Funaro, Daniele; Manzini, Gianmarco

The paper analyzes the spectral method for the numerical solution of the Vlasov-Poisson system, which describes the distribution of collisionless plasma in the electrostatic limit. The method uses Hermite functions, defined as Hermite polynomials multiplied by the Gaussian function. The authors distinguish two types of Hermite functions. In dependence on the concrete Gaussian function, the functions are either symmetrically or asymmetrically weighted. This results in two definitions of stabilizing Lenard-Bernstein diffusive operators, which are both proved to be dissipative and preserve the first modes of spectral expansion. The stability is first studied for the simplified one-dimensional model, where the absolute stability in weighted norms is proven for both symmetric and antisymmetric basis functions, and it is shown that the main conservation properties are maintained. Then, the results are partly extended to the complete nonlinear Vlasov-Poisson system.

Reviewer: Dana Černá (Liberec)

MSC:
65M70 Spectral, collocation and related methods for initial value and initial-boundary value problems involving PDEs
65M06 Finite difference methods for initial value and initial-boundary value problems involving PDEs
65N35 Spectral, collocation and related methods for boundary value problems involving PDEs
65M12 Stability and convergence of numerical methods for initial value and initial-boundary value problems involving PDEs
33C45 Orthogonal polynomials and functions of hypergeometric type (Jacobi, Laguerre, Hermite, Askey scheme, etc.)
78A30 Electro- and magnetostatics
82D10 Statistical mechanics of plasmas
35Q60 PDEs in connection with optics and electromagnetic theory
35Q83 Vlasov equations

Keywords:
Vlasov equation; Vlasov-Poisson system; spectral methods; conservation laws; Hermite polynomials

Software:
SpectralPlasmaSolver

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References:


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