Title: Explorations in Quantum Information-9

Date: Mar 26, 2015 09:00 AM

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Abstract:

Bloch Eqns

$$\frac{d\langle\sigma_x\rangle}{dt} = -\Delta\omega\,\langle\sigma_y\rangle - \frac{\langle\sigma_x\rangle}{T_2}$$

$$\frac{d\langle\sigma_y\rangle}{dt} = \Delta\omega\,\langle\sigma_x\rangle - \omega_{RF}\,\langle\sigma_z\rangle - \frac{\langle\sigma_y\rangle}{T_2}$$

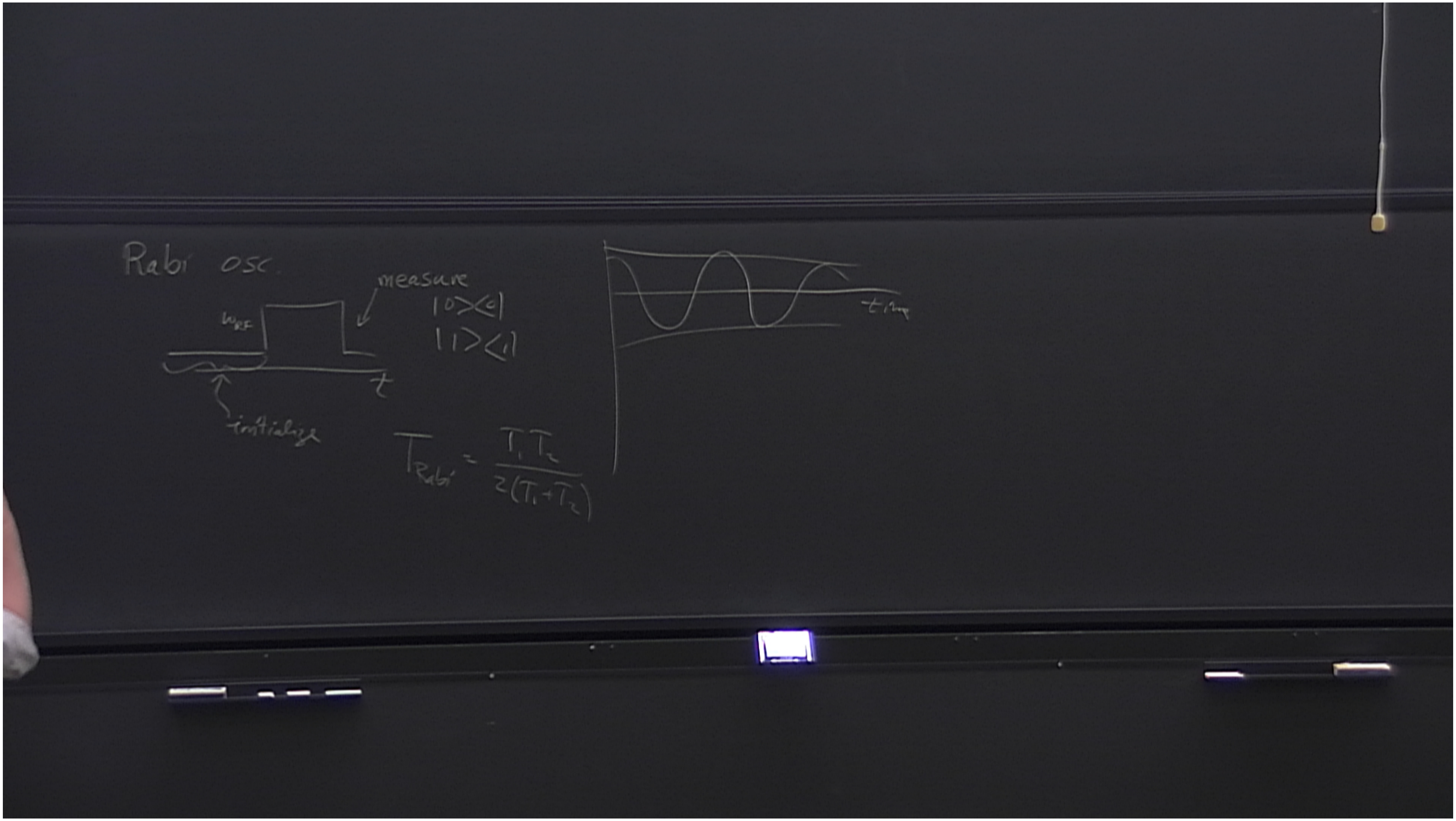
$$\frac{d\langle\sigma_z\rangle}{dt} = \omega_{RF}\,\langle\sigma_y\rangle - \frac{\langle\sigma_z\rangle - \langle\sigma_z\rangle_0}{T_1}$$

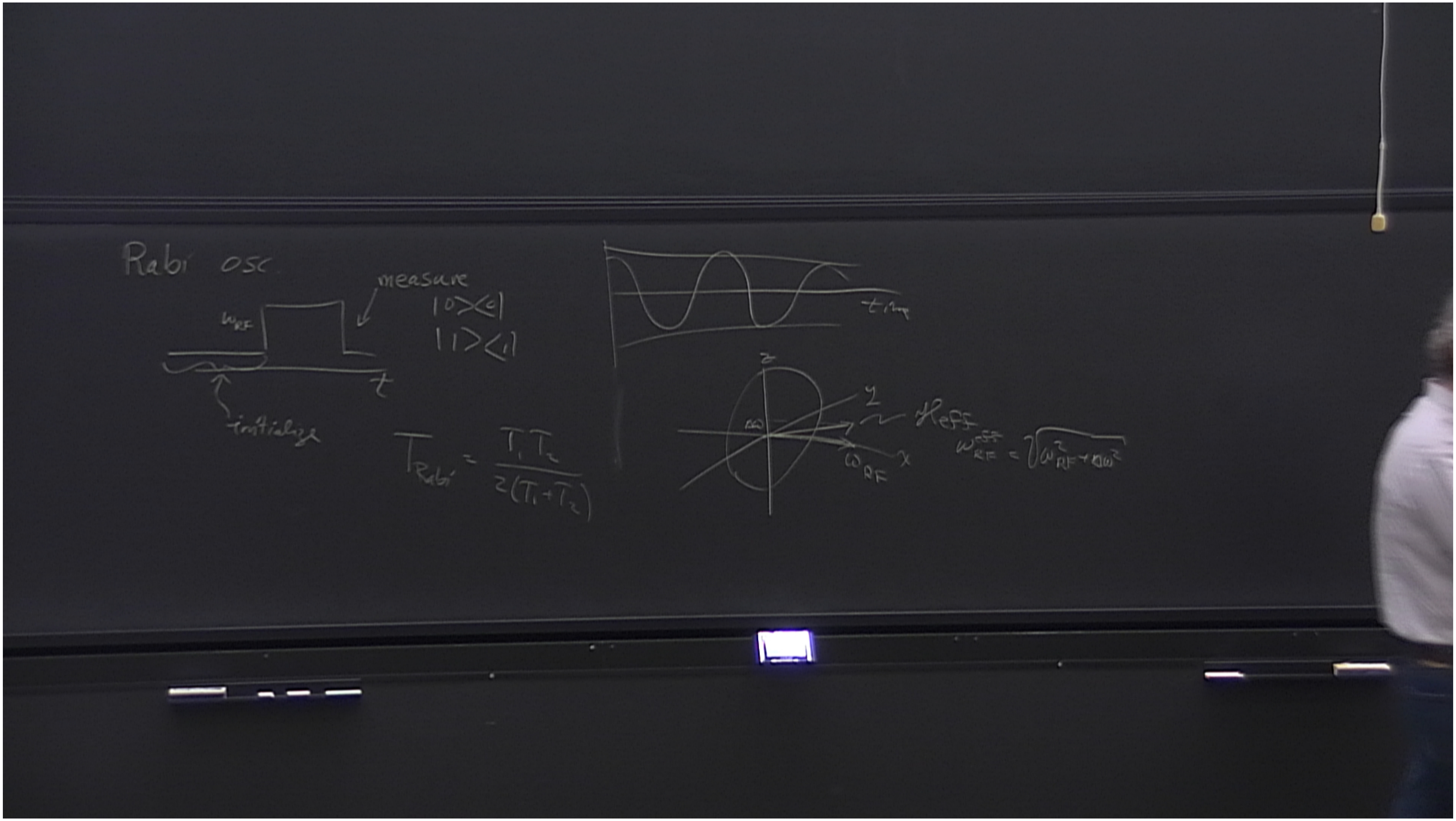
Bloch Eqns

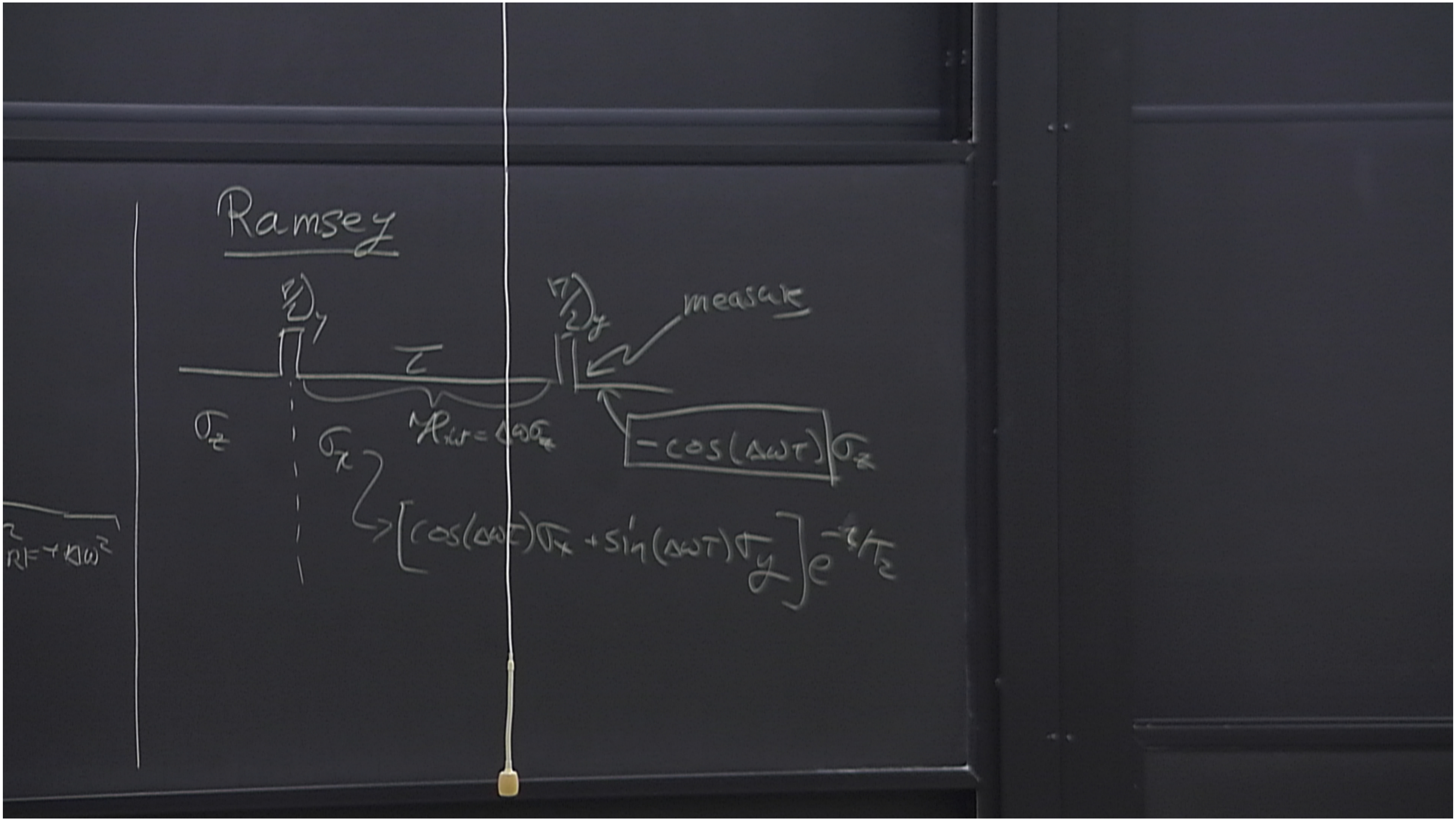
$$\frac{d\langle\sigma_x\rangle}{dt} = -\Delta\omega\,\langle\sigma_y\rangle - \frac{\langle\sigma_x\rangle}{T_2}$$

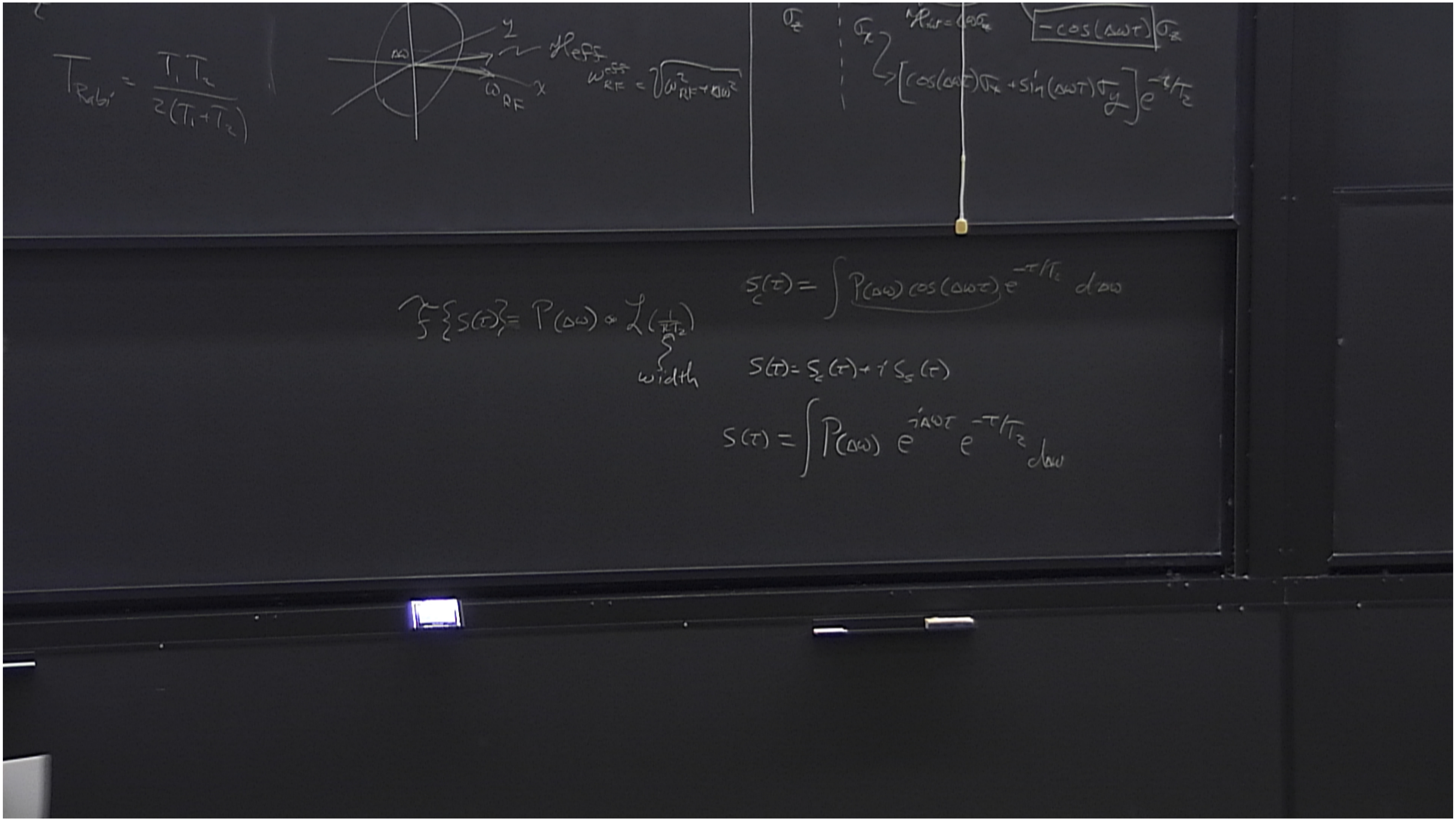
$$\frac{d\langle\sigma_y\rangle}{dt} = \Delta\omega\,\langle\sigma_x\rangle - \omega_{RF}(t)\langle\sigma_z\rangle - \frac{\langle\sigma_y\rangle}{T_2}$$

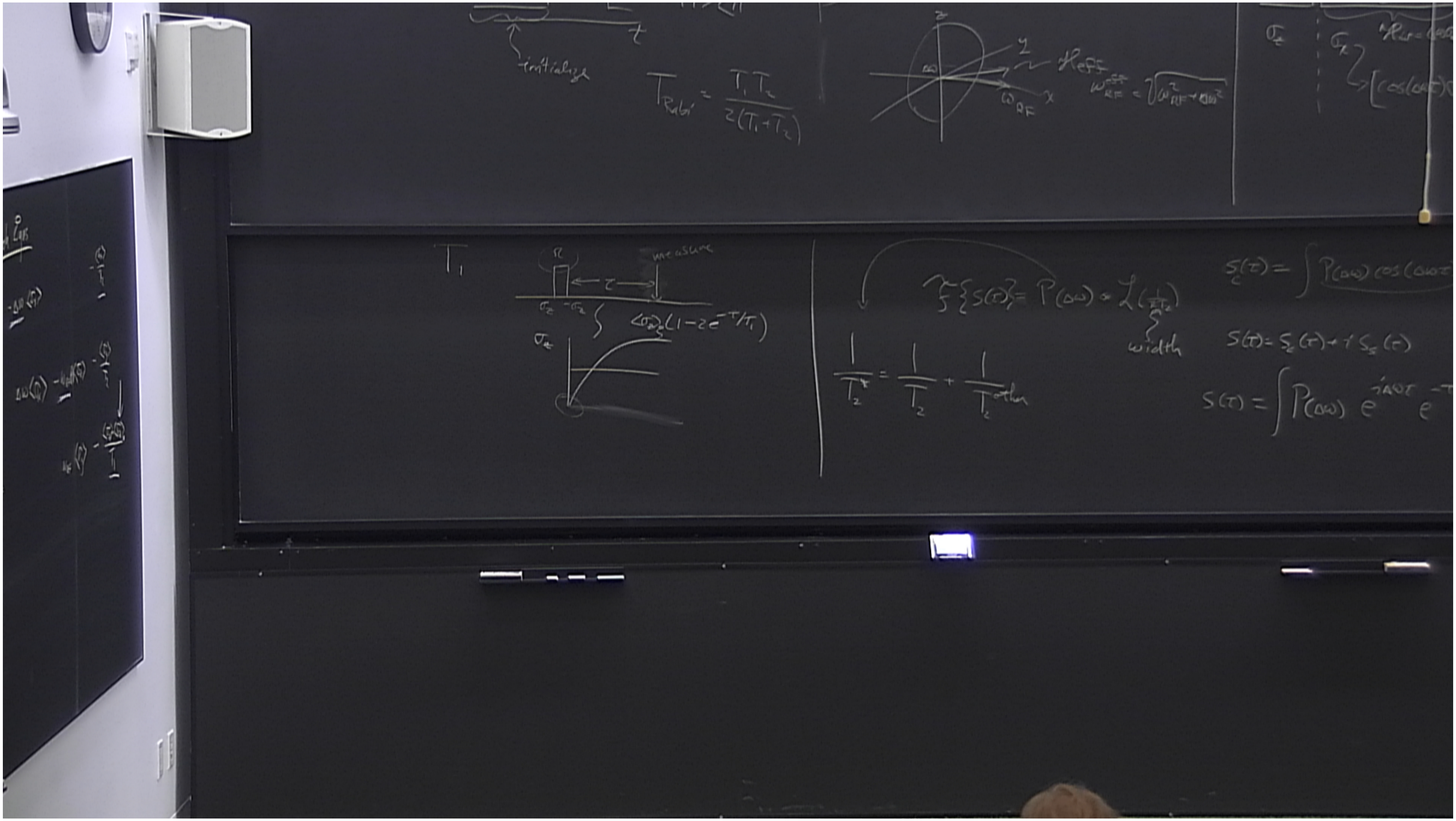
$$\frac{d\langle\sigma_z\rangle}{dt} = \omega_{RF}\,\langle\sigma_y\rangle - \frac{\langle\sigma_z\rangle - \langle\sigma_z\rangle_0}{T_1}$$

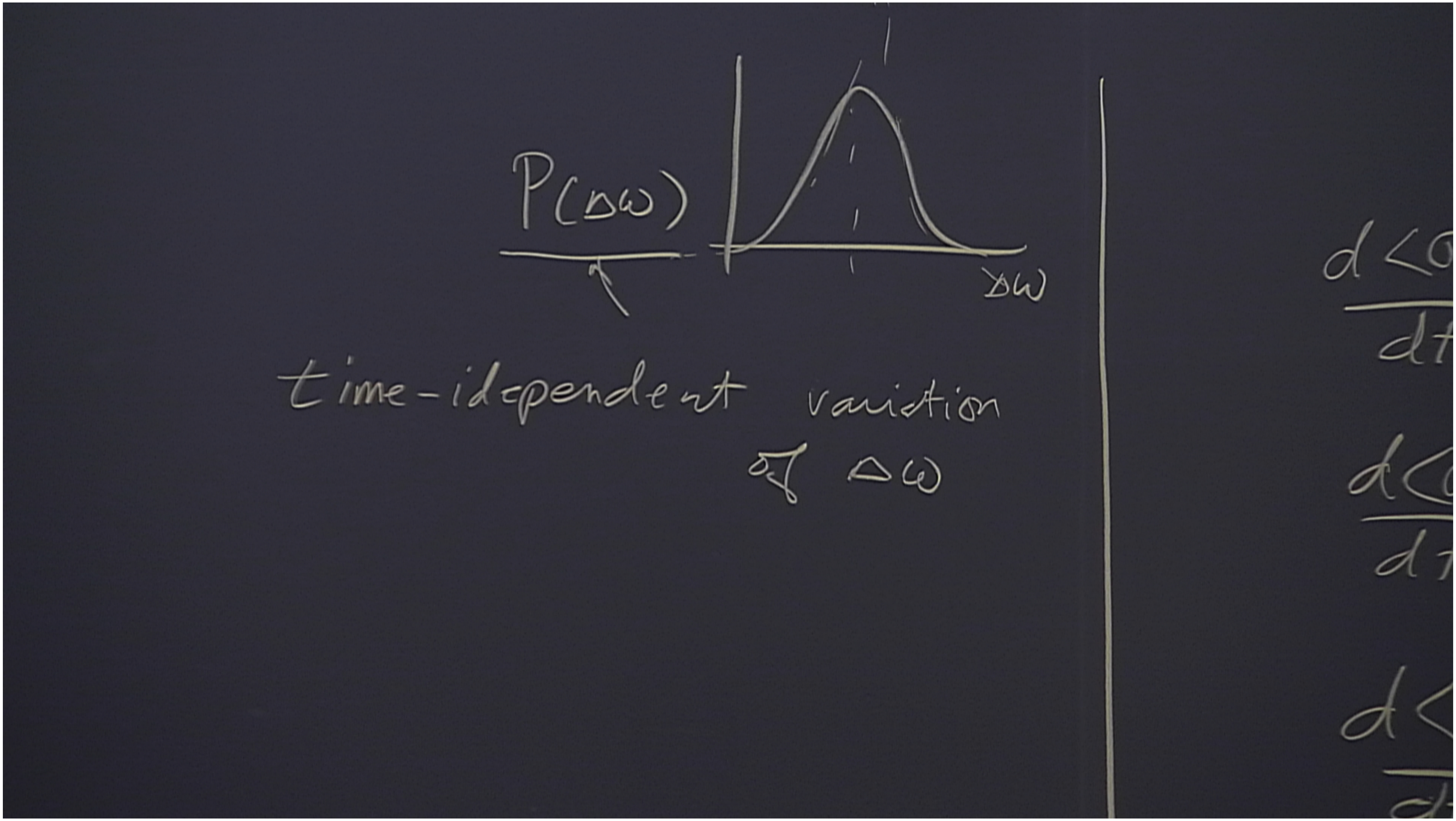

Rabi osc.
measure
|0><0|
|1><1|
ω_RF
t
initialize
T_Rabi = T1T2 / 2(T1+T2)
time

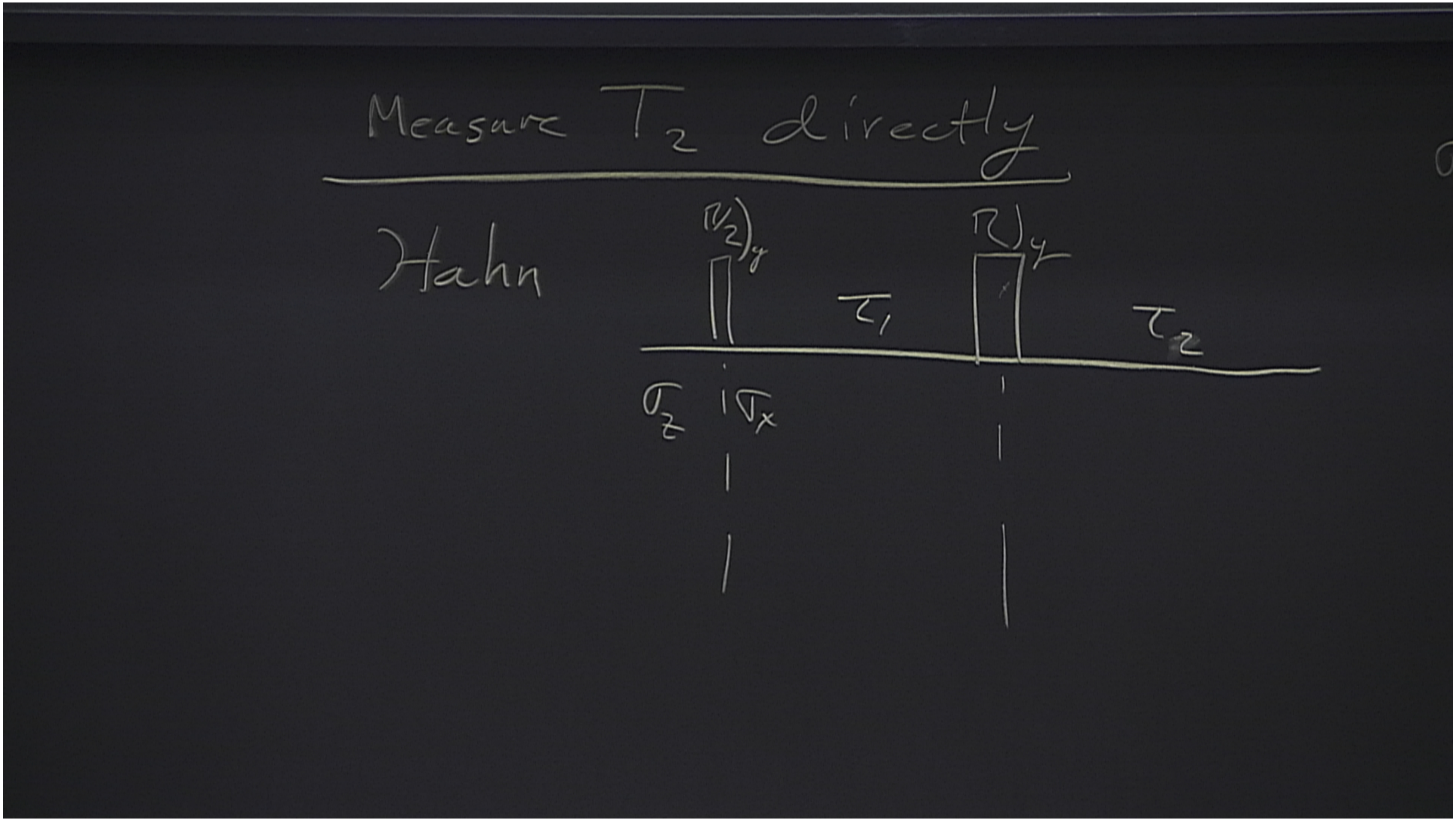

Rabi osc
measure
|0><0|
|1><1|
ω_RF
t
initialize
T_Rabi = T1T2 / 2(T1+T2)
time
z
y
x
Δω
Heff
ω_RF
ω_RF^eff = √(ω_RF² + Δω²)

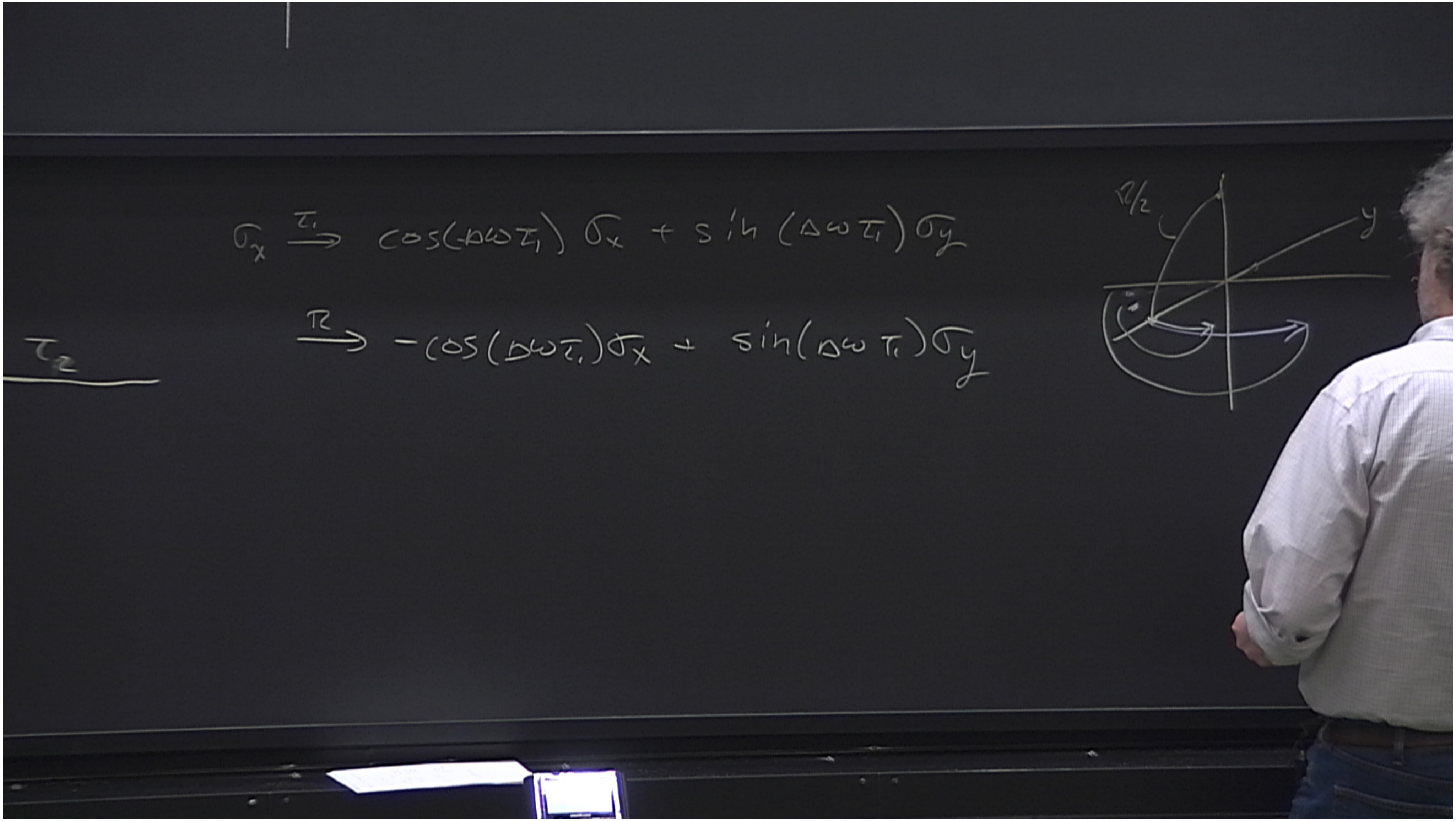

Ramsey
π/2)y
π/2)y
measure
τ
σz
σx
-cos(Δωτ) σz
[cos(Δωτ)σx + sin(Δωτ)σy] e^{-t/T2}


$T_{Rabi} = \frac{T_1 T_2}{2(T_1+T_2)}$
$\Delta\omega$
z
$\mathcal{H}_{eff}$
ω_{RF}
x
$\omega^{eff}_{RF} = \sqrt{\omega_{RF}^2 + \Delta\omega^2}$
σ_z
σ_x
$\boxed{-\cos(\Delta\omega\tau)}\sigma_z$
$[\cos(\Delta\omega\tau)\sigma_x + \sin(\Delta\omega\tau)\sigma_y]e^{-t/T_2}$
$S_c(\tau) = \int P(\Delta\omega)\cos(\Delta\omega\tau)e^{-\tau/T_2}\,d\Delta\omega$
$\mathcal{F}\{S(\tau)\} = P(\Delta\omega) * \mathcal{L}(\frac{1}{\pi T_2})$
width
$S(\tau) = S_c(\tau) + i S_s(\tau)$
$S(\tau) = \int P(\Delta\omega)\, e^{i\Delta\omega\tau}\, e^{-\tau/T_2}\, d\Delta\omega$


initialize
measure
width
other


P(Δω)
Δω
time-idependent variation
of Δω


Measure T_2 directly
Hahn
$(\pi/2)_y$
$\pi)_y$
τ_1
τ_2
σ_z
σ_x



$\sigma_x \xrightarrow{\tau_1} \cos(\Delta\omega\tau_1)\sigma_x + \sin(\Delta\omega\tau_1)\sigma_y$
$\xrightarrow{\pi} -\cos(\Delta\omega\tau_1)\sigma_x + \sin(\Delta\omega\tau_1)\sigma_y$
τ_2
$\pi/2$
y

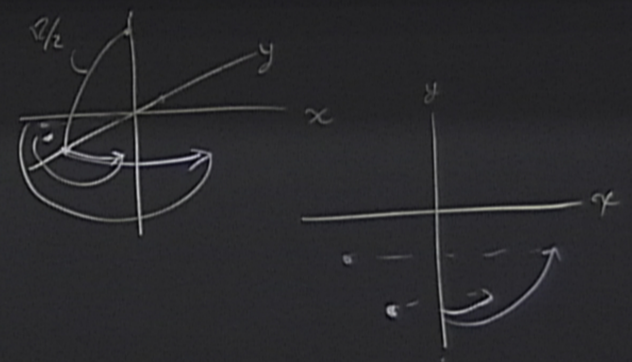
$$\frac{1}{T_2^*} = \frac{1}{T_2} + \frac{1}{T_2^{\text{other}}}$$

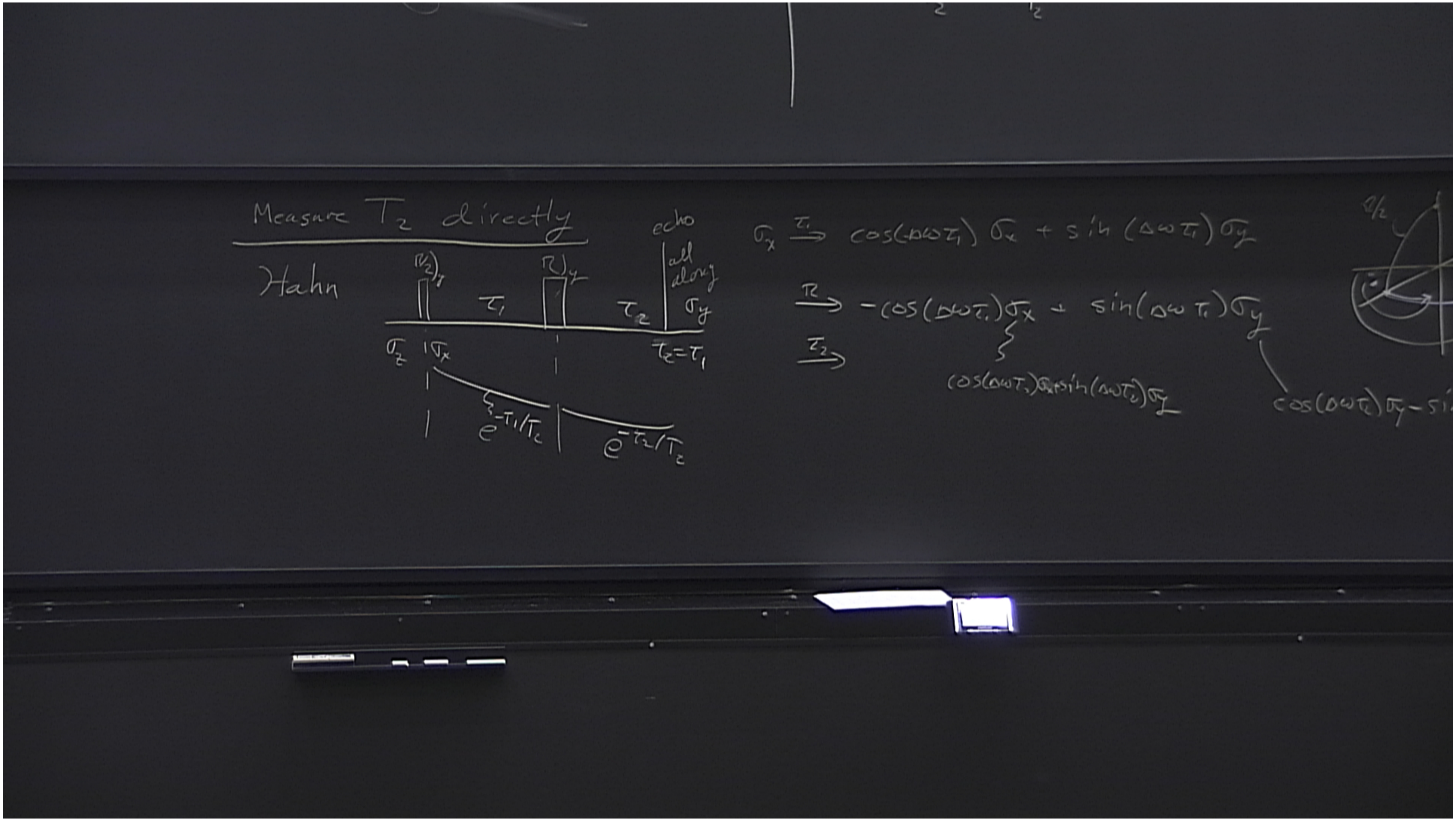
$$S(\tau) = \int P(\Delta\omega)\, e^{i\Delta\omega\tau}\, e^{-\tau/T_2}\, d\Delta\omega$$

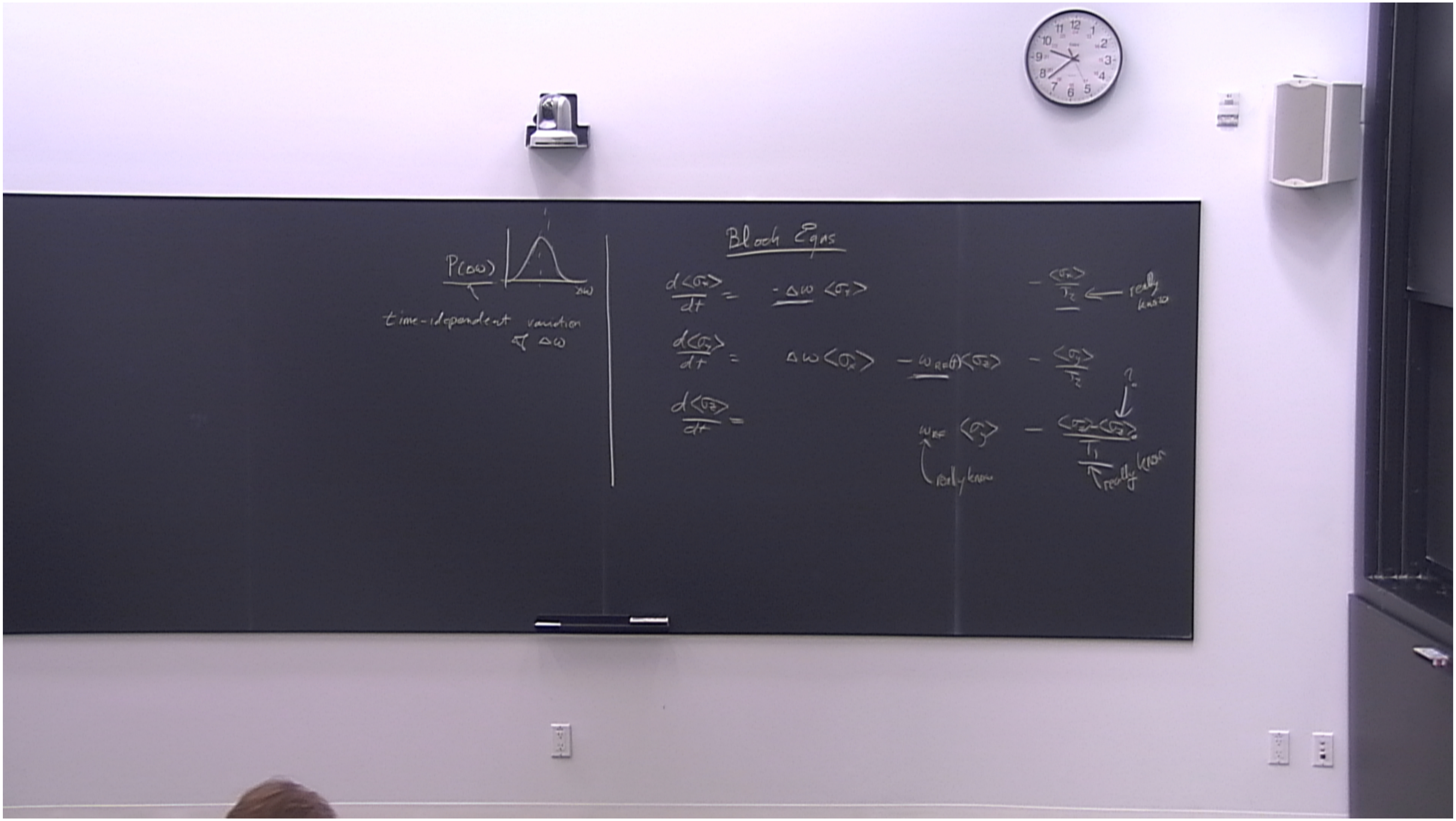
τ_2

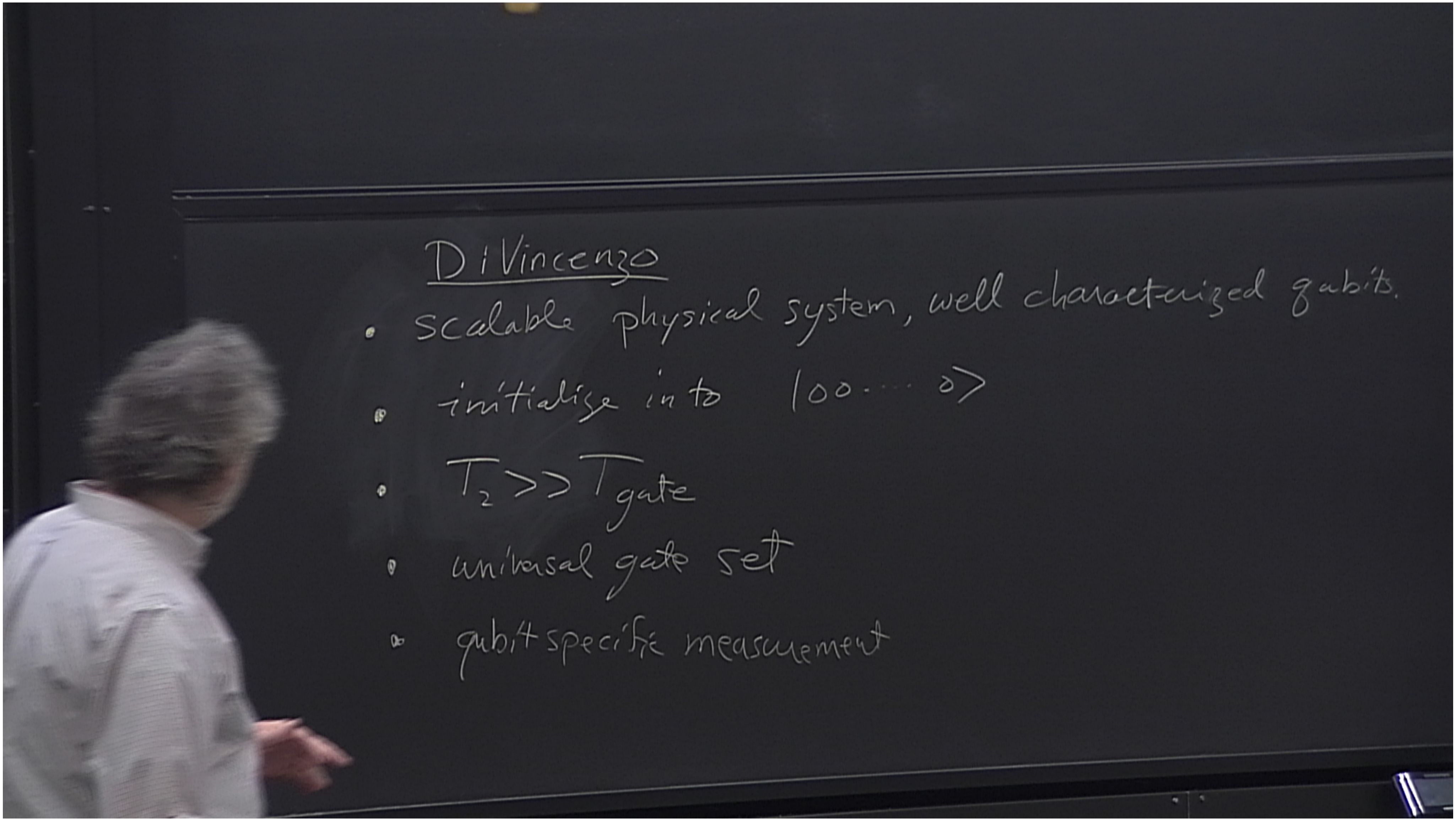
$$\sigma_x \xrightarrow{\tau_1} \cos(\Delta\omega\tau_1)\,\sigma_x + \sin(\Delta\omega\tau_1)\,\sigma_y$$

$$\xrightarrow{\pi} -\cos(\Delta\omega\tau_1)\,\sigma_x + \sin(\Delta\omega\tau_1)\,\sigma_y$$




Measure T2 directly
Hahn
echo
all along
σy
τ2 = τ1
e^{-τ1/T2}
e^{-τ2/T2}
σx →τ1 cos(Δω τ1) σx + sin(Δω τ1) σy
→π −cos(Δω τ1) σx + sin(Δω τ1) σy
→τ2


Bloch Eqns
P(Δω)
time-dependent variation
really know
really know
really know


DiVincenzo
• scalable physical system, well characterized qubits.
• initialise into |00.....0>
• T2 >> Tgate
• universal gate set
• qubit specific measurement