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Positivity-Preserving Algorithms for Continuum Gyrokinetic and Gyrofluid Simulations of Edge Plasma Turbulence[1] G.W. HAMMETT, J.L. PETERSON, Princeton Plasma Physics Laboratory — The steep density and temperature gradients associated with the edge and scrape off layer regions of a fusion plasma complicate the numerical simulation of plasma turbulence. Spectral methods and Arakawa finite differencing have the useful property of exactly preserving certain conservation properties of Hamiltonian systems and work well for simulating small amplitude fluctuations. However, such algorithms can exhibit Gibbs phenomena, small overshoots in the vicinity of large gradients. While these overshoots are unimportant for small amplitude turbulence in the core region of tokamaks, these algorithms can lead to negative density or temperature in the tokamak edge region. Here we consider a 2-D test case and compare several different methods of solving multi-dimensional hyperbolic equations, including modern shock-capturing algorithms such as 3rd order WENO/UNO, discontinuous Galerkin, and a recent extremum-preserving 4th order method[2], which combines features of the Piecewise-Parabolic Method and Zalesak's version of Flux-Corrected Transport.

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[2]P. Colella, M. D. Sekora, J. Comp. Phys. 227, 7069 (2008).

Gregory Hammett
Princeton Plasma Physics Laboratory

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