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Controlled generation of higher-order Poincaré sphere beams from a laser

Naidoo D
Roux FS
Dudley A
Litvin I
Piccirillo B
Marrucci L
Forbes A

ABSTRACT:

The angular momentum of light can be described by positions on a higher-order Poincaré sphere, where superpositions of spin and orbital angular momentum states give rise to laser beams that have many applications, from microscopy to materials processing. Many techniques exist to create such beams but none so far allow their creation at the source. Here we report on a new class of laser that is able to generate all states on the higher-order Poincaré sphere. We exploit geometric phase control inside a laser cavity to map polarization to orbital angular momentum, demonstrating that the orbital angular momentum degeneracy of a standard laser cavity may be broken, producing pure orbital angular momentum beams, and that generalized vector vortex beams may be created with high purity at the source. This work paves the way to new lasers for structured light based on intracavity geometric phase control.