Háskóli Íslands
Raunvísindadeild
Eðlisfræði

Haust 2015

Eðlisfræði þéttefnis I

Dæmablað 11

Skilafrestur 17. November 2015 kl. 15:00

1. **Fermi surfaces in two dimensions** (10)

   Consider a two-dimensional system of nearly free electrons (weak periodic potential) with a square unit cell (lattice constant a). Determine the Fermi surfaces for the cases of 1, 2, 3, and 5 electrons per unit cell. To this end, first project the free electron Fermi surface into the 1st Brillouin zone and then think about at what points gaps open. Plot the Fermi surfaces in the Brillouin zone. It might be useful to make separate plots for the different bands. (Note: Semi-quantitative plots are OK, i.e., you need to get the topology right, the exact positions are not so important.)

2. **Hall effect** (10)

   A sample of $n-$type GaAs whose carrier concentration is 10^{16} cm^{-3} is in the shape of a slab whose length is 5 cm, width 0.5 cm, and thickness of 1 mm. When this slab is palced in a magnetic field of 0.6 Wb/m^2 normal to the slab, with a current of 10 mA. Calculate

   (a) The Hall constant in this sample

   (b) The Hall voltage developed across the slab.

3. **The single Dirac potential** (10)

   We consider a particle of mass m trapped in a narrow potential well of depth V_0 (we assume $V_0 > 0$) and width a modeled as $V(x) = -aV_0\delta(x)$. Establish the particle ground state wave function $\psi(x)$ and energy E_0.