Liquid-Hexatic-Solid phases in active and passive Brownian particles determined by stochastic birth-death events

Alejandro Almodóvar, Tobias Galla, and Cristóbal López
IFISC, Instituto de Física Interdisciplinar y Sistemas Complejos (CSIC-UIB),
Campus Universitat de les Illes Balears, E-07122 Palma de Mallorca, Spain

We study the structural phases of a system of active or passive finite-size particles undergoing Brownian motion subject to volume exclusion. As a new ingredient we introduce stochastic reproduction and removal processes. The system of passive particles is hence also out-of-equilibrium even if forces between particles derive from a potential. The number of particles in the system at long times depends on the birth and death rates, and on the activity parameter. Thus, as these rates are varied we find liquid, hexatic or solid phases. For passive particles we find these phases to be spatially homogeneous. The system shows similar behaviour when the self-propulsion velocity is non-zero but small compared to temperature. However, for larger activity and sufficiently small birth rates motility-induced phase separation (MIPS) is observed. The solid and liquid phases then coexist. When the birth rate increases further, a hexatic phase is the only one reached; this comes from a balance of more particles filling the system, but also a larger number of defects due to demography.