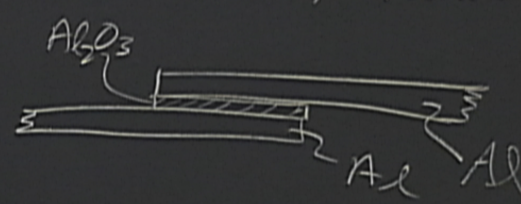
Title: 13/14 PSI - Explorations in Quantum Information - Lecture 15

Date: Apr 04, 2014 09:00 AM

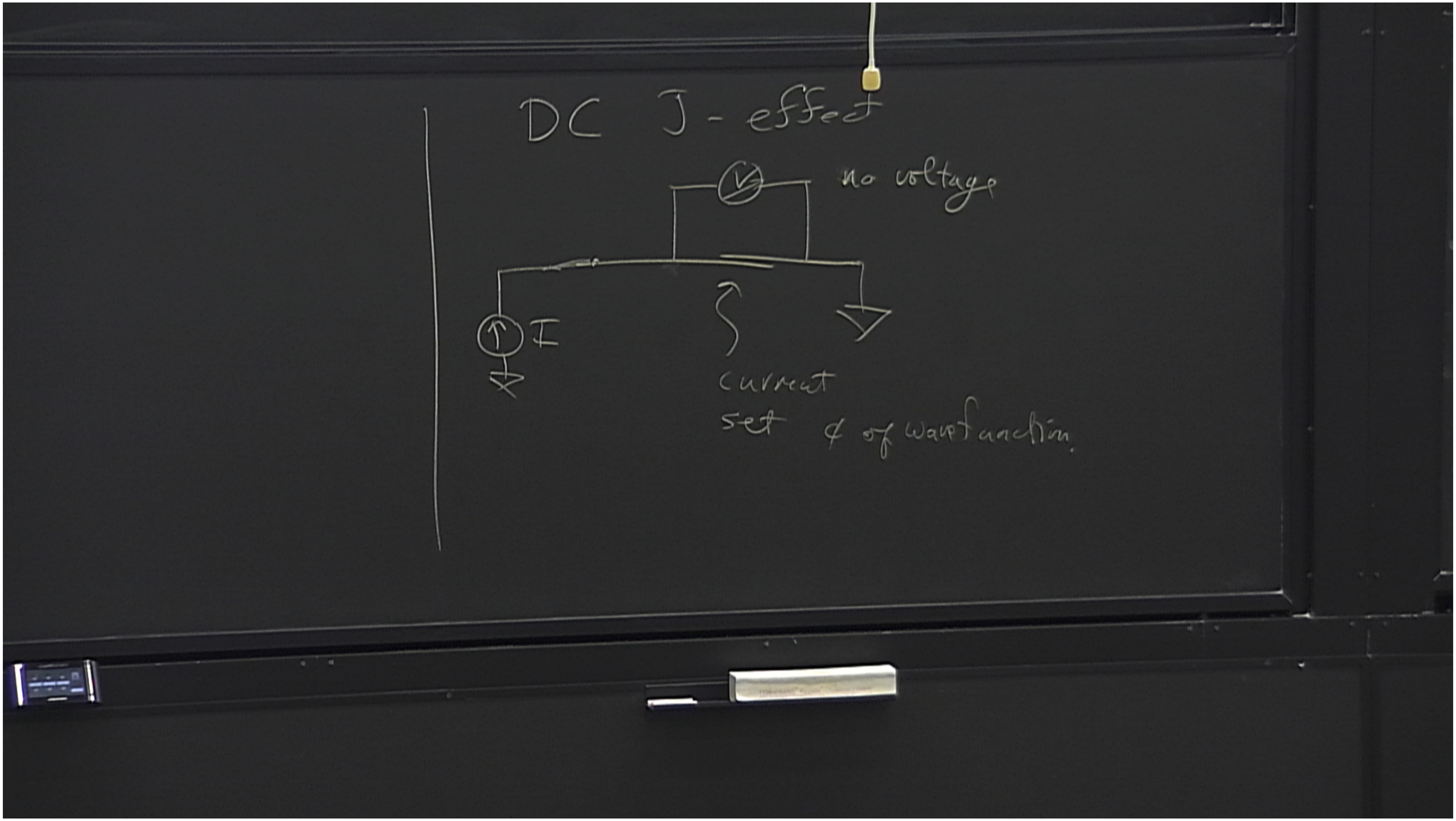
URL: http://pirsa.org/14040012

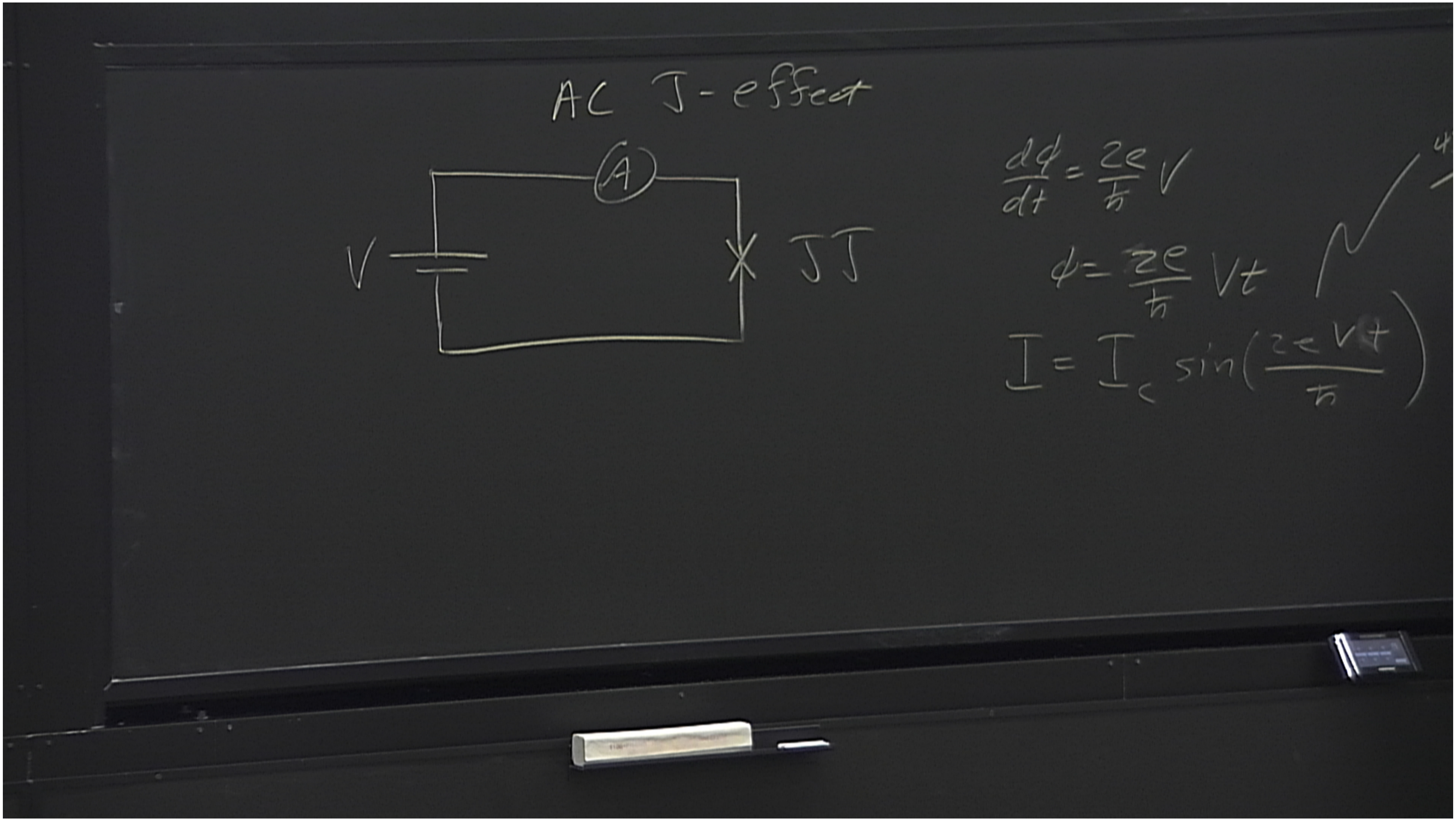
Abstract:

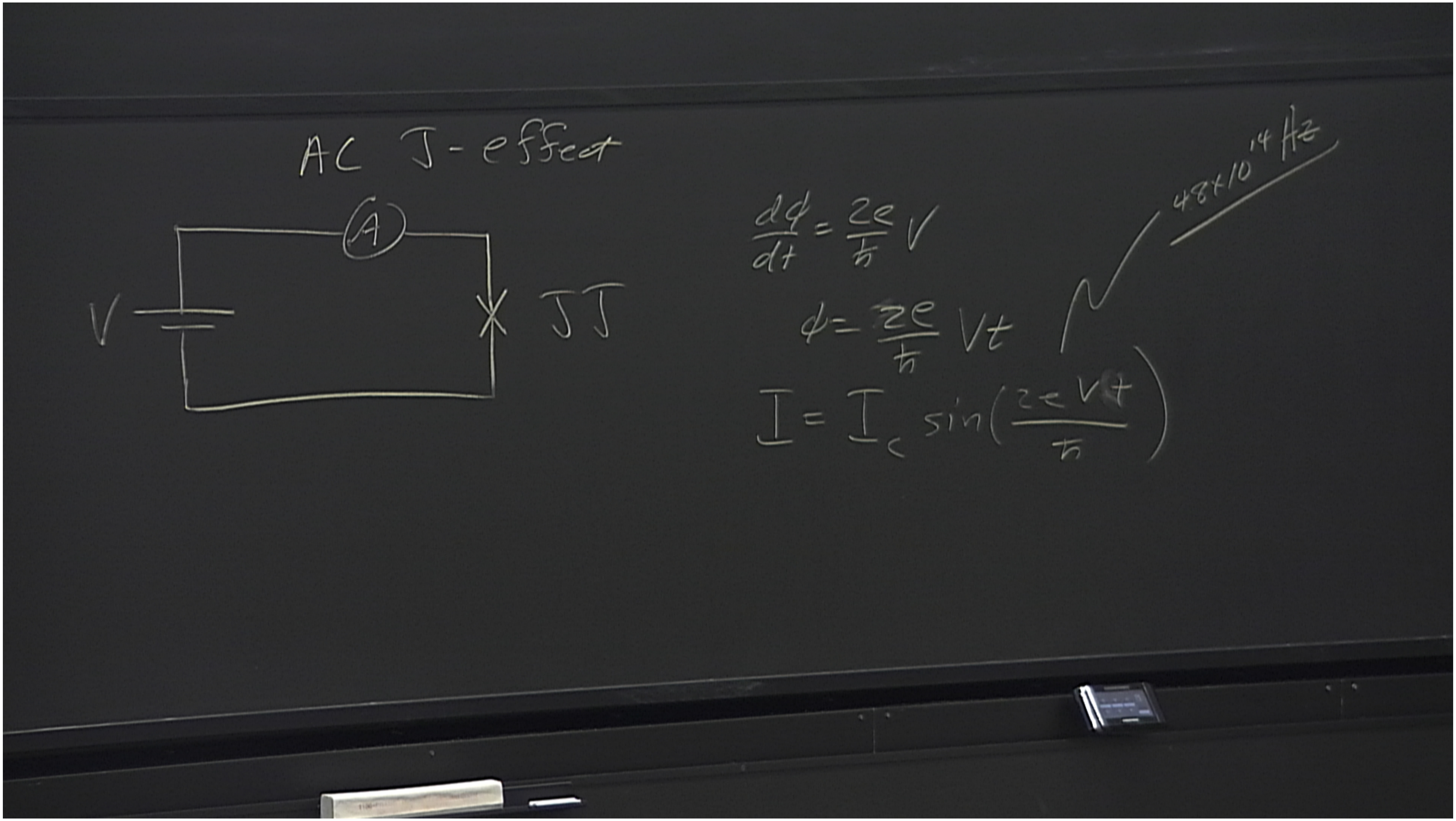
Josephson ; tunneling between superconductors.

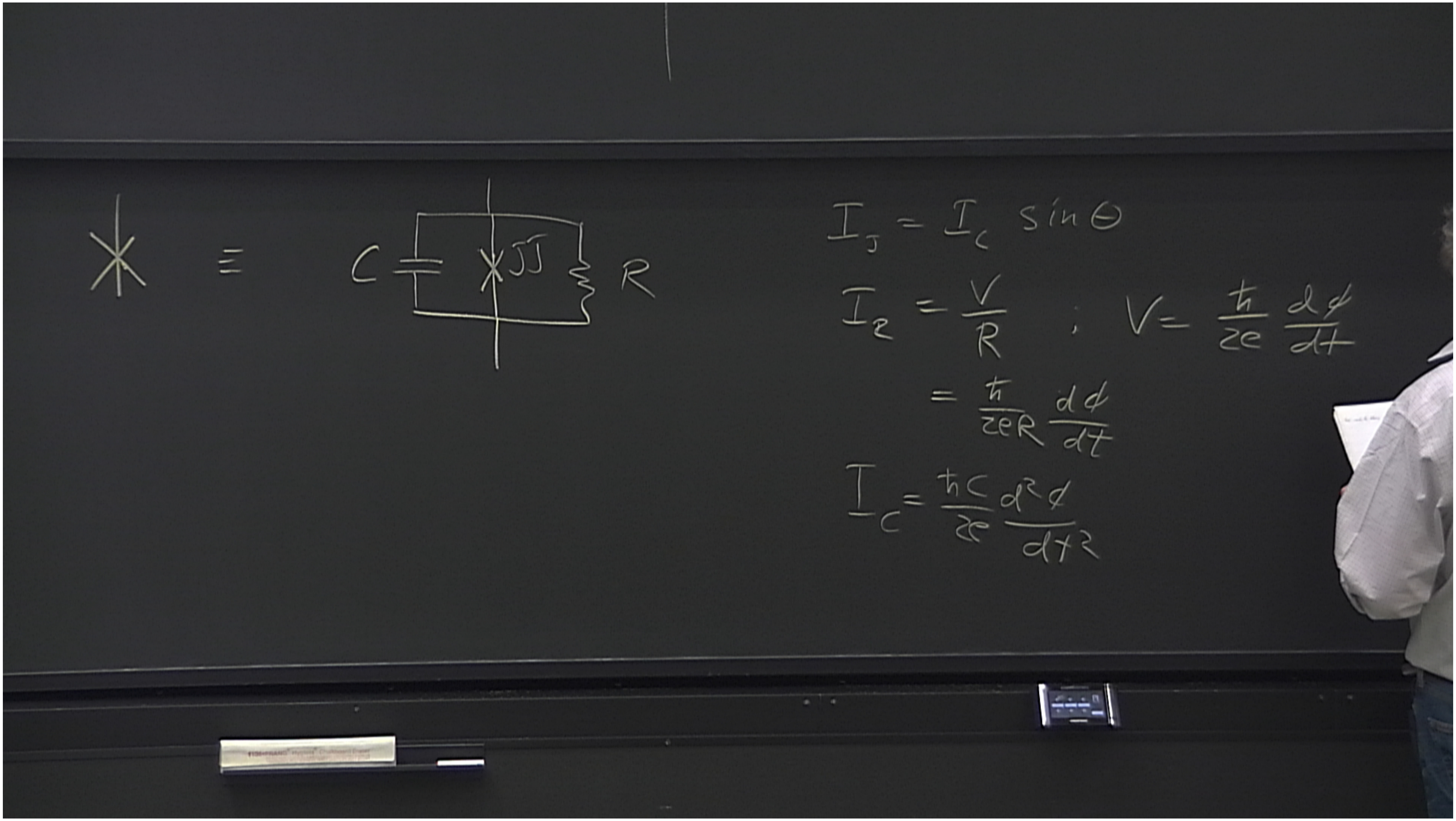


$$I = I_c \sin\phi$$


DC J - effect
no voltage
I
current
set φ of wavefunction


AC J-effect
A
V
JJ
$\frac{d\phi}{dt} = \frac{2e}{\hbar} V$
$\phi = \frac{2e}{\hbar} Vt$
$I = I_c \sin\left(\frac{2eVt}{\hbar}\right)$


AC J-effect
A
V
JJ
$\frac{d\phi}{dt} = \frac{2e}{\hbar} V$
$\phi = \frac{2e}{\hbar} Vt$
$I = I_c \sin\left(\frac{2eVt}{\hbar}\right)$
48×10^{14} Hz

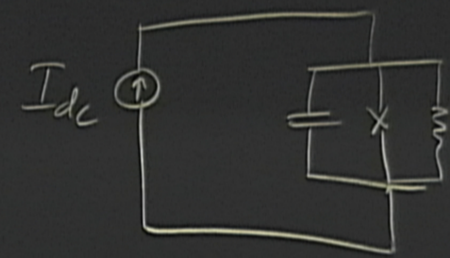

C
JJ
R
$I_J = I_c \sin\theta$
$I_R = \frac{V}{R}$; $V = \frac{\hbar}{2e}\frac{d\phi}{dt}$
$= \frac{\hbar}{2eR}\frac{d\phi}{dt}$
$I_C = \frac{\hbar C}{2e}\frac{d^2\phi}{dt^2}$

$$= I_c \sin\Theta$$

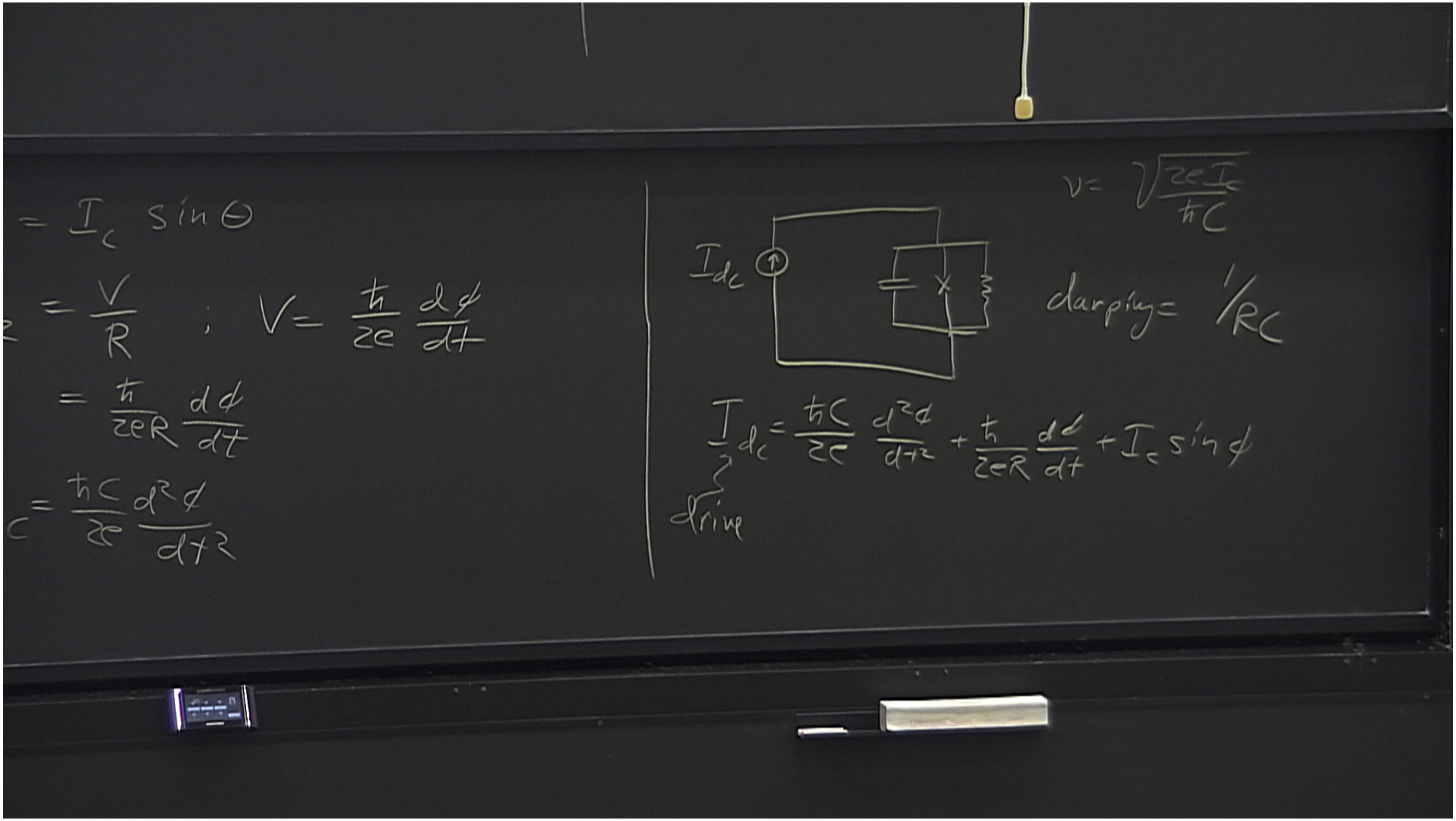
$$= \frac{V}{R} \quad ; \quad V = \frac{\hbar}{2e}\frac{d\phi}{dt}$$

$$= \frac{\hbar}{2eR}\frac{d\phi}{dt}$$

$$c = \frac{\hbar C}{2e}\frac{d^2\phi}{dt^2}$$



$$I_{dc} = \frac{\hbar C}{2e}\frac{d^2\phi}{dt^2} + \frac{\hbar}{2eR}\frac{d\phi}{dt} + I_c \sin\phi$$



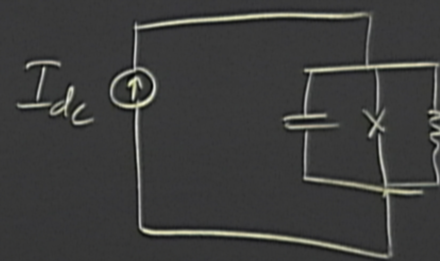
$= I_c \sin\theta$
$= \frac{V}{R}$; $V = \frac{\hbar}{2e}\frac{d\phi}{dt}$
$= \frac{\hbar}{2eR}\frac{d\phi}{dt}$
$c = \frac{\hbar C}{2e}\frac{d^2\phi}{dt^2}$
$v = \sqrt{\frac{2eI_c}{\hbar C}}$
I_{dc}
damping $= 1/RC$
$I_{dc} = \frac{\hbar C}{2e}\frac{d^2\phi}{dt^2} + \frac{\hbar}{2eR}\frac{d\phi}{dt} + I_c \sin\phi$
drive

$$= I_c \sin\theta$$

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

$$= \frac{\hbar}{2eR}\frac{d\phi}{dt}$$

$$= \frac{\hbar C}{2e}\frac{d^2\phi}{dt^2}$$

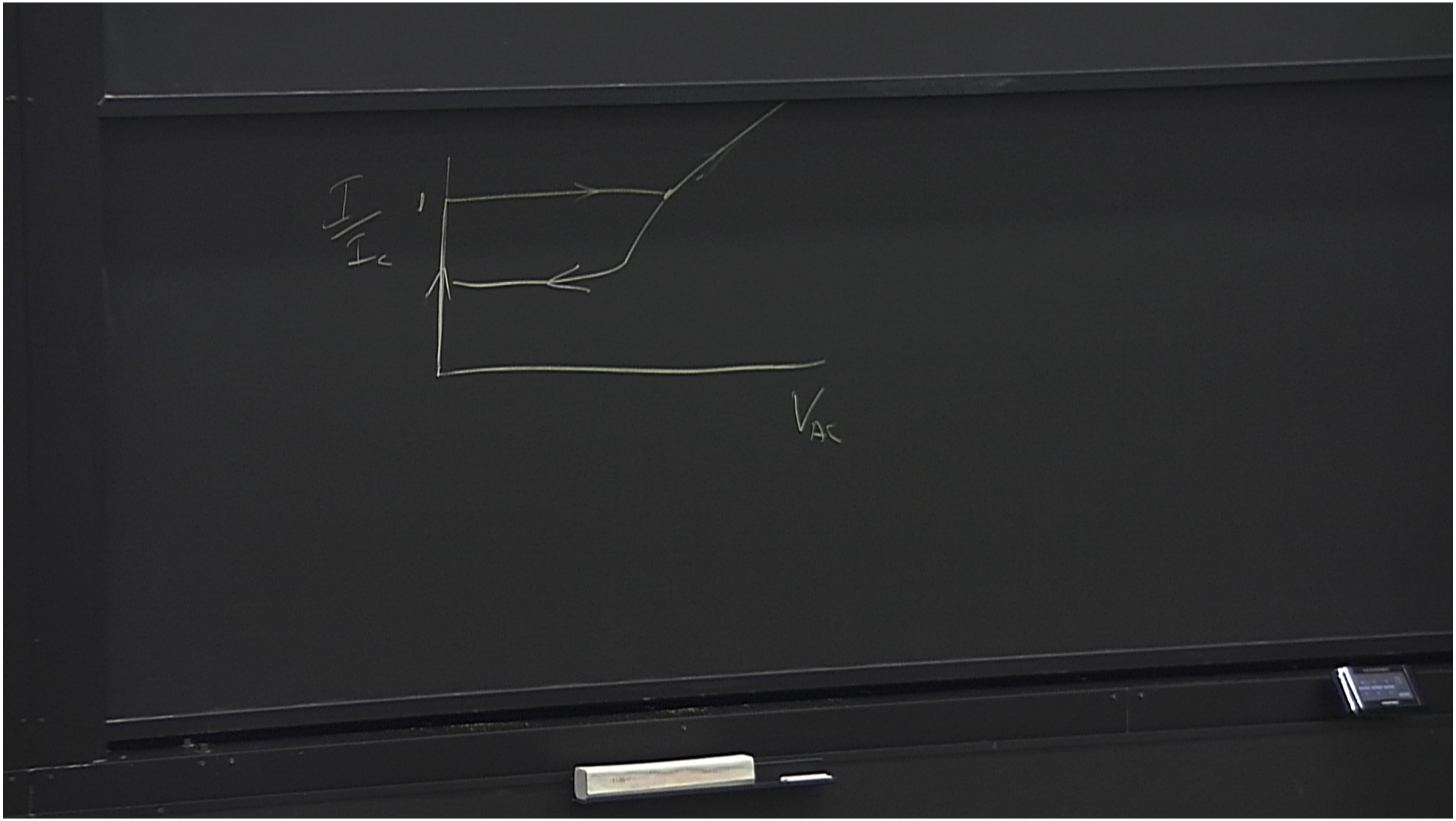


$$v = \sqrt{\frac{2eI_c}{\hbar C}}$$

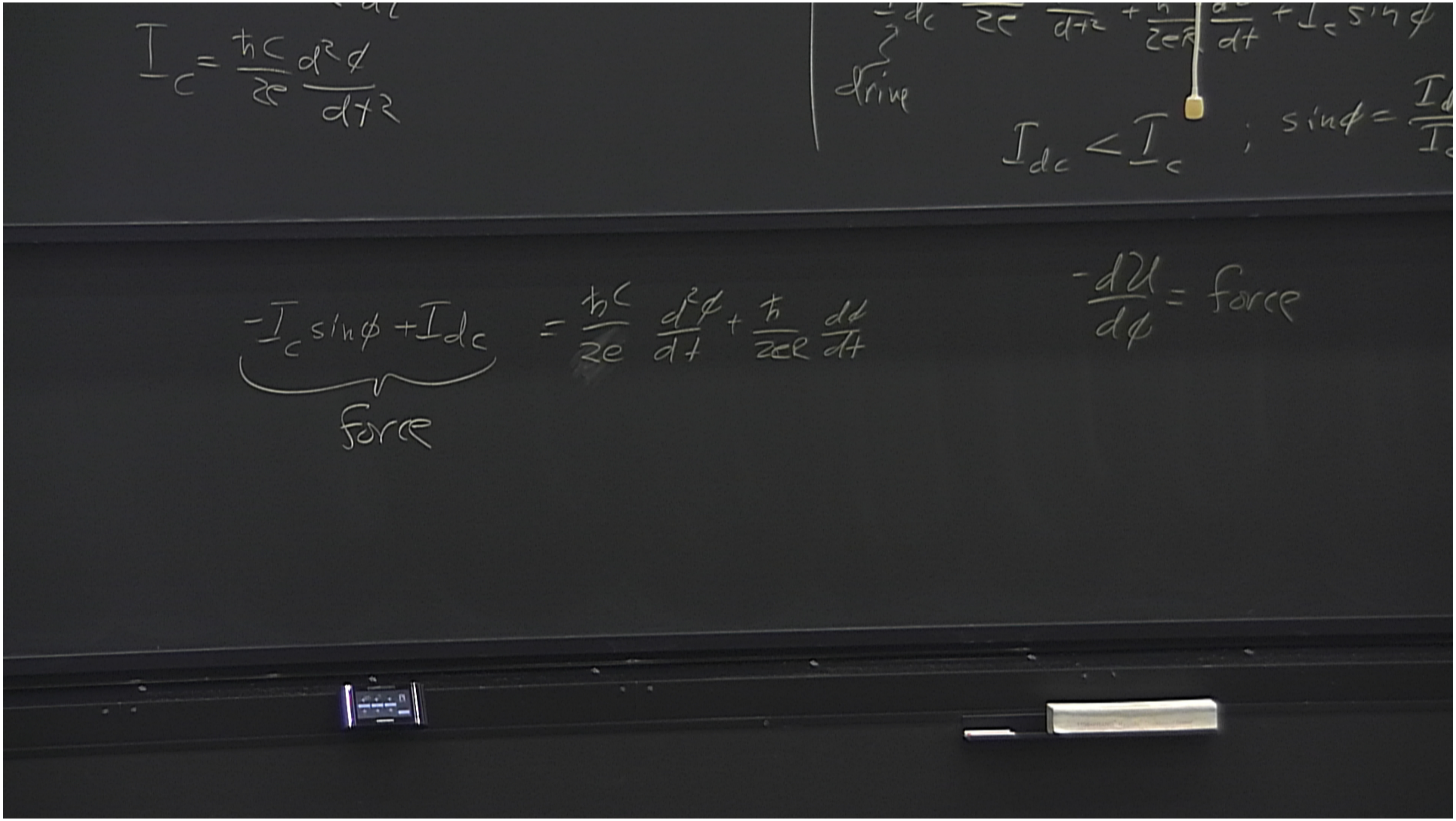
$$\text{damping} = 1/RC$$

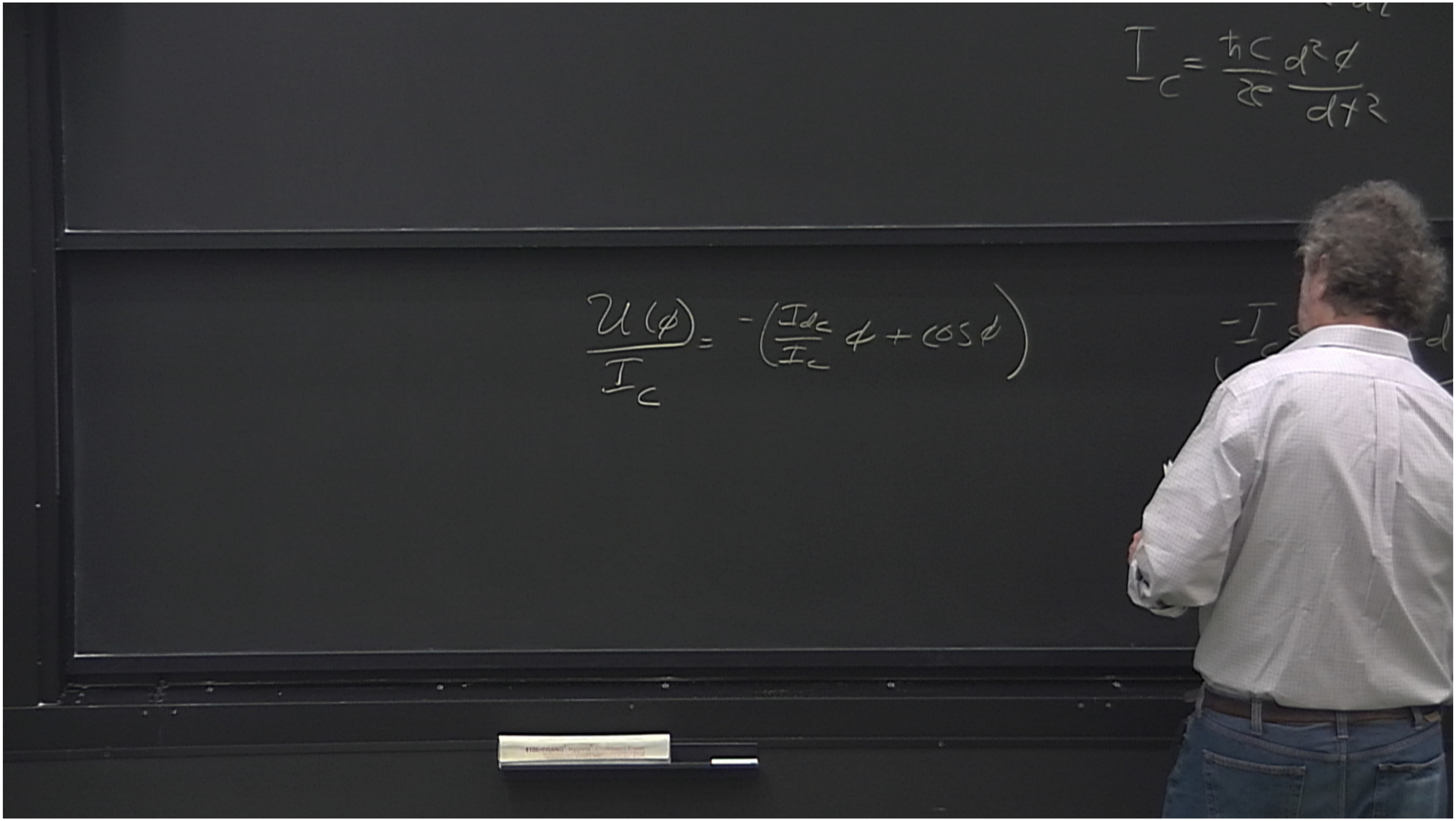
$$\underbrace{I_{dc}}_{\text{drive}} = \frac{\hbar C}{2e}\frac{d^2\phi}{dt^2} + \frac{\hbar}{2eR}\frac{d\phi}{dt} + I_c \sin\phi$$

$$I_{dc} < I_c \quad ; \quad \sin\phi = \frac{I_{dc}}{I_c}$$

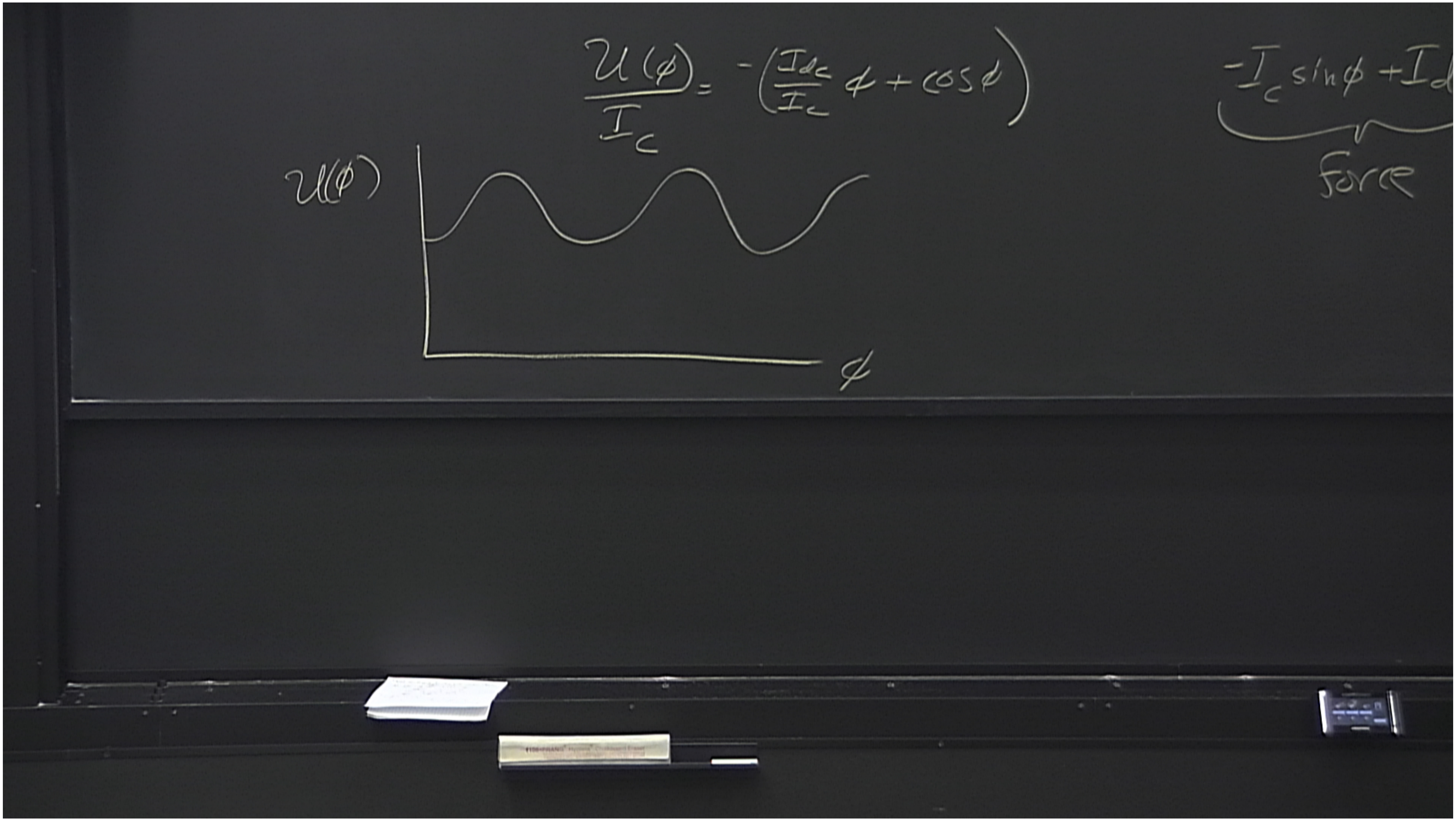


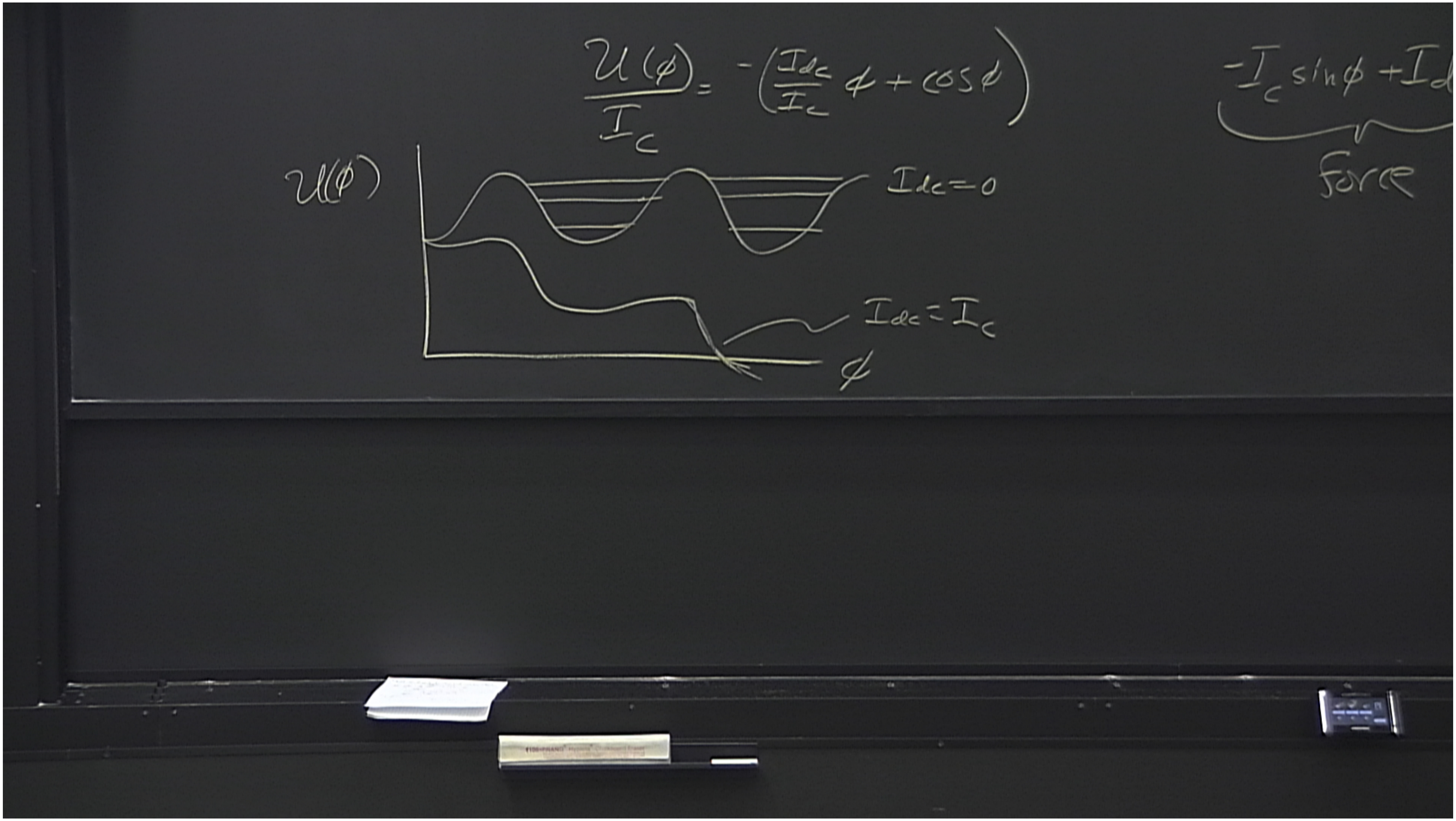
I/I_c
1
V_AC


$I_c = \frac{\hbar C}{2e}\frac{d^2\phi}{dt^2}$
drive
$I_{dc} < I_c$; $\sin\phi =$
$\underbrace{-I_c \sin\phi + I_{dc}}_{\text{force}} = \frac{\hbar C}{2e}\frac{d^2\phi}{dt^2} + \frac{\hbar}{2eR}\frac{d\phi}{dt}$
$-\frac{dU}{d\phi} =$ force



$I_c = \frac{\hbar c}{2e} \frac{d^2\phi}{dt^2}$
$\frac{U(\phi)}{I_c} = -\left(\frac{I_{dc}}{I_c}\phi + \cos\phi\right)$


$\frac{U(\phi)}{I_c} = -\left(\frac{I_{dc}}{I_c}\phi + \cos\phi\right)$
$-I_c \sin\phi + I_d$
force
$U(\phi)$
ϕ


$\frac{U(\phi)}{I_c} = -\left(\frac{I_{dc}}{I_c}\phi + \cos\phi\right)$
$-I_c \sin\phi + I_d$
force
$U(\phi)$
$I_{dc}=0$
$I_{dc}=I_c$
ϕ


resonator
Q~100,000
Φ = n (h/2e

- Connect fault tolerance to Physics
  - control open Q systems
  - how count resources
  - deal w/ memory in the environment
  - efficient remove entropy

Verify Q.

Physics

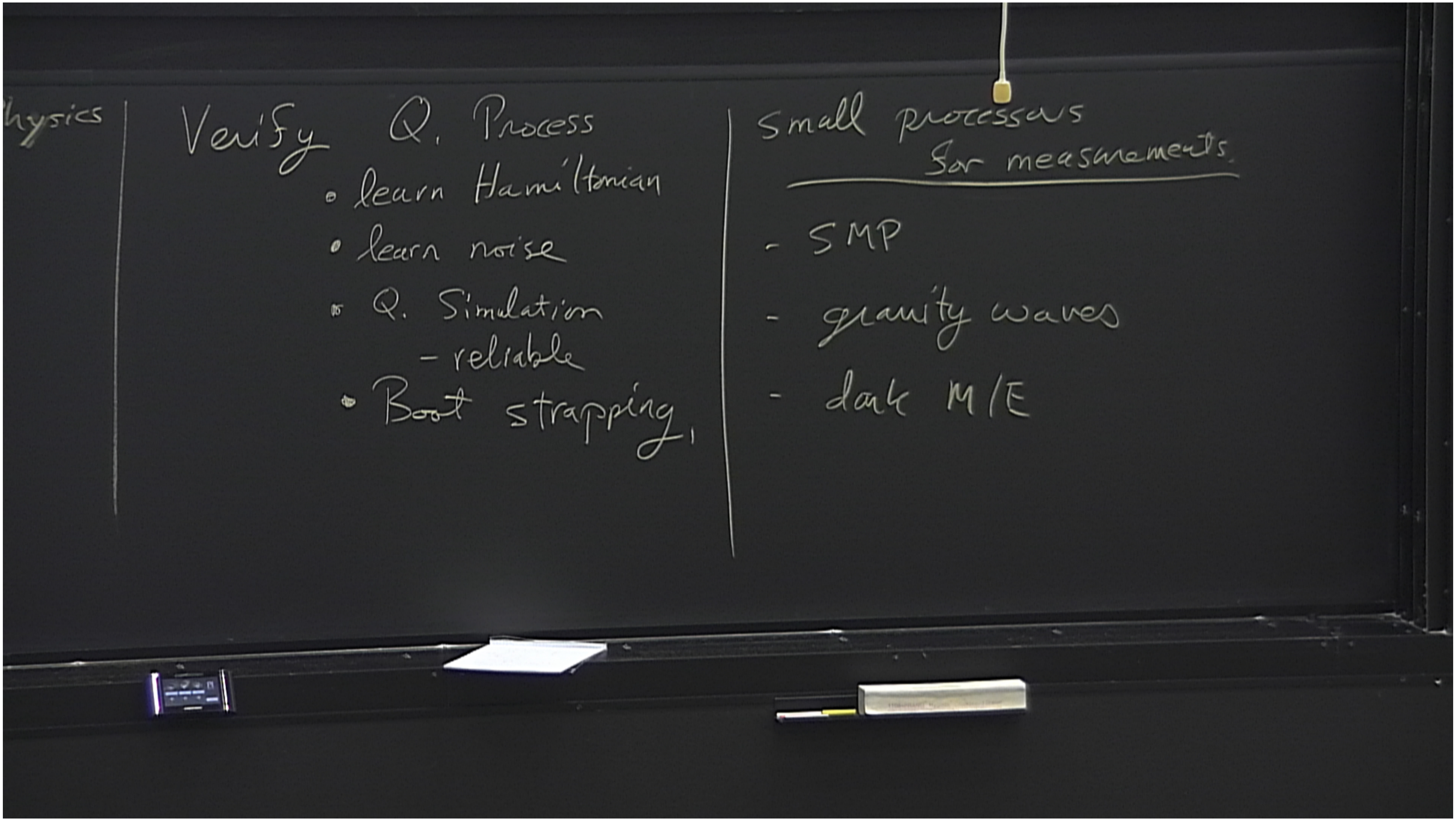
Verify Q. Process

- learn Hamiltonian
- learn noise
- Q. Simulation
  - reliable

Physics

Verify Q. Process

- learn Hamiltonian
- learn noise
- Q. Simulation
  - reliable
- Boot strapping,


hysics
Verify Q. Process
• learn Hamiltonian
• learn noise
• Q. Simulation
- reliable
• Boot strapping.
Small processors
for measurements
- SMP
- gravity waves
- dark M/E