# ECE 656: Fall 2009
## Lecture 20 Homework
(Revised 10/27/09)

1) It is tempting to estimate the momentum relaxation time, $\langle\langle \tau_m \rangle\rangle$, from the mobility and then to multiply by a velocity to get the mean-free-path. Give the correct expression for the mfp for backscattering in 2D – in terms of $\langle\langle \tau_m \rangle\rangle$ as extracted from the measured mobility. You may assume a non-degenerate semiconductor.

From L20, Sec. 2

$$\langle \lambda_{BS} \rangle = 2\frac{(k_BT/q)}{\upsilon_T}\mu_n \frac{\mathcal{F}_0(\eta_F)}{\mathcal{F}_{-1/2}(\eta_F)}$$

$$= 2\frac{(k_BT/\cancel{q})}{\upsilon_T}\cdot \cancel{q}\frac{\langle\langle \tau \rangle\rangle}{m^*}\left( \quad \right)$$

$$= 2\sqrt{\frac{\pi m^*}{2k_BT}}\cdot\frac{k_BT}{m^*}\langle\langle \tau \rangle\rangle\left( \quad \right)$$

$$= \sqrt{\frac{2\pi k_BT}{m^*}}\langle\langle \tau \rangle\rangle\left( \quad \right)$$

$$\langle \lambda_{BS} \rangle = \pi\upsilon_T\langle\langle \tau \rangle\rangle \underbrace{\left(\frac{\mathcal{F}_0(\eta_F)}{\mathcal{F}_{-1/2}(\eta_F)}\right)}_{=1 \text{ for non-deg.}}$$

$$\langle \lambda_{BS} \rangle = \pi\upsilon_T\langle\langle \tau \rangle\rangle$$ backscattering mfp

$$\lambda_{BS} = \frac{\pi}{2}\upsilon\tau = \frac{\pi}{2}\lambda$$

$$\langle \lambda \rangle = 2\upsilon_T\langle\langle \tau \rangle\rangle$$