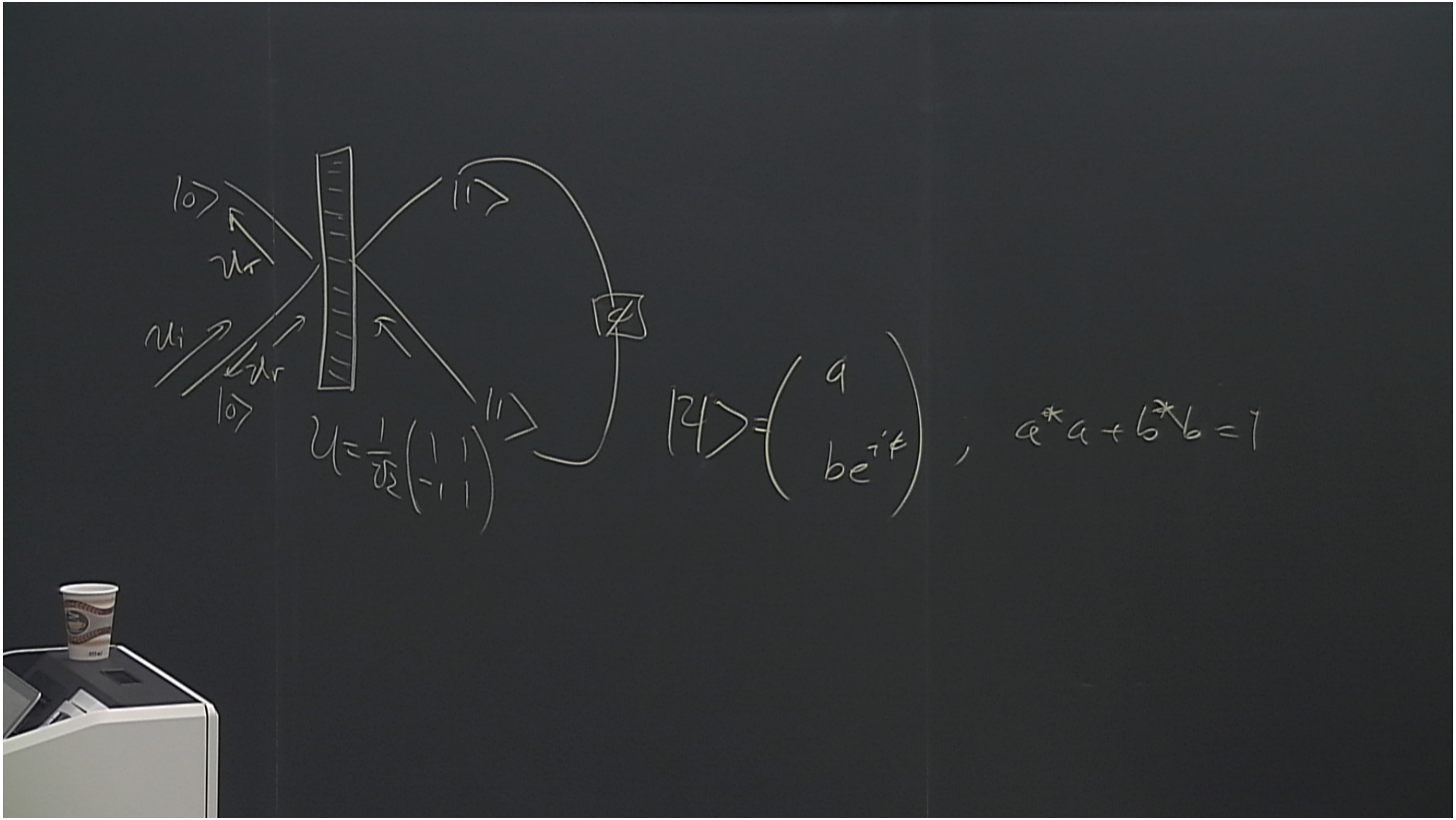
Title: 13/14 PSI - Explorations in Quantum Information - Lecture 6

Date: Mar 24, 2014 09:00 AM

URL: http://pirsa.org/14030036

Abstract:


|0⟩
|1⟩
|0⟩
|1⟩
U = 1/√2 (1 1 / -1 1)
|ψ⟩ = (a ; be^{-iφ}),
a*a + b*b = 1

Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help Mon 9:10 AM dcory

Ring interferometer.nb

In[4]:= b = (-a + b Exp[I ϕ])/Sqrt[2]

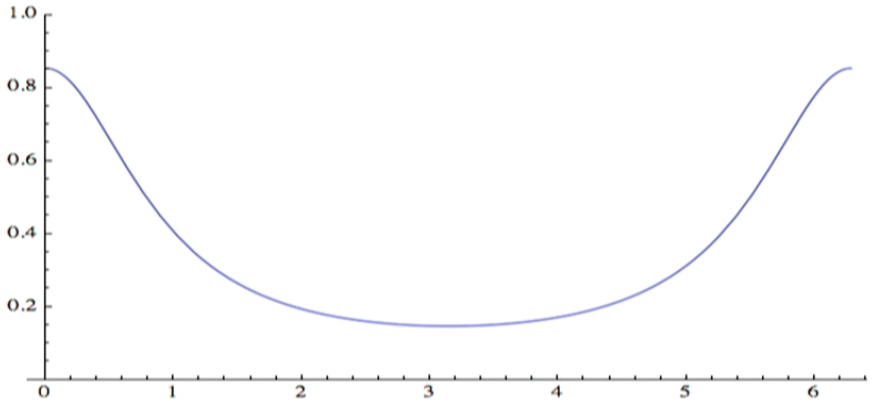
Solve for a and b as a function of ϕ

```
In[1]:= b[ϕ_] := 1 / Sqrt[4 - 2 Sqrt[2] Cos[ϕ]]

In[2]:= a[ϕ_] := b[ϕ] Exp[I ϕ] - Sqrt[2] b[ϕ]

In[3]:= Plot[b[ϕ] Conjugate[b[ϕ]], {ϕ, 0, 2 π}, PlotRange → {0, 1}]
```

Out[3]=




```
In[4]:= Plot[a[ϕ] Conjugate[a[ϕ]], {ϕ, 0, 2 π}, PlotRange → {0, 1}]
```

150%

Magnetic Resonance, spin 1/2

$\mu = \hbar \gamma \vec{\sigma}$

γ: gyromagnetic ratio

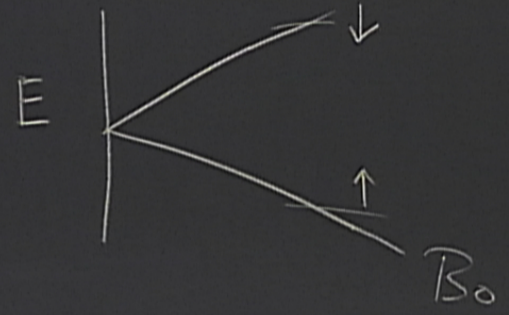
static magnetic field, $B_0 \hat{z}$

$E = -\mu \cdot B$

few T

$10^4 G = 1 T$

$\nu_H = 2\pi \, 4{,}250 \, Hz/G$;



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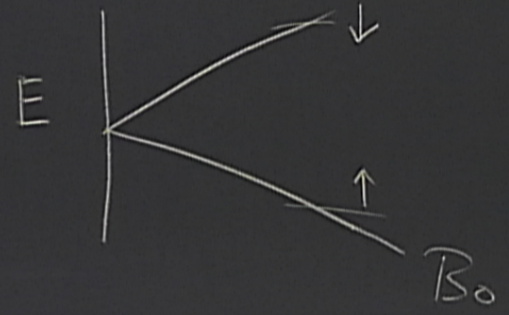

^1H	^2D	^3T	^{13}C	^{14}N	^{15}N	^{31}P	^{19}F
1/2	1	1/2	1/2	1	1/2	1/2	1/2

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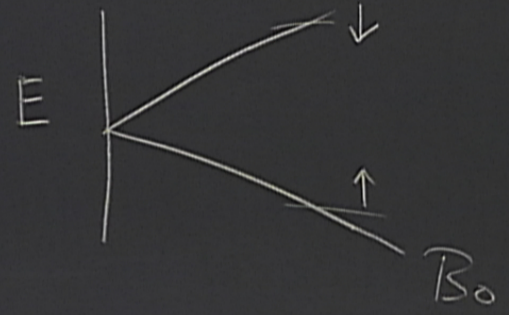
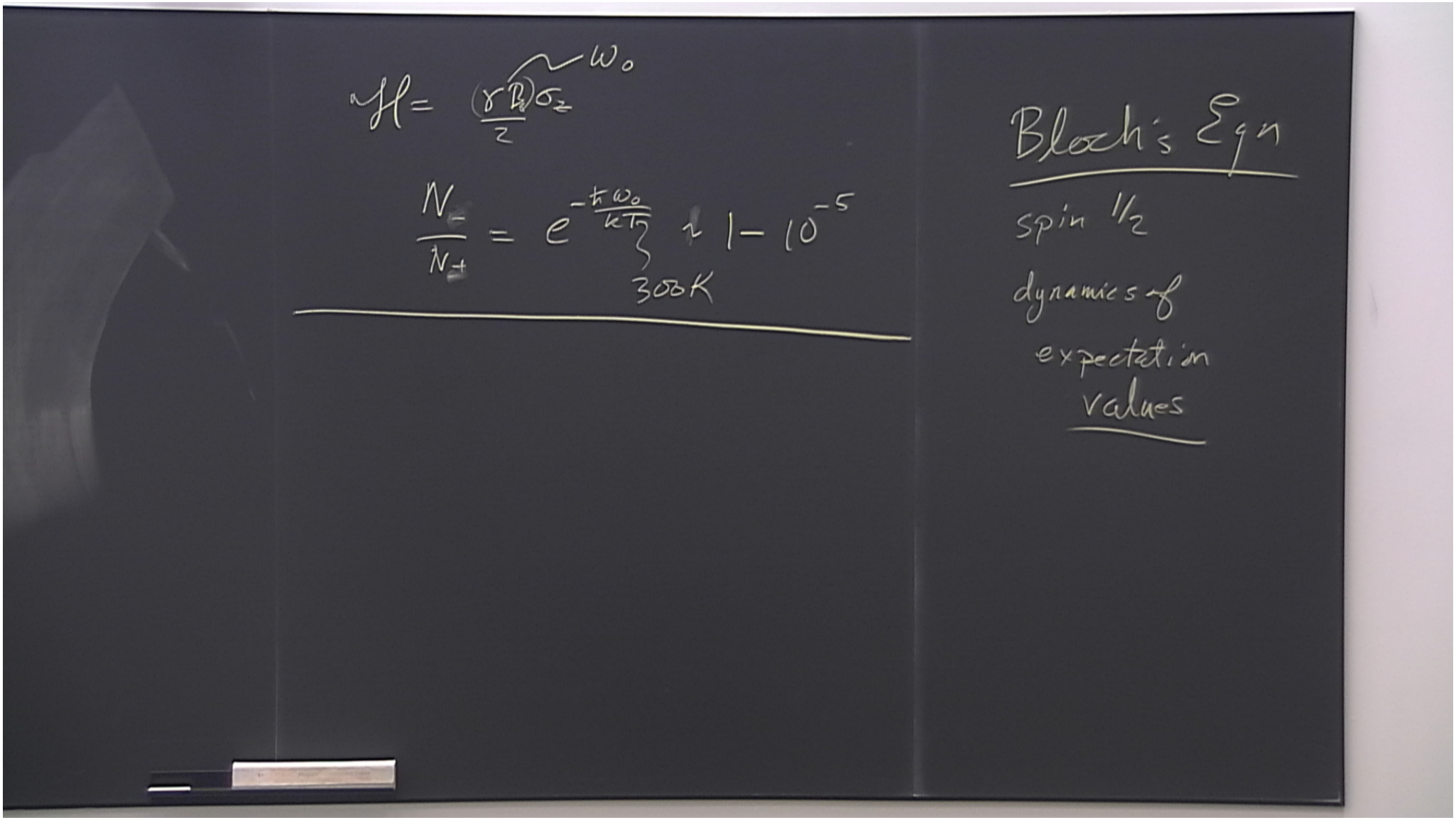


^1H	^2D	^3T	^{13}C	^{14}N	^{15}N	^{31}P	^{19}F
1/2	1	1/2	1/2	1	1/2	1/2	1/2


$\mathcal{H} = \frac{\gamma \hbar B_0}{2}\sigma_z \sim \omega_0$
$\frac{N_-}{N_+} = e^{-\frac{\hbar\omega_0}{kT}} \approx 1 - 10^{-5}$
300K
Bloch's Eqn
spin 1/2
dynamics of
expectation
values

Magnetic Resonance, spin 1/2

$\mu = \hbar \gamma \vec{\sigma}$ ← gyromagnetic ratio

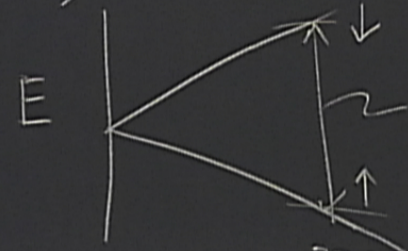
static magnetic field, $B_0 \hat{z}$

$E = -\mu \cdot B$

few T

macroscopic sample water $(1\,\mu m)^3 = 10^{11}_{spins}$; $^1H = 2\pi\ 4{,}250\ Hz/G$;

$10^4 G = 1\,T$



age of Universe

^1H	^3D	^3T	^{13}C	^{14}N	^{15}N	^{31}P	^{19}F
1/2	1	1/2	1/2	1	1/2	1/2	1/2

Magnetic Resonance, spin 1/2

$\mu = \hbar \gamma \sigma$ ← gyromagnetic ratio

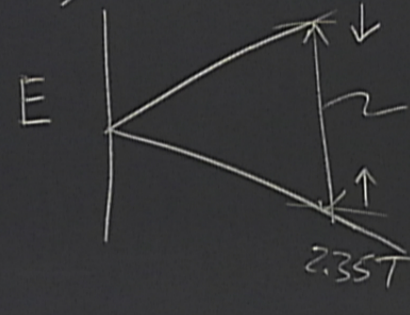
static magnetic field, $B_0 \hat{z}$

$E = -\mu \cdot B$

macroscopic sample water $(1\,\mu m)^3 = 10^{11}$ spins; $^1H = 2\pi \cdot 4{,}250\ Hz/G$;

few T

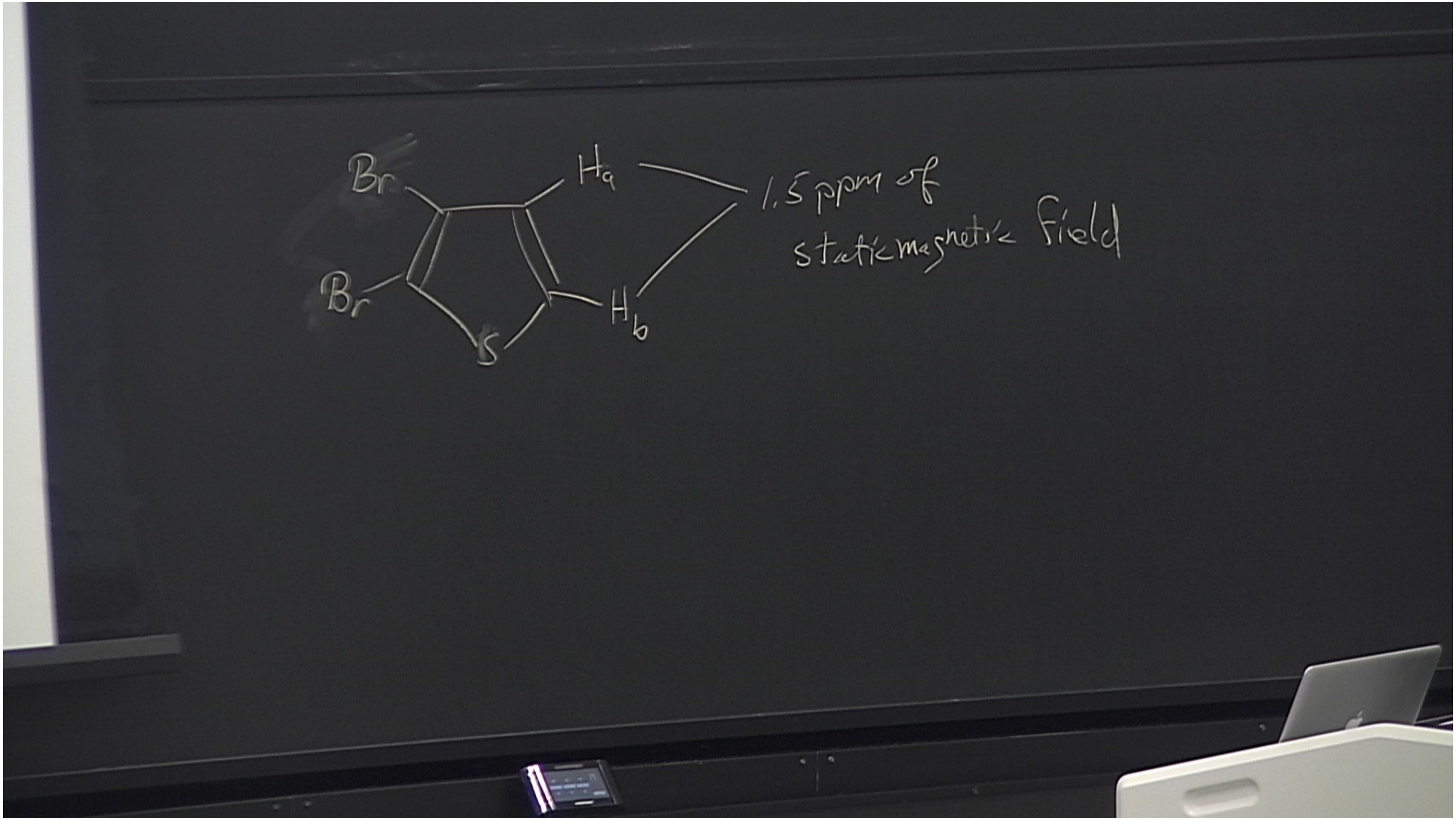
$10^4 G = 1 T$



$\frac{3}{5}$

^1H	^2D	^3T	^{13}C	^{14}N	^{15}N	^{31}P	^{19}F
1/2	1	1/2	1/2	1	1/2	1/2	1/2

age of Universe


Br
Br
S
H_a
H_b
1.5 ppm of
static magnetic field

$$\frac{d\langle\sigma_x\rangle}{dt} = \frac{dM_x}{dt} = -\omega_0 M_y - \frac{M_x}{T_2}$$

$$\frac{dM_y}{dt} = \omega_0 M_x - \frac{M_y}{T_2}$$

$$\frac{dM_z}{dt} = 0 \quad 0 \; (\text{dephasing}) \quad + \frac{M_0 - M_z}{T_1}$$

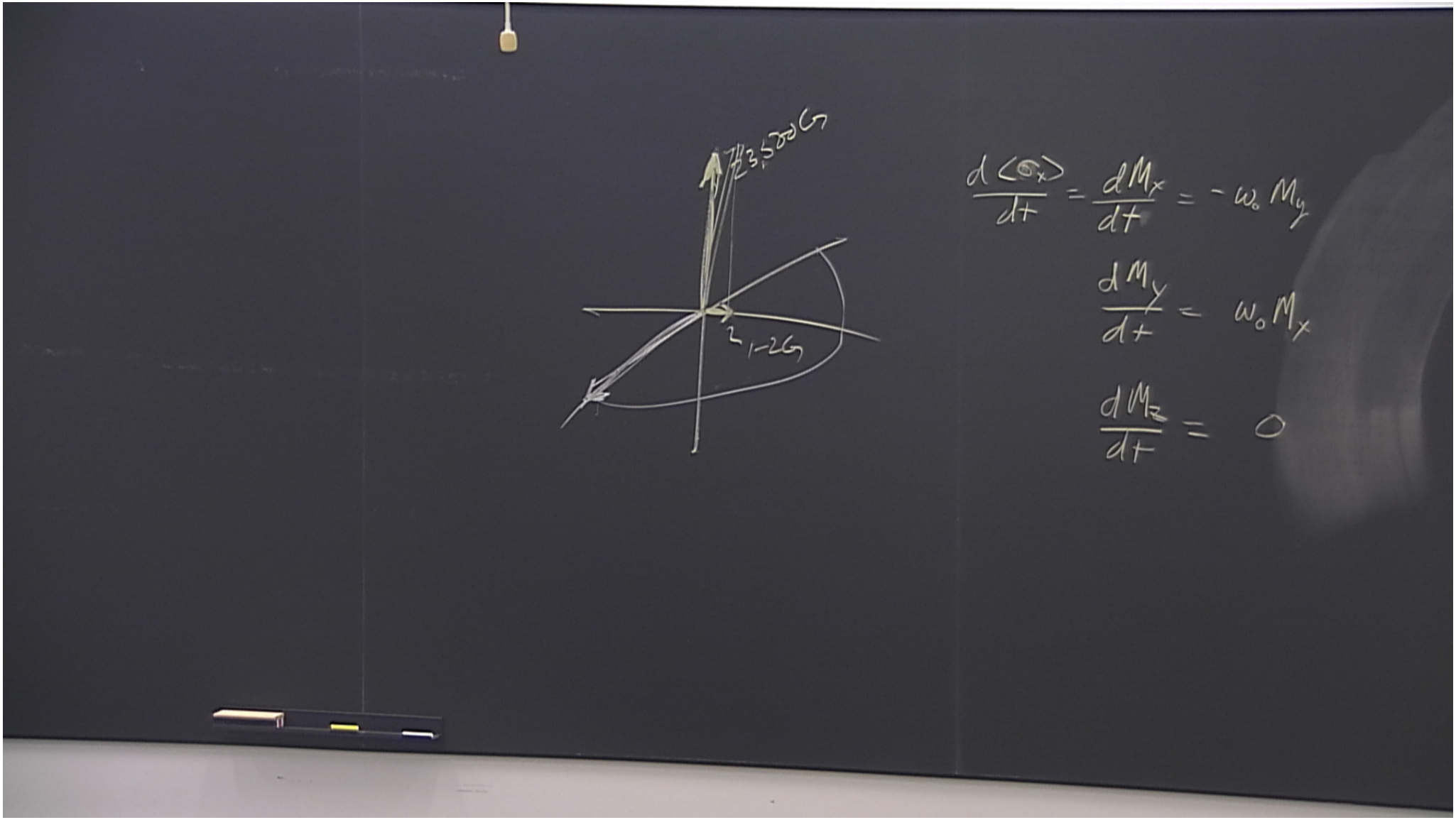
M_0: equilibrium value of M_z

$$\mathcal{H} = \frac{\gamma B_0}{2}\sigma_z$$

$\gamma B_0 \sim \omega_0$ — dynamics are to rotate about $\hat{z}$

$$\frac{N_-}{N_+} = e^{-\frac{\hbar\omega_0}{kT}} \approx 1 - 10^{-5}$$

T: 300K



$$\frac{d\langle S_x\rangle}{dt} = \frac{dM_x}{dt} = -\omega_0 M_y$$

$$\frac{dM_y}{dt} = \omega_0 M_x$$

$$\frac{dM_z}{dt} = 0$$