University of Zurich[UZH]

Solid State Physics
Exercise Sheet 11

FS17
Prof. Dr. Johan Chang

Discussion on 17th May

Due on 24th May

Exercise 1 *Electron / hole density and Hall effect in GaAs*
In the lecture, we derived for the electron density $n = 2\left(\frac{m_e k_B T}{2\pi\hbar^2}\right)^{3/2} \exp[(\mu - E_c)/k_B T]$ and a similar formula for the hole density p.

(a) Use the effective mass and the band gap (see table values of the lecture slides) to estimate n and p (for light holes).

(b) Calculate the Hall coefficient if only holes or electrons contribute.

Exercise 2 *Quantum oscillations on quasi two-dimensional systems*
In $Tl_2Ba_2CuO_{6+\delta}$, quantum oscillations with a frequency of $F = 18.1\,\mathrm{kT}$ are observed (B. Vignolle et al., Nature **455**, 952-955 (2008)).

(a) Use the Onsager relation ($S = 2\pi\frac{eF}{\hbar}$) to calculate the Fermi surface area.

(b) If we assume a circular Fermi surface shape, what is the Fermi momentum?

Exercise 3 *Quantum oscillations in gold*
Estimate the Fermi energy of gold (in eV) based on the oscillations of the spin susceptibility in a magnetic field, see figure 1. Which of the two superimposed oscillations corresponds to the largest orbit on the Fermi-sphere? Compare the result with the literature value $\epsilon_F = 5.51\,\mathrm{eV}$. Where is the other oscillation originating from?

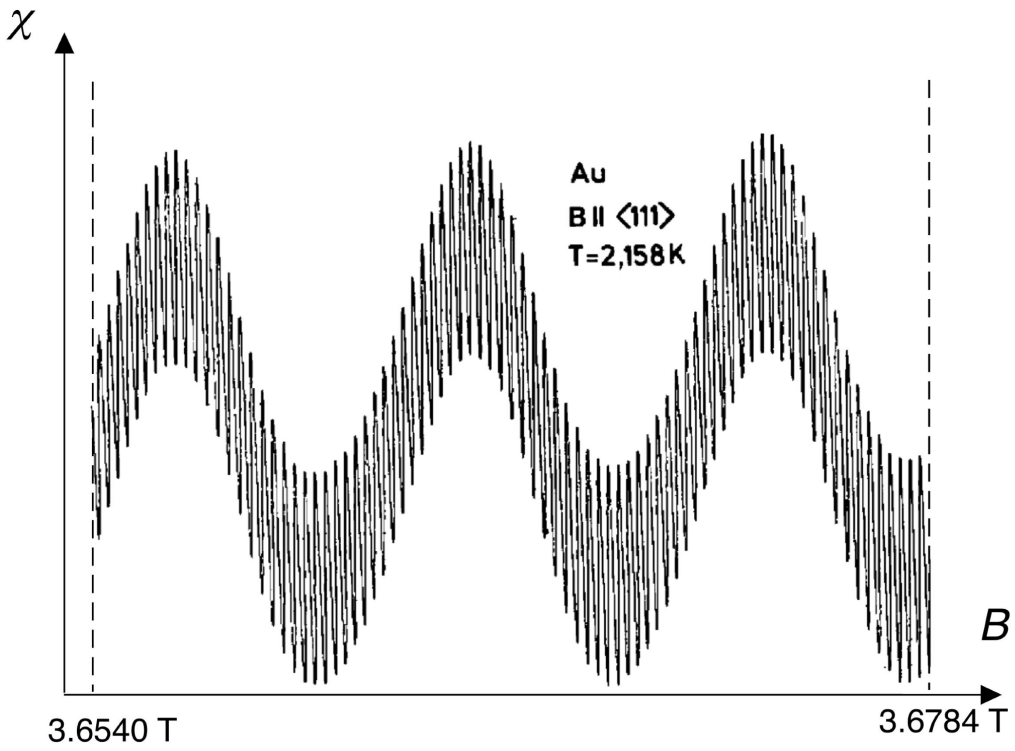

Figure 1: The spin susceptibility of gold in a magnetic field.