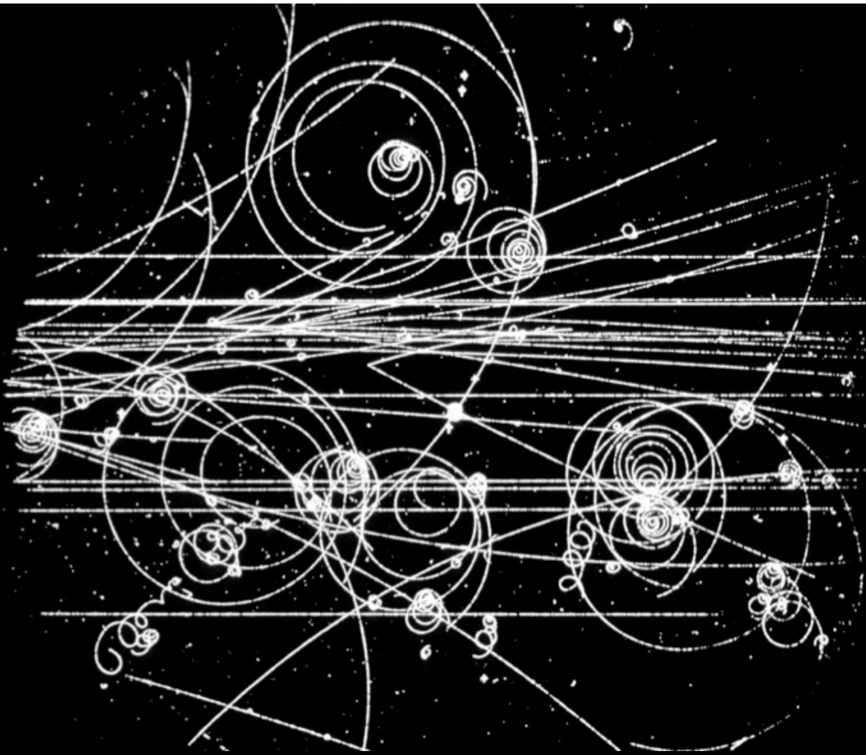
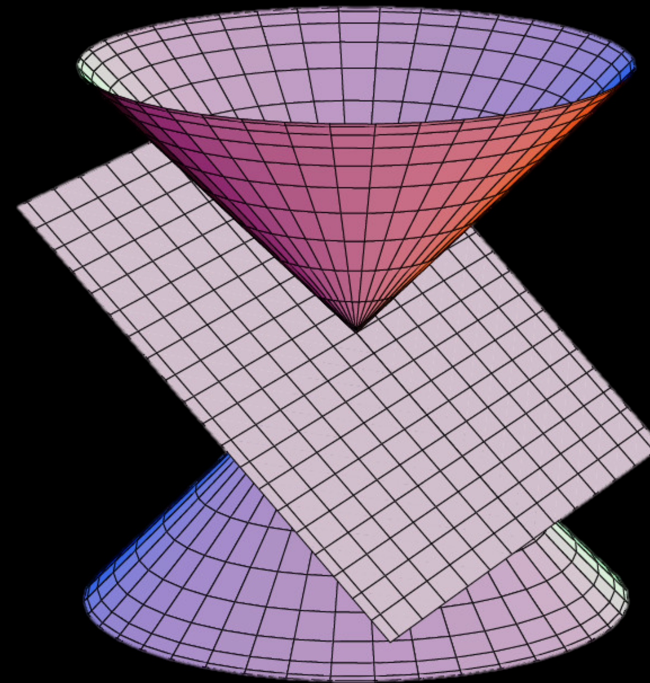




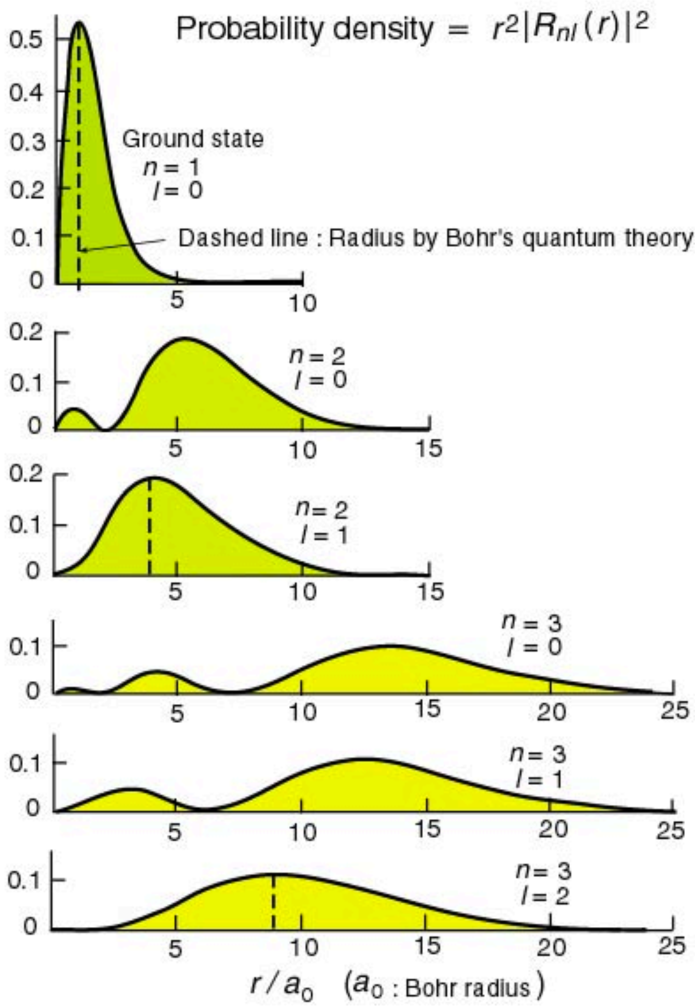
Modern Physics (Phys. IV): 2704

Professor Jasper Halekas
Van Allen 70
MWF 12:30-1:20 Lecture

Energy and Angular Momentum

- $E = -me^4/(32\pi^2\varepsilon_0^2\hbar^2) \cdot 1/n^2$
  - $n = 1, 2, 3, \ldots.$
- $L^2 = l(l+1)\hbar^2$
  - $l = 0,1,2,\ldots,n-1$
- $L_z = m_l\,\hbar$
  - $m_l = -l, -l+1, .., l-1, l$

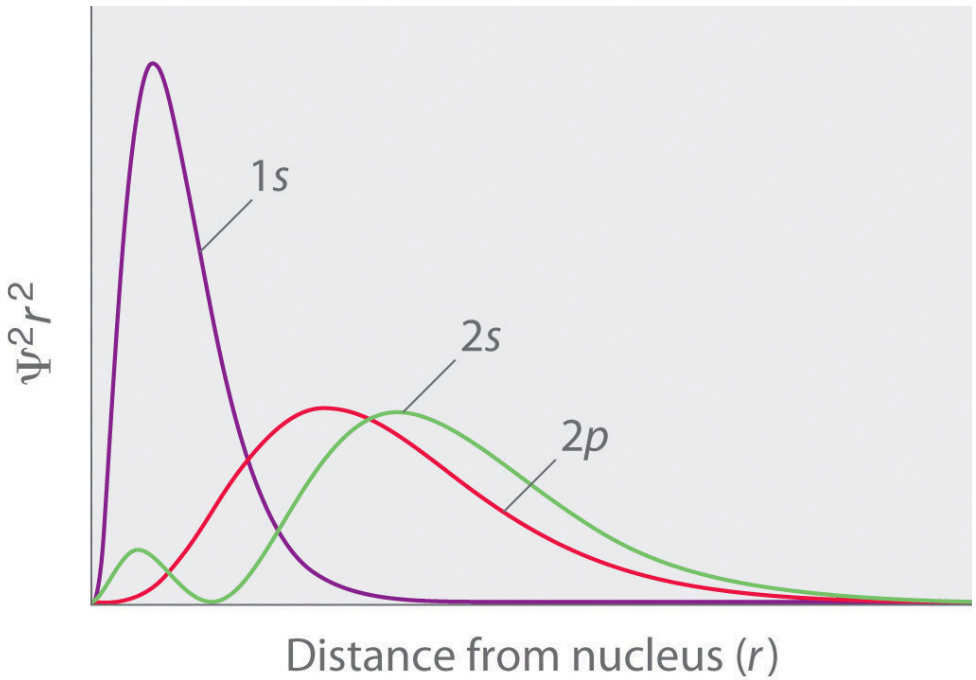
Radial Probability Distribution



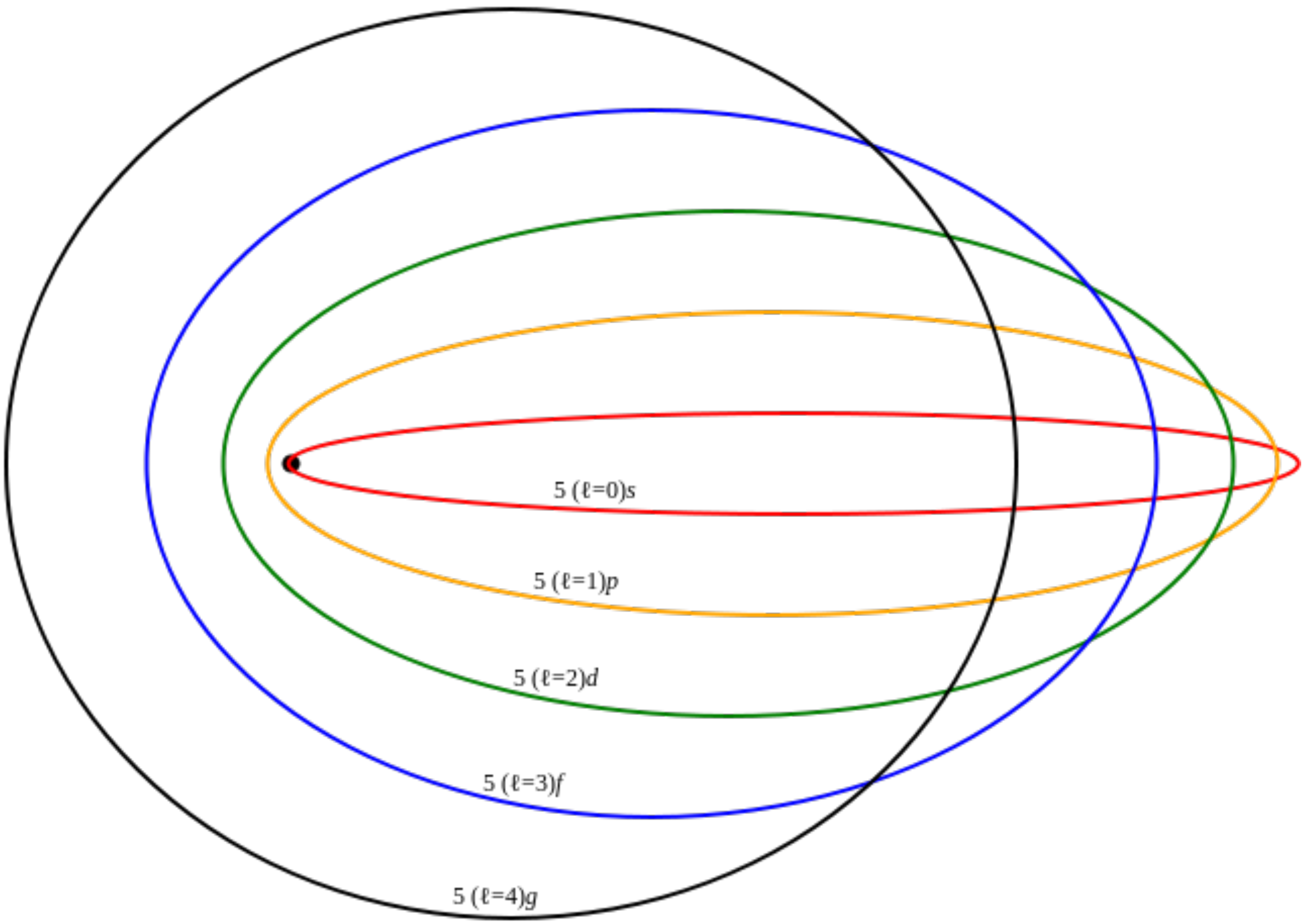
***s*: *l* = 0**

***p*: *l* = 1**

***d*: *l* = 2**



Classical Orbits and Angular Momentum



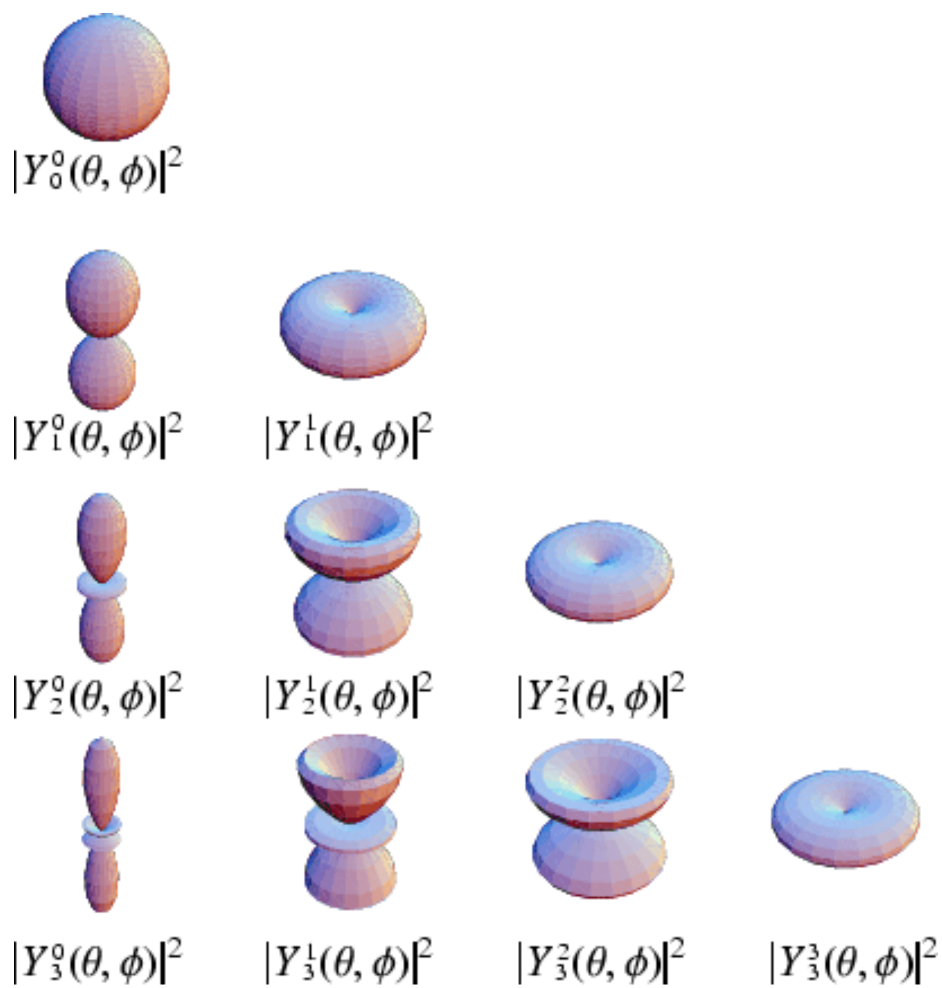
Angular Probability Density

s: $l = 0$

p: $l = 1$

d: $l = 2$

f: $l = 3$



Concept Check

- The angular part of an electron wave function is proportional to $\cos(\theta)$. Where is the electron most likely to be found?

A. Near the z-axis
B. Near the x-y plane
C. Somewhere in between

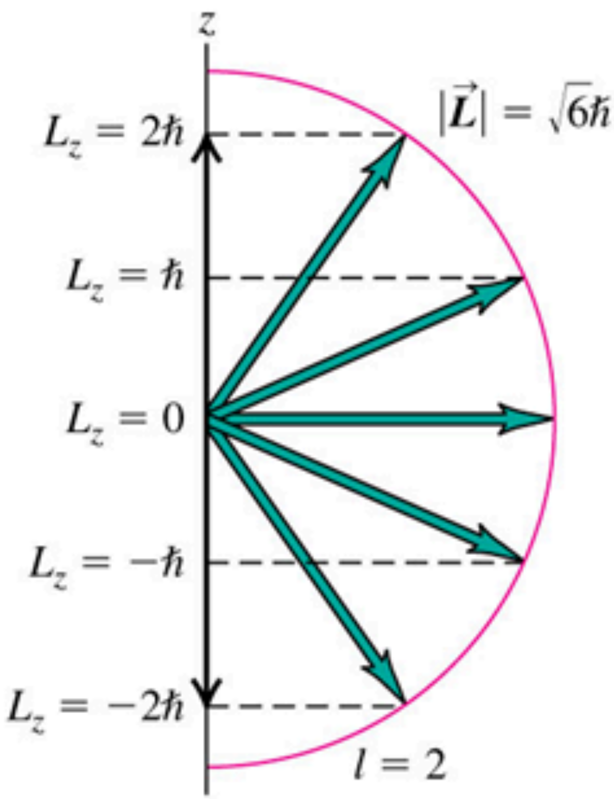
Concept Check

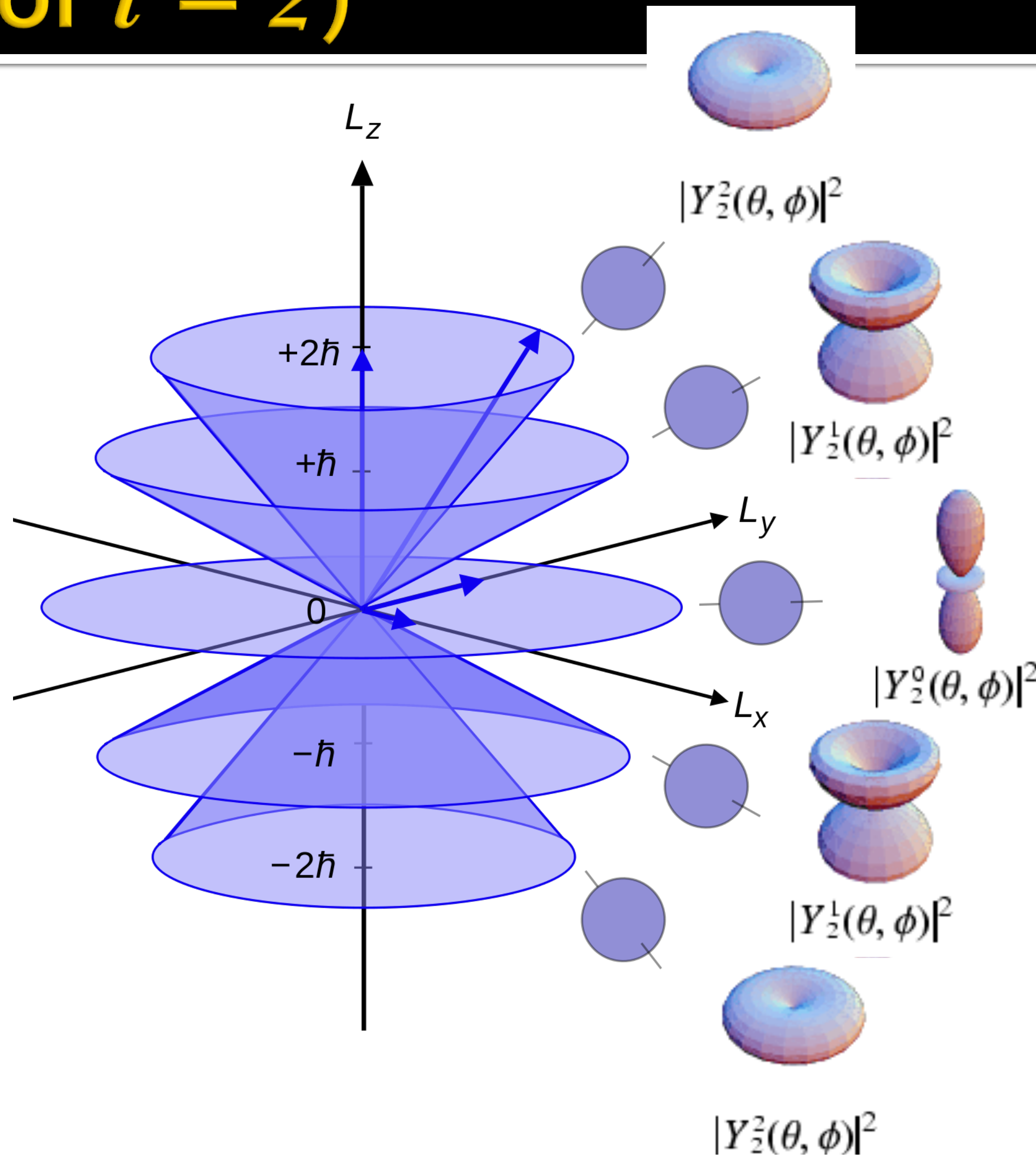
- The angular part of an electron wave function is proportional to cos(θ). Where is the electron most likely to be found?

A. Near the z-axis
B. Near the x-y plane
C. Somewhere in between

$|Y_1^0(\theta, \phi)|^2$

Angular Momentum Magnitude and Orientation (for $l = 2$)





Concept Check

- What is the magnitude of the angular momentum of the ground state ($n = 1$) of Hydrogen?

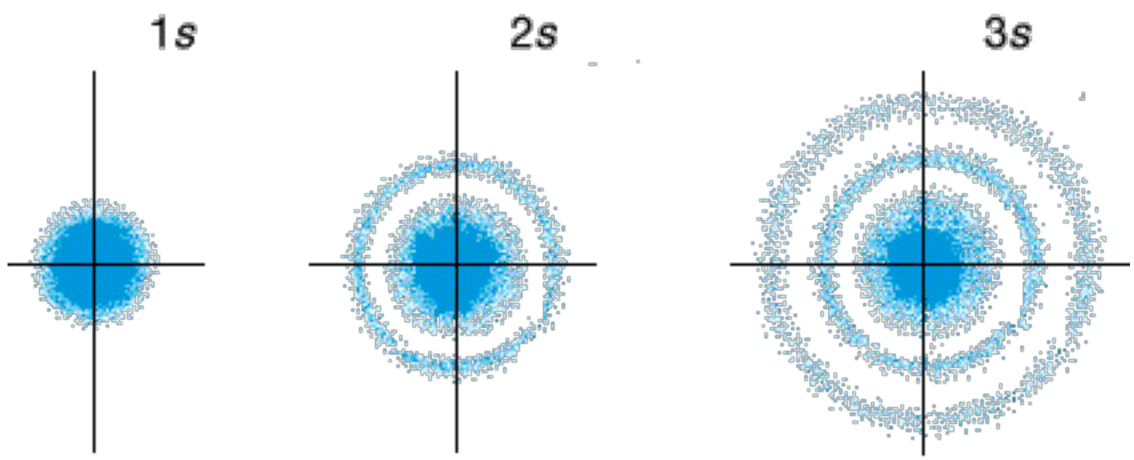
a. 0 b. $\hbar$ c. $\sqrt{2}\,\hbar$ d. not enough information

Concept Check

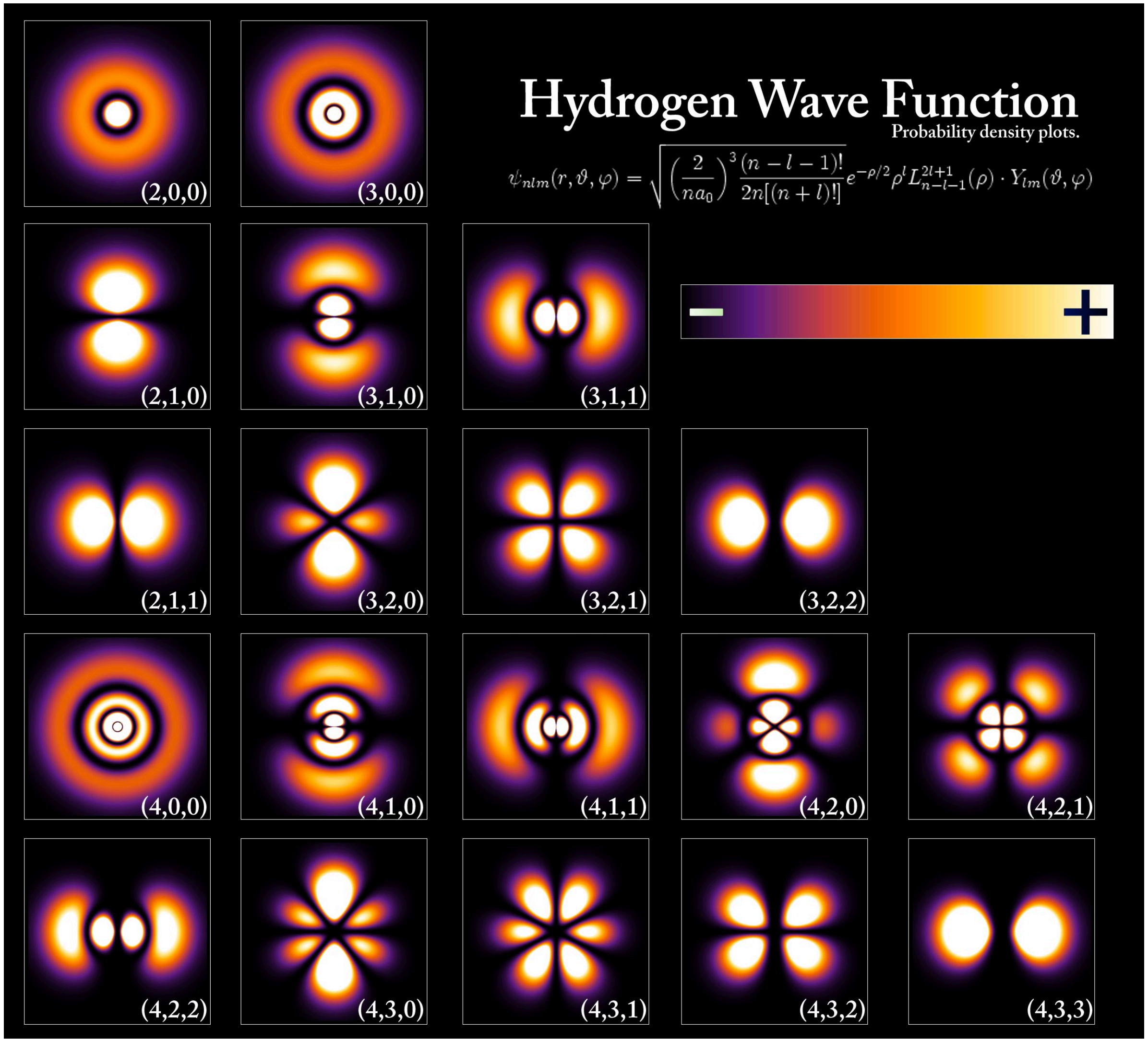
- What is the magnitude of the angular momentum of the ground state (n = 1) of Hydrogen?

a. 0 b. ħ c. √2 ħ d. not enough information

l = 0 orbitals



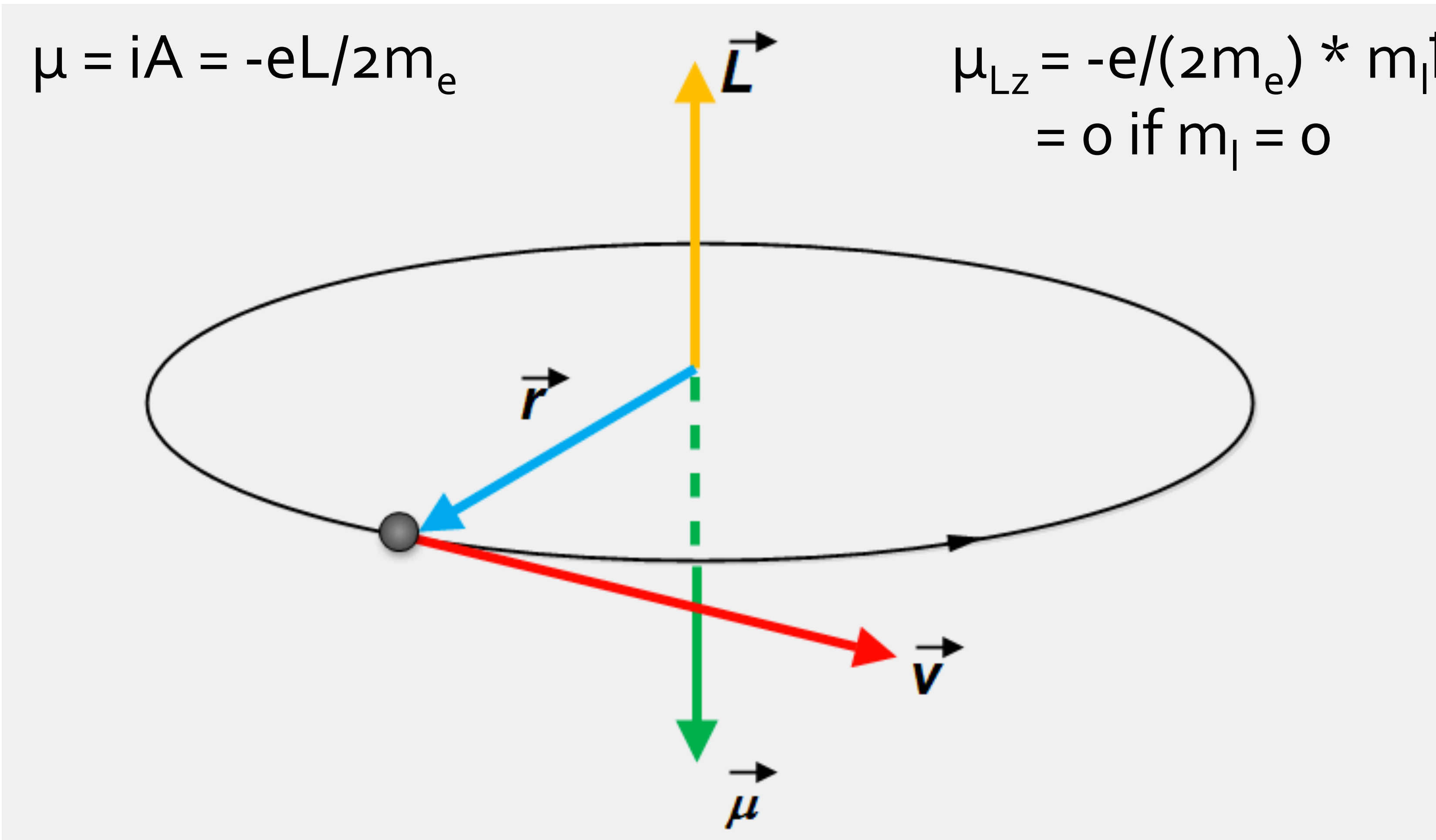
Full Hydrogen Wave Function



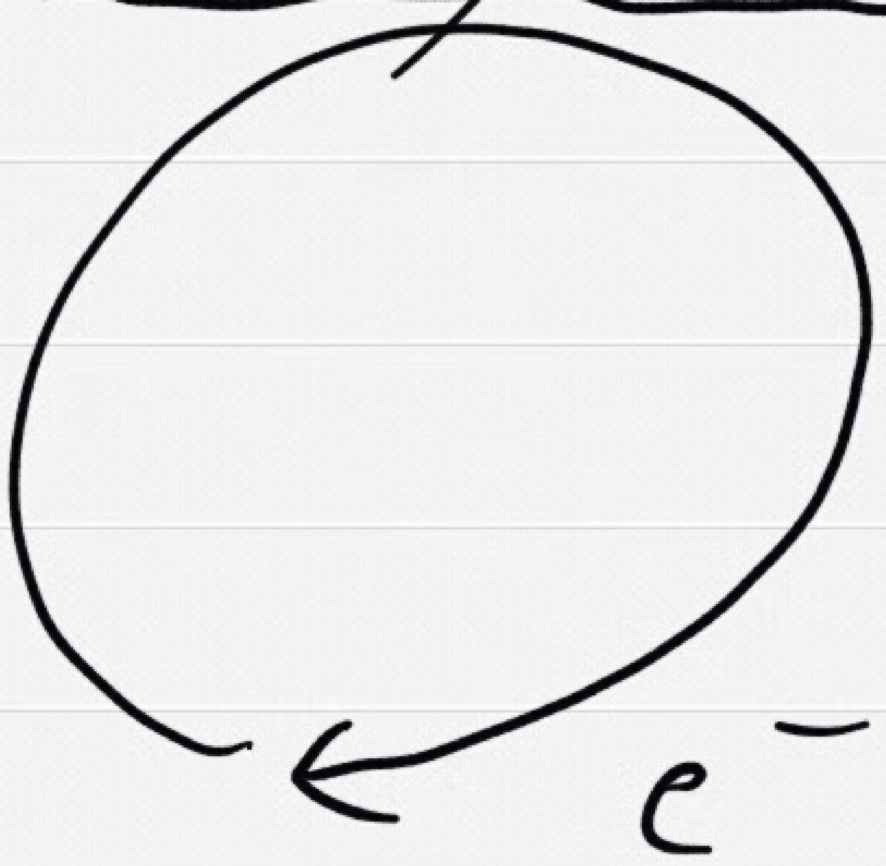
Full Wave Function Applet

- http://www.falstad.com/qmatom/

Orbital Angular Momentum and Magnetic Moment



Magnetic Moment



$\mu = iA$

$i = -e/t \qquad t = 2\pi r/v$

$$= \frac{2\pi r^2 m_e}{m_e v r}$$

$$= 2\pi r^2 m_e / L$$

$i = -eL/(2\pi r^2 m_e)$

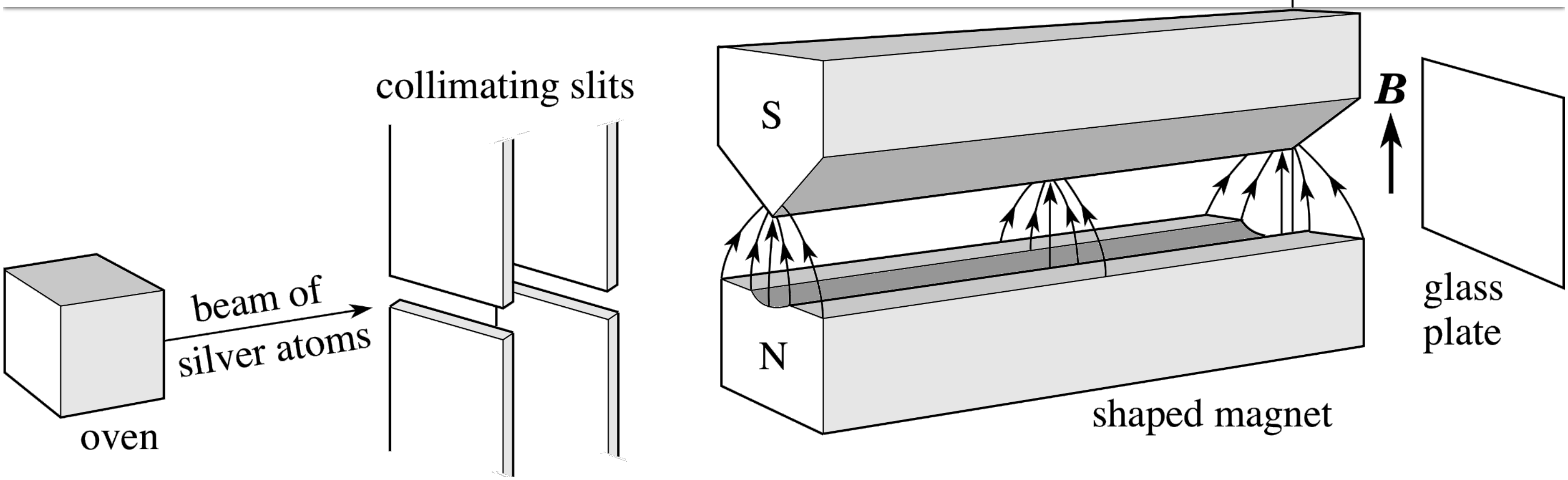
$iA = -eL/(2m_e)$

$$\mu_{L_z} = -eL_z/2m_e = \frac{-e m_\ell \hbar}{2m_e}$$

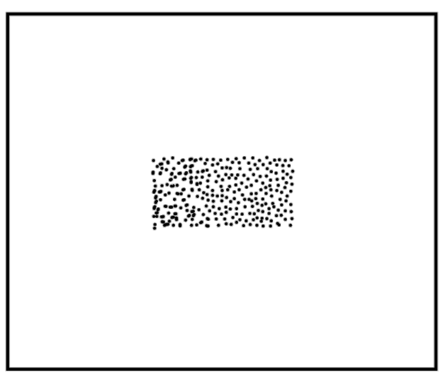
$$= -\mu_B m_\ell$$

w/ $\mu_B = e\hbar/2m_e$ = "Bohr Magneton"

Stern-Gerlach Experiment

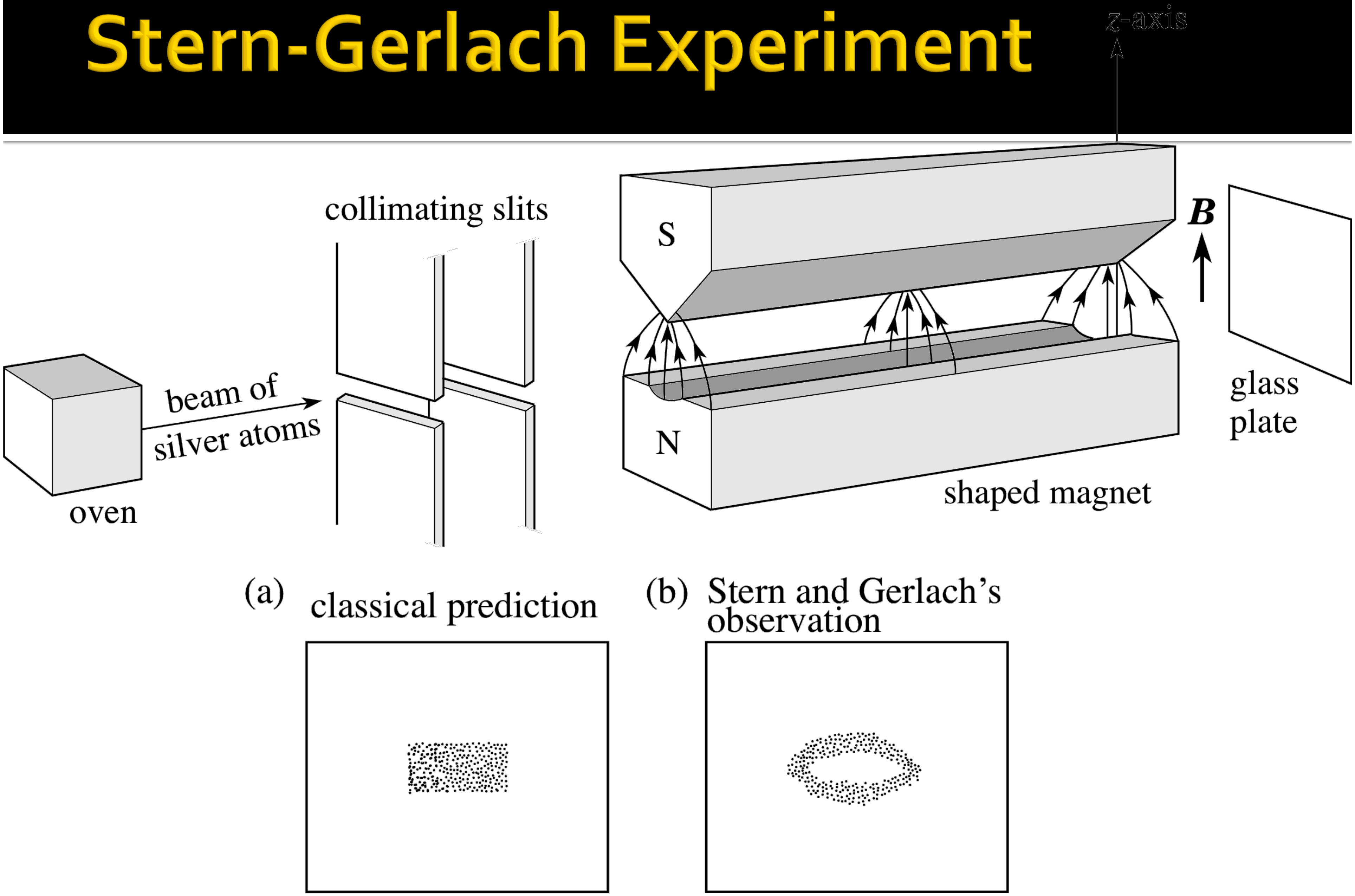


(a) classical prediction



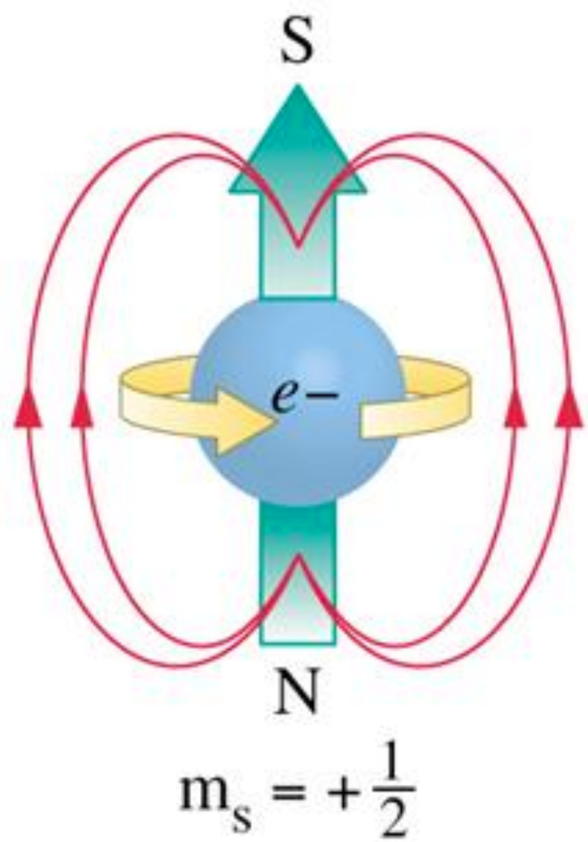
Ground state
of outer electron
of silver (2s) has
$l = 0$, so no
deflection
expected

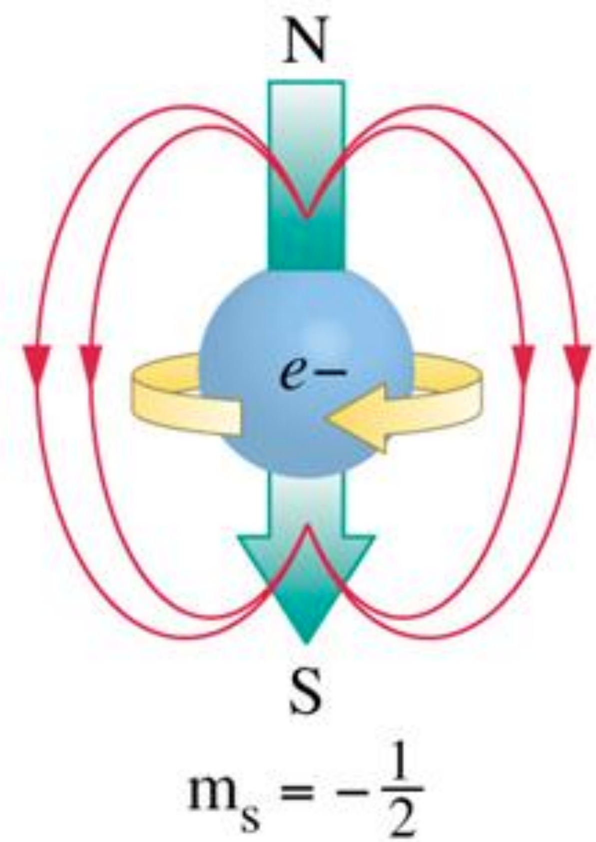
Stern-Gerlach Experiment



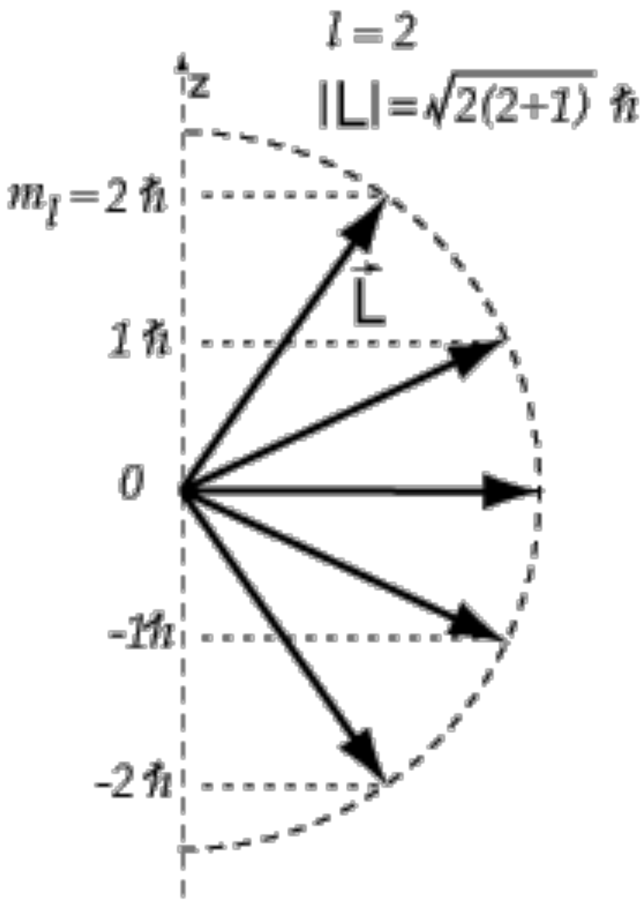
Spin Angular Momentum and Magnetic Moment

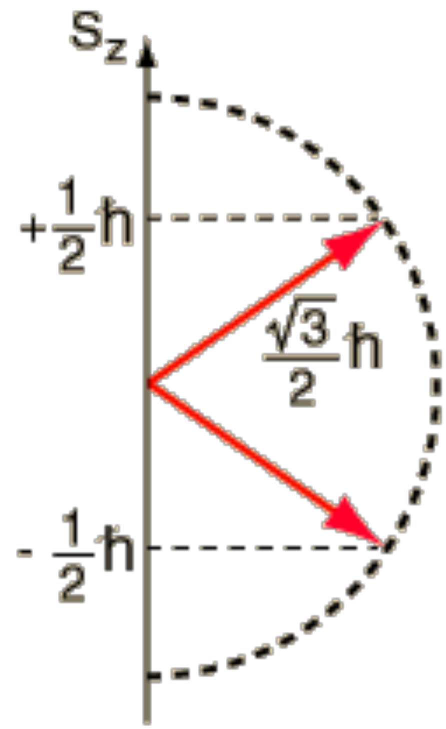
$\mu_{Sz} = -e/(m_e) * m_s\hbar$





Spin and Orbital Angular Momentum





Energy and Angular Momentum

- $E = -me^4/(32\pi^2\varepsilon_0^2\hbar^2) \bullet 1/n^2$
  - $n = 1, 2, 3, \ldots.$
- $L^2 = l(l+1)\hbar^2$
  - $l = 0,1,2,\ldots,n-1$ (n values)
- $L_z = m_l\,\hbar$
  - $m_l = -l, -l+1, .., l-1, l$ (2l +1 values)
- $S_z = m_s\,\hbar$
  - $m_s = -1/2, 1/2$ (2 values)

Concept Check

- How many different sets of quantum numbers (n, l, m_l, m_s) are possible for n = 3?

A. 5
B. 6
C. 10
D. 16
E. 18

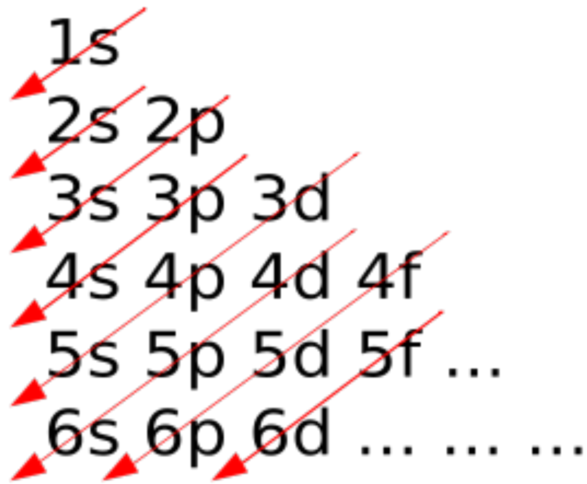
Concept Check

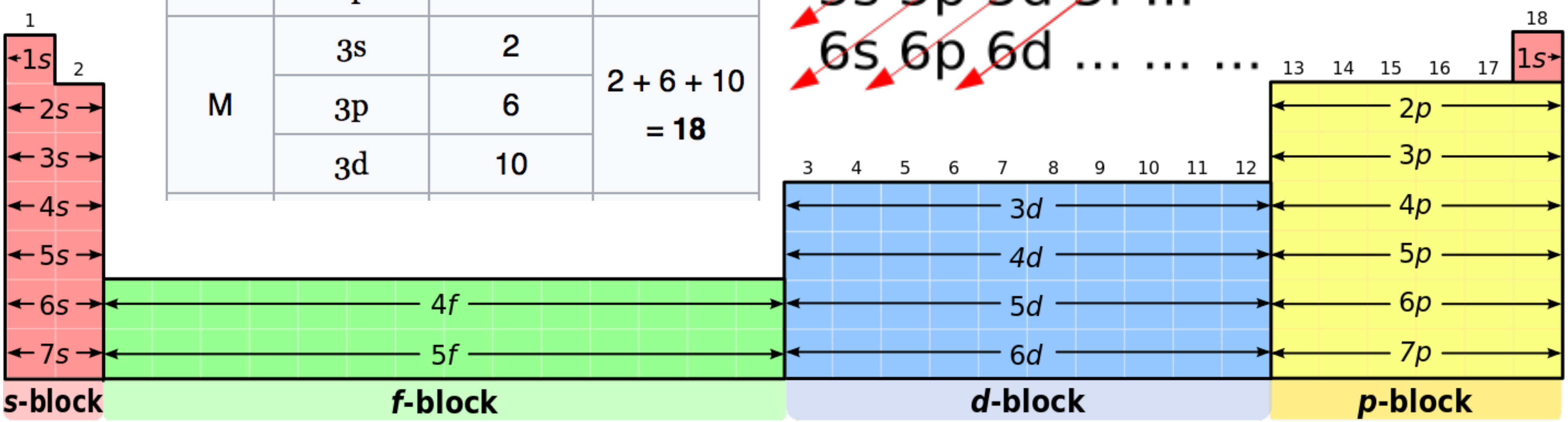
- How many different sets of quantum numbers ($\boldsymbol{n}$, $\boldsymbol{l}$, $\boldsymbol{m_l}$, $\boldsymbol{m_s}$) are possible for n = 3?

A. 5
B. 6
C. 10
D. 16
E. 18

Number of Possible States

Shell name	Subshell name	Subshell max electrons	Shell max electrons
K	1s	2	**2**
L	2s	2	2 + 6 = **8**
	2p	6	
M	3s	2	2 + 6 + 10 = **18**
	3p	6	
	3d	10	





NOT on Midterm II

- Sections
  - 6.7 Correspondence Principle
  - 7.7 Energy Levels and Spectroscopic Notation
  - 7.8 Zeeman Effect
  - 7.9 Fine Structure

- Topics
  - Reduced Mass
  - Franck-Hertz
  - Selection Rules