Role of density fluctuations and fluctuation-induced transport in a stochastic magnetic field

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Magnetic reconnection is characterized by discrete sawtooth-like bursts in many finite-β toroidal plasmas such as tokamaks and the Reversed Field Pinch (RFP) where equilibrium profile relaxation is observed.. These magnetic reconnection events, which are associated with magnetic field, current density and electron density fluctuations, enhance radial transport and degrade confinement. Herein, we report on measurement of magnetic fluctuation-induced transport and zonal flow generation (resulting from perpendicular Maxwell stress) during the sawtooth crash in the core of a high-temperature RFP plasma. Density fluctuations, observed to play a key role in both particle and momentum transport, are shown to stem from both linear advection and nonlinear three-wave interactions, depending on mode number. Both the sign and amplitude of the nonlinearly-driven advection are measured in wavenumber space for the dominant core-resonant tearing modes. Measurements reveal how correlated fluctuating fields lead to changes in the equilibrium profiles. The importance of the edge-resonant m=0 mode in mediating nonlinear three-wave interactions which serve to alter the phase between density and magnetic fluctuations for maximum flux. By removing the m=0 mode resonant surface, density profile relaxation is no longer observed. Interactions between fluctuations, fluctuation-induced fluxes, zonal flows and equilibrium profile evolution are measured and discussed.