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Optics-Related Problems Include Electromagnetic Coherence and Polarization

Malorie Evaristo*

Department of Optics and Photonics, University of Canterbury, Kirkwood Avenue, Upper Riccarton, Christchurch, New Zealand, UK

Description

The coherence theory of random, vector-valued optical fields has received a lot of attention in recent years. With an emphasis on various kinds of optical interferometry, we lay the groundwork for electromagnetic coherence theory in the space-time and space-frequency domains. By analyzing statistically stationary, two-component paraxial electric fields in both classical and quantum-optical environments, we demonstrate crucial connections between the conventional polarization Stokes parameters and the corresponding two-point coherence Stokes parameters. Nanoparticle scattering and two-photon absorption are also used to measure the coherence and polarization of random vector beams [1].

The intrinsically interconnected light field properties of intensity, polarization, and coherence are the focus of this chapter's metrological elements. The Wolf's coherency matrix serves as the conceptual basis for all of these numbers. However, by anticipating the existence of major regularities in electromagnetic fields that were previously thought to be very random, the singular-optical method provides new insight into their connectivity [2]. Different skeletons, or carrying elements of a field, are formed by singularities of correlation functions in partially coherent, partially polarized fields, polarization singularities of vectors in homogeneously polarized fields, and phase singularities of scalars in homogeneously polarized fields. At least theoretically, one can predict a field's behavior in other areas by knowing its loci and features. Optic field metrology has a lot of new options in this scenario, and it could lead to new metrological approaches being put to use in real-world situations. Here, we discuss the connections between the polarization and coherence properties of light fields in a variety of forms, including one-point and two-point functions [3].

A framework for generalizing polarisation metrology on a broad class of coupled optical beams constructed as components that are either partially mutually coherent or mutually incoherent and can be orthogonal in polarization is presented by us in order to accomplish this. Non-destructive optical diagnostics and optical telecommunications with polarization coding can benefit from this generalization because it makes it possible to take into account partial polarization and the vector singularities that are associated with it. In addition, we illustrate the singular-optical concept of polarisation diagnostics and the Stokes-polarimetry approach. Local Stokes-polarimetry and conventional interferometry can be combined, as shown. The feasibility of experimentally measuring coherence by measuring metrology's spatial polarization distributions is the focus of a significant portion of this paper. Today, it concerns fields with uniform polarization. We are the most recent metrological instrument associated with the revolutionary idea of optical currents and flows. Some intimate properties of complex optical fields with arbitrary degrees of spatial coherence and polarization can be deciphered by observing how these fields affect embedded micro- and nanoparticles, as we demonstrate.

The construction of optical traps and tweezers for the manipulation of single particles at the micro- and nanoscales using a metrological approach appears promising [4]. In the context of early pre-clinical diagnosis of some common disorders, we represent experimental and data processing methodologies that result in highly sensitive and dependable diagnoses. This is a distinct part of Using local Stokes-polarimetry in biological tissue diagnostics. Members of our team recently developed all of the novel metrological approaches and procedures under consideration [5]. The necessity and potential strategies for overcoming some of the current shortcomings of optical metrology in the fields of coherence and polarization are discussed in the concluding section, along with some prospects for additional research in this direction.

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Conflict of Interest

None.

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***Address for Correspondence:** Malorie Evaristo, Department of Optics and Photonics, University of Canterbury, Kirkwood Avenue, Upper Riccarton, Christchurch, New Zealand, UK; E-mail: malorieevaristo@gmail.com*

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