

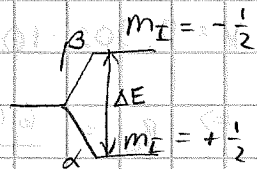
KEWA 2.22
demot 8
ratk.

①

$$E_{m_I} = -\gamma \hbar B_0 m_I$$

$$^{13}\text{C} \text{ - ydin } \rightarrow I = \frac{1}{2} \rightarrow m_I = -\frac{1}{2}, \frac{1}{2}$$

$$\Delta E = \frac{1}{2} \gamma \hbar B_0 - \left(-\frac{1}{2} \gamma \hbar B_0\right) = \gamma \hbar B_0$$



$$\text{Resonanssichto: } h\nu = \Delta E = \gamma \hbar B_0 \Rightarrow \nu = \frac{\gamma \hbar B_0}{h} = \frac{\gamma B_0}{2\pi}$$

$$= \frac{6,73 \cdot 10^7 \frac{1}{\text{ks}} \cdot 14,4 \text{ T}}{2\pi} \approx \underline{\underline{154 \text{ MHz}}}$$

② Kysä s. 517:

$$N_\alpha - N_\beta \approx \frac{N \gamma \hbar B_0}{2kT}$$

$$\text{protoni: } \gamma = 26,75 \cdot 10^7 \frac{1}{\text{T}\cdot\text{s}}$$

$$\frac{N_\alpha - N_\beta}{N_\alpha + N_\beta} = \frac{N_\alpha - N_\beta}{N} \approx \frac{\gamma \hbar B_0}{2kT}$$

$$, T = 300 \text{ K}$$

$$\text{a) } B_0 = 0,3 \text{ T} \Rightarrow \frac{\gamma \hbar B_0}{2kT} = \frac{26,75 \cdot 10^7 \frac{1}{\text{T}\cdot\text{s}} \cdot 1,0546 \cdot 10^{-34} \text{ J} \cdot 0,3 \text{ T}}{2 \cdot 1,38 \cdot 10^{-23} \frac{\text{J}}{\text{K}} \cdot 300 \text{ K}}$$

$$\approx \underline{\underline{1,0 \cdot 10^{-6}}}$$

$$\text{b) } B_0 = 1,5 \text{ T} \Rightarrow \frac{\gamma \hbar B_0}{2kT} = \dots = \underline{\underline{5,1 \cdot 10^{-6}}}$$

$$\text{c) } B_0 = 10 \text{ T} \Rightarrow \frac{\gamma \hbar B_0}{2kT} = \dots = \underline{\underline{3,4 \cdot 10^{-5}}}$$

③ Intensiteetti $I \propto \nu$

$$\Rightarrow \frac{I(800 \text{ MHz})}{I(60 \text{ MHz})} = \frac{800 \text{ MHz}}{60 \text{ MHz}} \approx 13$$

Sis n. 13 kertainen.

④

$$h\nu = g\mu_B B_0 \Rightarrow B_0 = \frac{h\nu}{g\mu_B}$$

Huom. luentodioissa ja
kagassa painorikhe $\mu_B = 9.274 \cdot 10^{-24} \frac{J}{T}$ (ei 9,724...)

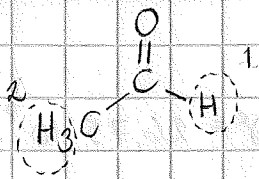
a) $\nu = 9.302 \cdot 10^9 \text{ Hz}$

$$\Rightarrow B_0 = \frac{6.626 \cdot 10^{-34} \text{ J} \cdot 9.302 \cdot 10^9 \frac{1}{s}}{2.0025 \cdot 9.274 \cdot 10^{-24} \frac{J}{T}} = (3.5679 \cdot 10^{-11} \cdot 9.302 \cdot 10^9) \text{ T}$$

$$\approx \underline{\underline{331,9 \text{ mT}}}$$

b) $B_0 = (3.5679 \cdot 10^{-11} \cdot 33,67 \cdot 10^9) \text{ T} = \underline{\underline{1,201 \text{ T}}}$

⑤



δ kemiall. siirtymä
 δ varjostusvakio

$$\nu = (1 - \delta) \frac{\gamma B_0}{2\pi}, \quad \delta = \frac{\nu - \nu^0}{\nu^0} \cdot 10^6$$

$$\Rightarrow \delta = \frac{(1 - \delta) \frac{\gamma B_0}{2\pi} - (1 - \delta^0) \frac{\gamma B_0}{2\pi}}{(1 - \delta^0) \frac{\gamma B_0}{2\pi}} \cdot 10^6 = \frac{\delta^0 - \delta}{1 - \delta^0} \cdot 10^6$$

$$\approx (\delta^0 - \delta) \cdot 10^6$$

$$\uparrow$$

$$\delta^0 \ll 1$$

$$\delta_1 - \delta_2 = [(\delta^0 - \delta_1) - (\delta^0 - \delta_2)] \cdot 10^6 = (\delta_2 - \delta_1) \cdot 10^6$$

$$\Rightarrow \delta_2 - \delta_1 = (\delta_1 - \delta_2) \cdot 10^{-6}$$

$$B_{loc} = (1 - \delta) B_0 \Rightarrow \Delta B_{loc} = B_{loc,1} - B_{loc,2} = (\delta_2 - \delta_1) B_0$$

$$= (\delta_1 - \delta_2) \cdot 10^{-6} B_0$$

a) $B_0 = 1,5 \text{ T} \Rightarrow \Delta B_{loc} = (9,80 - 2,20) \cdot 10^{-6} \cdot 1,5 \text{ T}$
 $\approx \underline{\underline{11,4 \mu\text{T}}}$

b) $B_0 = 15 \text{ T} \Rightarrow \Delta B_{loc} = (9,80 - 2,20) \cdot 10^{-6} \cdot 15 \text{ T}$
 $\approx \underline{\underline{114 \mu\text{T}}}$