Ideal gas approximation for a two-dimensional rarefied gas under Kawasaki dynamics

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Abstract

In this paper we consider a two-dimensional lattice gas under Kawasaki dynamics, i.e., particles hop around randomly subject to hard-core repulsion and nearest-neighbor attraction. We show that, at fixed temperature and in the limit as the particle density tends to zero, such a gas evolves in a way that is close to an ideal gas, where particles have no interaction. In particular, we prove three theorems showing that particle trajectories are non-superdiffusive and have a diffusive spread-out property. We also consider the situation where the temperature and the particle density tend to zero simultaneously and focus on three regimes corresponding to the stable, the metastable and the unstable gas, respectively.

Our results are formulated in the more general context of systems of "quasi random walks", of which we show that the lattice gas under Kawasaki dynamics is an example. We are able to deal with a large class of initial conditions having no anomalous concentration of particles and with time horizons that are much larger than the typical particle collision time. The results will be used in two forthcoming papers, dealing with metastable behavior of the two-dimensional lattice gas in large volumes at low temperature and low density.

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