The Wonderful World of Flatbands:

From Basics of Compact Localized States to Caging of Classical and Quantum Interactions

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Abstract: Certain lattice wave systems in translationally invariant settings have one or more spectral bands that are strictly flat or independent of momentum in the tight binding approximation, arising from either internal symmetries or fine-tuned coupling [1]. These flat bands support compact localized eigenstates (CLS) and display remarkable strongly interacting phases of matter. Originally considered as a theoretical convenience useful for obtaining exact analytical solutions of ferromagnetism, flat bands have now been observed in a variety of settings, ranging from electronic systems to ultracold atomic gases and photonic devices [1],[2]. A finetuning of additional nonlinear interactions allows to continue CLS into compact discrete breathers [3]. Combining finetuning for lattices with All Bands Flat and classical and quantum interactions results caging of interactions [4], and ultimately in the explicit derivation of Many-Body-Flat-Band Hamiltonians [5].

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