Modeling active nematic dynamics at liquid-liquid interface

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Recent experiments have shown the possibility to adsorb a microtubule suspension to a liquid-liquid interface [1]. If the suspension contains molecular motors and ATP, the adsorbed microtubule layer becomes active, imparting novel properties to the liquid interface [2].

We introduce a model to study an active nematic absorbed at a liquid-liquid interface. We propose a free energy that accounts for the presence of two immiscible liquid phases, an adsorbed potential that confines the active liquid to the interface, and the energetic cost associated to collective microtubule alignment. We couple this free energy model to a mesoscopic computational model to describe the coupled dynamics of the microtubule concentration and the fluid flow in the two fluid phases that generate the liquid interface [3]. This coupling accounts for the active stress that the molecular motors induce in the microtubule layer. The model, based on a Lattice Boltzmann description for the solvent and a Cahn-Hilliard model for the evolution of the microtubule concentration, is dynamically consistent and allows to tackle the impact that the fluid environment has in the intrinsic dynamics of the active adsorbed layer.

We have quantified the transition from the passive state to an active steady state and the final chaotic state of the active nematics. We have developed the required tools [4] to localize and track the topological defects that are created and annihilated due activity. We have studied the dynamics of this defects and have characterized its dependence and properties on the degree of activity.

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