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Hermite expansions with hypercollisionality for velocity space degrees of freedom in ion-temperature-gradient driven instabilities[1] JOSEPH PARKER, PAUL DELLAR, University of Oxford — We study a 1+1 dimensional model for instabilities driven by ion density and temperature gradients. We use a truncated Hermite expansion in velocity space, and an iterated Fokker–Planck collision operator. This selectively damps the highest terms in the Hermite expansion, analogous to the hyperviscous dissipation used in Fourier spectral simulations of Navier–Stokes turbulence. Our approach accurately captures the full range of growing and decaying modes with only a few tens of Hermite coefficients in velocity space, and is insensitive to parameter values in the collision operator. Without hypercollisions, hundreds of Hermite coefficients are required to capture the growing modes. Decaying modes (due to Landau damping in the original kinetic equation) are completely absent without some form of collisionality, or other source of dissipation. We also derive an partial differential equation for the flow of relative entropy in Hermite space. Solutions of this equation are in excellent agreeement with computed Hermite spectra. The approach developed here extends to more general kinetic equations, and should improve the accuracy of large-scale gyrokinetic simulations, for which only modest numbers of degrees of freedom in velocity space are computationally feasible.

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