Robustness of flat band superconductivity against disorder in the two-dimensional Lieb lattice

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For the last decade, the flat band superconductivity has been the focus of a great deal of activity for its unusual scalings, connection with quantum geometry and possibility of high critical temperatures [1,2,3]. Nevertheless, the sensitivity of the superconducting phase to disorder had not been investigated so far. Here, performing large scale numericals calculations, we address this issue in order to estimate its impact in real compounds.

Our findings reveal that unlike conventional intraband superconductivity for which disorder has a dramatic impact, that associated with flat bands is surprisingly robust to disorder-induced fluctuations and quasiparticle localization [4]. We believe that these findings could have a major impact on the research and development of new compounds whose high purity will no longer be a critical barrier to their synthesis.

References

[1] Iglovikov, Grémaud, Batrouni, Scalettar, Phys. Rev. B, **90** 094506 (2014)

[2] Peotta, Törmä, Nat Commun. , **6** 8944 (2015)

[3] Thumin, Bouzerar, Phys. Rev. B, **107** 214508 (2023)

[4] Bouzerar, Thumin, Phys. Rev. B Letter, **111** L020506 (2025)

Figures

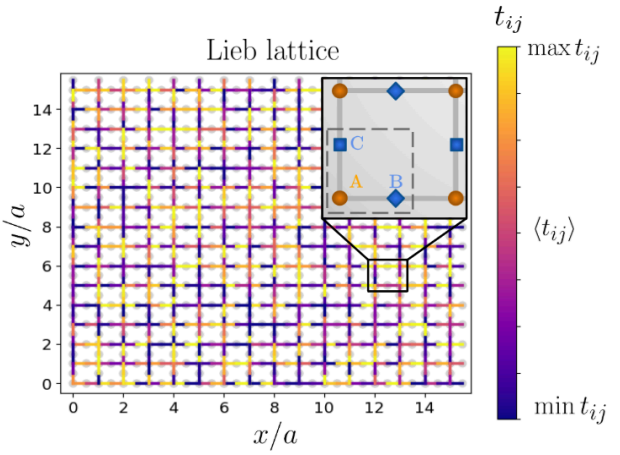

Figure 1: Configuration of disorder in the Lieb lattice. The disorder is realized by randomizing the nearest neighbors hopping integrals.

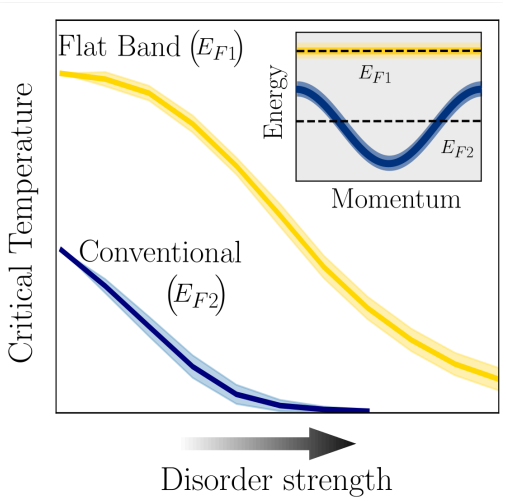

Figure 2: Superconducting critical temperatures in the Lieb lattice as a function of the disorder strength for the Fermi energy crossing (i) a flat band (unconventional superconductivity) and (ii) a dispersive band (conventional superconductivity).