

## Soft-X-Ray ARPES at Swiss Light Source: Instrumentation and Applications to Three-Dimensional Systems

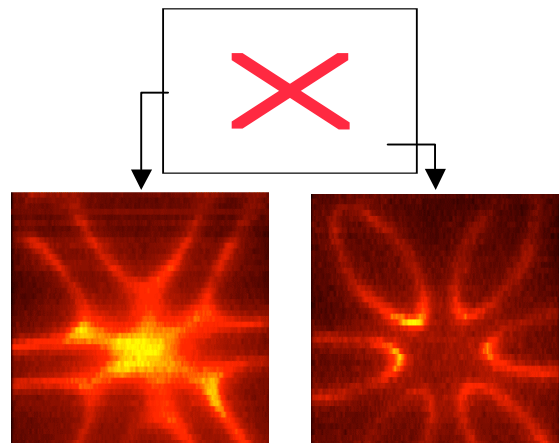
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ARPES experiments in the soft-X-ray energy range bring advantages of free-electron final states, simplified matrix elements and increasing photoelectron escape depth  $\lambda$ . The latter, along with enhancement of the bulk sensitivity, implies improvement of the intrinsic resolution in surface-perpendicular momentum  $\Delta k_z = \lambda^{-1}$ . In combination with the free-electron final states, this enables reliable investigations of electronic structure in 3-dim systems.

The ADDRESS beamline (V.N. Strocov *et al*, J. Synchrotron Rad. **17** (2010) 631) delivers soft-X-ray radiation with variable polarizations in  $h\nu$  range from 300 to 1600 eV. Large photon flux topping up  $10^{13}$  photons/s/0.01%BW at 1 keV has allowed us to break through the notorious problem of small valence band cross-section in the soft-X-ray range. Operation with a combined energy resolution of 110 meV delivers spectra of publication quality within 5 min, and with 60 meV within 30 min.

Our study of 3-dim electronic structure of VSe<sub>2</sub> performed around 1 keV shows excellent spectral contrast, demonstrating that the Debye-Waller factor and phonon broadening are in general not prohibitive for  $\mathbf{k}$ -resolution of soft-X-ray ARPES. Evolution of the spectra with  $h\nu$  reveals  $\Delta k_z \sim 0.05 \text{ \AA}^{-1}$  corresponding to  $\lambda$  of about a factor of 4 greater than in conventional ARPES. The figure shows the experimental Fermi surface (FS) sliced with  $k_z$  in the  $\Gamma$ KM plane ( $h\nu = 885 \text{ eV}$ ) and AHL plane (945 eV). Such textbook clear maps appear by virtue of free-electron final states, their good definition with small  $\Delta k_z$  and smooth matrix elements achieved with soft-X-ray energies. Furthermore, a perpendicular cut of the FS demonstrates its significant warping to give rise to out-of-plane component of CDWs.



I will also overview our recent experiments on signatures of exciton mediated CDWs in TiSe<sub>2</sub>, alternating shapes of the FS in 3-dim HTSC pnictides, and hybridization between  $sp$ - and  $f$ -states in heavy-fermion systems. Our first results demonstrate an immense potential of soft-X-ray ARPES to deliver a clear view of 3-dim electronic structure.