Interacting particle systems for swarming and their kinetic PDEs: explicit patterns and stability

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The complex behavior of animals in swarms such as fish schools and bird flocks exhibits the emergence of macroscopic patterns from seemingly local interactions. Interacting particle system and their continuum limiting PDEs provide a mathematical modeling framework for such social interactions, also frequently used in crowd dynamics, opinion formation and cell biology.
In my talk I will first discuss two simplistic hence general models based on interaction potentials - the aggregation equation and the self-propelled particle system and show some of their properties. Surprisingly, complex patterns observed in nature are already obtained with very few interactions rules. I will then present some of our recent results on the analysis of these models. First, we discuss the explicit derivation of stationary states of the kinetic and macroscopic PDEs for a particular class of potentials (the Quasi-Morse potentials). Then, we provide a nonlinear stability result for flocking states in the self-propelled particle model.

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