Exploring Multiband Topology in Exciton-Polariton Lattices

S. Ravets [1,*]

[1]Université Paris-Saclay, CNRS, Centre de Nanosciences et de Nanotechnologies (C2N), 91120 Palaiseau, France

Exciton-polaritons, hybrid quasiparticles arising from the strong coupling between quantum well excitons and cavity photons, offer a versatile platform to study topological physics [1, 2]. Their unique light-matter nature allows for engineering topological bands, topological lasers, topological solitons... [3, 4, 5, 6, 7] In this presentation, I will report on recent progress in the experimental investigation of multiband topology in exciton-polariton lattices.

Building upon earlier studies of two-band systems, we have developed and implemented a generalized tomography technique that reconstructs the full Bloch eigenstate structure across the Brillouin zone for lattices with an arbitrary number of bands. This method relies on k-space interferometric measurements combined with controlled phase modulations between sub-orbitals, enabling us to extract the full Stokes vector for each Bloch mode. Applied to polariton honeycomb lattices (see Fig. 1) incorporating multiple orbitals and/or polarization-dependent effects, our approach allows the measurement of the Berry curvature and quantum geometric tensor of each band. We demonstrate this technique on a honeycomb lattices featuring up to six bands, and reveal clear signatures of topology beyond the two-band paradigm.

Our work highlights the potential of exciton-polariton lattices as a testbed for exploring multiband topological effects in a highly tunable photonic platform, and paves the way for accessing more exotic phenomena, such as non-Abelian topology in driven photonic systems [8].

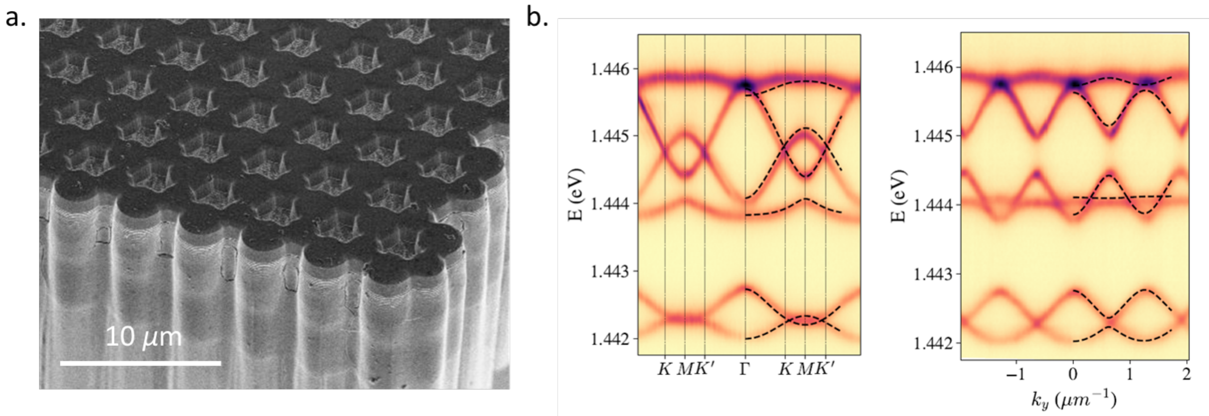

Figure 1: a. Scanning electron microscope image of a polariton honeycomb lattice. b. Measured band dispersion featuring six bands, two s-bands and four p-bands.

Acknowledgments

S.R. acknowledges support by the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (starting grant project ARQADIA, grant agreement no. 949730).

References

[1] I. Carusotto, and C. Ciuti, *Rev. Mod. Phys.* **85**, 299 (2013).
[2] T. Ozawa, *et al.*, *Rev. Mod. Phys.* **91**, 015006 (2019).
[3] T. Karzig, *et al.*, *Phys. Rev. X* **5**, 031001 (2015).
[4] A. Nalitov, *et al.*, *Phys. Rev. Lett.* **114**, 116401 (2015).
[5] S. Klembt, *et al.*, *Nature* **562**, 552 (2018).
[6] Nicolas Pernet, *et al.*, *Nature Physics* **18**, 678 (2022).
[7] D. Solnyshkov, *et al.*, *Optical Materials Express* **11**, 1119 (2021).
[8] R.-J. Slager, *et al.*, *Nature Communications* **15**, 1144 (2024).

*E-mail: sylvain.ravets@c2n.upsaclay.fr