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The Many Behaviors of Active Droplets

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Active fluids consume fuel at the microscopic scale, converting this energy into forces that can drive macroscopic motions over scales far larger than their microscopic constituents. In some cases, the mechanisms that give rise to this phenomenon have been well characterized, and can explain experimentally observed behaviors in both bulk fluids and those confined in simple stationary geometries. More recently, active fluids have been encapsulated in viscous drops or elastic shells so as to interact with an outer environment or a deformable boundary. Such systems are not as well understood. In this work [1], we examine the behavior of droplets of an active nematic fluid. We study their linear stability about the isotropic equilibrium over a wide range of parameters, identifying regions in which different modes of instability dominate. Simulations of their full dynamics are used to identify their nonlinear behavior within each region. When a single mode dominates, the droplets behave simply: as rotors, swimmers, or extensors. When parameters are tuned so that multiple modes have nearly the same growth rate, a pantheon of modes appears, including zigzaggers, washing machines, wanderers, and pulsators. This is a collaboration with David Stein and Mike Shelley.

REFERENCES

[1] Y.-N. Young, Michael J. Shelley, and David B. Stein, The many behaviors of deformable active droplets. *Mathematical Biosciences and Engineering*, Vol. **18**, pp. 2849–2881, 2021.