

Topological links and knots of speckled light mediated by coherence singularities

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Links and knots are exotic topological structures that have garnered significant interest across multiple branches of natural sciences. Coherent links and knots, such as those constructed by phase or polarization singularities of coherent light, have been observed in various three-dimensional optical settings. However, incoherent links and knots — knotted or connected lines of coherence singularities — arise from a fundamentally different concept. They are “hidden” in the statistic properties of a randomly fluctuating field, making their presence often elusive or undetectable. Here, we theoretically construct and experimentally demonstrate such topological entities of incoherent light. By leveraging a state-of-the-art incoherent modal-decomposition scheme, we unveil incoherent topological structures from fluctuating light speckles, including Hopf links and Trefoil knots of coherence singularities that are robust against coherence and intensity fluctuations. Our work is applicable to diverse wave systems where incoherence or practical coherence is prevalent, and may pave the way for design and implementation of statistically-shaped topological structures for various applications such as high-dimensional optical information encoding and optical communications.

Short Bio:



Chengliang Zhao received his Ph.D. in Physics from Zhejiang University. He is a professor at the School of Physical Science and Technology, Soochow University, China, and serves as Vice Director of the Suzhou Key Laboratory of Intelligent Optoelectronic Perception. He has held visiting scholar and visiting professor positions at Delft University of Technology in the Netherlands. His research interests include coherent optics, diffractive imaging, phase retrieval, and optical tweezers. He has published over 120 peer-reviewed articles in journals such as *Light: Science & Applications*, *Advanced Photonics*, *Laser & Photonics Reviews*, *Photonics Research*. He also holds 24 authorized Chinese invention patents.