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Aktuelle Fragen
der Nanophysik

Sonderseminar

Unveiling hidden out-of-plane spin polarization in Bi(110) surface states by spin-resolved photoemission

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Magnetism and Density Waves in the van der Waals Antiferromagnet RTe_3

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Donnerstag, 27.08.2026 um 14:15 Uhr
R517, Wilhelm-Klemm-Str. 10

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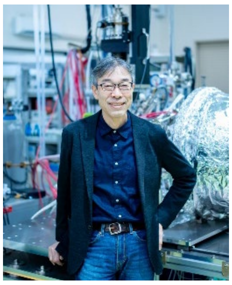

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Bismuth is a prototypical system for Rashba-type spin-polarized surface states arising from strong spin–orbit interaction. While the spin texture of the high-symmetry Bi(111) surface has been extensively studied, the lower-symmetry Bi(110) surface offers a unique platform where more complex and less constrained spin textures can emerge.

In this work, we investigate the full three-dimensional spin texture of the Bi(110) surface states using spin- and angle-resolved photoemission spectroscopy (SARPES) at HiSOR.

As shown in Fig. 1, we observe a complex in-plane spin texture originating from the Rashba effect, in general agreement with previous reports [1,2] and first-principles calculations [2,3]. In addition, we find a substantial out-of-plane spin polarization (*Pz*), which has not been fully characterized. More importantly, the *Pz* texture exhibits an unexpected lifting of spin degeneracy at the Brillouin zone boundary, in apparent contradiction to symmetry-based expectations. Our first-principles calculations indicate that the nominal cancellation of *Pz* arises from quantum interference between two surface wave functions with opposite out-of-plane spin polarizations. Our results suggest that the photoemission process selectively probes one of these components, thereby revealing a hidden *Pz* polarization. This demonstrates that the apparent vanishing of spin polarization does not necessarily imply its absence, but can originate from interference effects at the wave-function level.

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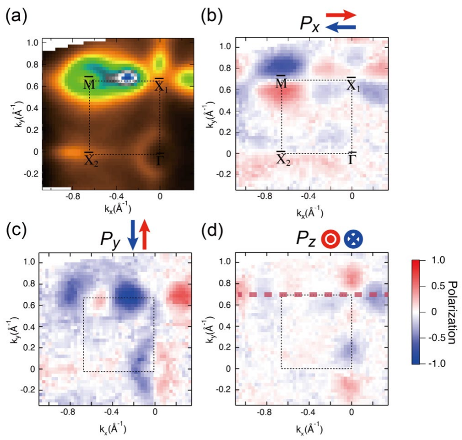

Figure 1:
(a) Spin integrated Fermi Surface(FS) and spin-resolved FS mapping for (b) *PX*, (c) *PY*, and (d) *PZ* taken with unpolarized light from an He discharge lamp ($h\nu$=21.22 eV). The degree of spin polarization is shown using the same red-white-blue color scale. Unexpected breaking of spin degeneracy at the Brillouin zone boundary (pink dashed line) is observed in *PZ*.

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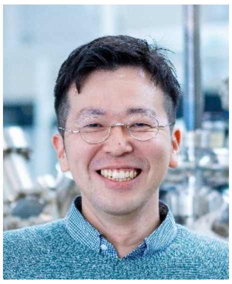

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In recent years, exotic electronic and magnetic phases arising from Fermi-surface instabilities have attracted considerable attention [1]. In the quasi-two-dimensional compounds RTe_3 (R: rare-earth element), multiple Fermi-surface nesting vectors have been proposed. However, only a single charge-density wave (CDW) had been observed in $CeTe_3$, and the remaining nesting instabilities were thought to play little role in its physical properties (Fig. 1). Meanwhile, intriguing magnetic structures closely related to the CDW wave vectors have been discovered in several RTe_3 compounds [2].

Using low-temperature scanning tunneling microscopy, we visualized multiple electronic modulations emerging within the antiferromagnetic phase of $CeTe_3$. Across the spin-flop transition [3], the modulation switches dramatically from a stripe pattern to a checkerboard-like electronic Moiré phase formed by the superposition of distinct wave vectors [4]. Comparison with the Fermi surface extracted from quasiparticle-interference measurements reveals that these modulation wave vectors correspond to multiple latent Fermi-surface instabilities. These results suggest that magnetic order selects among competing, frustrated Fermi-surface instabilities, thereby generating versatile electronic Moiré phases. In this talk, I will discuss the origin of these phases and their connection to Fermi-surface frustration based on real-space imaging and quasiparticle-interference measurements.

References:

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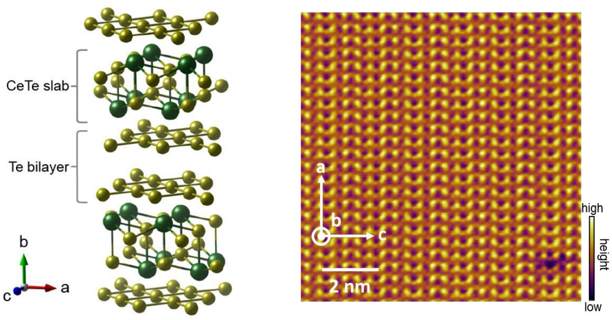

Figure 1.
Crystal structure of CeTe3 and STM topograph taken at 4 K (-60 mV/200 pA).