Nonlocal transport and fast pulse propagation

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Perturbative experiments have proved to be a very useful tool in the study of transport in fusion plasmas. The main idea of these experiments is to follow the transient response of the plasma to externally applied small perturbations, e.g. plasma edge cooling and heating power modulation. These experiments provide valuable time dependent transport information in a relatively controlled setting that can be used for validating and testing transport models. In the case of cold pulses, it has been observed that perturbations travel from the edge to the core at speeds significantly faster than the typical diffusive time scales raising doubts on the validity of the standard diffusion transport paradigm. The goal of this presentation is to explore the use of non-local transport models as an alternative to diffusive models in the description of fast cold pulse propagation. Following Ref.[1] we use fractional diffusion operators to model the non-local response of the plasma. These operators incorporate in a unifying framework non-locality, non-Gaussian statistics (Levy processes), non-diffusive scaling, and memory (non-Markovian) effects. As in critical gradient models, the fractional model assumes a supercritical region where transport is strongly intermittent and non-local, and a sub-critical region dominated by diffusive transport. The model incorporates finite-size boundary conditions and sources. We present numerical and analytical results on the dependence of the pulse shape and speed on the size of the supercritical region, the degree of non-locality, and the degree of spatial asymmetry in the non-local response. The role of non-locality on heat transport in the presence of heating power modulation will be also discussed.

[1] D. del-Castillo-Negrete, Phys. Plasmas **13**, 082308 (2006).