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Fractional diffusion models of non-local transport DIEGO DEL-CASTILLO-NEGRETE, Oak Ridge National Laboratory — A class of non-local models based on the use of fractional derivatives (FDs) is proposed to describe non-diffusive transport in magnetically confined plasmas. FDs are integro-differential operators that incorporate in a unified framework asymmetric non-Fickian transport, non-Markovian ("memory") effects, and non-diffusive scaling. To overcome the limitations of fractional models in unbounded domains, we use regularized FDs that allow the incorporation of finite-size domain effects, boundary conditions, and variable diffusivities. A numerical method is proposed to solve the fractional model. An anomalous fractional pinch is observed, accompanied by the development of an up-hill transport region where the "effective" diffusivity becomes negative. The fractional flux is in general asymmetric and has a component towards the core that enhances confinement and a component that increases towards the edge and leads to poor confinement. The model exhibits the anomalous scaling of the confinement time, τ, with system's size, L, $\tau \sim L^{\alpha}$, characteristic of low-confinement mode plasma where $1 < \alpha < 2$. Numerical solutions of the model with an off-axis source show that the fractional inward transport gives rise to profile peaking reminiscent of what is observed in tokamak discharges with auxiliary off-axis heating. Also, cold-pulse perturbations to steady sates in the model exhibit fast, non- diffusive propagation phenomena that resemble perturbative experiments.

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