Name: ____________________________

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

Winter semester 2014/2015

4th exercise sheet

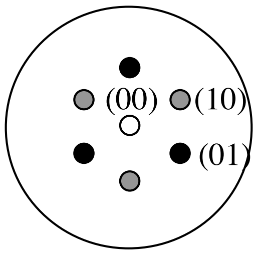
<u>Submission:</u> Tuesday, 11. November 2014, before the lecture
(or drop until 10 o'clock on the same day in mailbox between rooms 1.2.38 and 1.2.40)

10. Diffraction at finite particle number (**) (4 points)

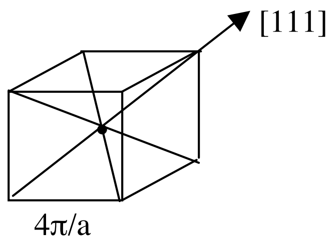
In a LEED system with sample–screen distance $L = 100$ mm the LEED spots of an ideal single crystal surface appear with a width of 1.0 mm on the screen at an electron energy of 150 eV. Estimate from those numbers the transfer width of this LEED system.

11. Kinematic approximation (***) (4 points)

In a LEED picture, certain diffraction spots exhibit maximum intensity at certain electron energies, similar to the (00) spot (cf. exercise no. 9). Some of these maxima correspond to the single-scattering, others are caused by multiple scattering events. The left sketch shows the LEED pattern of a (111) surface of an fcc crystal. When the electron energy is varied, always the three spots marked in black ("01 spots") show the same intensity. The same is true for the three spots marked in gray ("10 spots"). (While the surface layer shows six-fold symmetry, the symmetry of the bulk crystal for rotation around [111] is three-fold.) Calculate for a Rh(111) surface (Rh: *fcc*, a = 3.79 Å) the electron energies in eV of the first two single-scattering maxima of both the (01) and (10) spots. The inner potential is $V_0 = 10$ eV.
Possible approach (suggested): Consider the points of the reciprocal lattice in [111] direction (Laue condition) and calculate the energy at which the Ewald sphere hits these points.



LEED picture



reciprocal lattice

12. Tunneling probabilities (*) (4 points)

Calculate the following tunneling probabilities:

a) for a lion (m = 200 kg; energy: the lion can jump up 2.0 m) and a barrier of 2.5 m height and 10 cm width;
b) for an electron with 2.0 eV energy and a barrier of 4.0 eV height and 5.0 Å width.