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Arithmetic Operations with Topological Charges of Optical Vortices Nested in Large Vortex Lattices

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Abstract. Optical vortices (OVs) are intriguing phenomena in nature that attract much attention in many areas of physics. OVs are associated with the presence of a spiral phase dislocation in the wavefront of a light beam that determines also the intensity structure of the beam. Recently it was shown that the topological charge (TC) of an optical vortex beam can be "erased" when the vortex beam diffracts from computer-generated holograms encoded with identical TC but with reversed sing. As a result a well formed Gaussian-like bright peak is observed in the far-field. Previous experiments of generation and non-linear propagation of a square and hexagonal optical vortex lattices show that if the topological charges of the vortices have identical signs, the lattice exhibits rotation. If their signs are alternative, stable propagation of the structures is observed.

Here we investigate the diffraction of a square-shaped optical vortex lattice generated by a spatial light modulator (SLM) from second identical lattice produced by a second SLM. First, for calibration purposes, we create OV with TC=-1 on the first SLM which subsequently diffracts from another OV with TC=+1 created on the second SLM. As expected, the TC of the vortex beam is erased and a well formed single peak is seen in the

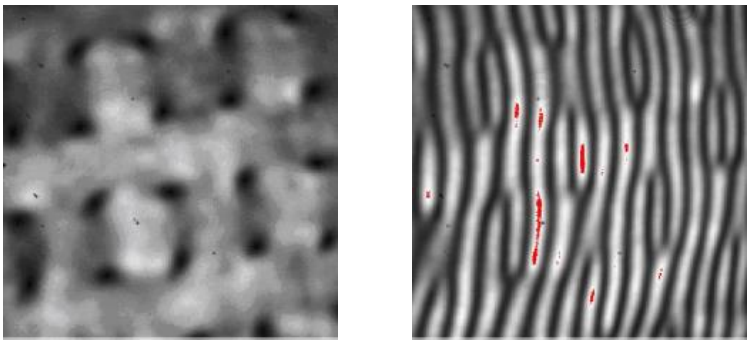

Figure 1: SLM 1 generating a square-shaped OV lattice with alternating TCs and the respective interferogram.

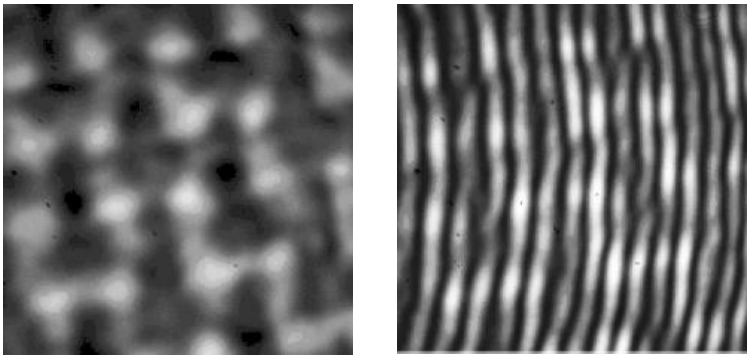

Figure 2: “Erasure” of the OV lattice after diffraction from the SLM2 encoded another vortex lattice carefully located on-site with respect to the first one.

beam waist (e.g. artificial far field). Then we create a square-shaped optical vortex lattice with alternating TCs and illuminate the second SLM encoded another square-shaped optical vortex lattice. If the TCs of the OVs are inverted with respect to the first one, we observed “erasure” of the OV lattice (see Figure 2). All frames shown in Figures 1 and 2 are recorded behind the focus in order to visualize better the location of the OVs (if present), however even more spectacular beam transformation was observed in the artificial far field. These results will be described and discussed in details.

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