Flat Band Induced Metal-Insulator Transitions With Weak Disorder and Many Body Interactions

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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]. 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]. I will review the design and implementation of flat bands, classification schemes, discuss recent results on adding many-body interactions [3] and disorder[4], and chart future directions of this exciting field.

[1] *Artificial flat band systems: from lattice models to experiments*. Daniel Leykam, Alexei Andreanov, Sergej Flach. Adv. Phys.: X **3**, 1473052 (2018)
[2] *Photonic Flat Bands*. Daniel Leykam, Sergej Flach. APL PHOTONICS **3**, 070901 (2018)
[3] *Many body flatband localization*. Carlo Danieli, Alexei Andreanov, Sergej Flach. Phys. Rev. B **102**, 04116(R) (2020); *Heat percolation in many-body flatband localizing systems*. Ihor Vakulchyk, Carlo Danieli, Alexei Andreanov, Sergej Flach. Phys. Rev. B **104**, 144207 (2021); *Many-body localization transition from flatband finetuning*. Carlo Danieli, Alexei Andreanov, Sergej Flach. Phys. Rev. B **105**, L041113 (2022).
[4] *Metal-insulator transition in infinitesimally weakly disordered flatbands*. Tilen Cadez, Yeongjun Kim, Alexei Andreanov, Sergej Flach. Phys. Rev. B **104**, L180201 (2021); *Flatband-induced metal-insulator transitions for weak magnetic flux and spin-orbit disorder*. Yeongjun Kim, Tilen Cadez, Alexei Andreanov, Sergej Flach. arXiv:2211.09410; *Critical-to-insulator transitions and fractality edges in perturbed flatbands*. Sanghoon Lee, Alexei Andreanov, Sergej Flach. Phys. Rev. B **107**, 0142024 (2023).