**Are vector vortex beams endowed with any entanglement?**

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**Abstract:**

It is generally believed that a vector vortex beam is an entangled state between polarization and spatial mode. However, that is a conclusion based on a paraxially approximate description. In the present paper we show that there is not any entanglement in a large class of representative vector vortex beams, including cylindrical-vector beams. This is achieved by developing an approach of fully characterizing the polarization of a general beam. It is found that the Stokes parameters, when generalized rigorously to a general beam in momentum space, are physical quantities with respect to the natural coordinate system. The so-called Stratton vector that determines the natural coordinate system fixes a natural representation in which the Pauli matrices to define the Stokes parameters represent the intrinsic degree of freedom of the polarization with respect to the same natural coordinate system. As a result, the Stratton vector itself appears as another degree of freedom of the polarization. When characterized in terms of these two degrees of freedom, the vector vortex beams that have a Stratton vector along the propagation axis are not endowed with any entanglement. The findings presented here pave the way towards genuine quantization of the polarization of radiation fields in free space.

**Biography:**

Chunfang Li is now a full professor of physics at Shanghai University. He joined Shanghai University as an associate professor in 1995. Before attending Shanghai University, he was a postdoctoral fellow at the University of Science and Technology of China. He received his Master Degree and Ph.D. from Xi’an Institute of Optics and Precision Mechanics of CAS. His primary research interests are in the field of optical and quantum physics. Specifically, he is interested in the polarization, spin, and orbital angular momentum of photons.