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All twist and no bend makes raft edges splay

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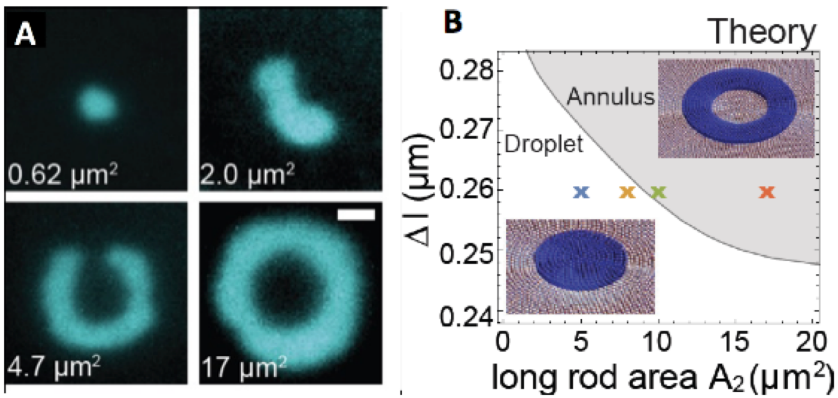
Immiscible fluids, such as oil and water, bulk phase separate leading to formation of liquid droplets. In 3D isotropic fluid mixtures droplets assume, on average, a spherical shape which minimizes the interfacial area, and thus the system free energy. Designing reconfigurable liquid droplets that adopt a broader class of non-spherical shapes remains an experimental challenge without a robust solution.

This study of liquid-liquid phase separation in a binary colloidal membrane composed of length asymmetric achiral rods demonstrates that the behavior of membrane-imbedded 2D liquid droplets is fundamentally different from their 3D bulk counterparts. Using a combination of theory and experiments, a universal geometric mechanism is developed which yields an interfacial tension between two liquids domains that selects a preferred edge curvature. Curvature-dependent interfacial tension has important consequences on the structure of membrane imbedded droplets. It selects stable finite-sized droplets independent of the constituent's chirality. It also destabilizes large circular droplets, giving rise to an array of unique non-convex and annular domain shapes.



Spontaneous curvature of domain edges in colloidal membranes. (A) Fluorescence images of long-rod rafts with increasing sizes. Increasing the area of a long-rod raft induces a shape transition from a circular droplet to elongated shapes before transforming into a horseshoe and eventually a complete annulus. **(B)** Theoretical prediction for the phase diagram of long-rod raft shapes as a function of raft area and the length difference between two rod species.

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