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Defect Dynamics in Active Nematics[1]

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In vitro suspensions of cytoskeletal filaments and motor proteins can form active fluids and gels with liquid crystalline order and self-sustained flows characterized by evolving topological defects. While in passive nematics opposite-sign defect attract and ultimately annihilate, in active liquid crystals defect pairs are continuously generated by activity. Using a continuum model of a planar active nematic in two dimensions, we have demonstrated that activity results in a turbulent-like state with a steady concentration of defect-antidefect pairs, as observed in recent experiments in suspensions of active microtubules-kinesin bundles. We have shown that these "active defects" behave as self-propelled particles with equilibrium interactions and a self-propulsion speed proportional to activity. This particle model quantitatively describes the dynamics of the four required defects in active nematics confined to the surface of vesicles that oscillate between tetrahedral and planar configurations at a tunable frequency.

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