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Set Point Effects in Fourier Transform Scanning Tunneling Spectroscopy

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Fourier Transform Scanning Tunneling Spectroscopy (FT-STS) has become an important experimental tool for the study of electronic structure. By combining the local real space picture of the electronic density of states provided by scanning tunneling microscopy with the energy and momentum resolution of FT-STS one can extract information about the band structure and dispersion. This has been thoroughly demonstrated in studies of the superconducting cuprates, the iron arsenides, and heavy fermion compounds.

FT-STS relies on the Fourier transform of the dI/dV, the derivative of the tunneling current with respect to the applied bias. Under the approximations of zero temperature, a flat tip density of states, and an energy independent tunneling matrix element it can be shown that the dI/dV signal is proportional to the local density of states of the sample. Under real experimental conditions, however, these approximations are not strictly valid, leading to additional functional dependencies of the dI/dV. A variety of artifacts can result when one considers the three most common measurement modes: constant current maps, constant height maps, and spectroscopic grids.

We illustrate the different artifacts that can appear in FT-STS using data taken from the well understood surface state of an Ag(111) single crystal at 4.2 K and under ultra-high vacuum conditions. We find that constant current dI/dV maps taken with a lock-in amplifier lead to a feature in the FT-STS dispersion that disperses as a function of energy below the Fermi level (E_F) and becomes constant above E_F. This result shows the importance of distinguishing dispersing features caused by quasiparticles in the sample from those caused by the measurement. We compare the set point artifacts in all three modes of measurement to scattering model simulations based on the T-matrix formalism. Finally we propose a guide to help identify and isolate these set point artifacts for future studies in systems where the band structure and correlations create a complex scattering space.

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