Disclination Dynamics Revealing Collective Motions in Active Nematics

(Talk #19)

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In recent experiments on active matter, topological defects are frequently found in systems like bacterial colonies, cytoskeleton extracts on substrates, self-propelled granular or colloidal layers, but their dynamical properties and the relations to large-scale organization and fluctuations in these active systems are still not well-understood. Here through a simple model for active nematics using self-driven hard elliptic rods, we show that the excitation, annihilation, and transportation of topological defects or disclinations differ dramatically from those in non-active media. In the absence of detailed balance in active nematics, these dynamical processes exhibit strong irreversibility. Moreover, topological defects with disclination number k_d=1/2, -1/2 and 1 are the key players in organizing large-scale dynamic structures and collective flows, resulting in multi-spatial-temporal effects. These findings may open a new window that allows us to control the self-organization of active matter through topological structures, which will inspire new insights into this promising area.