ETH
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Solid State Theory
Exercise 10

FS 15
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Problem 10.1 Reflectivity of semiconductors

In semiconductors, most electrons are not free to move through the crystal but are bound to the ions. In order to find a better description of their behavior, model this binding by an additional harmonic potential of the form $V = \frac{1}{2}m\omega_0^2\boldsymbol{r}^2$ and perform the same analysis as in Lecture 18. How does this influence the reflectivity discussed there?

Problem 10.2 Frequency dependence of conductivity

Keeping the $\partial f/\partial t$ term in the Boltzmann equation, find how the conductivity depends on the frequency of the ac electric field.

Problem 10.3 Umklapp processes

For electron-electron scattering all the momenta should lie close to the Fermi surface. The condition for the Umklapp process is

$$\max(|\mathbf{k_1} + \mathbf{k_2} - \mathbf{k_1'} - \mathbf{k_2'}|) > |\mathbf{K}_{\min}|,$$

where $\mathbf{K}_{\min}$ is the shortest reciprocal lattice vector. For very small Fermi surfaces this condition would not be satisfied. Check whether it is satisfied for the alkali metals that have half-filled band in the cubic lattice.