USC Viterbi
School of Engineering
Ming Hsieh Department of Electrical and Computer Engineering

Munushian Visiting Seminar Series

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Parity-Time-symmetric optics, extraordinary momentum and spin in evanescent waves, optical analog of topological insulators, and the quantum spin Hall effect of light

Friday, October 4, 2019

2:00 - 3:30 pm, EEB 132

Refreshments will be served

Abstract: This talk provides a brief overview to some aspects of parity-time-symmetric optics, extraordinary momentum and spin in evanescent waves, optical analog of topological insulators, and the quantum spin Hall effect of light.

1. Parity-Time-Symmetric Optics

Optical systems combining balanced loss and gain provide a unique platform to implement classical analogues of quantum systems described by non-Hermitian parity–time (PT)-symmetric Hamiltonians. Such systems can be used to create synthetic materials with properties that cannot be attained in materials having only loss or only gain. We report PT-symmetry breaking in coupled optical resonators. We observed non-reciprocity in the PT-symmetry-breaking phase due to strong field localization, which significantly enhances nonlinearity. In the linear regime, light transmission is reciprocal regardless of whether the symmetry is broken or unbroken. We show that in one direction there is a complete absence of resonance peaks whereas in the other direction the transmission is resonantly enhanced, which is associated with the use of resonant structures. Our results could lead to a new generation of synthetic optical systems enabling on-chip manipulation and control of light propagation.

2. The quantum spin Hall effect of light: photonic analog of 3D topological insulators

Maxwell's equations, formulated 150 years ago, ultimately describe properties of light, from classical electromagnetism to quantum and relativistic aspects. The latter ones result in remarkable geometric and topological phenomena related to the spin-1 massless nature of photons. By analyzing fundamental spin properties of Maxwell waves, we show that free-space light exhibits an intrinsic quantum spin Hall effect —surface modes with strong spin-momentum locking. These modes are evanescent waves that form, for example, surface plasmon-polaritons at vacuum-metal interfaces. Our findings illuminate the unusual transverse spin in evanescent waves and explain recent experiments that have demonstrated the transverse spin-direction locking in the excitation of surface optical modes. This deepens our understanding of Maxwell's theory, reveals analogies with topological insulators for electrons, and offers applications for robust spin-directional optical interfaces. Related work can be found in.

Bio: Dr. Nori received a PhD in Physics from the University of Illinois, and then did postdoctoral research work at the Institute for Theoretical Physics, now KITP, at the University of California, Santa Barbara.

Afterwards, he became Assistant, Associate, full Professor and Research Scientist at the Physics Department of the University of Michigan, Ann Arbor.

He is a RIKEN Chief Scientist, leading the "Theoretical Quantum Physics Laboratory" at RIKEN (the Japanese National Laboratory).

His research group has done pioneering interdisciplinary studies at the interface between nanoscience, quantum information, superconducting quantum circuitry for quantum computing, photonics, quantum optics, atomic physics, nano-mechanics, mesoscopics, computational physics, and condensed matter physics. During the past decade, his research group has produced 40 highly-cited papers (i.e., top 1% most cited publications among all papers in all areas of Physics) according to the Web of Science. He has more than 100 publications in Physical Review Letters, over 50 in Science and Nature journals, and also numerous in other top journals. According to the Web of Science: > 34K citations and h-index 89 (Google Scholar: > 48K citations and h-index 102). He has been a "Highly Cited Researcher" during both 2017 and 2018 (ranked in the top 1% in Physics in the Web of Science).