Atom-to-atom designed graphene-like structures

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Feynman's original idea of using one quantum system that can be manipulated at will to simulate the behavior of another more complex one has flourished during the last decades in the field of cold atoms. More recently, this concept started to be developed in nanophotonics and in condensed matter. In this talk, I will discuss a few recent experiments, in which 2D electron lattices were engineered on the nanoscale. The first is the Lieb lattice [1,2], and the second is a Sierpinski gasket [3], which has dimension D = 1.58. The realization of fractal lattices opens up the path to electronics in fractional dimensions. Then, I will show how to realize topological states of matter using the same procedure. We investigate the robustness of the zero modes in a breathing Kagome lattice, which is the first experimental realization of a designed *electronic* higher-order topological insulator [4], and the fate of the edge modes in a Kekule structure, upon varying the sample termination [5]. Finally, I will discuss how to realize *p*-orbital Dirac cones and flat bands in designed honeycomb lattices [6].

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FIGURES

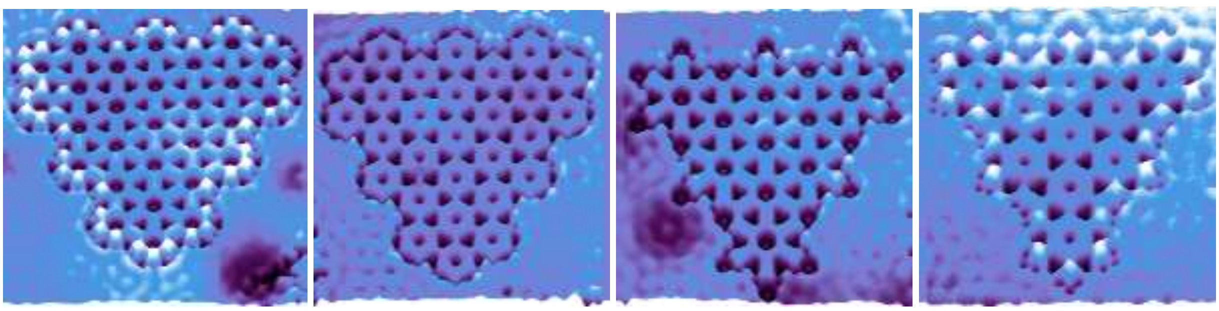

Figure 1: Kekule lattices with different ratio of weak and strong bonds and different termination. The existence or not of topological states depends on both, the sample termination and the position of strong bonds [5].