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Non-Hermitian band geometry and dynamics of exciton-polaritons

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Losses are ubiquitous in exciton-polariton systems, resulting in a short lifetime compared to thermalisation, which makes polariton condensates a good platform for investigating non-equilibrium physics. Additionally, losses can lead to intriguing non-Hermitian effects in systems with non-Hermitian effective Hamiltonians. In this talk, I will present the rich features that can arise in exciton-polariton systems when the losses depend on polarization and momentum [1].

A novel topological winding number can exist in momentum space around exceptional points, which are degeneracies where the eigenstates coalesce. This has direct consequences for the band geometry, resulting in the generalization of the quantum geometric tensor. We propose a method to experimentally measure the non-Hermitian tensor using the polarization of exciton polaritons [2]. The non-Hermiticity also leads to nontrivial dynamics in space, momentum, and pseudospin. For example, a wavepacket can split in both momentum and real space and exhibit self-acceleration without any external potential. Pseudospin defects can also form in momentum space along arcs where the imaginary parts of the energy eigenvalues cross [3]. The pseudospin dynamics are further modified due to an imbalance in loss rates, which directly impacts the zitterbewegung effect for exciton-polaritons.

References

[1] R. Su, E. Estrecho, et al., Sci. Adv. 7, eabj8905 (2021).
[2] Y.-M. R. Hu, E. A. Ostrovskaya, and E. Estrecho, Phys. Rev. B 108, 115404 (2023).
[3] Y.-M. R. Hu, E. A. Ostrovskaya, and E. Estrecho, Opt. Mater. Express 14, 664 (2024).

Short bio (50 words) or link to website

Eliezer Estrecho is an ARC Discovery Early Career Researcher Award Fellow specialising in exciton polaritons across various material and photonic platforms. His research encompasses precise measurements of polariton condensates, such as the interaction strength and the laser linewidth, and exploration of novel effects emerging from non-Hermitian physics.

Relevant publications (optional)

Career stage

Postdoc

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