Mathematical Physics

Linear theory and violent relaxation in long-range systems: a test case

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In this article, several aspects of the dynamics of a toy model for longrange Hamiltonian systems are tackled focusing on linearly unstable unmagnetized (i.e. force-free) cold equilibria states of the Hamiltonian Mean Field (HMF). For special cases, exact finite-N linear growth rates have been exhibited, including, in some spatially inhomogeneous case, finite-N corrections. A random matrix approach is then proposed to estimate the finite-N growth rate for some random initial states. Within the continuous, $N \rightarrow \infty$, approach, the growth rates are finally derived without restricting to spatially homogeneous cases. All the numerical simulations show a very good agreement with the different theoretical predictions. Then, these linear results are used to discuss the large-time nonlinear evolution. A simple criterion is proposed to measure the ability of the system to undergo a violent relaxation that transports it in the vicinity of the equilibrium state within some linear e-folding times.

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