{//}, \delta b_r)$. Convective radial momentum flux associated with density fluctuations acts to redistribute parallel momentum during magnetic reconnection, consistent with measured flows. Charge flux from parallel streaming is observed to burst during the sawtooth crash, reaching a maximum of 1% of the total radial particle flux. Global quasi-neutrality requires the formation of a large radial electric field and perpendicular flow. Direct measurement of electron density gradient change in the vicinity of magnetic island when $\Gamma_q \neq 0$ is consistent with formation of radial electric field and perpendicular Zonal flow.