# Self-mixing and Topological entropy in a biological active nematic

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Over the past few years, the surge of research into "active matter" systems has been one of the most important and exciting developments in soft condensed-matter physics. In an active fluid, the constituent particles are not simple passive tracers---instead the constituents consume energy and move relative to one other in a defined way. In such fluids, both local and global order can develop, persist, and evolve as the constituent particles propel themselves. This talk focuses on an active fluid with nematic order, inspired by biology. The fluid constituents are microtubules (components of the cytoskeleton) that are propelled tangent to one another via molecular motors (kinesin) powered by the consumption of ATP. Energy is thus injected on the microscale, through ATP hydrolysis, but produces unsteady laminar flow with structure on larger (millimeter) scales.

The microtubules exhibit a local nematic ordering with isolated topological defects; these defects wind around one another in a complex choreography. The net affect of the defect motion is an enhanced mixing of the fluid, which exhibits the classic stretch and fold patterns indicative of chaotic dynamics. A better understanding of this mixing mechanism could elucidate transport within the cytoskeleton and provide important insights for bioengineering and microfluidic applications, where efficient mixing in Stokes flows can be a challenge. However, despite this importance, the mixing properties of active nematic flows is understudied. Our work attempts to address this deficiency using both experiment and theory to investigate transport and mixing properties in active nematics.

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