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Engineering microfluidic flow networks and probing self-organisation with light-controlled active suspensions[1] XINGTING GONG, ARNOLD JTM MATHIJSSEN, ZEV D BRYANT, MANU PRAKASH, Stanford University — The transport and self-regulation of biomolecular constituents is essential for cellular pathways but also for autonomous microfluidic devices. In Chara cells, among the longest cells in nature, this self-organisation is facilitated by motor-driven vesicles that generate large-scale flows. Here, we consider reconstituting this system with light-controlled molecular motors in order to probe the emergent properties of this active suspension, and to engineer microfluidic flow networks with optogenetic control. We model myosin-coated colloids that can bind with the surfaces of an actin-patterned microchamber, together creating an active carpet. The attached colloids generate flows that in turn can advect detached particles towards the walls, forming a feed-back loop. Switching the motor velocities with light, we perturb this feed-back and create a rich design space of flow patterns. We derive the possible mode structures and use this theory to optimise transport and chaotic mixing. Our results pave the way towards understanding and controlling active fluids.

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