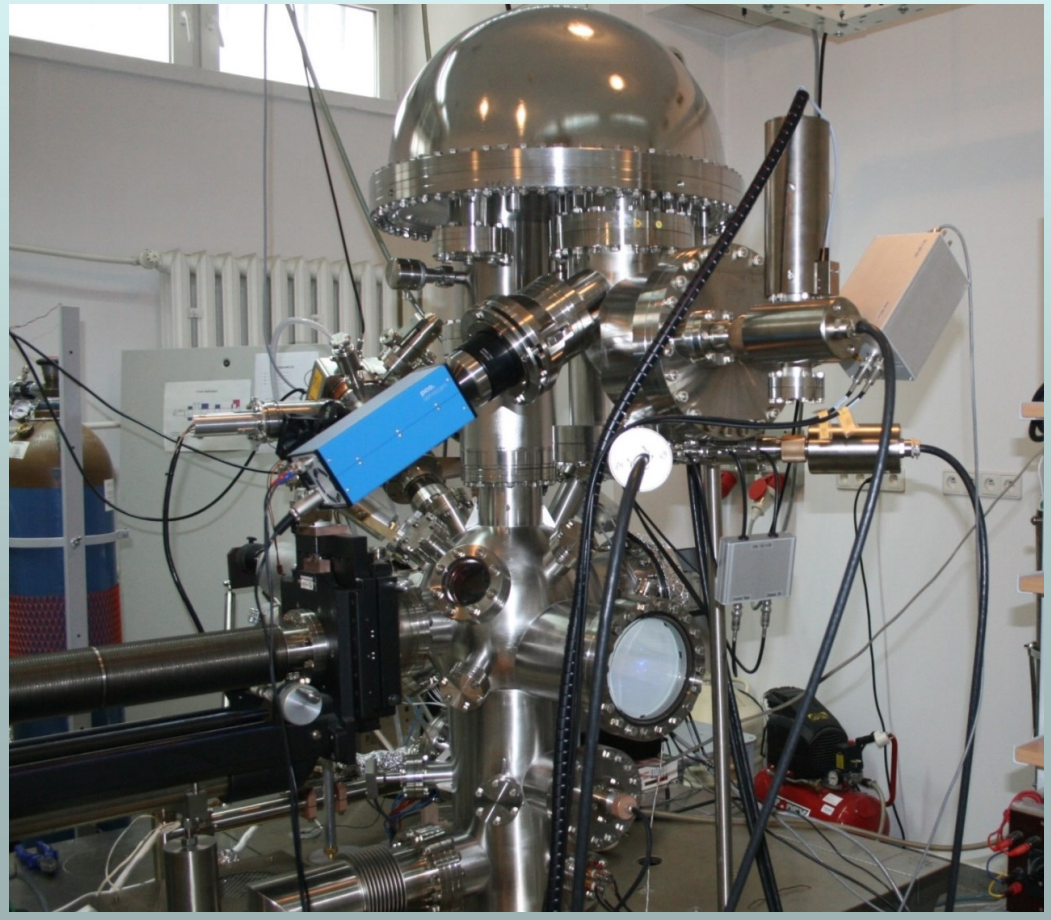
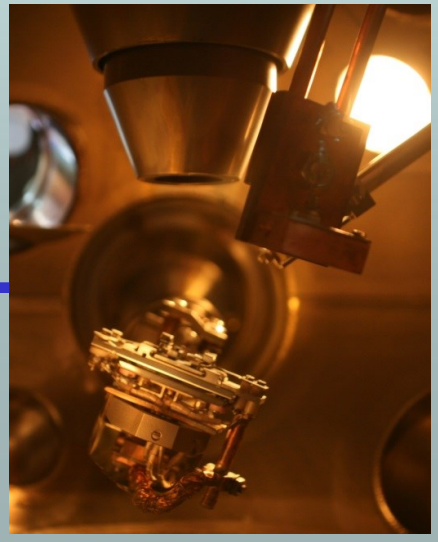
ARPES apparatus with Mott detector in UMCS

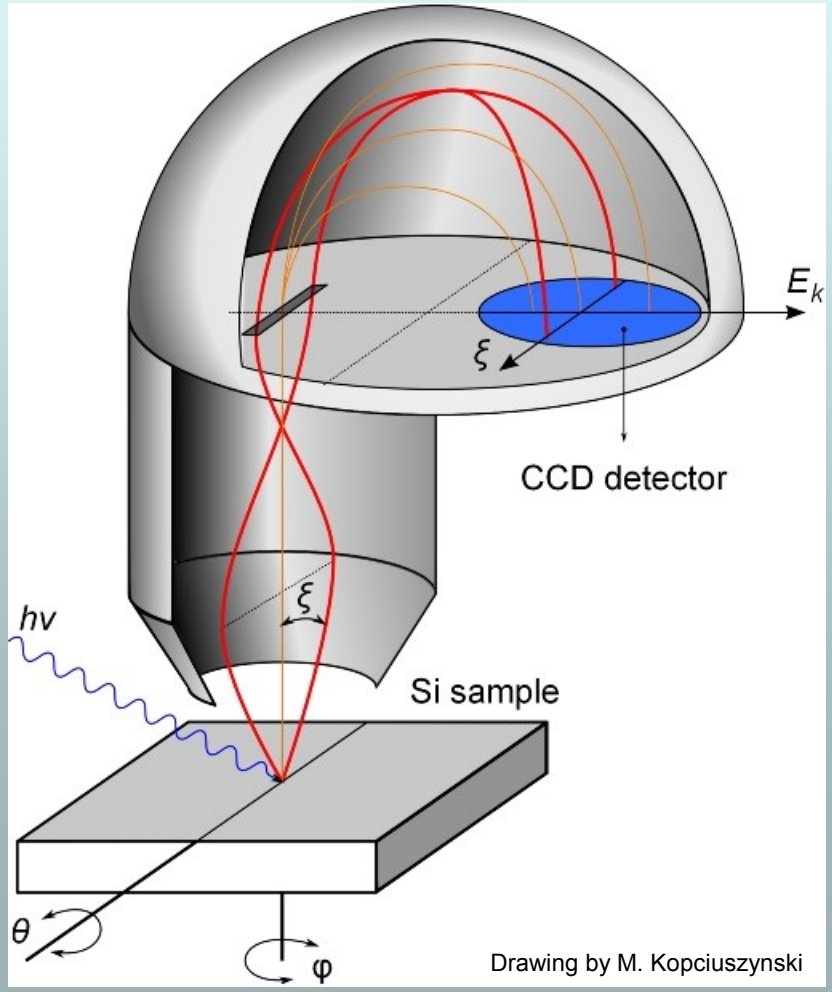


For ARPES measurement the photoelectrons, after passing the analyzer, are deflected to two-dimensional detector composed of channelplates and CCD camera (blue box).

For spin orientation mesurement the photoelectrons are deflected to Mott detector with two channeltrons (tubes with black cables).



Analyzer with energy and momentum dispersion



Drawing by M. Kopciuszynski

Thick red lines show trajectories of two photoelectrons emitted at two different angles and with the same energy.
Emission angle dispersion is along the ζ-axis.

Three thin lines mark trajectories of photoelectrons emitted normal to the sample surface, with different kinetic energies.
Energy dispersion is along the E_k -axis.
A slice determines energy resolution (desired effect) but simultaneously reduces intensity (not desired).

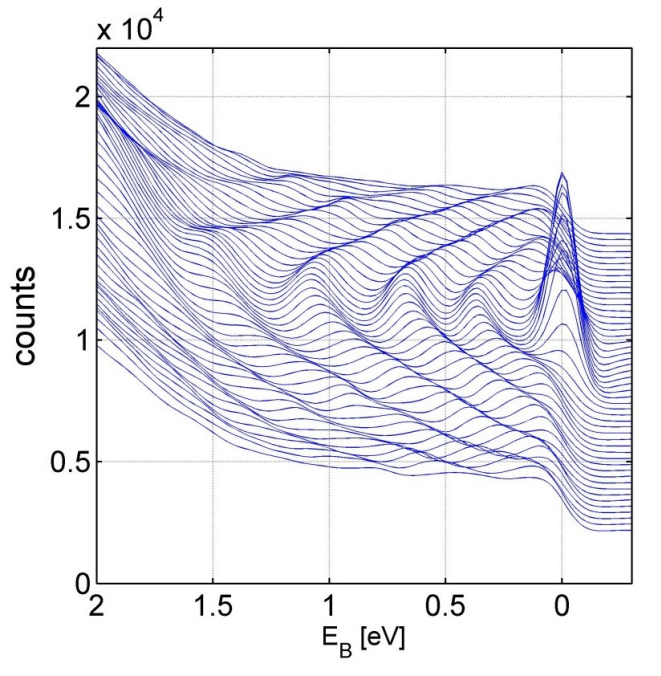
In this manner, each pair of coordinates on channelplate carries information on kinetic energy and emission angle of the detected photoelectron.

These parameters further allow determination parallel momentum component and binding energy of the electron inside the crystal.

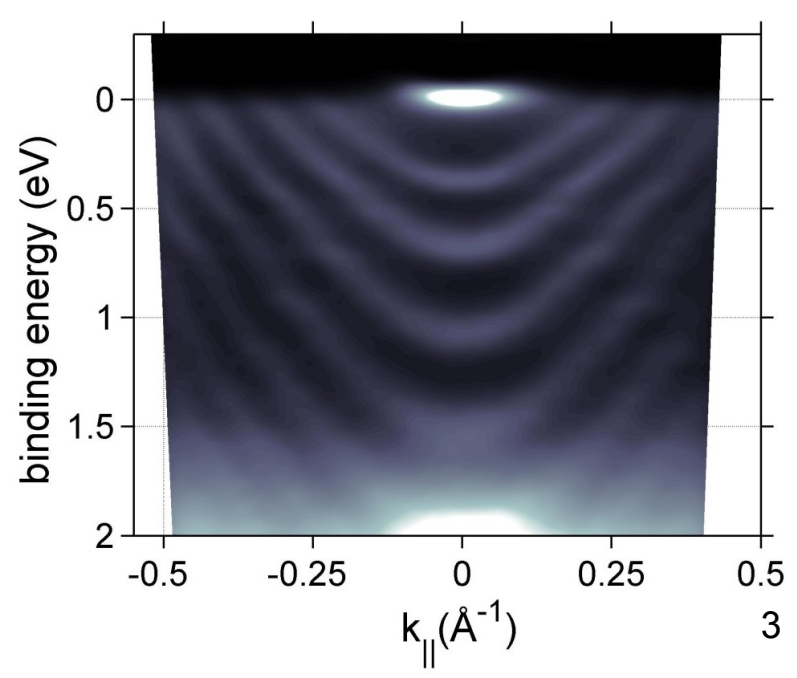
ARPES band map visualization - 16 ML Ag(111) on Si(111)

Results can be presented as a set of spectra of photoelectrons emitetd at different angles, or as intensity map vs k-vector component.

Several images from CCD camera are accumulated and numerically processed.



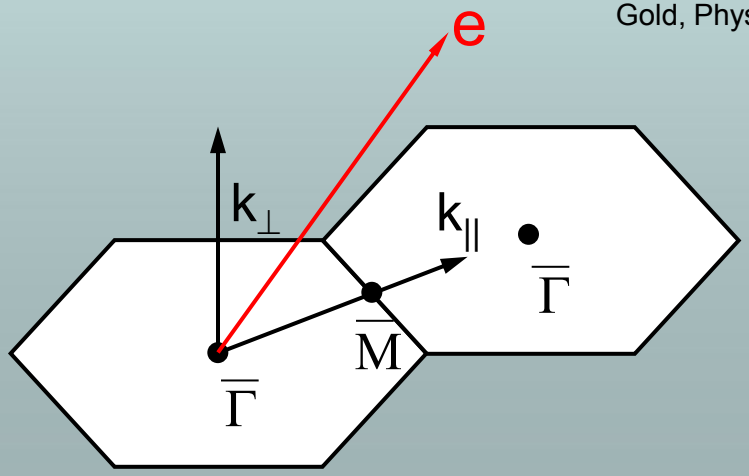
For enchancement of images contrast a second derivative of the intensity is frequently presented.



Photoemission from Quantum Well (QW)

Simple one-dimensional (1D) model assumes finite potential well with thickness given by integer number of Pb(111) crystal monoatomic layers (ML).

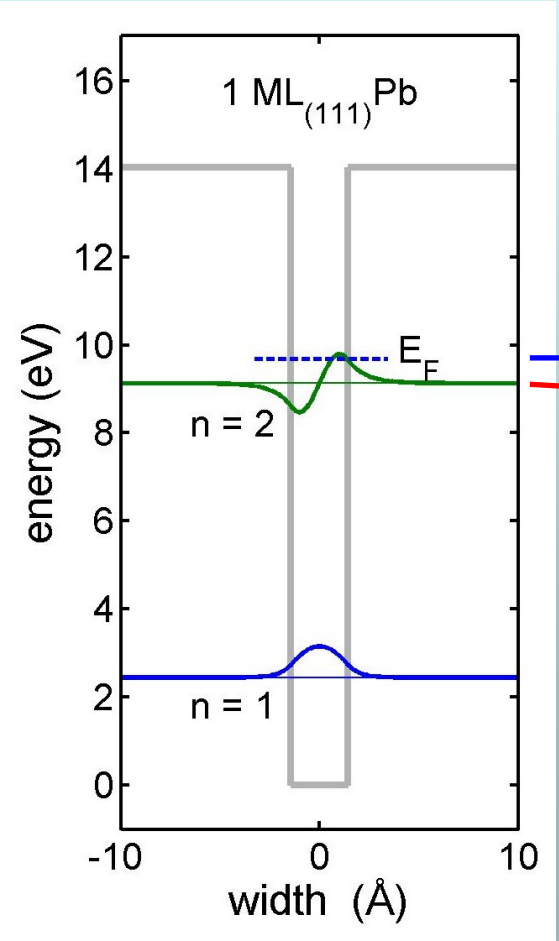
Depth of the well, Fermi energy position and electron effective mass are taken from much more advanced calculations within pseudopotential model of the band structure (J. R. Anderson and A. V. Gold, Phys. Rev. **139**, A1459 (1965)).



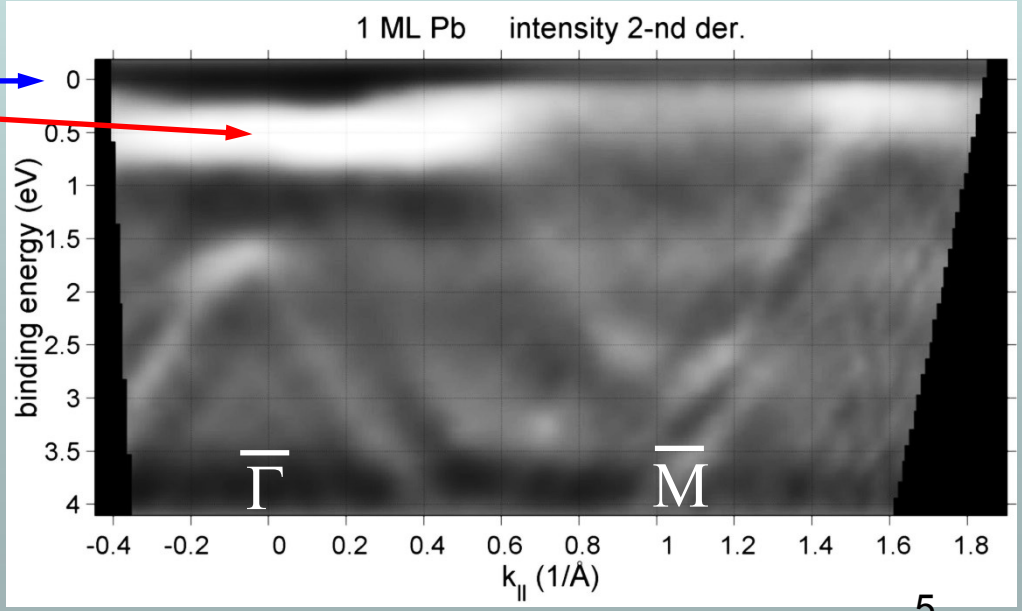
Following images show examples of ARPES results for photoelectrons with momentum component along $\overline{\Gamma}$ - $\overline{M}$ direction of the surface Brillouin Zone ([11$\bar{2}$] direction in the real space).

Photoemission from QW - 1 ML Pb(111)

Simplified 1D model

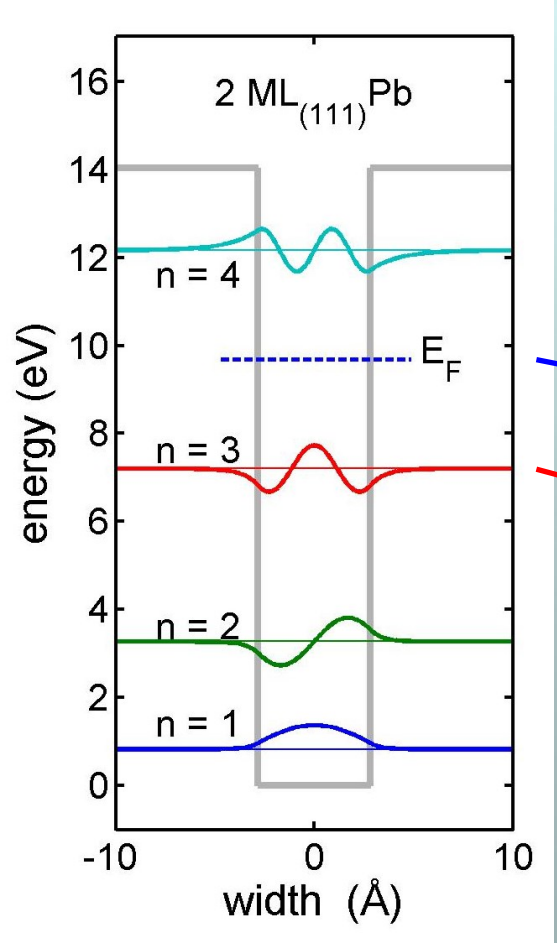


Second derivative of photoemission intensity for 1 ML Pb on Si(111)(6x)Au at 130 K.
A single QSE subband is observed.



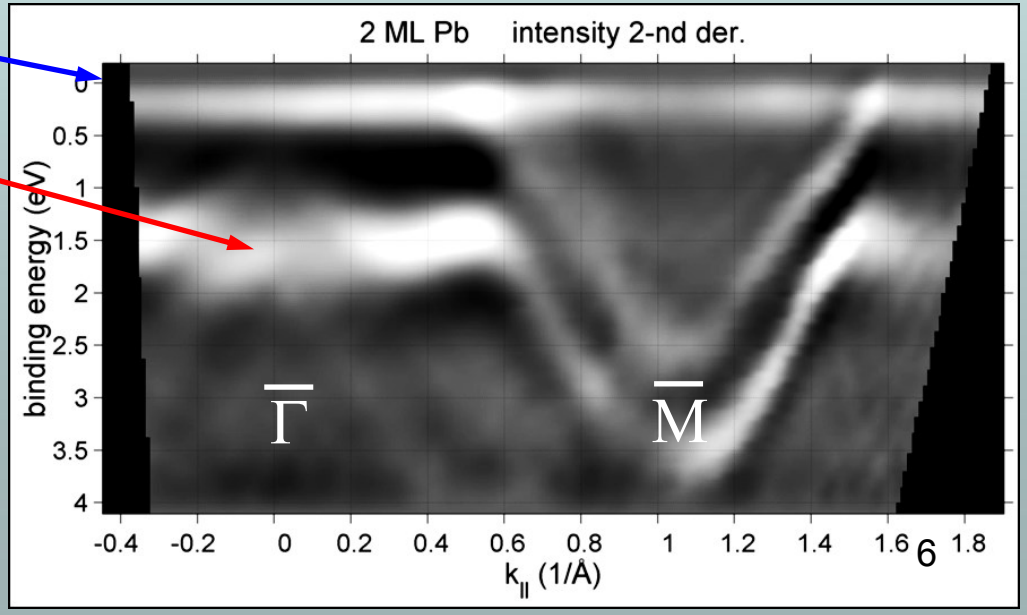
Photoemission from QW - 2 ML Pb(111)

Simplified 1D model



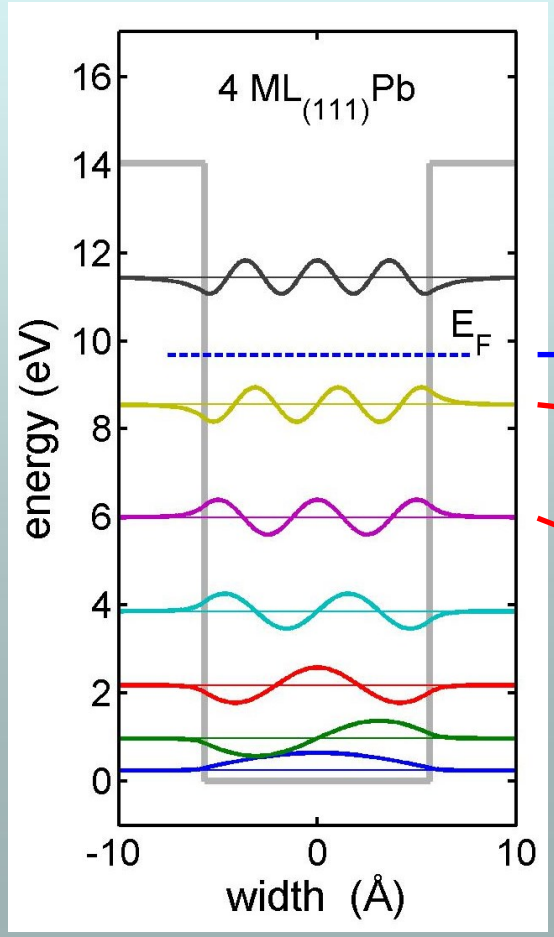
Second derivative of photoemission intensity for 2 ML Pb on Si(111)(6x)Au at 130 K. A single QSE subband is seen.

Intensity of the QSE level is modulated by parabolic bulk Si valence band. There electrons in Pb are less confined and "leak out" from the QW into bulk Si crystal.

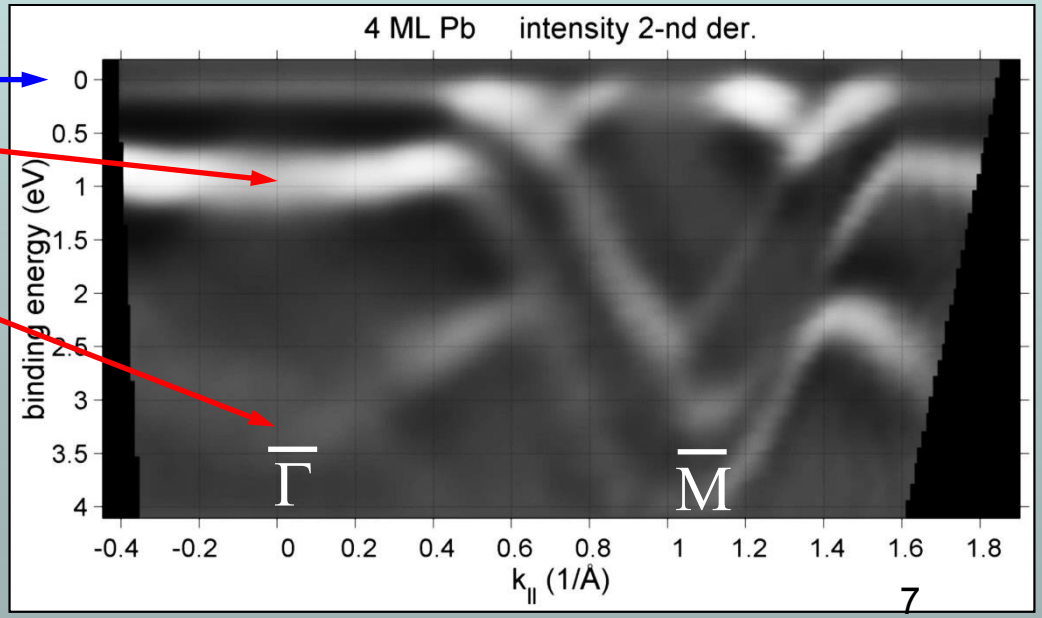


Photoemission from QW - 4 ML Pb(111)

Simplified 1D model



Second derivative of photoemission intensity for 4 ML Pb on Si(111)(6x)Au at 130 K.
Two QSE subband are observed.



Photoemission from thick film - 30 ML Pb(111)

Second derivative of photoemission intensity for 30 ML thick Pb layer on Si(111)(6x)Au at 130 K.

Numerous QSE subbands overlap. A sudden drop of photoemission intensity at the Fermi level is seen.