Non-Hermitian cQED at the chiral exceptional point

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Exceptional points (EPs) - exotic degeneracies in non-Hermitian systems - promise revolutionary control over light-matter interactions, yet their quantum optical implementation remains unexplored. Here, we experimentally demonstrate flexible and reversible engineering of quantum vacuum fluctuation in an integrated microcavity supporting chiral EPs, resulting in both tailored emission intensities and lifetimes for an embedded single solid-state quantum emitter. We develop a hybrid lithium niobate (LN)-GaAs quantum photonic platform, seamlessly combining high-quality quantum emitters, a low-loss photonic circuit, efficient electro-optic (EO) effect, and local strain actuator in a single device. Chiral EPs are reached by dynamically tuning the coupling between the clockwise (CW) and counter-clockwise (CCW) modes associated with a micro-ring resonator, resulting in an anomalous spontaneous emission dynamic with a 7-fold modulation of the lifetime (120 ps to 850 ps). Meanwhile, we also reconfigure the cavity's local density of states (LDOS) to shape the spectra of single photons emitted by a semiconductor quantum dot (QD) into squared-Lorentzian, Fano-like, and EP-induced transparency (EPIT), a suppression of emission at zero detuning due to non-Lorentzian EP responses. This work unveils exotic cavity quantum electrodynamics (cQED) effects unique to EPs and establishes a universal paradigm for non-Hermitian quantum photonics, enabling applications in topological quantum light sources, ultrafast optical switches, and chiral quantum networks.

Short Bio:

Yan Chen received his PhD degree in Experimental Physics from IFW Dresden, Germany. He is an Associate professor of National University of Defense Technology, China. His research interests are the integrated photonics and quantum photonics.