Pinch effect and chaotic motion in toroidal confinement devices

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Particle transport in a toroidal plasma confinement device can be non-diffusive when magnetic chaos is present but the system is not too far above the stochastic threshold. In some conditions a phenomenological fit to density and impurity profiles gives a diffusion coefficient and also a pinch effect\(^1\). We show that the combination of diffusion and pinch is an expression of the subdiffusive and nonlocal nature of the transport, brought about by the existence of a spectrum of long distance Lévy flights. The effect is illustrated by numerical modelling of magnetic structure and particle transport in conditions relevant for the reversed-field pinch experiment at the Consorzio RFX. Simulations consist of guiding center calculations of particle motion in the spectrum of MHD modes given by the 3D code SpeCyl\(^2\), and in integration of the Montroll equation\(^3\) with a kernel derived from the simulations, distinguishing between trapped and passing particles. Results are relevant for other systems with chaos induced transport, e.g. electron transport in Tokamaks.

\(^1\)X. Garbet, Phys. Rev. Lett. 91, 035001 (2003), and references therein.

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