Six-dimensional Adaptive Hierarchical Basis for Vlasov Equations

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Interpolatory hierarchical bases [2] have been used in two-dimensional adaptive Vlasov simulations with a semi-lagrangian method [1]. Here we propose an insight to higher dimensional simulations, in four and six dimensions of the phase space, with a finite difference method. Interpolets naturally associates to finite differences through point evaluation of the distribution function. It provides simple and efficient AMR schemes adpated to moderately smooth solutions. We present tests for the two-dimensional Landau damping, for the two- and four-dimensional two stream instability and for the six-dimensional collision of two Plummer spheres in astrophysics. The C implementation, parallelized with OpenMP, relies on a tree structure –usual in AMR schemes [4]– coupled to a system of flags for the point activation [3]. Associating these technics lightens the memory share of the AMR encoding, speeds the computations up and allows an encoding in high (four and six) dimensions.
The grid dynamically refines during the simulation of the six-dimensional Vlasov-Poisson equations. In the hierarchical basis expansion only the most significant coefficients are retained. This allows considerable savings in terms of computational time and memory usage and to favorably compare to a GADGET N-body simulation.

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