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On some kinetic models of swarming

We will present a kinetic theory for swarming systems of interacting, self-propelled discrete particles. Starting from the the particle model, one can construct solutions to a kinetic equation for the single particle probability distribution function using distances between measures. Moreover, I will introduce related macroscopic hydrodynamic equations. General solutions include flocks of constant density and fixed velocity and other non-trivial morphologies such as compactly supported rotating mills. The kinetic theory approach leads us to the identification of macroscopic structures otherwise not recognized as solutions of the hydrodynamic equations, such as double mills of two superimposed flows. I will also present and analyse the asymptotic behavior of solutions of the continuous kinetic version of flocking by Cucker and Smale, which describes the collective behavior of an ensemble of organisms, animals or devices. This kinetic version introduced in Ha and Tadmor is obtained from a particle model. The large-time behavior of the distribution in phase space is subsequently studied by means of particle approximations and a stability property in distances between measures. A continuous analogue of the theorems of Cucker-Smale will be shown to hold for the solutions on the kinetic model. More precisely, the solutions concentrate exponentially fast their velocity to their mean while in space they will converge towards a translational flocking solution.