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Whispering-gallery-mode resonators: a versatile platform for light-matter interactions

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In the last 15 years Whispering-Gallery-Mode (WGM) resonator-based photonic systems have emerged as frontrunners in a variety of areas from fundamental scientific research to practical applications including communication, sensing and public health. They have been exploited to significantly enhance light-matter interactions, creating the opportunities for a wealth of new scientific discoveries and technological breakthroughs.

In this talk, I will present two examples to show the WGM as a versatile platform for both fundamental research and applications. First, I will introduce a phonon laser achieved in a coupled resonator system, in which mechanical mode is supported in one of the resonators[1] (Fig. 1). By adjusting the system to an exceptional point (EP), a non-Hermitian degeneracy featuring the coalescence of the eigenvalues and the corresponding eigenstates, the increased optical noise imprints on the mechanical mode. Consequently, the broadening of the linewidth of the phonon laser is observed. It provides an optical approach to tune the linewidth of a phonon laser.

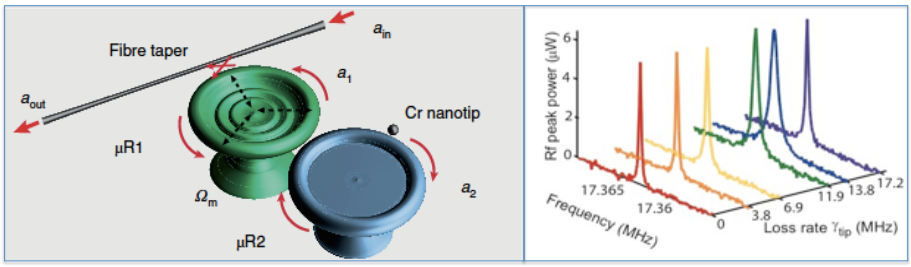

Figure 1. Left panel: a phonon laser formed by two coupled resonators. Right panel: Linewidth variation in a phonon laser tuned around an EP.

Optical sensing is the example I will present to show the applications of WGM resonators beyond a lab tool for fundamental research. The underlying mechanics for WGM sensors will be discussed. Of a special note is the recent progress in non-Hermitian physics, which has revealed a new route to further enhance the performance of WGM sensors[2]. I will compare the performance of a conventional WGM sensor and an EP sensor and explain difference of the mode splitting signals in response to the perturbation from a sensing target in those two different scenarios (Fig. 2). In the end, I will wrap up my talk on WGM sensors for IoT applications.

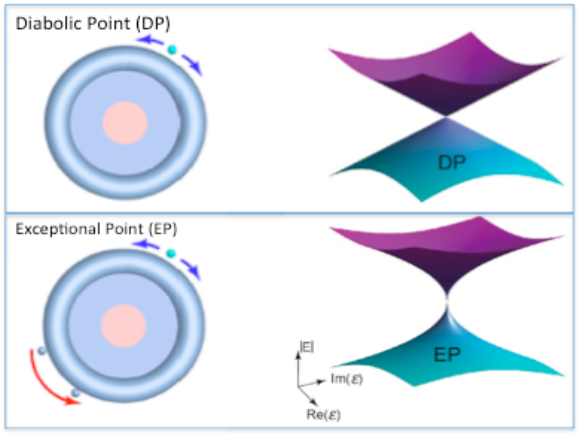

Figure 2. Upper panel: a WGM sensor operated around a diabolic point (DP). Lower panel: a WGM sensor operated around an exceptional point (EP).

References

1. "A phonon laser operating at an exceptional point," J. Zhang, B. Peng, Ş. K. Özdemir, K. Pichler, D. O. Krimer, G. Zhao, F. Nori, Y. Liu, S. Rotter, and L. Yang, Nature Photonics, **12**, 479-484 (2018).
2. W. Chen, Ş. K. Özdemir, G. Zhao, J. Wiersig, and L. Yang, Nature, **548**, 192 (2017).