Guest Editorial

Optical polarimetry

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Optical polarimetry is a term we have recently adopted to denote any type of optical measurement where light polarization plays a key role, and where polarization itself is a carrier of information. It also refers to measurement of the state of polarization light which is emitted from various sources, over a wide range of wavelengths, or which is scattered by different objects. The sources may range from minute atomic samples to entire galaxies; and the objects may range from atoms, molecules, or microscopic particles to whole planets. Evidently this is a field of vast scope that would require several special issues to be represented adequately. Ellipsometry, a branch of optical polarimetry which deals with surface and thin-film characterization by polarized-light reflection, is alone the subject of a series of international conferences with proceedings published as special volumes of *Surface Science*.[1] In astronomy the measurement of polarization of light, both emitted and scattered, is finding broad application for deducing the microstructure of particles and the macrostructure of atmospheres.[2] Other subspecialties of optical polarimetry have similarly expanded.

Through this special issue of *Optical Engineering*, therefore, the reader may expect to have only a glimpse of the field. Ten articles are featured: five on astronomical and atmospheric polarimetry, and five that deal with "down-to-earth" novel techniques and applications. Prominently absent from the issue are applications in biology, chemistry, and physics of spectroscopic techniques such as natural and induced optical rotatory dispersion (ORD), and circular dichroism (CD).

More than three years ago, we organized a successful two-day conference on the same topic as part of SPIE's 21st Annual Meeting (San Diego, August 23-24, 1977), with proceedings published in 1977 as SPIE Vol. 112. This special issue represents a fresh follow-up effort, with several new contributing authors.

Baur leads off with a review of applications of polarimetry to solar research. He compares the capabilities and special features of 51 polarimeters in use throughout the world, some of which achieve polarization noise levels as low as 0.001%! Walraven presents a pictorial sample of the information content of the linear polarization of light in the world around us, tempting us with the possibility of an atlas of terrestrial polarization phenomena. Ekstrom, Stokes, Stokes, and Hackwell present a design for an astronomical polarimeter capable of measuring all four Stokes parameters at wavelengths from 2.2 to 10 μm, utilizing a stress-birefringence polarization modulator operating at 37 kHz, a wire-grid polarization beamsplitter, and fast detectors. Fymat develops the theory for modification of a spectrometer to yield an interferometric spectrophotopolarimeter capable of measuring all four Stokes parameters, at high spectral resolution, for light scattering by an artificial cloud in the laboratory. Novick reviews progress in the development of x-ray polarimeters, and their use on satellites to unravel the mysteries of stellar and solar sources of these high energy photons.

King and Raine discuss the unconventional application of polarimetry to problems of mechanical alignment, to measurements of small rotational and linear displacements, and of departures from straight-line movements. Boyer, Lamouroux, Prade, and Vinet describe a novel approach of utilizing three-dimensional polarimetry to measure the Mueller matrix of a small volume element within an optically anisotropic, Rayleigh-scattering, transparent medium. They also discuss the interesting possibility of gravitational wave detection using an amplified piezo-optic effect. Harris presents a simple *ad hoc* phenomenological approach to photoelastic phenomena with particular application to transduction of surface forces, such as may be exerted on a substrate by single locomating tissue cells. Malewski reviews and gives his views on the status of polarization-based optical techniques for electrical measurements at high voltages. Finally, Azzam describes how perpendicular-incidence null ellipsometry (PINE) can be used to measure nondiagonal reflection matrices of surfaces with arbitrary anisotropy.

We are pleased to introduce this special issue, and we thank the Editor of *Optical Engineering*, H. J. Caulfield, for inviting us to prepare this topical selection of papers. We thank all the referees for their generous assistance.

1. The Proceedings of the Second, Third, and Fourth International Conference on Ellipsometry were published in 1969, 1976, and 1980 as Vols. 16, 56, and 96 of *Surface Science*.
2. A compendium of polarimetric work in astronomy was published as *Planets, Stars and Nebulae Studied with Photopolarimetry*, T. Gehrels, Ed., Univ. of Arizona Press, Tucson, 1974.