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Stochastic cycle selection in active flow networks FRANCIS WOODHOUSE, University of Cambridge, ADEN FORROW, Massachusetts Institute of Technology, JOANNA FAWCETT, The University of Western Australia, JORN DUNKEL, Massachusetts Institute of Technology — Active biological flow networks pervade nature and span a wide range of scales, from arterial blood vessels and bronchial mucus transport in humans to bacterial flow through porous media or plasmodial shuttle streaming in slime molds. Despite their ubiquity, little is known about the self-organization principles that govern flow statistics in such non-equilibrium networks. By connecting concepts from lattice field theory, graph theory and transition rate theory, we show how topology controls dynamics in a generic model for actively driven flow on a network. Through theoretical and numerical analysis we identify symmetry-based rules to classify and predict the selection statistics of complex flow cycles from the network topology. Our conceptual framework is applicable to a broad class of biological and non-biological far-from-equilibrium networks, including actively controlled information flows, and establishes a new correspondence between active flow networks and generalized ice-type models.

Francis Woodhouse
University of Cambridge

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