List of Responses

Dear Editors and Reviewers:

Thank you for your letter and for the reviewers’ comments concerning our manuscript entitled “All-passive Polarization Eigenstate Conjugated-Phase Components for Sorting Efficiently Vector Beams by Polarization Topological Charge” (ID: PJ-006857-2017). Those comments are all valuable and very helpful for revising and improving our paper, as well as the important guiding significance to us researches. We have studied comments carefully and have made correction which we hope meet with approval. The main corrections in the paper and the responds to the reviewer’s comments are as flowing:

Main Corrections:

1. INTRODUCTION:
   • In this part, we want to strengthen the impression of the capability of vector beam for improving the capacity of optical communications systems. Therefore, the following is added. “Recently, vector beams are also deemed available for improving the capacity of optical communications systems because the vector beam modes with different orders or polarization topological charges (PTCs) are orthogonal to each other [11-13]. In addition, the vector beam modes are the eigenmodes in an optical fiber, which have the advantages of high stability and efficiency during propagation [14, 15].”
   • And we hope the reader can realize the nature of our system, and strengthen the concept of vector beam modes can be the basis for constructing beam, the following is added. “Essentially, the OAM sorting system decompose beams by OAM basis, and our PTC sorting system decompose beams by PTC basis (i.e. vector beam modes).”

2. DESIGN PRINCIPLE OF OUR EIGENSTATE CONJUGATED COMPONENTS
   • This part is completely rewritten for explaining how the proposed sorter can work for both right and left circularly polarized beams, at least approximately.
   • First, we introduced principle of the OAM sorting system of G. Berkhout et al: convert helical phase into a linear phase gradient, and focuses each input OAM state to a different lateral position.
   • Then, we introduced principle of the PTC sorting system: convert the two helical phase with orthogonal polarization states into a same linear phase gradient by inducing opposite phase modulation for one of the two circular polarization states in vector beam modes, and focuses each input PTC basis (i.e. vector beam modes) to a different lateral position.
   • Finally, we explain how we do the job with polarization conjugated-phase component. The height profiles of the second LPCC (optical phase corrector, OPC) is changed. In the original manuscript, the OPC is available for the area \(\sqrt{x^2+y^2} > b\). And in this modified manuscript, the OPC is available for the area \(\sqrt{x^2+y^2} < b\). The reason is that, vector beam modes are the eigenmodes in an optical fiber, and the beam sizes of the modes are limited.
3. SIMULATIONS AND DISCUSSIONS

- This part is similar to the previous one, but the parameters change with $\lambda = 1550 \text{ nm}$ and $b = 10\text{ mm}$. The change in wavelength is expected to improve the impression of the system for improving the capacity of optical communications systems. The change in $b$ due to the change of OPC aforementioned.
- Because of the change in parameters, the corresponding simulation diagram has also changed, but the conclusion has not changed.

Reviewer: 1

Comments to the Author
This manuscript proposes an effective way to sort vector beams by polarization topological charge. By using two pieces of uniaxial crystal with a special thickness profile, vector beams with different phase structure can be spatially separated and detected with a 4-f system. I think the idea is novel nevertheless it was inspired by the Prof. Padgett’s work about OAM sorting. The theoretical analysis is convincing and the idea is demonstrated by simulation. I think the manuscript is above the criteria of IEEE Photonics and recommend to accept it.

Check the spelling, such as “PCT”, and typos in fig. 4: “... from -3 to -3”.

Thank you for positive comment and professional and careful reviews. We have check and corrected the spelling and typos.

Reviewer: 2

Comments to the Author
The paper by Lin Qinggang et al. deals with the theoretical design of an optical device that the authors baptized as Polarization Topological Charge Sorter. I got that such device is meant to sort topological charge and polarization components in vector beams of the kind reported in Eq. (4) in the manuscript.

Thank you. In fact, our system sort polarization Topological Charge. “Polarization topological charge (PTC) of a vector beam can be defined as the repetition number of polarization state change along the azimuthal axis, with its sign standing for the rotating direction of the polarization [11].” (This is added in modified manuscript). The Eq. (4) in original manuscript in order to explain how our system work. Sorting topological charge and polarization components in vector beams is not our aim. This opinion is derive from OAM basis. In fact, our system are derive from PTC basis (i.e. vector beam modes). This comment uncovers the deficiency on the explanations of the original manuscript: The nature of Polarization Topological Charge is not expressed clearly, and the vector beam modes can be the basis. In order to improve this issue, some effort has been made in modification.

The claim that such a device has not reported before is wrong: it was theoretically designed and experimentally demonstrated in the paper "The Polarizing Sagnac Interferometer: a tool for light orbital angular momentum sorting and spin-orbit photon processing", 20 December 2010 / Vol. 18, No. 26 / OPTICS EXPRESS 27205. However, the sorter reported in this paper operate on arbitrary
couples of topological charges, but not simultaneously on all of them. On the contrary, the sorter in Ref.[13] in the manuscript performs this job, but does not sort polarization states.

“The Polarizing Sagnac Interferometer” can be a tool for vector beam diagnose but not sorter due to the polarization sorting capability and OAM sorting capability (“The polarizing sagnac interferometer can be a tool for vector beam diagnose [16].” is add in modified manuscript). This is because the system consider OAM as basis, but not vector beam mode. So when the beam pass into the sorting system with Polarizing Sagnac Interferometers. One vector beam mode certainly come out from two port (corresponding to the two OAM state). The sorter by G. Berkhout et al. has the same problem for sorting vector beam.

In this framework, the author’s idea can be of interest. However, apart from a minor error in Eq. (2), for the expression of the phase correction, in which the parameter $b$ is missing, and a possible misunderstanding in the role played by the $|s>$ and $|p>$ states in the Eqs (7) and (8), I believe that that way the authors deduce the strategy for the operation of their sorter is really obscure, especially lines from 19 to 42 on page 3, where they attempt to explain how the proposed sorter can work for both right and left circularly polarized beams, at least approximately.

Thank you for professional comment and careful reviews. We have modified the error, and rewrite the part of DESIGN PRICINPLE OF OUR EIGENSTATE CONJUGATED COMPONENTS. We hope the modification can up to standard of the reviewer.

The following two part are explain how the proposed sorter work.

![Fig. 1. Principle difference between (a) OAM sorting and (b) PTC sorting](image-url)

If a vector beam passes into the OAM sorting system, the two OAM components are having same Cartesian to log-polar coordinate transformation, so they will all straightened on Fourier plane. Nevertheless, due to the opposite helical phase, they will be converted into opposite linear phase gradient, then two components will be split into two spots at the image plane due to their opposite topological charges, as shown in Fig. 1(a). If the optical geometric transverter can induce opposite phase modulation for one of the two polarization states. From Fourier optics, we can get that the distribution of the polarization will be rotated 180° compared with the other. After phase correction, the two states will convert into same linear phase gradient, then two states will be focused on the same location representing the polarization topological charge of the incident vector beam, as shown in Fig. 1(b). In other words, the system can decompose beams by PTC basis.”
The phase modulation by OGT for $|p\rangle$, $\psi_{pt}$ is conjugated with that for $|s\rangle$, $\psi_{st}$. $\psi_{pt}$ is the same as the phase profile of transforming element for OAM sorting [18]. Comparing to $\psi_{st}$, $\psi_{pt}$ can be considered as the parameter $a$ is replaced by $-a$. So the OGT perform different mappings $(x, y) \rightarrow (u, v)$ between $|p\rangle$ and $|s\rangle$. The mapping relations are $u = -ca \cdot \ln\left(\sqrt{x^2 + y^2}/b\right)$, $v = ca \cdot \arctan(y/x)$ where $c = 1$ for $|p\rangle$ and $-1$ for $|s\rangle$. From the mapping relations we can get the beam in area $\sqrt{x^2 + y^2} < b$, will straightened to the area $u > 0$ for $|p\rangle$ and $u < 0$ for $|s\rangle$. If the each straightened beam do not across the center horizontal line $u = 0$, then we can have a phase correction function for $|p\rangle$ at the area $u > 0$ (the same phase correction function as[18]), and phase correction function for $|s\rangle$ at the area $u < 0$ (Comparing with former, it can be considered as the parameter $a$ is replaced by $-a$). Then we can get the height profiles of OPC as Eq. (5). Different from phase correction function in the OAM detection system [18], there is adding an absolute function, and require the incident light radius shall be less than $b$ to meet the demand of straightened beam cannot be across the center horizontal line between the two area.”

There is also another point: since they use birefringent components, how do they think to manage the wavelength dependence of the refractive indices. It’s obvious that manufacturing different tailored components for each wavelength is fully unpractical. At the present stage, I cannot recommend the paper for publication.

The height profiles of OGT and OPC is:

$$h_1(x, y) = \frac{a}{(n_e - n_o)} \left[ \frac{1}{2} y \cdot \arctan \left( \frac{x}{y} \right) - x \cdot \ln \left( \sqrt{x^2 + y^2} \right) \right]$$

(4)

And

$$h_2(u, v) = -\frac{ab}{f(n_e - n_o)} \exp \left( -\frac{uv}{a} \right) \cos \left( \frac{uv}{a} \right)$$

(5)

It can be notice that in Eq.(4) and (5), if ignore the dispersion of focal length of the lens, the unique dispersion term is $n_e - n_o$ which is weak dispersion, so this system can work for converting two OAM states into same linear phase gradient broadband with achromatic lens. But the position of focal spot is dispersion due to the relation of $t = \lambda f / (2na)$ (the position is proportional to the wavelength).

The following figure shows the difference between $n_e$ and $n_o$ of $\alpha$-BBO, and the normalization with the value of 1550nm. We can see that, from 750nm~2000nm, the difference changes in $< 1\%$. 

![Graph showing the difference between n_e and n_o for alpha-BBO](image-url)
The following figure shows focal spot of the 750nm vector beams and 2000nm vector beams with different PTC input to the system for PTC sorting for 1550nm vector beams (upper: 750nm, under: 2000nm). From the figure, we can see the position is relevant to the wavelength. But the position of focal spot still represents the PTC of corresponding mode for monochromatic light incident.

The following figure shows the corresponding separation efficiency for 750nm and 2000nm (left: 750nm, right: 2000nm). The separation efficiency are about 57% for 750nm and 72% for 2000nm.

In short, the system is weak dispersion for converting two OAM states into same linear phase gradient broadband with achromatic lens, but the position of focal spot is dispersion due to the relation of $t = \frac{\lambda f}{2\pi a}$ but not the birefringent components. Our system can sort PTC for monochromatic light incident while the wavelength selection is broadband.
Polarization Conjugated-Phase Component for Sorting Efficiently Vector Beams by Polarization Topological Charge

Shuiqin Zheng1,2,#, Qinggang Lin1,#, Ying Li2, Xuanke Zeng1, Yi Cai1, Guoliang Zheng1, Dianyuan Fan2 and Shixiang Xu1,∗

1 Shenzhen Key Lab of Micro-Nano Photonic Information Technology, College of Electronic Science and Technology, Shenzhen University, Shenzhen, Guangdong 518060, People’s Republic of China.
2 SZU-NUS Collaborative Innovation Center for Optoelectronic Science & Technology, Key Laboratory of Optoelectronic Devices and Systems of Ministry of Education and Guangdong Province, Shenzhen University, Guangdong 518060, People’s Republic of China
∗Corresponding author: shxxu@szu.edu.cn

Polarization topological charge (PTC) of a vector beam can be defined as the repetition number of polarization state change along the azimuthal axis, with its sign standing for the rotating direction of the polarization. In this paper, we present a design for PTC sorting of vector beams with polarization conjugated-phase component (PCC). The components, made of birefringent crystals, can induce conjugated spatial phase modulations for the orthogonal polarizations. Our simulations show, using a pair of PCC with specific design in a 4-f optical system, the system focuses vector beam modes on the locations representing the PTC of corresponding mode, and sorts PTC with separation efficiency as high as 77%. Our designs have the potential applications in modal characterization, communication, encryption, and so on.

1. INTRODUCTION

Vector beams are modes consisting of pure laser modes with an additional spatial polarization modulation [1]. In recent years, vector beams have received a lot of attentions due to their unique properties, including the tighter focal spot and better spot shape compared with Gaussian beams [2], a focused nonzero longitudinal electric field component [3] and so on. These properties enable many applications, e.g. particle manipulation [4], microscopic imaging [4], dark-field imaging [6] and quantum teleportation [7]. Driven by the applications, many methods to generate vector beams have emerged, such as interferometer systems [8], liquid crystal devices [9] and space-variant sub-wavelength structures [10]. Recently, vector beams are also deemed available for improving the capacity of optical communications systems because the vector beam modes with different orders or polarization topological charges (PTCs) are orthogonal to each other [11-13]. In addition, the vector beam modes are the eigenmodes in an optical fiber, which have the advantages of high stability and efficiency during propagation [11-13]. However, the diagnosis of vector beams or vector beam sorting is still a hindrance that prevents the vector beams from further applications, especially optical communication. Some researchers did their effort to address this problem in recent years. The polarizing sagnac interferometer can be a tool for vector beam diagnose [16]. Non-separability of vector beams is reported for information encoding in an optical communication system [12]. Unfortunately, the design is only able to detect a single state each time, thus seems both complex and inconvenient. Vortex sensing diffraction grating encoded on a parallel-aligned LCD is also proposed for vector beam detection [17], but it only demonstrated with the radially and azimuthally polarized beams. Polarization topological charge (PTC) of a vector beam can be defined as the repetition number of polarization state change along the azimuthal axis, with its sign...
standing for the rotating direction of the polarization [11]. A PTC detection method of vector beams with a miniaturized polymer grating is proposed and demonstrated experimentally, which is possible for enabling potentially the optical fiber sensing and communication system based on vector beams [11]. However, it is unfortunate that this method is inefficiency.

In this paper, we present an efficient design of PTC sorting system of vector beam modes. The design is inspired by the efficient technique for OAM sorting by converting helical phase into a linear phase gradient [18]. Essentially, the OAM sorting system decompose beams by OAM basis, and our PTC sorting system decompose beams by PTC basis (i.e. vector beam modes). Polarization conjugated-phase component (PCC) presented in this paper, made of birefringent crystals, is an optical element introducing opposite spatial phase modulations for two orthogonal polarization states. The proposed design uses two PCCs in a 4-f optical system to convert the two opposite helical phases into the same direction plane waves, and eventually focuses them on the same location representing the PTC of the incident vector beam. Our simulation results demonstrate that the proposed design focuses vector beams with different PTCs to different lateral positions with separation efficiency as high as 77%. This capability could enable the readout of information encoded in PTCs. This work has the potential applications in encryption, optical communication, modal characterization etc.

2. DESIGN PRINCIPLE OF OUR EIGENSTATE CONJUGATED COMPONENTS

The OAM sorting system of G. Berkhout et al.[18], which consists of two optical components with a 4–f imaging system. The first one is optical geometric transverter (OGT) placing at the object plane, and the second one is optical phase corrector (OPC) at Fourier plane. The system performs a Cartesian to log-polar coordinate transformation, convert helical phase into a linear phase gradient, and focuses each input OAM state to a different lateral position , thereby realize decomposing of beams by OAM basis. However, a vector beam mode with a PTC value of \( m \) can be expressed as [18]

\[
E_{m}^{\phi_{0}} = \left( \frac{\cos(m\varphi + \varphi_{0})}{\sin(m\varphi + \varphi_{0})} \right) = \frac{1}{2} e^{i(m\varphi + \varphi_{0})\left( \frac{1}{i} \right)} + \frac{1}{2} e^{-i(m\varphi + \varphi_{0})\left( \frac{1}{i} \right)} = \frac{1}{2} |m, L\rangle + \frac{1}{2} |-m, R\rangle \tag{1}
\]

where \( \varphi_{0} \) represents the initial polarization angle, while \( \varphi \) is the azimuthal angle in polar coordinates. Eq. (1) means that a vector beam mode with a PTC of \( m \) can be decomposed into two OAM state which have two opposite topological charges of \( m \) and \(-m\) corresponding to orthogonal polarization states: the left-handed circularly polarizations \(|L\rangle\) and right-handed circularly polarizations \( |R\rangle\).

![Image](Fig. 1. Principle difference between (a) OAM sorting and (b) PTC sorting)

If a vector beam passes into the OAM sorting system, the two OAM components are having same Cartesian to log-polar coordinate transformation, so they will all straightened on Fourier plane. Nevertheless, due to the opposite helical phase, they will be converted into opposite linear phase gradient, then two components will be split into two spots at the image plane due to their opposite topological charges, as shown in Fig. 1(a). If the optical geometric transverter can induce opposite phase modulation
for one of the two polarization states. From Fourier optics, we can get that the distribution of the polarization will be rotated 180° compared with the other. After phase correction, the two states will convert into same linear phase gradient, then two states will be focused on the same location representing the polarization topological charge of the incident vector beam, as shown in Fig. 1(b). In other words, the system can decompose beams by PTC basis.

Intuitively, it can be realized by designing a kind of optical component, which induces conjugated spatial phase modulations for its two orthogonal circular polarization, called circular polarization conjugated-phase component (CPCC). Obviously, CPCC can be made by utilizing optical rotatory effect. However, we prefer to replace CPCC with the component inducing the conjugated phase for two orthogonal linear polarization (LPCC) based on optical birefringent effect. Because circular polarization is easily converted into linear polarization with a quarter wave-plate (QW), and for most of natural optical crystals, the available birefringent effect is usually much stronger than the optical rotatory from visible to near infrared region. Our LPCCs are made of two pieces of uniaxial crystals with their optical axes orthogonal with each other. As shown in Fig. 2(a), the first piece has its thickness profile by \( h(x,y) \), whereas the second has its thickness by \( d - h(x,y) \), where \( d \) is a constant. Accordingly, the phase modulation for vertical polarization \(|s⟩\) is,

\[
\phi_s = \frac{2\pi}{\lambda} \{n_oh(x,y) + n_e(d - h(x,y))\} = \frac{2\pi}{\lambda} (n_o - n_e)h(x,y) + \frac{2\pi}{\lambda} n_ed \tag{2}
\]

And the phase modulation for horizontal polarization \(|p⟩\) is,

\[
\phi_p = \frac{2\pi}{\lambda} \{n_oh(x,y) + n_o(d - h(x,y))\} = \frac{2\pi}{\lambda} (n_o - n_e)h(x,y) + \frac{2\pi}{\lambda} n_od \tag{3}
\]

where \( n_o \) or \( n_e \) is the refractive index for ordinary or extraordinary light. Obviously, in Eqs. (2) and (3), the contributing phase modulations for the two eigenstates: \( 2\pi(n_o - n_e)h(x,y)/\lambda \) and \( -2\pi(n_o - n_e)h(x,y)/\lambda \), are phase-conjugated with each other.

![Fig. 2. (a) Linear polarization conjugated-phase components and (b) schematic diagram of our PTC sorting system.](image)

According to above discussions, we can realize our PTC sorting system with the setup as Fig. 2(b), including a 4-f imaging system with one LPCC in object plane as OGT and the other LPCC in Fourier plane as OPC. A quarter-wave plate (QW) is set in front of OGT to convert the incident beam from \(|m, L⟩ + |−m, R⟩\) to \(|m, p⟩ + |−m, s⟩\). Correspondingly, the height profiles of OGT and OPC is designed as

\[
h_1(x,y) = \frac{a}{(n_e - n_o)f} \left[ \alpha \cdot \arctan \left( \frac{\alpha}{\beta} \right) - x \cdot \ln \left( \frac{\sqrt{x^2 + \alpha^2}}{\beta} \right) + x \right] \tag{4}
\]

And

\[
h_2(u, v) = -\frac{ab}{f(n_e - n_o)} \exp \left( -\frac{|u|}{\alpha} \right) \cos \left( \frac{\alpha}{\alpha} \right) \tag{5}
\]

The phase modulation by OGT for \(|p⟩\), \(\psi_{p1}\) is conjugated with that for \(|s⟩\), \(\psi_{s1}\). \(\psi_{p1}\) is the same as the phase profile of transforming element for OAM sorting [18]. Comparing to \(\psi_{s1}\), \(\psi_{p1}\) can be considered as
the parameter $a$ is replaced by $-a$. So the OGT perform different mappings $(x, y) \rightarrow (u, v)$ between $|p\rangle$ and $|s\rangle$. The mapping relations are $u = -ca \cdot \ln(\sqrt{x^2 + y^2}/b)$, $v = ca \cdot \arctan y/x$ where $c = 1$ for $|p\rangle$ and $-1$ for $|s\rangle$. From the mapping relations we can get the beam in area $\sqrt{x^2 + y^2} < b$, will straightened to the area $u > 0$ for $|p\rangle$ and $u < 0$ for $|s\rangle$. If the each straightened beam do not across the center horizontal line $u = 0$, then we can have a phase correction function for $|p\rangle$ at the area $u > 0$ (the same phase correction function as [18]), and phase correction function for $|s\rangle$ at the area $u < 0$ (Comparing with former, it can be considered as the parameter $a$ is replaced by $-a$). Then we can get the height profiles of OPC as Eq. (5). Different from phase correction function in the OAM detection system [18], there is adding an absolute function, and require the incident light radius shall be less than $b$ to meet the demand of straightened beam cannot be across the center horizontal line between the two area.

3. SIMULATIONS AND DISCUSSIONS

Our simulations base on Fig. 2(b), and the incident vector beam mode is defined as

$$
\vec{u}_m = A_m \left( \frac{\pi}{\omega_0} \right)^m \exp \left( -\frac{r^2}{\omega_0^2} \right) \cos(m\phi + \phi_0) \sin(m\phi + \phi_0)
$$

with $\lambda = 1550$ nm. The parameters $a$, $b$, $\omega_0$, and $f$ are equal to 1 mm, 10 mm, 3 mm and 50 cm, respectively.

Fig. 3(a) shows the incident spatial polarization and intensity profiles of the vector beam with a PTC of 2 by the red arrows. Fig. 3(c) simulates the propagation from OGT to OPC (OGT is at $z/f$ = -1, the first lens is at $z/f$ = 0 and OPC is at $z/f$ = 1), where the red or green stands for the spatial intensity of the $|p\rangle$ or $|s\rangle$ polarization component. Modulated by conjugate spatial phase with OGT, during the propagation, the two components have much different spatial intensity profiles with each other. After the OPC at the Fourier plane, they focus into their own rectangle zones, and turn into two plane waves with the same propagation direction as simulated in Fig. 2(d) and Fig. 2(e), where the colors represent for the phase and the brightness for intensity. Eventually, both the two fields with different polarizations are focused and overlap exactly with each other at the image plane due to the same phase gradient, as shown in Fig. 2(b), where yellow results from the superposition of red and green, or of the $|s\rangle$ and $|p\rangle$ intensities.

Fig. 3. The propagation simulation of the vector beam with a PTC of $m = 2$ in our PTC sorting system

Fig. 4. The propagation simulation of a composite vector beam with the PTC values: $m = 1$, $-2$ and 3
In Fig. 4, the incident vector beam is a composite of those with the PTCs including \( m = 1, -2 \) and 3. According to our simulations, after passing the detection system, the composite vector beam is broken into three spots by different PTCs \( (m = 1, -2, 3) \) at the recorded plane. As a result, our design allows the system to read out the information encoded by PTC through using the detectors with their separation of \( \Delta t = \lambda f / (2\pi a) \) in the recorded plane.

Fig. 5(a) shows the \( x \)-directional integral intensity integral projection along \( y \)-direction of the final focal spot with the incident vector beams of different PTC \( m \) from -5 to 5 but the same energy at the recorded plane. We can see that vector beams with different PTC \( m \) finally focused on different positions along \( y \)-direction. It is obvious that the intensity integral profile with a PTC of \( m \) overlaps somewhat with neighboring one, which means that some of the light in a state leaks into its neighboring regions, i.e., there exist some cross-talks between different states. In order to assess the “cross talks”, Fig. 5 (b) shows the incident energy distribution vs. the detecting units marked with the serial number \( m_{\text{Dec}} \) of detectors by means of the definition of separation efficiency for OAM detection[18]. The incident beam includes the components with the PTC value of \( m \) from -5 to 5, which are received by the detecting units \( m_{\text{Dec}} \) from -6 to 6. We can see the highest separation efficiency is 78%, which is the same as that achieved by G. Berkhout et al. [18] for the OAM detection system. Meanwhile, the separation efficiency decline via the increase of the absolute value of PTC \( m \). This reason is, in our simulation, the diameter of the vector beam will increase with the absolute value of PTC \( m \). So the distribution of the vector beam will not be less than \( b \), then the straightened beam on Fourier plane will across the center horizontal line \( u = 0 \), then the two phase polarization cannot be will corrected to linear phase gradient. So the intensity of focal spot will go down, and the separation efficiency will decline.

![Graph showing intensity distribution](image)

**Fig. 5.** (a)The \( x \)-directional integral intensity integral projection along \( y \)-direction of the final focal spot with the incident vector beams of different PTC \( m \) from -5 to 5; (b)Total intensities in all detector regions for pure vector beam states.

4. CONCLUSIONS

In short, we present an efficient design of polarization topological charges sorting system of vector beam modes basing on polarization conjugated-phase component. The components are made of birefringent crystals and can induce conjugated phase modulations for two orthogonal polarization. So applying a pair of our polarization conjugated-phase component with a specific design in a 4-\( f \) optical system with a quarter-wave plate, the system converts the two opposite helical phases of the two orthogonal polarization states into the same direction plane waves, and eventually focuses them on the same location representing the PTC of the incident vector beam. Accordingly, it can decompose beams by PTC basis (i.e. vector beam modes). Our simulation results demonstrate that the proposed design
focuses vector beams with different PTCs to different lateral positions with separation efficiency as high as 77%. This capability could enable the readout of information encoded in polarization topological charges. The abilities of this sorter system may have the potential applications in many fields, especially in optical communication.

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