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Transport Bifurcation in Plasma Interchange Turbulence[1]

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Transport bifurcation and mean shear flow generation in plasma interchange turbulence are explored with self-consistent two-fluid simulations in a flux-driven system with both closed and open field line regions. The nonlinear evolution of interchange modes shows the presence of two confinement regimes characterized by the low and high mean flow shear. By increasing the input heat flux above a certain threshold, large-amplitude oscillations in the turbulent and mean flow energy are induced. Both clockwise and counter-clockwise types of oscillations are found before the transition to the second regime. The fluctuation energy is decisively transferred to the mean flows by large-amplitude Reynolds power as turbulent intensity increases. Consequently, a transition to the second regime occurs, in which strong mean shear flows are generated in the plasma edge. The peak of the spectrum shifts to higher wavenumbers as the large-scale turbulent eddies are suppressed by the mean shear flow. The transition back to the first regime is then triggered by decreasing the input heat flux to a level much lower than the threshold for the forward transition, showing strong hysteresis. During the back transition, the mean flow decreases as the energy transfer process is reversed. This transport bifurcation, based on a field-line-averaged 2D model, has also been reproduced in our recent 3D simulations of resistive interchange turbulence, in which the ion and electron temperatures are separated and the parallel current is involved.

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