**Photoemission final states by very-low-energy electron diffraction: Resolving electronic structure in 3-dimensional k-space**

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Most of our knowledge about the electronic structure with resolution in the **k**-space has been achieved by angle-resolved photoemission spectroscopy (ARPES). This technique has however a fundamental flaw in that due to the involvement of the surface the control over full 3-dimensional **k** requires knowledge of the final-state dispersions and lifetimes. This information can be unveiled by Very-Low-Energy Electron Diffraction (VLEED), where energies of the spectral structures give energies of characteristic points in the final-state dispersions, and their broadenings reflect the lifetimes. A vast body of the VLEED experimental data demonstrates that for many materials the final states, contrary to the conventional free-electron-like picture, can feature dramatic deviations from that such as non-parabolic dispersions and multiband composition (often referred to as umklapp bands). As an example, the figure shows the VLEED intensity as a function of $\mathbf{K}_{//}$ measured on $VSe_2$, where the non-parabolic dispersions evidence non-free-electron final states. Combining ARPES with the VLEED derived final states allows complete resolution of the electronic structure in 3-dimensional **k**-space under control over the intrinsic resolution of the ARPES experiment. This innovative approach is illustrated on some weakly and strongly correlated metals (Cu, Ni), and quasi-2-dimensional materials (graphite, $VSe_2$, $TiTe_2$, $Bi_2Sr_2CaCu_2O_8$) focusing on the layer-perpendicular band dispersions. Further applications of VLEED such as determination of the mean free path and diffraction replicas of the ARPES signal are discussed.