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Control of periodic, quasicrystalline, and arbitrary arrays of liquid crystal defects stabilized by topological colloids and chirality[1]

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Condensed matter systems with ground-state arrays of defects range from the Abrikosov phases in superconductors, to various blue phases and twist grain boundary phases in liquid crystals, and to skyrmion lattices in chiral ferromagnets. In nematic and chiral nematic liquid crystals, which are true fluids with long-range orientational ordering of constituent anisotropic molecules, point and line defects spontaneously occur as a result of symmetry-breaking phase transitions or due to flow, but they typically annihilate with time and cannot be controlled. This lecture will discuss physical underpinnings of optically patterned and self-assembled two-dimensional arrays of long-term stable point defects and disclination loops bound together by elastic energy-minimizing twisted director structures and/or stabilized by colloids. The topological charge conservation and the interplay of topologies of genus $g > 1$ particles, fields, and defects provide robust means for controlling three-dimensional textures with arrays of optically- and electrically-reconfigurable defects. In the periodic lattices of defects, we introduce various dislocations (i.e., defects in positional ordering of defects) and use them to generate optical vortices in diffracted laser beams. The lecture will conclude with a discussion of how these findings bridge the studies of defects in condensed matter physics and optics and may enable applications in data storage, singular optics, displays, electro-optic devices, and diffraction gratings.

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