ABSTRACT

Phase transition and hysteresis in alignment dynamics of self-propelled Particles

Pierre Degond, Institut de Mathématiques de Toulouse
CNRS et Université Paul Sabatier

Systems of self-propelled particles interacting through local alignment provide models for various biological systems such as animal swarms, swimming bacteria colonies or self-organizing tissues during embryogenesis.

These model exhibit a competition between alignment and noise. If the relative strength of these two phenomena are varied, phase transitions from fully disordered motion to alignment order are observed. In this talk, we focus on kinetic models of such systems and provide a complete and rigorous description of these phase transitions in the spatially homogeneous case. In particular, we relate the phase transition features (number and nature of equilibria, stability, convergence rate, phase diagram, order of the phase transition, critical exponent) to the microscopic characteristics of the dynamics. In the spatially inhomogenous case, we derive macroscopic models associated to the stable equilibria and classify their hyperbolicity.