

Lecture summary

- Metric prefix
- Atomic Units
- Wavefunction of the hydrogen atom
 - Radial and angular parts
 - Electron density at the origin
- Isotope shift:
 - Nuclear mass shift
 - Nuclear volume shift, a.k.a. field shift

Homework

1. Textbook Exercise (2.4) Hydrogen.
2. Do the above problem for the 2p state. What is the ratio between the probability of finding the 2p electron inside the proton and that of the 1s electron?
3. **Volume effect** in isotope shift. Model the proton as a sphere of uniform charge distribution with a radius $r_b = 1.0$ fm. How much does the finite radius of the proton modify the frequency of the 1s – 2p transition in the H atom? In other words, what is the frequency difference between a real H atom ($r_b = 1.0$ fm) and an imaginary H atom with a point-like proton ($r_b = 0$ fm)?

Reading Assignments:

Making waves, Charles Townes, Nature **432**, 153 (2004).

How big is the proton? Helen S. Margolis, Science 339, 405 (2013).

Proton structure from the measurement of 2S-2P transition frequencies of muonic hydrogen. Aldo Antognini et al., Science 339, 417 (2013).