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The Vortex Phase Qubit: Generating Arbitrary, Counter-Rotating, Coherent Superpositions in Bose-Einstein Condensates via Optical Angular Momentum Beams KISHOR KAPALE, Jet Propulsion Laboratory, California Institute of Technology, JONATHAN DOWLING, Department of Physics and Astronomy, Louisiana State University — We propose a scheme for generation of arbitrary coherent superposition of vortex states in Bose-Einstein condensates (BEC) using the orbital angular momentum (OAM) states of light. We devise a scheme to generate coherent superpositions of two counter-rotating OAM states of light using known experimental techniques. We show that a specially designed Raman scheme allows transfer of the optical vortex superposition state onto an initially non-rotating BEC. This creates an arbitrary and coherent superposition of a vortex and anti-vortex pair in the BEC. The ideas presented here could be extended to generate entangled vortex states, design memories for the OAM states of light, and perform other quantum information tasks.

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