Topological charge and phase gradient measurement for optical vortex beams by modifying peripheral region of forked grating on spatial light modulator

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Recently, laser measurements of plasma flow using azimuthal Doppler shift associated with the phase structure of optical vortex (OV) beams have shown steady progress, where the topological charge (TC) that determines the azimuthal phase gradient plays a crucial role [1]. Various methods have been proposed to measure the topological charge of optical vortices using interference or diffraction, but most require dedicated optical paths and additional optical elements. Here we propose a new method of topological charge determination by only replacing the peripheral region of the hologram grating used for generating OV with blazed grating.

In our experimental setup, a Gaussian beam was converted into an optical vortex beam using a fork-shaped hologram grating depicted on the spatial light modulator (SLM). Figures 1 (a) and (b) show the hologram pattern for generating TC = 20 OV beam and the resulting diffracted beam image taken by a beam profiler, respectively. A narrow donut-shaped intensity distribution, which is characteristic of higher-order optical vortex (Laguerre-Gaussian) beams, is seen. In order to visualize the phase structure of this beam, it is necessary to measure the interference pattern with a plane wave traveling through another optical path. We instead replaced the hologram pattern on the SLM from Fig. 1 (a) to (c), where the forked diffraction grating in the central part is retained, and the other parts are replaced with blazed diffraction gratings. The resulting diffraction pattern is shown in Fig. 1 (d). The bright and dark patterns are repeated 20 times in the azimuthal direction, indicating that an interference pattern between the TC = 20 OV beam and a plane wave has been obtained.

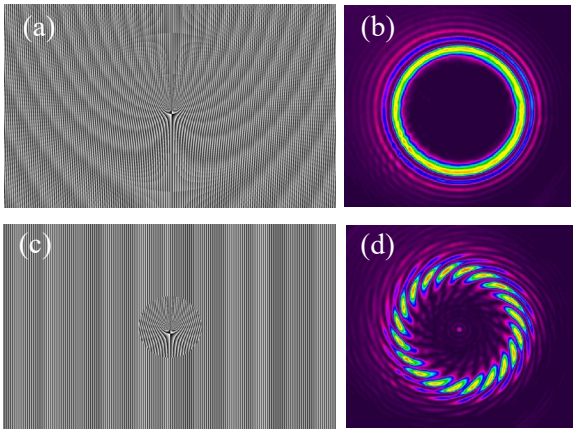

Fig. 1 (a) fork grating on SLM (b) OV with TC = 20 (c) modified fork grating on SLM (d) diffraction pattern (interference).

Details of this measurement method will be reported at the symposium, including the determination of phase gradients and the application to OV beams with asymmetric intensity distributions.

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