Effect of helicity of C-point on Sign of Stokes Vortex

Sushanta Kumar Pal[1], P. Senthilkumaran[1]

[1]Department of Physics, Indian Institute of Technology Delhi, Hauz Khas, New Delhi-110016, India

E-mail: sushanta1985@gmail.com

The state of polarization of an optical field can be described by four observable parameters namely Stokes parameters (S_0 , S_1 , S_2 , S_3) [1]. Using these parameters complex fields such as $S_{12} = S_1 + iS_2$, $S_{23} = S_2 + iS_3$ and $S_{31} = S_3 + iS_1$ can be constructed. These fields are known as Stokes fields and phase distributions of these complex fields are called as Stokes phase distributions. The singularities present in these phase distributions are known as Stokes singularities [2]. The positions of the S_{ij} Stokes vortices lie at the intersections of the zero crossings of S_i and S_j . Polarization singularities such as C-points and V-points appear as phase vortices in the S_{12} Stokes field phase distributions. The x and y component singularities of an optical field can be seen as phase vortices in the S_{23} Stokes field phase distribution. These are known as Poincare vortices in the literature [3]. Similarly phase singularities of the S_{31} Stokes field correspond to component singularities of an optical field in the 45° rotated xy-coordinate system. Handedness is undefined for both S_{23} and S_{31} Stokes fields vortices. Unlike S_{12} Stokes field vortices, the S_{23} and S_{31} Stokes fields vortices possess only orbital angular momentum.

To investigate the effect of handedness of C-point on sign of Stokes vortices we have taken two examples as shown in Fig. 1. In Figure 1(a_1) a left handed (LH) C-point polarization distribution with $I_c = -3/2$ is shown and corresponding three Stokes fields phase distributions are shown in Fig. 1(b_1, c_1 and d_1). The corresponding RH C-point and its Stokes field phase distributions are shown in Fig. 1(a_2, b_2, c_2 and d_2). The experimental results corresponding to these two C-points are shown in third and fourth row respectively. It can be seen that as we change the handedness of the C-point the signs of S_{23} and S_{31} Stokes vortices inverted.

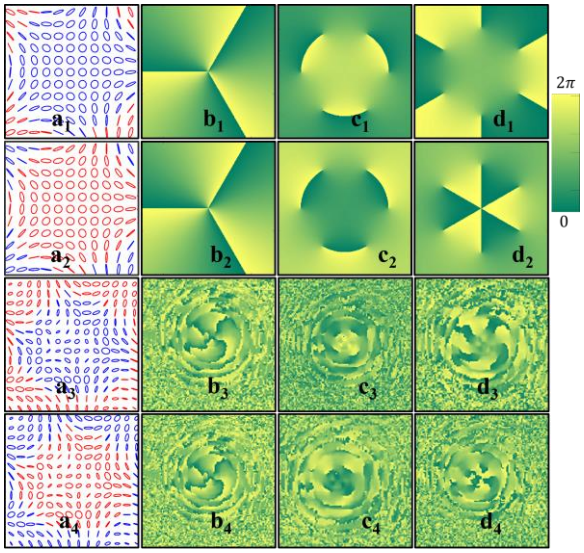

Fig. 1: Simulated polarization and Stokes fields phase distributions corresponding to a LH and a RH C-point of $I_c = -3/2$ are shown in first and second rows. Corresponding experimental results are presented in third and fourth rows.

References

[1] P. Senthilkumaran, Singularities in Physics and Engineering, 2053-2563, IOP Publishing, 2018.

[2] I. Freund, A. I. Mokhun, M. S. Soskin, O. V. Angelsky, and I. I. Mokhun, Opt. Lett. 27, 545-547, 2002.

[3] I. Freund, Opt. Lett. 26, 1996-1998, 2001.