A mesoscopic numerical approach to active matter

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Large collections of cell-sized particles capable of self-propulsion form so-called active fluids. We investigate the stochastic thermodynamics of these systems using the mesoscopic framework first introduced by De Groot and Mazur for Brownian motion. If used with the Local Thermodynamic Equilibrium hypothesis, this approach allows the definition of thermodynamic-like quantities on the system, governed by a set of non-linear partial differential equations. Their solution is numerically hard to obtain due to instabilities that arise when using traditional integration methods. We present the derivation of these equations in the general case of active Brownian elliptical particles in a 2D domain, subject to external force and torque. We then obtain numerical solutions with a finite difference procedure (Rosenbrok Wanner method) both for Brownian and active fluids particles. For the latter case, we show that the square mean displacement of mass density follows a superlinear trend with respect to time, uncovering a superdiffusive nature of active fluids.