Cu_2Si : a promising 2D Dirac nodal line semimetal

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With the discovery of Dirac nodal-line (DNL) semimetals, the notion of the Dirac point has been extended to lines and loops in momentum space. As for Dirac cones, the energy dispersion of DNL is linear around the band crossing.

The first DNL two-dimensional material evidenced is Cu_2Si [1], which is composed of a honeycomb Cu lattice and a triangular Si lattice, both coplanar (see Figure 1, left) . When prepared on a Cu(111) substrate, angle-resolved photoemission measurements revealed two concentric DNL close to the Fermi level and centred on the high-symmetry point Γ, in agreement with first principle calculations. These nodal lines are furthermore protected by inversion and time reversal symmetries, as well as a mirror crystalline symmetry.

In this talk, we will focus on the experimental realization of Cu_2Si, address the challenges to overcome for devices applications, and discuss more specifically the changes in the electronic structure that can be induced by the choice of substrate and by induced spin-orbit coupling. We investigated the use of a Si(111) semiconductor substrate, more relevant for electronic devices, and showed that the electronic structure was substantially modified due to interactions with the substrate [2]. We also present our ongoing work aiming at observing the effect of a strong spin-orbit coupling induced by heavy element deposition (Pb) on a Cu_2Si monolayer, which would lead to a lift of degeneracy of the electronic bands (see Figure 1, right) and to a possible gap opening, as it has already been shown on graphene [3].

References

[1] B. Feng et al., Nature Communications 8, 1007 (2017)
[2] M. Cameau et al., Phys. Rev. Materials 3, 4, 044004 (2019)
[3] I. I. Klimovskikh et al., ACS Nano 11, 368 (2017)

Figures

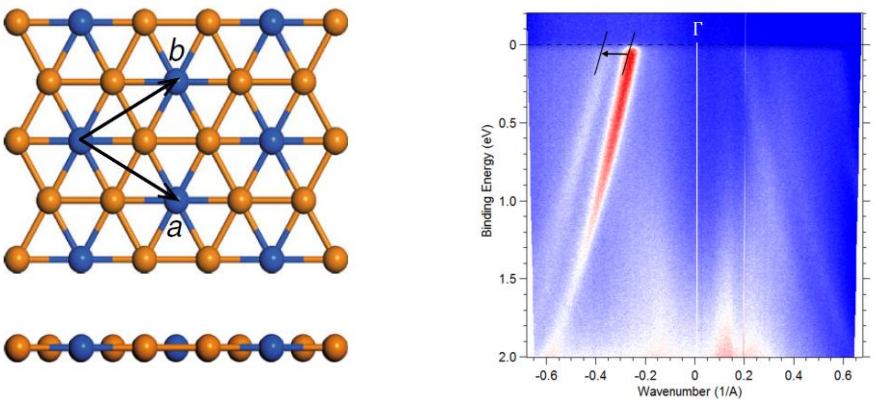

Figure 1: Left: Atomic structure of Cu_2Si, top and side view. Cu atoms are in orange, Si atoms in blue. **Right:** ARPES spectra at 30eValong Γ-M direction of Cu_2Si/Cu(111) after Pb deposition. The outermost band results from the splitting of the main one (in red), due to Pb interaction.