Condensed matter physics 2013
Exercise 3

Release: 1. Oct. 2013
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*Problem 11

As an example for a low-energy electron diffraction (LEED) experiment, electrons with a kinetic energy of 150 eV scatter at a Pd (100) surface (We assume no surface reconstruction, so that the crystalline structure of the bulk material continues to the surface). Determine all the reflexes that can be observed at this energy by means of Ewald's construction. Which symmetry has the diffraction pattern? Calculate the [11]-reflex angle between the incidence and the outgoing direction. We assume that the incident electrons perpendicular to the surface and interact only with the first surface layer. The lattice constant of the fcc-structure in Pd is 3.89 Å.

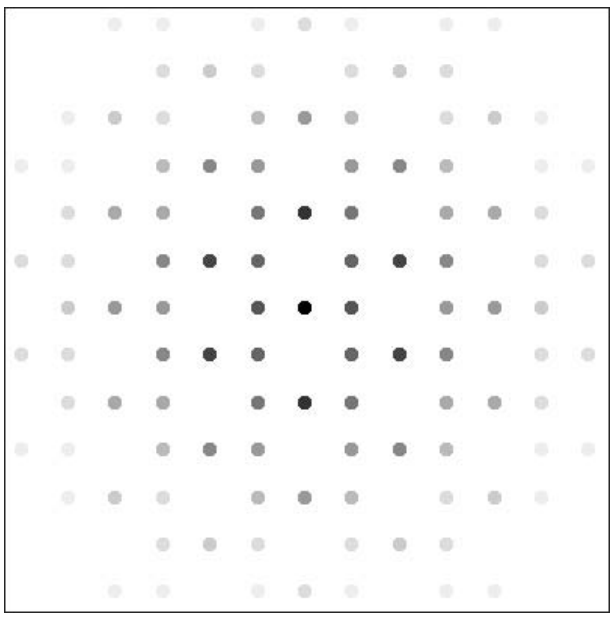
Problem 12

Make yourself familiar with Bravais lattices: Download the software "bravais" from *http://pages.physics.cornell.edu/sss/*, create a 2-dimensional square lattice with $a = 4$ Å and have the software generate its corresponding reciprocal lattice.

a) Insert another atom into the center of each square. How does the reciprocal lattice evolve?

b) Which lattice yields the Bragg pattern in the figure below?

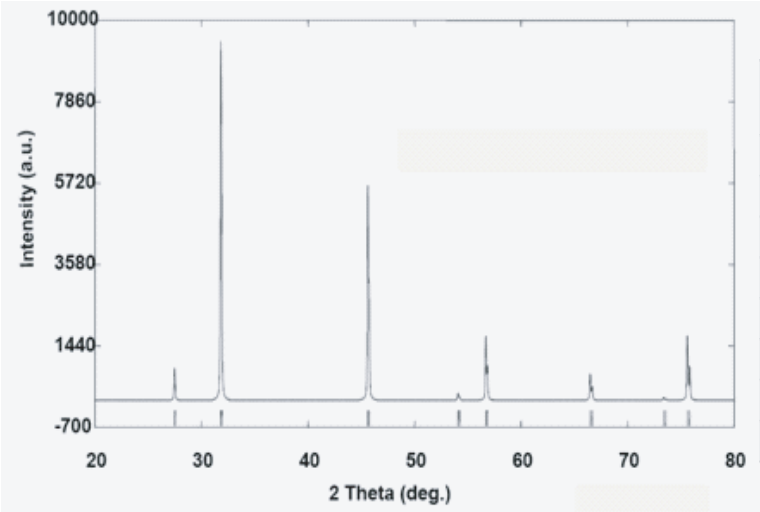
Please provide screenshots or accurate sketches as solutions.



*Problem 13

a) Prove that Laue and Bragg conditions are equivalent.

b) The following figures show the X-Ray diffraction (XRD) pattern ($\theta - 2\theta$ scan) for NaCl (fcc) powder obtained using a CuKα source ($\lambda = 1.54$Å). Obtain the Miller indices of the peaks using the Bragg equations. If we have an NaCl single crystal with [100] out-of-plane direction instead of the NaCl powder, which peaks will be observed in the XRD pattern? (lattice constant of NaCl: $a = 5.64$ Å)



Peak Positions (2θ)
27
32
45
54
56
66
73
75