

Vector singularity charge detection using tilted lens

Baby Komal¹, S. Deepa¹, Sunil Kumar¹ and P. Senthilkumaran¹

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

E-mail: bkomal2015@gmail.com

A scalar vortex (SV) beam due to its azimuthal dependence, $\exp(im\theta)$ comprises of orbital angular momentum (OAM) of $m\hbar$ per photon characterised by topological charge ‘m’ [1]. Vector vortex beams possess inhomogeneous polarization distribution in their spatial profile in addition to OAM thereby finding immense applications in optical communication, trapping, etc. These beams are expressed as superposition of two SV beams in orthogonal polarized states, as $\vec{E}(r, \theta) = r^m \exp(im\theta) \hat{e}_L + r^n \exp(i(n\theta + \theta_o)) \hat{e}_R$, where m and n are the topological charges, \hat{e}_L and \hat{e}_R are the left and right circular unit basis vectors and θ_o is the extra phase factor. V-point singular points are observed when $|m| = |n|$ and C-points when $|m| \neq |n|$.

The detection of the charge of SV beams have been done by studying the propagation dynamics of these beams through a tilted lens [2], [3] and measuring the OAM content by only recording the intensity distribution at a precise position where the beam of charge |m| breaks into |m|+1 intensity spots as shown in Fig. 1 (a1) and (a2). In this paper, a similar technique to detect the component topological charges of vector vortex beams using a tilted lens has been reported. This technique holds good for detection of component charges of both vector field singularity and ellipse field singularity. Fig. 1 (b1) and (b2) show the intensity distributions for V-points with $|m|=3$ and $|m|=4$ respectively. The detection of the topological charge of the C-points depends on the relative intensity of the contributing SV states [4] which is also verified through this technique.

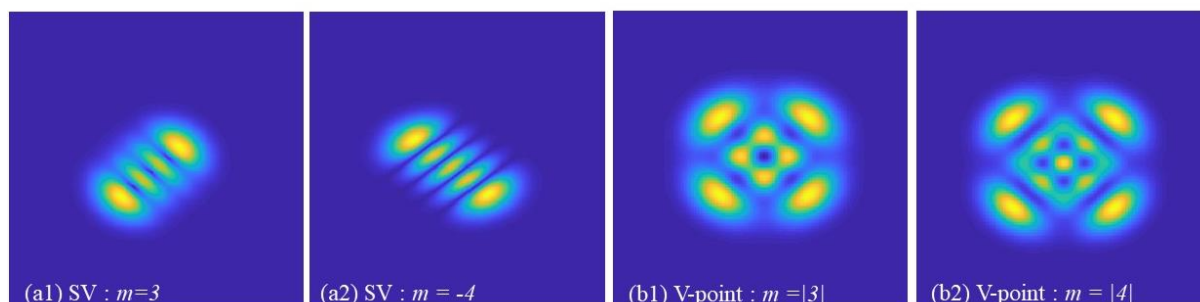


Fig.1 Simulation results: Intensity distribution for (a1) and (a2): scalar vortex beams, (b1) and (b2): V-points.

Reference:

- [1] P.Senthilkumaran, Singularities in Physics and Engineering, IOP Publishing, 2053–2563 (2018).
- [2] Pravin Vaity, J. Banerji, R.P. Singh, “Measuring the topological charge of an optical vortex by using a tilted convex lens”, Phys. Lett. A 377 (15), 1154–1156 (2013).
- [3] Meilan Luo, Zhaohui Zhang, Donghui Shen, Daomu Zhao, “Orbital angular momentum of the vortex beams through a tilted lens”, Opt. Commun. 396, 206–209 (2017).
- [4] Mariia Shutova, Alexandra A. Zhdanova, Alexei V. Sokolov, “Detection of mixed OAM states via vortex breakup”, Phys. Lett. A 381 (4), 408–412 (2017).