Effect of Coulomb interations on the optical properties of doped graphene

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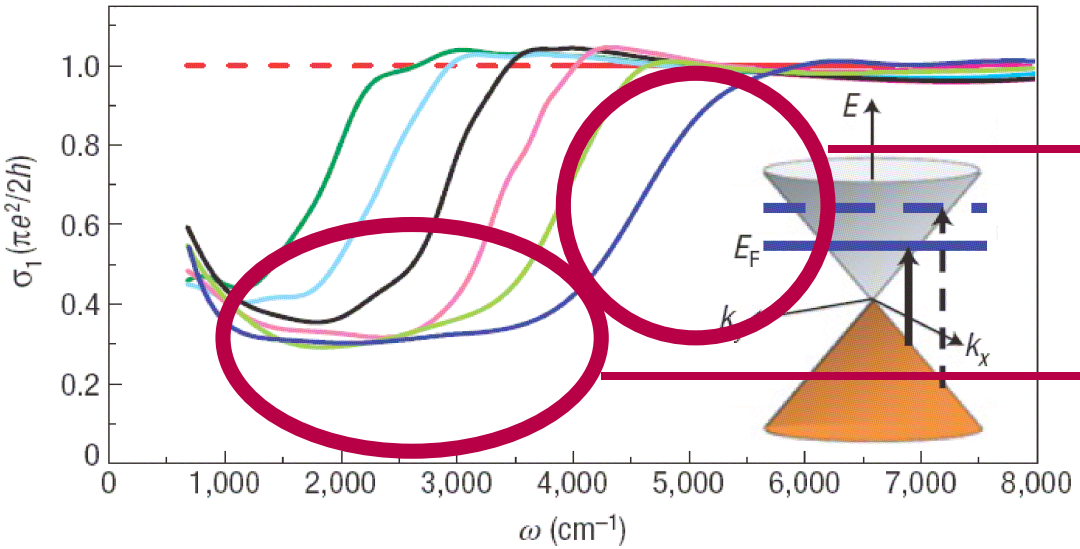
Motivation: Recent experiments by Z. Q. Li *et al.* Nature **4**, 532 (2008) regarding the optical conductivity in graphene:



Anomalous features

Broadening of the interband threshold step.

Prominent doping independent **residual conductivity** between intra and interband transitions.

Authors suggest a **possible mechanism**: electron-electron interaction combined with extrinsic effects such as impurities.

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Idea: The electronic properties of the Dirac point affects the optical properties of the doped system:

$$\mathrm{Im}\,\Sigma(\omega) = \begin{cases} a|\omega| + b & ,|\omega| < \Lambda \\ a\Lambda + b & ,|\omega| \geq \Lambda \end{cases}$$

Self energy ansatz

+

- $$\mathrm{Re}\sigma(\omega) = g_s g_v \frac{e^2 v_F^2}{4\omega} \sum_{s,s'} \int \frac{dkk}{(2\pi)^2} \int d\epsilon \left[n_F(\epsilon) - n_F(\epsilon+\omega)\right] A_s(k,\omega) A_{s'}(k,\epsilon+\omega)$$

  Kubo formula for the conductivity without vertex corrections.

- $$\omega\,\mathrm{Re}\,\sigma(\omega) \sim \mathrm{Im}\,\chi(\omega).$$

  Electronic contribution to the **Raman** spectra.

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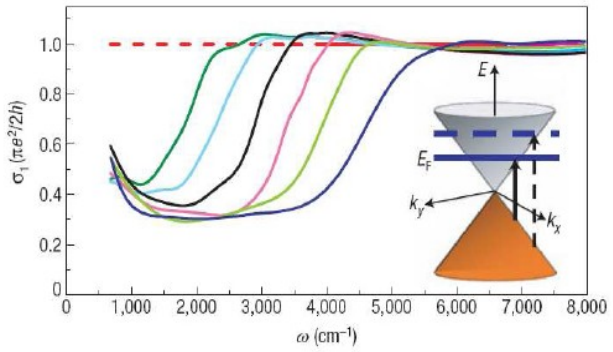
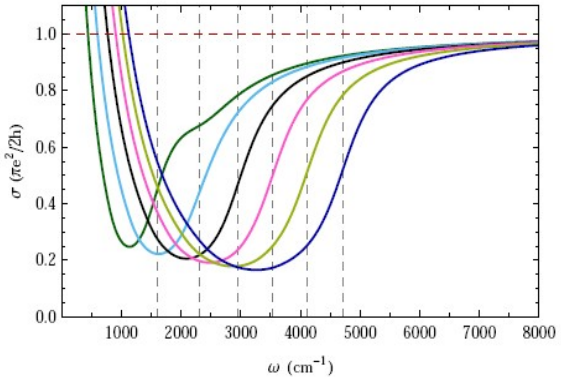
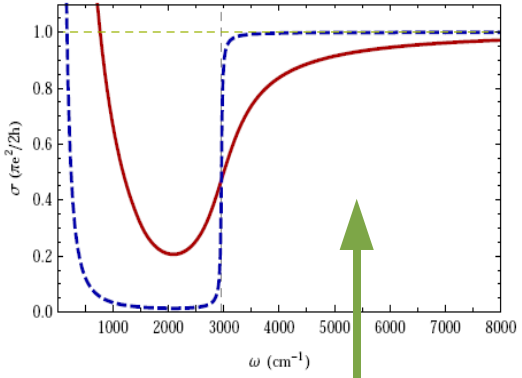
Results for α = 0.2, b = 0.001 eV, Λ= 0.15 eV:

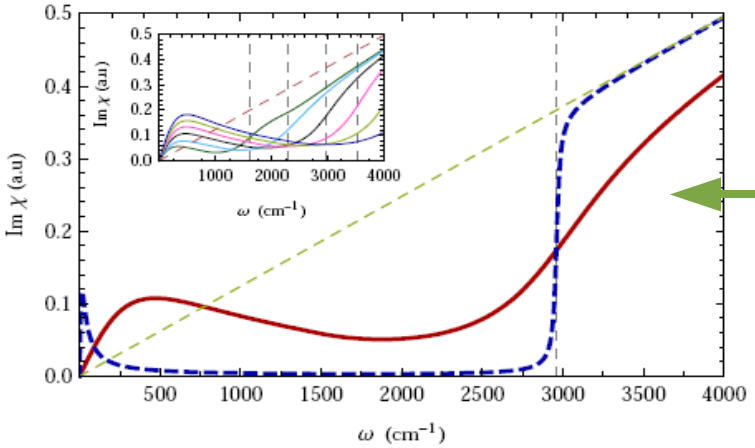
Optical conductivity:







Electronic Raman spectrum:



a = 0.2 b = 0

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