Physics 100 - October 15, 2007

- Hope to be able to return Exams on Wed.
- Presentation Topic Preferences

Last time ... Way back when

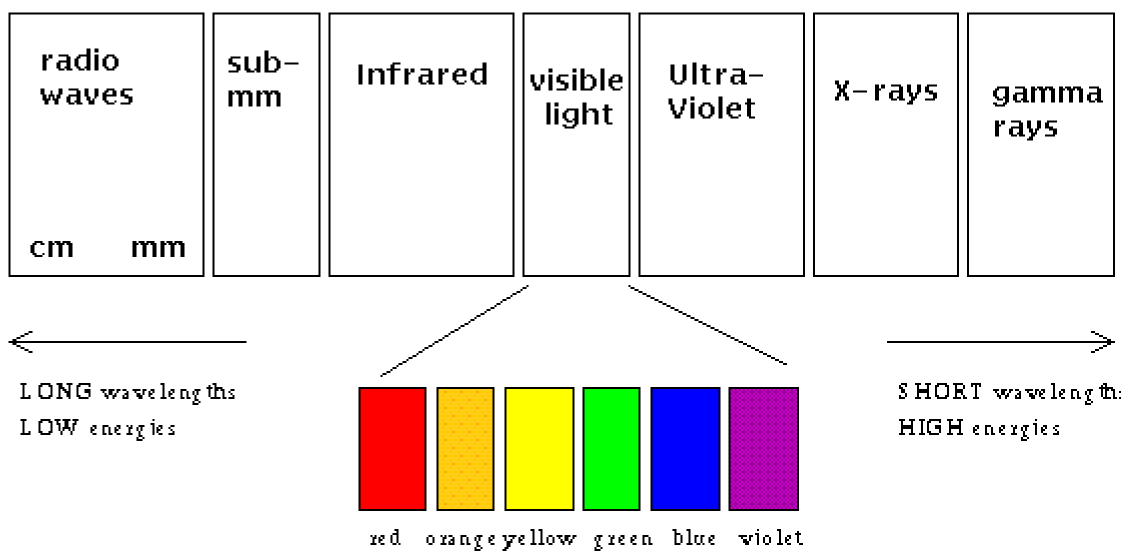
Let there be ...

$$\oint_S \vec{E}\bullet d\vec{a} = \frac{Q_{encl}}{\varepsilon_o}$$

$$\oint_S \vec{B}\bullet d\vec{a} = 0$$

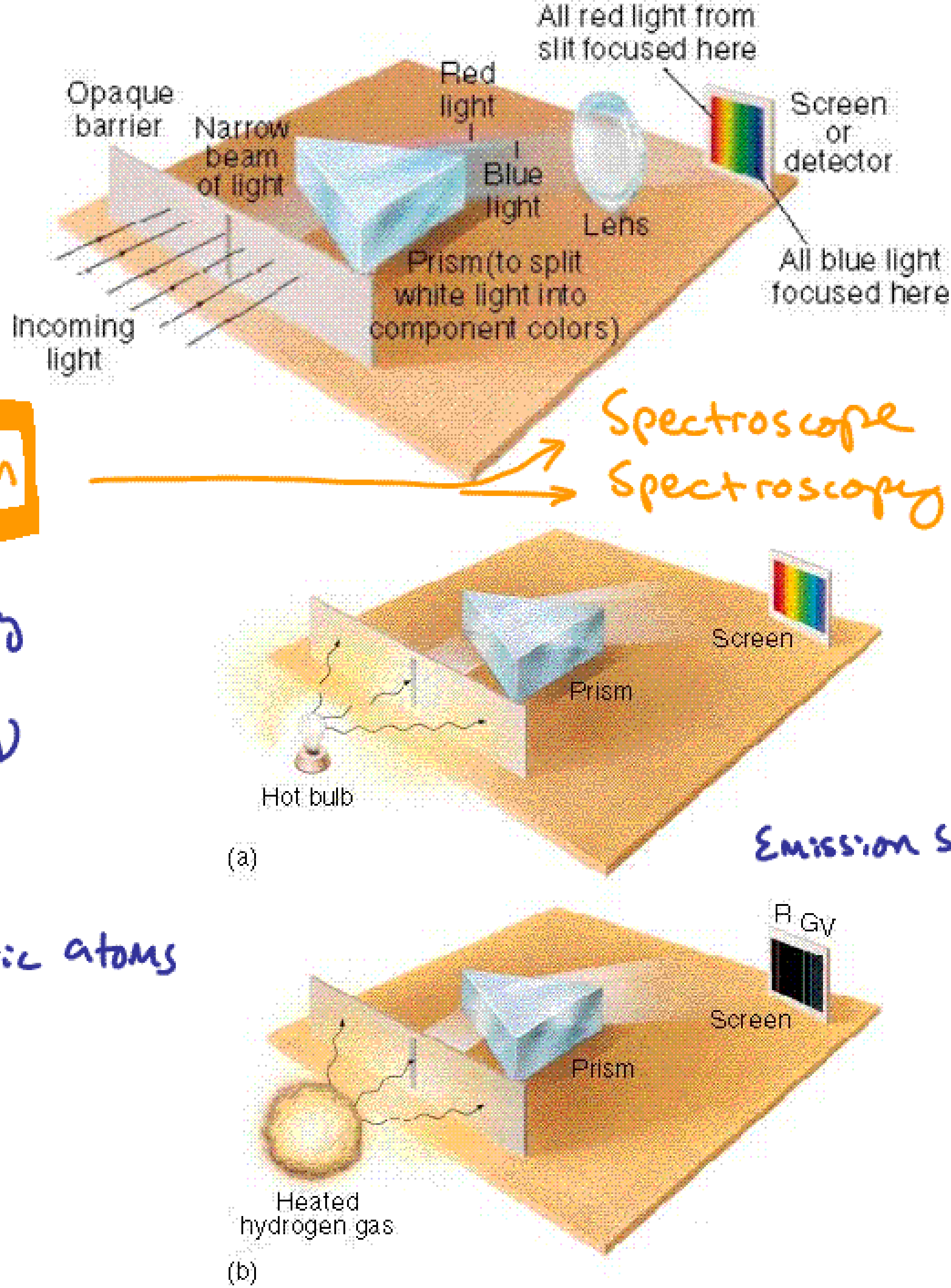
$$\oint_C \vec{E}\bullet d\vec{l} = -\frac{d\int_S \vec{B}\bullet d\vec{a}}{dt}$$

$$\oint_C \vec{B}\bullet d\vec{l} = \mu_o I_{encl} + \mu_o \varepsilon_o \frac{d\int_S \vec{E}\bullet d\vec{a}}{dt}$$



CAN split light to study as a function of frequency (ν) [or color]

→ **Spectrum** → Spectroscope, Spectroscopy

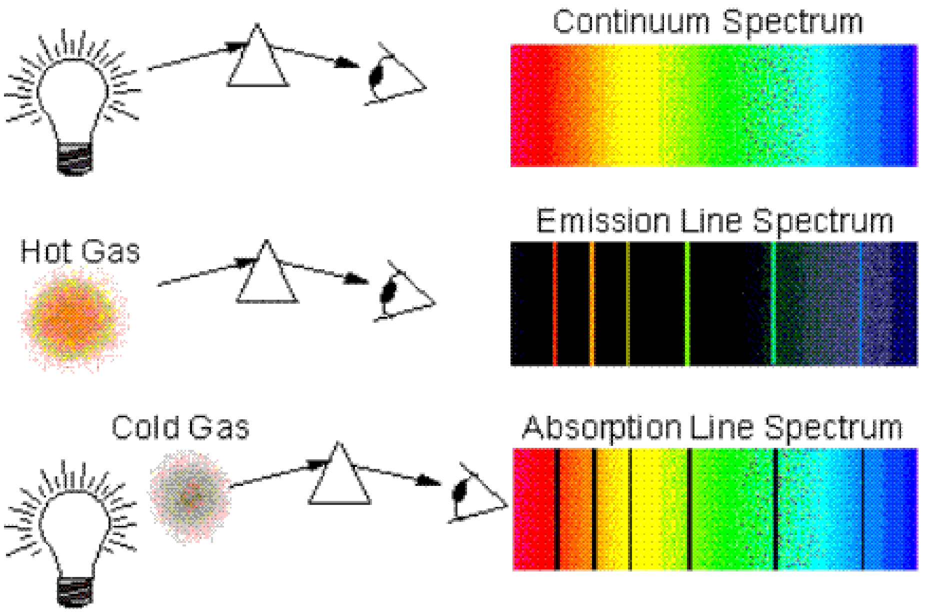


Light from many atoms ⇒ continuous ν

Emission Spectrum

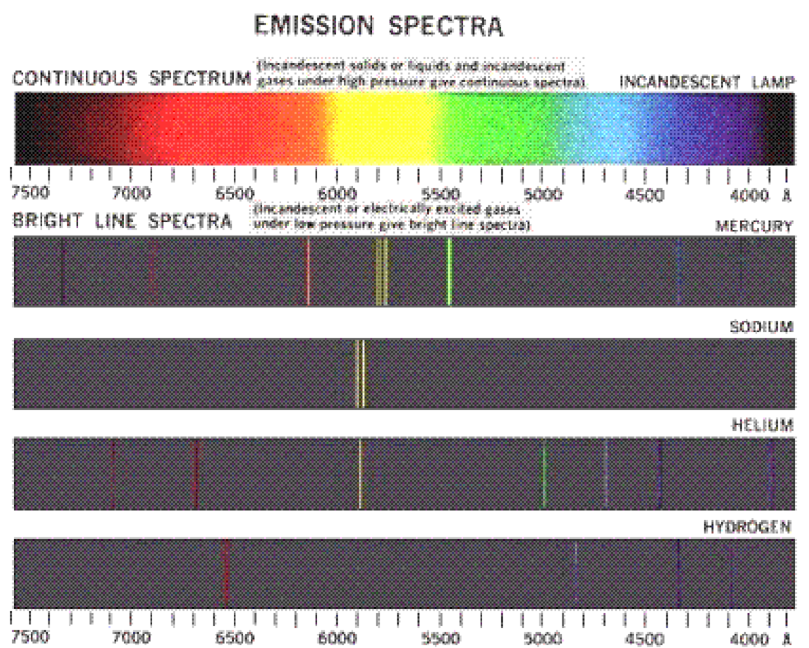
Light from specific atoms ⇒ discrete ν

Emission vs, Absorption



Different Atoms

→ different discrete frequency pattern



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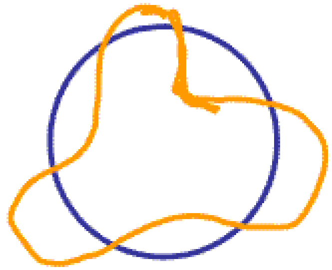
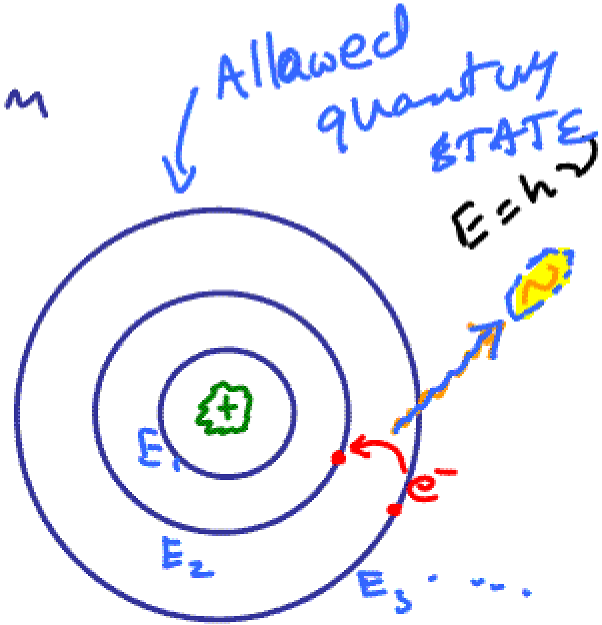
Atomic Fingerprinting

Bohr model of atom

Bohr

Energy quantum # 1, 2, 3 ...





can think of de Broglie matter wave interfering with itself → discrete orbits

- Circular orbit ... held in place by electric attraction
- discrete orbits ⇒ Discrete radii
  Discrete energies
- Photons emitted or absorbed by e^- making instantaneous transitions between orbits

Energy difference between orbits = Energy of Photon

Werner Karl Heisenberg

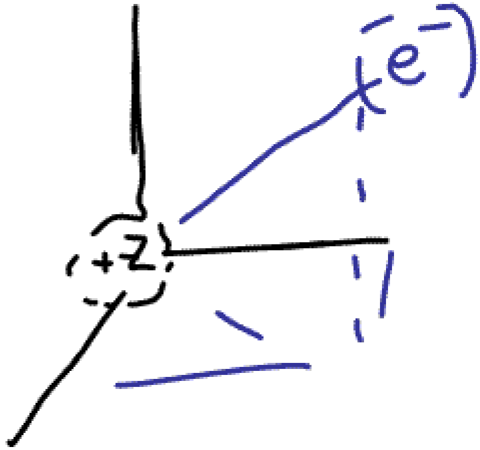
Erwin Rudolf Josef Alexander Schrödinger

$$-\frac{\hbar^2}{2m}\frac{d^2\psi(x)}{dx^2} + V\psi(x) = E\psi(x)$$

Schrödinger's Equation

Just so you've seen it

general wave equation for matter waves



put e⁻ in spherical symmetry situations

Put in Schr. eqn
Solve it

→ Particular Allowed Spatial STAtes for e⁻

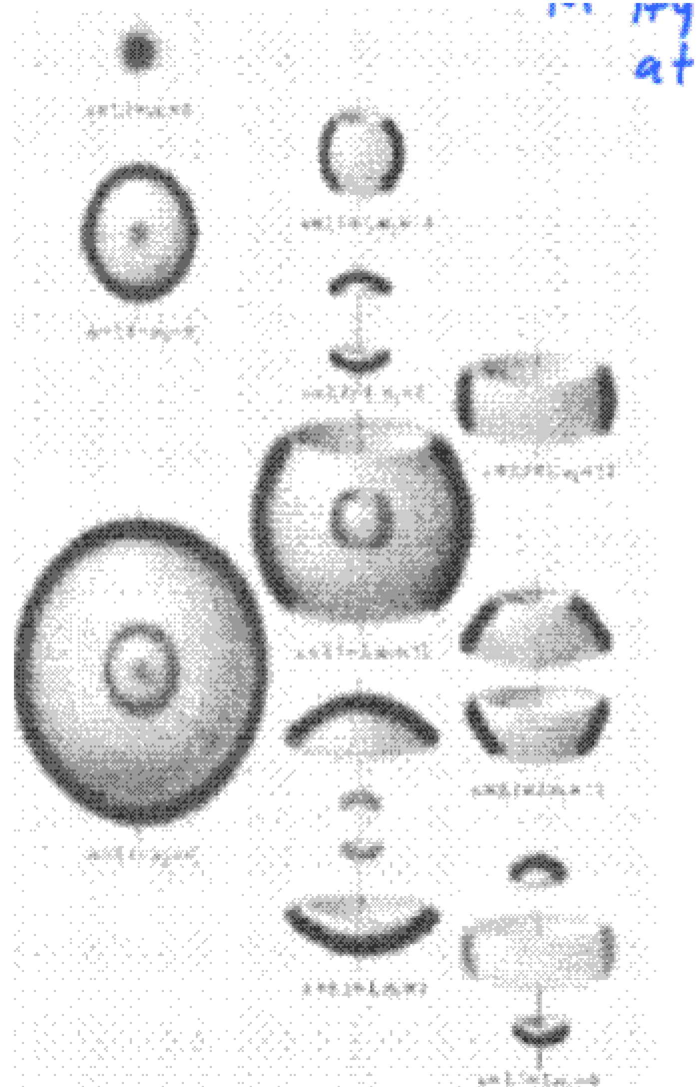
→ Paticular energies Allowed

Allowed STATES
orbitals
Allowed quantum STATES

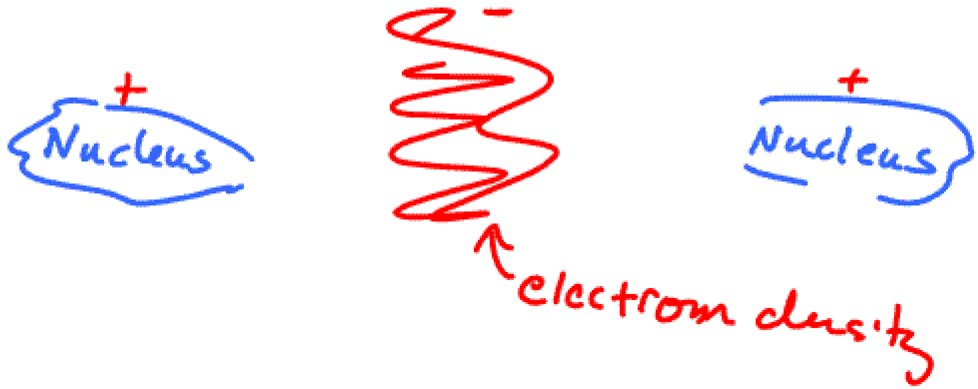
Schrödinger's eqn
soln to H atom
yields different possible
quantum states

different 3d shapes
and energies

AT right are sketches
of some of these
orbitals



chemical Bond



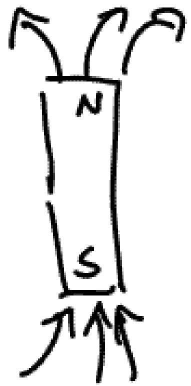
To understand chemistry

understand how e^- are arranged among available quantum state

Intrinsic spin (particle promiscuity)

imagine e^- is spinning ball of charge

spinning charge creates magnetic field



magnetic field lines

Stern-Gerlach discovered that particles can act like little magnets

...Said to have "spin"

Particle spin is quantized

Think of it as if particles come as magnets of selected strengths ... multiple of ½ (value for e^-)

$$\text{Spin} = 0,\ 1/2,\ 1,\ 3/2,\ 2\ \ldots\ldots$$

⟶ strength of the little particle magnet

Stern-Gerlach experiment — 1922

n
ℓ

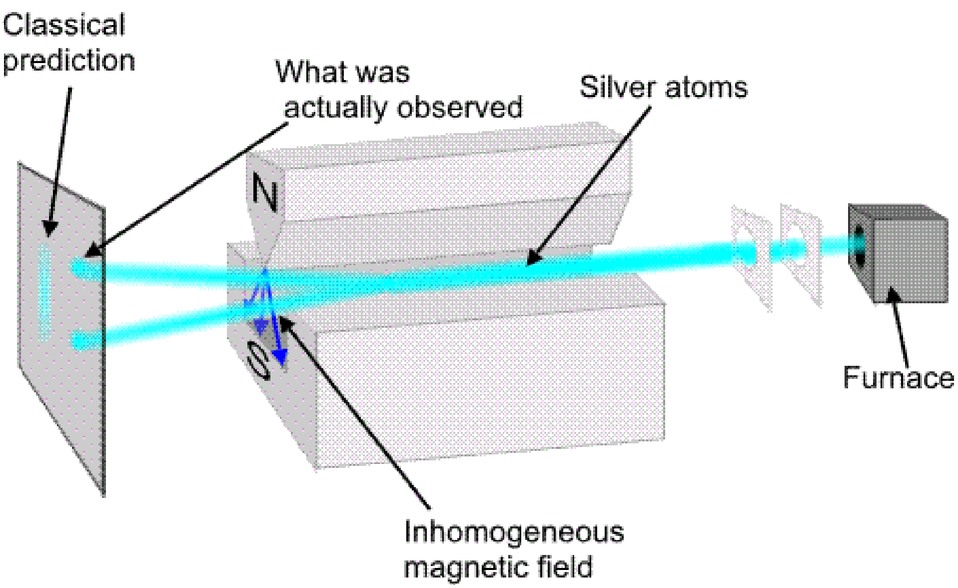


Diagram from Wikipedia

Otto Stern

-wikipedia

"If this nonsense from Bohr will prove to be right we will quit physics."
(Stern vowed in 1913)

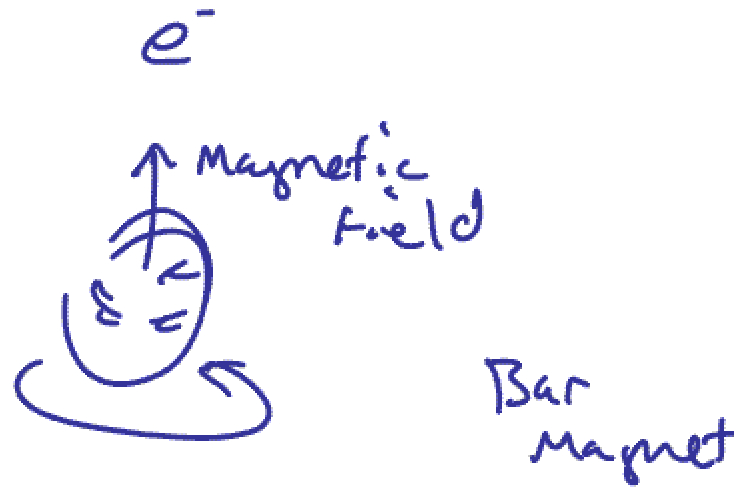
as quoted in Phys. Today Dec 03

Walther Gerlach

from phys Today article
(Dec. 03)

Intrinsic

Spin



Spin is quantized

$0, \frac{1}{2}, 1, \frac{3}{2}, 2 \dots$

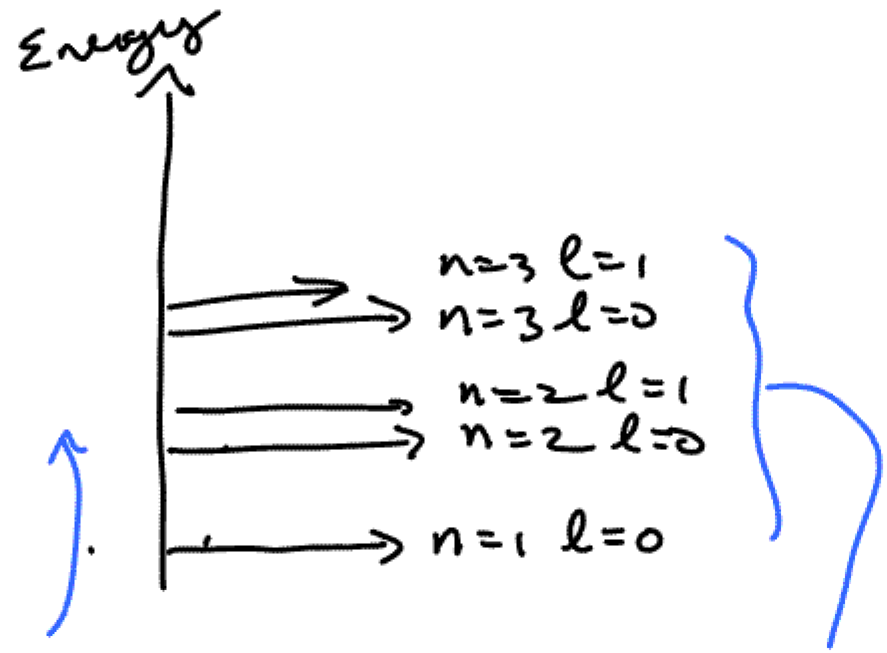
Integer Spin $0, 1, 2 \dots$ Boson

½ integer Spin $\frac{1}{2}, \frac{3}{2}, \frac{5}{2} \dots$ Fermion

2 fermions → cannot occupy the same quantum state

2 bosons → can occupy the same quantum state

Energies from Schr. eqn



Fill from low energy to high energy

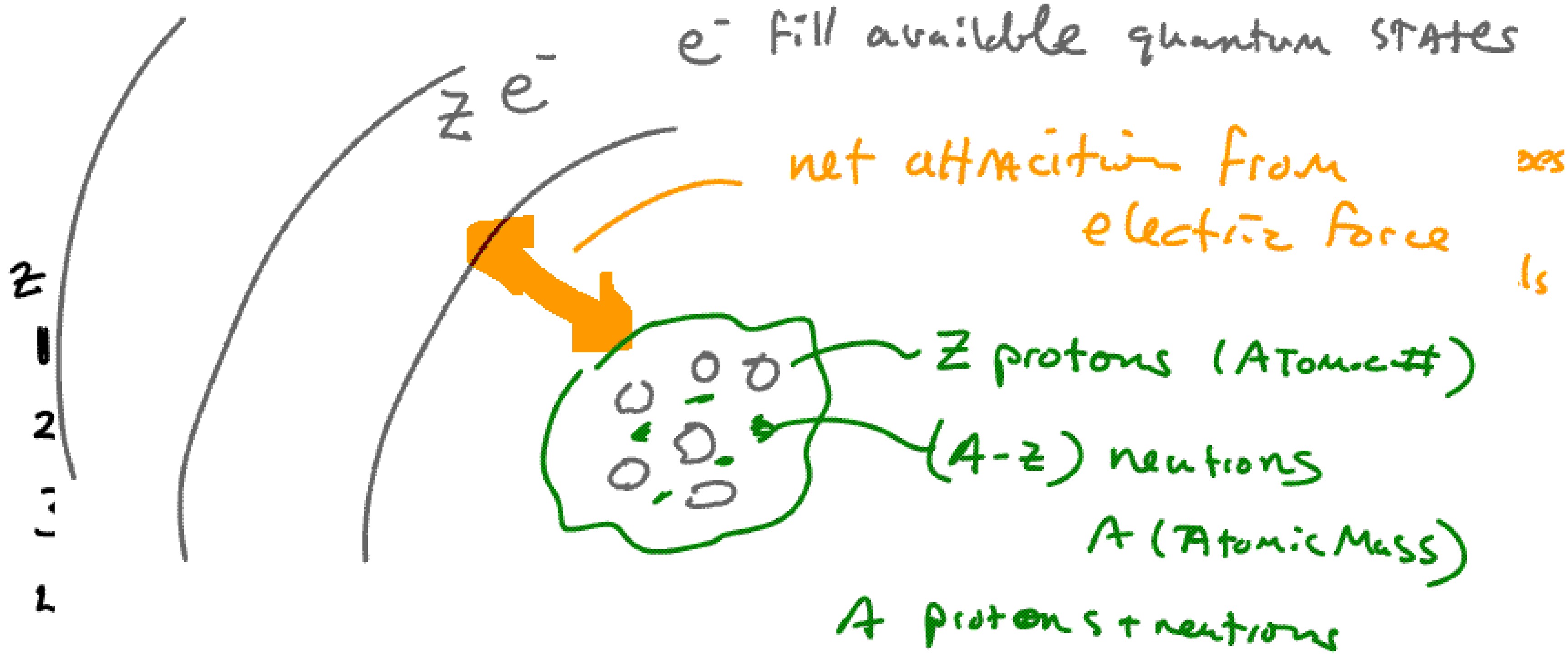
possible quantum states for e⁻ to occupy according to Schr. eqn.

Z	Energy	1	2	2			3
	L	0=S	0=S	1=P			S
1	H	↑	—	—	—	—	—
2	He	↑↓					
3	Li	↑↓	↑				
4	Be	↑↓	↑↓				
5	B	↑↓	↑↓	↑			
11	Na	↑↓	↑↓	↑↓	↑↓	↑↓	↑

as Z increases, so does # of electrons. Fill available quantum levels lowest to highest

How electrons fill energy levels in ATom

Columns are Available quantum states from Soln of Schr. eqn.



The way in which orbitals are filled gives periodicity to atomic characteristics as Z increases