Announcing the Final Examination of Ahmed El Halawany for the Degree of Doctor of Philosophy in Physics

Date: Monday, October 31, 2016
Time: 1:00 p.m.
Room: PSB 445
Dissertation title: Optical Parity Time Metasurface Structures

Abstract:

In the last few years, optics has witnessed the emergence of two fields namely metasurfaces and parity-time symmetry. Optical metasurfaces are engineered structures that provide unique responses to electromagnetic waves, absent in natural materials. Optical metasurfaces are known for their reduced dimensionality i.e. subwavelength and consequently lower losses are anticipated. The other paradigm is the parity-time (PT) symmetric materials, also known as photonic synthetic matter. PT symmetry has emerged from quantum mechanics when a new class of non-Hermitian Hamiltonian quantum systems was highlighted to have real eigenvalues, hence eradicating Hermiticity of the Hamiltonian as an essential condition to the existence of real eigenvalues.

This dissertation is focused on the experimental and numerical realization of parity time (PT) symmetric metasurfaces. A systematic methodology is developed to implement this class of metasurfaces in both one-dimensional and two-dimensional geometries. In two dimensional systems, PT symmetry can be established by employing either H-like diffractive elements or diatomic oblique Bravais lattices. It is further shown that the passive parity-time (PT) symmetric metasurfaces can be utilized to appropriately engineer the resulting far-field characteristics. Such PT-symmetric structures are capable of eliminating diffraction orders in specific directions, while maintaining or even enhancing the remaining orders. Later, a first ever attempt of PT metasurface fabricated on a flexible polymer (polyimide) substrate is demonstrated. The proposed PT symmetric metasurface is essentially diatomic Honeycomb Bravais lattice, where both the passive and lossy elements exist side by side on each site separated by 50 nm. The light scattered from the fabricated device in the undesired direction is attenuated by at least an order of magnitude. Moreover, the unidirectionality of the metasurface is observed to be effective on most of the visible band (400 – 600 nm). The PT symmetric meatsurface is also fabricated on a high strength substrate; sapphire (Al2O3). An excellent agreement between the experimental and numerical (COMSOL) results is found for both substrates. Customized modifications to the current design can open avenues to study the unidirectionality of metasurfaces to different optical bands, for example IR.

Outline of Studies:
Major: Physics

Educational Career:
M. S. University of Central Florida, USA, 2016
M. S. American University of Cairo, Egypt, 2008
B. S. American University of Cairo, Egypt, 2006

Committee in Charge:
Dr. Demetrios N. Christodoulides (Chair)
Dr. Talat S. Rahman
Dr. Robert Peale
Dr. Patrick L. LiKamWa (External Committee Member)

Approved for distribution by Dr. Demetrios N. Christodoulides, Committee Chair, on October 19, 2016.

The public is welcome to attend.