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Identifying and Isolating Flat Bands in 2D Systems

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Flat band systems are becoming popular due to special properties. For instance, the strong correlation of electrons leads to realization of unconventional superconductivity [1]. Typically, such bands are only approximately flat and are engineered by fine tuning Vanderwaal's structures. Here we consider Kagome and Lieb lattices with perfectly flat bands. However, at some points in the Brillouin zone the bands superimpose leading to degeneracies. It has been shown that the degeneracy can be lifted when time-reversal symmetry (TRS) is broken [2]. In this presentation, we explore further means to lift the degeneracy while preserving the flat band. We show that the flatness is robust under certain changes to the lattice and that breaking TRS is not sufficient to isolate the flat band. Instead, we show that modulating the flux based on Chern-Simons field as outlined in [3] successfully gaps out the band.
[1] Cao, Y. et al. (2018). Unconventional superconductivity in magic-angle graphene superlattices. Nature, 556(7699), 43-50
[2] Green, D., Santos, L., & Chamon, C. (2010). Isolated flat bands and spin-1 conical bands in two-dimensional lattices. Physical Review B, 82(7).
[3] Maiti, S., & Sedrakyan, T. (2019). Fermionization of bosons in a flat band. Physical Review B, 99(17).

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