Emergence of bi-cluster flocking for the Cucker-Smale model

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Abstract

We present the asymptotic emergence of bi-cluster flocking configurations for the Cucker-Smale model with short-range communication weights for well-prepared initial configurations. We derive a system of differential inequalities for the functionals that measure the local spatial and velocity fluctuations and differences of local spatial and velocity averages. We then derive the upper bound of spatial fluctuations and the lower bound of the difference between local velocity averages. We explicitly present an admissible class of initial configurations leading to the asymptotic emergence of bi-flocking configurations. Unlike global flocking (a mono-flocking configuration in velocity), where the convergence rate is always exponential, the asymptotic convergence to bi-flocking configurations is affected by the far-field decay rate of communication weights. Over a short period of time, the local velocity fluctuations relax to local average velocities. Then, in the long-time scale, the local average velocities converge to their asymptotic value for the rate of the Cucker-Smale communication weight.

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