Collisionless plasma transport in stochastic magnetic fields connecting to wall boundary

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The collisionless plasma transport in static stochastic magnetic fields has been studied for understanding the mechanisms of the thermal quench in tokamak disruption using a global gyrokinetic simulation code GTS. Previous studies have mostly focused on the dynamics of the passing particles along the open magnetic field lines during the thermal quench. However, although the magnetic field lines are open to the wall boundary, we found that a significant amount of the electrons can be trapped in the device due to the magnetic mirror effect and the positive electrostatic potential produced in the stochastic layer. In this study, we present a comprehensive picture of the relation between the plasma dynamics and the 3-D topology of the stochastic layer, which is essential to understand thermal quench physics. We found that the consistent coupling of electron and ion dynamics through the ambipolar electric fields plays a critical role in determining the electron thermal energy transport. The 3-dimensional ambipolar potential builds up in the stochastic layer to keep the quasi-neutrality of the plasma during the thermal quench. The ambipolar potential produces the ExB vortices that mix the plasma across the magnetic field lines. The ExB mixing enhances a collisionless detrapping of high-$v_\perp$ electron so that the electron temperature decreases steadily in the time scale of milliseconds.