Cold atoms with flat bands – from synthetic bilayers to flat band Bose-Einstein condensates

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Different systems with (nearly) dispersionfree energy bands have appeared in the past years, from magic angle twisted bilayer graphene to optical lattices with exotic lattice geometries, such as the Lieb lattice or the Kagome lattice. Flat bands provide a fascinating arena for strongly correlated manybody phenomena, since their physics is automatically dominated by interactions.

This talk is centered around different aspects of flat bands in cold atomic setups. First, I will discuss strategies to produce synthetic bilayer systems [1], and I will show how the superconducting phase of attractive fermions can be enhanced by twisting the bilayer [2]. Second, I will discuss Bose-Einstein condensation in flat bands [3]. In this context, an intriguing question arises: Will bosons in flat bands actually condense, and if yes, where? We have analyzed flat band condensates numerically and via a mean-field description. Our results do not only confirm that condensation in the flat band of a Kagome lattice is possible, but also that the condensate may even carry topological properties induced by interactions.

References

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Figures

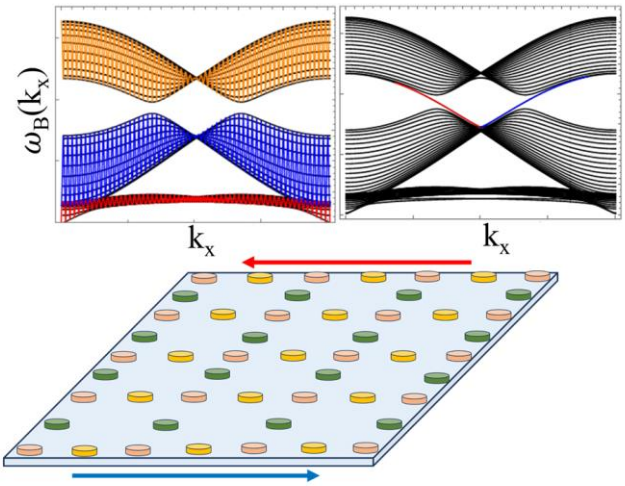

Figure 1: The topological condensate of bosons in a Kagome lattice (with pi flux) is characterized by a gap opening in the bulk spectrum and the appearance of edge states.