# Studies on orthogonal transformation of Poincaré beams due to transfer of Optical Angular Momentum

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**Abstract:** Realization of an orthogonal state of polarization of a homogeneously polarized beam is a straight forward process. However, performing an orthogonal transformation (OT) of inhomogeneously polarized Poincaré beams is not trivial. Here we study transformation of Poincaré beams when their optical angular momentum – orbital angular momentum (OAM) and spin angular momentum (SAM) content are subject to various changes. It is found that a sequential change in SAM and OAM can lead to orthogonal transformation of Poincaré beams.

## 1. Introduction

Beams with spatially varying polarization distributions across the beam cross-section have been subject of intense scrutiny in recent years [1, 2]. Such beams may host singular structures of polarization namely C-points, L-Lines or V-points [3, 4]. C-points and L-lines are found in ellipse fields, whereas V-points are found to occur in the vector fields. Due to spatial variation in the polarization distribution, the orthogonal polarization transformation (OPT) of these beams is a non-trivial process.

Co-axial superposition of orbital angular momentum (OAM) states in orthogonal spin angular momentum (SAM) states generates a beam with spatially varying polarization distribution. Termed as Poincaré beams, these are gaining wide research interests due to myriad applications. A general mathematical form of such beam can be written as

$$\psi = r^m e^{im\varphi}\hat{e}_R + r^n e^{in\varphi}\hat{e}_L \qquad (1)$$

where, $\hat{e}_R$ and $\hat{e}_L$ denote SAM states associated with orthogonal circular polarization. In the above expression, $m$ and $n$ denote topological charge of OAM beam. For C-points, $m \neq n$ whereas $m = -n$ for V-points. Here we study orthogonal transformation of Poincaré beams when their OAM and SAM content are subject to various changes. It is found that a sequential change in SAM and OAM can lead to OPT of Poincaré beams.

## 2. Orthogonal Transformation of Poincaré Beams

Realization of OPT for V-point polarization singularities is a two-step process of SAM transfer. This can be obtained by two consecutive half waveplates (HWPs) whose fast axes are oriented appropriately. Realization of an orthogonal state for ellipse fields is a non-trivial process. This is a three-step process that involves transfer of both SAM and OAM states. Transfer of an OAM state can be achieved by use of a spiral phase plate (SPP), whereas SAM transfer requires two HWPs. OPT of V-points and C-points are shown in 1(a) and 1(b) respectively.

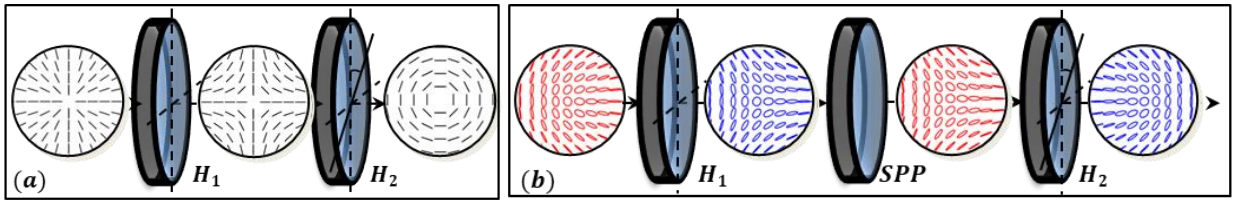


Figure 1: Orthogonal Polarization Transformation (OPT) of (a) V-points and (b) C-points. $H_1$, $H_2$ and SPP denote two half waveplates and a spiral phase plate respectively. OPT of a V-point is two-step process, whereas for C-points, it is a three-step process.

## 3. References

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