Exploring the electronic structure of topology-protected surface states by advanced angle-resolved photoemission

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Novel quantum materials, characterized by different forms of strongly correlated electrons in solids, may pave the way towards next generation applications such as dissipationless quantum transport or quantum computing. A key feature of some of these materials are non-spin degenerate electronic bands, such as in the recently discovered altermagnets [1]. For example, topological insulators and topological Weyl semimetals host topology-protected, spin-polarized surface states. A full experimental characterization of these states thus requires measurements of the electron spin over wide regions in momentum space.

In the first part of this talk, I will present first results from our recently established spin-resolved momentum microscope setup at NTNU Trondheim (Fig. 1(a)), which gives the photoelectron momentum distribution over the full half-sphere above the sample surface. When combined with a 2D imaging spin filter, this allows parallel measurement of the in-plane spin polarization for full constant energy cuts $E(k_x, k_y)$ (Fig. 1(b)). The second part of the talk will focus on our results on the layered topological Weyl semimetal $PtBi_2$. In this material, bulk Weyl nodes – the emergence of which is commonly attributed to accidental crossings between non-degenerate valence and conduction bands – are connected on the surface by Fermi arcs. Recent reports indicate that these Fermi arcs host unconventional superconductivity at elevated temperatures [2, 3, 4]. We have performed a comprehensive analysis of the two inequivalent surface terminations of $PtBi_2$ by means of spin- and angle-resolved VUV photoemission at the BLOCH Beamline of the MAX IV Synchrotron in Lund, Sweden, complemented by bulk-sensitive soft-X-ray ARPES experiments at the ASPHERE III end station at the variable polarization XUV beamline P04 of the PETRA III storage ring at DESY (Fig. 1(c, d)).

References:
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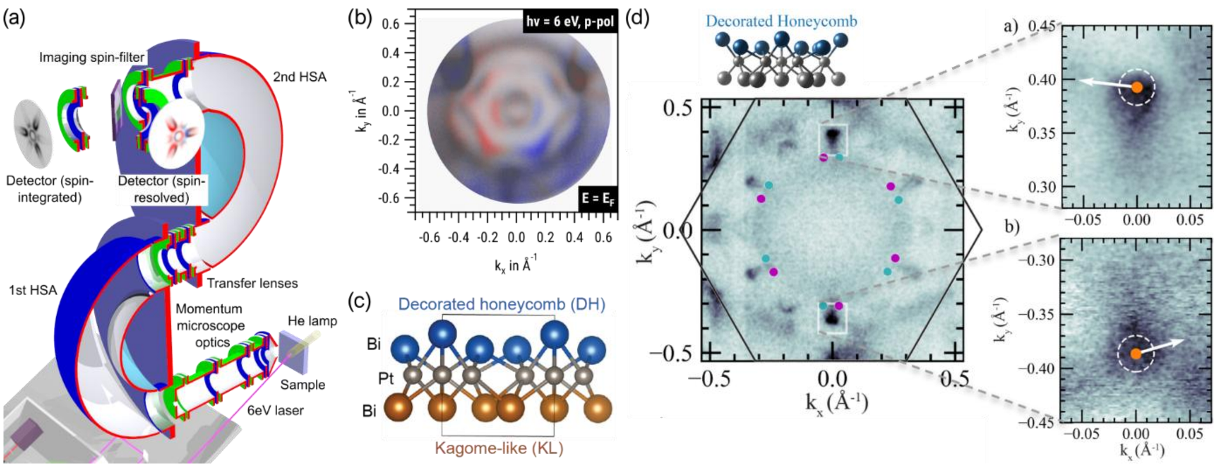

Fig. 1: (a) Sketch of the spin-resolved momentum microscope setup at NTNU Trondheim. (b) Spin-resolved momentum map of a $BiCu_2$ surface alloy. (c) Layer structure of $PtBi_2$. (d) Spin-integrated momentum map of DH-terminated $PtBi_2$ (insets: in-plane spin orientation of the Fermi arcs).