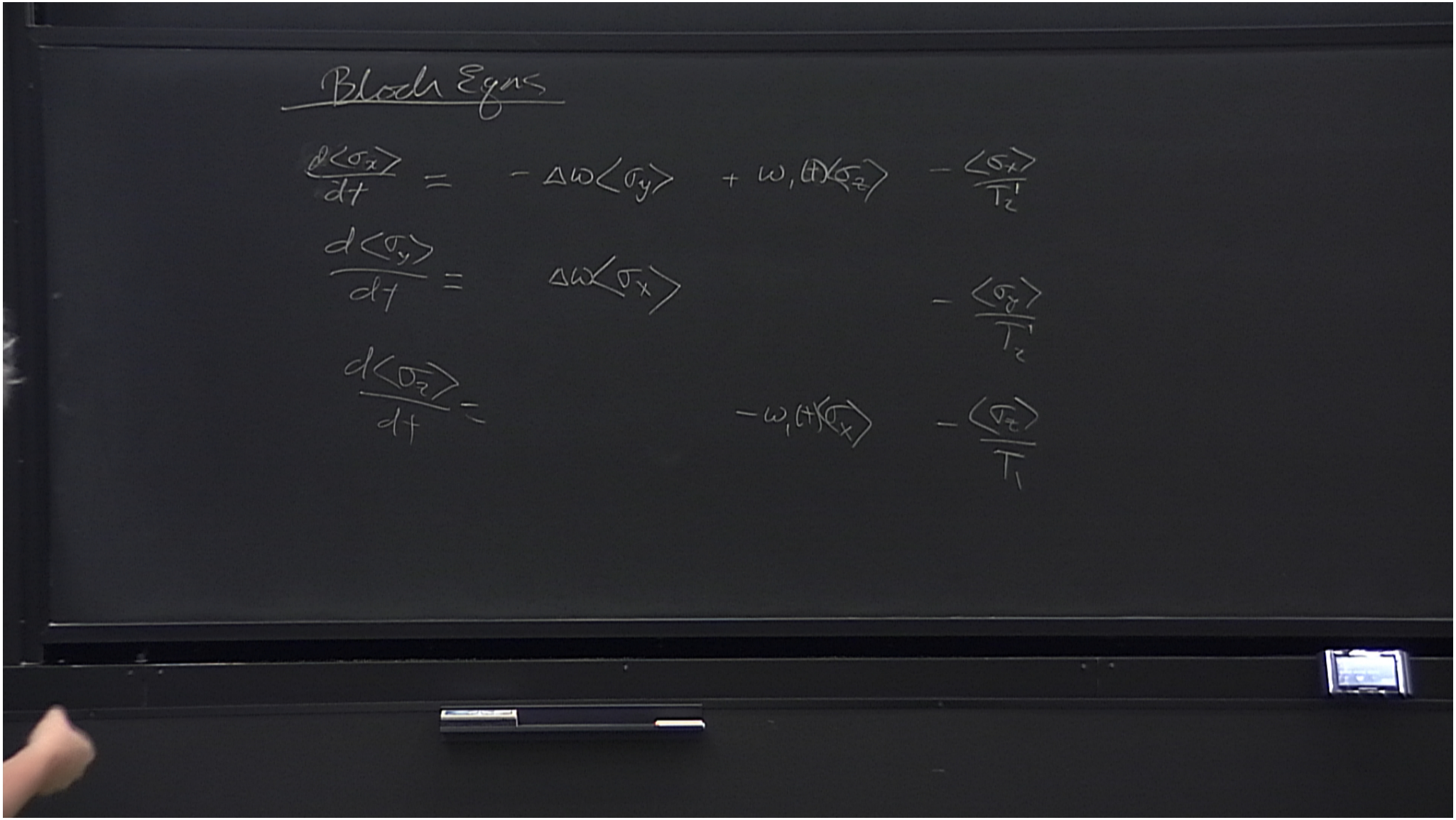
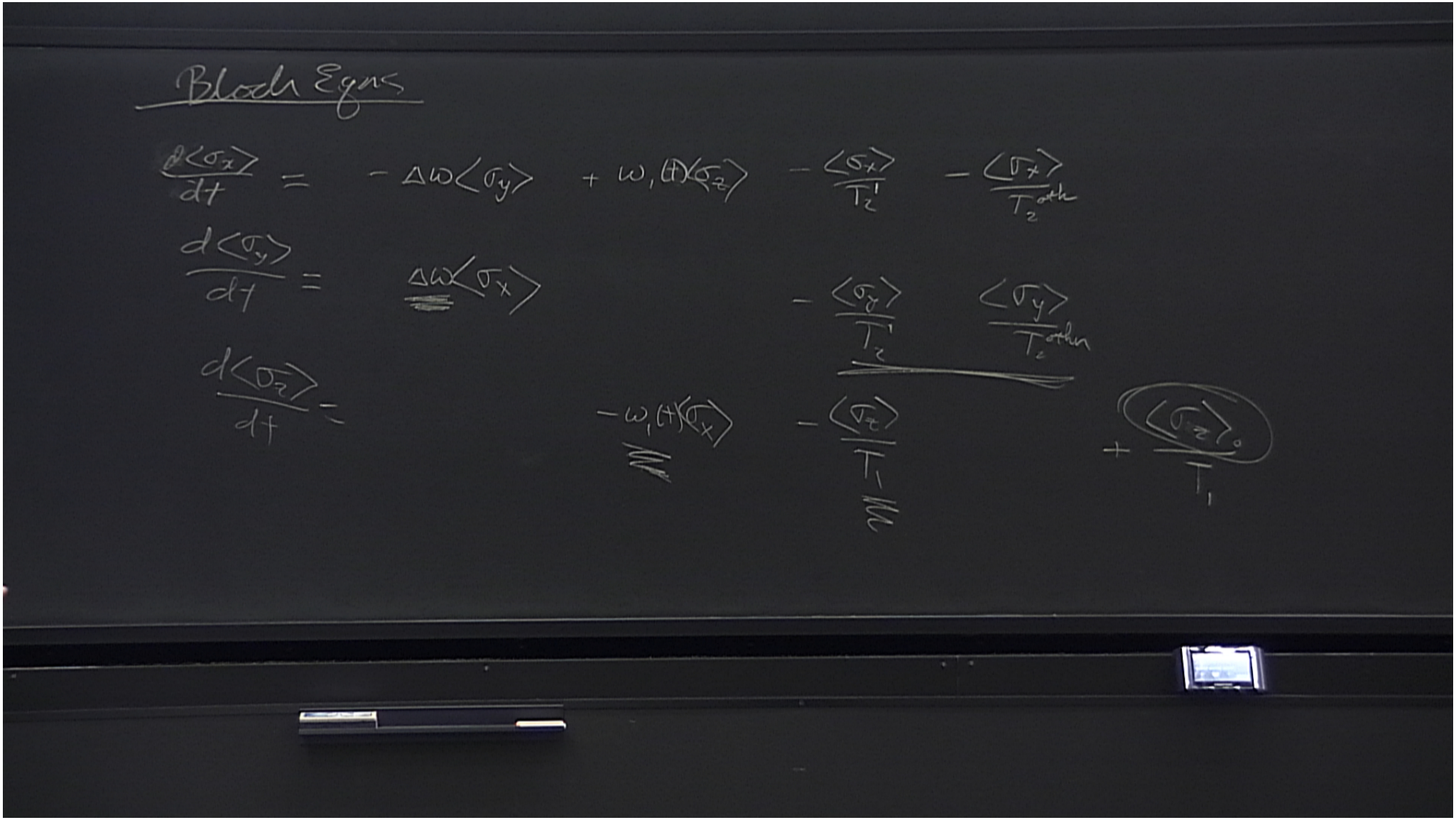
Title: PSI 2016/2017 Explorations in Quantum Information - Lecture 4

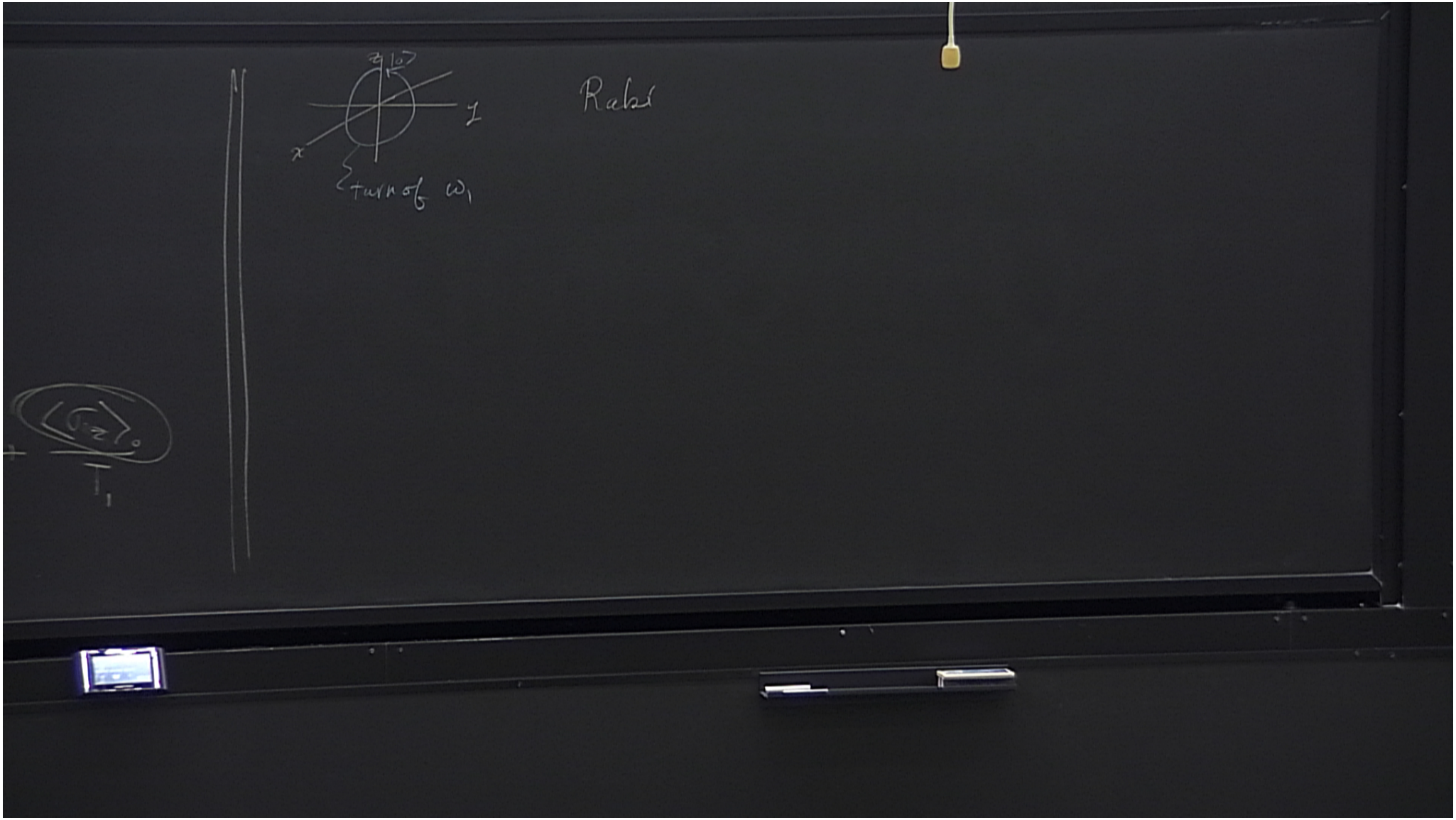
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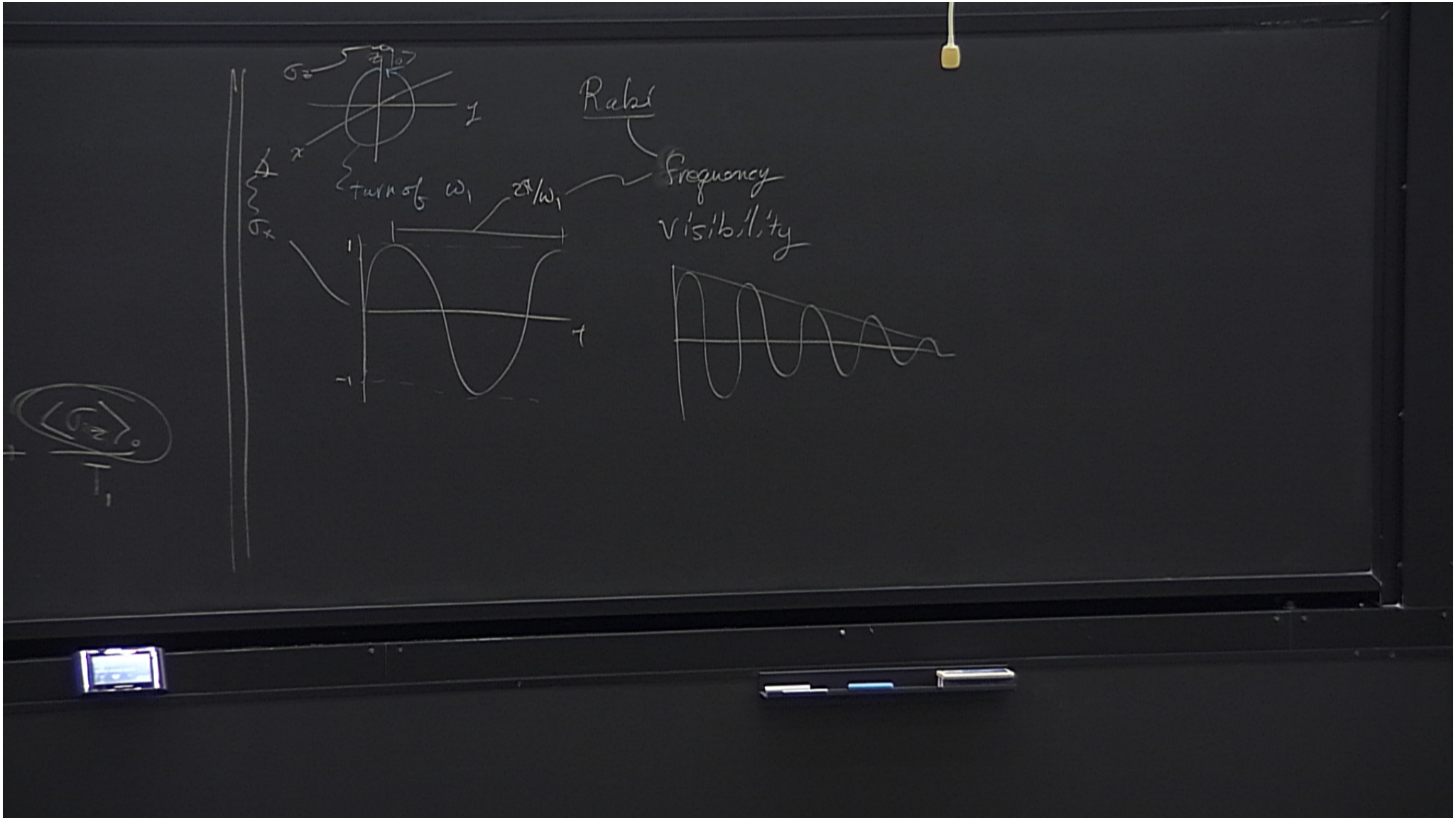
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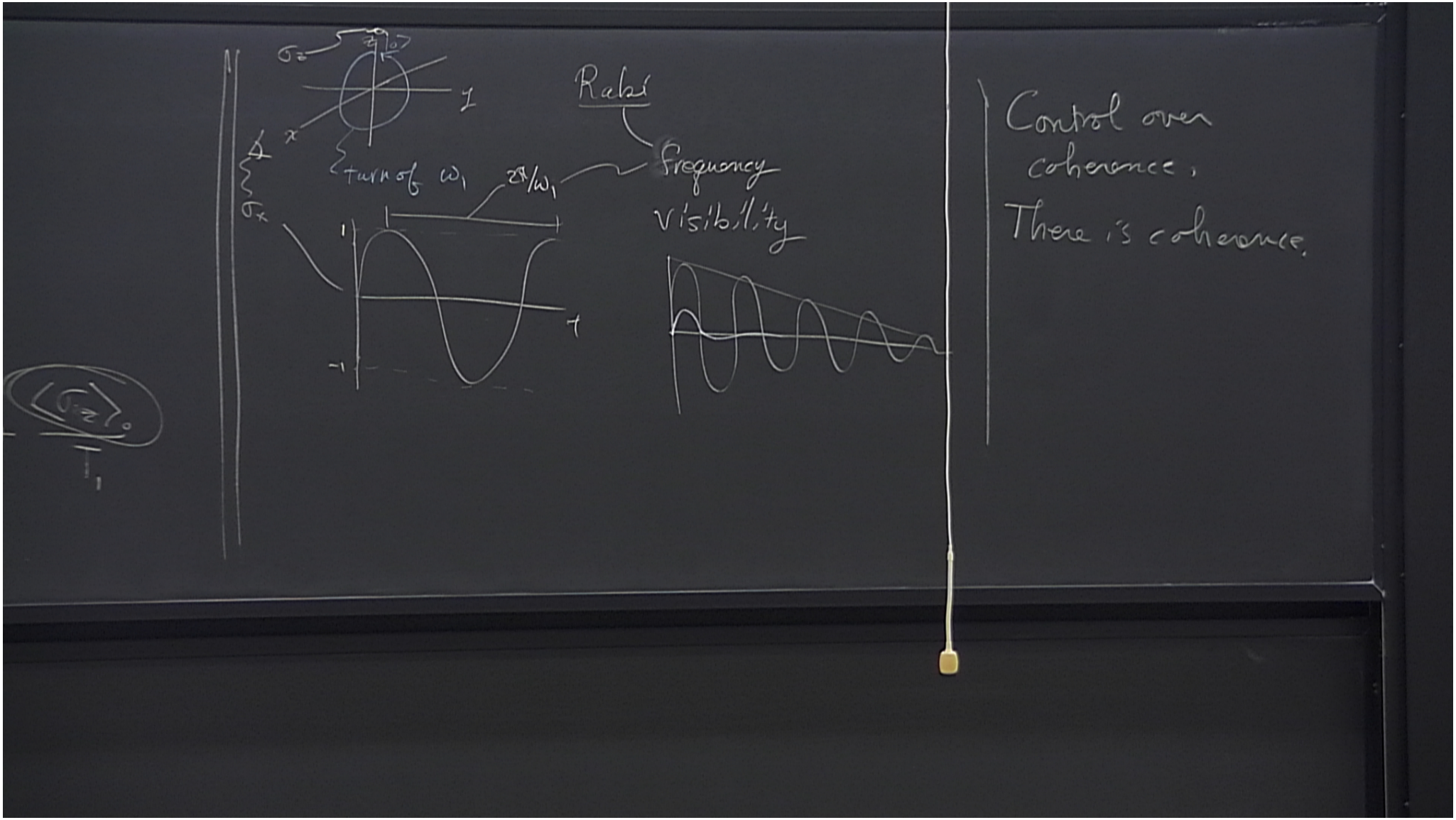
Abstract:

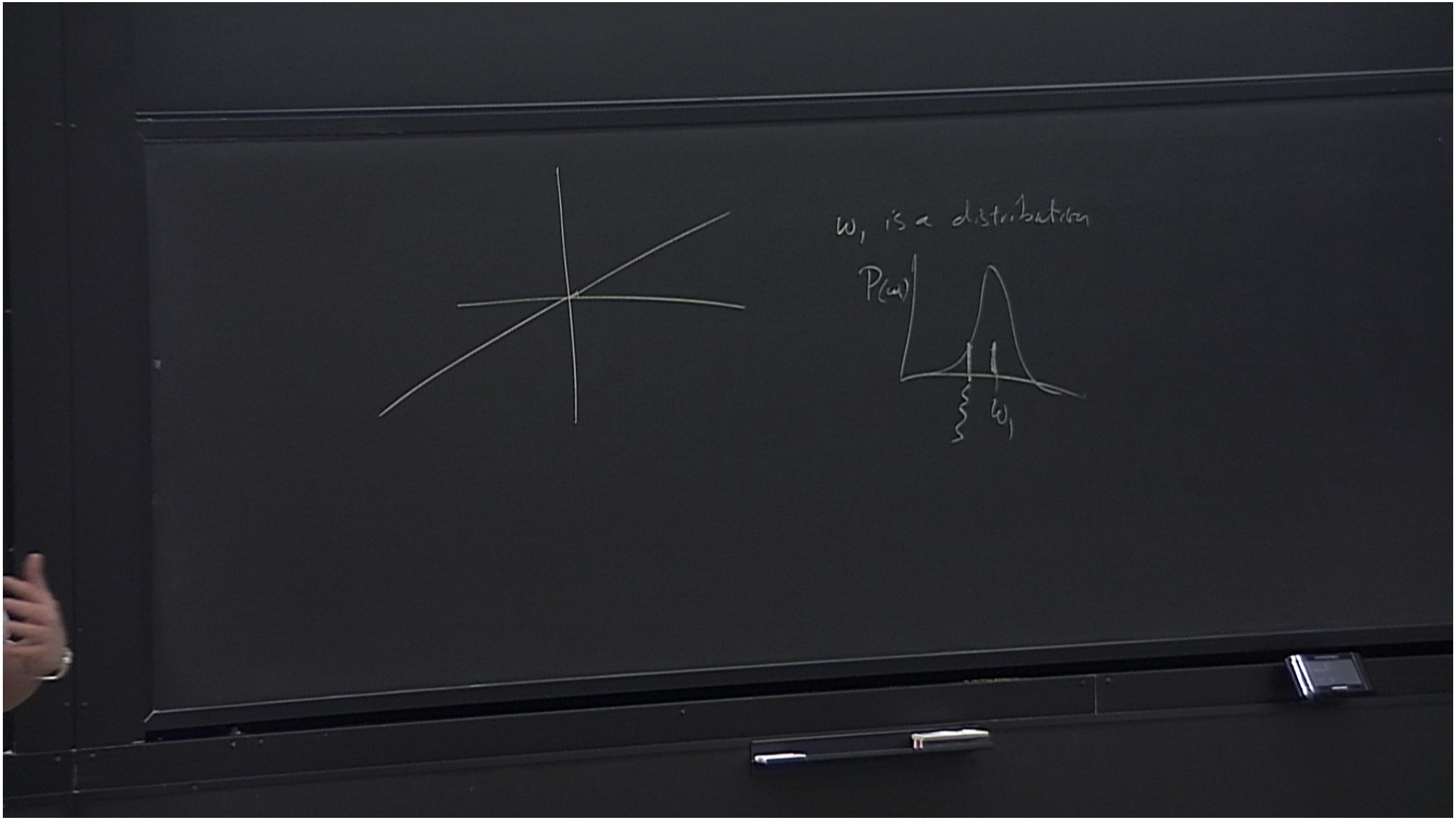

Bloch Eqns
$\frac{d\langle\sigma_x\rangle}{dt} = -\Delta\omega\langle\sigma_y\rangle + \omega_1(t)\langle\sigma_z\rangle - \frac{\langle\sigma_x\rangle}{T_2'}$
$\frac{d\langle\sigma_y\rangle}{dt} = \Delta\omega\langle\sigma_x\rangle - \frac{\langle\sigma_y\rangle}{T_2'}$
$\frac{d\langle\sigma_z\rangle}{dt} = -\omega_1(t)\langle\sigma_x\rangle - \frac{\langle\sigma_z\rangle}{T_1}$

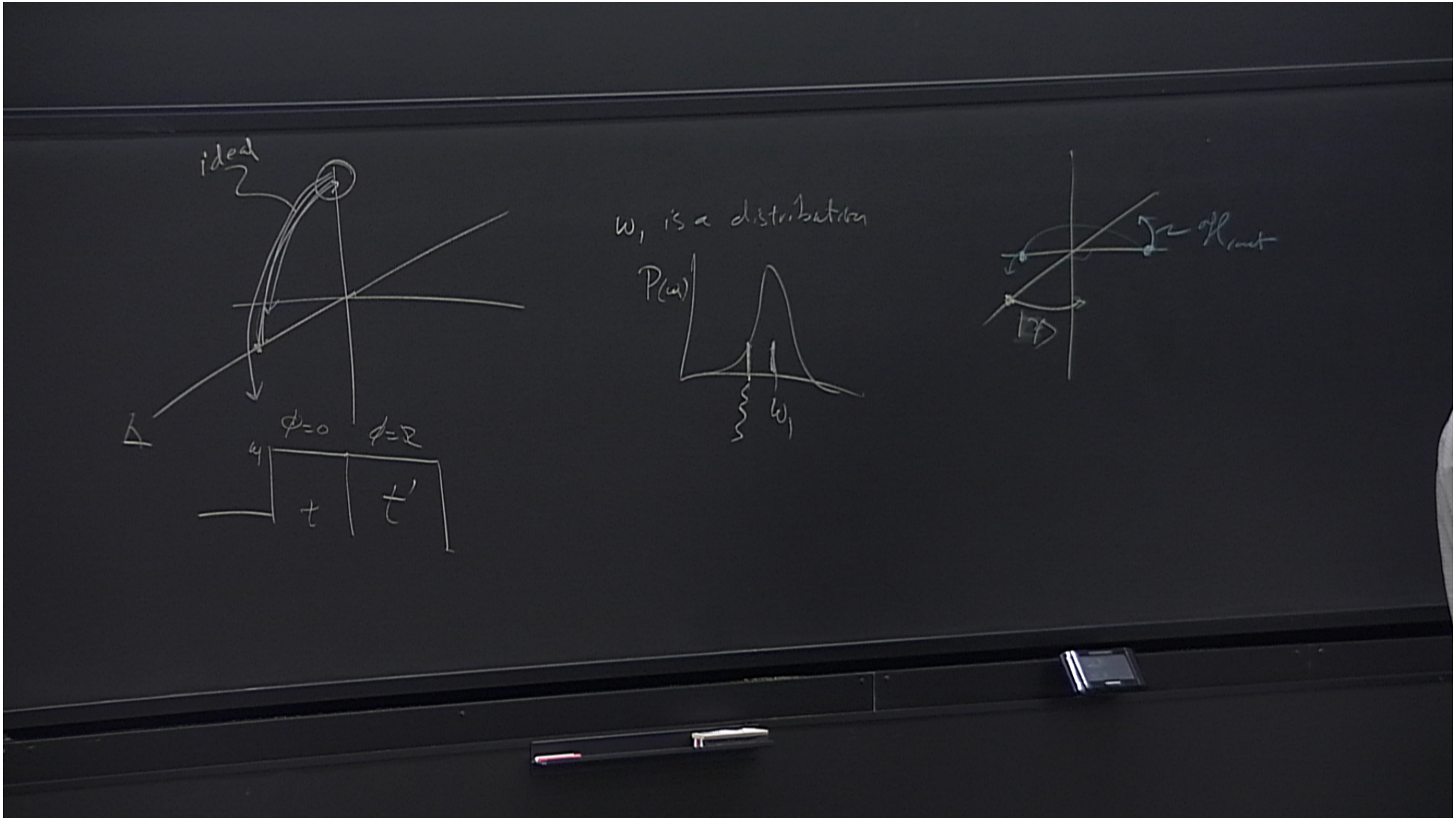

Bloch Eqns
$\frac{d\langle\sigma_x\rangle}{dt} = -\Delta\omega\langle\sigma_y\rangle + \omega_1(t)\langle\sigma_z\rangle - \frac{\langle\sigma_x\rangle}{T_2'} - \frac{\langle\sigma_x\rangle}{T_2^{other}}$
$\frac{d\langle\sigma_y\rangle}{dt} = \Delta\omega\langle\sigma_x\rangle - \frac{\langle\sigma_y\rangle}{T_2'} - \frac{\langle\sigma_y\rangle}{T_2^{other}}$
$\frac{d\langle\sigma_z\rangle}{dt} = -\omega_1(t)\langle\sigma_x\rangle - \frac{\langle\sigma_z\rangle}{T_1} + \frac{\langle\sigma_z\rangle^0}{T_1}$

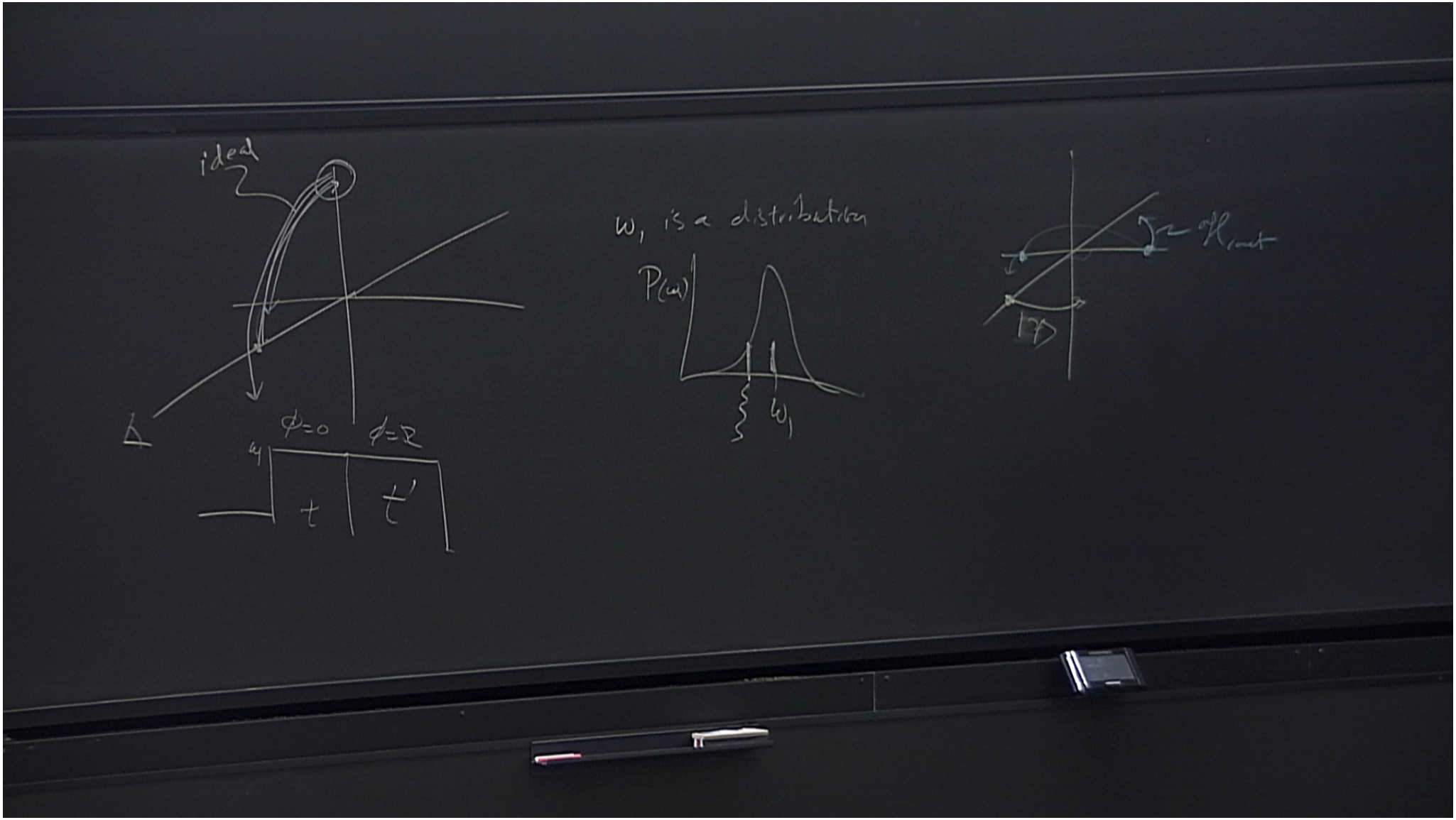

Rabi
turn of ω_1

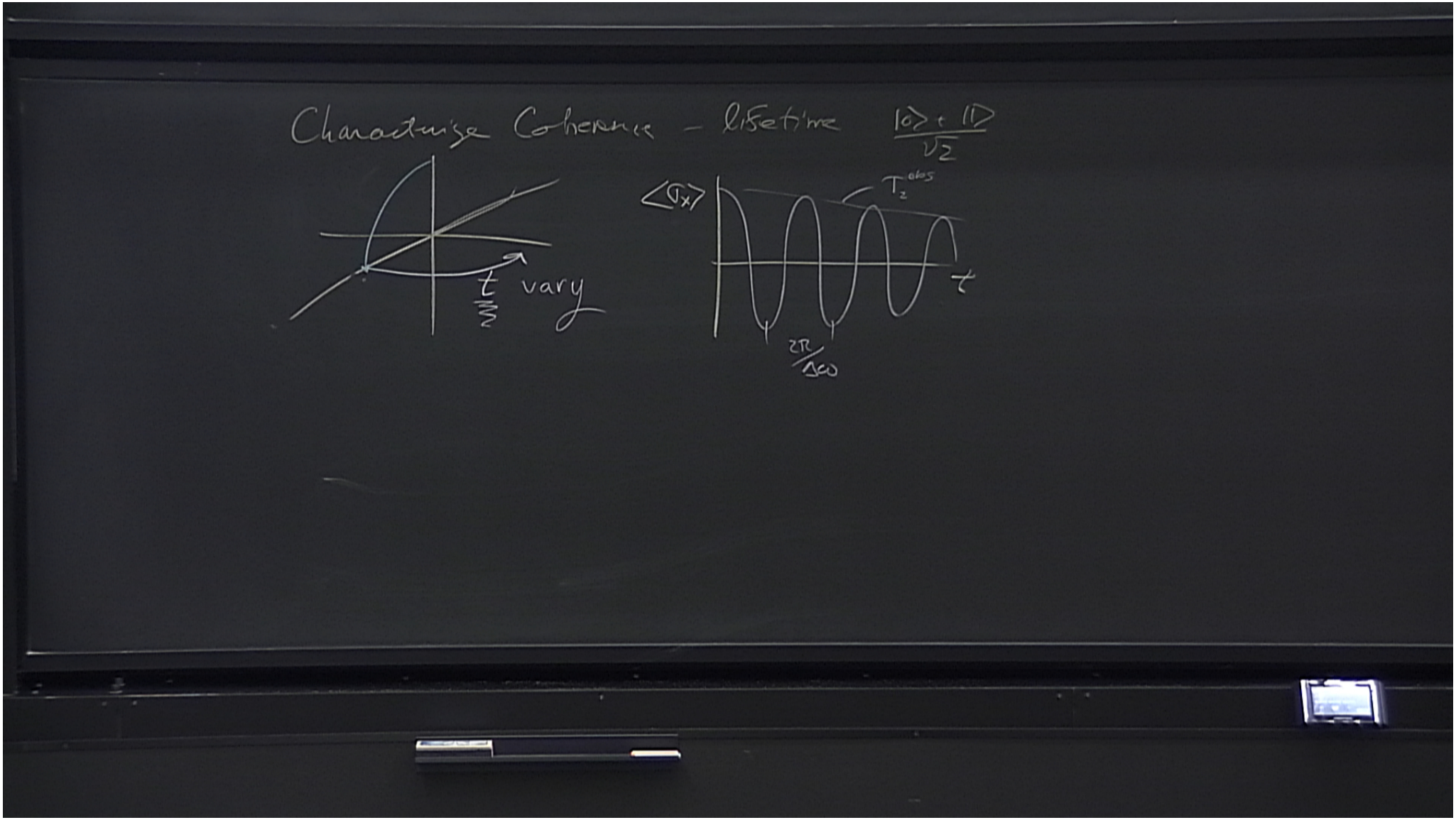

Rabi
Frequency
visibility
turn off ω_1
$2\pi/\omega_1$
1
-1
t

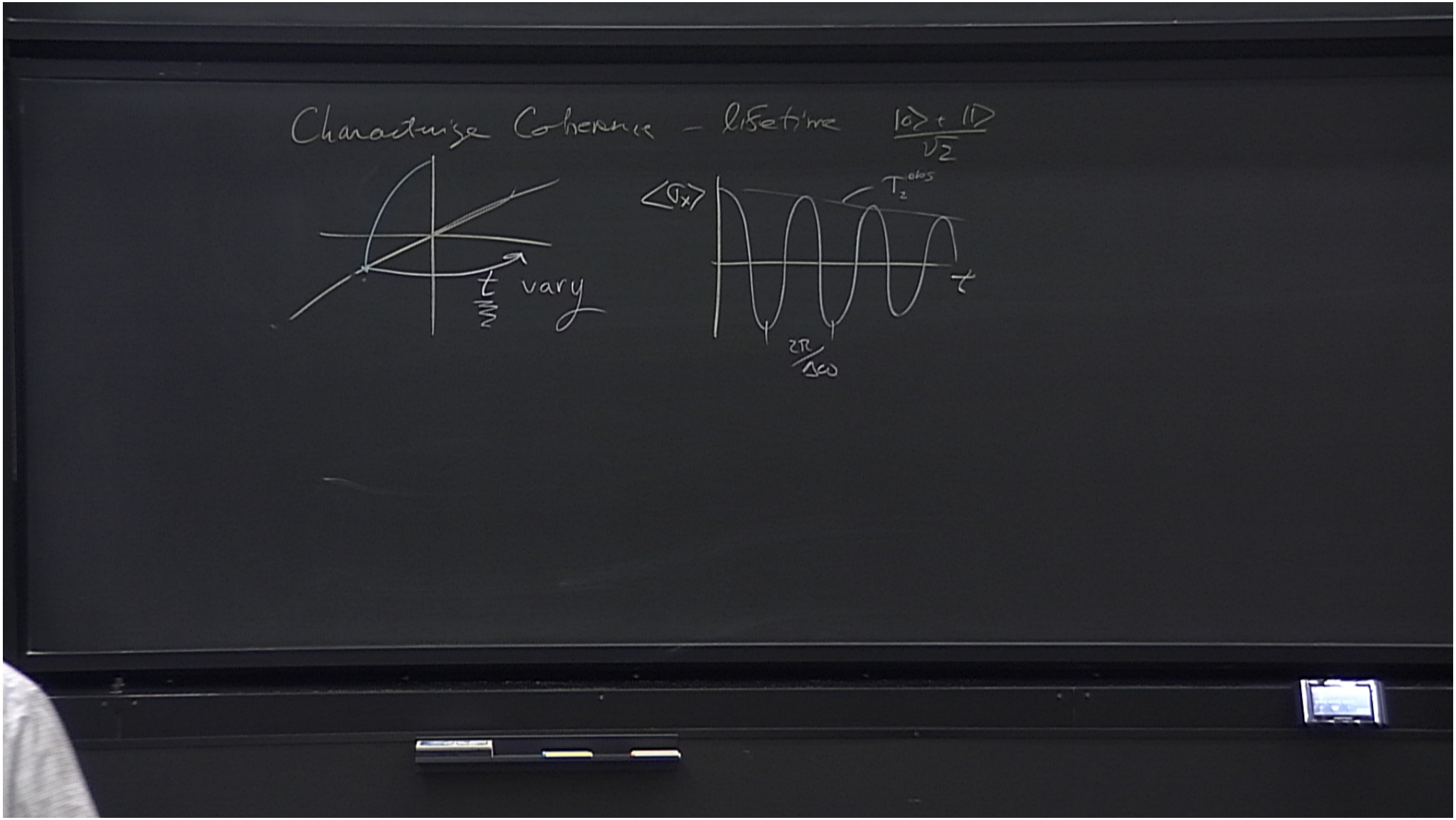

Rabi
frequency
visibility
Control over coherence.
There is coherence.

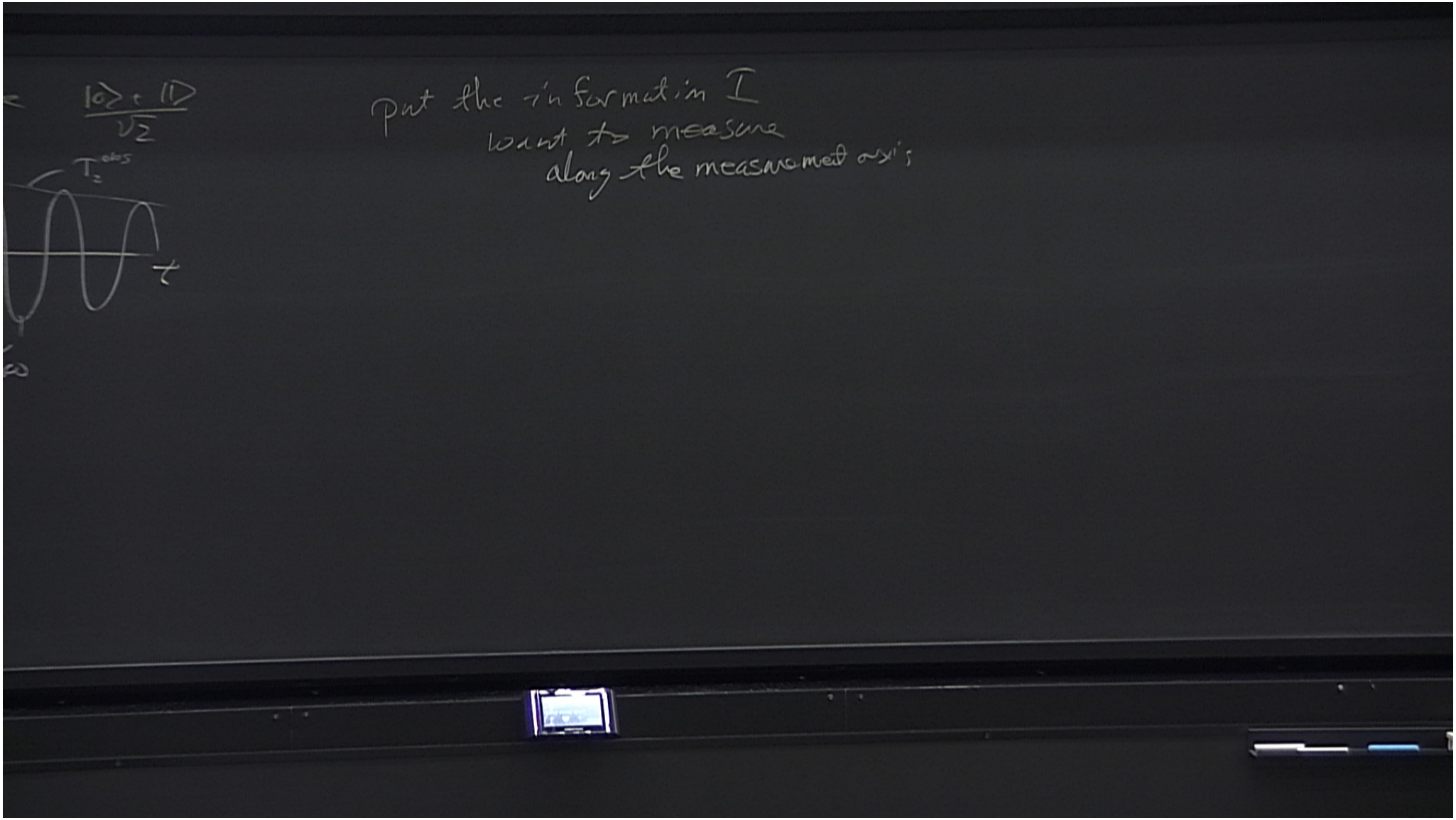

ω_1 is a distribution
$P(\omega)$
ω_1

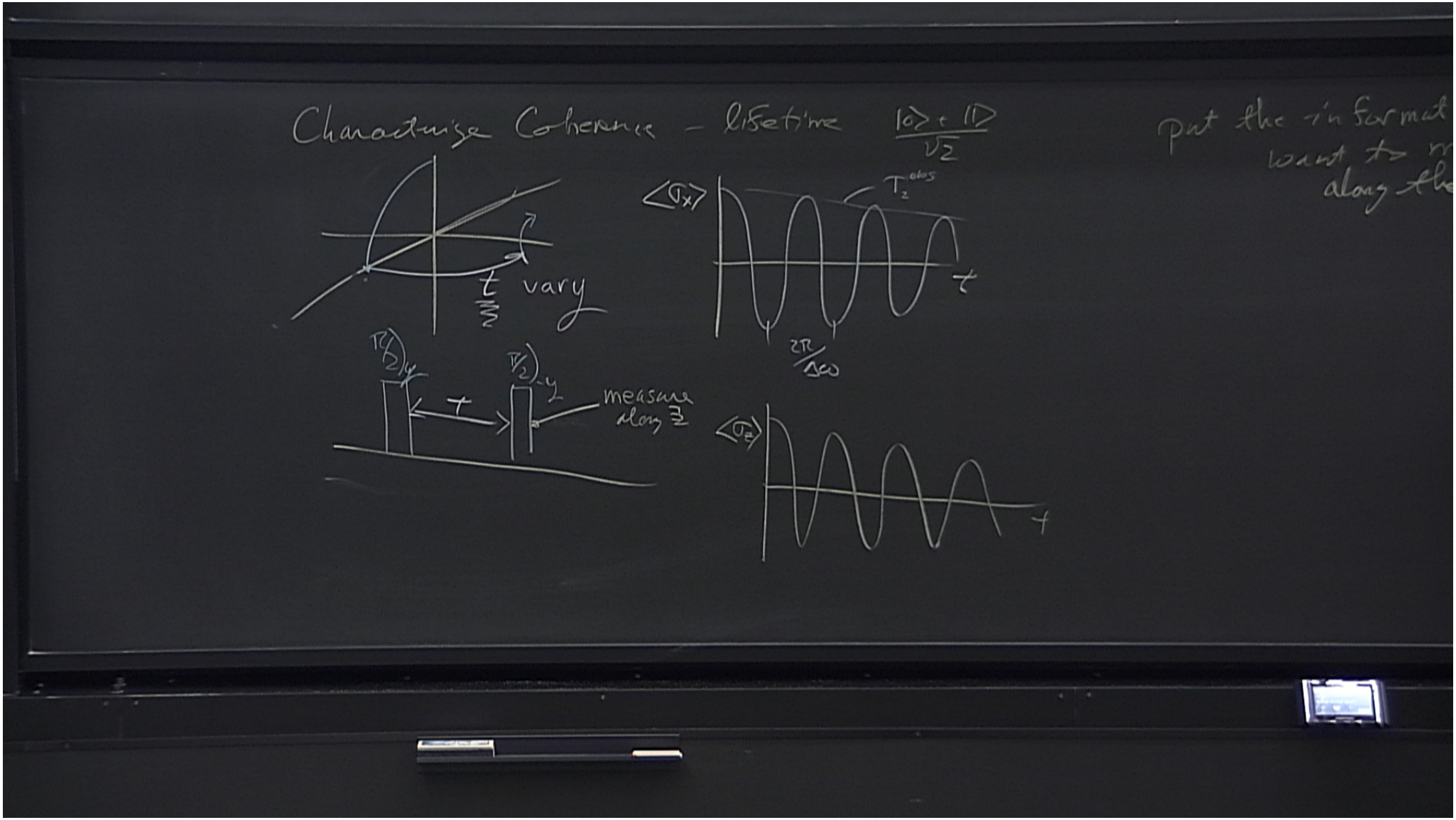

ideal
Δ
Φ=0
Φ=π
t
t'
ω₁ is a distribution
P(ω)
ω₁

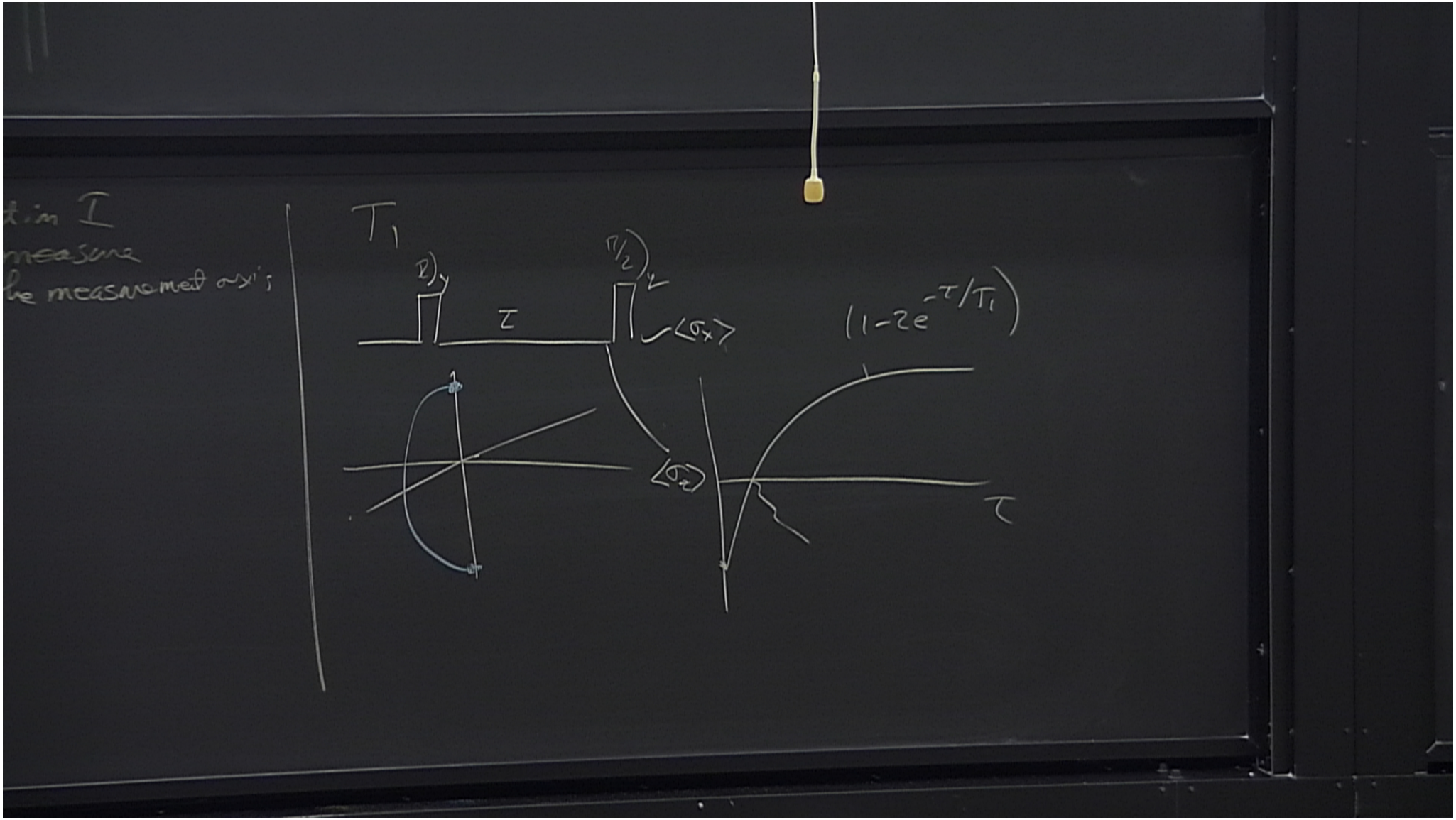

ideal
Δ
Φ=0
Φ=2
t
t'
ω₁ is a distribution
P(ω)
ω₁

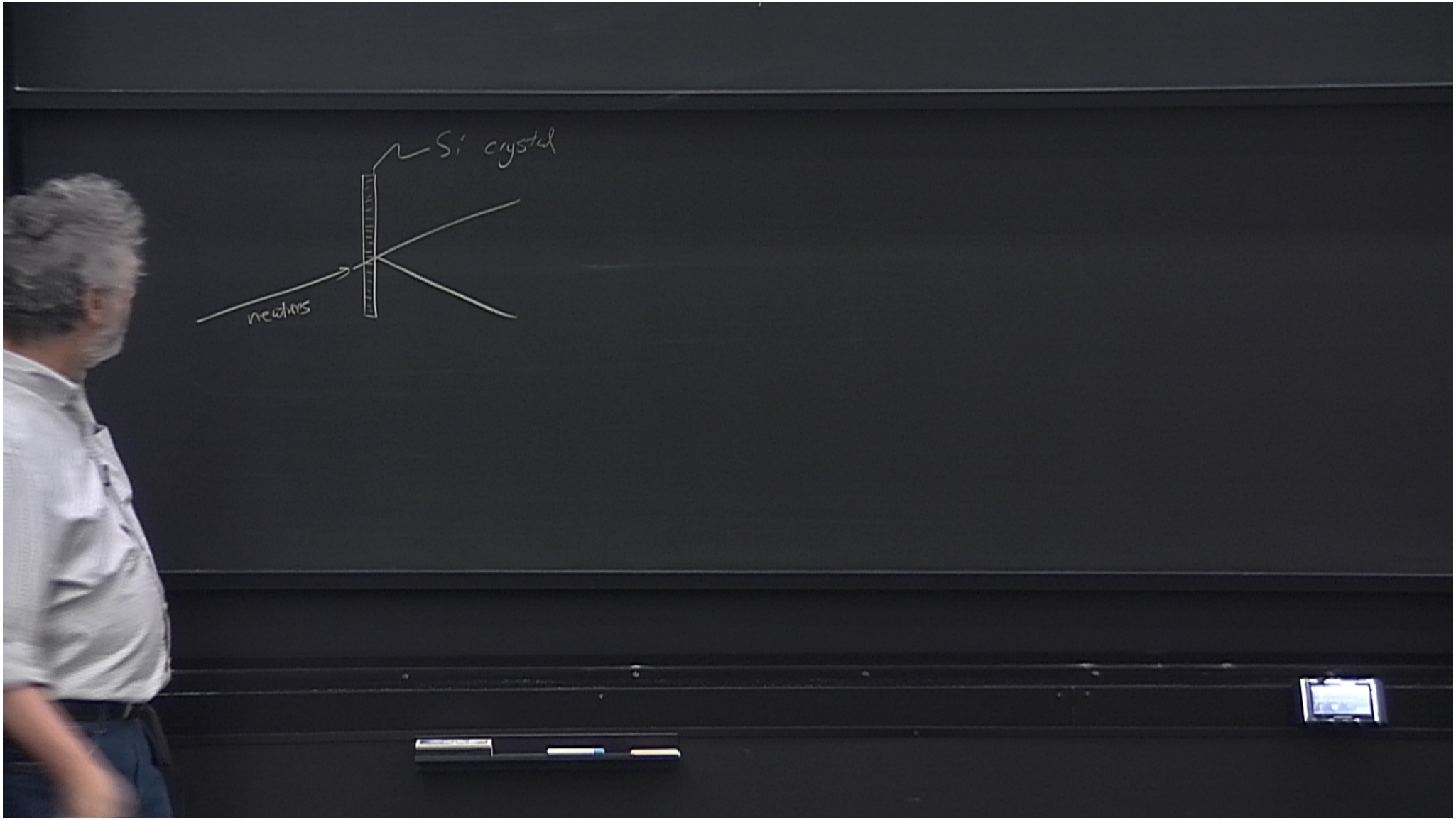

Characterise Coherence - lifetime
$\frac{|0\rangle + |1\rangle}{\sqrt{2}}$
τ vary
$\langle \sigma_x \rangle$
T_2^{obs}
t
$\frac{2\pi}{\Delta\omega}$

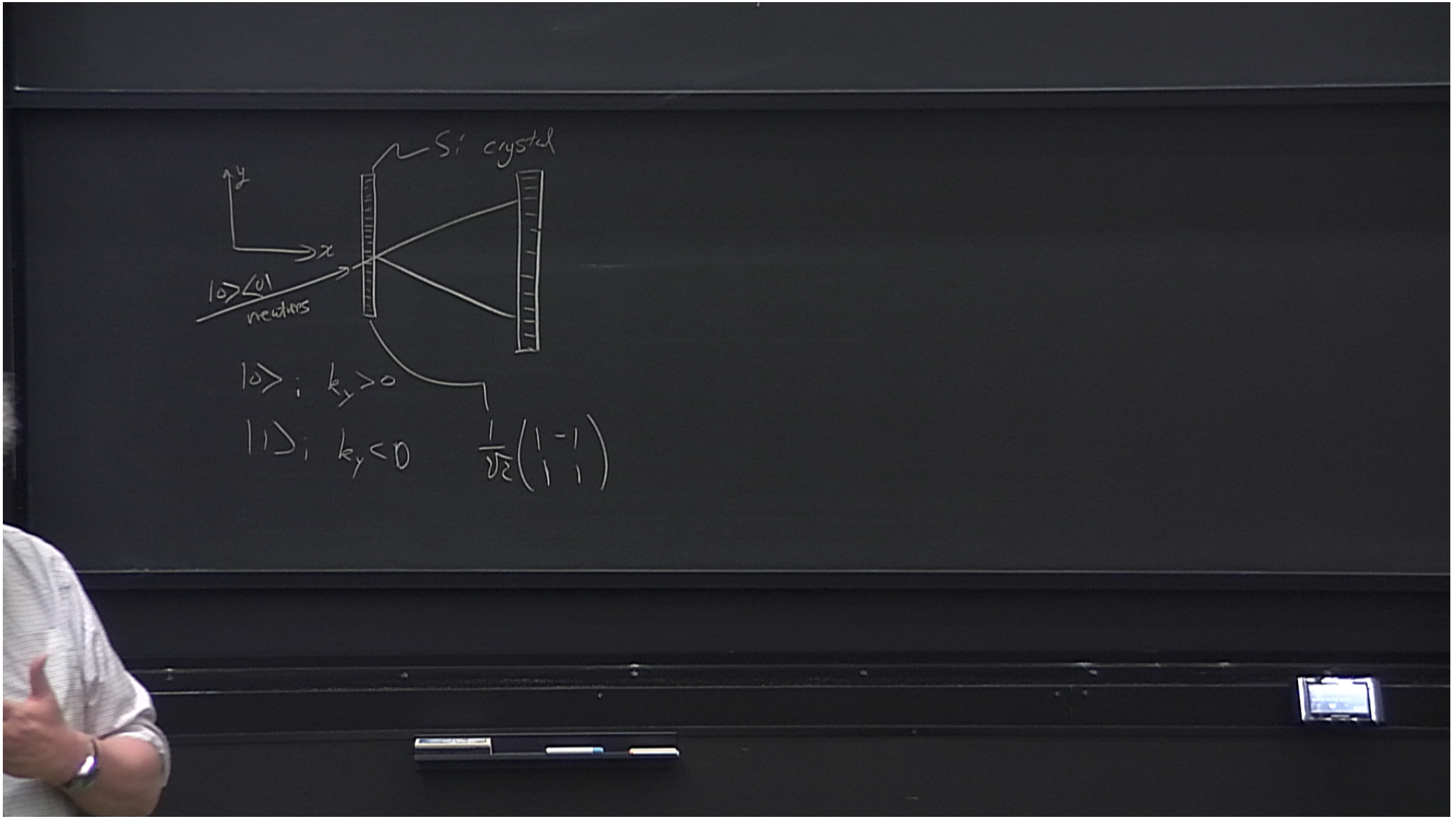

Characterise Coherence - lifetime
$\frac{|0\rangle + |1\rangle}{\sqrt{2}}$
t vary
$\langle \sigma_x \rangle$
T_2^{obs}
t
$\frac{2\pi}{\Delta\omega}$

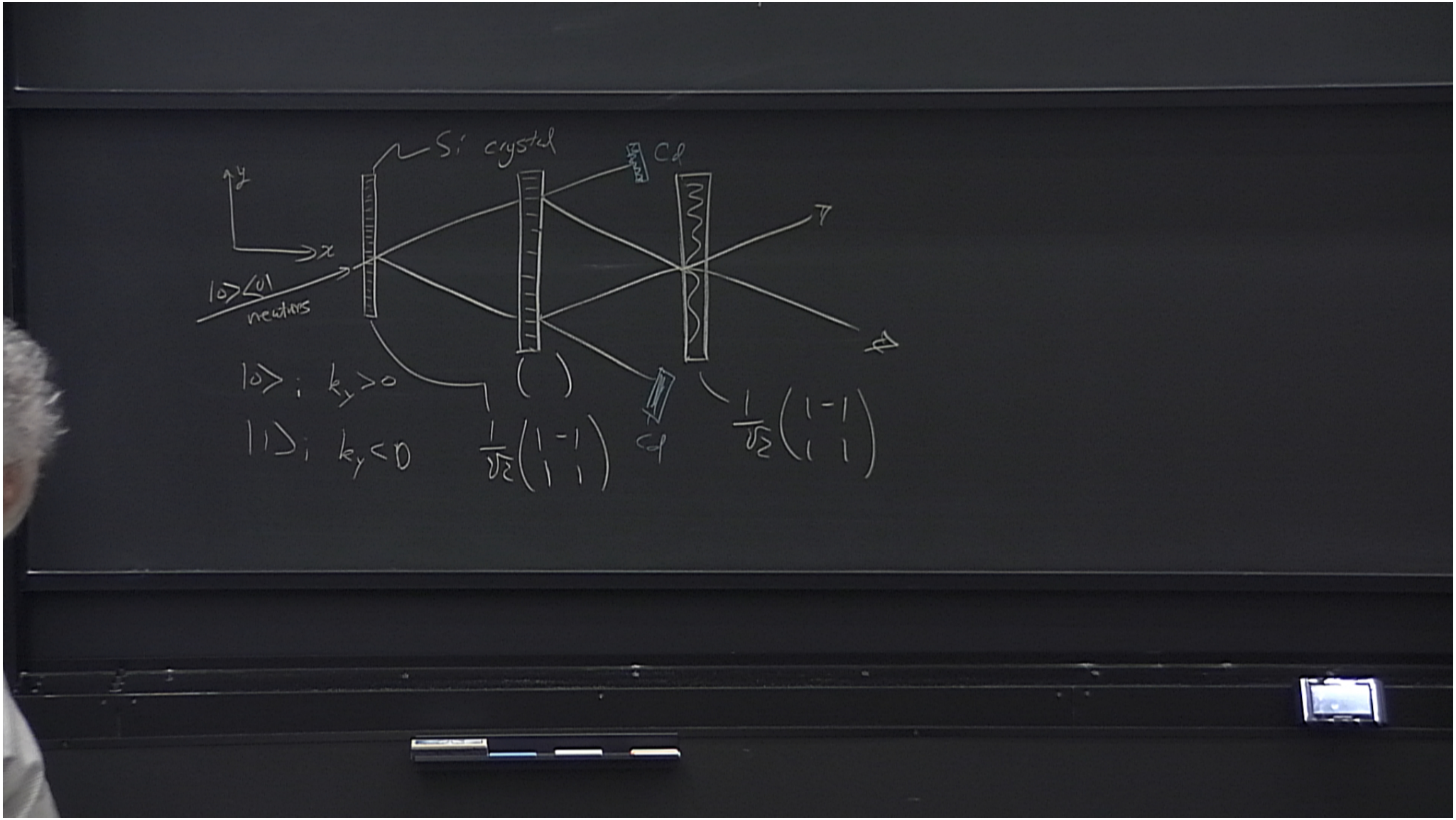

$\frac{|0\rangle + |1\rangle}{\sqrt{2}}$
T_2^{obs}
t
put the information I
want to measure
along the measurement axis

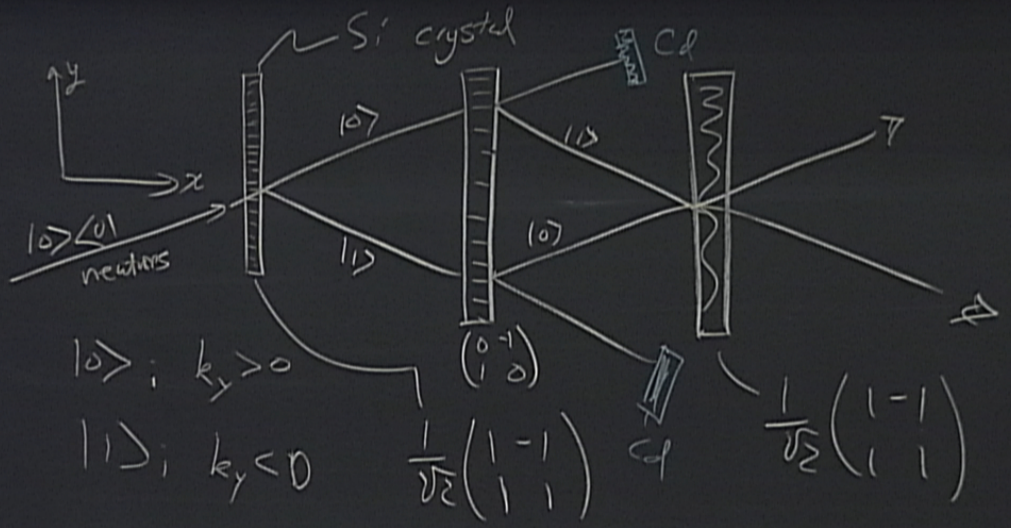

Characterise Coherence – lifetime
vary
measure along
put the in formati

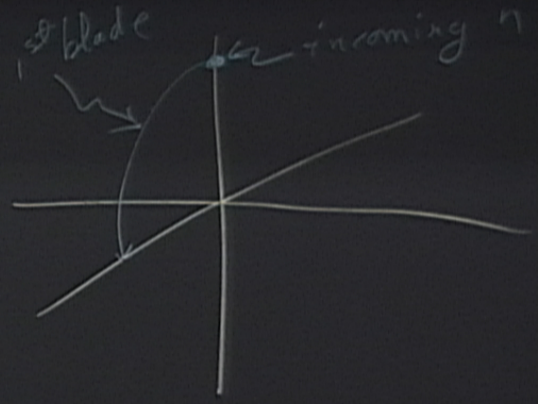

T1
π/2
τ
⟨σz⟩
(1-2e^{-τ/T1})
τ

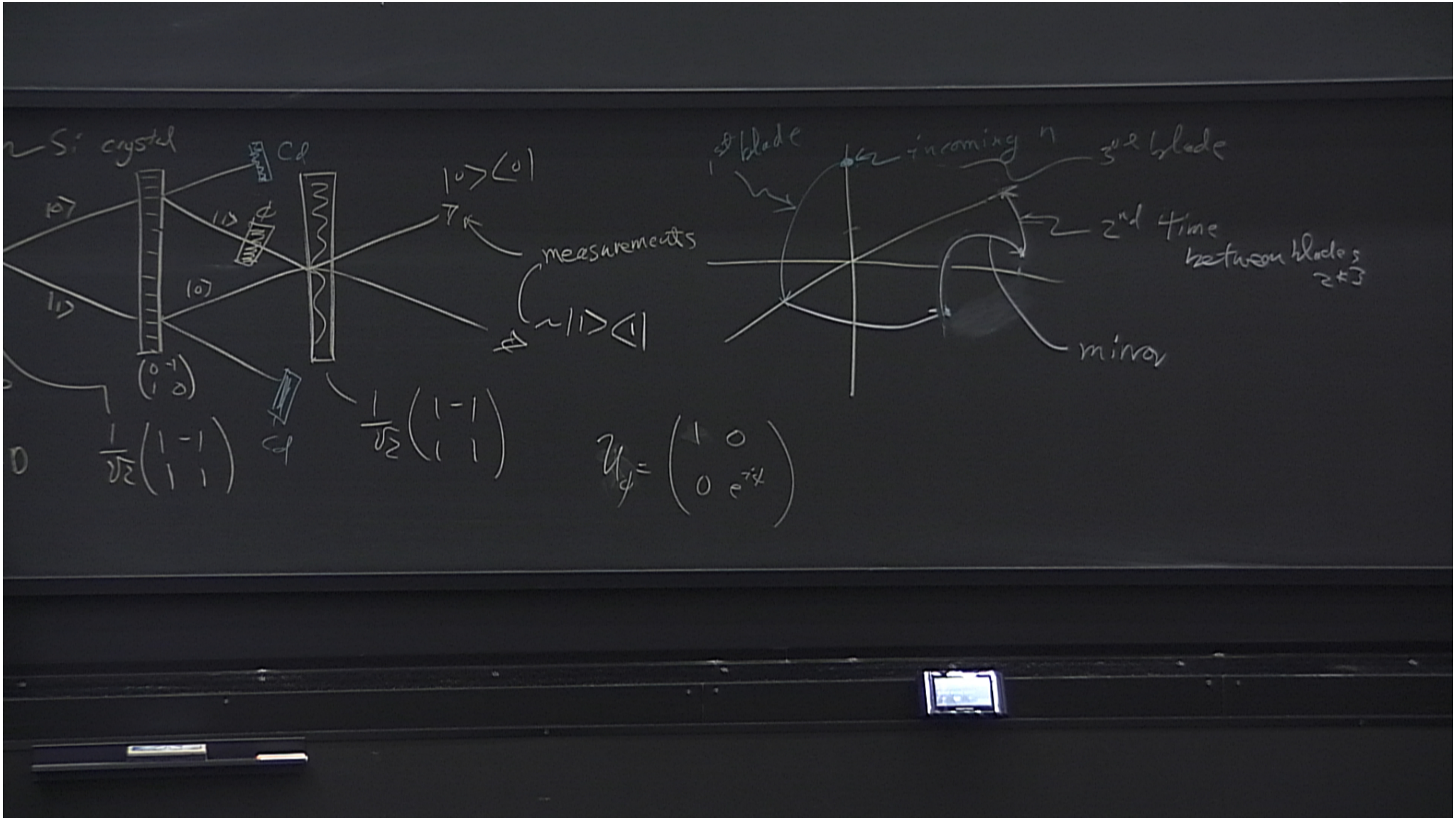

Si crystal
neutrons

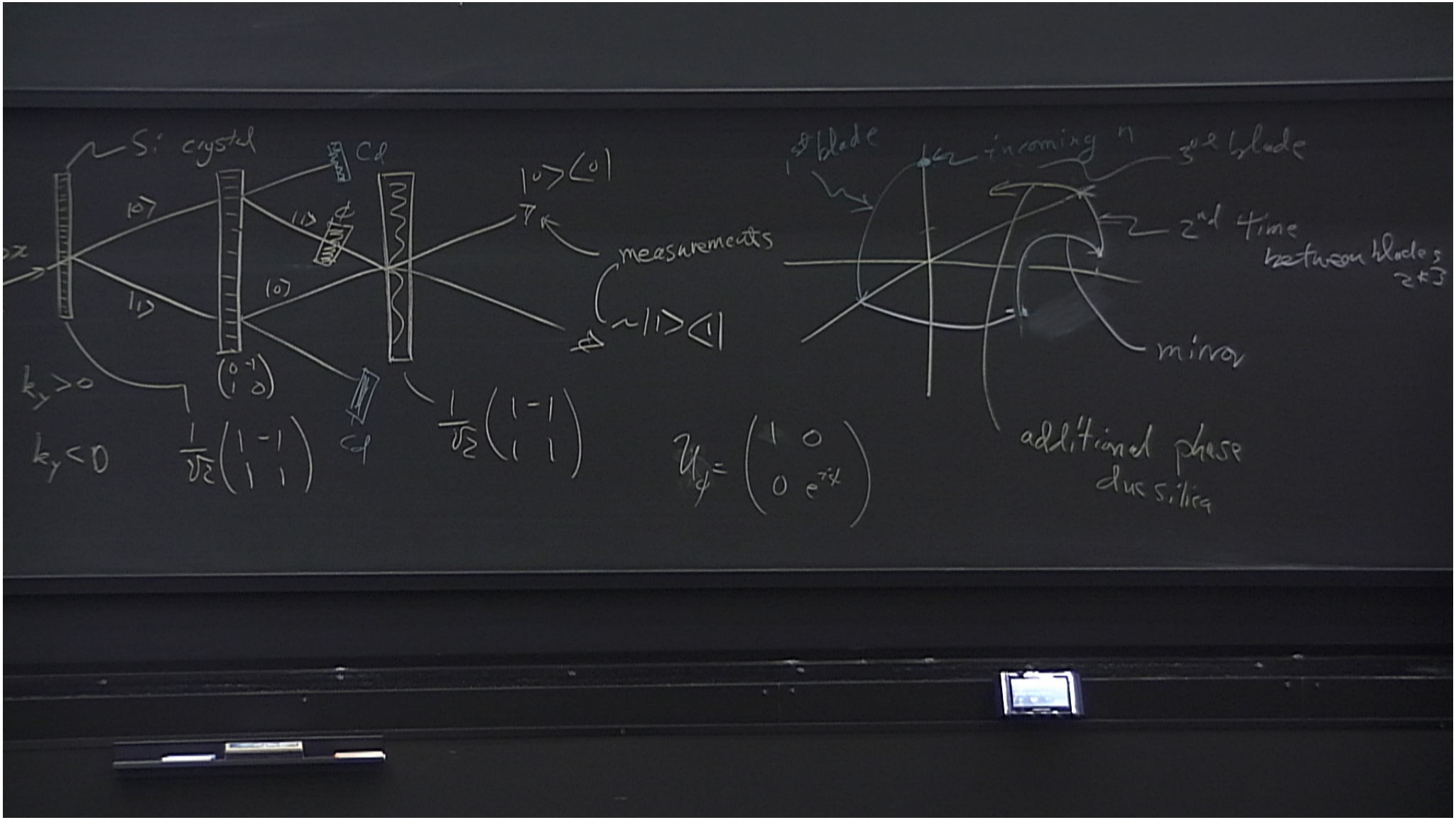

Si crystal
y
x
|0><0|
neutrons
|0>: $k_y > 0$
|1>: $k_y < 0$
$\frac{1}{\sqrt{2}}\begin{pmatrix} 1 & -1 \\ 1 & 1 \end{pmatrix}$

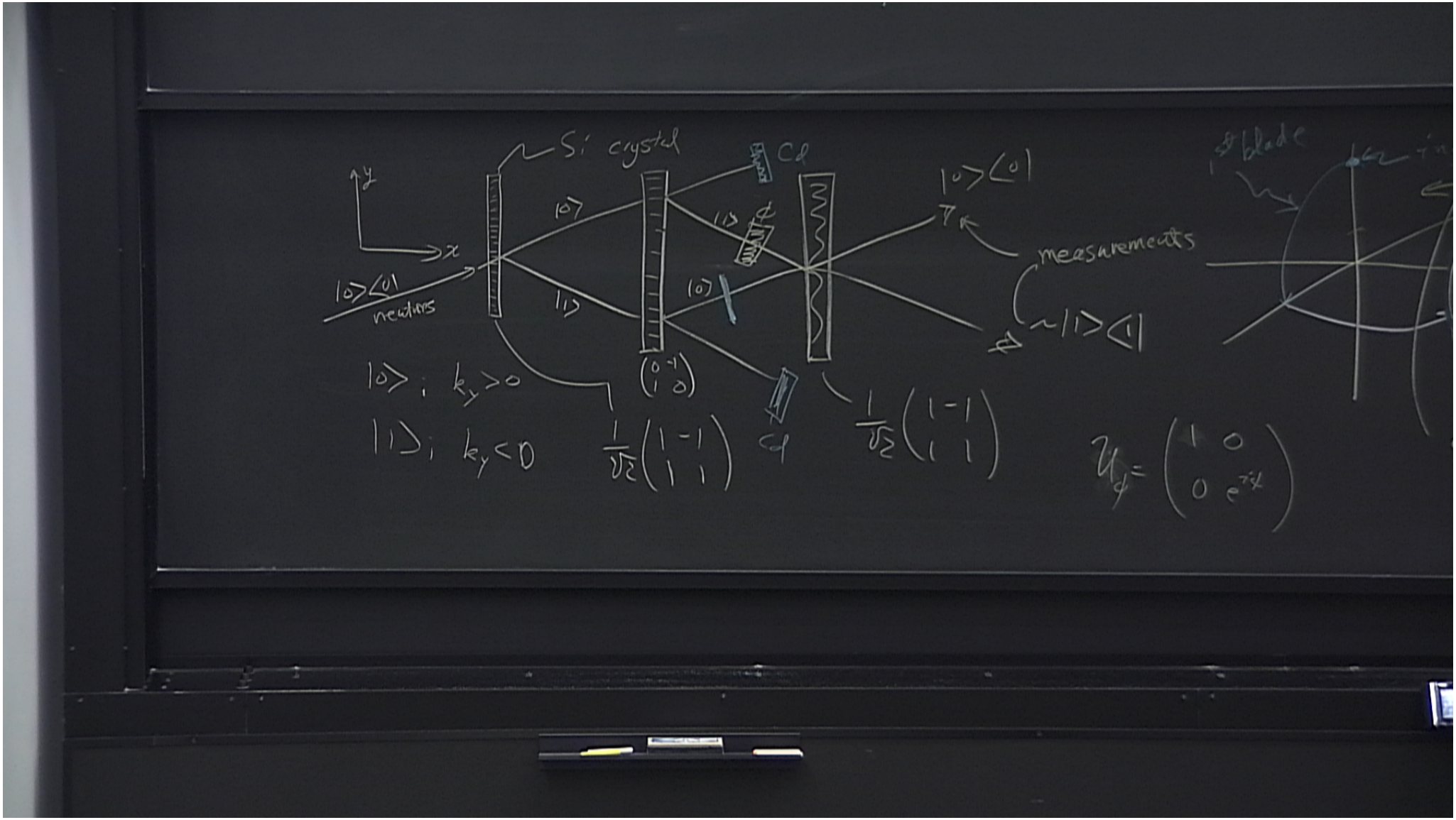

Si crystal
Cd
y
x
|0><0|
neutrons
|0>; $k_y > 0$
|1>; $k_y < 0$
$\frac{1}{\sqrt{2}}\begin{pmatrix} 1 & -1 \\ 1 & 1 \end{pmatrix}$
Cd
$\frac{1}{\sqrt{2}}\begin{pmatrix} 1 & -1 \\ 1 & 1 \end{pmatrix}$


Si crystal
Cd
y
x
|0><0|
neutrons
|0⟩
|1⟩
|1⟩
|0⟩
|0⟩; $k_y > 0$
|1⟩; $k_y < 0$
$\frac{1}{\sqrt{2}}\begin{pmatrix} 1 & -1 \\ 1 & 1 \end{pmatrix}$
Cd
$\frac{1}{\sqrt{2}}\begin{pmatrix} 1 & -1 \\ 1 & 1 \end{pmatrix}$


blade
incoming


Si crystal
Cd
|0><0|
|1><1|
measurements
1st blade
incoming n
3rd blade
2nd time between blades
z=3
mirror
$\frac{1}{\sqrt{2}}\begin{pmatrix}1&-1\\1&1\end{pmatrix}$
$\frac{1}{\sqrt{2}}\begin{pmatrix}1&-1\\1&1\end{pmatrix}$
$U_\phi = \begin{pmatrix}1&0\\0&e^{-i\phi}\end{pmatrix}$


Si crystal
Cd
|0⟩⟨0|
measurements
~|1⟩⟨1|
|0⟩
|1⟩
$k_y > 0$
$k_y < 0$
$\frac{1}{\sqrt{2}}\begin{pmatrix} 1 & -1 \\ 1 & 1 \end{pmatrix}$
$\begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$
$U_\phi = \begin{pmatrix} 1 & 0 \\ 0 & e^{i\phi} \end{pmatrix}$
1st blade
incoming n
3rd blade
2nd time between blades; 2≠3
mirror
additional phase due silica


Si crystal
Cd
|0><0|
measurements
|1><1|
neutrons
|0>; $k_y > 0$
|1>; $k_y < 0$
$\frac{1}{\sqrt{2}}\begin{pmatrix} 1 & -1 \\ 1 & 1 \end{pmatrix}$
$\begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$
$\frac{1}{\sqrt{2}}\begin{pmatrix} 1 & -1 \\ 1 & 1 \end{pmatrix}$
$U_\varphi = \begin{pmatrix} 1 & 0 \\ 0 & e^{i\varphi} \end{pmatrix}$