Spontaneous Crystallization of Skyrmions and Fractional Vortices in the Fast-rotating and Rapidly-quenched Spin-1 Bose-Einstein Condensates

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Topological defects are a manifestation of spontaneously broken symmetries. Formation and observation of topological defects is one of the most fundamental and fascinating topics in various aspects of physics, ranging from condensed matter physics to cosmology. However, owing to the limitation of energy scales in the earth-bound physics experiments, topological defects are mostly created and observed in the condensed matter systems. Recently, owing to the realization of spinor Bose-Einstein condensate (BEC) of alkali atoms in optical trap, the creation of topological defects in ultracold atomic systems has become possible. In this presentation, we report the spontaneous generation of crystallized topological defects via the combining effects of fast rotation and rapid thermal quench on the spin-1 BECs. By solving the stochastic projected Gross-Pitaevskii equation, we show that, when the system reaches equilibrium, a hexagonal lattice of skyrmions, and a square lattice of half-quantized vortices can be spontaneously formed in a ferromagnetic and antiferromagnetic spinor BEC, respectively.
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