Numerical Stability of Hermite moments system coupled to the Poisson equation.

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We are interested in the stability analysis of several numerical schemes for a linear transport system derived from the Hermitian moments of the Vlasov equation coupled to Poisson equation. This arises naturally in kinetic models for charges species in plasma dynamics. In such models, the accurate treatment of wave-particle interactions and collective effects is crucial, as numerical instabilities may lead to non-physical growth (or decay) of electric energy or spurious oscillations.
More precisely, we investigate how the coupling with the electric field through the Poisson equation should be taken into account at the discrete level. This coupling presents a major source of stiffness and strongly constrains the choice of discretization. While explicit treatment are attractive from a computational cost perspective, they may result in great stability restrictions on the time step or even unconditional instability.
In this context, Fabre [1] proved in the case of the isothermal Euler-Poisson system that the electric field requires an implicit integration to get a stable numerical scheme. Our goal is to extend this study to the Hermitian moments framework, and to adapt the balance between numerical stability, physical fidelity, and computational cost when using schemes for plasma simulations.

[1] S. Fabre. *Stability analysis of the euler-poisson equations.* Journal of Computational Physics, **101(2)**, 445–451, 1992. doi :https ://doi.org/10.1016/0021-9991(92)90020-Y.

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