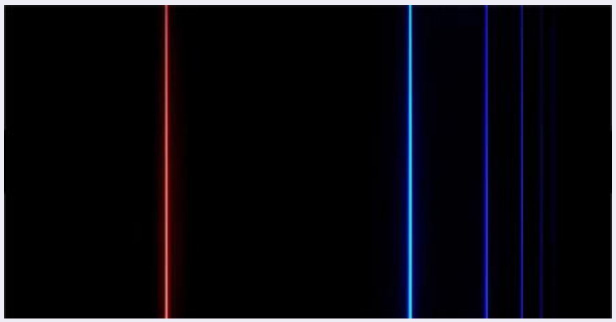
Стара квантна теорија

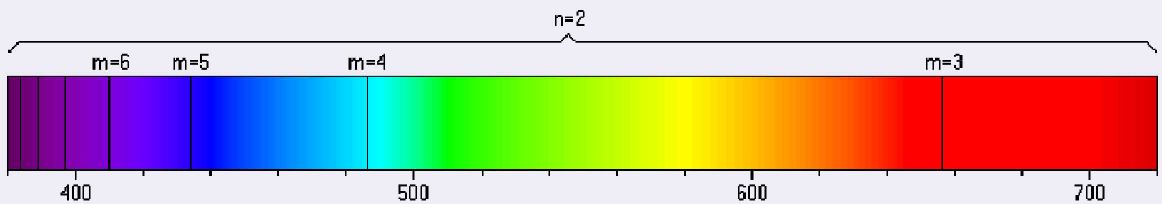
Атомски спектри су линијски.

Део спектра атома водоника из видљиве области . . .

. . . у емисији . . .



. . . и апсорпцији.



Пронаћи правилност:

а) 1, 2, 3, 4 . . .

$n + 1$

б) 6562,1; 4860,74; 4340,1; 4101,2; . . .

$$\lambda = b\frac{m^2}{m^2 - n^2} \qquad b = 3645,6 \qquad n = 2 \qquad m = 3,4,5.$$

Балмерова серија. Рицов комбинациони принцип. Лајманова, Пашенова . . . серија.

Боров модел атома

$$\left|\vec{F}_e\right| = \frac{1}{4\pi\varepsilon_0}\frac{Ze^2}{r^2},$$

$$a_c = \frac{v^2}{r},$$

$$\frac{1}{4\pi\varepsilon_0}\frac{Ze^2}{r^2} = \frac{mv^2}{r}$$

$$v = \sqrt{\frac{1}{4\pi\varepsilon_0 m}\frac{Ze^2}{r}}$$

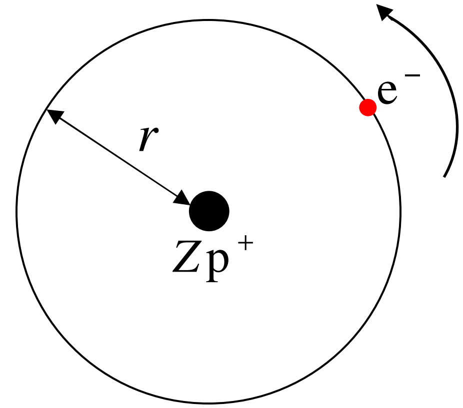
$$T = \frac{mv^2}{2} = \frac{1}{4\pi\varepsilon_0}\frac{Ze^2}{2r}$$

$$W_{1\to2} = \int_1^2 \vec{F}_e \mathrm{d}\vec{r} = \int_r^\infty \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}\mathrm{d}r = -\left(\frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r}\right)\Bigg|_r^\infty$$

$$= \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r} = -\frac{1}{4\pi\varepsilon_0}\frac{Ze^2}{r}$$

$$\Delta E_{\mathrm{p}(1\to2)} = -W_{1\to2}$$

$$W_{1\to2} = -\Delta E_{\mathrm{p}(1\to2)} = E_{\mathrm{p}1} - E_{\mathrm{p}2} = E_{\mathrm{p}1}$$



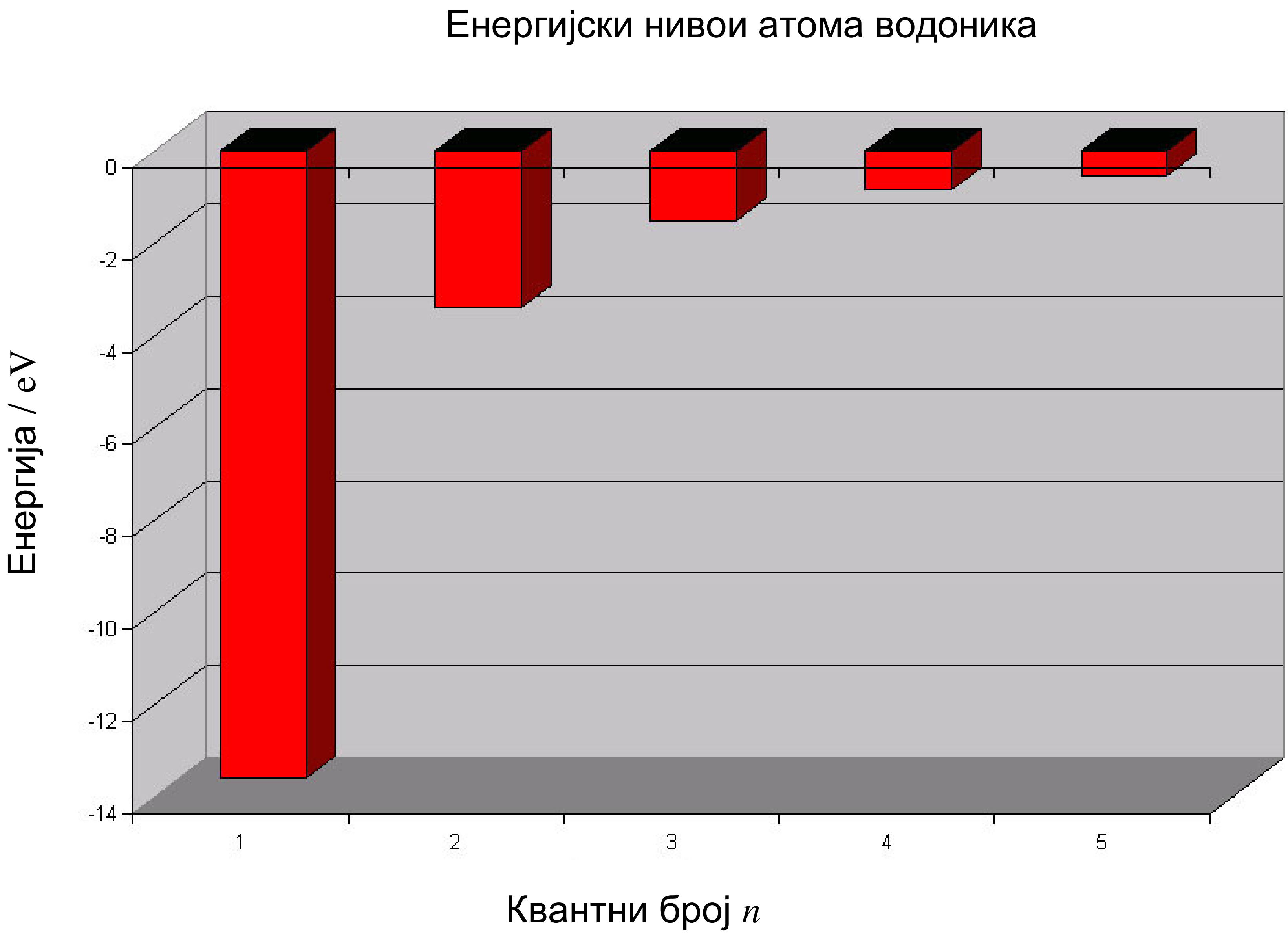
$$U \equiv E_{\mathrm{p}1} = -\frac{1}{4\pi\varepsilon_0}\frac{Ze^2}{r} \qquad E = T + U = \frac{1}{4\pi\varepsilon_0}\frac{Ze^2}{2r} - \frac{1}{4\pi\varepsilon_0}\frac{Ze^2}{r} = -\frac{1}{4\pi\varepsilon_0}\frac{Ze^2}{2r}$$

$$E = -\frac{1}{(4\pi\varepsilon_0)^2}\frac{mZ^2e^4}{2n^2\hbar^2}$$

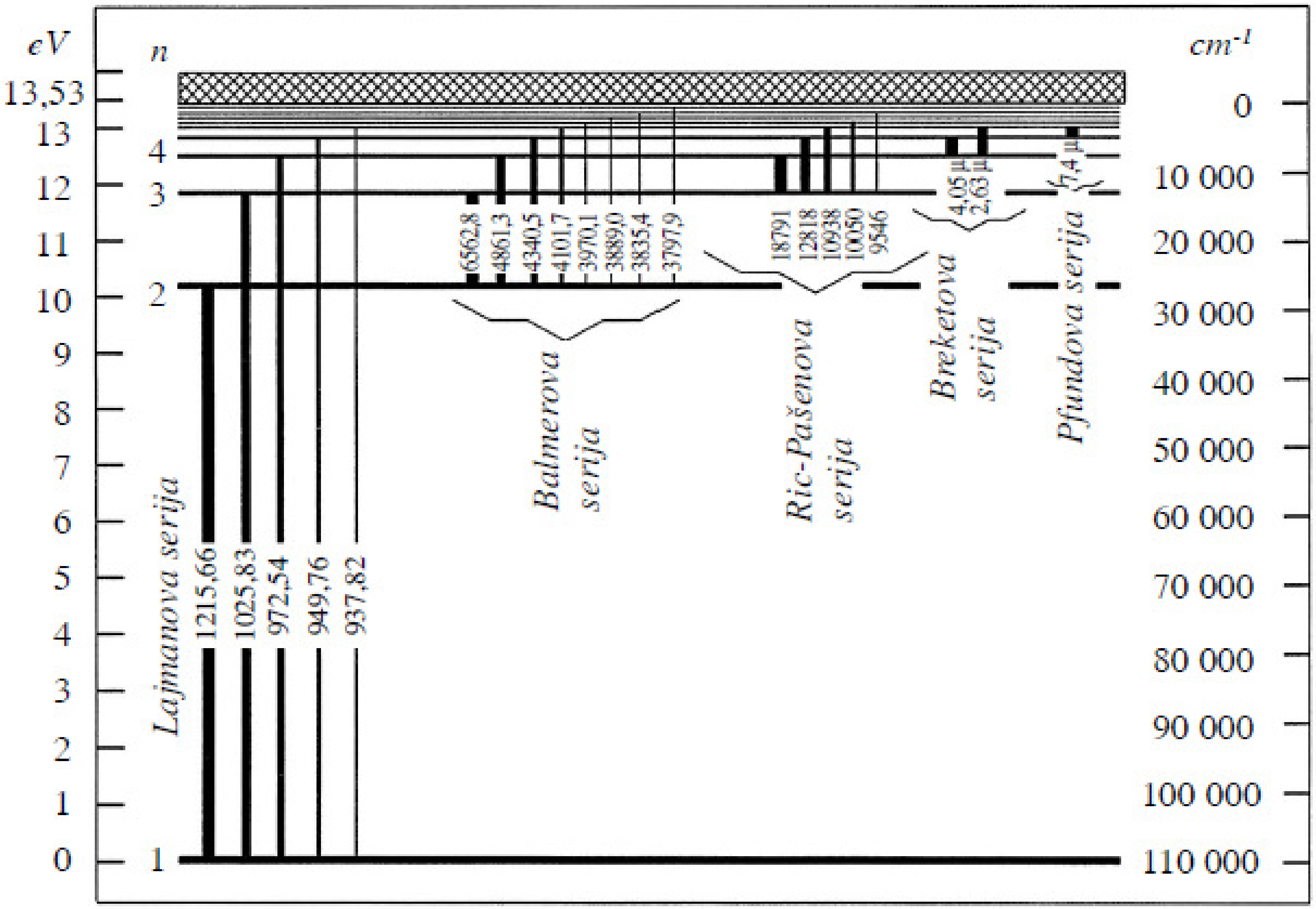
$$L = mvr = n\hbar,\ n \in N$$

$$r = 4\pi\varepsilon_0\frac{n^2\hbar^2}{mZe^2}$$

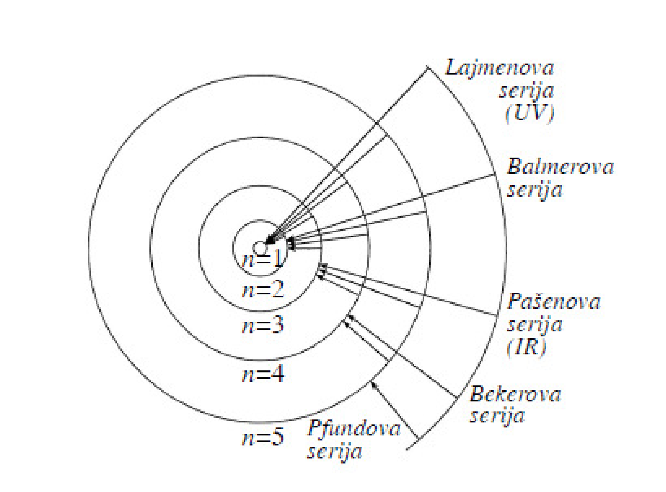
$$h\nu = \Delta E = E_k - E_n \to 1/\lambda = \tilde{\nu} = R\left(\frac{1}{n^2} - \frac{1}{k^2}\right),\quad R = \frac{mZ^2e^4}{8\varepsilon_0^2 h^3 c}$$



Енергијски нивои атома водоника
Енергија / eV
0
-2
-4
-6
-8
-10
-12
-14
1
2
3
4
5
Квантни број n



Гротријанов дијаграм



Зависност Ридбергове константе од масе језгра

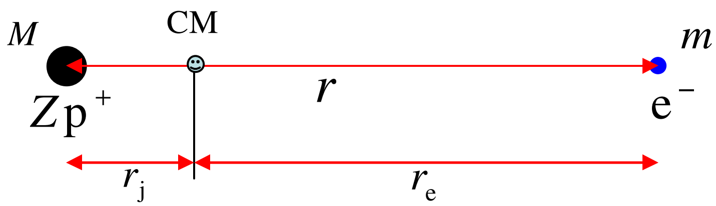
$$R = \frac{mZ^2e^4}{8\varepsilon_0^2h^3c}$$

$$R_{teo} = 109737\ \text{cm}^{-1}$$

$$R_{exp} = 109678\ \text{cm}^{-1}$$

$$\Delta R = 59\ \text{cm}^{-1}$$

?



$$r_e + r_j = r$$

$$m r_e = M r_j$$

$$r_e = \frac{M}{M+m} r$$

$$r_j = \frac{m}{M+m} r$$

Ако сада применимо Боров услов (да укупан момент импулса система треба да буде квантиран):

$$L_{uk} = L_j + L_e = Mv_jr_j + mv_er_e \qquad v_i = \omega r_i$$

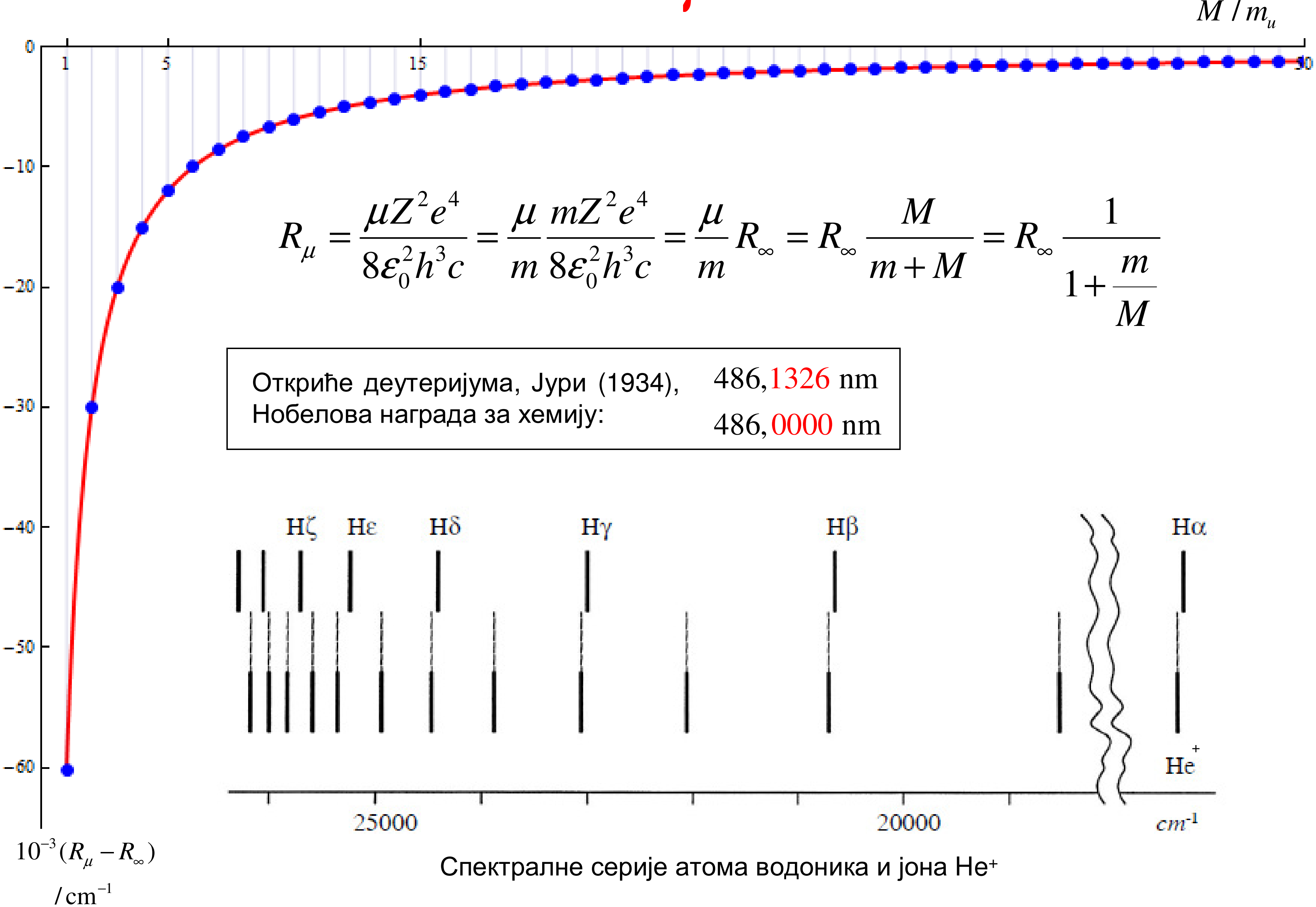
$$L_{uk} = \omega\left[M\left(\frac{mr}{M+m}\right)^2 + m\left(\frac{Mr}{M+m}\right)^2\right] = \mu\cdot\omega r\cdot r$$

Слично:

$$T_{uk} = T_j + T_e = M\frac{v_j^2}{2} + m\frac{v_e^2}{2} = \ldots = \frac{1}{2}\mu(\omega r)^2$$

$$\mu = \frac{mM}{M+m}, \qquad \mu < m < M$$

$m \rightarrow \mu$

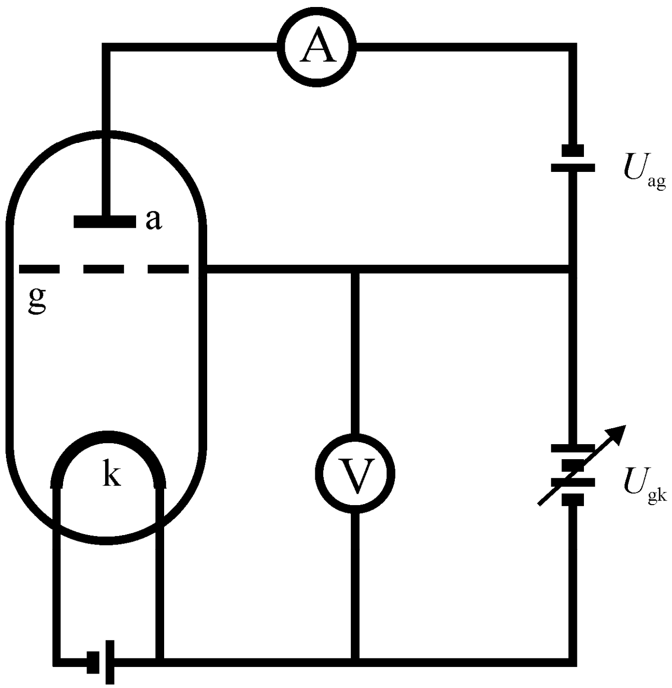


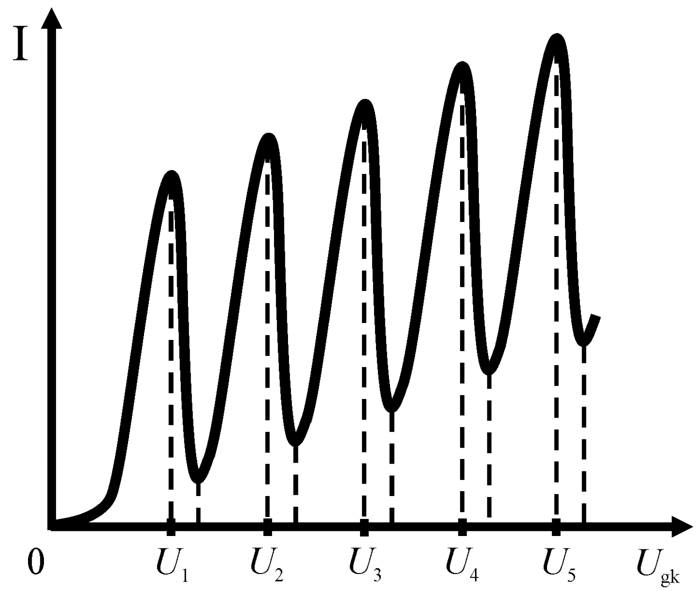
$$R_\mu = \frac{\mu Z^2 e^4}{8\varepsilon_0^2 h^3 c} = \frac{\mu}{m}\frac{m Z^2 e^4}{8\varepsilon_0^2 h^3 c} = \frac{\mu}{m} R_\infty = R_\infty \frac{M}{m+M} = R_\infty \frac{1}{1+\frac{m}{M}}$$

Откриће деутеријума, Јури (1934), Нобелова награда за хемију:	486,1326 nm 486,0000 nm

Спектралне серије атома водоника и јона He+

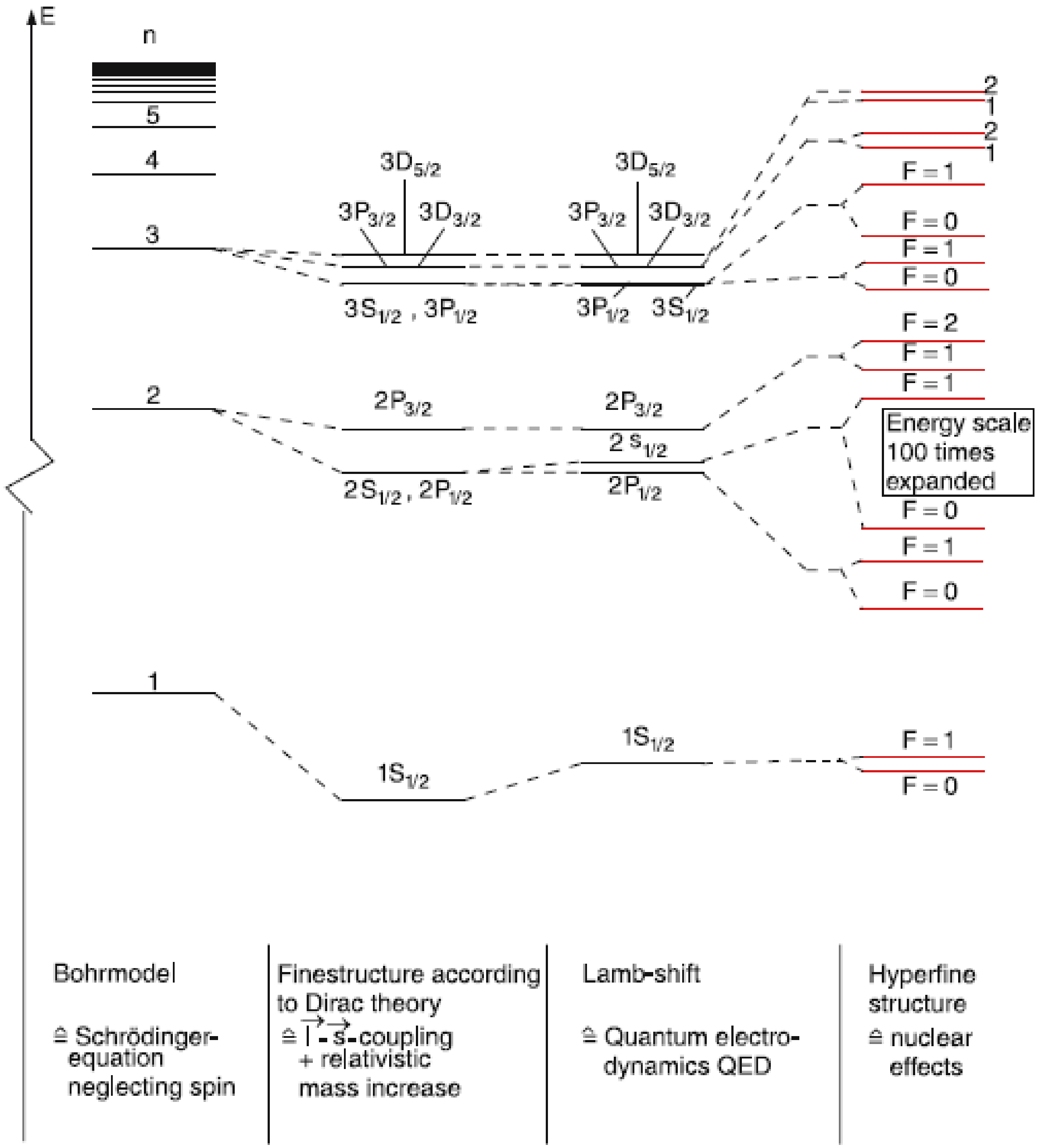
Франк-Херцов оглед





$$h\nu = \Delta E = E_k - E_n$$

http://phys.educ.ksu.edu/vqm/free/FranckHertz.html


E
n
5
4
3
2
1
3D5/2
3P3/2
3D3/2
3S1/2 , 3P1/2
3D5/2
3P3/2
3D3/2
3P1/2
3S1/2
2P3/2
2S1/2 , 2P1/2
2P3/2
2 s1/2
2P1/2
1S1/2
1S1/2
2
1
2
1
F = 1
F = 0
F = 1
F = 0
F = 2
F = 1
F = 1
Energy scale 100 times expanded
F = 0
F = 1
F = 0
F = 1
F = 0
Bohrmodel
≙ Schrödinger-equation neglecting spin
Finestructure according to Dirac theory
≙ l - s-coupling + relativistic mass increase
Lamb-shift
≙ Quantum electro-dynamics QED
Hyperfine structure
≙ nuclear effects