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Editorial

Advanced Polarimetry and Polarimetric Imaging

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Polarization, a core attribute of light waves, offers insights into light's physical properties and its interactions with materials [1,2]. This unique aspect of polarization paves the way for its application across a broad range of fields, from object detection and biomedical imaging to remote sensing and beyond [3–6]. This Editorial is part of the Special Issue "Advanced Polarimetry and Polarimetric Imaging", which highlights new theories in and applications of advanced polarimeters and polarimetric imaging. Seventeen manuscripts were submitted to this Special Issue, and all of them were subject to a rigorous review process. In total, fourteen papers were finally accepted for publication and included in this Special Issue (twelve articles and two reviews). These contributions are listed below.

Precision in polarization measurements is foundational to achieving superior polarimetric imaging [7–9], and there are four contributions related to advanced polarization measurements in this issue (1, 2, 3, 4). The Stokes–Mueller formalism models how a light beam's polarization state is altered through its linear interactions with materials [1]. In Contribution 1, Gil et al. introduced a novel, synthesized Mueller polarimetry imaging approach, creating new avenues for the enhancement of Mueller polarimetry's application. Liu et al. (Contribution 2) engineered a vertically aligned, high-speed Mueller matrix ellipsometer, achieving a remarkable, dynamic monitoring of rapidly changing processes, with a measurement resolution in the 10 μs range and unparalleled accuracy. The calibration challenges arising from waveplate field of view effects, often caused by manufacturing or installation errors, can significantly impact optical systems' precision. In Contribution 3, Jiang et al. responded to this challenge with a calibration strategy that mitigates these effects, improving systems' accuracy. Taking cues from nature, Liu et al. (Contribution 4) developed a polarization sensor inspired by insects' sky-based navigation, integrating an image chip with nanograting via nanoimprint lithography for autonomous navigation, with impressive accuracy in polarization angle measurements.

Polarized light research extends into the realms of metasurfaces and metamaterials [10]. In Contribution 5, Shang et al. demonstrated dynamic, tunable structural coloration through a polarization-sensitive metasurface, showcasing its full-color image display and switching capabilities—a promising tool for virtual reality and high-density data storage. Li et al. (Contribution 6) crafted a fully dielectric chiral metasurface, achieving a full-color display with anti-counterfeiting features. Liu et al. (Contribution 7) delved into perfect absorber metamaterials, exploring the principles of impedance matching and coherent perfect absorption. Fundamental research, such as Smolkin et al.'s numerical method for wave propagation constant calculations (Contribution 8) and Li et al.'s limb boundary extraction technique for EUV solar images (Contribution 9), further broadens the scope of this Special Issue.

Polarimetric imaging excels in enhancing the image quality of images captured in scattering environments, leveraging the partial polarization of light scattered by microparticles [11–15]. In Contribution 10, Zhang et al. proposed an active polarization imaging technique tailored to turbid waters, dramatically improving image quality. Deep learning, as utilized by Lin et al. in Contribution 11, augments the capabilities of polarimetric

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imaging, achieving high-performance imaging reconstructions. Polarimetric technology can also advance 3D reconstruction efforts, with applications ranging from tunnel crack detection to passive 3D face reconstruction, as demonstrated by Zhang et al. (Contribution 12) and Han et al. (Contribution 13), respectively. Polarization lidar, or P-lidar, expands our detection capabilities by harnessing polarization's physical properties, thus enriching the information obtained from targets. In Contribution 14, Liu et al. provided a comprehensive overview of P-lidar's principles and applications, highlighting its potential use in atmospheric, oceanic, and terrestrial observations.

This Special Issue on polarization technology illustrates the field's notable progress and potential. It features research articles that introduce innovative solutions and tackle key challenges in polarimetric image restoration, 3D reconstruction, high-speed Mueller ellipsometry, and P-lidar. These promising applications and novel approaches in polarimetry and imaging technology herald a promising future.

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Conflicts of Interest: The authors declare no conflicts of interest.

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