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Morphology and flow patterns in active emulsions

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Active Matter has estabilished itself as a topical area in Statistical Mechanics over the last decade. Active fluid systems, in particular, are internally driven and continuosly supply energy in their surroundings. Here I present a numerical study about morphology and flow patterns in a binary mixture of a passive isotropic fluid and an active polar gel, conducted through the implementation of a LBM algorithm. The choice of parameters in the underlying free energy of our mean-field model favours the lamellar phase in the passive limit, while it leads to a range of multifarious exotic emulsions, depending both on the importance of active doping and overall concentration of the two components.

If the mixture is symmetric and the active component is contractile (e.g. an actomyosin solution), moderate activity enhances the efficiency of lamellar ordering, whereas strong activity leads to an emulsion of passive droplets within an active matrix. In a higly off-symmetric mixture with extensile minority component (e.g. microtubule bundles gel in an oil background), in the moderate active-doping regime, a hexatic array of active droplets is formed with some defects in the arrangement, while for stronger doping, a suspension of aster-like rotating domains emerges.
We find that mean kinetic energy and enstrophy can be used to mark the transition from the ordered to the disordered regime, regardless of the overall mixture composition.

Furthermore a comparison between relevant lengthscales of the structure factors of both active forces and velocity fields offers a first clue to pave the road towards a more complete characterization of active turbulence.

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