Abstract Submitted
for the MAR16 Meeting of
The American Physical Society

Self-Pumping Active Gel. KUN-TA WU, JEAN BERNARD HISHAMUNDA, SETH FRADEN, ZVONIMIR DOGIC, Department of Physics, Brandeis University — Isotropic active gels are the network which is consist of cross-linked building blocks and the structure of which changes randomly and isotropically with time. Dogic et. al. show that pairs of anti-parallel microtubules form extensile bundles, which merge, extend, and buckle. In an unconfined system, the dynamics of these bundles causes spontaneous turbulent-like flow driven by motion of microscopic molecular motors. We found that confining these active gels in a millimeter sized toroids causes a transition into a new dynamical state characterized by circulation currents persisting for hours until ATP is depleted. We show how toroid dimensions impact the properties of self-organized circular currents, how directions of circulation can be designed by engineering ratchet-shaped boundaries, and how circulations of connected toroids can be either synchronized or antisynchronized. Furthermore, we demonstrate that the flow rate in the circulation is independent of curvature and length of flow path. The flow rate persists for centimeters without decay, disregarding conventional pipe flow resistance. Such findings pave the path to self-pumping pipe transport and performing physical work with biological system.

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Date submitted: 24 Nov 2015 Electronic form version 1.4