

Hydrodynamic Limit of the Kinetic Cucker-Smale Model Toward the Incompressible Euler-Alignment Model

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Abstract

We present the rigorous hydrodynamic limit of the kinetic Cucker-Smale model in the d -dimensional torus including collisions described by the nonlinear Fokker-Planck operator. We focus on the regime where collisions have large frequency and also large mean thermal velocity. The limiting system is characterized by the incompressible Euler-alignment model with weakly singular influence function. Contrarily to previous literature, where all the resulting hydrodynamic limits led to (both pressureless and pressured) compressible versions of the Euler-alignment system, we obtain incompressible alignment models for the first time in the literature. We develop a holistic method combining techniques from hydrodynamic limits for kinetic systems based on relative entropy methods for the macroscopic quantities, together with tools from incompressible limits of Euler-type systems via compensated compactness arguments. We also discuss some well-posedness results of the involved systems, with particular emphasis on the new target system.

This is based on a recent joint work with Francesco Fanelli (Basque Center for Applied Mathematics) and Gabriele Sbaiz (Università degli studi di Trieste).

References

- [1] F. Fanelli, D. Poyato, G. Sbaiz, From the kinetic Cucker-Smale model to the incompressible Euler-alignment system with weakly singular couplings. *In preparation.*