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Collective motion and aggregation of active inclusions on biological membranes HARISHANKAR MANIKANTAN, University of California, Davis — We study hydrodynamic aggregation of active membrane inclusions within biological membranes. The typical cell membrane is a crowded assembly of molecular motors and biomolecules embedded in a 2D fluid mosaic. Active molecular motors perform complex cellular tasks by binding, releasing, and changing conformations, inducing hydrodynamic flows in the membrane and the surrounding fluid. These long-ranged hydrodynamic fields perturb neighboring inclusions, leading to large-scale collective dynamics. We illustrate these novel flow physics by theoretically examining a pair of hydrodynamically interacting membrane inclusions. Pairs display unique oscillatory dynamics that disappear when the 3D fluid adjacent to the membrane is confined. The phase behavior of the pair problem reveals the underlying mechanisms and suggests strategies for control of large-scale aggregation. Building on these insights, we perform numerical simulations to show that bulk confinement introduces flows on the membrane that favor aggregation. Traditional engineering of foreign inclusions in membranes has targeted interactions due to capillarity, curvature and electrostatics; we propose hydrodynamic confinement as an additional controllable parameter to tune collective motility and aggregation on lipid membranes.

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