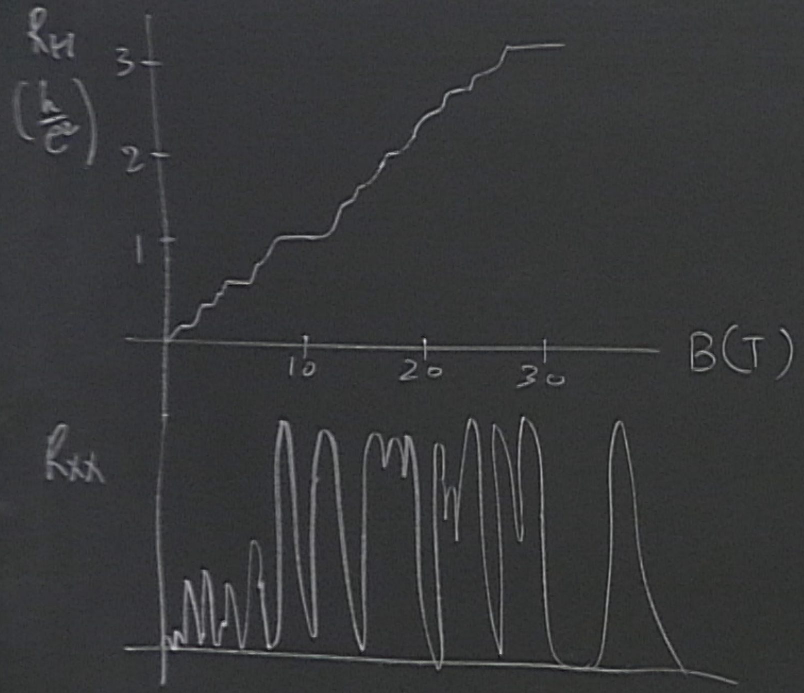
Title: PSI 2018/2019 - Condensed Matter - Lecture 15

Date: Nov 30, 2018 10:45 AM

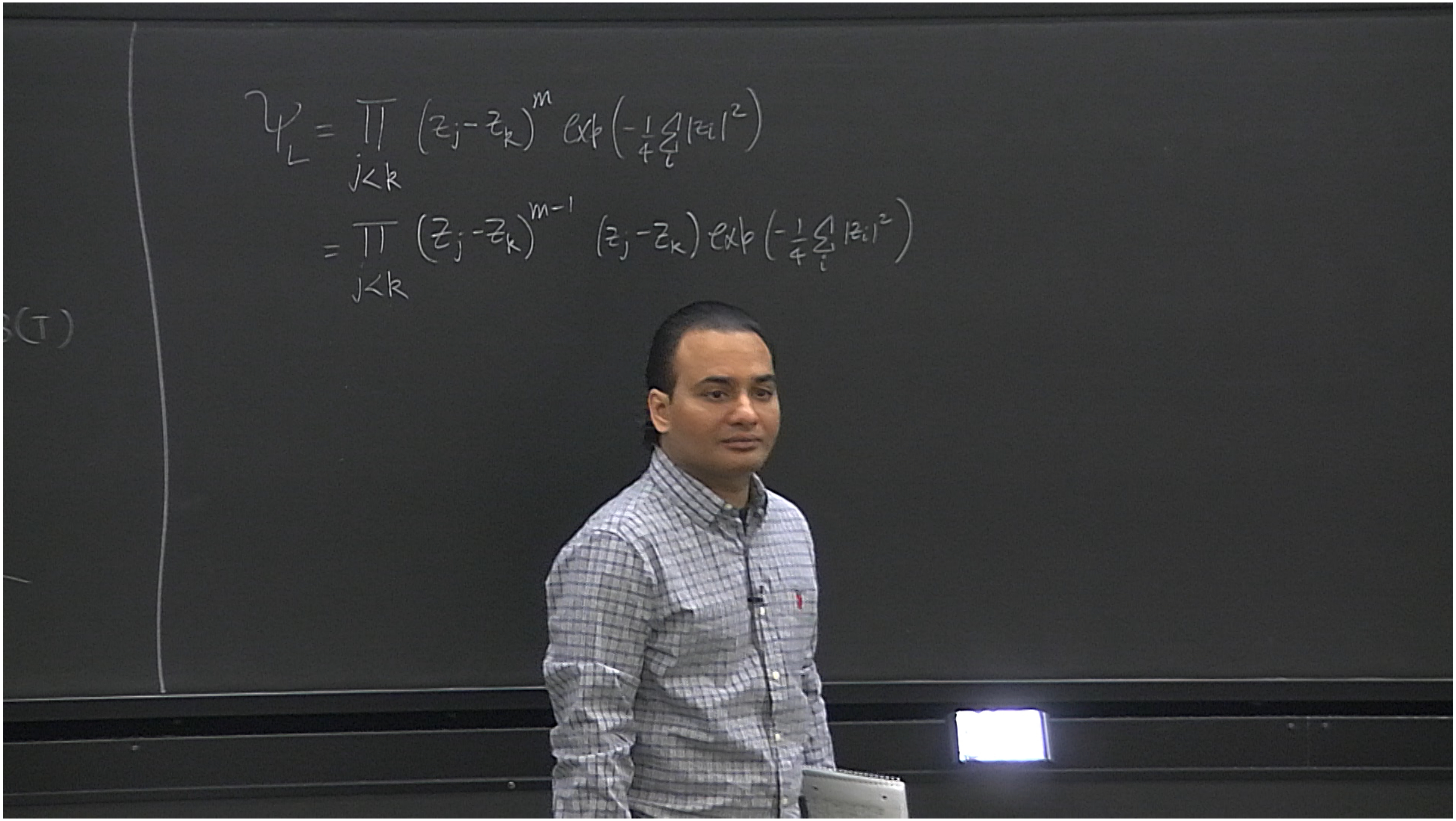
URL: http://pirsa.org/18110033

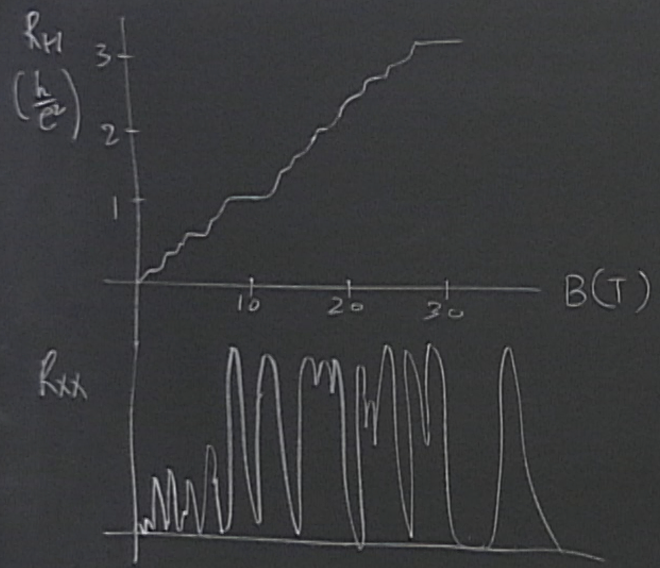
Abstract:



$$\Psi_L = \prod_{j<k} (z_j - z_k)^m \exp\left(-\frac{1}{4}\sum_i |z_i|^2\right)$$

$$= \prod_{j<k} (z_j - z_k)^{m-1} (z_j - z_k) \exp\left(-\frac{1}{4}\sum_i |z_i|^2\right)$$


$\psi_L = \prod_{j<k} (z_j - z_k)^m \exp\left(-\frac{1}{4}\sum_i |z_i|^2\right)$
$= \prod_{j<k} (z_j - z_k)^{m-1} (z_j - z_k) \exp\left(-\frac{1}{4}\sum_i |z_i|^2\right)$

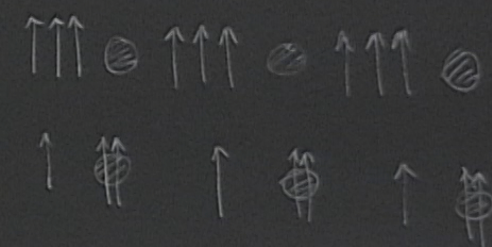


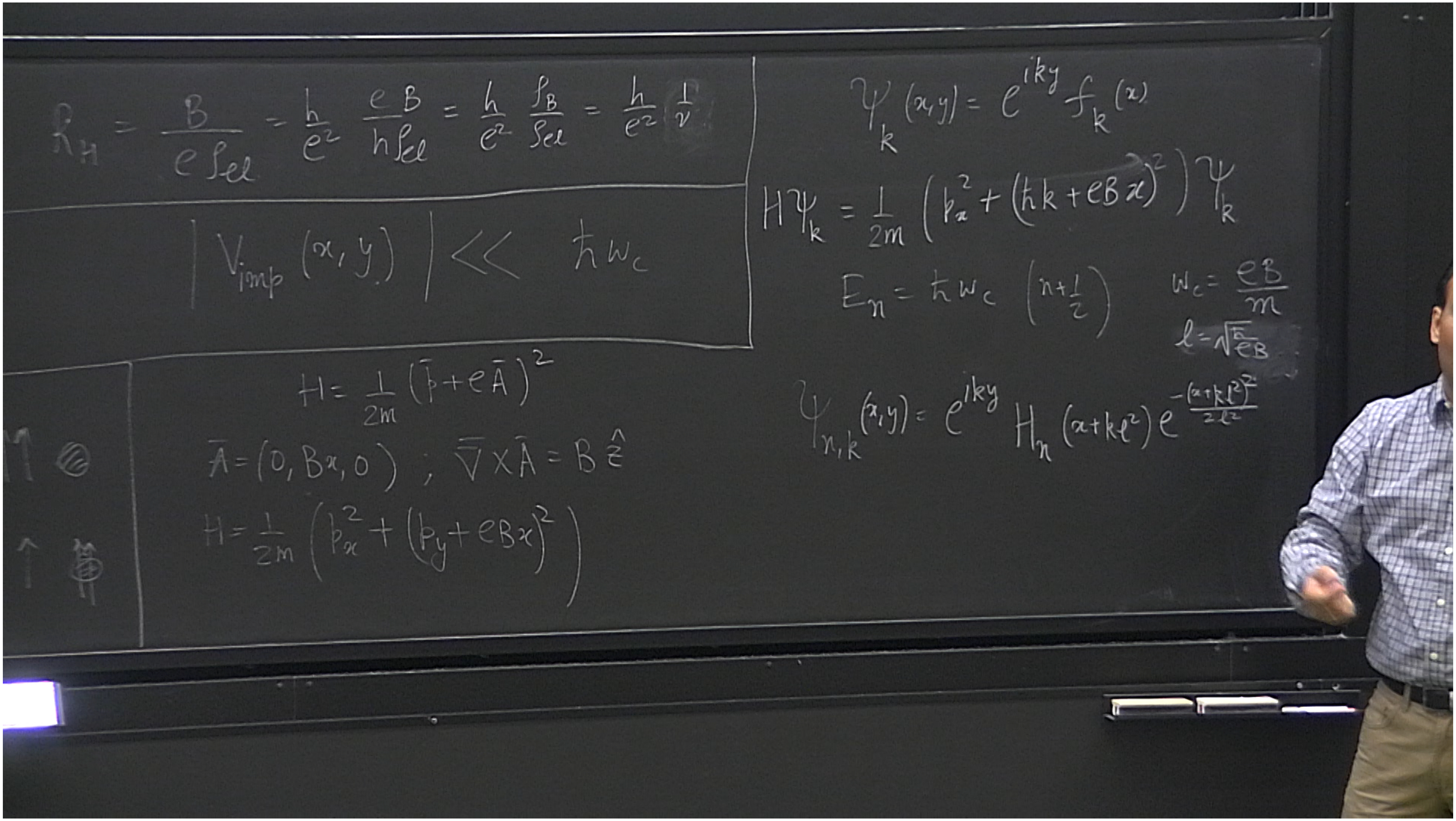
$$\Psi_L = \prod_{j<k} (z_j - z_k)^m \exp\left(-\frac{1}{4}\sum_i |z_i|^2\right)$$

$$= \prod_{j<k} (z_j - z_k)^{m-1} \underbrace{(z_j - z_k)\exp\left(-\frac{1}{4}\sum_i |z_i|^2\right)}$$

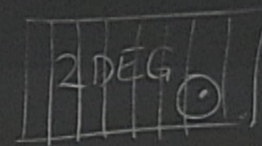
$m = 3,\ \nu = \frac{1}{3}$

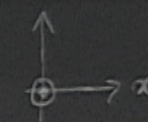
$$\frac{\rho_{el}}{\rho_B} = \frac{1}{3} \Rightarrow \rho_{el} = \frac{\rho_B}{3}$$



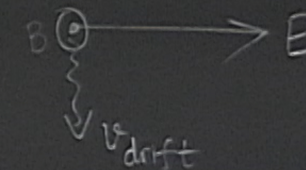

$R_H = \frac{B}{e\rho_{el}} = \frac{h}{e^2}\frac{eB}{h\rho_{el}} = \frac{h}{e^2}\frac{\rho_B}{\rho_{el}} = \frac{h}{e^2}\frac{1}{\nu}$
$|V_{imp}(x,y)| \ll \hbar\omega_c$
$H = \frac{1}{2m}(\bar{p} + e\bar{A})^2$
$\bar{A} = (0, Bx, 0)\ ;\ \bar{\nabla}\times\bar{A} = B\hat{z}$
$H = \frac{1}{2m}\left(p_x^2 + (p_y + eBx)^2\right)$
$\psi_k(x,y) = e^{iky} f_k(x)$
$H\psi_k = \frac{1}{2m}\left(p_x^2 + (\hbar k + eBx)^2\right)\psi_k$
$E_n = \hbar\omega_c\left(n+\frac{1}{2}\right)$
$\omega_c = \frac{eB}{m}$
$\ell = \sqrt{\frac{\hbar}{eB}}$
$\psi_{n,k}(x,y) = e^{iky} H_n(x+k\ell^2)\, e^{-\frac{(x+k\ell^2)^2}{2\ell^2}}$

$$H = \frac{1}{2m}\left(p_x^2 + \left(p_y + eBx\right)^2\right) + eEx$$



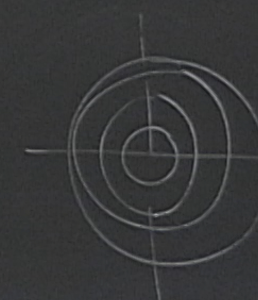


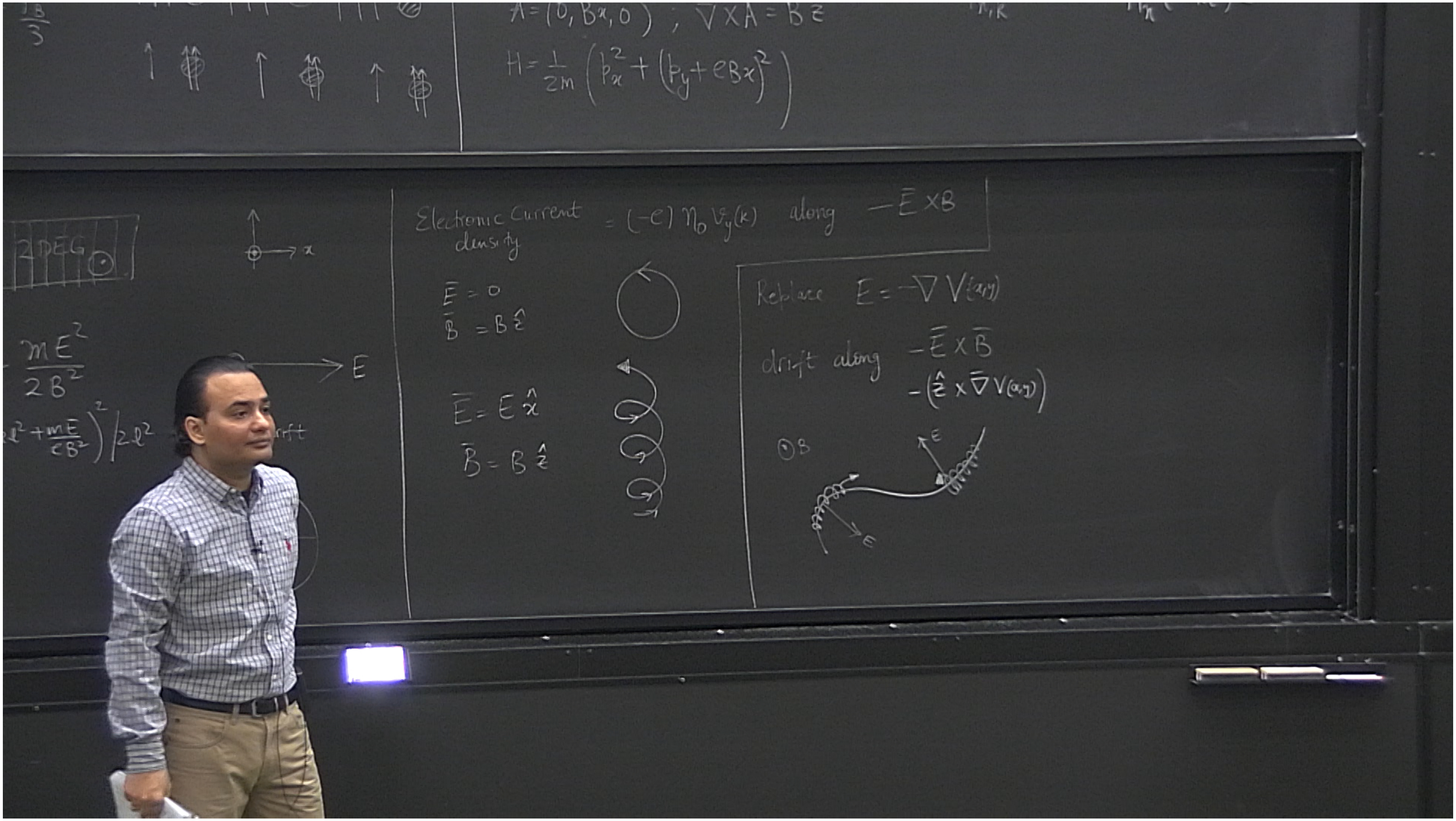
$$E_{nk} = \hbar\omega_c\left(n+\frac{1}{2}\right) - eE\left(kl^2 - \frac{eE}{m\omega_c^2}\right) + \frac{mE^2}{2B^2}$$



$$\psi_{n,k}(x,y) = e^{iky}\, H_n\left(x + kl^2 + \frac{mE}{eB^2}\right) e^{-\left(x+kl^2+\frac{mE}{eB^2}\right)^2/2l^2}$$

$$v_y = \frac{1}{\hbar}\frac{\partial}{\partial k}E_{nk} = -\frac{E}{B}$$

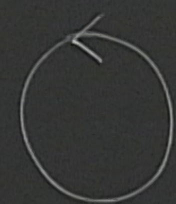



A = (0, Bx, 0) ; ∇ × A = B z
H = 1/2m (p_x^2 + (p_y + eBx)^2)
2DEG
x
E
Electronic Current density = (−e) n_0 v_y(k) along −E × B
E = 0
B = B ẑ
E = E x̂
B = B ẑ
Replace E = −∇ V(x,y)
drift along −E × B
−(ẑ × ∇ V(x,y))
B
E
E

Electronic Current density $= (-e)\, n_0\, v_y(k)$ along $-\bar{E} \times B$

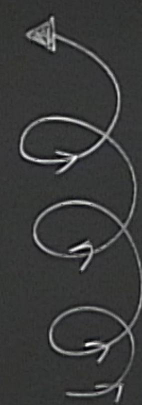
$\bar{E} = 0$

$\bar{B} = B\hat{z}$



$\bar{E} = E\hat{x}$

$\bar{B} = B\hat{z}$

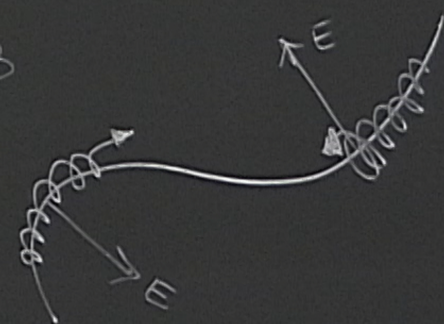


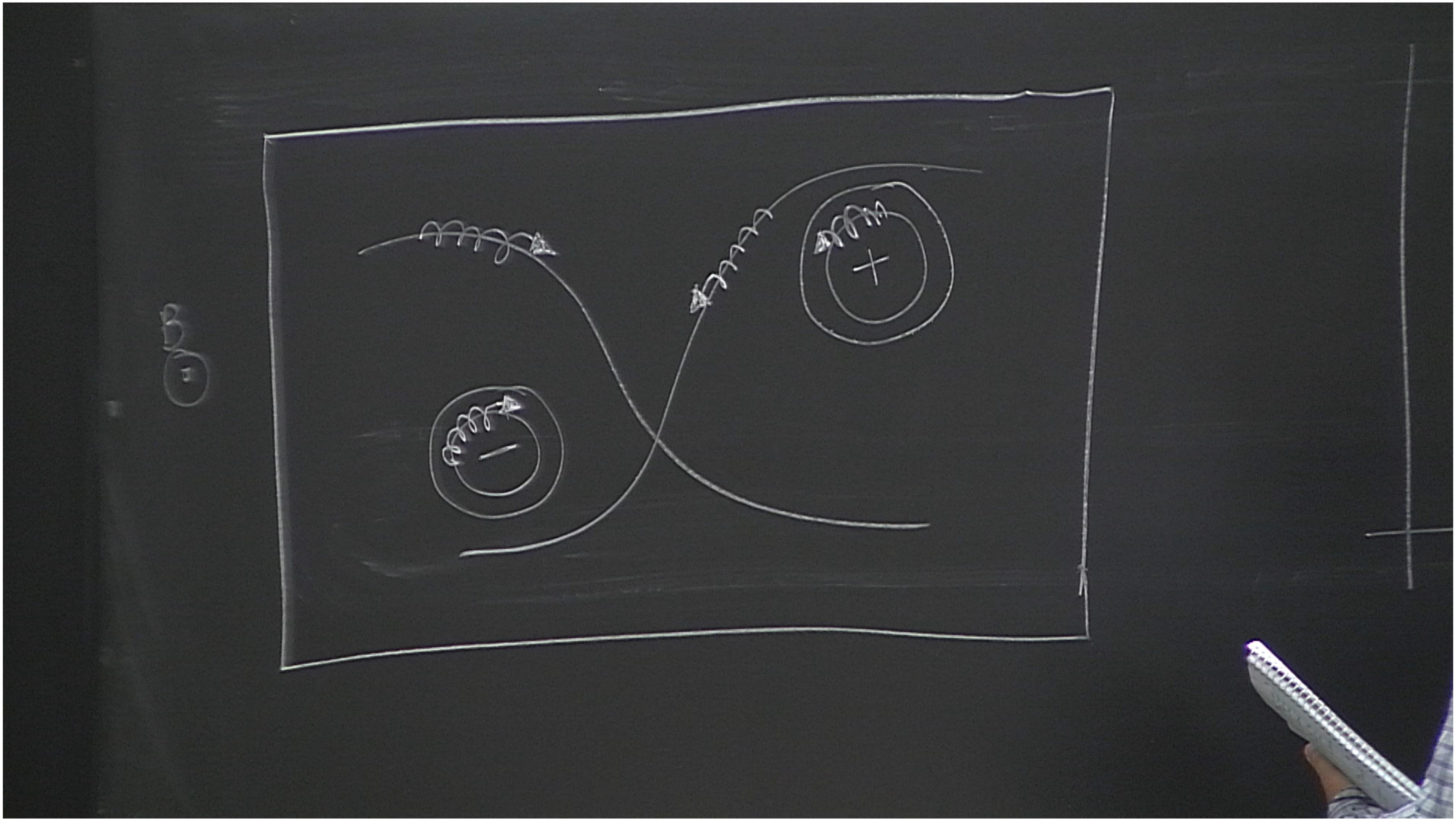
Replace $E = -\nabla V(x,y)$

drift along $-\bar{E} \times \bar{B}$

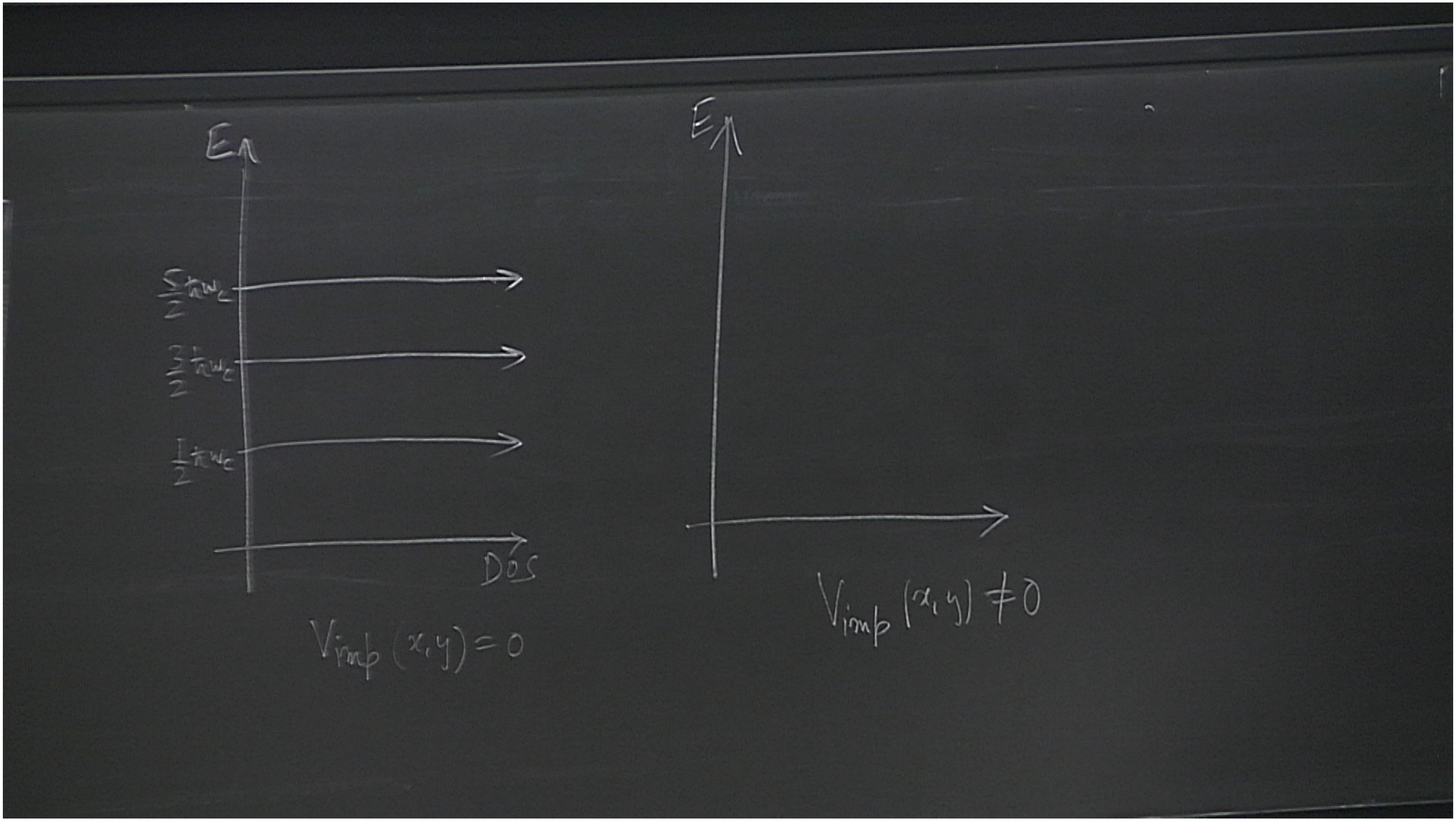
$-\left(\hat{z} \times \bar{\nabla} V(x,y)\right)$

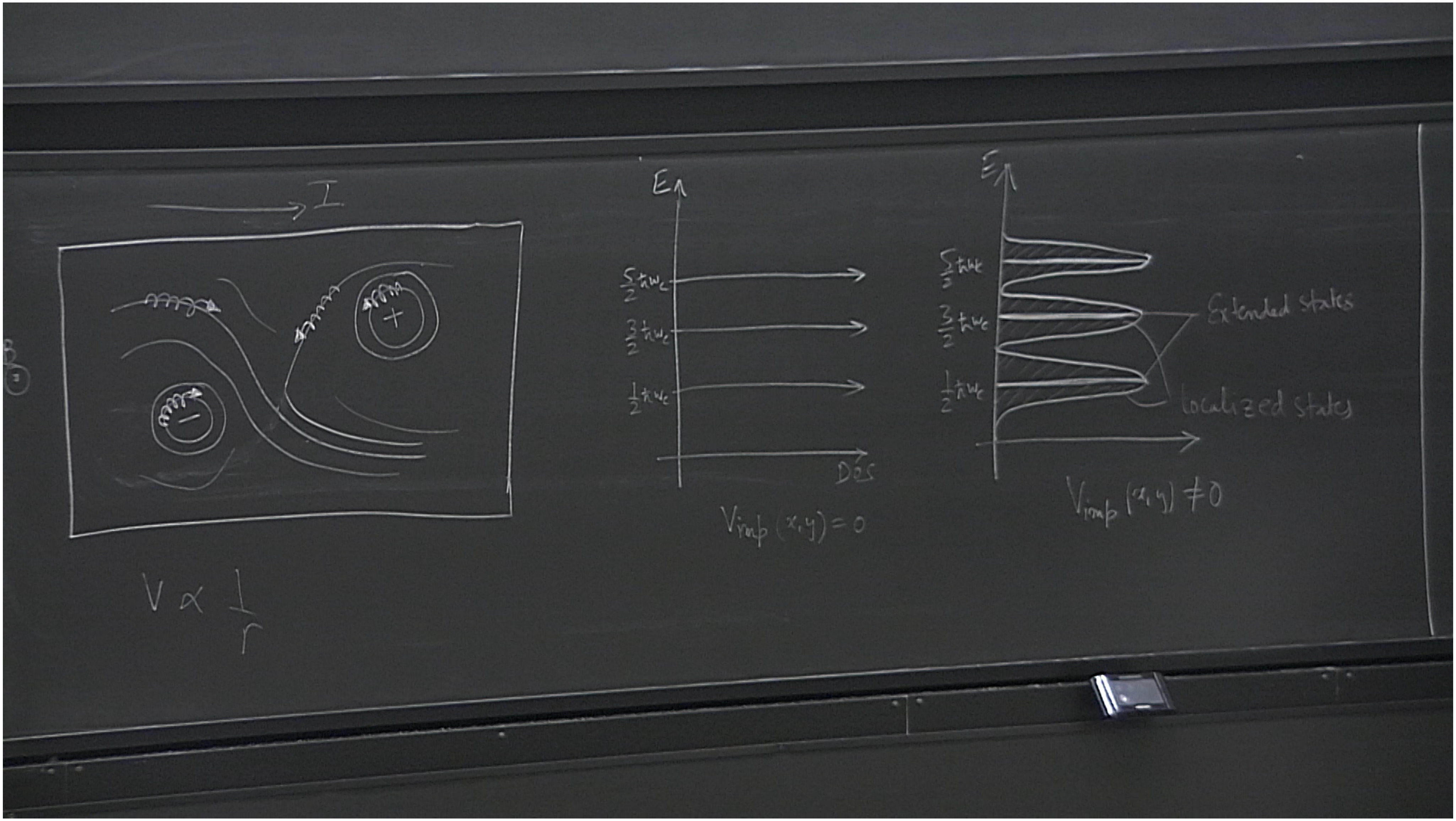
$\odot B$



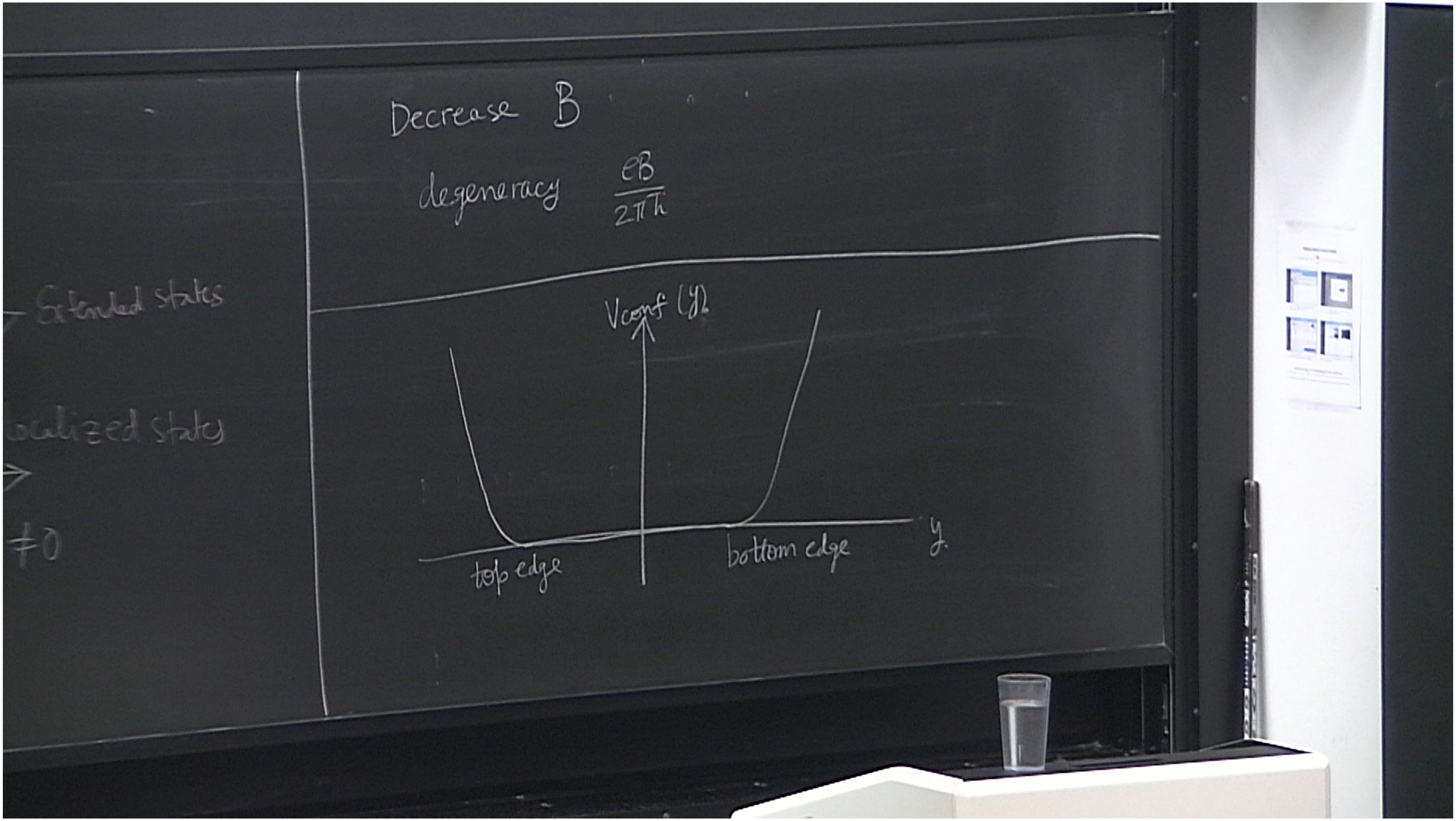


B
+
−


E
$\frac{5}{2}\hbar\omega_c$
$\frac{3}{2}\hbar\omega_c$
$\frac{1}{2}\hbar\omega_c$
DOS
$V_{imp}(x,y)=0$
E
$V_{imp}(x,y)\neq 0$



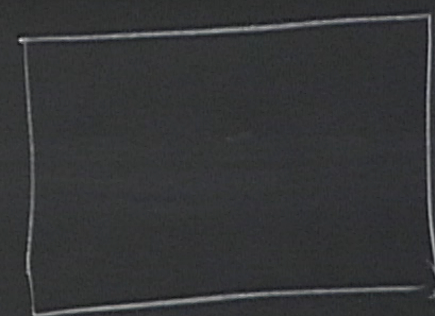
I
B
+
−
$V \propto \frac{1}{r}$
E
$\frac{5}{2}\hbar\omega_c$
$\frac{3}{2}\hbar\omega_c$
$\frac{1}{2}\hbar\omega_c$
DOS
$V_{imp}(x,y)=0$
E
$\frac{5}{2}\hbar\omega_c$
$\frac{3}{2}\hbar\omega_c$
$\frac{1}{2}\hbar\omega_c$
Extended states
localized states
$V_{imp}(x,y)\neq 0$


Decrease B
degeneracy $\frac{eB}{2\pi\hbar}$
Extended states
localized states
$\neq 0$
Vconf (y)
top edge
bottom edge
y

$$C = \frac{1}{2\pi i}\int d^2k \left(\partial_{k_x} A_y(k) - \partial_{k_y} A_x(k) \right)$$

$$A_\mu(k) = \langle n(k) | \partial_{k_\mu} | n(k) \rangle$$

$$H_k | n(k) \rangle = E_n(k) | n(k) \rangle$$



$C = 0$

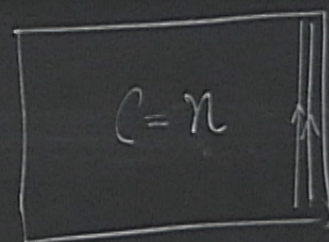
$V_{imp}(x,y) = 0$ $\quad$ $V_{imp}(x,y) \neq 0$

$V \propto \frac{1}{r}$

$$C = \frac{1}{2\pi i} \int d^2k \left(\partial_{k_x} A_y(k) - \partial_{k_y} A_x(k) \right)$$

$$A_\mu(k) = \langle n(k) | \partial_{k_\mu} | n(k) \rangle$$

$$H_k | n(k) \rangle = E_n(k) | n(k) \rangle$$



$C = 0$

n edge states

$$\sigma_H^{xy} = n \frac{e^2}{h}$$

$$R_H = \frac{h}{ne^2}$$