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Flat-band Nanostructures

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The electronic band structure of many systems, e.g., carbon-based nanostructures, can exhibit essentially no dispersion. Models of electrons in such flat-band lattices define non-perturbative strongly correlated problems by default. Here strong interactions can give rise to novel quantum phases of matter with intriguing collective excitations. Flat bands therefore allow the possibility of discovering emergent physics determined solely by interactions. I will review work that theoretically explores strongly correlated lattice models with flat bands. Zero-field flat-band lattice systems offer arenas to study quantum crystals, quantum liquids, and magnetism. I will also discuss recent results from microscopic modeling of a specific flat-band system, electrons in graphene nanoribbons with zig zag edges. Here I will show that interactions can lead to quantum crystals with ferromagnetic order.