Quiz 21

Thursday, June 8, 2017 12:41 PM

LIGHT ABSORBTION BY GRAPHENE

The dispersion relationship of graphene near the Fermi energy is

$$E(\vec{k}) = \begin{cases} -\hbar v_F |\vec{k}| & \text{valance band} \\ +\hbar v_F |\vec{k}| & \text{conduction band} \end{cases}$$

For each value of $\vec{k}$ there is 4-fold degeneracy (spin & valley).

The optical transition matrix element for graphene is

$$\langle f | H' | i \rangle = \frac{e v_F \mathcal{E}_{opt}}{\sqrt{8}\, \omega_{opt}}$$

where ω_{opt} is the frequency of the incident light and $\mathcal{E}_{opt}$ is the amplitude of the oscillating electric field associated with the light. The incident photon flux (photons per unit time per unit area) is

$$\Phi = \frac{c \epsilon_0 \mathcal{E}_{opt}^2}{2 \hbar \omega_{opt}}$$

a) How many photons will be absorbed per unit time?

Hint, Fermi's Golden Rule $\frac{2\pi}{\hbar} |\langle f | H' | i \rangle|^2 JDOS(\hbar\omega_{opt})$

b) Show that the fraction of incident photons absorbed is 2.3%