Pulsating active matter

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We propose two types of diffusive models where the internal states of particles are subject to a periodic drive. In the first model, inspired by biological tissues, the activity of dense repulsive particles drives periodic change in size [2]. We show that the competition between repulsion and synchronization triggers an instability which promotes a wealth of dynamical patterns, ranging from spiral waves to defect turbulence. In the second model, the discrete symmetry of states enforces an effective energy landscape which can counteract the drive to arrest the dynamics, and leads again to the emergence of spiral waves [3]. In both models, using analytical coarse-graining, we rationalize the emergence of dynamical patterns from the breakdown of a specific gauge invariance at the hydrodynamic level.

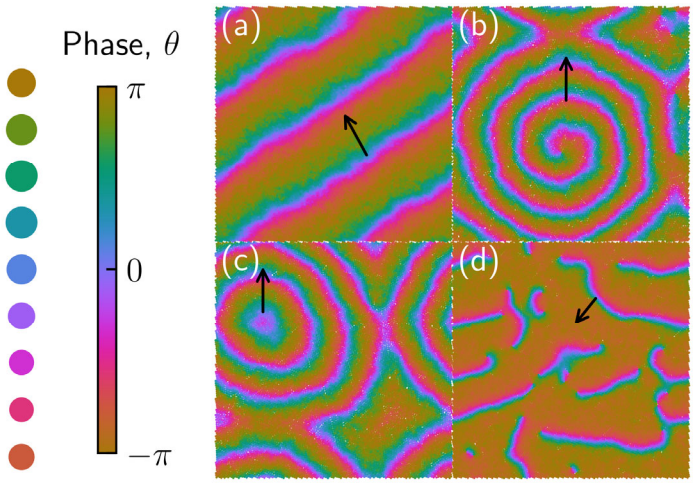

Figure 1: Repulsive particles with pulsating size yield contraction waves: (a) planar, (b) spiral, (c) circular, and (d) turbulent. Waves propagation (black arrows) stabilizes dynamical patterns reminiscent of reaction-diffusion systems [1].

[1] Y. Zhang and É. Fodor, Phys. Rev. Letters 131, 238302 (2023).
[2] A. Manacorda and É. Fodor, arXiv:2310.14370.