Kubo formula for AC linear response

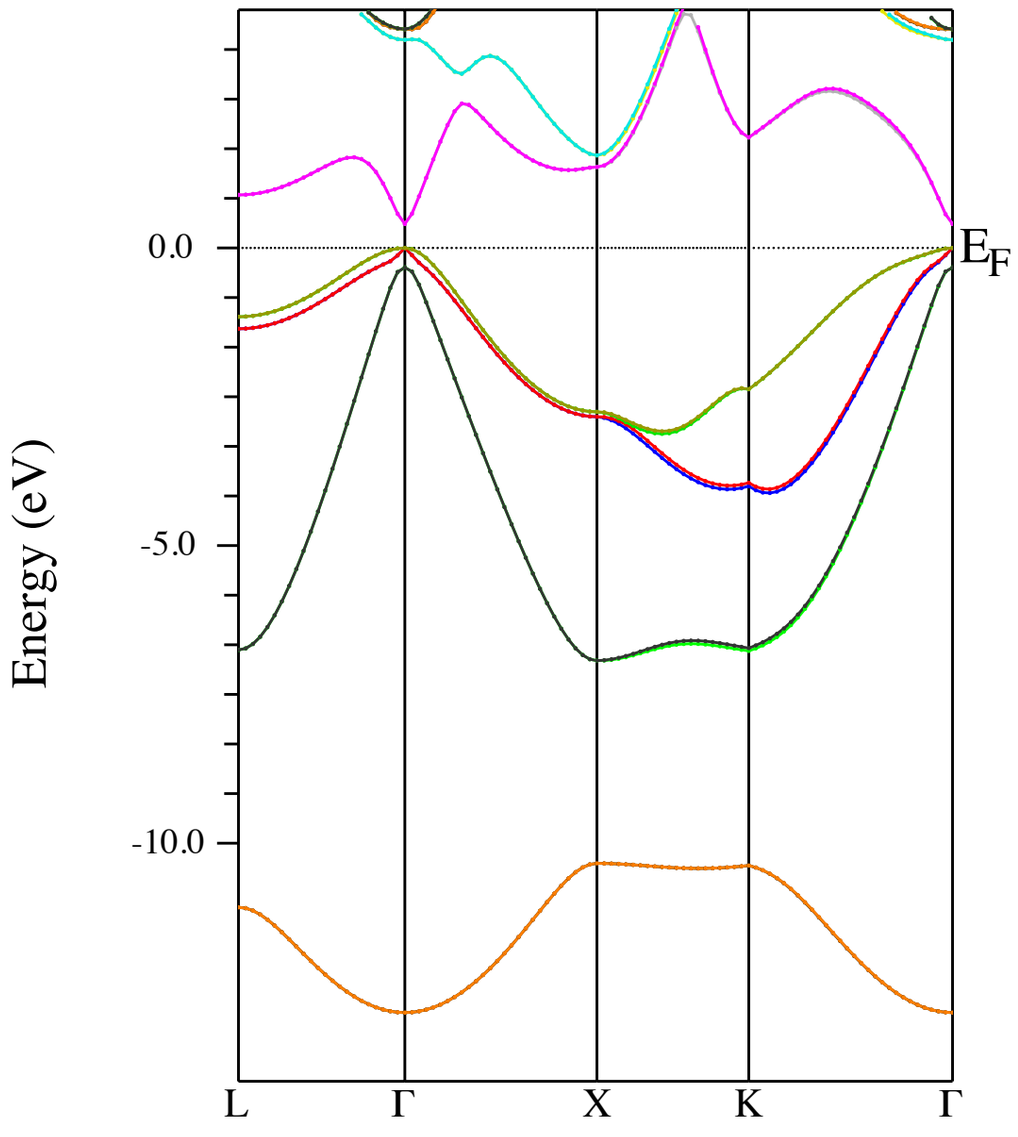
$$\sigma_{xx}(\omega) = -\frac{i\hbar e^2}{V}\sum_{\vec{k},a,b}\big(f(E_a)-f(E_b)\big)\frac{v_x^{ab}v_x^{ba}}{(E_{ab}+i\tilde{\varepsilon})(E_{ab}-\hbar\omega+i\tilde{\varepsilon})}$$

$$\sigma = \sigma_{\text{intra}} + \sigma_{\text{inter}}$$

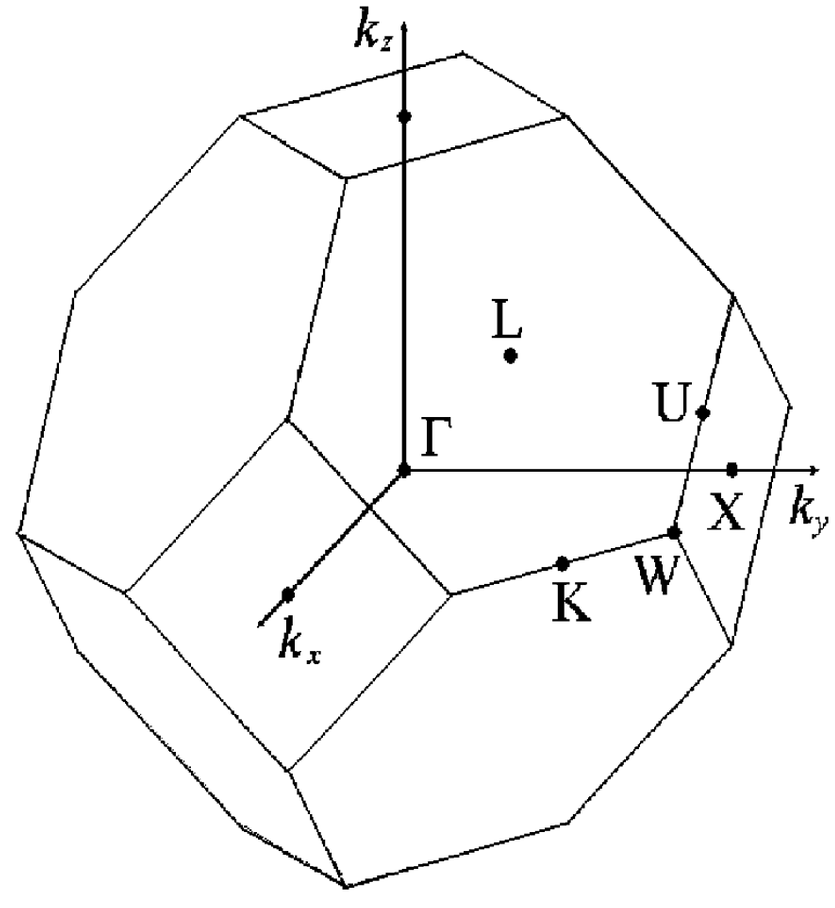
$$\sigma_{xx,\text{intra}}(\omega) = \frac{i\hbar e^2/V}{\hbar\omega+i\Gamma}\sum_{\vec{k},a}\left(-\frac{\partial f}{\partial E}\right)|v_x^{aa}|^2$$

$$\sigma_{xx,\text{inter}}(\omega) = \pi\hbar e^2 M_{xx}\frac{g_{ab}(\hbar\omega)}{\hbar\omega} - \frac{i\hbar e^2 M_{xx}}{V}\sum_{\vec{k},a<b}\frac{f_a-f_b}{E_{ab}}\frac{2\hbar\omega}{E_{ab}^2-(\hbar\omega)^2}$$

Example: GaAs

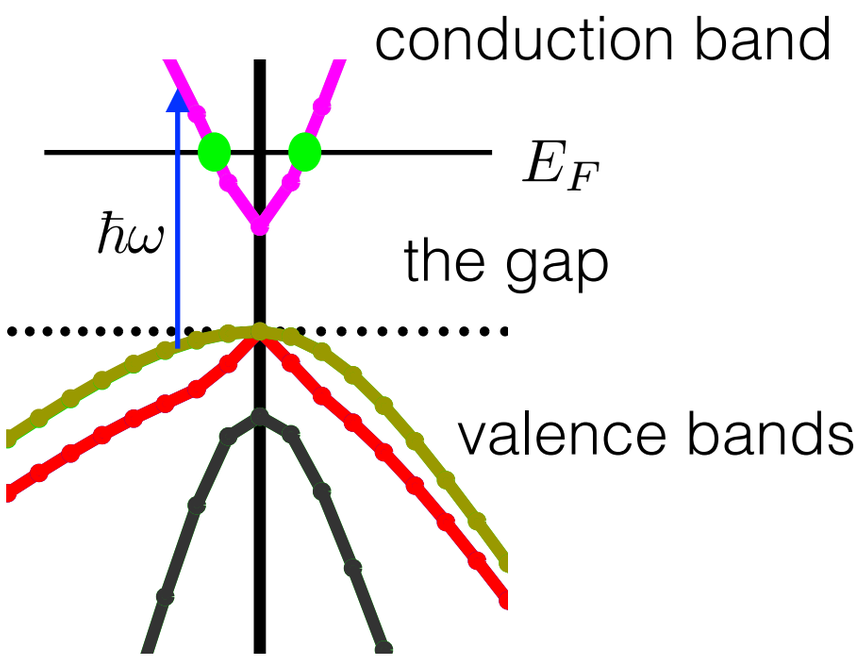


Brillouin zone



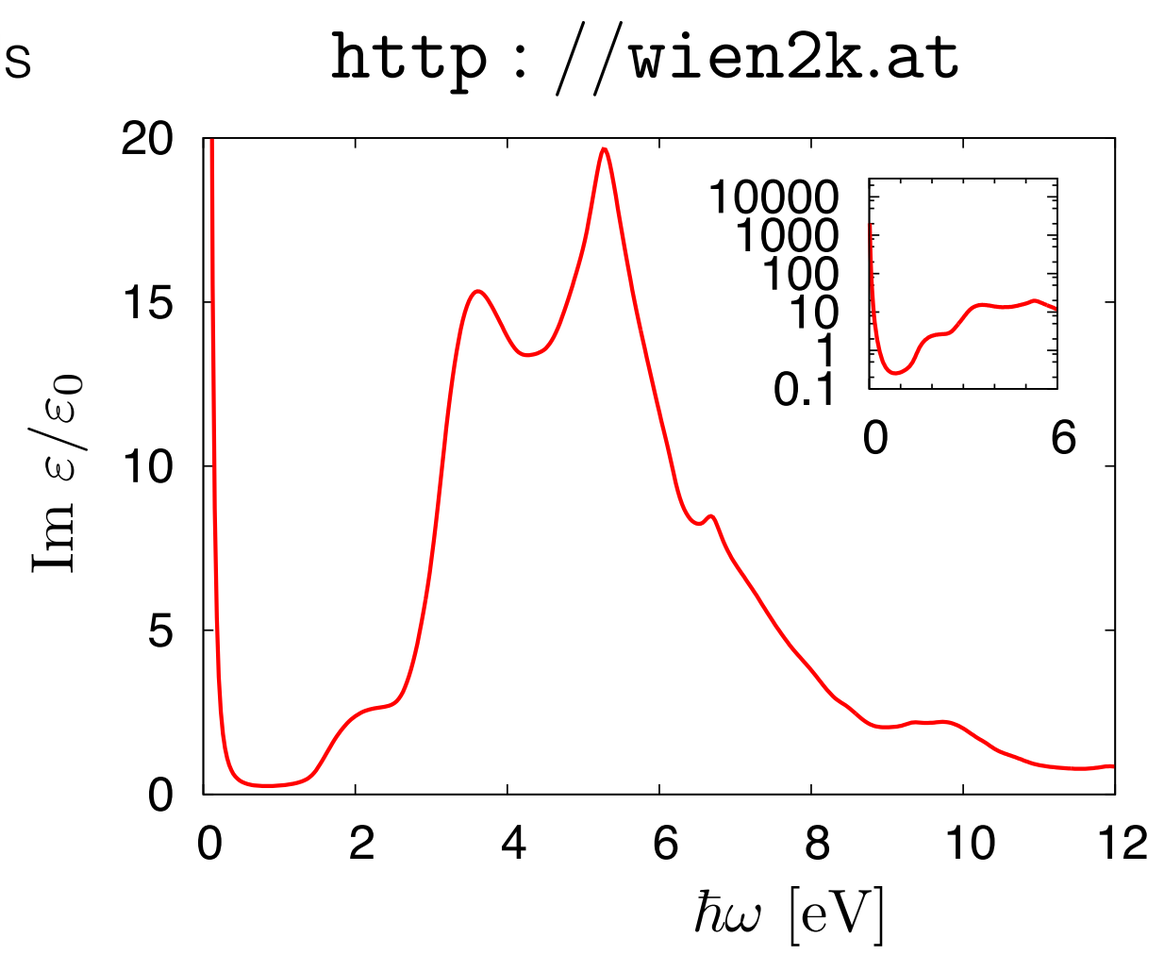
Example: GaAs

Say, n-doped…



- intraband: from plasma frequency - $\sigma_0 = \omega_p^2 \epsilon \tau$
- interband: from joint density of states - $g_{ab}(\hbar\omega)$

- interband transitions above the gap $\hbar\omega$
- Drude peak at low
- transparency window in between



Geometrical magnetoresistance (MR)