Kinetic equations and turbulence

Swarming by noisy curvature control

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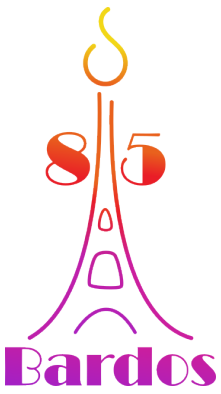
We consider a system of self-propelled agents that move at constant speed and control the curvature of their trajectories. This type of control provides a good fit to fish or bird trajectories. Trajectory control aims to attract the agents to one-another but is subject to noise. This model has been proposed in 2D by Degond & Motsch in 2011 and in 3D by Cavagna et al in 2015. Here, we aim at generalizing the model in arbitrary dimension and deriving kinetic and hydrodynamic models under convenient scaling assumptions. Because the particle velocities lie on a sphere, the model is naturally posed on the tangent bundle to the sphere which is acted upon by the orthogonal group. We derive the particle and kinetic models in this geometrical setting and use equivariance by the orthogonal group to derive expressions of the collision invariants and to ultimately formulate the associated hydrodynamic model. The latter is the so-called Self-Organized Hydrodynamics, which was first derived By Degond & Motsch in 2008 in the context of the simpler alignment dynamics proposed by Vicsek in 1995. This is a joint work with A. Diez (Kyoto) and A. Frouvelle (Paris-Dauphine).



In honor of Claude Bardos's 85th birthday