Hypocoercivity Based Local Sensitivity Analysis for Multiscale Kinetic Equations with Uncertainties

FRIDAY, February 8, 2019, at 4:00 PM
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ABSTRACT

Hypocoercivity based analysis is a powerful tool for kinetic equations which allows one to understand the regularity and long-time behavior of both linear and nonlinear kinetic equations, despite that kinetic operators are degenerately dissipative.

We extend such analysis to linear and nonlinear kinetic equations with random uncertainties in initial data or collisional kernels, which allows us to establish regularity, local sensitivity with respect to uncertain random parameters, and long-time exponential decay of the solution toward the global equilibrium in the random space, as well as spectral convergence and long-time error decay of the polynomial chaos based stochastic Galerkin methods, a popular method used for uncertainty quantification.