*

g

*

g

$\boldsymbol{P}\boldsymbol{\mu}$

$$\boldsymbol{\mu} = \gamma \boldsymbol{P}$$

γ

$$\boldsymbol{\mu} = g \cdot \frac{q}{2m_N} \boldsymbol{P}$$

$qm_N gg$

$$\mu_N = \frac{eh}{2m_p}$$

hg

$$g = \frac{\boldsymbol{\mu}/\mu_N}{\boldsymbol{P}/\!\!\!\hbar} = \frac{\gamma/2\pi}{\mu_N/h}$$

$\mu_N/hg\gamma$

I

$$\begin{cases} P = \sqrt{I(I+1)}\hbar \\ \mu = g\sqrt{I(I+1)}\mu_N \end{cases}, I = 0, \frac{1}{2}, 1, \frac{3}{2} \dots$$

I

$$\begin{cases} P_z = m\hbar \\ \mu_z = \gamma m\hbar \end{cases}, m = I, I-1, \dots, -I+1, -I$$

$$E = -\boldsymbol{\mu} \cdot \boldsymbol{B} = -\mu_z B = -m\hbar B, m = I, \dots, -I$$

$$\Delta E = \hbar B$$

$B\Delta m = \pm 1$

$$\omega = \gamma B \nu = \frac{\gamma}{2\pi} B$$

$$\frac{N_{20}}{N_{10}} = (-\Delta E/kT)$$

$N_{20}, N_{10}\Delta E \ll kT$

$$n_0 \approx \frac{\hbar B}{2kT} N$$

N

$$\boldsymbol{M} = \sum_i \boldsymbol{\mu_i}$$

$$\frac{d\boldsymbol{M}}{dt} = \gamma \boldsymbol{M} \times \boldsymbol{B}$$

$\boldsymbol{M}_0$

$$\begin{cases} \frac{dM_z}{dt} = -\frac{1}{T_1}(M_z - M_0) \\ \frac{dM_x}{dt} = -\frac{1}{T_2}M_x \\ \frac{dM_y}{dt} = -\frac{1}{T_2}M_y \end{cases}$$

$T_1 T_2 M_0 z$

$$M_0 = \frac{I+1}{3I}\frac{N\mu^2}{kT}B_0$$

$$\frac{d\boldsymbol{M}}{dt} = \gamma \boldsymbol{M} \times \boldsymbol{B} - \frac{1}{T_2}(M_x \boldsymbol{i} + M_y \boldsymbol{j}) - \frac{1}{T_1}(M_z - M_0)\boldsymbol{k}$$

$$\begin{cases} u = \frac{\gamma B_1 T_2^2 (\omega_0 - \omega) M_0}{1 + T_2^2(\omega_0 - \omega)^2 + \gamma^2 B_1^2 T_1 T_2} \\ v = \frac{-\gamma B_1 M_0 T_2}{1 + T_2^2(\omega_0 - \omega)^2 + \gamma^2 B_1^2 T_1 T_2} \\ M_z = \frac{\left[1 + T_2^2(\omega_0 - \omega)\right] M_0}{1 + T_2^2(\omega_0 - \omega)^2 + \gamma^2 B_1^2 T_1 T_2} \end{cases}$$

$uxoyvxoy$

$$\Delta\omega = \frac{2}{T_2}$$

$B_0 > 0.5\,(5\,)^2 1 \times 10^{-5}$

Q

$B_0\omega_0\omega - \omega_0$

f	f_U	f_D

$$\frac{\gamma}{2\pi} = (42.576\,388\,8 \pm 0.000\,001\,8)\ /$$

$$B = (0.494\,889 \pm 0.000\,002)$$

g

$$\frac{\mu_N}{h} = (7.622\,593\,96 \pm 0.000\,000\,31)\ /$$

g

$$g = 5.254\,19 \pm 0.000\,09$$

$$\Delta\omega = 3.267 \times 10^{4\ -1}$$

$$T_2 \approx 6.12 \times 10^{-5}$$

β