World Academy of Science, Engineering and Technology
International Journal of Physical and Mathematical Sciences
Vol:12, No:06, 2018

Quasistationary States and Mean Field Model

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Abstract : Systems with long-range interactions are very common in nature. They are observed from the atomic scale to the astronomical scale and exhibit anomalies, such as inequivalence of ensembles, negative heat capacity, ergodicity breaking, nonequilibrium phase transitions, quasistationary states, and anomalous diffusion. These anomalies are exacerbated when special initial conditions are imposed; in particular, we use the so-called water bag initial conditions that stand for a uniform distribution. Several theoretical and practical implications are discussed here. A potential energy inspired by dipole-dipole interactions is proposed to build the dipole-type Hamiltonian mean-field model. As expected, the dynamics is novel and general to the behavior of systems with long-range interactions, which is obtained through molecular dynamics technique. Two plateaus sequentially emerge before arriving at equilibrium, which are corresponding to two different quasistationary states. The first plateau is a type of quasistationary state the lifetime of which depends on a power law of N and the second plateau seems to be a true quasistationary state as reported in the literature. The general behavior of the model according to its dynamics and thermodynamics is described. Using numerical simulation we characterize the mean kinetic energy, caloric curve, and the diffusion law through the mean square of displacement. The present challenge is to characterize the distributions in phase space. Certainly, the equilibrium state is well characterized by the Gaussian distribution, but quasistationary states in general depart from any Gaussian function.

Keywords : dipole-type interactions, dynamics and thermodynamics, mean field model, quasistationary states
Conference Title : ICCP 2018 : International Conference on Computational Physics
Conference Location : Dubai, United Arab Emirates
Conference Dates : June 21-22, 2018