

SEMINAR NOTICE

Preston M. Green Department of Electrical and Systems Engineering

NON-HERMITIAN WHISPERING-GALLERY MODE OPTICAL MICRORESONATORS AND APPLICATIONS

DISSERTATION DEFENSE

By

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Abstract: The time evolution of classical and quantum systems with loss or/and gain is described by non-Hermitian Hamiltonians. One striking feature of such systems is the existence of non-Hermitian degeneracies, also known as exceptional points (EPs), at which both the eigenvalues and the corresponding eigenstates coalesce. This is in stark contrast with conventional Hermitian degeneracies at which only the eigenvalues coalesce, but the eigenstates are still orthogonal. Many counterintuitive and interesting phenomena are associated with EPs, such as unidirectional invisibility, asymmetric mode switching and topological energy transfer. Photonic structures have proven to be excellent platforms for studying and ultimately exploiting non-Hermitian physics, due to the ease with which non-Hermiticity can be controlled, via optical gain/loss distribution and modal coupling. In this talk, I will present our studies of non-Hermitian whispering-gallery mode (WGM) optical resonators and their applications in laser mode management and optical sensing.

WGM resonators with (quasi-) circular geometries usually support two degenerate modes with the same eigenfrequency but opposite propagating directions, i.e., clockwise (cw) and counterclockwise (ccw) directions. For a WGM microlaser coupled with a waveguide, the laser emission is usually bidirectional. By judiciously introducing two nanoscatterers into the mode volume, the resonator can be steered to EPs, at which it only supports one travelling direction (either cw or ccw). Such effect can be used to realize unidirectional laser emission. At the vicinity of EPs, there exists a special topology that can be exploited to enhance optical sensing. The response (e.g., frequency shift/split) of conventional WGM sensors is proportional to the perturbation strength of the object. However, thanks to the complex-square-root topology near the (second-order) EPs, the response of WGM sensors at EPs is proportional to the square-root of the perturbation strength. Thus, for sufficiently small perturbations, the WGM sensors operating at EPs can exhibit much larger sensitivity than the conventional WGM sensors.

DATE: Tuesday, October 9, 2018

TIME: 10:00 a.m.-12:00 p.m

PLACE: Green Hall, Room 0120

Dissertation advisor:
Dr. Lan Yang

This seminar is in partial fulfillment
of the Doctor of Philosophy degree