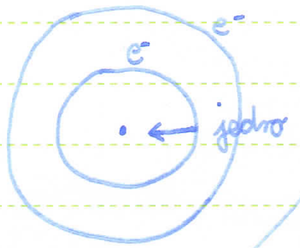
BOHROV MODEL ATOMA



VRTILNA KOLIČINA je KVANTIZIRANA

$$\boxed{L = n\hbar} \Rightarrow \text{krožnice so stabilne, atom ne seva}$$

$n \in \mathbb{N}$

H-atom

$$\boxed{F_e = F_R}$$

$$\frac{e_1 e_2}{4\pi\varepsilon_0 r^2} = m_e \frac{v^2}{r}$$

$$\frac{e_0^2}{4\pi\varepsilon_0 r^{\cancel{2}}} = m_e \frac{v^2}{\cancel{r}}$$

$$L = r \cdot G = r \cdot m_e v$$

$$\underline{m_e v_n r_n = n\hbar}$$

$$v_n = \frac{n\hbar}{m_e r_n}$$

$$\underline{e_0^2 = 4\pi\varepsilon_0 m_e r_n v_n^2}$$

$$e_0^2 = 4\pi\varepsilon_0 \cancel{m_e} \cancel{r_n} \frac{n^2\hbar^2}{m_e^{\cancel{2}} r_n^{\cancel{2}}} = \frac{4\pi\varepsilon_0 n^2 \hbar^2}{m_e r_n}$$

$$\boxed{r_n = n^2 \cdot \frac{4\pi\varepsilon_0 \hbar^2}{m_e e_0^2}}$$

$$a_0 = \frac{4\pi\varepsilon_0 \hbar^2}{m_e e_0^2} = \underline{0{,}529 \cdot 10^{-10}\ \text{m}} \quad \text{Bohrov radij}$$

$$v_n = \frac{\cancel{n\hbar}\,\cancel{m_e} e_0^2}{\cancel{m_e}\, n^{\cancel{2}}\, 4\pi\varepsilon_0 \hbar^2} = \frac{\cancel{\hbar} e_0^2}{4\pi\varepsilon_0 \hbar n} = \boxed{\frac{e_0^2}{n\, 4\pi\varepsilon_0 \hbar}}$$

$$W_{k_n} = \frac{1}{2} m_e v_n^2 = \frac{1}{2} m_e \frac{e_0^4}{n^2 (4\pi\varepsilon_0)^2 \hbar^2} = \underline{\underline{\frac{1}{2} \frac{m_e e_0^4}{n^2 (4\pi\varepsilon_0)^2 \hbar^2}}}$$

$$W_p = \frac{-e_0^2}{4\pi\varepsilon_0 r_n} = -\frac{e_0^2 \cdot m_e e_0^2}{4\pi\varepsilon_0 n^2 4\pi\varepsilon_0 \hbar^2} = \underline{\underline{\frac{-e_0^4 m_e}{(4\pi\varepsilon_0)^2 \hbar^2 n^2}}}$$

$$E = W_{kn} + W_{pn} = -\frac{1}{2}\frac{e_0^4 m_e}{(4\pi\varepsilon_0)^2 \hbar^2 n^2} = \frac{-13{,}6\ eV}{n^2}$$

$$E_m \longrightarrow E_n$$

$$\Delta E = E_n - E_m = h\nu_{mn} = -\frac{1}{2}\frac{e_0^4 m_e}{(4\pi\varepsilon_0)^2 \hbar^2 n^2} + \frac{1}{2}\frac{e_0^4 m_e}{(4\pi\varepsilon_0)^2 \hbar m^2} =$$

$$h\nu_{mn} = \frac{1}{2}\frac{e_0^4 m_e}{(4\pi\varepsilon_0)^2 \hbar^2}\left(\frac{1}{m^2} - \frac{1}{n^2}\right)$$

oz. $\left(\frac{1}{n^2} - \frac{1}{m^2}\right)$

Bohrov model atoma velja:

$H, He^{+}, Li^{2+}, Be^{3+}, B^{4+}, C^{5+} \ldots$

$$\boxed{E_n = \frac{-13{,}6\ eV\ z^2}{n^2}}$$

z = vrstno število elementa

Moseleyeva formula $n=1 \longrightarrow n=2$

$$\boxed{h\nu = \frac{1}{2}\frac{e_0^2 m_e (z-1)^2}{(4\pi\varepsilon_0)^2 \hbar^2}\left(1 - \frac{1}{n}\right)}$$

svetloba → valovanje
→ curek delcev } IMA DUALNO NARAVO

↓

fotoni: $W_f = h\nu$

$p = \frac{h}{\lambda}$

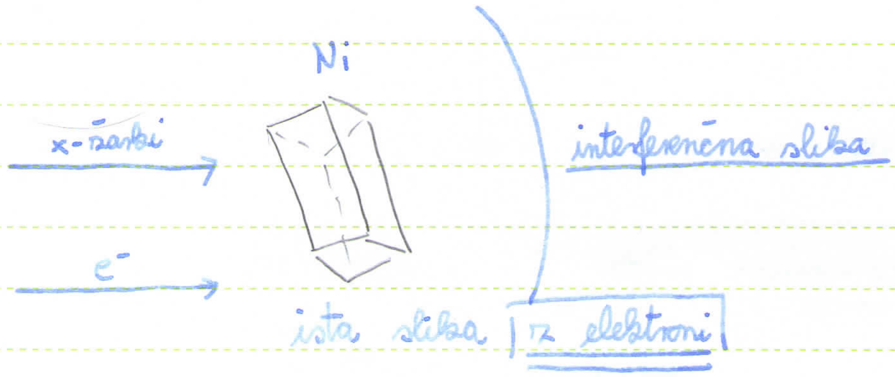
de Broglie:

delci z gib. kol. p

$\boxed{\lambda = \frac{h}{p}}$

e^- $m_e = 9{,}1 \cdot 10^{-31}$ kg $\lambda = \frac{h}{m_0 v} = \frac{10^{-34}}{10^{-31} \cdot 10^{5}} \doteq 10^{-8}$

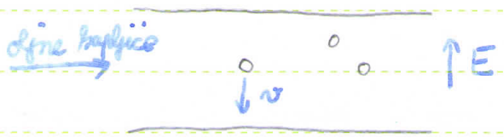
l. 1927: Davisson in Germer:



Millikanov poskus:

vsak naboj je mnogokratnik osnovnega naboja: $e = N \cdot e_0$

$e_0 = 1{,}6 \cdot 10^{-19}$ As



$F_g - F_{vz} - F_u = 0$

$\boxed{F_g - F_{vz} - F_u + F_e = 0}$

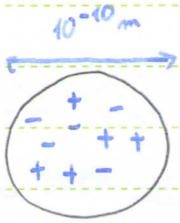
$F_e = eE$

- naboj ni zvezen, ampak KVANTIZIRAN

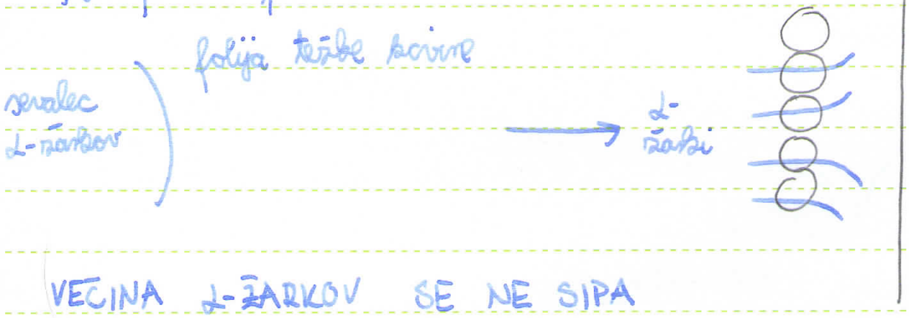
Thomsonov poizkus:

delci imajo 1500-krat manjšo maso kot H^+ → to so bili e^-

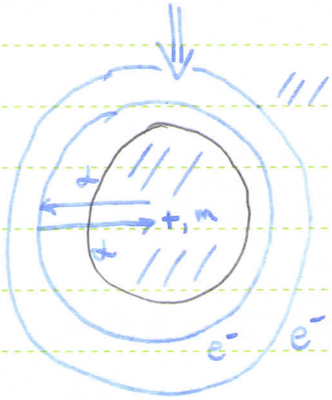
THOMSONOV MODEL ATOMA:



Rutherfordov poizkus:



VEČINA α-ŽARKOV SE NE SIPA



/// - prazen prostor

→ velikost jedra 10^{-15} m

PLANETNI MODEL OZ. RUTHERFORDOV MODEL ATOMA

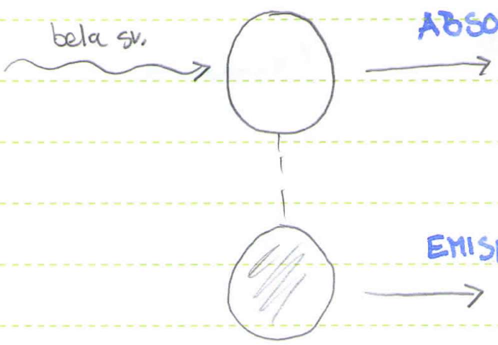
||

ampak e^- bi morali sevati ⇒ pomikajo se bliže jedru

SPEKTER VODIKOVEGA ATOMA

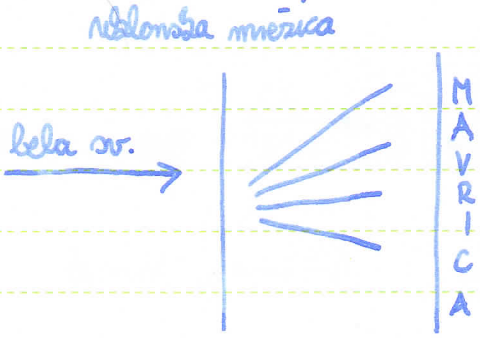
spektri → plini - ČRTASTI

spektri → tekoče in trdne snovi - ZVEZEN



ABSORPCIJSKI SPEKTER (gledamo, kaj pride skozi plin)

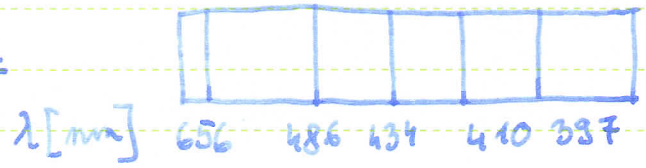
EMISIJSKI SPEKTER (plin segrejemo in gledamo kakšen spekter izseva iz njega)



$$\boxed{N\lambda = d \sin\alpha}$$

$$\alpha = \arcsin\frac{\lambda}{d} \quad \text{za } N=1$$

za vodik



Balmerjeva serija

$$\frac{1}{\lambda} = R_H\left(\frac{1}{2^2} - \frac{1}{n^2}\right) \quad n = 3, 4 \ldots$$

$$\boxed{\frac{1}{\lambda} = R_H\left(\frac{1}{m^2} - \frac{1}{n^2}\right)}$$

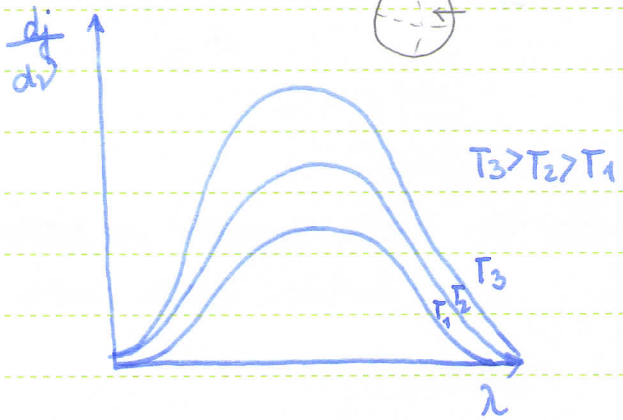
$n > m$

za $m=1$: 122 nm, 103 nm, 97,3 nm, 95 nm, 93,8 nm Lymanova serija

$m=3$: 1870 nm, 1280 nm, 1090 nm, 1005 nm, 954 nm Paschenova serija

Sevanje črnega telesa

Črno telo vso svetlobo absorbira, belo telo pa vso odbije.



$\boxed{j = \sigma \cdot T^4}$ Stefanov zakon $\sigma = 5{,}67 \cdot 10^{-8} \frac{W}{m^2K^4}$ Stefanova konst.

$\boxed{k_w = T\lambda_{MAX}}$ $k_w = 2{,}897 \cdot 10^{-3}\ mK$ Wienova konst.

$L = n\hbar$ reducirana Planckova konstanta $\qquad \hbar = \frac{h}{2\pi}$

$$m \cdot r \cdot v = n\frac{h}{2\pi} \quad / \, 2\pi$$

$$m v \, 2\pi r = n h \qquad p = mv, \quad o = 2\pi r$$

$$p o = n h \quad / : p$$

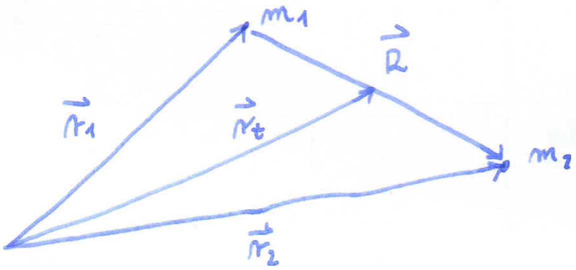
$$o = n\frac{h}{p}$$

$$\underline{o = n\lambda}$$

$n=1$

$n=2$

$$h\nu_{mn} = \frac{z^2 e_0^2 m_e}{32\pi^2 \varepsilon_0^2 \hbar^2}\left(\frac{1}{n^2} - \frac{1}{m^2}\right)$$



$$\underline{H = \frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2 + V(|\vec{r}_1 - \vec{r}_2|)}$$

$$\vec{v}_1 = \dot{\vec{r}}_1 \qquad \vec{v}_2 = \dot{\vec{r}}_2$$

$$\vec{R} = \vec{r}_2 - \vec{r}_1$$

$$\vec{r}_t = \frac{m_1\vec{r}_1 + m_2\vec{r}_2}{m_1 + m_2}$$

$$(m_1 + m_2)\vec{r}_t = m_1\vec{r}_1 + m_2\vec{r}_2$$

$$\vec{R} = \vec{r}_2 - \vec{r}_1 \qquad / \cdot m_1) + \quad / \cdot m_2) -$$

$$(m_1 + m_2)\vec{r}_t + m_1\vec{R} = m_1\vec{r}_2 + m_2\vec{r}_2 \Rightarrow$$

$$\underline{\vec{r}_2 = \vec{r}_t + \frac{m_1}{m_1 + m_2}\vec{R}}$$

$$(m_1 + m_2)\vec{r}_t - m_2\vec{R} = m_1\vec{r}_1 + m_2\vec{r}_2 \Rightarrow$$

$$\underline{\vec{r}_1 = \vec{r}_t - \frac{m_2}{m_1 + m_2}\vec{R}}$$

$$\dot{\vec{r}}_1 = \dot{\vec{r}}_t - \frac{m_2}{m_1 + m_2}\dot{\vec{R}}$$

$$\dot{\vec{r}}_2 = \dot{\vec{r}}_t + \frac{m_1}{m_1 + m_2}\dot{\vec{R}}$$

NASLEDNJA STRAN

$$H = \frac{1}{2} m_1 \left(\dot{\vec{r}}_t - \frac{m_2}{m_1+m_2}\dot{\vec{R}}\right)^2 + \frac{1}{2} m_2\left(\dot{\vec{r}}_t + \frac{m_1}{m_1+m_2}\dot{\vec{R}}\right)^2 + V(R)$$

$$H = \frac12 m_1\left(\dot{\vec r}_t^{\,2} - \cancel{2\frac{m_2}{m_1+m_2}\dot{\vec R}\,\dot{\vec r}_t} + \frac{m_2^2}{(m_1+m_2)^2}\dot{\vec R}^2\right) + \frac12 m_2\left(\dot{\vec r}_t + \cancel{\frac{2m_1}{m_1+m_2}\dot{\vec r}_t\,\dot{\vec R}} + \frac{m_1^2}{(m_1+m_2)^2}\dot{\vec R}^2\right) + V(R)$$

$$H = \frac12 \dot{\vec r}_t^{\,2} (m_1+m_2) + \frac12 \dot{\vec R}^2 \underbrace{\left(\frac{m_1 m_2^2}{(m_1+m_2)^2} + \frac{m_2 m_1^2}{(m_1+m_2)^2}\right)} + V(R)$$

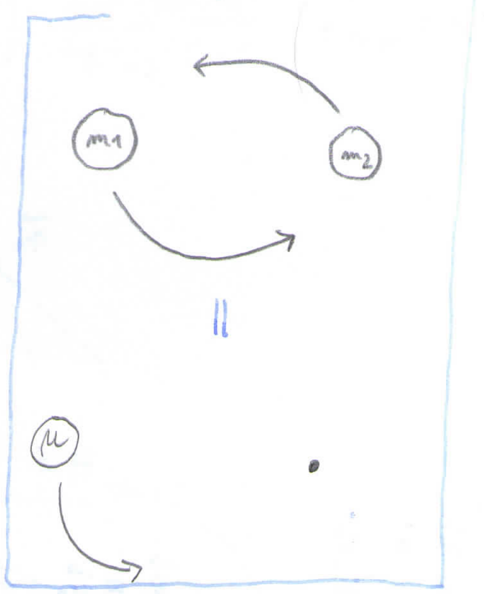
$$\boxed{H = \underbrace{\frac12 \dot{\vec r}_t^{\,2} (m_1+m_2)}_{\text{gibanje težišča}} + \underbrace{\frac12 \mu \dot{\vec R}^2 + V(R)}_{\text{gibanje red. mase okoli krajišča}}}$$

$$\frac{m_1 m_2 \cancel{(m_1+m_2)}}{(m_1+m_2)^{\cancel{2}}} = \mu$$

reducirana masa

⇓

gledamo maso, ki se giblje okoli ene ~~točke~~ (to je druga masa)



p^+ e^-

težišče

$m_e = 9{,}1094\cdot 10^{-31}$ kg

$m_p = 1{,}67262\cdot 10^{-27}$ kg

⇓

$\mu = 9{,}10442\cdot 10^{-31}$ kg

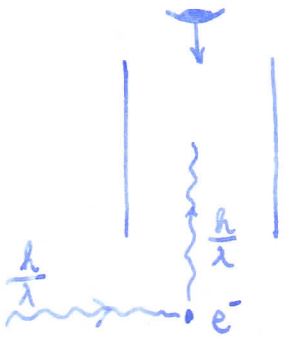
$\frac{\mu}{m_e} = 0{,}999456$

$m_1 = m_e$

$m_2 = m_e$

$\mu = \frac{m_e\cdot \cancel{m_e}}{2\cancel{m_e}} = \frac{m_e}{2}$

Heisenbergov mikroskop



napaka mikroskopa je valovna dolžina $\Rightarrow$ za boljši odčitek potrebujemo manjšo valovno dolžino

$\boxed{\Delta x = \lambda}$ $\boxed{\Delta x \cdot \Delta p_x = h}$

gib. količina delca (e^-) se je spremenila za $\Delta p_x = \frac{h}{\lambda}$

manjša je val. dolžina svetlobe $\Rightarrow$ večja gib. k. $\Rightarrow$ e^- odfrči bolj stran

če hočemo bolj natančno izmeriti eno količino, izgubimo drugo

$\Downarrow$

$\boxed{\Delta x \cdot \Delta p_x \geq \frac{1}{2}\hbar}$

Δx ... položaj

Δp_x ... gib. količina