Contribution ID: **8** Type: **Invited**

Control of light with phase discontinuities: photonics with metasurfaces

Thursday, 26 July 2012 09:30 (25 minutes)

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Conventional optical components such as lenses and holograms rely on gradual phase shifts accumulated during light propagation to shape light beam. New degrees of freedom in optical design are attained by introducing in the optical path abrupt phase changes over the scale of the wavelength. In this talk, we will discuss the results presented in [1], where a two-dimensional array of plasmonic resonators in form of V-shape antennas with spatially varying phase response and sub-wavelength separation can imprint such phase discontinuities on propagating light.
We demonstrated that a linear phase variation on the interface between two media leads to anomalously reflected and refracted beams in accordance with generalized laws of reflection and refraction derived from Fermat's principle. If we consider an interface with a phase gradient arbitrarily oriented with respect to the plane of incidence rather than parallel to it as in Ref. [1], the reflected and refracted beams are non-coplanar with the incident beam, leading to a three-dimensional generalization of the new laws of reflection and refraction [2] . Out of plane refraction has been experimentally demonstrated [2].
Phase discontinuities enable wavefront engineering with unprecedented flexibility, which is promising for a wide variety of planar optical components [3]. Optical phase array with subwavelength control of light parameters could lead to a surface optics technology capable of large scale applications including novel spatial wave modulators
[1] N. Yu, et al. Science 334, 333 (2011)
[2] F. Aieta, et al. NanoLetters, Published on line Feb. 15, 2012 DOI: 10.1021/nl300204s
[3] P. Genevet, et al. Appl. Phys. Lett. 100, 13101 (2012)

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Session Classification: Plasmonics

Track Classification: Plasmonics / Metamaterials