High- and low-confinement modes in simple magnetized toroidal plasmas

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Global fluid simulations of interchange turbulence are presented for a simple magnetized toroidal plasma, in which a vertical magnetic field superposed on a toroidal magnetic field creates helicoidal field lines with both ends terminating on the torus vessel. We consider $\beta << 1$ plasma, with $T_i << T_e$, and we study the dynamics of density, electron temperature, and potential. The simulations show the presence of two turbulent regimes characterized by low and high confinement properties. We evaluate analytically the properties of the low confinement regime, obtaining expressions for the plasma gradients and for the density and heat fluxes that agree well with the simulation results. By increasing the plasma source strength or reducing the vertical magnetic field, a transition to a high confinement regime occurs, in which a strong velocity shear limits the perpendicular transport, the peak density and temperature increase and their gradients steepen up. We present an analytic estimate of the L-H transition condition that agrees well with the simulation results.