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Effect of Resonant Magnetic Perturbations on secondary structures in Drift-Wave turbulence[1]

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In this work, we study the effects of RMPs on turbulence, flows and confinement, in the framework of two paradigmatic models, resistive ballooning and resistive drift waves. For resistive ballooning turbulence, we use 3D global numerical simulations, including RMP fields and (externally-imposed) sheared rotation profile. Without RMPs, relaxation oscillations of the pressure profile occur. With RMPs, results show that long-lived convection cells are generated by the combined effects of pressure modulation and toroidal curvature coupling. These modify the global structure of the turbulence and eliminate relaxation oscillations. This effect is due mainly to a modification of the pressure profile linked to the presence of residual magnetic island chains. Hence convection-cell generation increases for increasing $\frac{\delta B_r}{B_0}$. For RMP effect on zonal flows in drift wave turbulence, we extend the Hasegawa-Wakatani model to include RMP fields. The effect of the RMPs is to induce a linear coupling between the zonal electric field and the zonal density gradient, which drives the system to a state of electron radial force balance for large $\frac{\delta B_r}{B_0}$. Both the vorticity flux (Reynolds stress), and particle flux are modulated. We derive an extended predator prey model which couples zonal potential and density dynamics to the evolution of turbulence intensity. This model has both turbulence drive and RMP amplitude as control parameters, and predicts a novel type of transport bifurcation in the presence of RMPs. We find a novel set of system states that are similar to the Hmode-like state of the standard predator-prey model, but for which the power threshold is now a function of the RMP strength. For small RMP amplitude and low collisionality, both the ambient turbulence and zonal flow energy increase with $\frac{\delta B_r}{B_0}$. For larger RMP strength, the turbulence energy increases, but the energy of zonal flows decreases with $\frac{\delta B_r}{B_0}$, corresponding to a damping of zonal flows. At high collisionnality, zonal flow damping occurs even at small RMP amplitude. Finally, for very strong values of $\frac{\delta B_r}{B_0}$, the system bifurcates back to an Lmode-like state.

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