Gaussian theory for spatially distributed self-propelled particles

H. Seyed-Allaei[1], L. Schimansky-Geier[2], M. Ejtehadi[1]

[1]Sharif University of Technology

[2]Humboldt University of Berlin

The collective behavior of active matters, e.g. colony of micro swimmers and flocks of birds is modeled with self-propelled particles. It is evident that a continuum description of such systems is useful in determining the collective behavior in large scales. One can make continuum equations in active matter with the help of symmetry arguments. However, the equation is in a phenomenological level with undetermined transport coefficients.

It is possible to construct the continuum equations from microscopic rules to find the transport coefficients in terms of microscopic parameters with approximations. One of the usual approximations called truncation method is to truncate the Fourier series of the orientation distribution of the particles. The truncation method gives a reasonable description of ordered to disordered transition. Nevertheless, in low ordered truncation approximation, the resulting transport coefficients are not correct in low noise limit.

In this presentation, we are going to introduce another technique in obtaining transport coefficients from microscopic rules. In this technique the distribution of the particles orientations is approximated by a wrapped Gaussian distribution function. This assumption, let us to derive the continuum equations from Fokker-Planck equations. The resulting continuum equations describe qualitatively all features of the system in all range of noise intensities. Therefore we can accurately describe the collective behavior of the system in low noise. Gaussian approximation is an applicable method which is easy to apply and gives astonishing accurate behavior of the system, specially in low noise intensities.

The structure of our talk is as following. First we describe the problem and its importance. Then we shortly give the general idea of the derivation of continuum equations. After that, we present the result of solving the continuum equations and we compare it with the result of particle based simulations. Finally we conclude the comparison.

[l] E. Bertin, M. Droz and G. Grég, Phys. Rev. E **74**, 022101 (2006).

[2] A. Peshkov, I. S. Aranson, E., Phys. Rev. Lett. **109**, 268701 (2012).

[3] T. Ihle, Phys. Rev. E **83**, 030901 (2011).