Contribution ID: **156** Type: **Poster**

Local Hilbert space fragmentation in flat-band lattices

Monday, 11 September 2023 22:40 (20 minutes)

We report on a family of Bose-Hubbard diamond necklaces with n central sites that exhibit quantum local Hilbert space
fragmentation [1]. Such models possess a single-particle spectrum with a flat band, which is composed of compact localized states (CLSs) that occupy the up and down sites of each diamond. Due to the presence of these CLSs, when adding more bosons with on-site interactions, the Hilbert space becomes locally fragmented. By performing an appropriate basis rotation, the fragmentation of the many-boson Hilbert space becomes apparent in the adjacency graph of the Hamiltonian, showing disconnected subsectors with a wide range of dimensions. Also, by analyzing the dimension of the largest sector, we show that the system exhibits strong fragmentation. We have found a conserved quantity that uniquely identifies each subsector of the Hamiltonian, the local CLS number parity. The subsectors present a wide range of dimensions, including one-dimensional subsectors, and also entanglement entropy scalings ranging from area-law to logarithmic growth, while also including one sector with an antivolume correction. As a result of the fragmentation, the distribution of entanglement entropies presents a nested-dome structure, that stems from the number of particles that are trapped in a CLS. We find subsector-restricted entanglement evolution and subthermal entanglement growth within each nonintegrable sector. Additionally, we show how the visibility of the nested-dome structure can be enhanced by increasing the sparsity of the CLSs, and how the results hold both for open and periodic boundary conditions.

Moreover, we generalize these previous results and demonstrate that a general local fragmentation mechanism arises in arbitrary flat-band lattices possessing commutative local symmetries associated with local reflection symmetries [2]. The equitable partition theorem (EPT) ensures distinct parities for the CLSs present in this class of flat-band lattices and the extended eigenstates of the system. In the presence of on-site bosonic interactions, such models exhibit a conserved quantity, the parity of the number of particles located in all the CLSs in a unit cell. As a consequence, the Hilbert space presents local fragmentation. We find that the fragmentation is strong and also robust to the addition of long-range interactions.
[1] E. Nicolau *et al.*, Physical Review B **107**, 094312 (2023).
[2] E. Nicolau *et al.*, arxiv:2306.15660 (2023).

Primary authors: MARQUES, Anselmo M. (University of Aveiro); NICOLAU, Eulàlia (Universitat Autònoma de Barcelona); MOMPART, Jordi (Universitat Autònoma de Barcelona); DIAS, Ricardo G. (University of Aveiro); AHUFINGER, Verònica (Universitat Autònoma de Barcelona)

Presenter: AHUFINGER, Verònica (Universitat Autònoma de Barcelona)

Session Classification: Poster Session II

Track Classification: Other