ECE 495N

Fundamentals of Nanoelectronics

Fall 2008

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Lecture: 24
Title: Subbands
Date: October 27, 2008

Video Lectures posted at:
https://www.nanohub.org/resources/5346/

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Subband

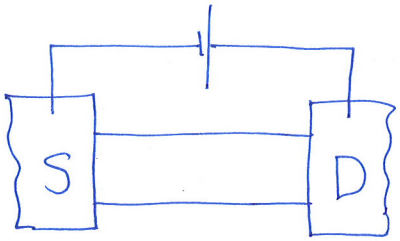
Lecture 24

Oct. 27, 2008

$$\mathcal{E}(\vec{K}) = \tilde{\mathcal{E}} \pm at\sqrt{K_x^2 + b_y^2} \leftarrow K_y - \frac{2\pi}{3b}$$

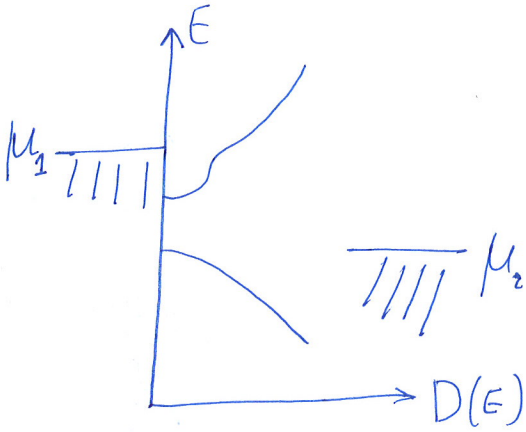
$$\Rightarrow \pm at|K|$$

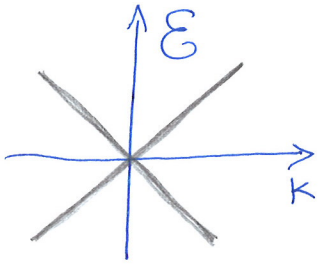
$$D(E) = \sum_{K_x}\sum_{K_y} \delta(E - \mathcal{E}(K))$$

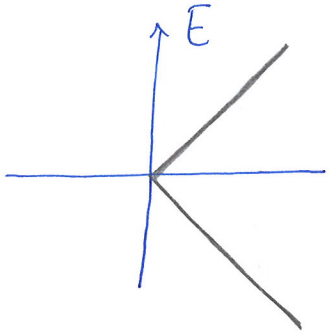


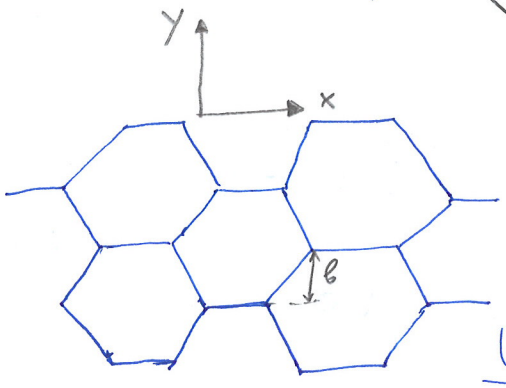
How I am going from the E-K relationship to the DOS?

$$D(E) = \iint \frac{dK_x}{2\pi/L_x}\,\frac{dK_y}{2\pi/L_y}$$







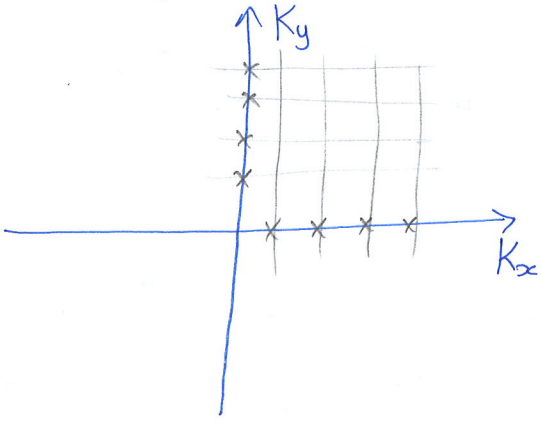


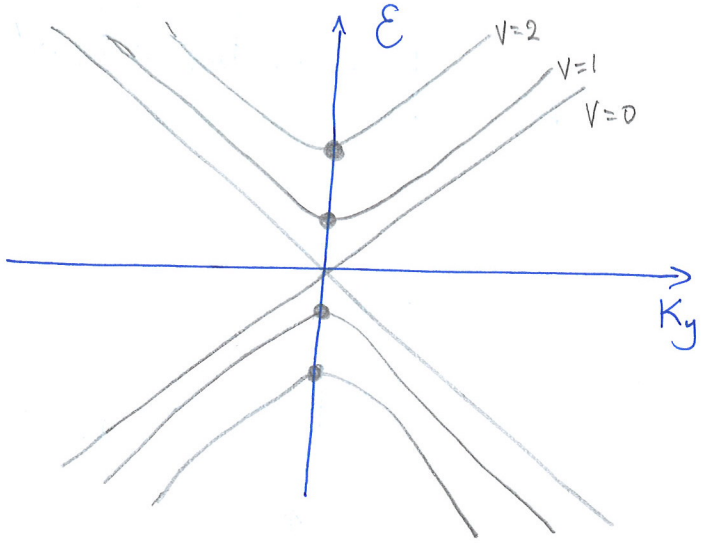
Wrapping along x

$$\mathcal{E}_\nu(K_y) = \pm at\sqrt{K_\nu^2 + K_y^2}$$

$$K_\nu \cdot 2a \cdot m = 2\pi \cdot \nu$$

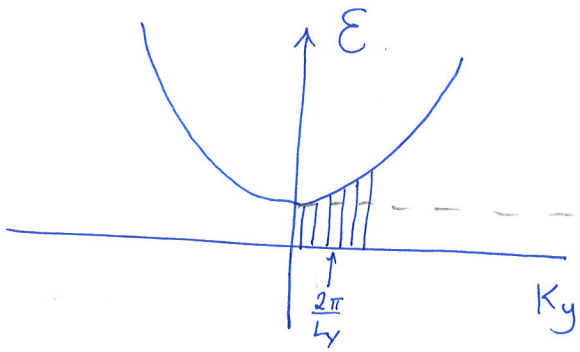
Integer

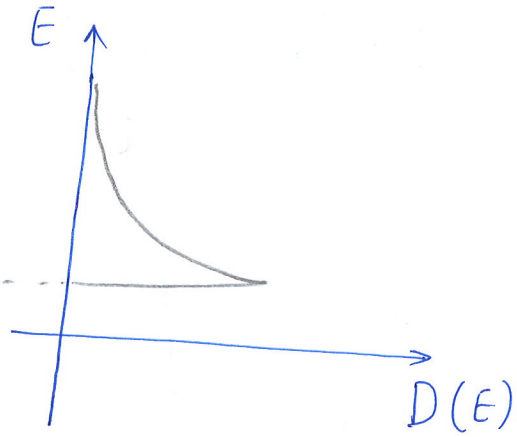




$$K_\nu = \frac{2\pi}{2am}\,\nu$$

If the solid is big then this term is big and then all the subbands are moved close to zero.





$$\sum_K \delta(E(K)-E) \longrightarrow \int \frac{dK}{2\pi/L}\,\delta(\mathcal{E}(K)-E)$$

$$\frac{L}{2\pi}\int d\mathcal{E}\,\frac{dK}{d\mathcal{E}}\,\delta(\mathcal{E}-E) \Rightarrow \left.\frac{L/2\pi}{d\mathcal{E}/dK}\right|_{\mathcal{E}=E}$$

Wrapping along y

$$\mathcal{E}_\nu(K_x) = \pm a t\sqrt{K_x^2 + b_y^2} \longleftarrow \left(K_{y\nu} - \frac{2\pi}{3b}\right)^2$$

$$K_{y\nu}\cdot(2b_y n) = 2\pi\cdot\nu$$

to become zero $K_{y\nu} = \frac{2\pi}{3b}$

but $K_{y\nu} = \frac{2\pi\cdot\nu}{2bn} = \frac{2\pi}{3b} \Rightarrow \nu = \frac{2n}{3}$ ← Integer

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Wrapping along other directions

(m, n)	$\mathcal{E}(K_x, K_y, \cdots)$
$(0, n)$	$\mathcal{E}_\nu(K_x, K_y)$ Quantum Well
$(m, 0)$	$\mathcal{E}_{\nu\nu}(K_x)$ Quantum Wire