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Review

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Vectorial optical fields: recent advances and future prospects

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Abstract

Driven by their potential applications, vectorial optical fields with spatially inhomogeneous states of polarization within the cross section have drawn significant attention recently. This work intends to review some of the latest development of this rapidly growing field of optics and offer a general overview of the current status of this field in a few areas. Mathematical descriptions of generalized vectorial optical fields are provided along with several special examples. A time-reversal methodology for the creation of a wide variety of exotic optical focal fields with prescribed characteristics within the focal volume is presented. Recently developed methods for the generation of vectorial optical fields that utilize fiber lasers, digital lasers, vectorial optical field generator, metasurfaces or photoalignment liquid crystals are summarized. The interactions of these vectorial optical fields with various micro- and nano-structures are presented and the prospects of their potential applications are discussed. The connection of vectorial optical fields with higher dimensionality in quantum information is summarized.

Keywords

Vectorial optical field, Cylindrical vector beam, Full

Poincaré beam, Spatial light modulator, Metasurface, Spin-orbit interaction, Quantum information, Quantum communication

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1 Introduction

Polarization is an important vector property of light that has been exploited in many areas of optical sciences and optical engineering. Traditionally scientists and researchers dealt with optical fields with spatially homogeneous states of polarization (SOP), such as linear, elliptical and circular polarizations, within the cross section of the fields under study. Spatial dependence of SOP in the beam cross section has been largely ignored and deviation from the homogeneous distribution has mostly been treated as nuances that need to be compensated or corrected. However, with the recent rapid advances in high power computing and nanofabrication, there has been rapidly increasing interests in vectorial optical fields with spatially inhomogeneous SOPs within the cross section. These types of optical fields are increasingly available and the study of

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