Polarization structure of an optical vortex beam near the unfolding point using a modified birefringent interferometer

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Abstract—In the present paper, we discuss the construction of a modified optical vortex birefringent interferometer to reconstruct the unfolding point of an optical vortex beam propagating through a birefringent crystal. The polarization structure near the unfolding point is mapped by measuring the phase difference between the eigen beams of birefringent crystal.

Keywords—Birefringent interferometer; optical vortex beam

I. Introduction

There has been an increased interest in investigating the topological transformation of the scalar singularities to the vector singularities using birefringent crystals. The spatial polarization structures have been observed at the output of a birefringent crystal [1]. However, in the aforementioned work, the polarization structures were studied at the output of a birefringent crystal with a finite length, where the two eigen-beams are well separated. The spatial polarization structure close to the unfolding point where the optical vortex beam splits into two eigen-polarizations has not been studied experimentally. To understand the effect of rotational phase structure of the OV beam on the spatial polarization structure very close to the unfolding point and very near to the optical vortex, we constructed a modified birefringent interferometer with optical vortex beam.

II. Modified Birefringent Interferometer

The birefringent interferometer (BI) consists of two identical birefringent crystals, with a half wave plate (HWP) in between [3]. Using BI, the polarization distribution at 1.7% separation relative to beam diameter between the two eigen-beams is observed. However as we approach the unfolding point, the wave front curvature coupled with the beam separation resulted in a relative tilt between the two eigen-beams. A residual beam separation of 2.5% in the vertical direction is also observed. Relatively long crystal causes the distortion in beam profile as we increase the beam diameter. To deal with these issues the experimental setup is modified. The schematic of the modified experimental setup is shown in Fig. 1.

Fig. 1. The main aim of the redesign is to place the BI well within the Rayleigh range of the beam to alleviate the curvature issue. To observe the polarization distribution in detail, magnification between the BI output and the CCD camera is also done.

The phase difference between the two eigen-beams near the unfolding point where the horizontal and vertical separations are 5.04 % (121 µm) and 1.64% (40 µm) of the input beam diameter respectively is shown in Fig. 2.

Fig. 2. Phase difference between the two eigen-beams

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References