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Fractional calculus phenomenology in two-dimensional plasma models KYLE GUSTAFSON, Univ. of MD, Dept. of Physics, DIEGO DEL CASTILLO NEGRETE, ORNL, BILL DORLAND, Univ. of MD, Dept. of Physics — Transport processes in confined plasmas for fusion experiments, such as ITER, are not well-understood at the basic level of fully nonlinear, three-dimensional kinetic physics. Turbulent transport is invoked to describe the observed levels in tokamaks, which are orders of magnitude greater than the theoretical predictions. Recent results show the ability of a non-diffusive transport model to describe numerical observations of turbulent transport. For example, resistive MHD modeling of tracer particle transport in pressure-gradient driven turbulence for a three-dimensional plasma reveals that the superdiffusive ($\sigma^2 \sim t^\alpha$ where $\alpha > 1$) radial transport in this system is described quantitatively by a fractional diffusion equation [1]. Fractional calculus is a generalization involving integro-differential operators, which naturally describe non-local behaviors. Our previous work showed the quantitative agreement of special fractional diffusion equation solutions with numerical tracer particle flows in time-dependent linearized dynamics of the Hasegawa-Mima equation (for poloidal transport in a two-dimensional cold-ion plasma). In pursuit of a fractional diffusion model for transport in a gyrokinetic plasma, we now present numerical results from tracer particle transport in the nonlinear Hasegawa-Mima equation and a planar gyrokinetic model. Finite Larmor radius effects will be discussed.

[1]D. del Castillo Negrete, et al, Phys. Rev. Lett. 94, 065003 (2005)

Kyle Gustafson
University of Maryland, Department of Physics

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