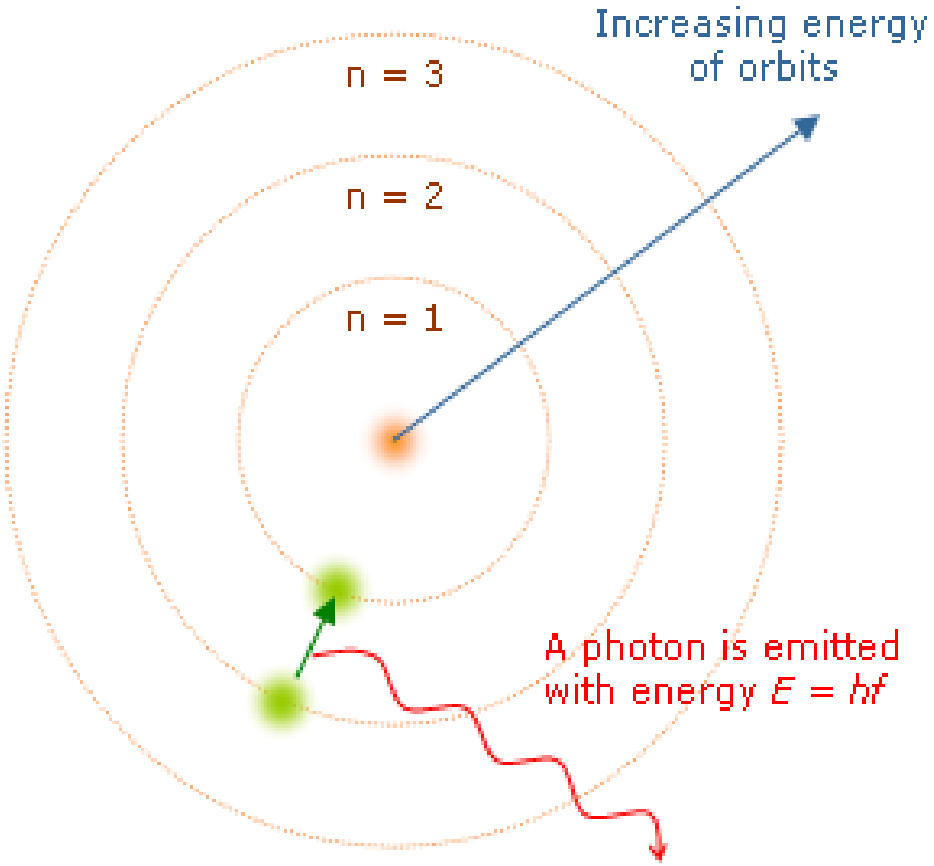
The Modern Model of the Atom

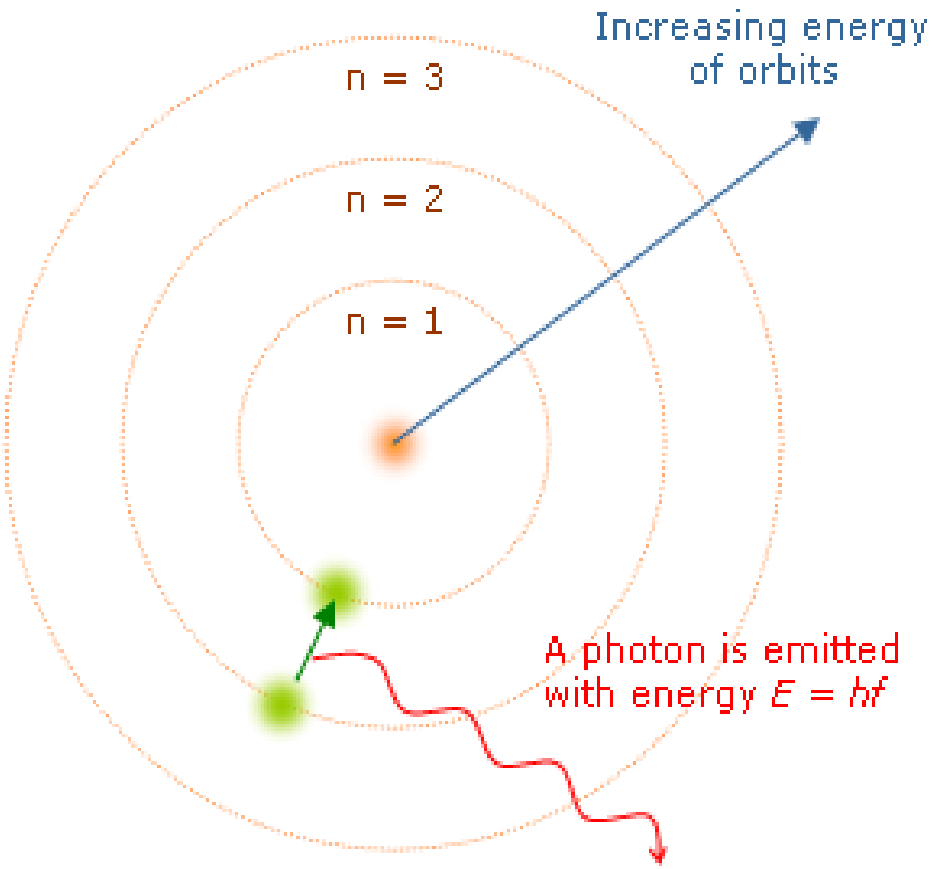
Bromfield Chem CP

The Bohr Model…recap



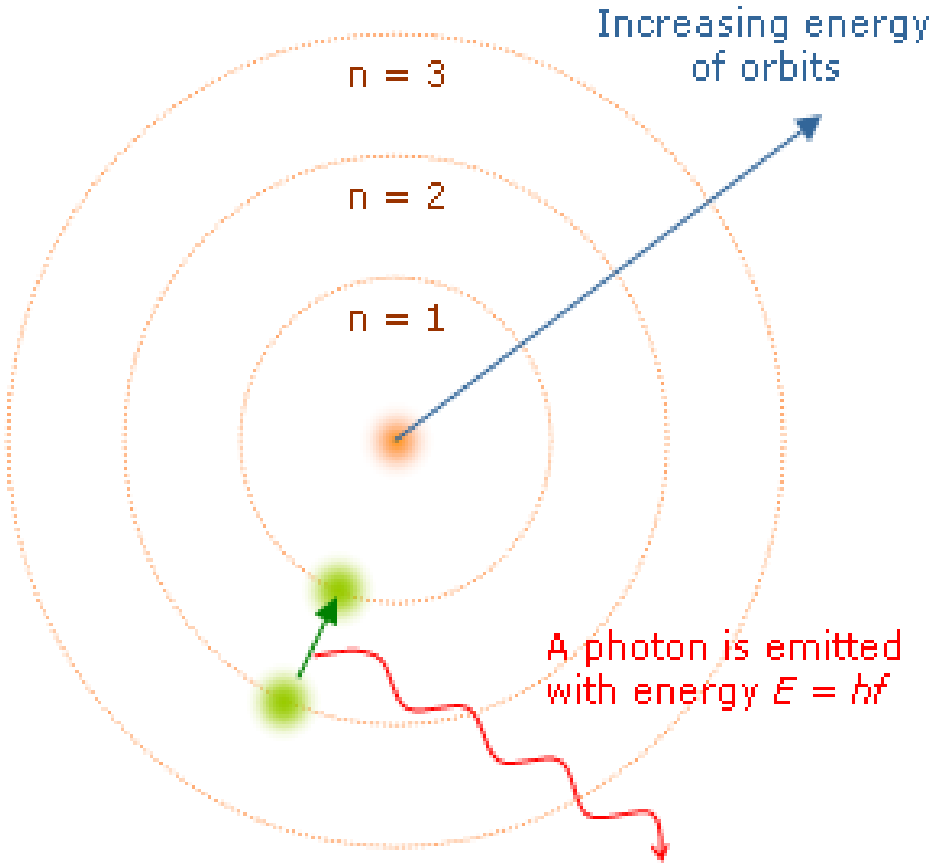
- Electrons travel around the nucleus in fixed circular orbits

The Bohr Model…recap



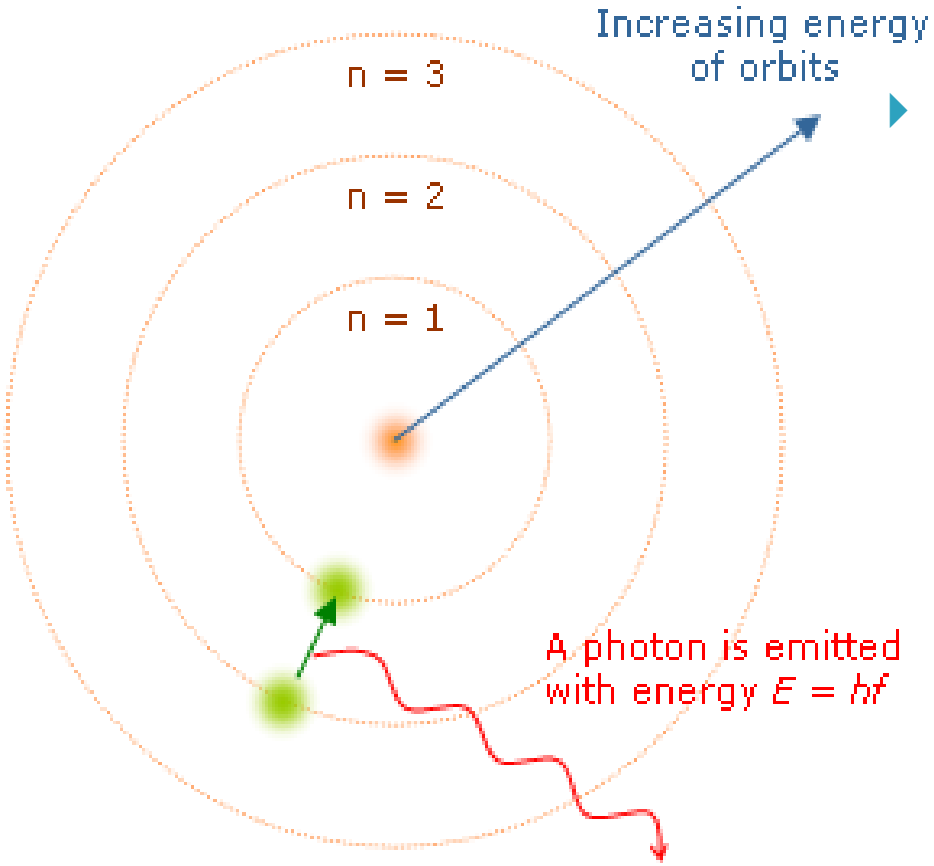
- Electrons travel around the nucleus in fixed circular orbits
  - Only certain orbits with certain energies are allowed

The Bohr Model…recap



- Electrons can transition between energy levels

The Bohr Model…recap



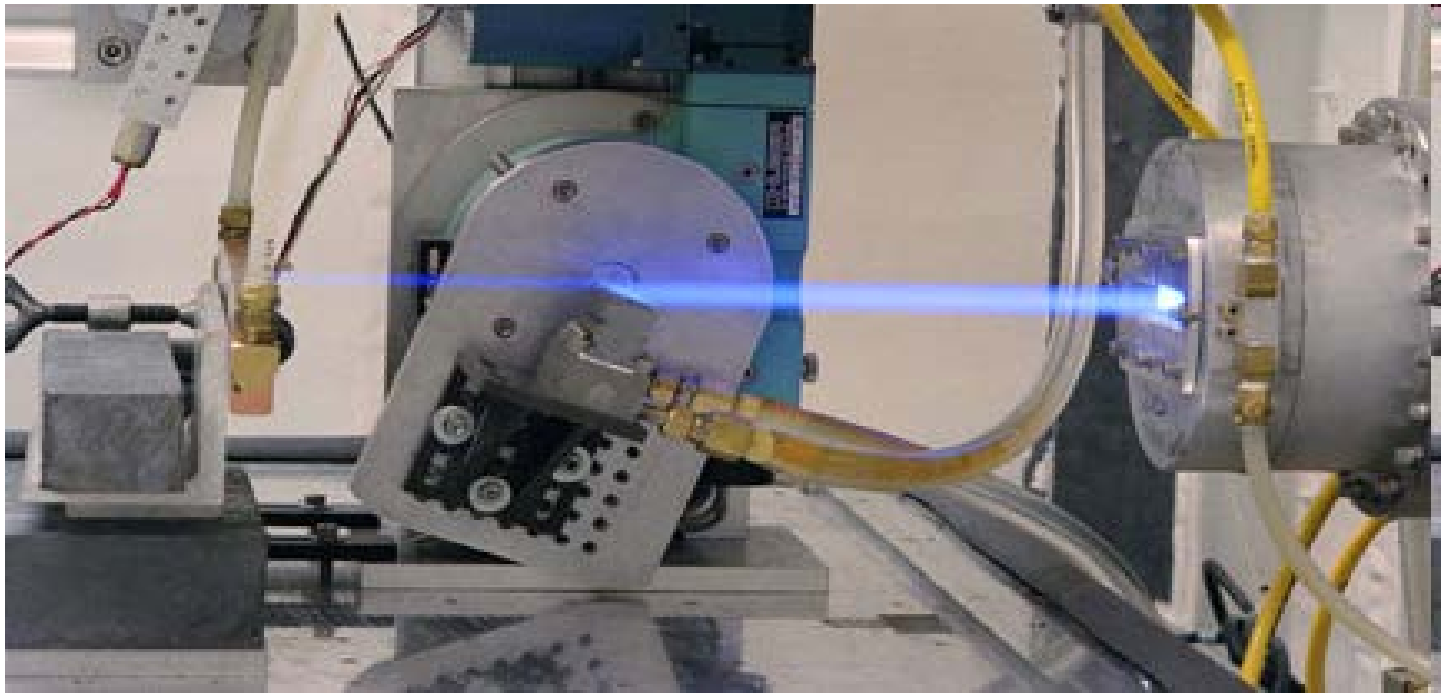
- Electrons can transition between energy levels
  - Gives off or absorb light of certain wavelength
  - Interactive animation

Problems with the Bohr model

- Only works for one electron atoms

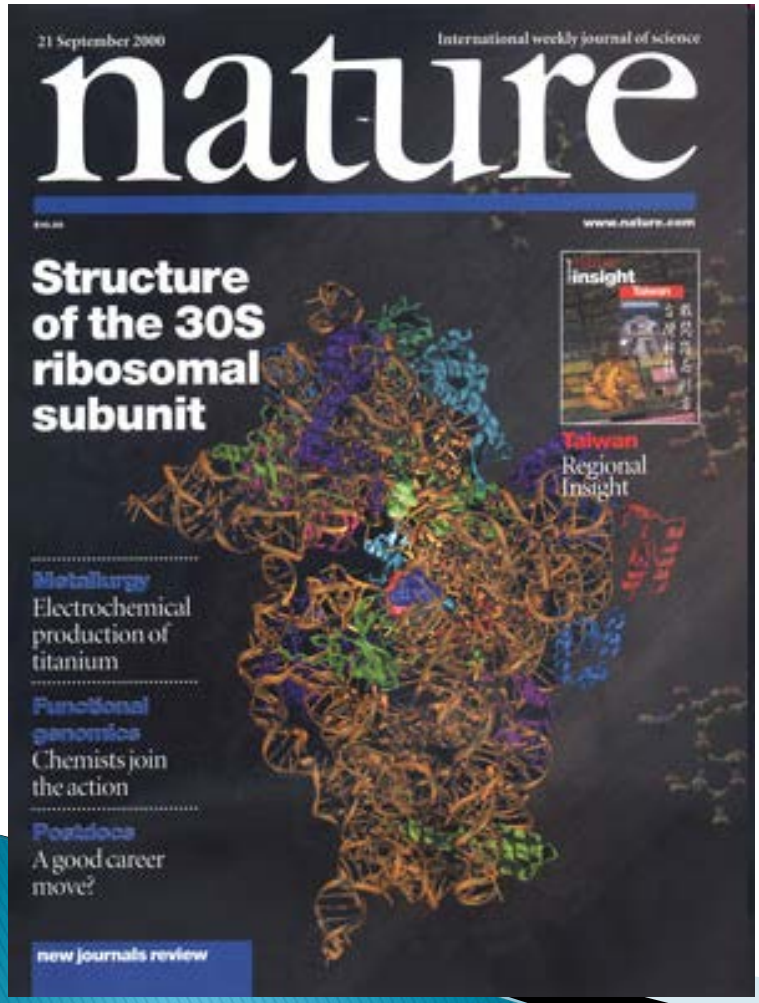
Synchrotron sources

- Electrons that travel in circular paths give off xrays



Courtesy of NSLS, Brookhaven National Laboratory

2009 Nobel Prize in Chemistry



- Structural and functional studies of the ribosome
  - Venkatraman Ramakrishnan
  - Thomas A. Steitz
  - Ada E. Yonath

The Modern Model

- A mathematical, statistical description of electrons in atoms

The Modern Model

- A mathematical, statistical description of electrons in atoms

- Electrons display a wave-particle duality.

Erwin Schrödinger

- We can use waves to predict the locations of electrons.
- Video

Werner Heisenberg

- Uncertainty Principle

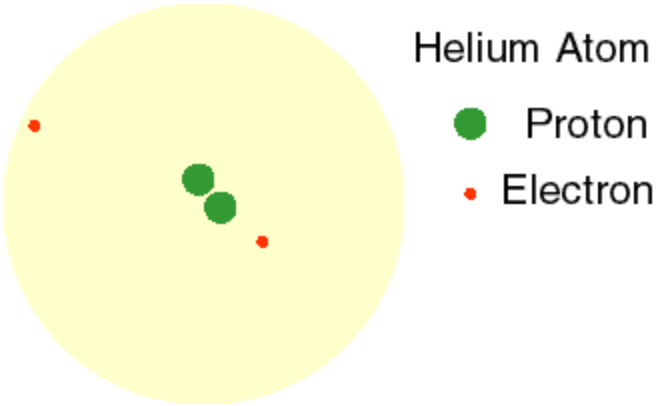
Werner Heisenberg

- Uncertainty Principle
- We can't know the location and momentum of an electron simultaneously.
- Video

Modern Model

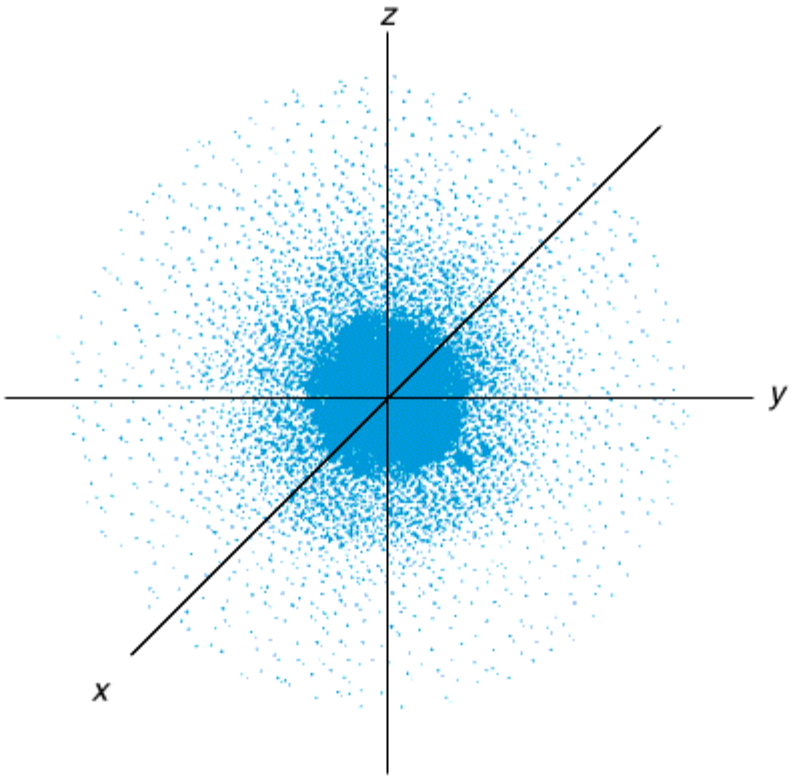
- Orbital: region of space where electron is likely to be found

- Animation



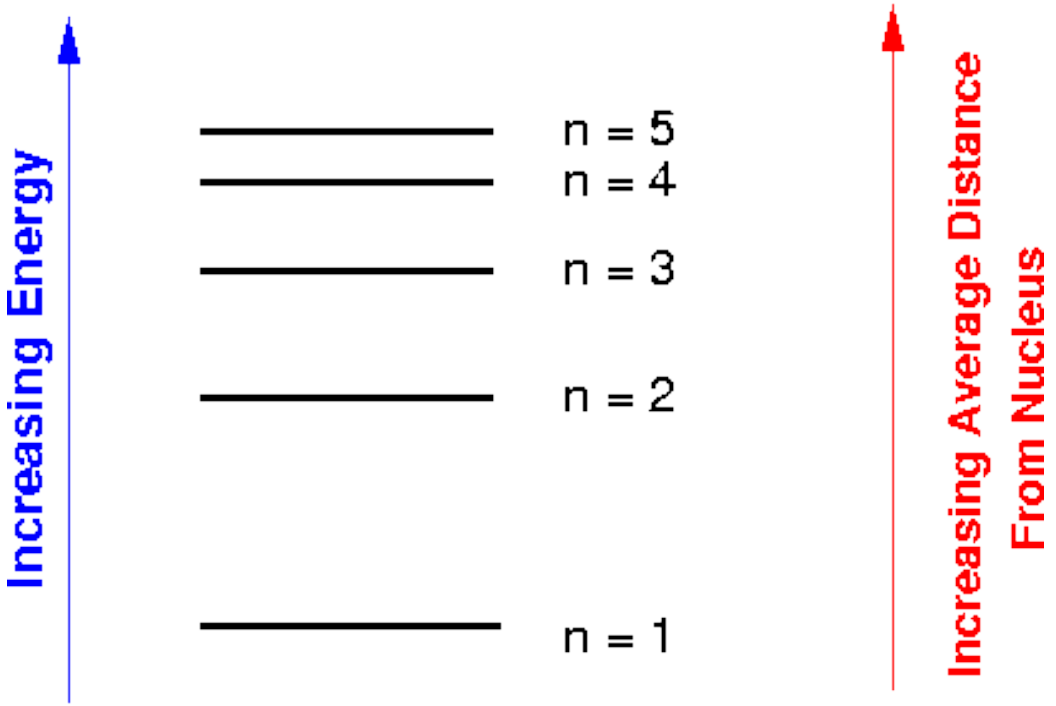
Modern Model

- Orbital: region of space where electron is likely to be found



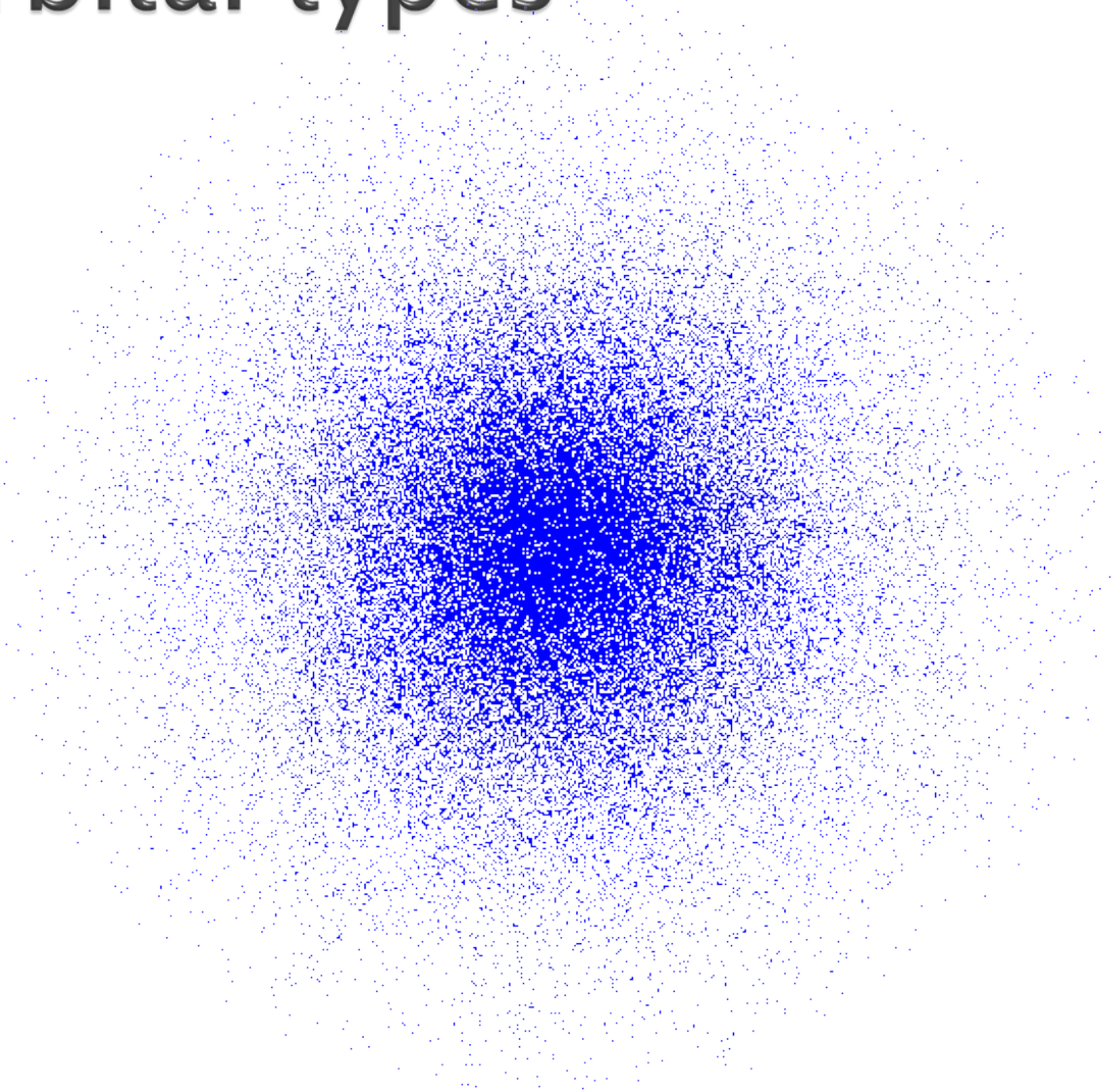
Modern Model

- Orbitals are arranged in primary energy levels (just like those in the Bohr model)



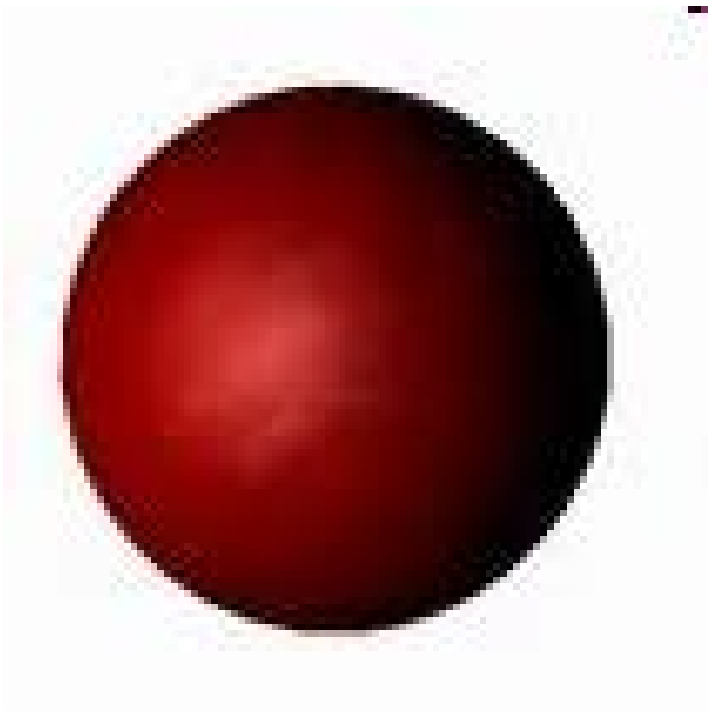
4 basic orbital types

- “s” orbitals



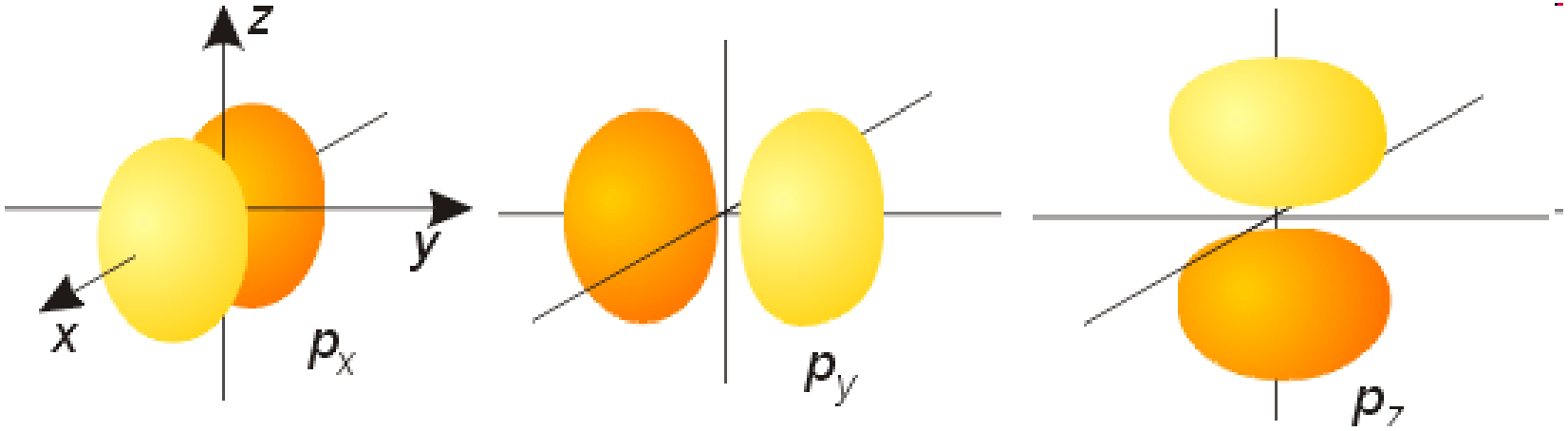
4 basic orbital types

- “s” orbitals
  - Spherical
  - 1 s orbital in an s sublevel



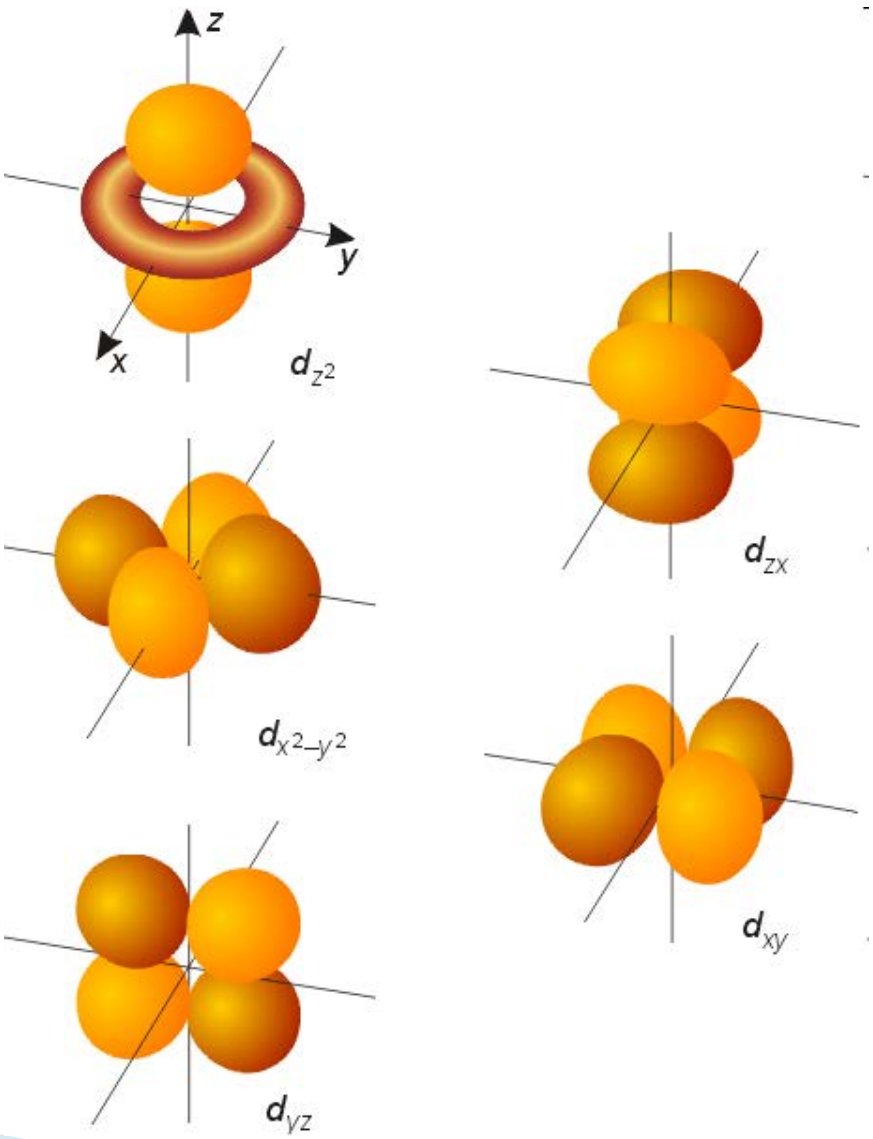
4 basic orbital types

- “p” orbitals
- Dumbbell shaped
- Come in sets of 3



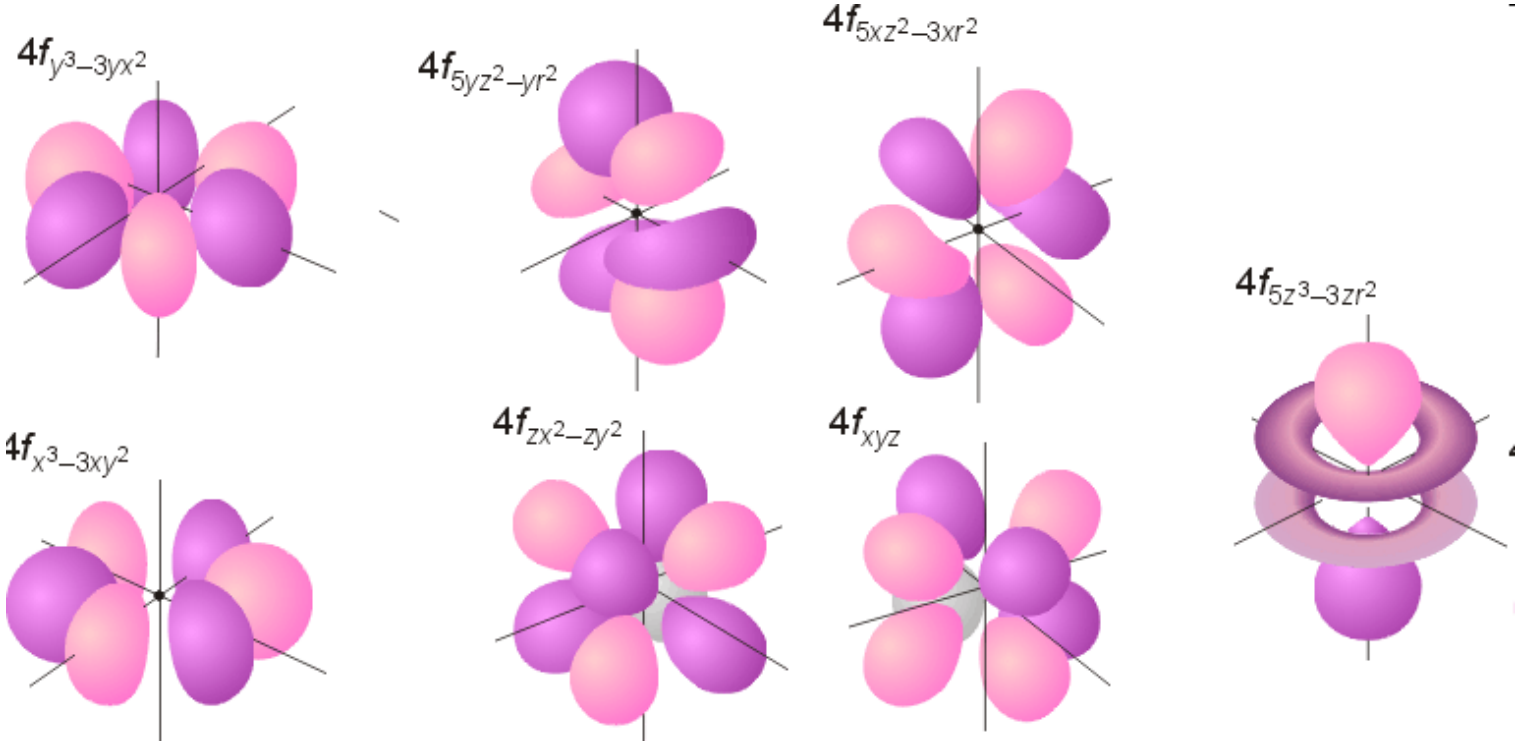
4 basic orbital types

- “d” orbitals
- Cloverleaf shape
- Come in sets of 5



4 basic orbital types

- “f” orbitals
- Come in sets of 7 (do not need to draw them)



Principal Energy Level

- n

Principal Energy Level

- Value of n gives the maximum number of sublevels (i.e., types of orbitals) in level

Principal Energy Level

- n^2 gives the maximum number of orbitals in energy level n

Principal Energy Level

- $2n^2$ gives the maximum number of electrons in energy level n

Practice problems

- What is the maximum number of orbitals that can exist in energy level 4?
- What is the maximum number of electrons that occupy energy level 6?
- How many sublevels can be present in energy level 3?