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Topological edge and corner states in 2D SSH model

Topology offers us a unique dimension of designing solid-state materials. One famous example is the Quantum spin Hall effect (QSHE) where electrons of opposite spins propagate oppositely. The origin of QSHE comes from a geometric field strength in momentum space that is the so-called Berry curvature. Besides QSHE, the geometric vector potential whose curl yields the Berry curvature – the Berry connection, can induce an electric dipole even under zero Berry curvature. The topological electric dipoles result fractional surface charges that manifest as topological edge states, which are robust to bulk defects and edge roughness. Furthermore, a pair of such the topological dipoles can form a high order multipole – quadrupole, which corresponds to the topological corner states. These topological edge and corner states not only yield a new concept of topological materials dubbed as high-order topological insulators, but also may have applications in low-power electronics and laser technology.

In this talk we will discuss a simple tight-binding model that possesses topological dipoles and quadrupoles in zero Berry curvature, which is the so-called two-dimensional (2D) Su-Schrieffer-Heeger (SSH) model [1]. Experimental realizations based on solid-state material and dielectric photonic crystal are proposed [2]. Furthermore, we show that in a pure quadrupole phase accompanied with (pseudo-)spin degree of freedom, topological edge and corner states are (pseudo-)spin polarized in general even without spin-orbit coupling [3].

References

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[3] F. Liu, H.-Y. Deng and K. Wakabayashi, Phys. Rev. Lett. **112**, 086804 (2019)

Figure

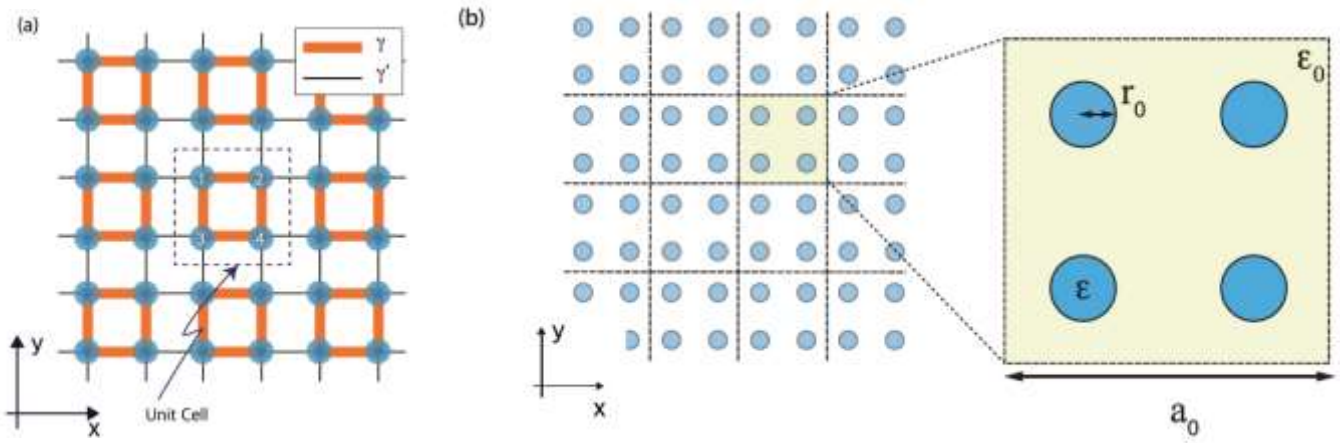

Figure: (a) Schematic lattice structure of the 2D SSH model. The model is specified by the intracellular hopping γ and the intercellular hopping γ'. (b) Schematic of the dielectric crystal mimicking the 2D SSH model. The unit cell consists of four identical dielectric cylinders of radius r_0 placed at $(\pm 0.25, \pm 0.25)r_0$. The lattice constant is a_0.