



Colloquium

Realization of large-angular-momentum resonant geometric modes with external mode converter in off-axis pumped solid state lasers

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Abstract :

Singular optics explores phase and polarization singularities in optical waves, offering transformative capabilities in single-molecule spectroscopy, nanoscale optical manipulation, and particle acceleration. A paraxial cylindrical beam endowed with an azimuthal phase factor of $\exp(i\ell\phi)$ carries a discrete orbital angular momentum (OAM) of $\ell\hbar$ per photon along its propagation direction. Due to their helical wavefronts, optical vortex beams carrying high OAM have gained significant traction in optical trapping, light-matter interactions, optical communications, and quantum optics. Furthermore, coherent optical states can be constructed through superpositions of states with well-defined angular momentum. In this work, we investigate the generation of optical vortex beams with high angular momentum, tracing their evolution from spatial eigenmodes to resonant geometric modes. Both theoretical predictions and experimental results confirm the robust generation of structured light fields with high OAM, providing vital insights into the fundamental bridge between geometrical and wave optics.