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Part of MT2 Kinetic Descriptions of Multiscale Phenomena in Collective Dynamics
Kinetic Descriptions of Multiscale Phenomena in Collective Dynamics

Abstract. We begin our discussion with a series of prototype models for self-propelled collective dynamics encountered in human and mobile networks and in biological organisms, such as opinion dynamics, flocking, swarming, and bacterial self-organization driven by chemotaxis and phototaxis. The dynamics of such systems is governed solely by interactions among individuals or "agents', with the tendency to adjust to their environmental averages through finite repulsion, alignment and attraction. This, in turn, leads to the emergence of clusters, such as colonies of bacteria, flocks of birds, parties of people, etc. Natural questions which arise in this context are to understand when and how clusters emerge and what type of "rules of engagement" influence the formation of such clusters. Of particular interest to us are cases in which the self-organized behavior tends to concentrate into one cluster, reflecting a consensus of opinions or concentration of other positions intrinsic to the dynamics. Kinetic descriptions provide a particularly effective framework for studying the emergence of such macroscopic clusters. We will give a concise overview on the passage from agent-based models to a mean-field limit, and show how the overall methodology carries over to a kinetic description and thereby can be cast into hydrodynamic equations. Questions which arise in this context include pattern formation, their phase transition, equilibrium and its (meta-)stability.

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