PHYSICAL MATHEMATICS SEMINAR

Three-dimensional crystals and topology of knot solitons

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ABSTRACT:

Starting from Gauss, Kelvin and Skyrme, knots in fields were postulated behaving like particles, but experimentally they were found only as transient features and couldn't self-assemble into three-dimensional crystals. We introduce energetically stable knots in helical fields of chiral liquid crystals and magnets, which we call "heliknotons" [1]. While spatially localized and freely diffusing in all directions, they resemble colloidal particles and atoms, self-assembling into triclinic and other crystalline lattices with open and closed structures. These knots are robust and topologically distinct from the host medium, though in liquid crystals they can be morphed and reconfigured by weak stimuli under conditions like in displays, exhibiting giant electrostriction of the ensuing crystals. A combination of free-energy-minimizing numerical modeling and imaging uncovers the internal structure and topology of individual helical field knots and various hierarchical crystalline organizations that they form. I will discuss relations between heliknotons [1], three-dimensional skyrmions and hopfions [2,3] in both magnetic and liquid crystal systems, as well as a variety of topological solitonic crystals that they can form.

References:

1. J.-S. B. Tai and I. I. Smalyukh. "Three-dimmensional crystals of adaptive knots." *Science* **365**, 1449-1453 (2019).
2. J.-S. B. Tai and I. I. Smalyukh. "Static Hopf solitons and knotted emergent fields in solid-state chiral ferromagnetic nanostructures." *Phys Rev Lett* **121**, 187201 (2018).
3. P. J. Ackerman and I. I. Smalyukh. "Static 3D knotted solitons in fluid chiral ferromagnets and colloids." *Nature Mater* **16**, 426-432 (2017).

TUESDAY, NOVEMBER 26, 2019
2:30 PM – 3:30 PM
Building 2, Room 131

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

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