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Combining spheres and spirals of light for noise free communication through optical fibre

Topology has played a significant role many areas in Physics, ranging from cosmology and condensed matter to high-energy physics and waves. In electromagnetism, one can create an optical Skyrmion through correlations between position and polarization which map from real space to the Poincaré sphere. These topological states of light can be realised in classical laser beams and biphoton entangled states, demonstrating remarkable resilience in both regimes to a wide range of perturbations and noise. This makes them a viable candidate for information encoding and transport, promising inherent robustness and a higher dimensional encoding alphabet. However, optical Skyrmions are not resilient to modal noise, currently hindering their implementation in multimode optical fibres which are necessary for the long range and high-speed transmission of information. In this work we leverage the recently discovered phenomenon of topological confinement in optical fibres for light with spiral wavefronts to greatly diminish the effects of modal noise. Our findings demonstrate the potential for Skyrmions to be transported over large, previously unreachable distances by leveraging two topological phenomena. This opens the doorway for the use of optical Skyrmions in communication networks as a means for encoding and transporting information in a manner that is robust to virtually all forms of noise.

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