Flocking turbulence of microswimmers in confined domains

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We extensively study the Toner-Tu-Swift-Hohenberg model of motile active matter[1][2] by means of direct numerical simulations in a two-dimensional confined domain. By exploring the space of parameters of the model we investigate the emergence of a new state of active turbulence which occurs when the aligning interactions and the self-propulsion of the swimmers are strong.

This regime of *flocking turbulence* is characterized by a population of few strong vortices, each surrounded by an island of coherent flocking motion. The energy spectrum of flocking turbulence displays a power-law scaling with an exponent which depends weakly on the model parameters. We highlight the importance of the interplay between the Landau force and the nonlinear advection term to induce the transition from the regime of isotropic mesoscale turbulence towards flocking turbulence.

Finally, we investigate the effects of the confinement in the circular domain, showing that these effects become relevant when the radius of the domain is of the order of the correlation scale of the flow.[3]

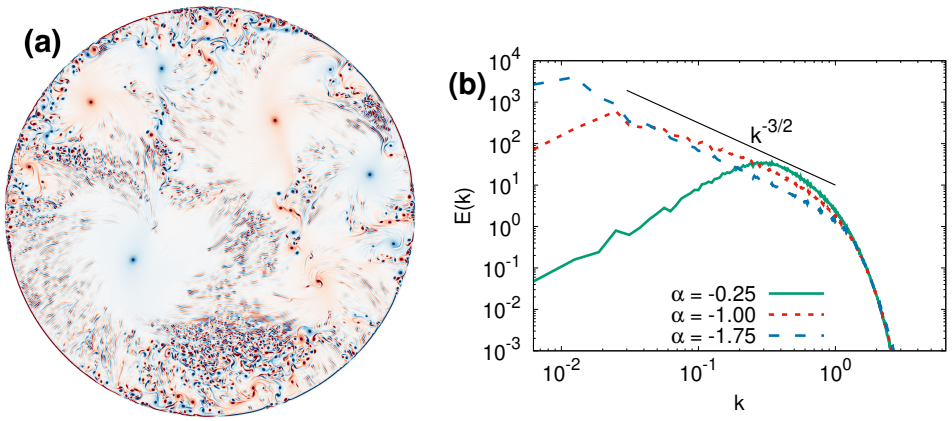

Figure 1: (a) Vorticity field in the flocking turbulence regime. (b) Kinetic energy spectra for different values of the Landau forcing coefficient α, in the regimes of mesoscale and flocking turbulence.

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[1]Wensink, H. H., et al., *Proc. Nat. Acad. Sciences* **109**, 14308 (2012).

[2]Dunkel J., et al., *Phys. Rev. Lett.* **110**, 228102 (2013)

[3]Puggioni L., et al., *arXiv preprint* 2212.11008 (2022)