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Editorial

Introduction to the Special Issue on Coherent and Polarization Optics

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Both coherence and polarization are important inherent properties of light. Optical coherence, including spatial coherence and temporal coherence, demonstrates correlations between the components of a fluctuating electric field at two or more points. By adjusting the spatial and temporal coherence states of light sources, all fundamental properties of light beams can be changed, including the intensity, phase, color, polarization, and orbital angular momentum [1–10]. Polarization, on the other hand, arises from correlations between the components of a fluctuating electric field at a single point. The manipulation of polarization states of light beams also plays a crucial role in determining the properties of light beams [11–13]. Furthermore, though coherence and polarization have been treated independently from each other so far, in 2003, Wolf et al. found that they are also closely related aspects of statistical optics [14,15], which may help people to fully understand optical coherence and polarization. In this Special Issue, we highlight the recent progress on coherence and polarization optics, and show the properties of coherence and polarization and how both of them affect light beam propagation and light–matter interaction.

Coherence may be used to improve the light beam performance in random media. In Contribution 1, the authors study the propagation of partially coherent self-splitting structured beams in ocean turbulence. It was found that by reducing the coherence length and enhancing the order of the beam, the ocean-turbulence-induced negative effects could be reduced. The effect of ocean turbulence on the spectral degree of coherence on propagation is also discussed. The authors of Contribution 2 introduce a new class of non-uniformly correlated beam, termed the Lorentz non-uniformly correlated beam, and investigate its propagation both in free space and oceanic turbulence. The results show that such a beam exhibits self-focusing properties on propagation, and by increasing the beam width and decreasing the coherence length, the negative effects of the turbulence can be reduced. In Contribution 3, the authors propose a radially phase-locked Hermite–Gaussian-correlated beam array and study the propagation properties of such a beam array in ocean turbulence. The beam array with a smaller coherence length is shown to better retain the splitting properties during propagation in ocean turbulence.

The effect of coherence and polarization on the propagation of a light beam in anisotropic media is studied in Contribution 4. The authors of Contribution 4 investigated the propagation of a vector partially coherent twisted Laguerre–Gaussian pulsed beam through anisotropic atmospheric turbulence. Both the coherence and polarization of the beam are considered, and the advantage of the beam in reducing the atmospheric-turbulence-induced degeneration is discussed.

The tight focusing of optical fields can be used to control many properties of the fields, including the polarization, angular momentum, Poynting vector, etc. In Contribution 5, the authors investigate the properties of tightly focused Pearcey beams with a cross-phase, and discuss the effect of intensity of the cross-phase on the intensity and gradient forces of these beams. The authors of Contribution 6 study the separation of polarization and orbital degrees of freedom, energy flow, and radial optical Hall effect of tightly focused Poincaré beams. In Contribution 7, the authors discuss the effect of the twisting phase on the conversion between the linear and circular polarizations of the tightly focused scalar and vector beams. The authors of Contribution 8 study the energy flow of the tightly focused azimuthally polarized beam with an x-type vortex, and show how to manipulate the longitudinal and transverse energy distributions by adjusting the anisotropic parameter of the noncanonical vortex. For an off-axis noncanonical vortex beam, the properties of energy flux are significantly influenced by the anisotropy parameter of such a tightly focused beam (Contribution 9). Partially coherent radially polarized Laguerre–Gaussian rotationally symmetrical power-exponent phase vortex beams with a Laguerre–Gaussian-correlated Schell model are introduced in Contribution 10. The intensity distribution, the degree of polarization and coherence, and the Stokes parameters of such tightly focused beams are demonstrated.

Asymmetric generalized Hermite–Gaussian and Laguerre–Gaussian beams are introduced in Contribution 11; they may have a high stability upon propagation in turbulent medium and could be used for optical trapping, rotating, and shifting of microparticles.

In Contribution 12, the authors study the possibility of obtaining powerful terahertz radiation with elliptical polarization by driving an orientated strong discharge current in a target with an elliptically shaped surface. The polarization properties of two-dimensional polarization holographic gratings in thin azopolymer films was studied in Contribution 13.

The effect of temporal coherence on interference contrast microscopy systems was studied for Contribution 14; the authors discuss the relationship between prism wedge angles and the interference color when the prism moves at multiple wavelengths.

In summary, the development of optical coherence, polarization, and their combination comprise an attractive research area, which may find a variety of potential applications for optical communication, imaging, sensing, and matter manipulation. I hope that this Special Issue will not only serve as a summary of the different research lines, but also encourage further study in this exciting field.

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