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Phase transitions in programmable active matter

We consider stochastic solutions to problems arising from programmable active matter based on emergent phenomena. We view active matter as a collection of simple computational elements (or particles) with limited memory that self-organize to solve system-wide problems of movement, configuration, and coordination. First, we present a solution to the compression problem, which aims to have the particle system gather as tightly together as possible through a distributed, local, and asynchronous algorithms. We assume the geometric amoebot model and show that we can achieve compression whenever we start with a particle system that is simply connected. We also present a stochastic solution to the separation problem, in which heterogenous (colored) particles interact initially without bias, but separate into homogeneous clusters in the presence of new environmental conditions.