PHYS 3313 – Section 001
Lecture #23

Wednesday, April 19, 2017
Dr. Jaehoon Yu

- Intrinsic Spin
- Equipartition Theorem
- Quantum Distributions

Announcements

- Reminder: Homework #5
  - CH6 end of chapter problems: 34, 46 and 65
  - CH7 end of chapter problems: 7, 9, 17 and 29
  - Due Monday, Apr. 24
- Reminder: Reading assignments
  - CH7.6 and the entire CH8
- Final Exam
  - In class, Monday, May 8
  - Comprehensive exam – covers CH1.1 through what we finish today (CH8?)+ math refresher
  - BYOF
- Research presentation deadline is 8pm, Sunday, April 23
- Research paper deadline is Wednesday, April 26
- Reminder: Quadruple extra credit
  - Colloquium TODAY in UH108
  - Speaker: Dr. Nigel Lockyer, Director of Fermilab

Presentation Judging Guidelines

- Contents of the presentation: 60
  - Inclusion of all important points as mentioned in the contents
  - The quality of the research and making the right points
- Quality of the presentation itself: 15
  - Does the presentation have necessary components, such as title page, outline?
  - Is the presentation coherent and to the point?
  - Are the slides high quality? Pictures in good resolution?
- Presentation manner: 10
  - Are the presenters professional?
  - Do they keep eye contact and the audience's attention?
- Q&A handling: 10
  - Do all the group members participate in Q&A?
  - Do the answers make sense and to the point?
- Staying in the allotted presentation time: 5
  - Did the presentation stay within the allotted time?
  - Did the answer drag along unnecessarily?
- Judging participation and sincerity: 5

Intrinsic Spin

- In 1920, to explain spectral line splitting of Stern-Gerlach experiment, Wolfgang Pauli proposed the forth quantum number assigned to electrons
- In 1925, Samuel Goudsmit and George Uhlenbeck in Holland proposed that *the* ***electron must have an intrinsic angular momentum*** and therefore a magnetic moment.
- Paul Ehrenfest showed that the surface of the spinning electron should be moving faster than the speed of light to obtain the needed angular momentum!!
- In order to explain experimental data, Goudsmit and Uhlenbeck proposed that the electron must have an **intrinsic spin quantum number** $s = 1/2$.

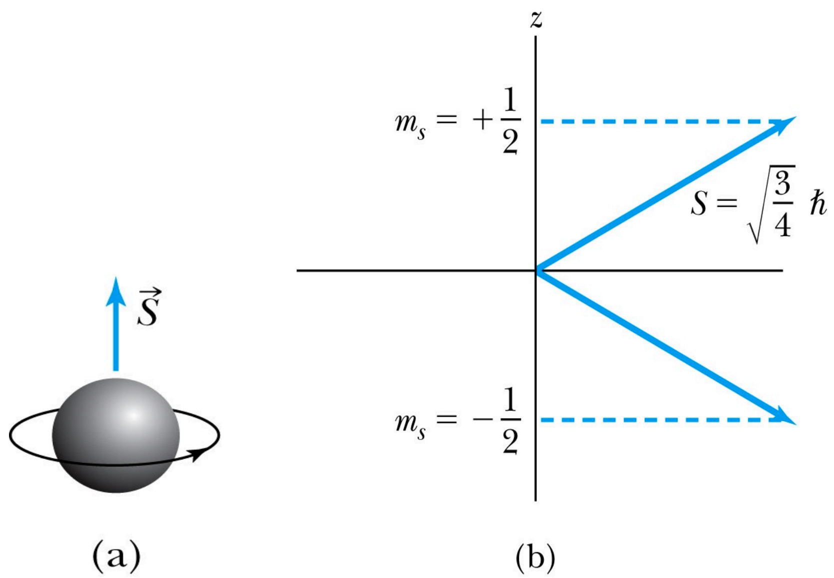
Intrinsic Spin

- The spinning electron reacts similarly to the orbiting electron in a magnetic field. (Dirac showed that this is necessary due to special relativity.)
- We should try to find L, L_z, ℓ, and m_ℓ.
- The **magnetic spin quantum number** m_s has only two values, $m_s = \pm½$.

The electron's spin will be either "up" or "down" and can never be spinning with its magnetic moment μ_s exactly along the z axis.

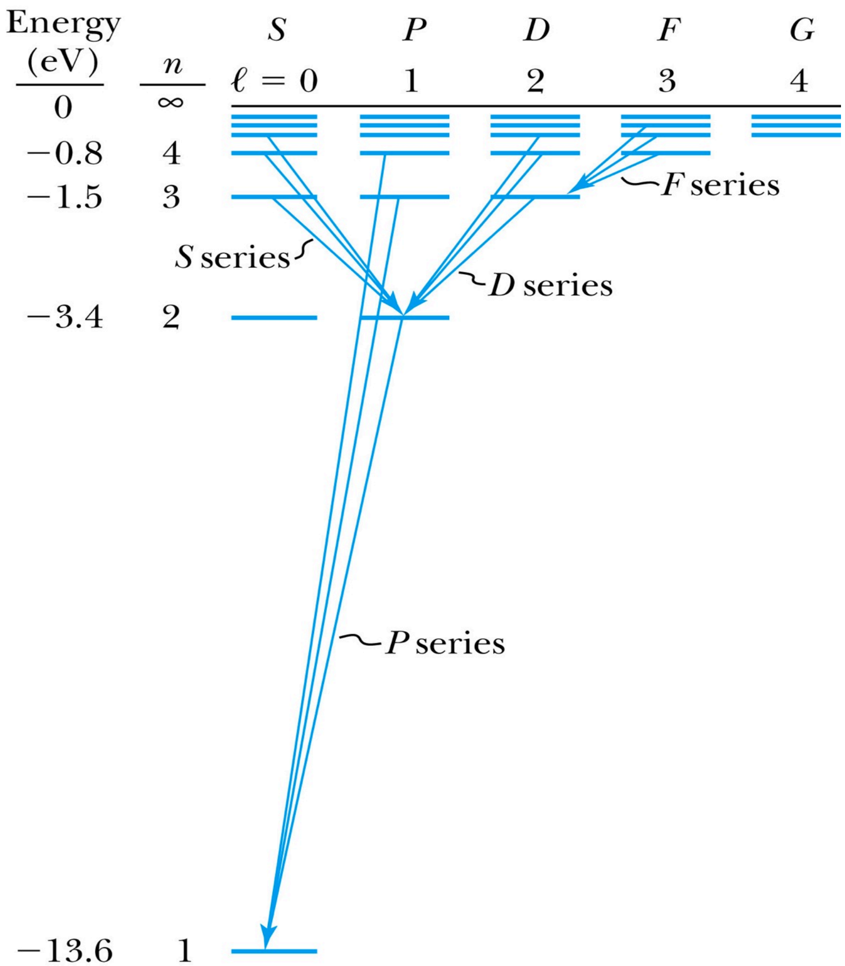
For each state of the other quantum numbers, there are two spin values

The **intrinsic spin angular momentum** vector $\left|\vec{S}\right| = \sqrt{s(s+1)}\hbar = \sqrt{3/4}\hbar$



Energy Levels and Electron Probabilities

- For hydrogen, the energy level depends on the principle quantum number *n*.



- In ground state an atom cannot emit radiation. It can absorb electromagnetic radiation, or gain energy through inelastic bombardment by particles.

Selection Rules

- We can use the wave functions to calculate transition probabilities for the electron to change from one state to another.

Allowed transitions: Electrons absorbing or emitting photons can change states when $\Delta\ell = \pm 1$. (Evidence for the photon carrying one unit of angular momentum!)

$$\Delta n = \text{anything}$$

$$\Delta\ell = \pm 1$$

$$\Delta m_\ell = 0, \pm 1$$

Forbidden transitions: Other transitions possible but occur with much smaller probabilities when $\Delta\ell \neq \pm 1$.