PHYSICAL MATHEMATICS SEMINAR

From Ceilidh dancing to meso-scale turbulence

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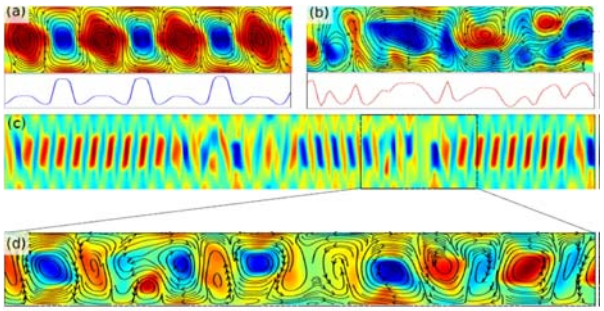
ABSTRACT:

Recent experimental work highlights the role of topological effects within active biological fluids, including intracellular filaments-protein mixtures, confluent spindle-shaped fibroblasts or myoblasts, and epithelial tissues. We shall discuss two timely issues through numerical studies of the dynamics of confined active nematics. Firstly, we will discuss the spontaneous emergence of structured and dynamic flows in confining microchannels, in conjunction with a regular motion of topological disclinations. As pairs of self-motile disclinations navigate through the channel, they continually exchange partners producing a dynamic ordered state, reminiscent of Ceilidh dancing. As a system-spanning ordered flow state, the Ceilidh dynamics state can itself possess various irregularities producing quantized drift velocities. Secondly, we shall discuss how the ordered Ceilidh dance state transitions into the irregular flow patterns of quasi-1D meso-scale turbulence. Meso-scale turbulence is an innately active phenomenon that occurs in the zero-Reynolds number limit and is distinct from inertial turbulence. Despite these fundamental differences, we find that the transition to meso-scale turbulence occurs through through the evolution of disordered patches (active puffs) from the ordered state, just as in confined inertial turbulence. Despite the fact that the Ceilidh dance state is not an ideal absorbing state, we find that the critical behavior of this transition corresponds entirely to the directed percolation universality class.

Caption: Emergence of active puffs from Ceilidh dynamics. (a) The vortex-lattice of Ceilidh dynamics with its highly ordered height-averaged enstrophy signal. (b) Fully established meso-scale turbulence is at higher activities. (c) Coexistence of the vortex-lattice and localized meso-scale turbulence domain near the critical point. The zoomed-in panel in (d) illustrates the active puff.



TUESDAY, OCTOBER 25, 2016
2:30 PM
Building 4, Room 257

Reception following in Building 2, Room 290
(Math Dept. Common Room)

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