Conversion circularly polarized beam shifting optical vortices with a fractional topological charges in a uniaxial crystal

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Abstract. In this work we have studied the distribution of a circularly polarized beam carrying the optical vortex with fractional topological charge equal to ½ in a uniaxial crystal. We have found that by increasing the angle of inclination of the beam relative to the optical axis of the crystal to α = 1.75 °, mixed dislocation movement observed wave front interference pattern to beam periphery. Experimental research has shown that when the angle α = 2 ° in the central region of the beam, we are seeing the emergence of "fork", optical vortex with a topological charge of the order of 1. The results show depolarization of the beam and the transition to the spin angular momentum of the orbital angular momentum. The intensity of the RCP and LCP component in the beam carrying the optical vortex with fractional topological charge oscillate. The total intensity of the beam as the sum of two orthogonally polarized components does not change.

1. Introduction

As know, at the moment, we investigate a new type of singular beams carrying optical vortices with fractional topological charges. Earlier work [1] had shown that there are four types of optical vortices with fractional topological charges: even, odd characters with opposite topological charges. The sum or difference of even and odd optical vortex with fractional topological charge, the standard form of the vortex (or vortex) beam with a topological charge of the whole order. All optical vortices with a fractional topological charges in a beam annihilated. This means that the wavelength of the optical vortex state with fractional topological charge is structurally unstable in the propagation of the beam in free space. It has been shown that the structurally stable optical vortex with fractional topological charge must be, first and foremost, a vector field with circularly polarized components having a half-order of topological charges. In addition, the medium must have a birefringent properties, which essentially forms the tensor field with fractional topological index.

The aim is to analyze the structural features of a circularly polarized beam carrying the optical vortex with fractional topological charge in a uniaxial crystal.

2. Experimental study of the conversion of a circularly polarized beam shifting optical vortices with a fractional topological charges in a uniaxial crystal

Methods of experimental studies of the structure of the singular beam is to obtain a picture of the intensity distribution of the beam and the interference pattern.

The study was conducted in the experimental plant shown in Figure 1

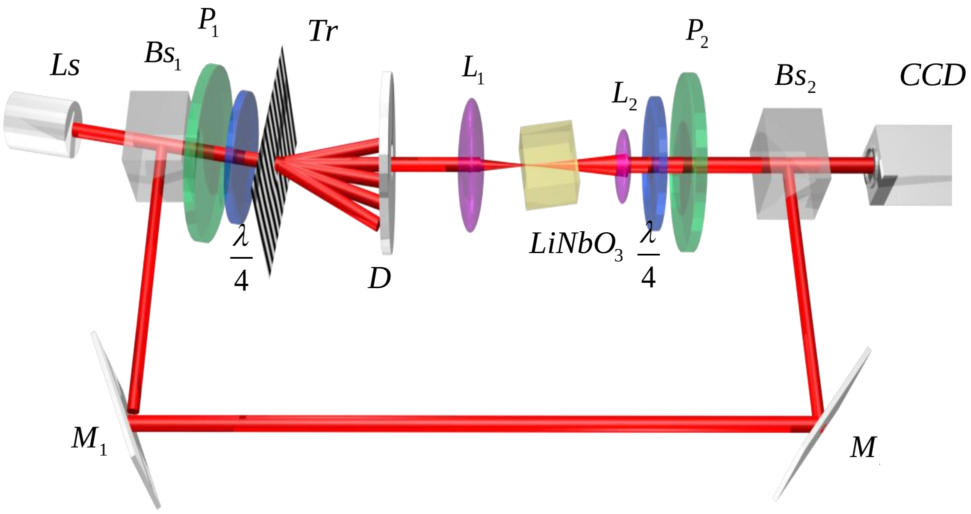
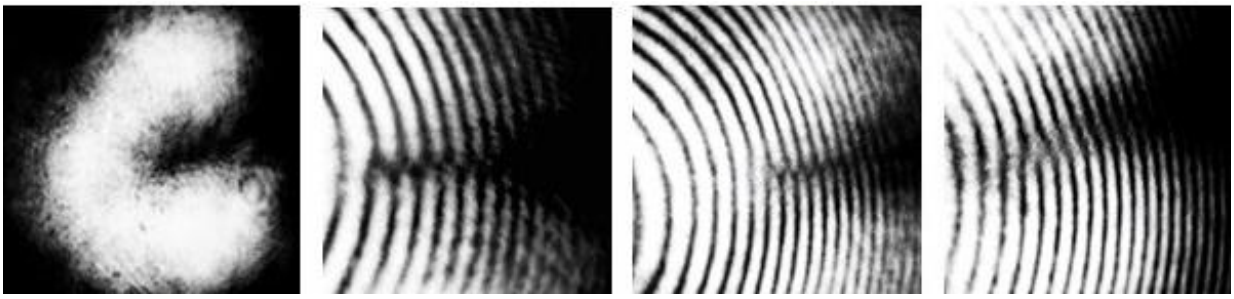


Figure 1. Experimental setup: (Ls) laser, (Bs) beam splitter, (P) a polarizer, (λ / 4) wave plate, (Tr) phase transparency, (D) aperture, (L) lens, (LiNbO3) uniaxial crystal, (M) mirror, (CCD) camera.

The experimental setup is a MachZander interferometer in which the right-circularly polarized Gaussian beam passing through a phase transparency, converted to optical vortex with fractional topological charge. The light then passes through a uniaxial crystal is placed on the progress, allowing the crystal to rotate in the horizontal plane with a pitch 0,03 °. The data recorded by a CCD camera are transmitted to a personal computer.

In the experimental study, to get a picture of the intensity distribution of interference and the right-circularly polarized beam, carrying the optical vortex with fractional topological charge equal to ½, in a uniaxial crystal, when the angle between the optical axis of the beam and the optical axis of the crystal in the range Δα = 0 01 ÷ 2 °, (Figure 2).



(a) (b) (c) (d)

Figure 2. The intensity of the (a) and interference patterns (b, c, d) a circularly polarized beam carrying the optical vortex with fractional topological charge equal to ½ in a uniaxial crystal, when the angle between the optical axis of the beam and the optical axis of the crystal (b) α = 0,75 °, (c) α =1.75°, (d) α = 2 °, with the beam waist radius w= 100 mkm and a length of the crystal z=2 cm.

Figure 2 shows that an increase in the angle of the beam relative to the optical axis of the crystal to α = 1,75 °, there is a mixed movement of wave front dislocations [2,3] in the interference pattern to the periphery of the beam. Upon reaching the angle α = 2 ° in the central region of the beam, we are seeing the emergence of "fork", i.e. optical vortex with a topological charge of the order of 1. The results show depolarization of the beam and the transition to the spin angular momentum of the orbital angular momentum.

According to the results of the experiment were the curves of the intensity $I_{\pm}$ on the angle α for the value of waist radius w= 100 mkm. This graph is shown in Figure 3.

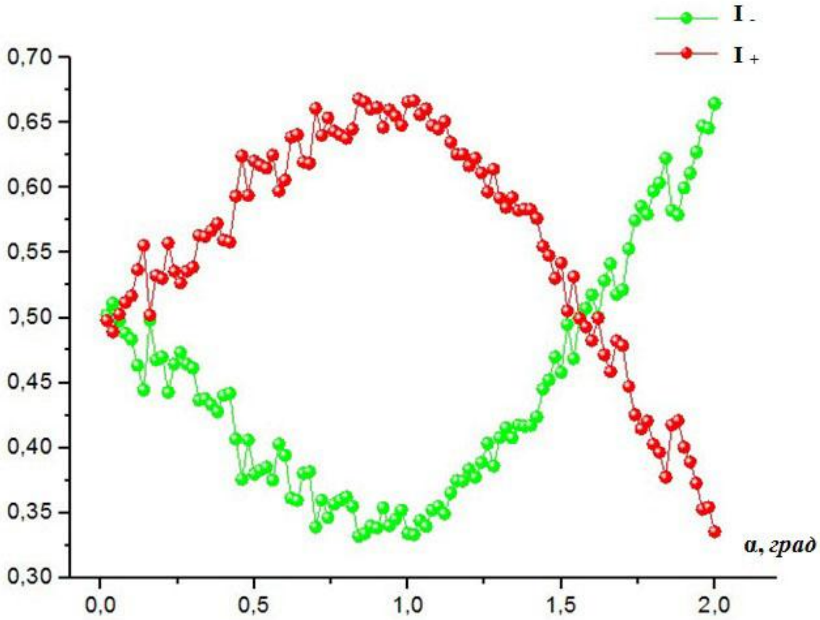


Figure 3. The intensity of the angle between the beam axis and the axis of the crystal α. I_- - the intensity of the left circularly polarized (LCP) components, I_+- the intensity of the right circularly polarized (RCP) component.

Figure 3 shows that the phase difference that occurs between the RCP and LCP orthogonal circularly polarized components of the beam, resulting in energy transfer. Since this transfer changes the value of the spin angular momentum, it is based on the spin-orbit coupling. The intensity of the RCP and LCP component in the beam carrying the optical vortex with fractional topological charge oscillate. The total intensity of the beam as the sum of two orthogonally polarized components does not change.

References

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