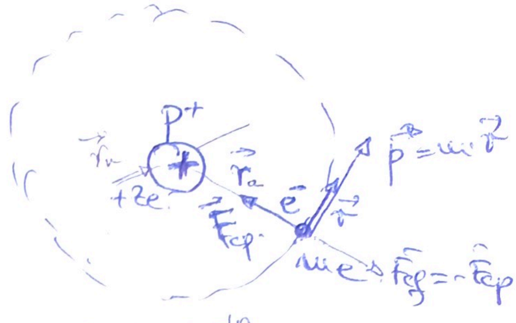
cl. 12a (S12-1) – Modelul planetar pt. hidrogen (^1_1H) 02.12.2020

pg. (64–65)

1. Alcatuirea at. ^1_1H
2. Conditia de stabilitate a e^- in atom.
3. $E_c, E_p, E_t = E_c + E_p$.
4. Starea legata. $E_\ell \geq -E_t > 0$ a e^- in atom.
5. Calculul constantelor at. de ^1_1H, $\vec{v}$; $\vec{p} = m\vec{v}$; ν, $\vec{L} = \vec{r} \times \vec{p}$



$\begin{cases} r_a = 10^{-10} m \\ r_n = 10^{-15} m \end{cases}$

1). Conform modelului planetar al atomului (Rutherfor) atomul de (^1_1H) este compus din: nucleu care cuprinde (p^+) o sarcina pozitiva data de proton ($^1_{+1}p$), unul dintre nucleoni, si e^- – particula negativa ce graviteaza pe orbita/invelisul electronic (conf. desen)

2). Conditia de stabilitate a e^- pe orbita este:

$$\begin{cases} F_e = F_{cp} \\ \dfrac{e^2}{4\pi\varepsilon_0 r^{\cancel{2}}} = \dfrac{mv^2}{\cancel{r}} \end{cases} \qquad \begin{cases} F_e = \dfrac{1}{4\pi\varepsilon_0} \cdot \dfrac{e^2}{r^2}, (1) \\ F_{cp} = \dfrac{mv^2}{r^2}, (2) \end{cases}$$

3). Energiile e^- in atom. $\left(\dfrac{mv^2}{2}\right) = E_c = \dfrac{e^2}{8\pi\varepsilon_0 r}$ (3); $E_{pg} = -\dfrac{e^2}{4\pi\varepsilon_0 r}$

$$\begin{cases} E_c = \dfrac{e^2}{8\pi\varepsilon_0} \cdot \dfrac{1}{r} \quad ; \quad E_p = -\dfrac{e^2}{4\pi\varepsilon_0} \cdot \dfrac{1}{r} (4) \\ E_t = E_c + E_p = \dfrac{e^2}{8\pi\varepsilon_0} \dfrac{1}{r} - \dfrac{e^2}{4\pi\varepsilon_0 \cdot r} = -\dfrac{e^2}{8\pi\varepsilon_0} \cdot \dfrac{1}{r} = E_p/2. (5) \end{cases}$$

4). Obs: Orice corp/particula caracterizata printr-o, $E_t < 0$ se numeste sistem legat(a) iar energia ei corespunzatoare ($E_\ell = -E_t > 0$) s.n. energie de legatura. deci e^- este legat in atom de nucleu.

$$\boxed{E_\ell = \frac{e^2}{8\pi\varepsilon_0 r} = -E_t.}$$

Daca sistemul legat (electronul) primeste din exterior o cantitate de energie $E \geq E_\ell$ atunci el paraseste atomul si devine liber iar atomul ionizeaza:
$$\underset{atom.}{A} + \underset{h\nu}{E_\ell} \rightarrow \underset{ion}{A^+} + e^- (liber)$$

5). Calculul marimilor specifice atomului de ^1_1H conf. modelului planetar.

din (3) $\rightarrow v^2 = \dfrac{e^2}{8\pi\varepsilon_0 m} \cdot \dfrac{1}{r_n} \rightarrow \boxed{v = \sqrt{\dfrac{e^2}{8\pi\varepsilon_0 m} \cdot \dfrac{1}{r}} \sim 10^3 Km/s.}$ viteza e^-

$\begin{cases} v = \omega \cdot r = 2\pi\nu \cdot r \\ \omega = 2\pi\nu \end{cases} \rightarrow \boxed{\nu = \left(\dfrac{v}{2\pi r}\right) = \sqrt{\dfrac{e^2}{16\pi^2\varepsilon_0 m} \cdot \dfrac{1}{r^3}} \sim 10^{22} Hz.}$ – frecventa e^-

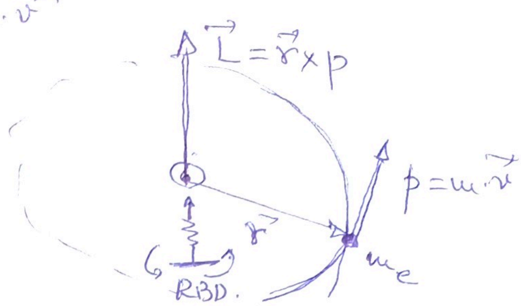
- $\vec{p} = m_e \vec{v} = m_e\left(\sqrt{\frac{e^2}{8\pi\varepsilon_0 \cdot m}\cdot\frac{1}{r}}\right) = \sqrt{\frac{m e^2}{8\pi\varepsilon_0 \cdot r}} \sim 10^{-20}$ kg m/s., $\boxed{m_e \simeq 9{,}1\cdot 10^{-31}\,kg}$

impulsul e⁻ — masa e⁻

- Momentul cinetic, $\vec{L} = \vec{r}\times\vec{p}$, $\vec{r} \perp \vec{p} = m\cdot\vec{v}$.

$$|\vec{L}| = r\cdot mv = r\cdot m\cdot\sqrt{\frac{e^2}{8\pi\varepsilon_0 m}\cdot\frac{1}{r}} =$$

$$|\vec{L}| = \sqrt{\frac{m e^2 r}{8\pi\varepsilon_0}} \sim 10^{-10}\ J\cdot s.$$



- Reprezentarea grafică a energiilor e⁻ în at. de H

$$\boxed{E_t = E_c + E_p}$$

$$E_c = \frac{e^2}{8\pi\varepsilon_0}\cdot\frac{1}{r_a}$$

$$E_{pq} = -\frac{e^2}{4\pi\varepsilon_0}\cdot\frac{1}{r_a}$$

$$E_t = -\frac{e^2}{8\pi\varepsilon_0}\cdot\frac{1}{r_a}$$