SEMINAR NOTICE

Preston M. Green Department of Electrical and Systems Engineering

NON-HERMITIAN WHISPERING-GALLERY-MODE OPTICAL MICRORESONATORS AND APPLICATIONS

PhD Preliminary Research Examination

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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. Many counterintuitive and interesting phenomena are associated with EPs such as asymmetric mode switching and topological energy transfer. Recently, high-quality whispering-gallery mode (WGM) optical resonators have proved to be excellent platforms to study non-Hermitian physics. By tailoring the modal coupling and loss or/and gain distribution, WGM optical resonators can be steered to EPs. In this talk, I will present two applications of EPs in non-Hermitian WGM optical microresonators: one is unidirectional lasing emission, and the other one is sensitivity enhancement for detecting nanoscale objects.

WGM resonators with (quasi-) circular geometries usually support two degenerate modes with the same eigenfrequency but opposite propagating directions, i.e., clockwise (cw) and counter-clockwise (ccw) directions. Therefore, light emission from WGM microlasers is usually bidirectional. By judiciously introducing two scatterers into the mode volume, the resonator can be steered to EPs and then only supports one travelling direction (either cw or ccw), which is used to achieve unidirectional light emission.

There exists a special topology near the EPs that can be exploited to enhance the sensitivity of WGM sensors. 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 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. Such sensitivity enhancement is studied in two different WGM resonator based platforms.

DATE: Tuesday, October 24, 2017
TIME: 10:00 a.m.
PLACE: Green Hall, Room 0120

Dissertation advisor:
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