Fluid description of ion dynamics in a toroidally confined plasma

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Abstract

Fluid equations describing ion dynamics in a toroidally confined plasma at low collision frequency are derived. The ions are assumed to be magnetized in the sense that relevant scale lengths are much longer than the ion gyroradius, and time scales of interest are assumed long compared to the ion bounce time. These assumptions are consistent with, for example, the evolution of unstable magnetic islands, as well as conventional transport. A special case of the present description is the quasistatic, axisymmetric state with nearly uniform pressure and density on flux surfaces. In that case the equations reproduce the radial ion heat transport predicted by neoclassical transport theory. The essential feature of our derivation is its emphasis on heat flow in the direction of the magnetic field.