

## Flat Band Induced Metal-Insulator Transitions for Weak Magnetic Flux and Spin-Orbit Disorder

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We consider manifolds of tunable all-bands-flat (ABF) lattices in dimensions  $d=1,2$ , parametrized by a manifold angle parameter  $\theta$ . We study localization properties of eigenstates in the presence of weak magnetic flux disorder and weak spin-orbit disorder. We demonstrate that weakly disordered ABF lattices are described by effective scale-free models where the disorder strength is scaled out. For weak magnetic flux disorder we observe sub-exponential localization at flatband energies in  $d=1$ , which differs from the usual Anderson localization. We also find diverging localisation length at flatband energies for weak flux values in  $d=2$ , however the character of the eigenstates at these energies is less clear. For weak spin-orbit coupling disorder in  $d=2$  we identify a tunable metal-insulator transition with mobility edges. We also consider the case of mixed spin-orbit and diagonal disorder and obtain the metal-insulator transition driven by the manifold parameter  $\theta$ .

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