

Physics 100 - February 18, 2009

■ EXAM I takes place Monday, March 2
in Hoyt during regular class time

■ Material - from start of course up to
Bohr atom, atomic spectra

Quantum Mechanics/Schr. eqn on
not covered on this exam

■ Will send out detailed list of material coverage soon

■ 3x5 inch index card, Calculator that does parts of 10

■ Q + A session on Friday, Feb. 27 ...

Bohr model of the atom (1912)

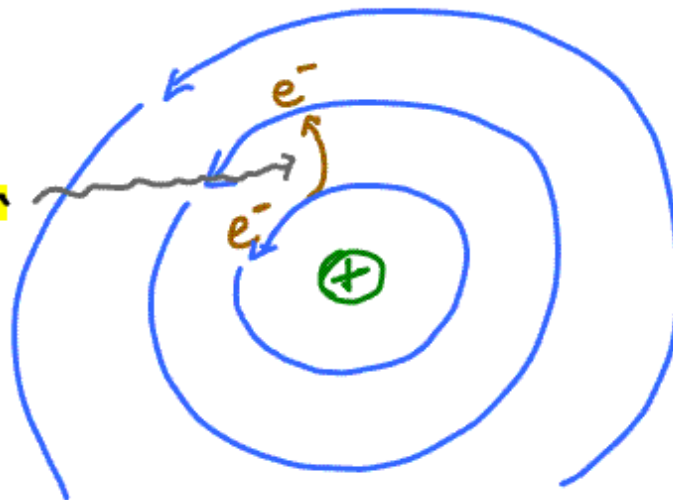


- Positive Nucleus
- electrons orbit in circles
- only particular "discrete" orbits

↑ known as quantization

- electric (Coulomb) force holds electron on circle as it orbits ... attracts electron toward Nucleus

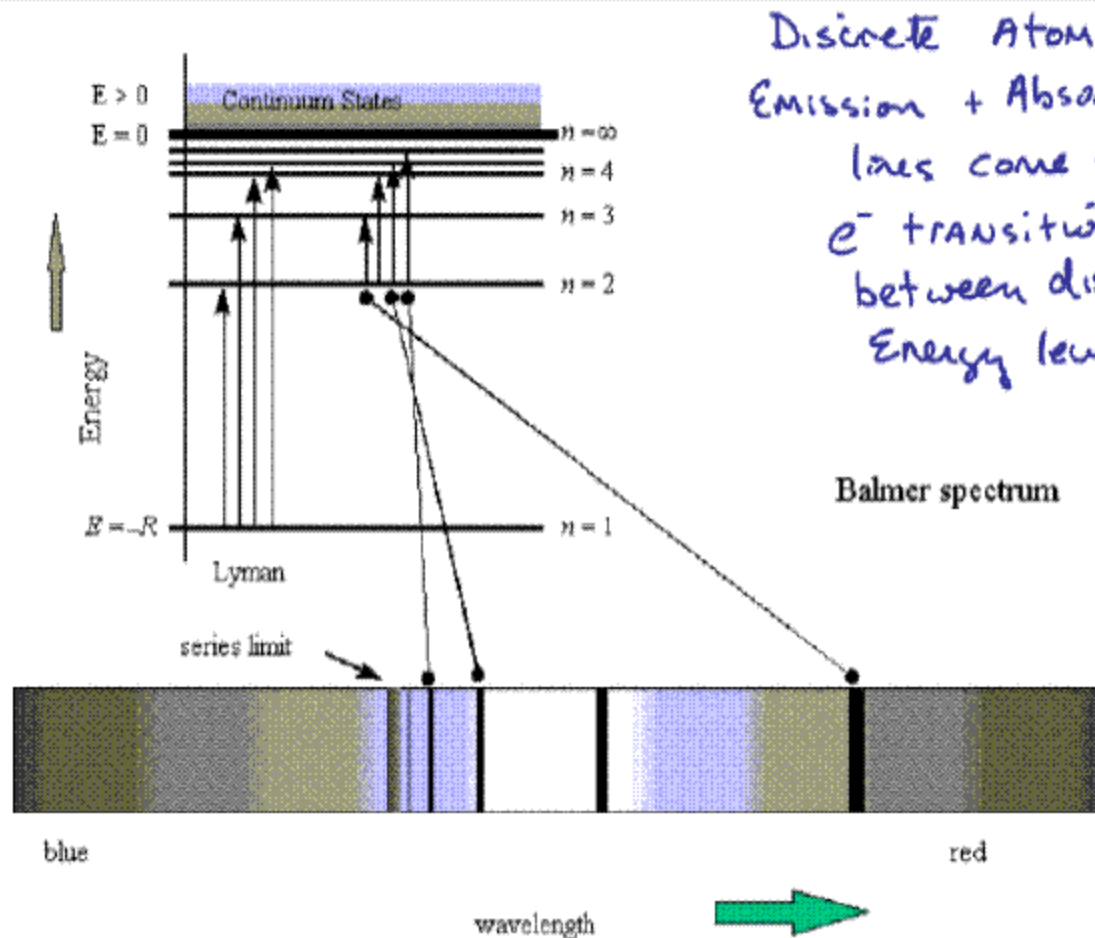
Absorb γ -
 e^- makes transition
from low Energy
orbit to high
energy orbit



possible
orbits
for
electron

Transition from high energy
orbit to low energy orbit
→ emission of photon

* Do Bohr model Applet



Discrete Atom
Emission + Absorption
lines come from
 e^- transitions
between discrete
Energy levels

Figure from

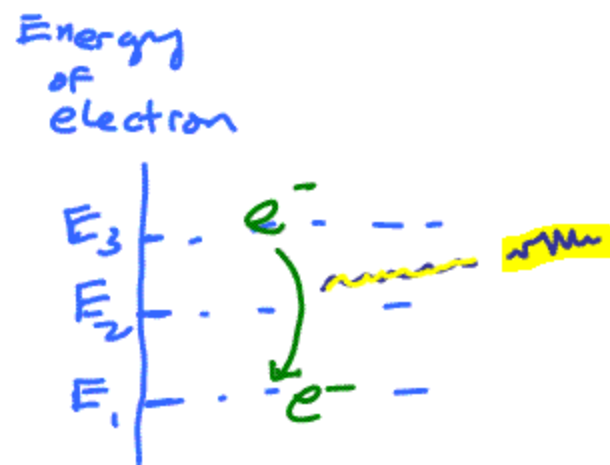
http://www.uclan.ac.uk/facs/science/physastr/x99/PAM98/UCert/Ch06/6_6ato-1.htm

- Bohr model of atom worked well in describing the discrete spectra observed coming from atoms.
- In this model photons are only absorbed/emitted as electron makes transitions between specific allowed energy states.

So photons have fixed energies

$$E = h\nu$$

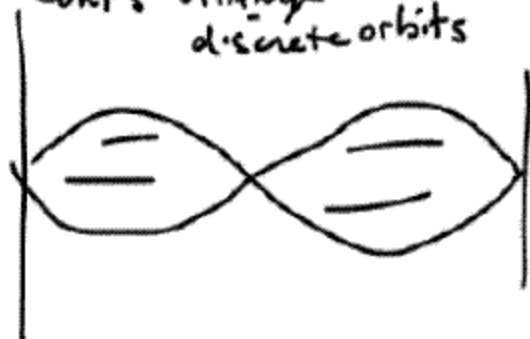
↑ means
light is emitted
with specific colors



- Bohr model orbits are stable ... not easily understandable with classical physics
NOT motivated by Bohr ... just put in ad hoc to get discrete spectra

de Broglie Matter wave idea

Motivated Bohr's strange
discrete orbits



Recall demo of
"STANDING waves"
on a string

waves travelling $\rightarrow$
interfere w/ reflected

waves travelling $\leftarrow$

to create resonance

$\Rightarrow$ only for specific
wavelengths
or
frequencies

only orbits where
wavelength of
electron is
correct length
to form
STANDING wave
around the
circle of
orbit
are STABLE



$\rightarrow$ leads to discrete stable orbits

De Broglie vision of
 e^- as wave
plus

interference

sort of motivates
the Bohr model's
discrete orbits

STABLE wave



UNSTABLE
wave



But Bohr model Not the last word

Bohr model mixes the particle + wave pictures of e^- ...
not really self-consistent.

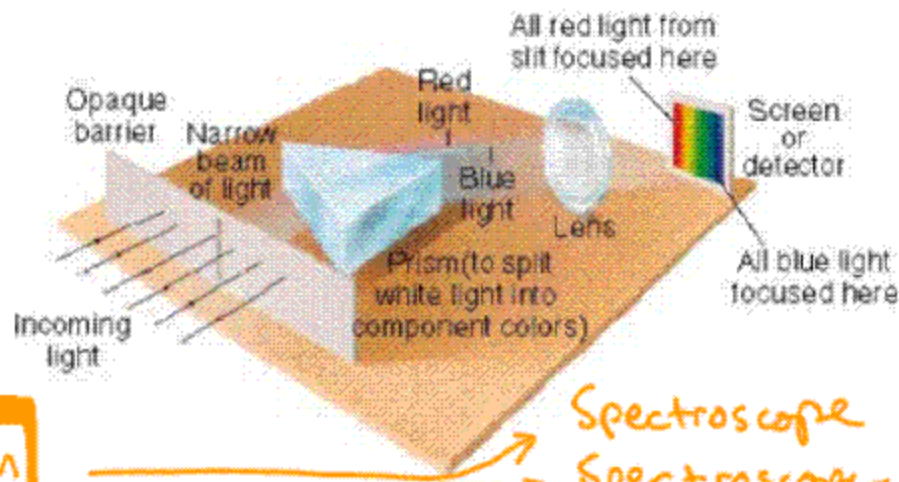
mid-1920's physicists they needed to develop a theory that
works with matter waves. $\rightarrow$ quantum mechanics

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

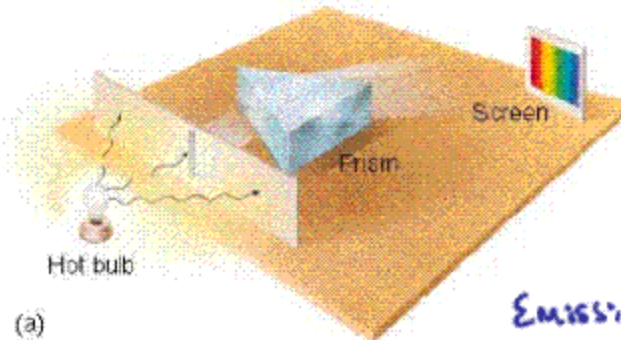
Spectrum

Light from many
atoms
 $\Rightarrow$ continuous ν

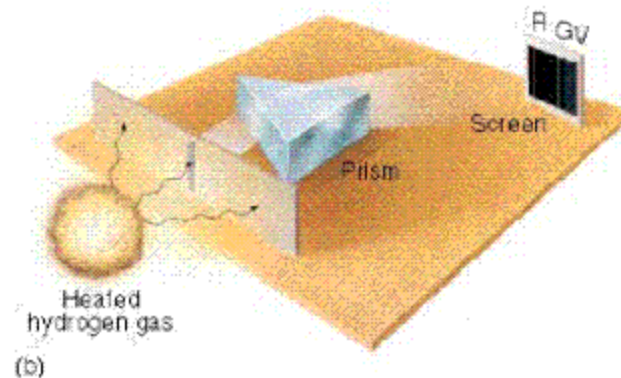
Light from specific atoms
 $\Rightarrow$ discrete ν



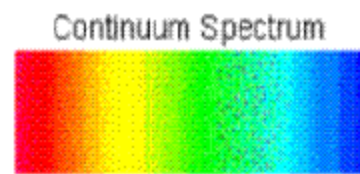
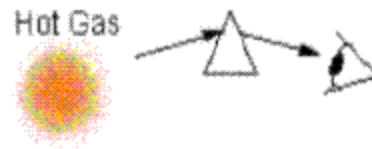
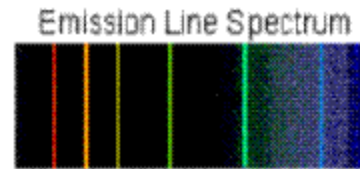
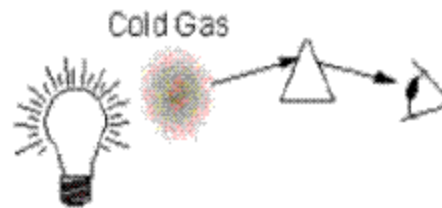
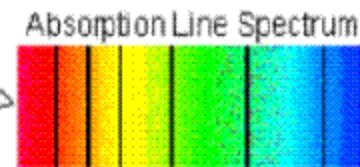
Spectroscope
Spectroscopy



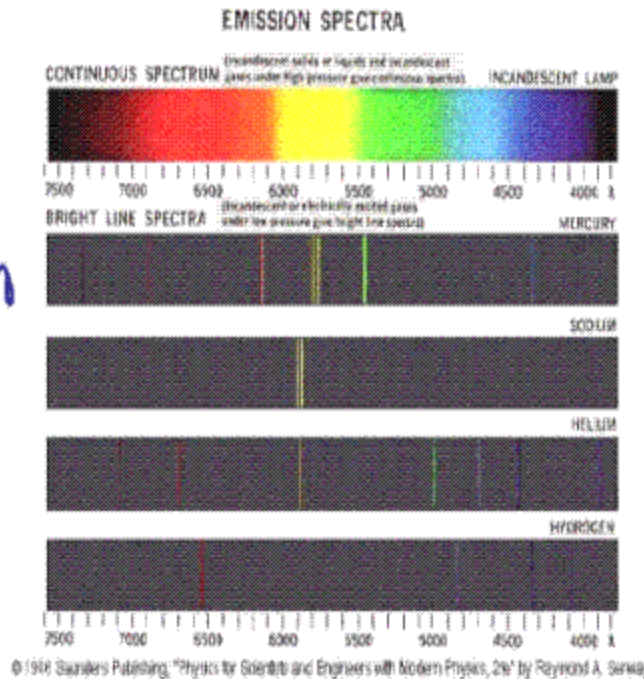
Emission Spectrum



Emission
VS,
Absorption



Different
Atoms
→ different
discrete frequency
pattern



Atomic
Fingerprinting

End of material
for Exam I

Werner Karl Heisenberg
(1901 - 1976)

Nobel Prize in physics - 1932
for "the creation of quantum
Mechanics"

(Max Born, Pascual Jordan - co-workers)



Erwin Rudolf Josef Alexander Schrödinger
(1887 - 1961) Austria

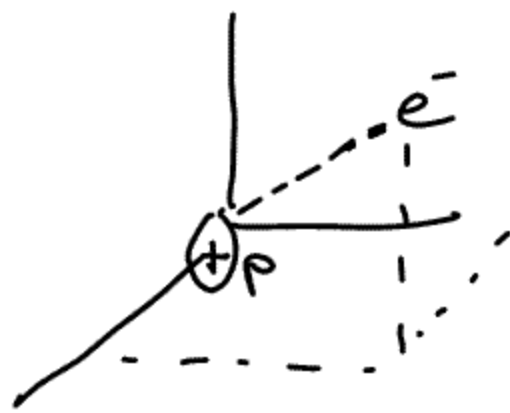
1933 Nobel Prize in physics

1926 - Paper on wave Mechanics of Matter
Annalen der Physik

"for discovery of new and productive forms of
atomic theory"

$$-\frac{\hbar^2}{2m} \frac{d^2 \psi(x)}{dx^2} + V \psi(x) = E \psi(x) \quad \text{Schrödinger's Equation}$$

Just so
you've seen
it



Physicists
Put wave e^- in

Spherically symmetric
Physical Situation

into Schrödinger's equation
and solve

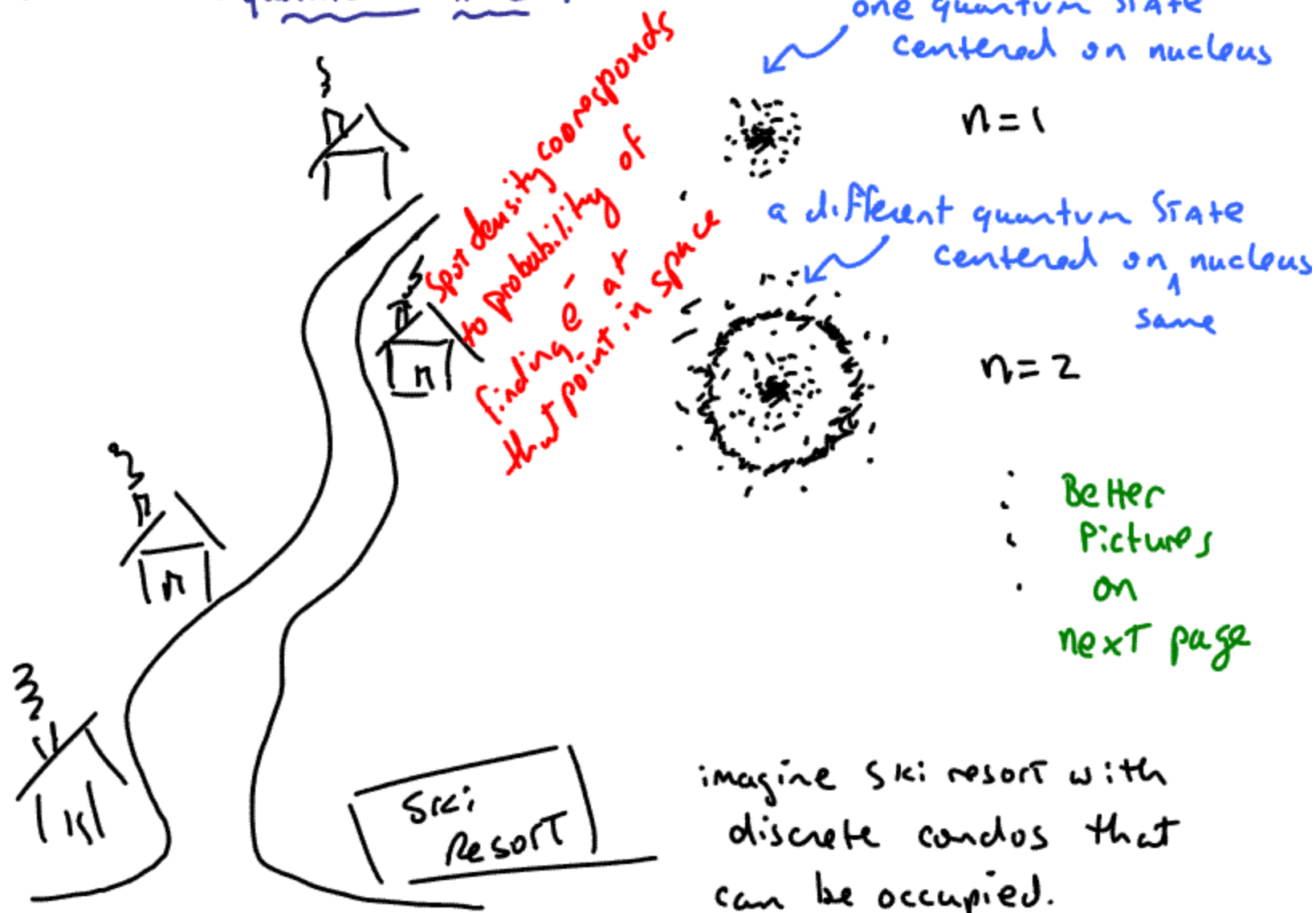
What comes out of this?

→ Particular Allowed spatial STATES
(of existence)

→ Each Associated with a particular energy

→ These are known as "Quantum States"

What is a quantum STATE ?



Pictures of different H atom "orbits". Graphical representations of the probability of finding e^- around the nucleus for each of the different possible quantum states coming from the solution of Schrödinger's equation

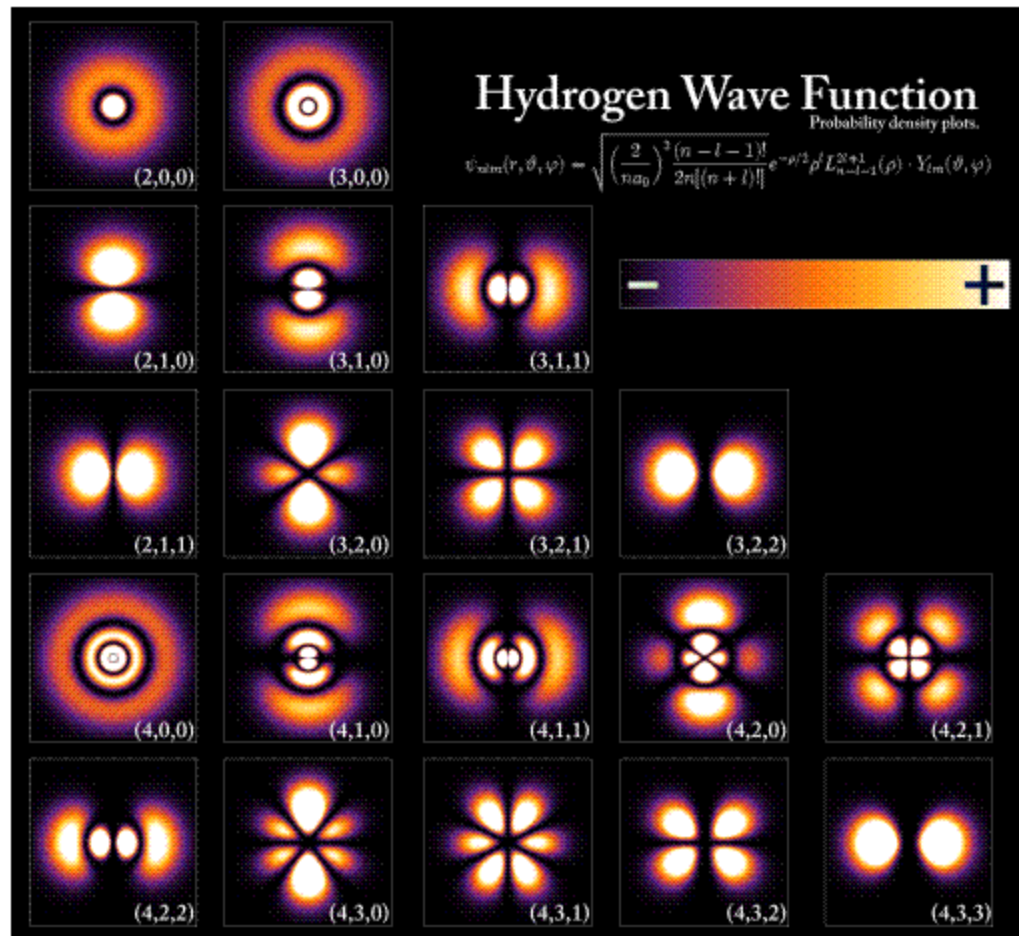


figure from <http://en.wikipedia.org/wiki/File:Hydrogen-Density-Plots.png>