Metasurface Polarization Optics and Instrumentation

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Metasurfaces are subwavelength diffractive optical elements comprised of nanostructures with custom polarization properties [1]. These metasurfaces can be used as free-space polarization optics with new functions, e.g., as gratings which serve as parallel analyzers for multiple polarization states [2], or as polarization holograms which project structured polarization illumination patterns onto a scene [3]. In this talk, we present three recent efforts to apply metasurface polarization optics to new types of optical systems: 1) A polarimetric telescope dubbed SIMPol (the Solar Imaging Metasurface Polarimeter), developed in collaboration with Ball Aerospace and the National Center for Atmospheric Research (NCAR). In SIMPol, a metasurface polarization grating enables a highly simplified, single-path solar telescope for snapshot full-Stokes magnetic field diagnostics of the 460.7 nm Sr-I line. 2) An effort to create a fully "flat" imaging polarimeter by fabricating a polarization-analyzing metasurface grating and a diffractive lens on opposite sides of a glass substrate to perform snapshot full-Stokes polarization imaging over a 40 degree FOV with a highly miniaturized camera. 3) A snapshot full-Mueller matrix polarimeter in which the 16 elements of the Mueller matrix are acquired in parallel in the Fourier domain by use of two metasurfaces, one which provides structured polarization illumination and a second which performs snapshot polarization analysis. This represents, to the best of our knowledge, the first experimentally demonstrated snapshot full-Mueller matrix polarimeter.

References

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