Non-Hermitian synthetic lattice with light-matter coupling

Amir Rahmani[1], Mateusz Kedziora[2], Andrzej Opala[1,2], and Michał Matuszewski[1]

[1] *Institute of Physics Polish Academy of Sciences, Al. Lotników 32/46, 02-668 Warsaw, Poland*

[2] *Institute of Experimental Physics, Faculty of Physics, University of Warsaw, ul. Pasteura 5, PL-02-093 Warsaw, Poland*

We propose that light-matter coupling can be used to realize a synthetic lattice. In particular, we consider a one-dimensional chain of exciton-photon sites to create a synthetic comb lattice (see Figure 1) that exhibits a transition from a Lieb lattice flat band to a finite mass dispersion by tuning site-dependent light-matter coupling. Moreover, in a non-Hermitian system with gain and loss, the flat band phase is much more robust and the transition is accompanied by the appearance of exceptional points in the complex energy spectrum. We demonstrate that by engineering the light-matter coupling in the synthetic comb lattice, one can explore various phases in the polariton lasing regime. Our proposal paves the way for studying non-Hermitian systems in higher dimensions.

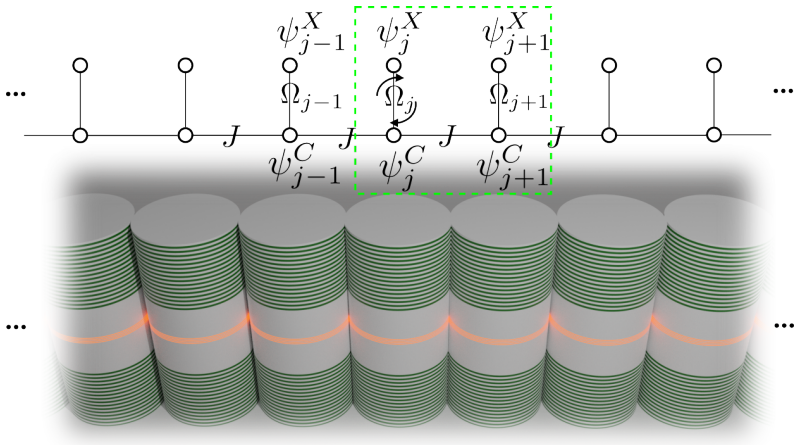

Figure 1: Scheme of our model. (Top) At lattice site j photonic (ψ^C_j) and excitonic (ψ^X_j) states are coupled. The neighboring photonic sites are coupled to each other with coupling rate J. A possible choice of a unit cell is marked by the green square. (Bottom) In practice the model can be implemented in a lattice of coupled micropillars.

[1] O. Boada, A. Celi, J. I. Latorre, and M. Lewenstein, *Phys. Rev. Lett.* **108**, 133001 (2012).

[2] M. A. Miri, and A. Alù, *Science* **363**, 6422 (2019).