Intro

Mittwoch, 2. November 2022 12:48

What is the reduced mass and why is it interesting?

Reality: e^- p^+ bound Coulomb system

[see sun - earth = same: force $\propto \frac{1}{r^2}$]

Math: 1 body in a $\frac{1}{r}$ potential:

$\Rightarrow$ mass of orbiting body

Reality: finite mass of center (proton; sun) $\Rightarrow$ both particles orbit around the common center of gravity / mass

$\downarrow$

$\Rightarrow$ real units: can be taken into account by reduced mass

$$\boxed{m_{red} = \frac{m_1 \cdot m_2}{m_1 + m_2}} \;\hat{=}\; \boxed{\frac{1}{m_{red}} = \frac{1}{m_1} + \frac{1}{m_2}}$$

original Bohr problem:

energies Balmer / Rydberg $= R_\infty \left(\frac{1}{(n_1)^2} - \frac{1}{(n_2)^2} \right)$

$n_1, n_2 \;\hat{=}\;$ principal quantum numbers

$\Rightarrow$ gross structure

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small differences between H, D

$\Rightarrow R_H \quad , R_D$

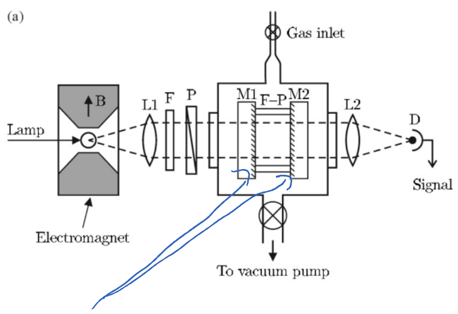
can be explained $= R_\infty \cdot \frac{m_{red}}{m_e}$ or $\frac{m_e}{m_{red}}$

Sommerfeld theory: relativistic mass increase with velocity $\quad m = \gamma m_0 \quad ; \quad \gamma = \frac{1}{\sqrt{1-\left(\frac{v}{c}\right)^2}}$

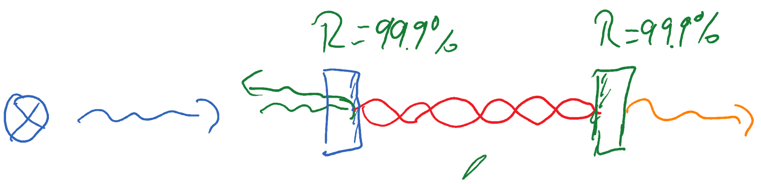
$\Rightarrow$ "fine structure" $\quad (\alpha Z)^2 \times$ smaller

$\alpha \approx 1/137$

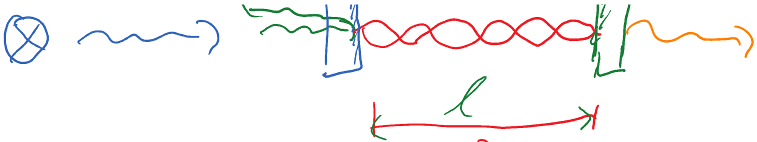
Zeeman effect



Fabry-Perot-Interferometer



$T \approx 1$ for



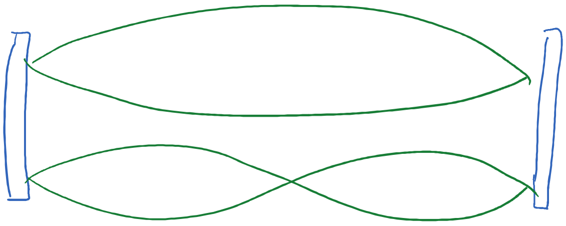
T ≈ 1 for the correct wave length

$$m \cdot \frac{\lambda}{2} = n\,l$$

standing wave ≙ a multiple of half the wavelength fits into the optical length of the resonator $= n \cdot l$

refractive index

length



$m = 1$

$m = 2$

⋮

$m = 100\,000$ or so

In reality: $l = \text{cm}$ vs $\lambda = 400\,\text{nm}$ (blue)