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Turbulent Equipartition and the Dynamics of Transport Barriers in Electrostatic Turbulence

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The formation of transport barriers and the related intermittent turbulent fluxes are investigated for flux driven interchange mode turbulence. Numerical simulations on a bounded domain show that the turbulence leads to an equipartition of Lagrangian invariants by mixing. The averaged equilibrium quantities approach the profiles predicted by turbulent equipartition (TEP). However, below a critical aspect ration $\alpha = L_y/L_x \approx 3.8$ large scale poloidal - so-called zonal - flows are found to develop. These flows, which are strongly sheared and often only develops in a part of the domain, quenches the turbulence and acts as effective barriers for transport and mixing. For long periods the system is very quiescent. As there is no longer sufficient mixing by the turbulence to maintain the TEP profiles, they start to steepen via the diffusive inflow of heat from the heated boundary, at the same time scale the zonal flows are damped by the viscosity. This leads to the appearance of sporadic flux bursts, which are observed to occur at somewhat random intervals. The time scale of the quiescent periods between the burst is related to the viscous time scale.