Title: PSI 2016/2017 Explorations in Quantum Information - Lecture 14

Date: Apr 06, 2017 09:00 AM

URL: http://pirsa.org/17040013

Abstract:

Fluxoid

no scattering
ballistic transport.

$$\psi = \sqrt{\rho}\, e^{i\phi}$$

$\phi = n\theta$

$\rho \equiv$ particle density.

electron current

$$J = \frac{ie\hbar}{2m}\left(\psi \nabla \psi^* - \psi^* \nabla \psi \right)$$

w/ magnetic field

$$\nabla \Rightarrow \nabla - i\frac{e}{\hbar}\vec{A}$$

$$J = \frac{ie\hbar}{2m}\left(\psi\left(\nabla - \frac{ie}{\hbar}\vec{A}\right)\psi^* - \psi^*\left(\nabla - \frac{ieA}{\hbar}\right)\psi\right)$$

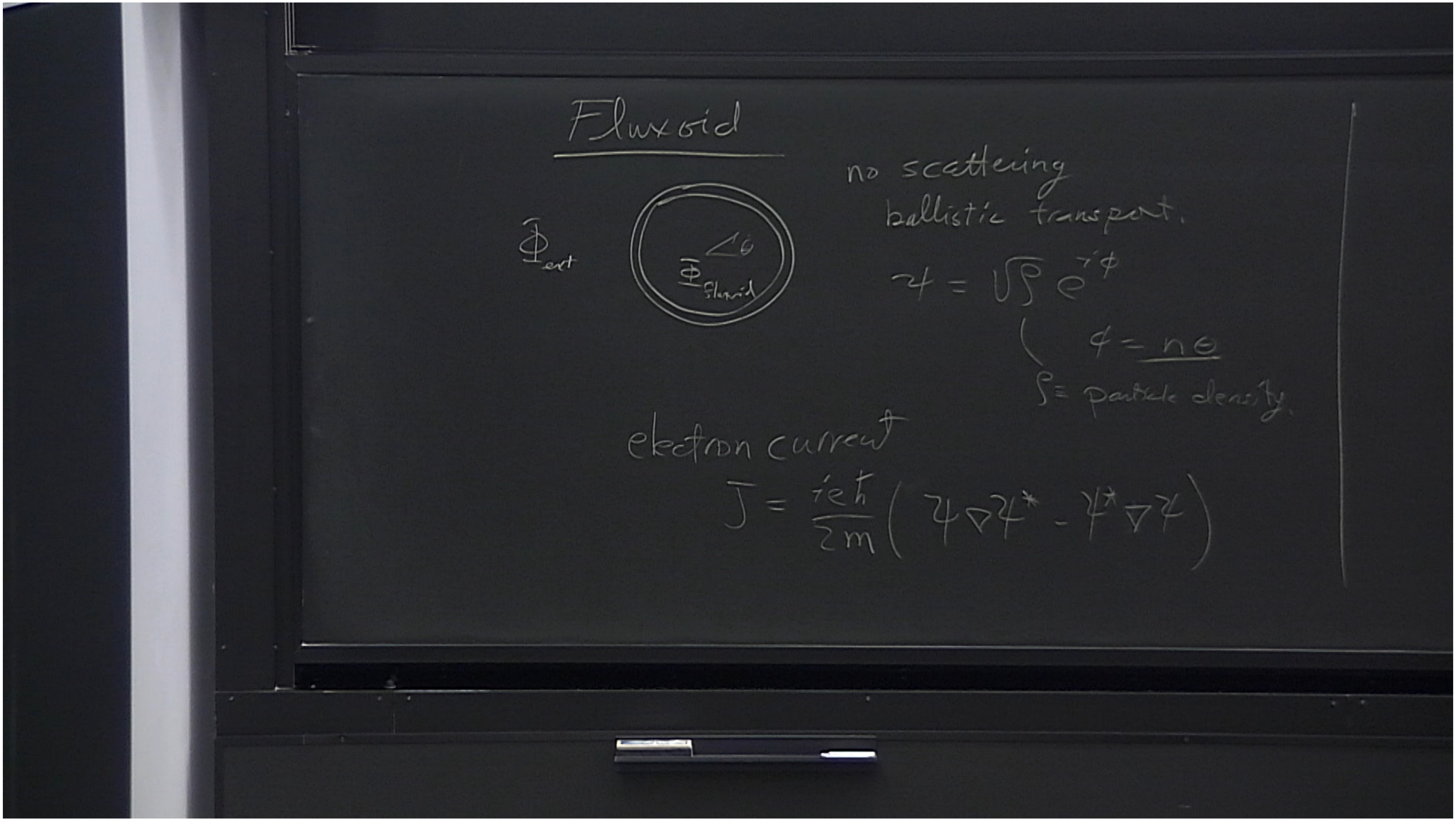
$$\bar{J} = \frac{e\hbar\rho}{m}\nabla\rho - \frac{e^2\rho}{m}\vec{A}$$

current is zero $\quad \nabla\phi = \frac{e}{\hbar}\vec{A}$; over ring $\boxed{\frac{e}{\hbar}\Phi_0}$

$$\ldots - \psi^* \left(\nabla - \frac{ieA}{\hbar} \right) \psi \Big)$$

$$\boxed{\Phi = n\left(\frac{h}{e}\right) \qquad n = 1, 2, \ldots}$$

$\frac{e}{\hbar}\vec{A}$; over ring $\boxed{\frac{e}{\hbar}\Phi_0}$


Fluxoid
no scattering
ballistic transport.
Φ_{ext}
θ
$\Phi_{fluxoid}$
$\psi = \sqrt{\rho}\, e^{i\phi}$
$\phi = n\theta$
ρ = particle density.
electron current
$J = \frac{ie\hbar}{2m}\left(\psi \nabla \psi^* - \psi^* \nabla \psi\right)$

$$\ldots \psi^* \left(\nabla - \frac{ieA}{\hbar} \right) \psi \Big)$$

$\vec{A}$; over ring $\boxed{\frac{e}{\hbar} \Phi_0}$

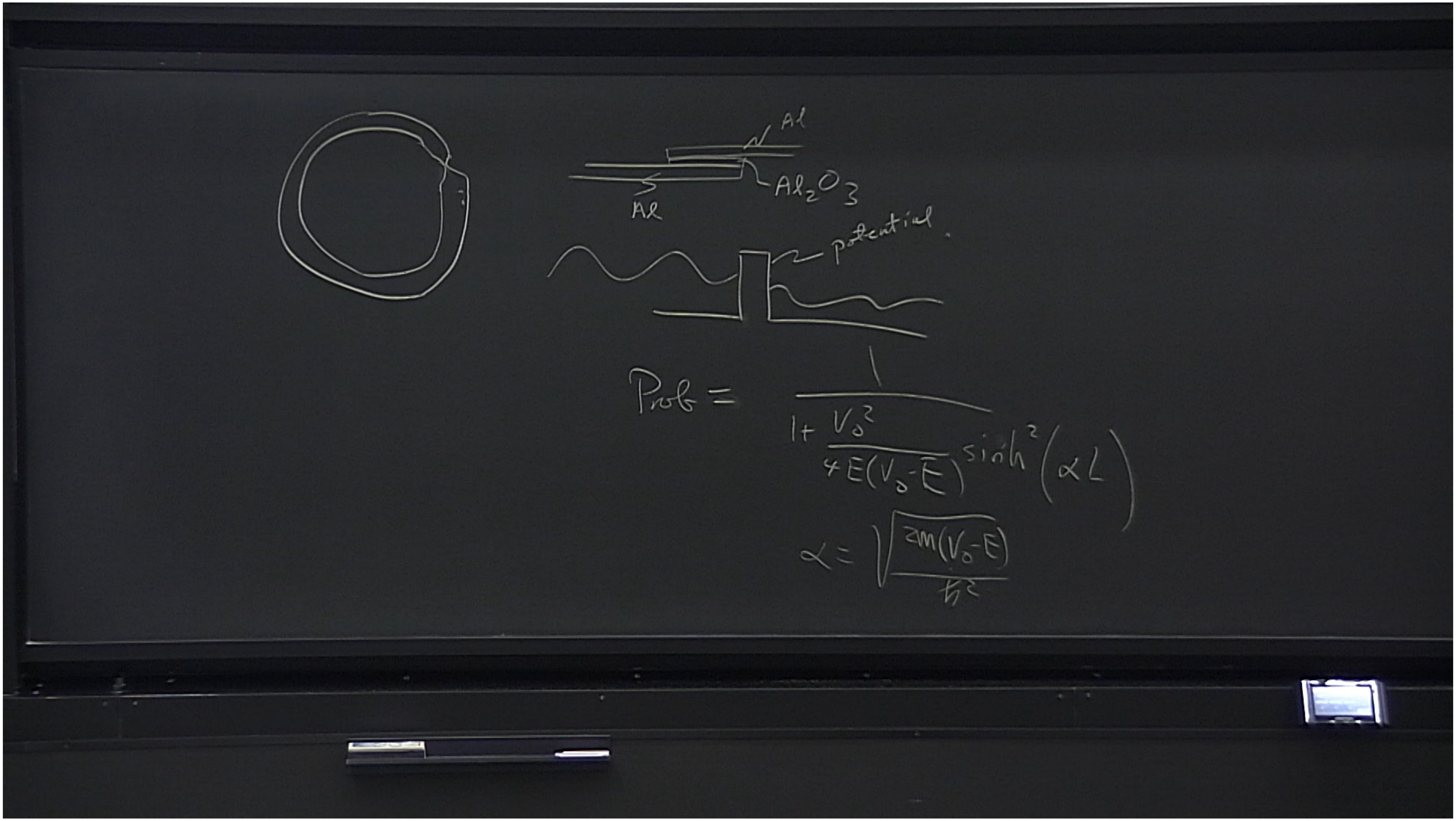
conductor (e)

$$\Phi = n \left(\frac{h}{e} \right)$$

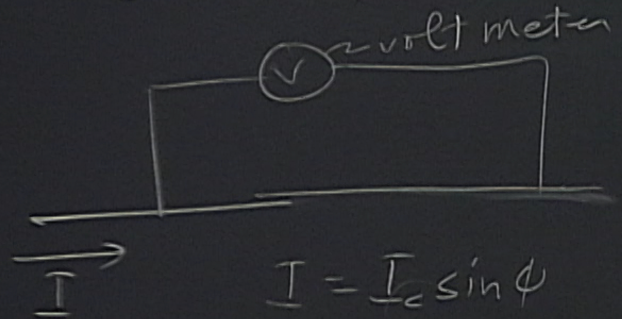
$n = 1, 2, \ldots$

superconductor (CP)

$$\Phi = n \left(\frac{h}{2e} \right)$$


Al
Al_2O_3
Al
potential
$\text{Prob} = \frac{1}{1 + \frac{V_0^2}{4E(V_0-E)}\sinh^2(\alpha L)}$
$\alpha = \sqrt{\frac{2m(V_0-E)}{\hbar^2}}$

DC Josephson effect

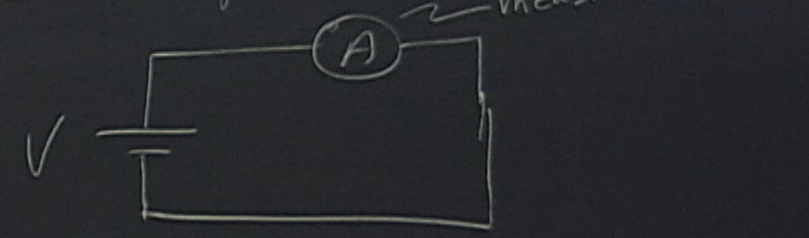


$$I = I_c \sin\phi$$

but no voltage appear.

tunnel junctions remain SC.

AC Josephson effect.



$$\frac{d\phi}{dt} = \frac{2e}{\hbar} V \; ; \quad \phi = \frac{2e}{\hbar} V t$$

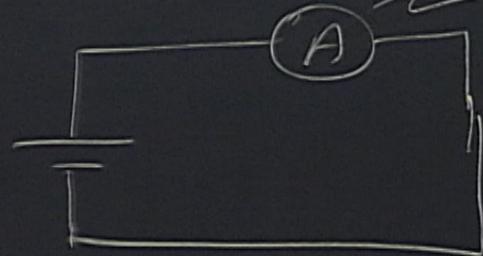
$$I = I_c \sin(\phi)$$

$$I = I_c \sin\left(\frac{2e}{\hbar} V t\right)$$

AC Josephson effect.

measure current.

V



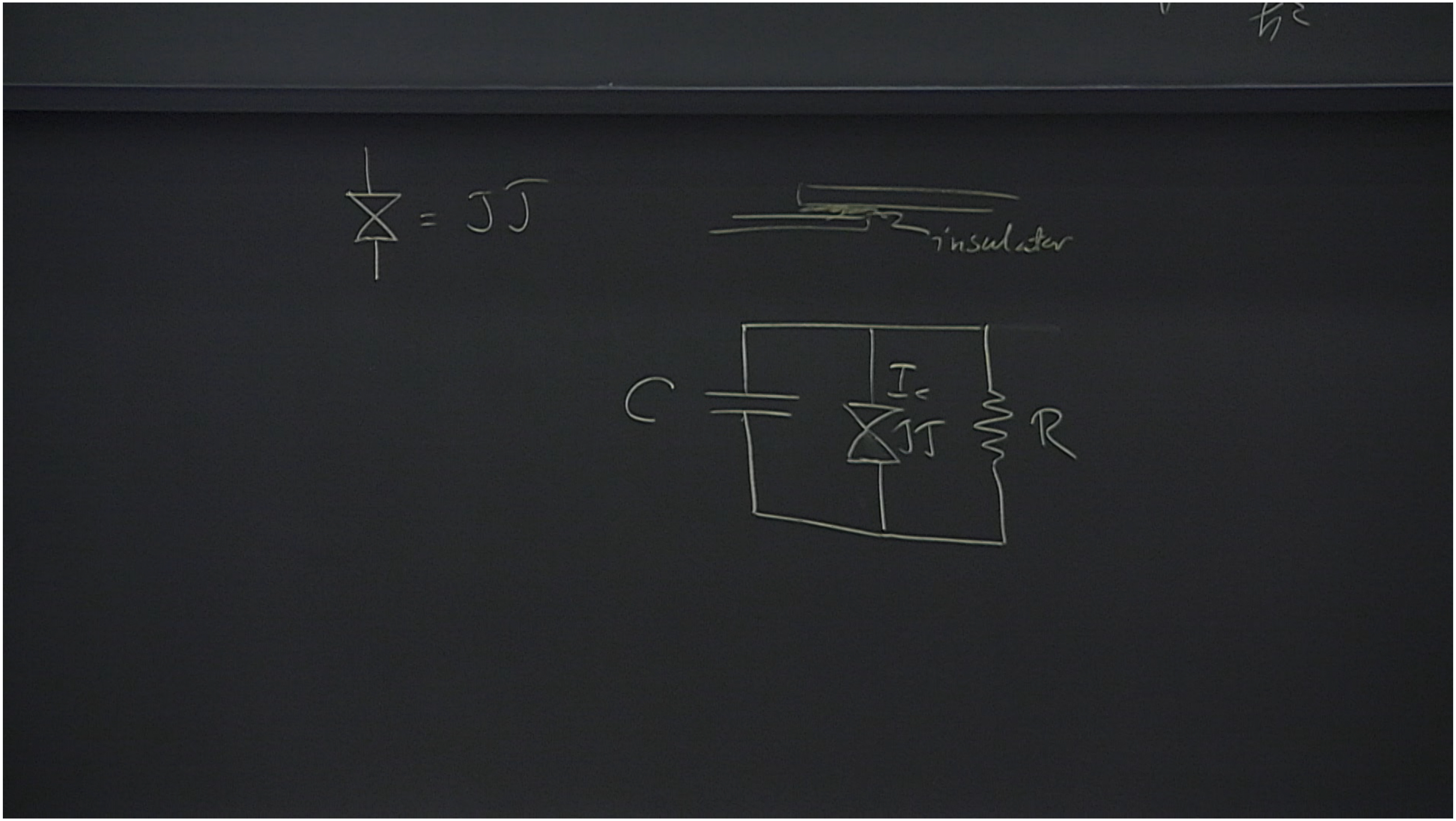
$$\text{frequency} = \frac{2e}{h}$$

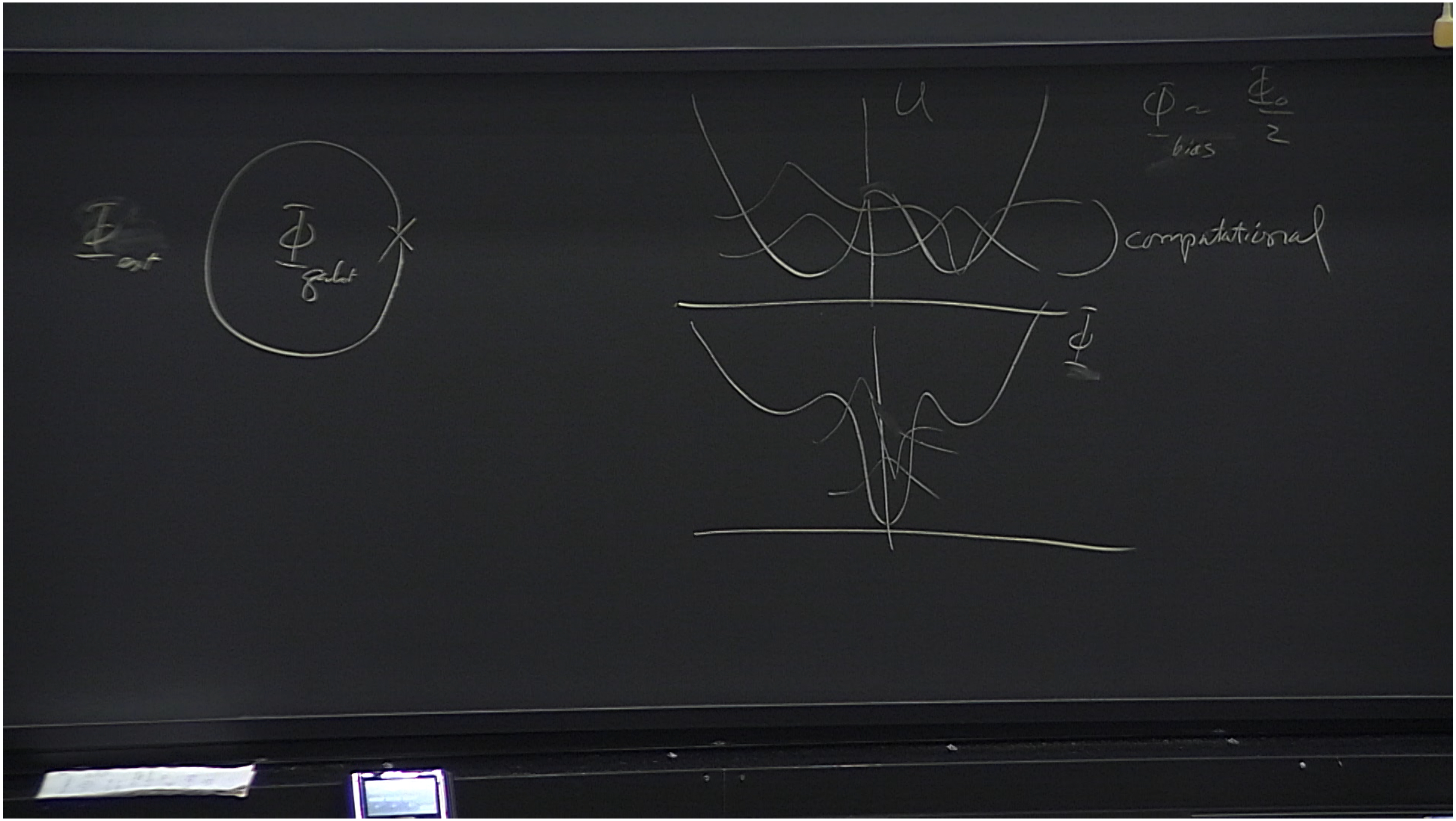
$$4.8 \times 10^{14}\ \mathrm{Hz}/\mathrm{V}$$

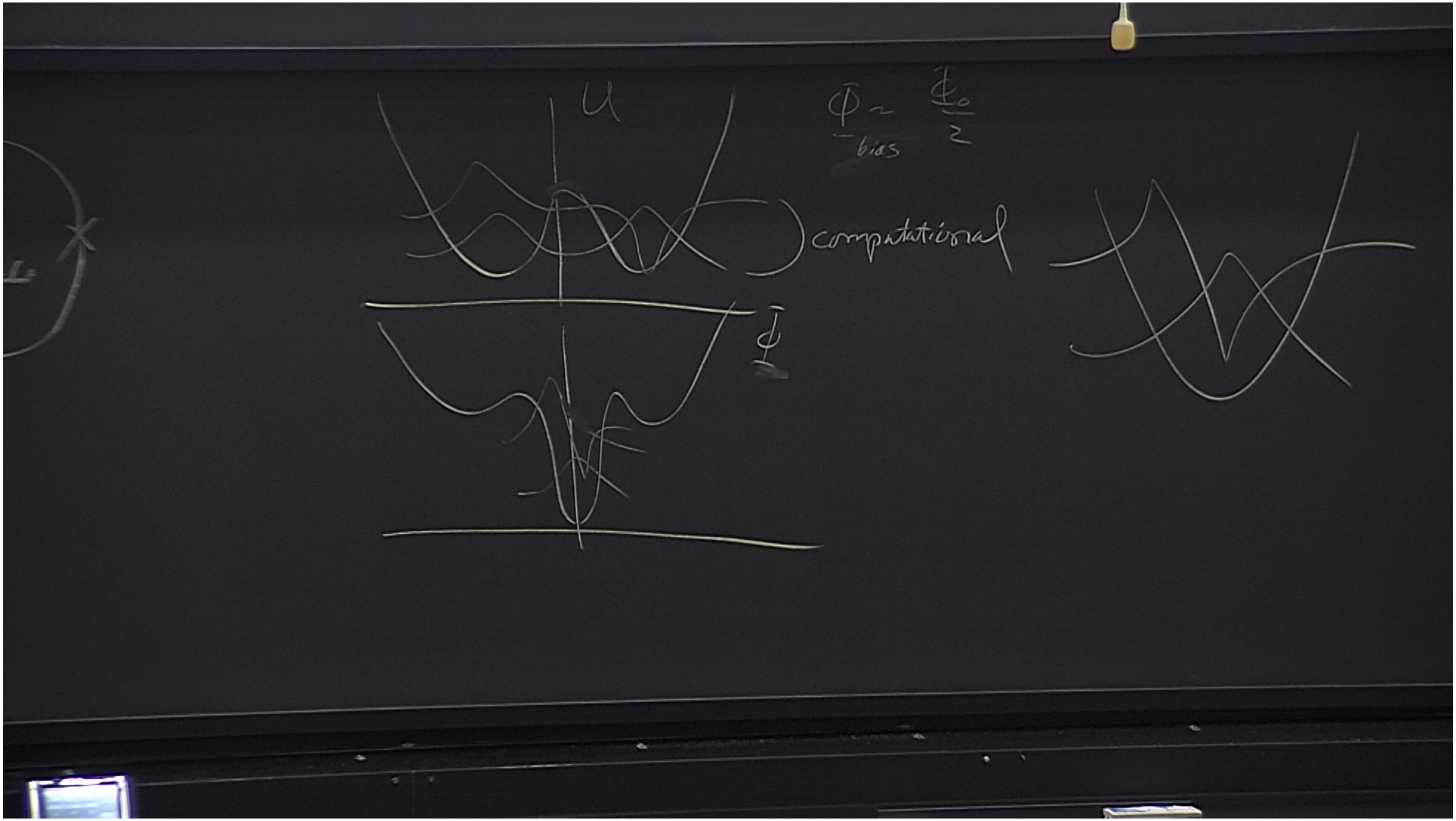
$$\frac{d\phi}{dt} = \frac{2e}{\hbar} V \ ; \quad \phi = \frac{2e}{\hbar} V t$$

$$I = I_c \sin(\phi)$$

$$I = I_c \sin\left(\frac{2e}{\hbar} V t\right)$$


= JJ
insulator
C
I_c
JJ
R


Φ_{ext}
Φ_{qubit}
U
$\Phi_{bias} \sim \frac{\Phi_0}{2}$
computational
Φ


U
$\Phi_{bias} \approx \frac{\Phi_0}{2}$
computational
Φ