TUNABLE OPTICAL SKYRMIONS FROM LIQUID CRYSTAL STRUCTURES

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Recent advances have expanded the idea of skyrmions, topologically stable vector textures, from particle physics to optics, where optical skyrmions denote structured light fields with complex topological features. These configurations provide promising prospects for applications in topological optics, optical communications, and sensing [1]. However, their generation often relies on bulky, costly components such as spatial light modulators, creating challenges for integration and tunability.

In this work, we introduce a compact and reconfigurable method for generating optical skyrmions by utilising the spin-orbit interaction of light and self-organized anisotropic media based on nematic liquid crystals. By engineering spatial variations in the orientational order, we achieve controlled modulation of the optical axis and birefringent phase retardation allowing the conversion of uniformly polarized input beams into skyrmionic polarization textures across a broad spectral range, which extends previous works restricted to the generation of optical vortices [2,3]. The experimental observations are supported by a model that allows anticipating the development of more exotic configurations.

Our results demonstrate that self-assembled structures can serve as tunable beam-shaping elements without requiring complex fabrication [4]. External electric or thermal fields enable dynamic control over skyrmion properties, such as their topological charge and operating wavelength. This approach provides an alternative to traditional skyrmionic beam-shaping techniques, promoting practical applications and allowing on-demand control of skyrmion configurations.

References

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