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Evolution of the Hofstadter butterfly in a tunable optical lattice MEHMET O. OKTEL, Bilkent Univ, NUR UNAL, Cornell Univ, FIRAT YILMAZ, Bilkent Univ — Advances in realizing artificial gauge fields on optical lattices promise experimental detection of topologically non-trivial energy spectra. Self-similar fractal energy structures, known as Hofstadter butterflies, depend sensitively on the geometry of the lattice, as well as the applied magnetic field [1]. The recent demonstration of an adjustable lattice geometry [L. Tarruell et al., Nature 483, 302 (2012)] presents a unique opportunity to study this dependence. We calculate the Hofstadter butterflies that can be obtained in such an adjustable lattice and find three qualitatively different regimes. We show that the existence of Dirac points at zero magnetic field does not imply the topological equivalence of spectra at finite field. As the real-space structure evolves from the checkerboard to the honeycomb lattice, two square lattice Hofstadter butterflies merge to form a honeycomb lattice butterfly in a topologically non-trivial way, as it is accomplished by sequential closing of infinitely many gaps. We discuss the evolution of topological properties with underlying lattice geometry by calculating the Chern numbers and comment on the validity of simulating graphene in such an adjustable lattice. [1] F. Yilmaz, F. Nur Unal, and M. O. Oktel, Phys. Rev. A 91, 063628 (2015).

Nur Unal
Cornell Univ

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