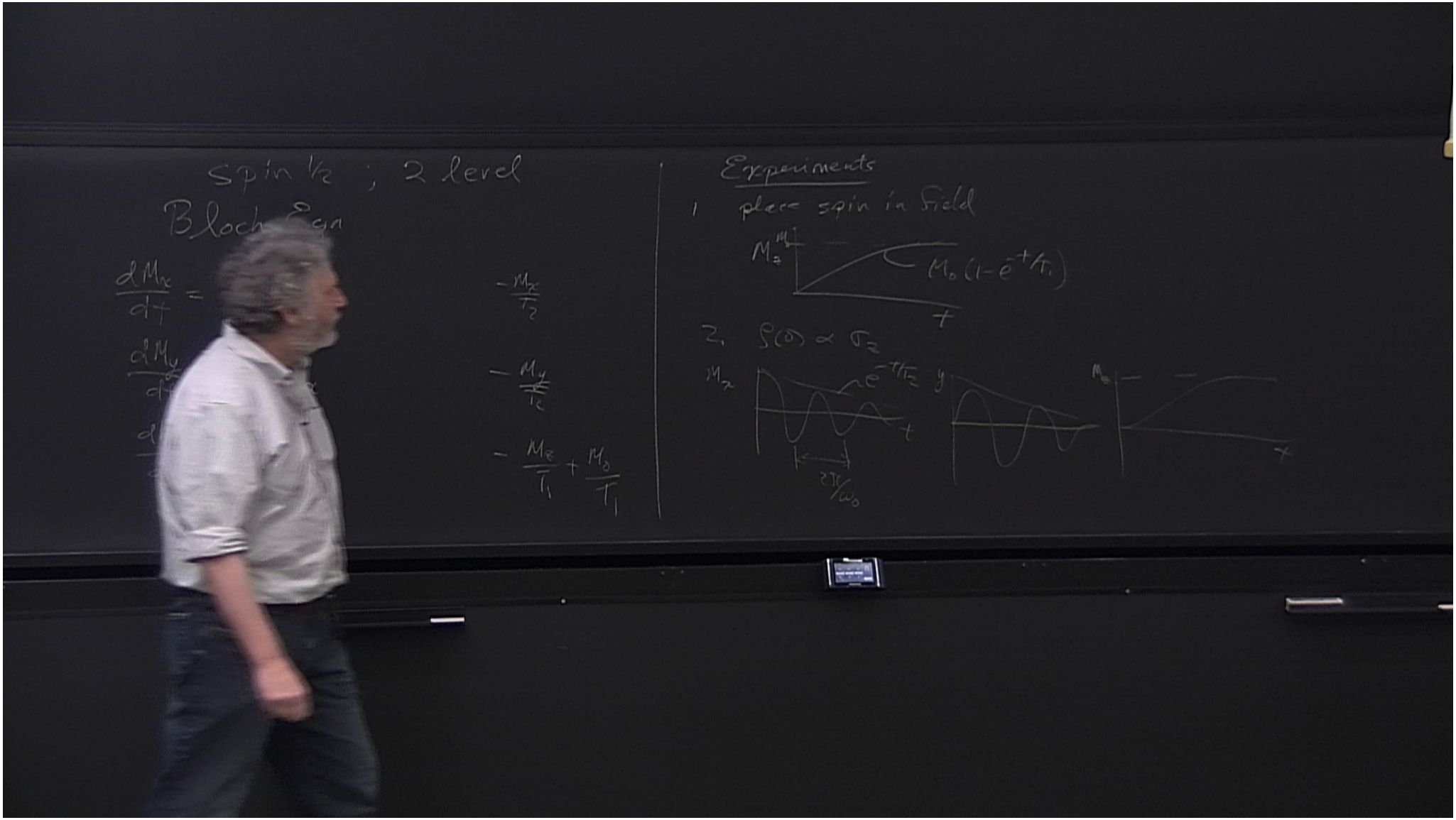
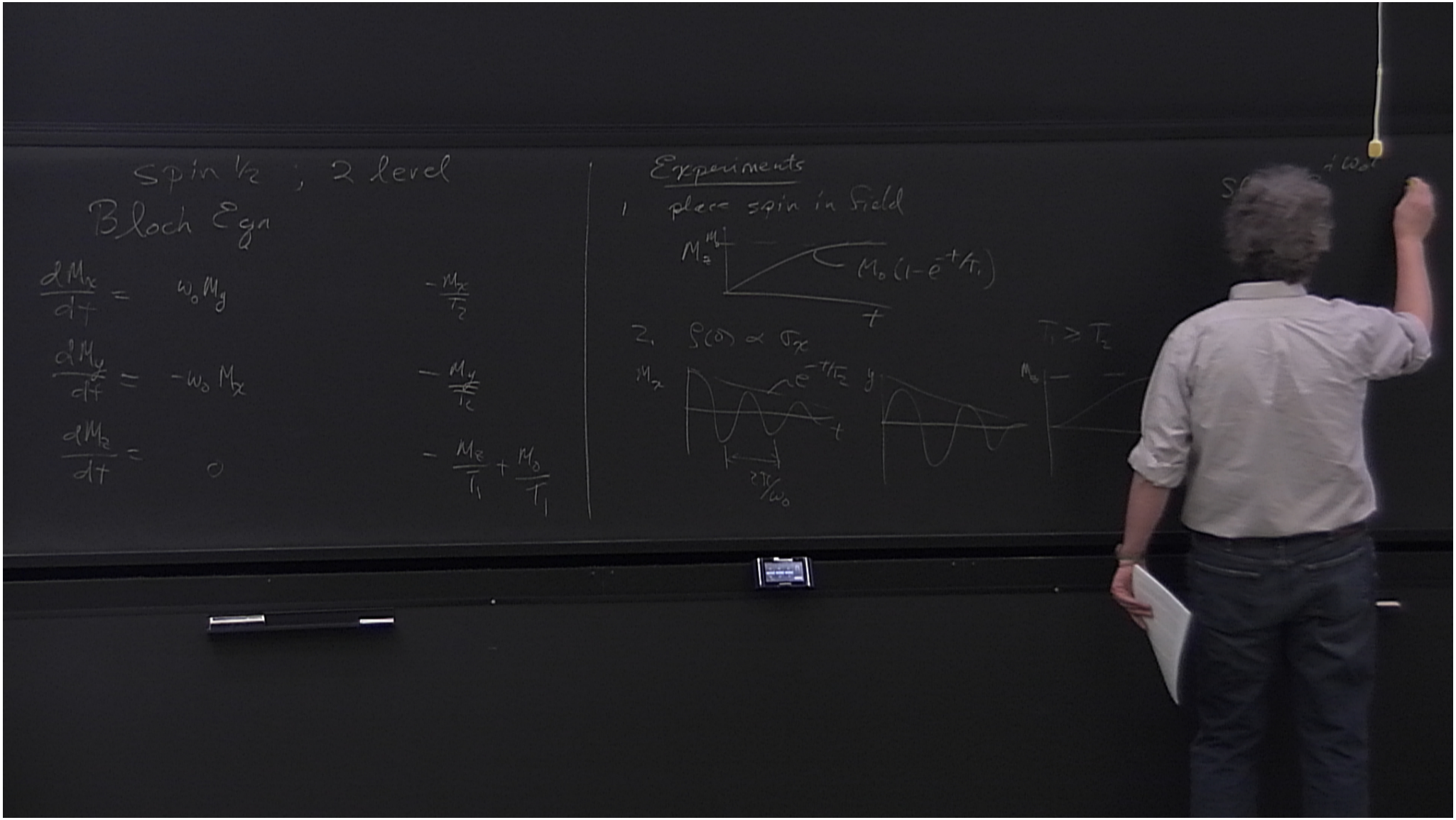
Title: PSI 2015/2016 Explorations in Quantum Information - David Cory - 2

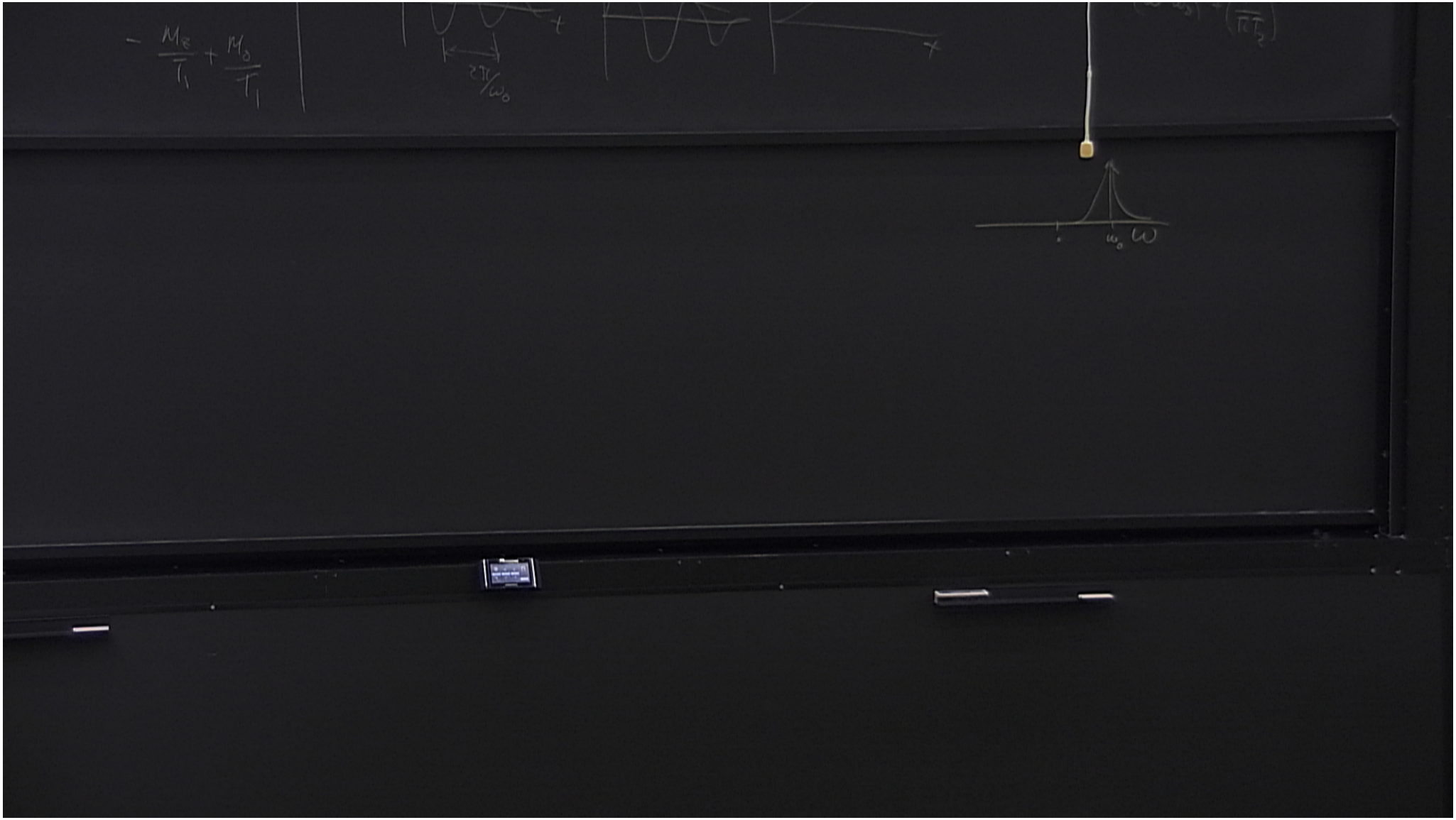
Date: Mar 22, 2016 09:00 AM

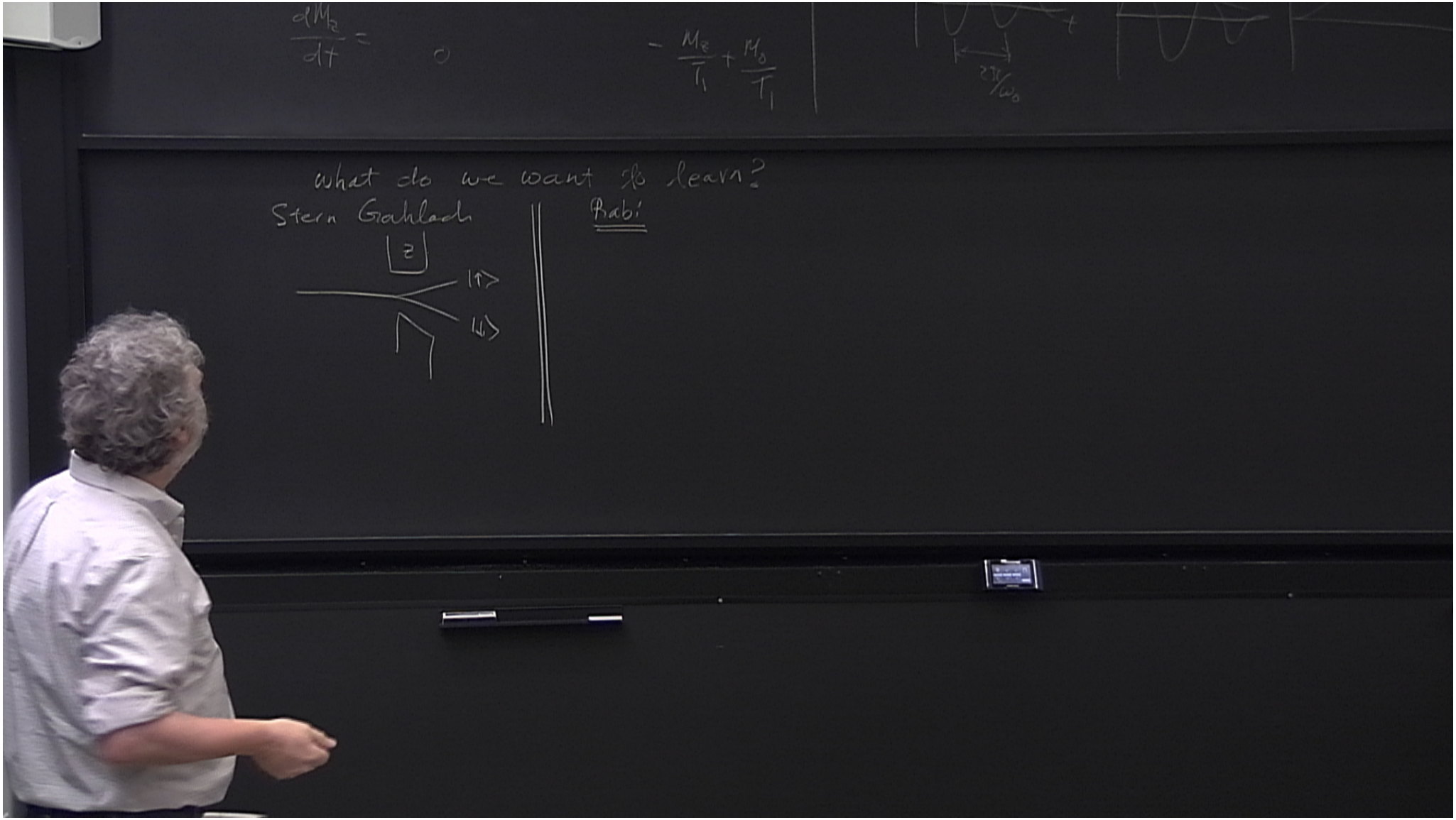
URL: http://pirsa.org/16030001

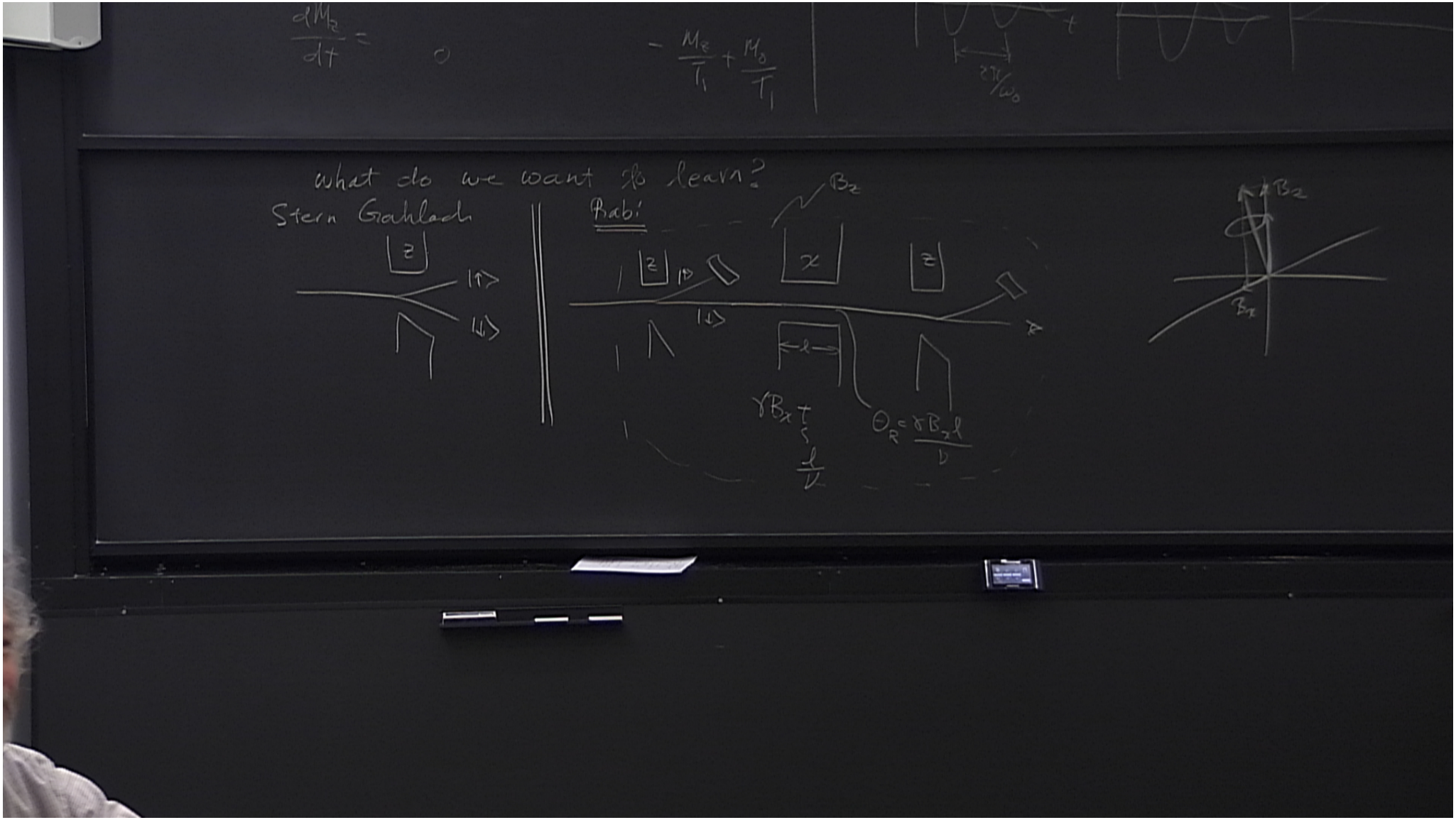
Abstract:

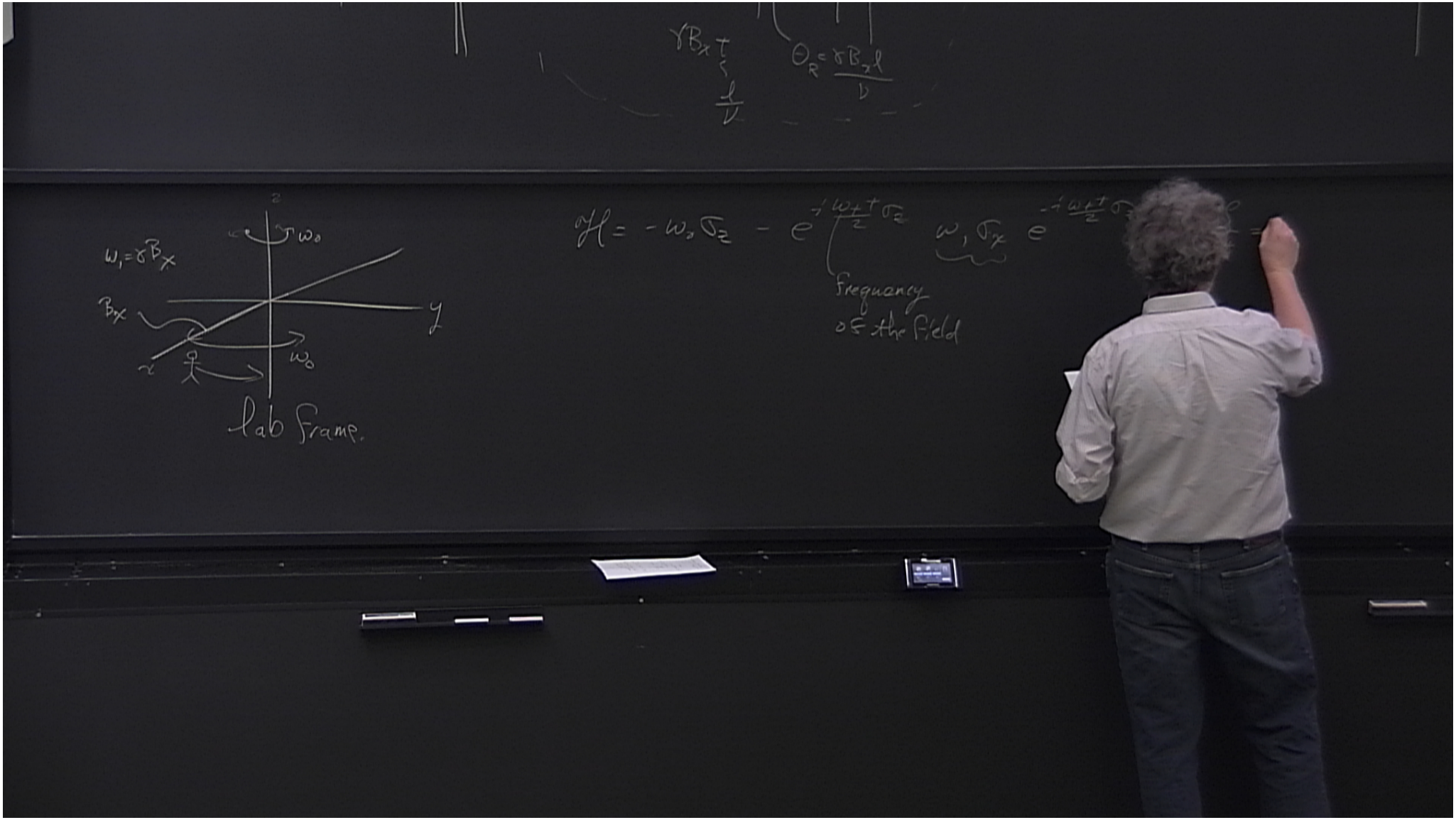

spin 1/2 ; 2 level
Bloch Eqn
Experiments
1. place spin in field
$M_0(1-e^{-t/T_1})$
t
2. $S(0) \propto \sigma_z$
M_x
e^{-t/T_2}
t
$2\pi/\omega_0$
M_0
t

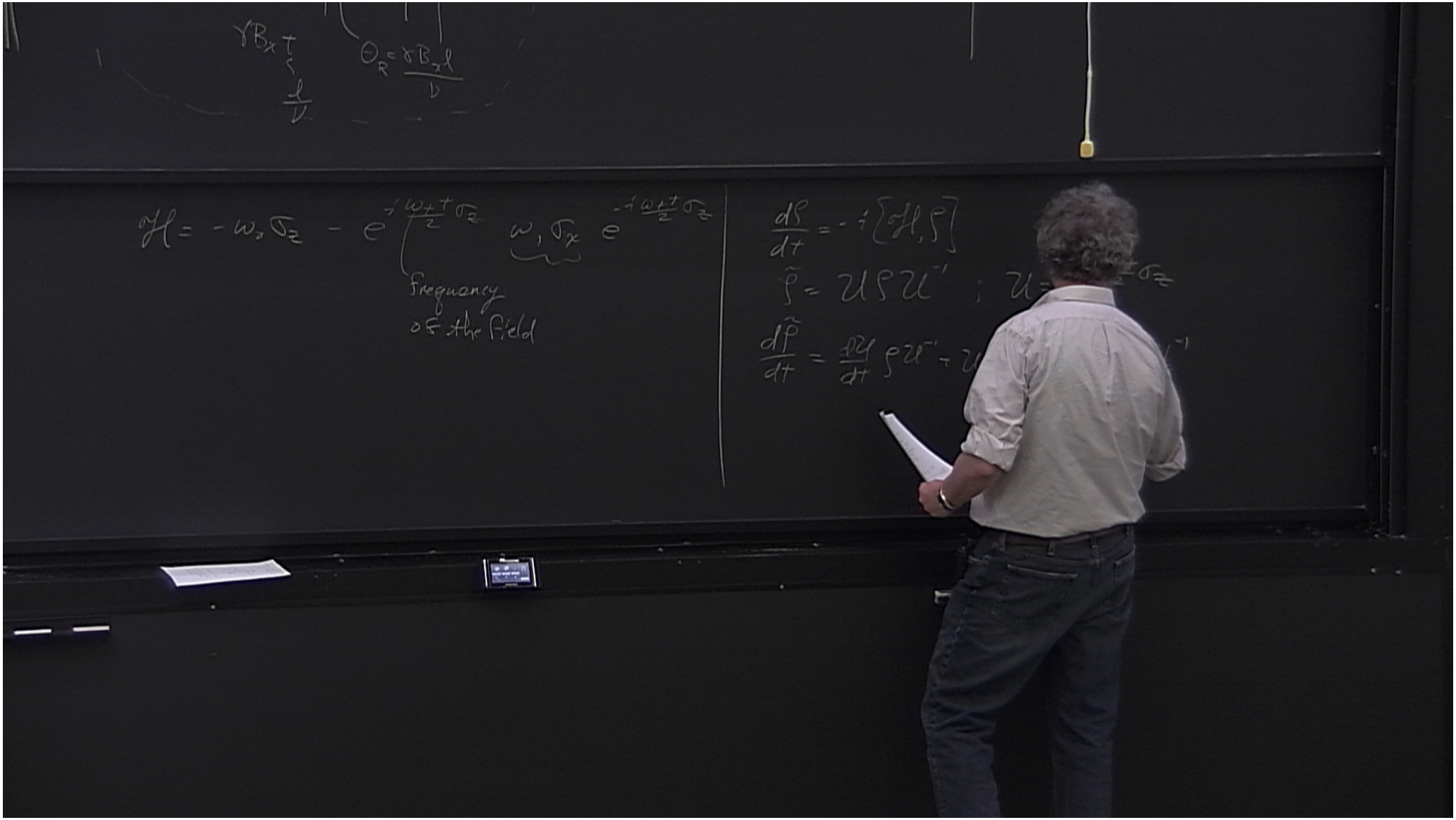

spin ½ ; 2 level
Bloch Eqn
dMx/dt = ω0 My − Mx/T2
dMy/dt = −ω0 Mx − My/T2
dMz/dt = 0 − (Mz − M0)/T1
Experiments
1 place spin in field
Mz
M0
M0(1−e^−t/T1)
t
2. S(0) ∝ Mx
e^−t/T2
T1 >> T2
M0
2π/ω0

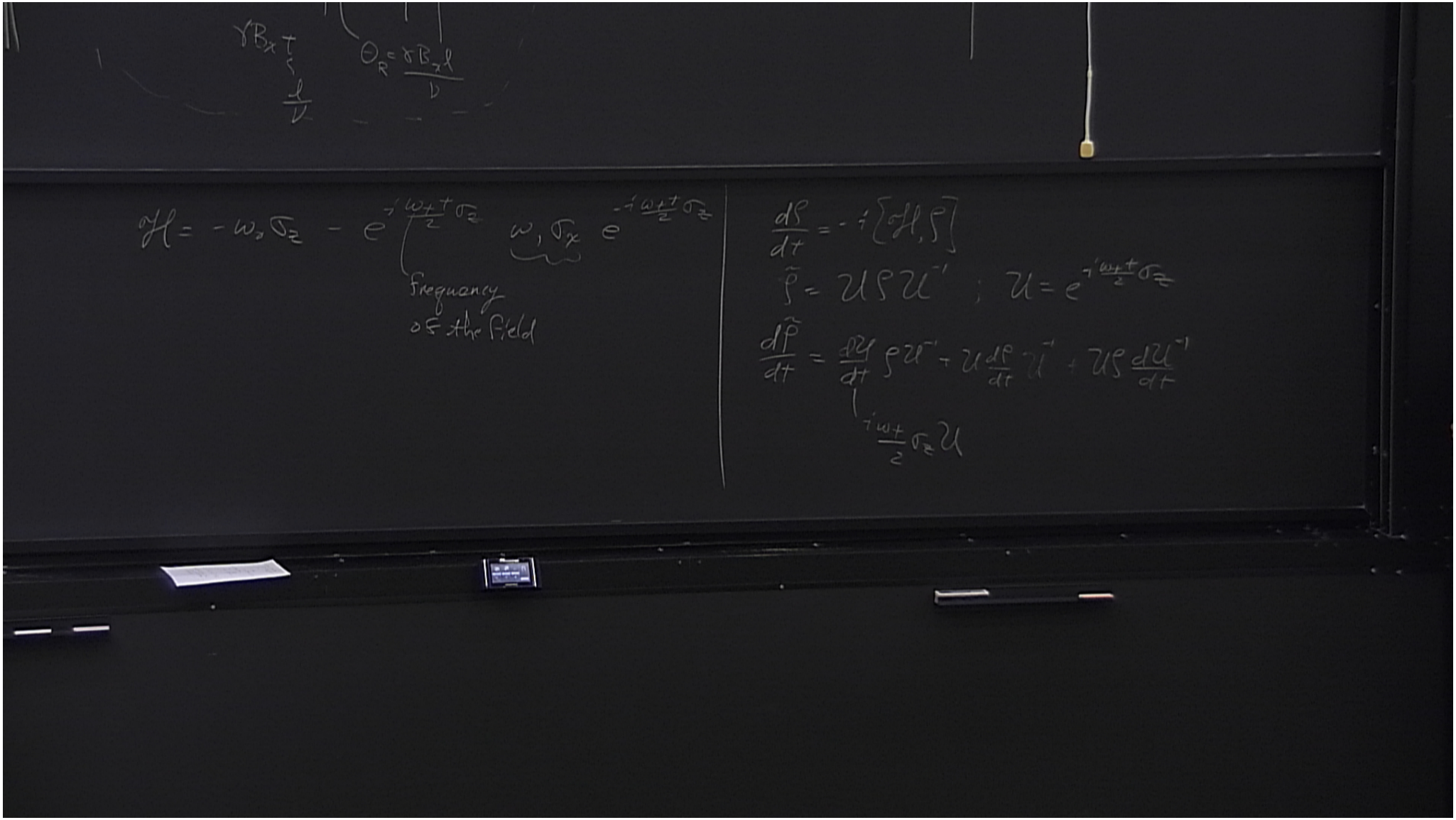

$-\frac{M_z}{T_1}+\frac{M_0}{T_1}$
$2\pi/\omega_0$
ω_0 ω

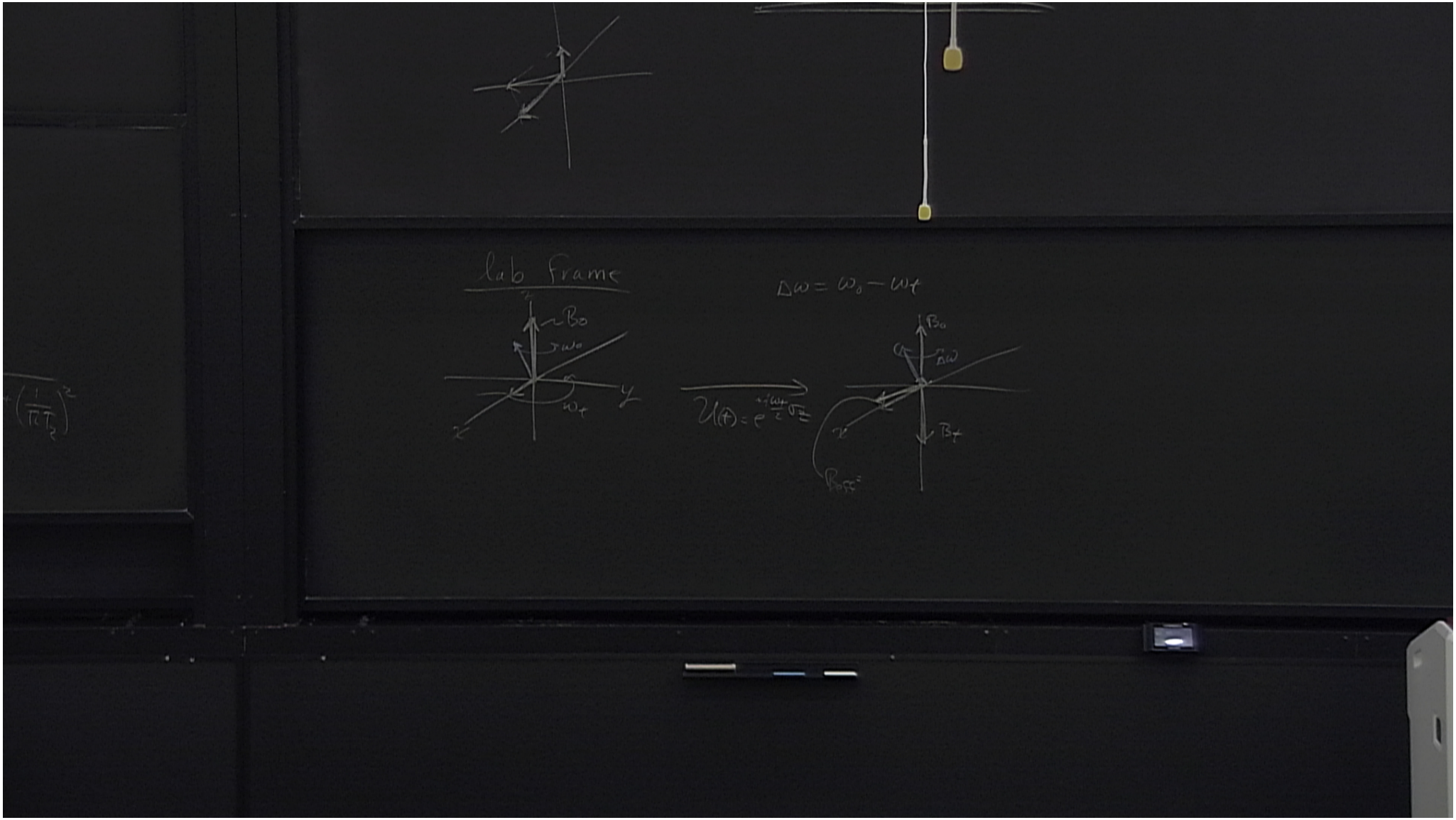

$\frac{dM_z}{dt} = 0$
$-\frac{M_z}{T_1} + \frac{M_0}{T_1}$
$2\pi/\omega_0$
what do we want to learn?
Stern Gahlach
Rabi
z
|↑>
|↓>

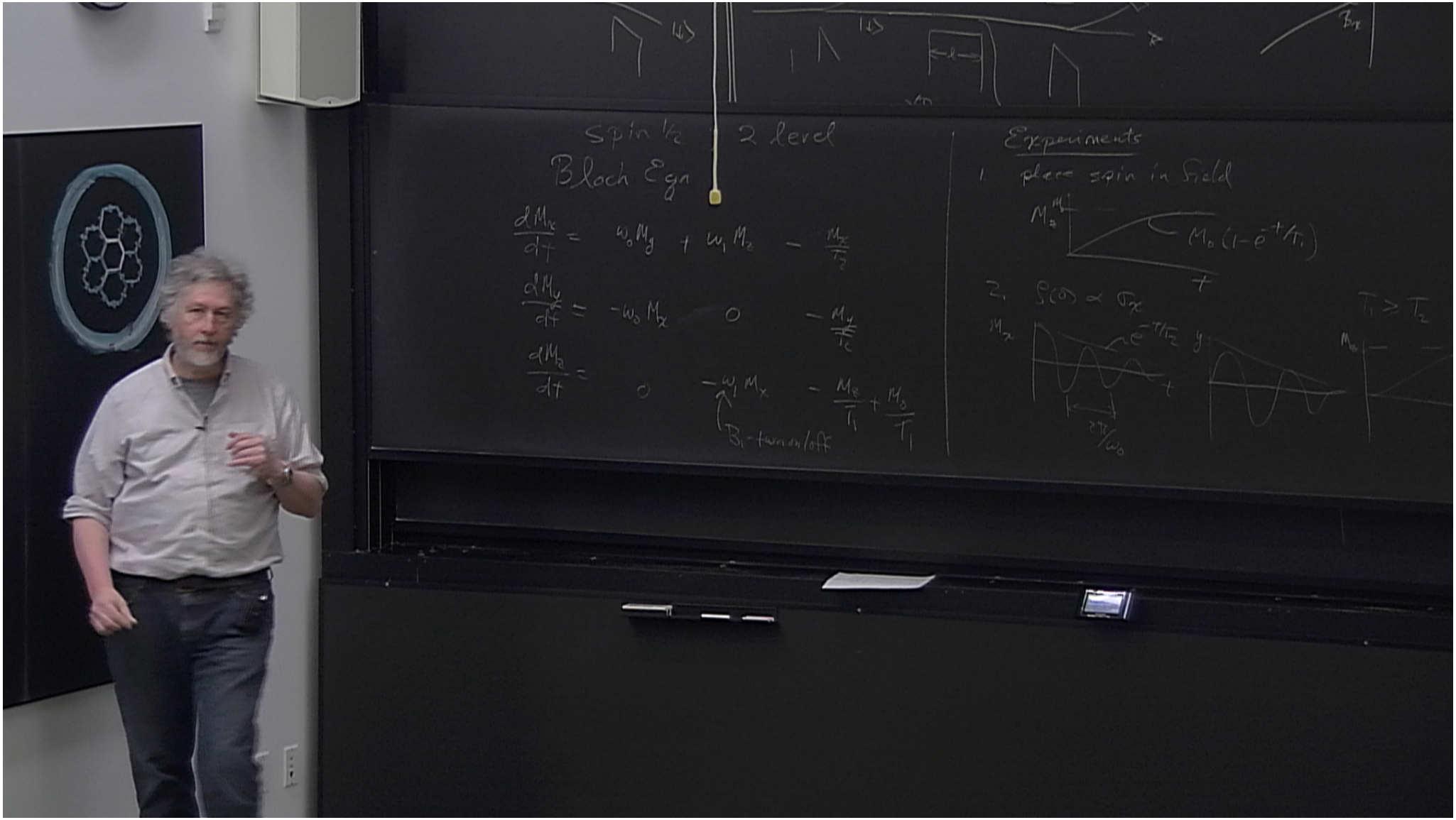

what do we want to learn?
Stern Gahlach
Rabi
B_z
B_x
$\gamma B_x \frac{l}{v}$
$\theta_z = \gamma B_x \frac{l}{v}$

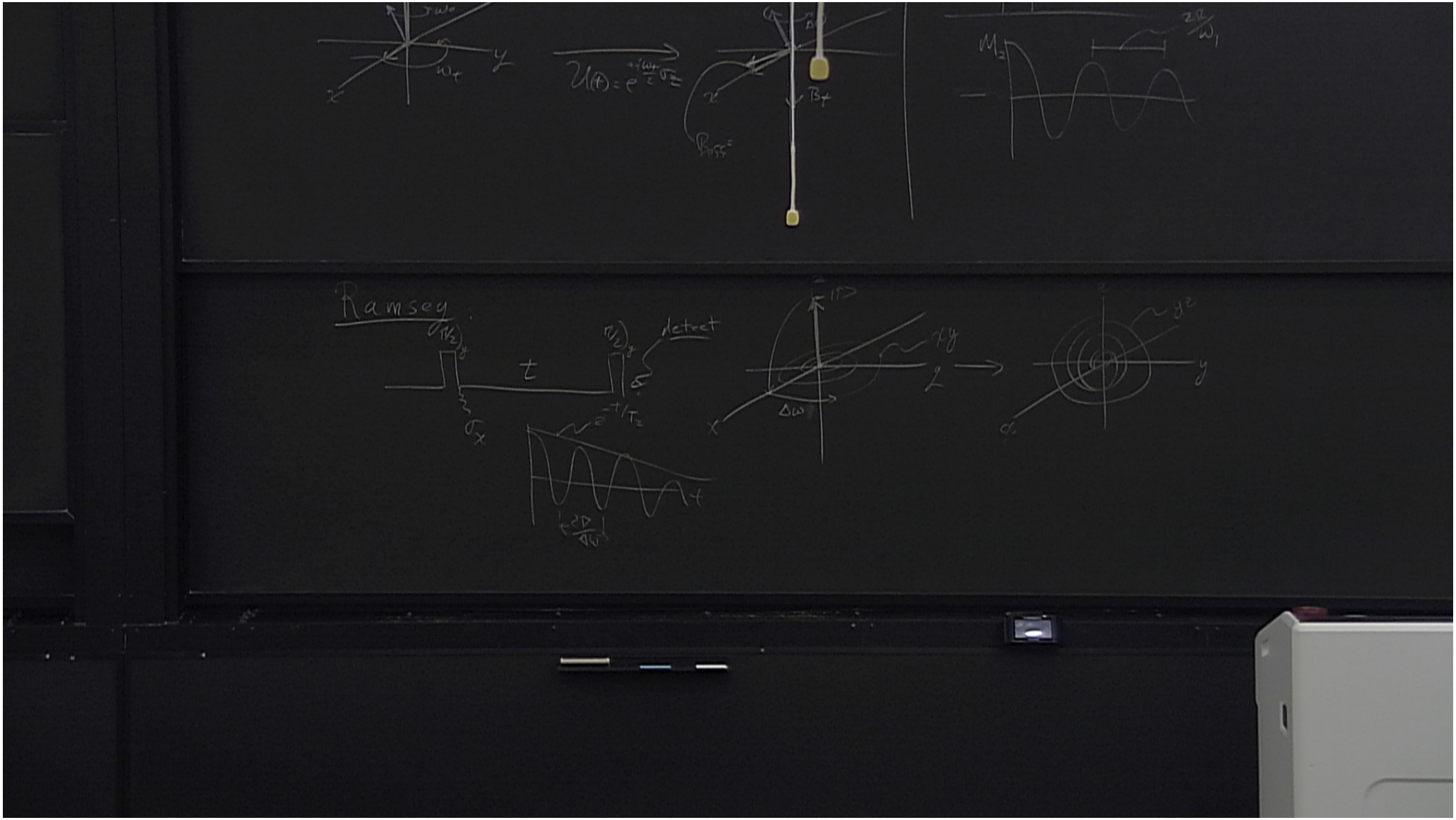

$\gamma B_x \frac{t}{2} = \frac{\pi}{2}$
$\theta_R = \gamma B_x \frac{l}{v}$
$\omega_1 = \gamma B_x$
ω_0
B_x
y
x
ω_0
lab frame.
$\mathcal{H} = -\omega_0 \sigma_z - e^{-i\frac{\omega_0 t}{2}\sigma_z} \omega_1 \sigma_x e^{-i\frac{\omega_0 t}{2}\sigma_z}$
frequency of the field

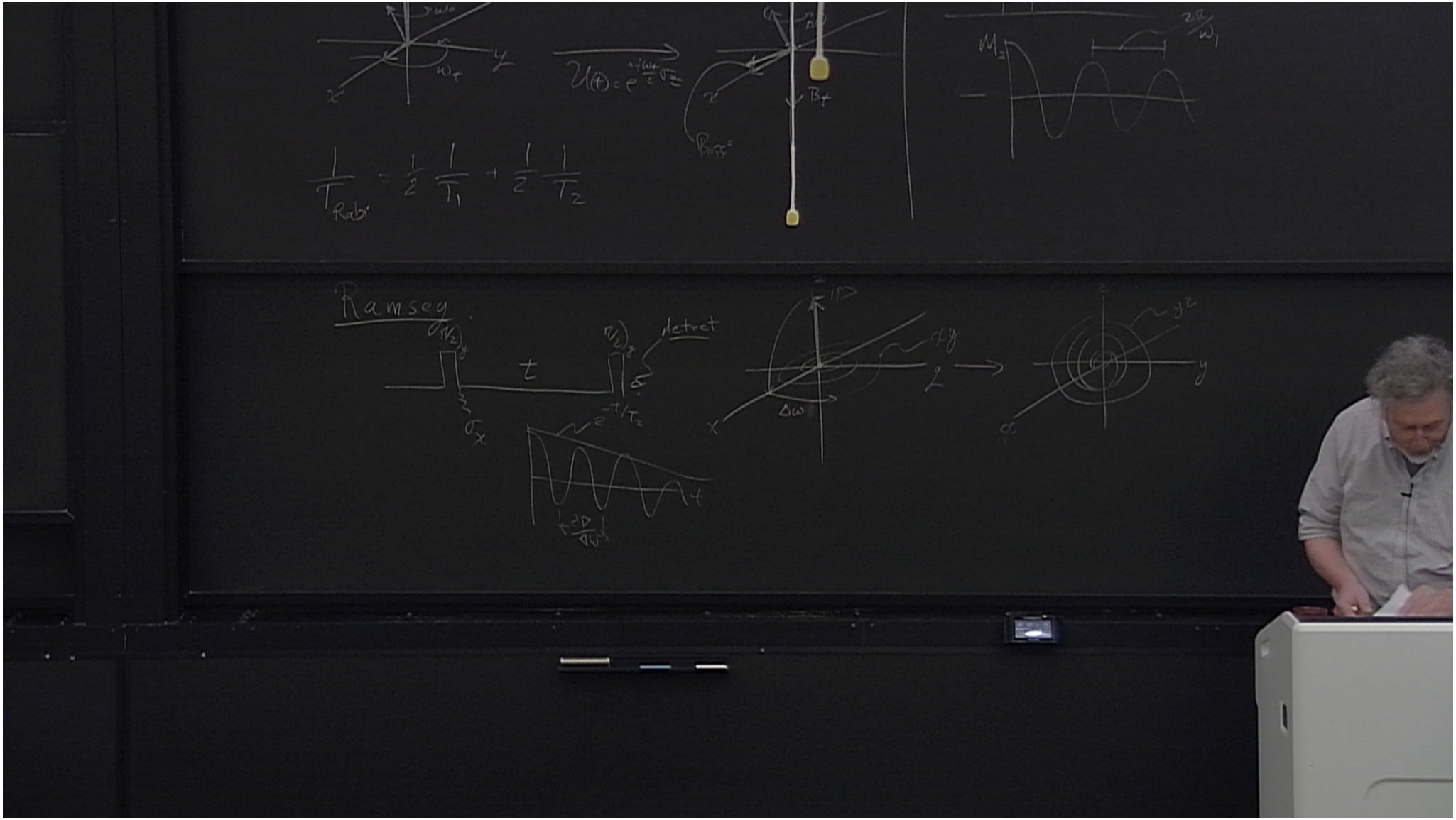

$\gamma B_x \tau \sim \frac{d}{v}$
$\theta_R = \frac{\gamma B_x d}{v}$
$\mathcal{H} = -\omega_0 \sigma_z - e^{-i\frac{\omega_+ t}{2}\sigma_z}\ \omega_1 \sigma_x\ e^{-i\frac{\omega_+ t}{2}\sigma_z}$
Frequency of the field
$\frac{d\rho}{dt} = -i[\mathcal{H}, \rho]$
$\tilde{\rho} = U \rho U^{-1}$

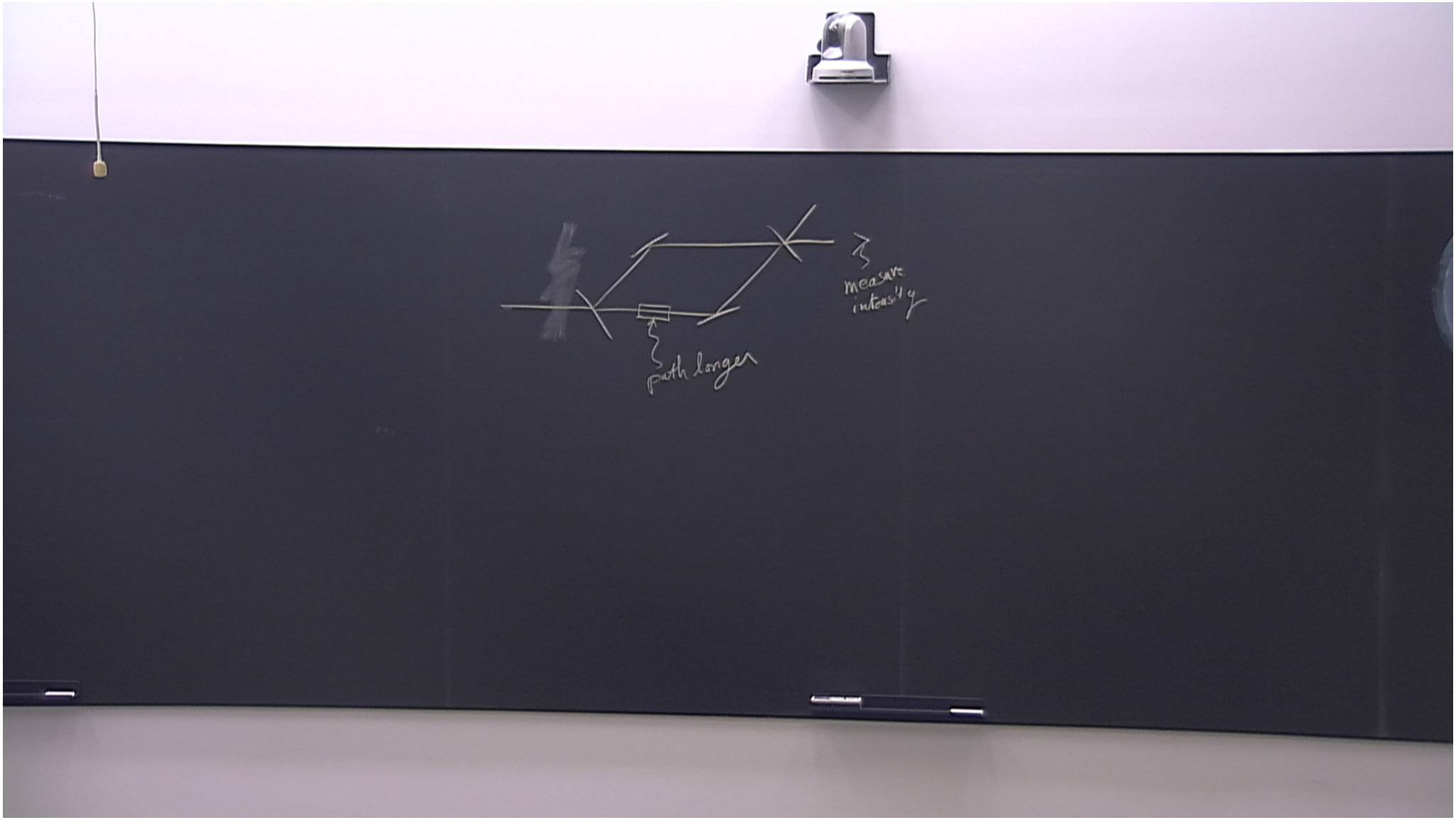

$\gamma B_x \tau \sim \frac{l}{v}$
$\theta_R = \frac{\gamma B_x l}{v}$
$\mathcal{H} = -\omega_z \sigma_z - e^{-i\frac{\omega_z t}{2}\sigma_z}\ \omega_1 \sigma_x\ e^{-i\frac{\omega_z t}{2}\sigma_z}$
Frequency of the field
$\frac{d\rho}{dt} = -i[\mathcal{H}, \rho]$
$\tilde{\rho} = U \rho U^{-1}$; $U = e^{-i\frac{\omega_z t}{2}\sigma_z}$
$\frac{d\tilde{\rho}}{dt} = \frac{dU}{dt}\rho U^{-1} + U\frac{d\rho}{dt}U^{-1} + U\rho\frac{dU^{-1}}{dt}$
$i\frac{\omega_z}{2}\sigma_z U$

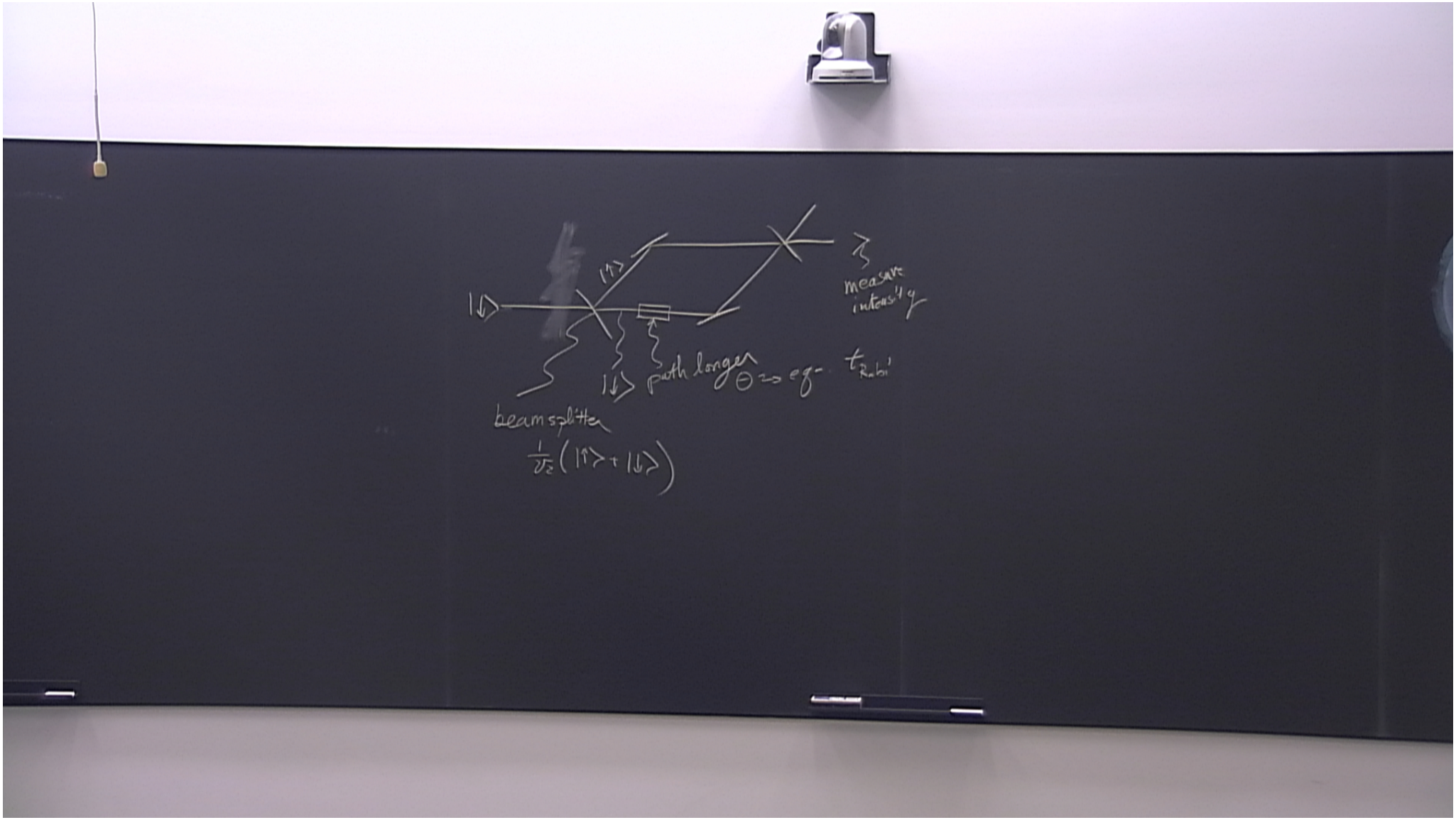

lab frame
B_0
ω_0
ω_t
$\Delta\omega = \omega_0 - \omega_t$
B_0
$\Delta\omega$
B_t


Spin 1/2 ; 2 level
Bloch Eqn
Experiments
1. place spin in field
M_z
$M_0(1-e^{-t/T_1})$
t
2. $S(t) \propto S_x$
M_x
e^{-t/T_2}
t
$T_1 > T_2$
M_0
$2\pi/\omega_0$
B_1 turn on/off


Ramsey
detect
t


Ramsey
detect
t


measure intensity
path longer


|↑⟩
|↓⟩
|↓⟩
measure intensity
path longer
θ = eg. t_Rabi
beamsplitter
1/√2 (|↑⟩ + |↓⟩)