Übung 1

Mittwoch, 9. November 2022 17:11

① H vs. D

reduced mass $\frac{1}{\mu} = \frac{1}{m_1} + \frac{1}{m_2}$

$\mu = \frac{m_1 m_2}{m_1 + m_2}$

$m_1 = m_e$

$m_2 = m_p$ or m_d

$R_{H,D} = R_\infty \cdot \frac{m_N}{m_e + m_N}$ $\begin{cases} = 10967758\ m^{-1}\ H \\ = 10970744\ m^{-1}\ D \end{cases}$

$\frac{1}{\lambda} = R_{H,D} \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$

Balmer $2 \leftrightarrow 3$ $\searrow ( ) = \frac{5}{36}$

$\lambda_H = \frac{36}{5 \cdot R_H} = 656.470\ nm \leftarrow$

D $\quad 656.291\ nm$

T $\quad 656.231\ nm$

Freqn. $\nu = \frac{c}{\lambda} = 456.674\ THz \quad H$

$.798 \quad D$

$.840 \quad T$

isotope shift

1	2	$\Delta\lambda$	$\Delta\nu$
H	D	0.18 nm	$-0.124\ THz$

H	T	0.24nm	-0.166 THz
D	T	0.06	-0.041 THz

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② H vs. He^+

nearly matching λ, a → isotope shift

$$\frac{\lambda_H}{\lambda_{He}} = \frac{R_{He}}{R_H} \approx 1.00041$$ ✓

complete: Z^2 $Z=1$ H, $Z=2$ He^+

$$\Delta E = \alpha Z^2 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

H	He^+	H	He^+
656.28	656.01	2→3	4→6
	541.16		4→7
486.13	485.93	2→4	4→8
	454.16		4→7
434.05	433.87	2→5	4→10

⋮

③ Zeeman shift

$$\Omega_L = \frac{eB}{2me}$$

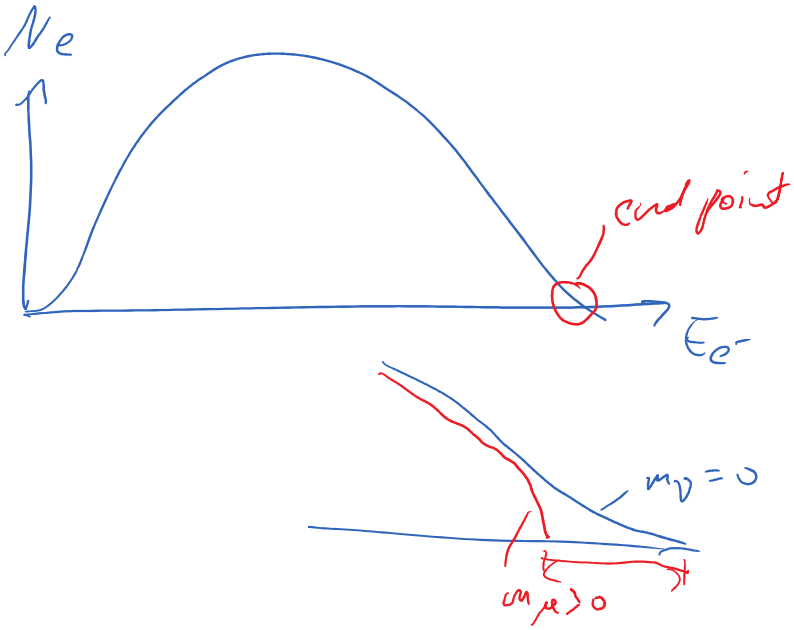
frequency shift $\Delta\nu = \frac{\Delta\omega}{2\pi} = \frac{\Omega_L}{2\pi}$

Ω_L e

$$\frac{\Omega_L}{2\pi B} = \frac{e}{4\pi m_e} = 14\ \mathrm{GHz/T}$$

Project 8:

$$T \rightarrow {}^3He^+ + e + \bar{\nu}_e$$



$B_{earth} \approx 5 \cdot 10^{-5}\,T = 50\,\mu T$ (45 μT)

25..65 μT

Balmer α in H 656.28 nm
456.805720 THz

	$\Delta\nu$	$\Delta f/f$
45 μT	630 MHz	$1.38 \cdot 10^{-9}$
1 T	14 GHz	$30 \cdot 10^{-6}$

typ. laser spectroscopy : 10 MHz easily

1 kHz very hard