Name: ____________________________

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Advanced Solid State Physics — Prof. Dr. W. Kuch

Winter semester 2014/2015

9th exercise sheet

<u>Submission:</u> Tuesday, 16. December 2014, before the lecture
(or drop until 10 o'clock of the same day in mailbox between rooms 1.2.38 and 1.2.40)

**25. Angle-resolved photoemission: High-symmetry points** (**) (6 points)

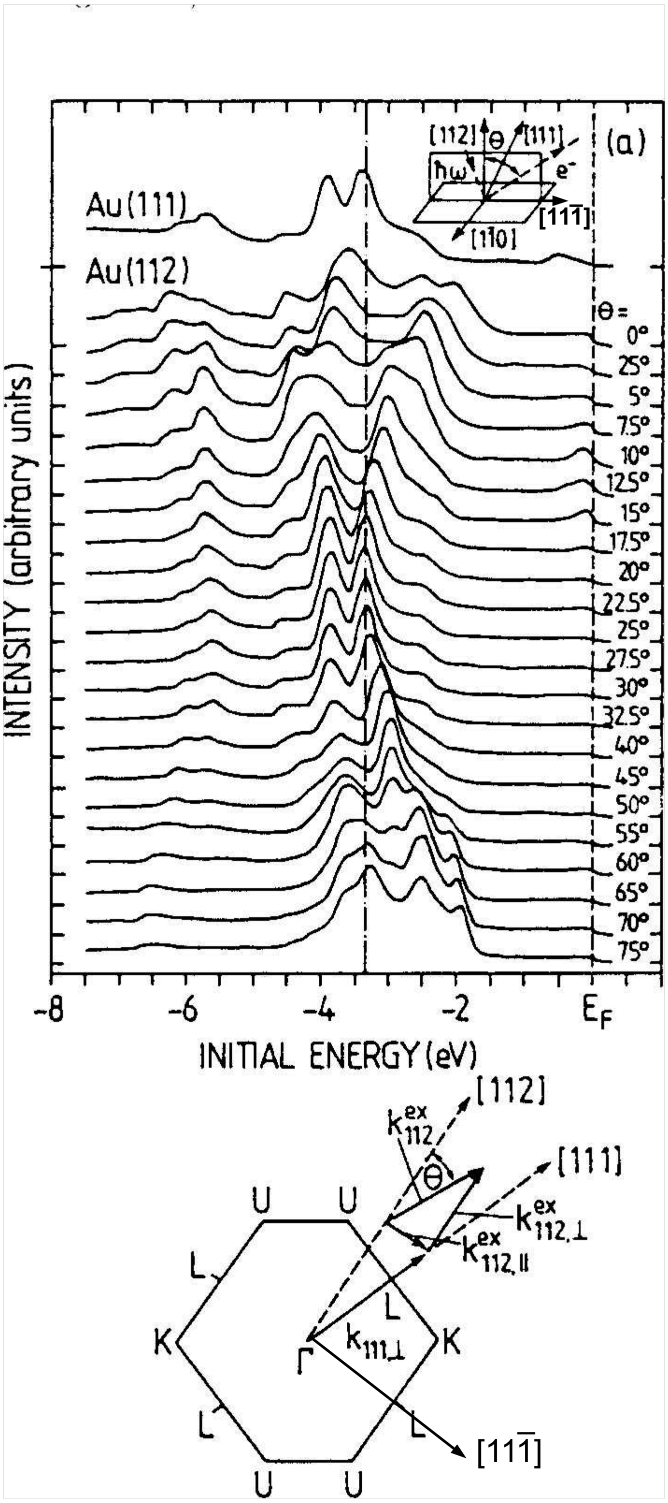
Imagine you are conducting an angle-resolved photoemission experiment at a Cu(001) surface and have a source delivering photons with energy between 20 and 100 eV. You want to measure initial states with a binding energy of about 2 eV. The work function of both sample and detector is 4.5 eV, the Fermi energy of Cu 8.5 eV, and the lattice constant 3.61 Å. Assume a free-electron parabola for the final state and calculate

a) the photon energy at which you detect in normal emission states at the X point;
b) the photon energy and the emission angle to the surface normal along the [110] azimuth at which you detect states at the L point.

**26. Angle-resolved photoemission: Triangulation** (***) (6 points)

In an angle-resolved energy coincidence photoemission experiment shown overleaf photoelectron spectra are measured for different emission angles within the $[11\bar{1}]$ azimuth on a Au(112) surface. In order to determine the wave vector **k** of the electrons in the crystal, the spectra are compared to a photoelectron spectrum measured in normal emission on a Au(111) surface.

Let us assume we would not have the additional spectrum from the Au(111) surface, and need to determine **k** from the free-electron approximation for the final state band. Calculate the emission angle θ within the $[11\bar{1}]$ azimuth of Au(112) at which emission from initial states on the $\overline{\Gamma L}$ axis with a binding energy of 3.5 eV would be expected in the free-electron approximation for the final state band. Use the following parameters: Photon energy 16.85 eV, work function 4.5 eV, Fermi energy 7.5 eV. Compare your result to the result of the energy coincidence experiment shown overleaf.



(a)
Au(111)
Au(112)
[112]
[111]
[11$\bar{1}$]
[1$\bar{1}$0]
ħω
e⁻
Θ
Θ =
0°
2.5°
5°
7.5°
10°
12.5°
15°
17.5°
20°
22.5°
25°
27.5°
30°
32.5°
40°
45°
50°
55°
60°
65°
70°
75°
INTENSITY (arbitrary units)
-8
-6
-4
-2
$E_F$
INITIAL ENERGY (eV)
$k^{ex}_{112}$
$k^{ex}_{112,\perp}$
$k^{ex}_{112,\parallel}$
$k_{111,\perp}$
U
L
K
Γ