



Observation of Exceptional point in a chaotic exciton polariton billiard

Time: 10:00am, December 22, 2015 (Tuesday)

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10:00

Venue: Room W563, Physics Building, Peking University

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Abstract

Exciton-polaritons are hybrid light-matter quasiparticles formed by strongly interacting photons and excitons (electron-hole pairs) in semiconductor microcavities. They have emerged as a robust solid-state platform for next-generation optoelectronic applications as well as for fundamental studies of quantum many-body physics. Importantly, exciton-polaritons are a profoundly open (that is, non-Hermitian) quantum system, which requires constant pumping of energy and continuously decays, releasing coherent radiation. Thus, the exciton-polaritons always exist in a balanced potential landscape of gain and loss. However, the inherent non-Hermitian nature of this potential has so far been largely ignored in exciton-polariton physics. In this talk, I will demonstrate that non-Hermiticity dramatically modifies the structure of modes and spectral degeneracies in exciton-polariton systems, and, therefore, will affect their quantum transport, localization and dynamical properties. Using a spatially structured optical pump, we create a chaotic exciton-polariton billiard. Eigenmodes of this billiard exhibit multiple non-Hermitian spectral degeneracies, known as exceptional points. Such points can cause remarkable wave phenomena, such as unidirectional transport, anomalous lasing/absorption and chiral modes. By varying parameters of the billiard, we observe crossing and anti-crossing of energy levels and reveal the non-trivial topological modal structure exclusive to non-Hermitian systems. I will also show mode switching and a topological Berry phase for a parameter loop encircling the exceptional point. Our findings pave the way to studies of non-Hermitian quantum dynamics of exciton-polaritons, which may uncover novel operating principles for polariton-based devices.

Reference:

- [1] Observation of non-Hermitian degeneracies in a chaotic exciton-polariton billiard
T. Gao, E. Estrecho, K.Y. Bliokh, T.C.H. Liew, M.D. Fraser, S. Brodbeck, M. Kamp, C. Schneider, S. Höfling, Y. Yamamoto, F. Nori, Y.S. Kivshar, A. Truscott, R. Dall, E.A. Ostrovskaya, *Nature* 526, 554 (2015)
- [2] Kasprzak, J. et al. Bose-Einstein condensation of exciton polaritons. *Nature* 443, 409–414 (2006).
- [3] Dembowski, C. et al. Encircling an exceptional point. *Phys. Rev. E* 69, 056216 (2004).

About the Speaker

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