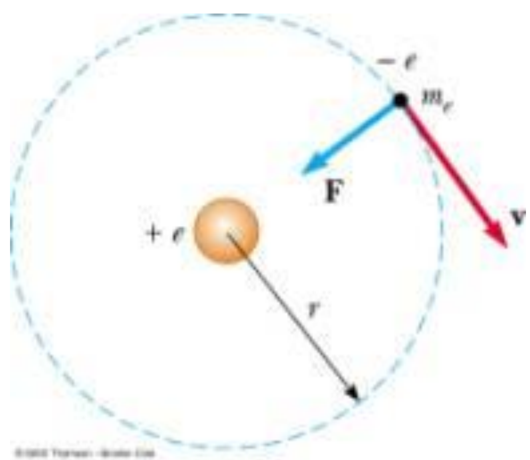
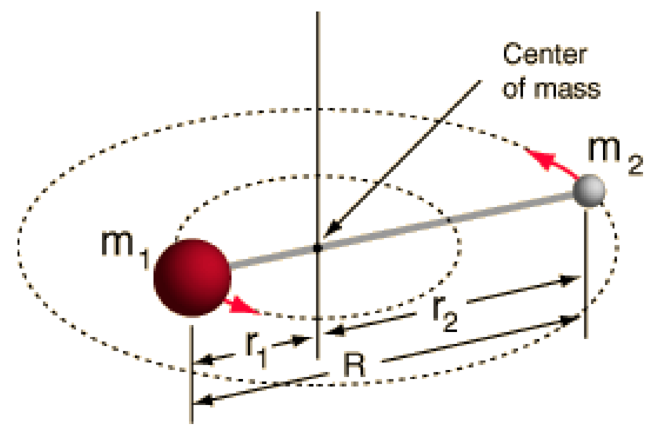
ATOMIC STRUCTURE

1. The Nuclear Atom
2. Electron Orbits
3. Atomic Spectra
4. The Bohr Atom
5. Energy Level and Spectra
6. Correspondence Principle
7. Nuclear Motion
8. Atomic Excitation
9. The Laser

NUCLEAR MOTION

• We have assumed that the H nucleus (a proton) remains stationary while the orbital electron revolves around it.
• What must actually happen is that both nucleus and electron revolve around their common center of mass.
• The CoM is close to the nucleus.
• This system is equivalent to a single particle of mass *m'* that revolves around the position of the heavier particle.





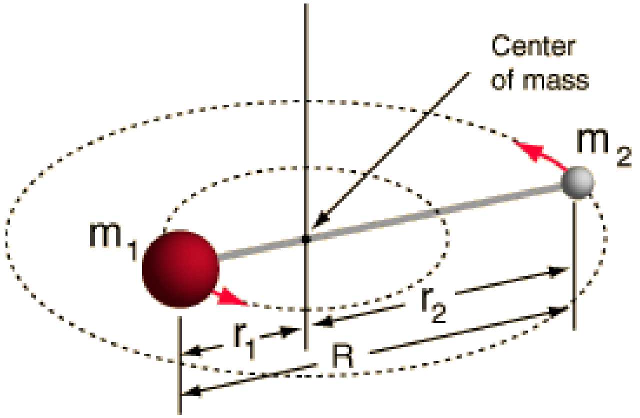
NUCLEAR MOTION

The **reduced mass** of the electron:

$$m' = \frac{mM}{m+M}$$

Taking into account the motion of the nucleus of the H atom we replace the electron with a particle of mass m'.

$$E_n = -\frac{me^4}{8\varepsilon_o^2 h^2}\left(\frac{1}{n^2}\right)$$



$$E'_n = -\frac{m'e^4}{8\varepsilon_o^2 h^2}\left(\frac{1}{n^2}\right) = \left(\frac{m'}{m}\right)\left(\frac{E_I}{n^2}\right)$$

$$\frac{m'}{m} = \frac{M}{m+M} = 0.99945$$

$$R = 1.0973731 \times 10^7 \, m^{-1}$$

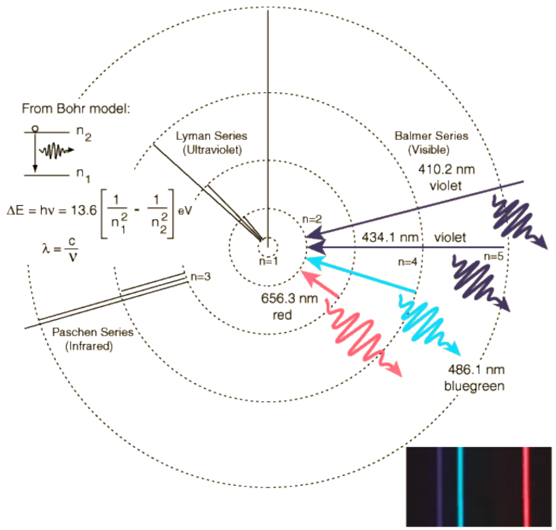
$$R' = 1.0967758 \times 10^7 \, m^{-1}$$

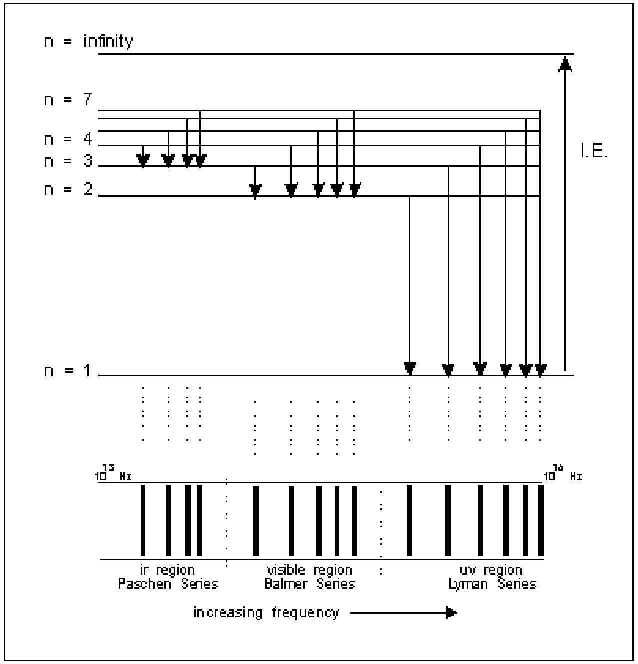
NUCLEAR MOTION

Taking the nuclear motion helped in the discovery of **deuterium** (isotope of H).

Spectral lines of deuterium are all shifted slightly to shorter wavelengths in comparison with H spectral lines.

H_α (for H, n=3 → n=2) = 656.3 nm
H_α (for D, n=3 → n=2) = 656.1 nm





NUCLEAR MOTION

Remember…

The nuclear mass affects the wavelengths of spectral lines.