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Recent development in vortex and LG $_{01}$-mode Ti: Sapphire laser

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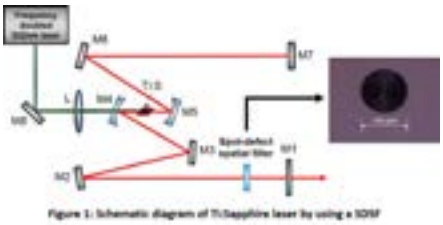
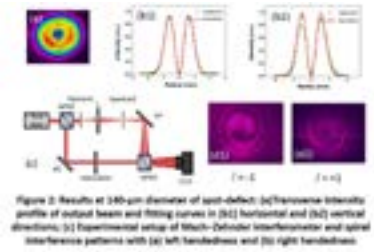
Statement of the Problem: The Laguerre- Gaussian (LG) beam is known as doughnut-shaped cross section and spiral phase wavefront. The exponential term exp(−imφ) in its amplitude expression grants an orbit angular momentum to the beam photon, and such the vortex beam on LG modes becomes valuable for numerous applications such as optical manipulation, super-resolution microscopy, quantum communication, gravitational-wave detection, etc. Presently Ti-doped sapphire laser is one of the most common types of solid-state laser, which can generate femtosecond pulses with high peak power up to terawatt or petawatt level and be used in the fields of plasma physics, ion acceleration, etc. A new and interesting line for this laser is to generate vortex laser emission, which would be undoubtedly much more valuable for various kinds of applications in fields like the strong-field laser physics, etc. Nevertheless, the concern on vortex Ti: sapphire laser is much inferior to those in Nd: YAG and Yb: YAG lasers.

Methodology & Theoretical Orientation: We fabricated several spot defect spatial filters (SDSFs) with different sizes (i.e. diameters), then inserted them into an ever-built Ti: sapphire laser. The SDSF was antireflection coated glass plate containing a laser-treated opaque region of a circular shape. By inserting the SDSF into the laser cavity, the effect of the sizes of SDSF on the transverse laser mode and laser power was analyzed.

Findings: The Ti: sapphire laser emitted vortex LG_{01} mode at proper size of SDSF and pump power. When applying a spot defect with 140-μm diameter, the power of vortex LG_{01} mode reached 135 mW and the slope efficiency of the laser was 17.7%.

Conclusion & Significance: In summary, this study reported the first vortex LG_{01}-mode Ti: sapphire laser. By using SDSF as intracavity mode selector, we demonstrated a vortex Ti: sapphire laser that emitted 800-nm and LG_{01}-mode vortex light. The next investigation will focus on the mode-locked operation of the vortex Ti: sapphire laser by applying intracavity spot defect for spatial filtering.





Biography

Jianlang Li is a Professor at Shanghai Institute of Optics and Fine Mechanics (SIOM), Chinese Academy of Sciences, and his research is in the field of Laser Sciences. He has the interest in the development of high-power vector and vortex laser. As a pioneer, he developed the first radially polarized fiber laser, and thereafter extended it to the high-power and pulsed operation. Until now, he has been playing a leading role in the field of Vector Fiber Laser. He also revealed the efficient and high-power excitation of both radial and azimuthal polarizations in solid-state laser by combining the end-pumped microchip laser geometry with the photonic crystal grating mirror. In recent years, he developed highly efficient vector and vortex solid-state laser. Most recently, He invented the maglev and optically-driven rotary disk laser.

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