Fast 3D-Mapping of Electronic Band Structures

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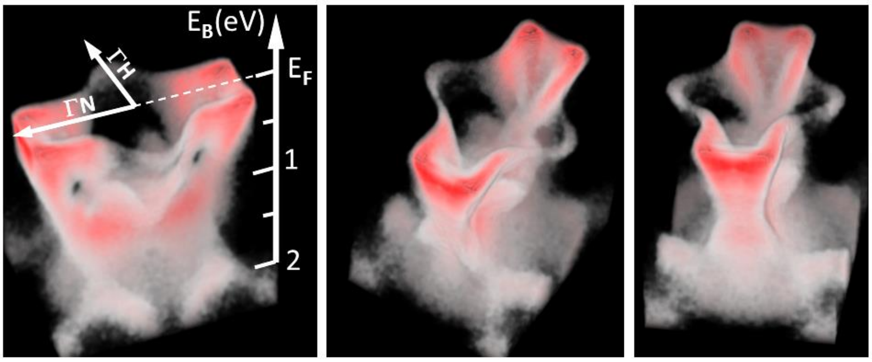
Owing to the translational symmetry of crystalline solids, their electronic band structure is periodic in *k*-space and is fully described in the 1st Brillouin zone (BZ). ARPES (mostly with hemispherical analyzers) is established as standard method for the analysis of *k*-space topologies.

In cooperation with MPI für Mikrostrukturphysik (Halle), we develop a novel *3D*-technique (***time-of-flight k-microscopy***) for simultaneous detection of the $E(k_{II})$-dispersion in the full surface BZ. The method exploits a basic principle of electron microscopy: A reciprocal (or Fourier) image occurs in the backfocal plane of a special objective lens (strong electrostatic immersion lens). This image in Fourier space is nothing else that the k_{II}-distribution, which is conserved in the photoemission process. *k*-microscopy thus provides a direct look into the $E(k_{II})$ bandstructure on a linear *k*-scale in a range exceeding the first BZ. Parallel energy acquisition is facilitated by implementation of an imaging time-of-flight spectrometer, cf. [1]. The 3D acquisition causes minimum radiation damage to delicate samples, because all electrons are detected in parallel. The status of the development is demonstrated by the example of an anomalous surface state discovered on Mo(110) [2], see figure (taken in 20 min. at fixed setting of the microscope).

3D dichroism maps yield information on the band symmetries. An imaging spin filter will open an extremely fast way of spin-resolved band mapping [3]. A high-energy version will establish a novel way of HAXPES.

[1] Schönhense et al., *Surf. Sci.* **480** (2001) 180; [2] Chernov et al., *submitted*; [3] Tusche et al., *APL* **99** (2011) 032505; Kolbe et al., *PRL* **107** (2011) 207601. Funded by BMBF (05K12UM2,05K12EF1,05K13UM2).



3D data stack taken for the Mo(110)-surface at hν=35 eV in 3 perspective views (from [2]).
BESSY II, single bunch, U125 SGM.