

# Bohr's Model of the Atom

Chapter 3.2

# The Chemist and the Physicist

A One Act Play by Mrs. Docker

**CHEMIST:** So what do you think of Rutherford's Model of the Atom? Cool huh?

**PHYSICIST:** Well...An electron moving in an orbit around the nucleus is constantly changing direction.

**CHEMIST:** Yeah...

**PHYSICIST:** And...when something is changing speed or direction, us physicists say it is 'accelerating'.

**CHEMIST:** So...

**PHYSICIST:** Us physicists have proved that when a charged particle accelerates, it continuously produces electromagnetic radiation which is emitted as photons.

**CHEMIST:** Uh Huh...

**PHYSICIST:** This means that an electron travelling in an orbit should be emitting photons, and therefore it should be losing energy

**CHEMIST:** Okay...

**PHYSICIST:** If the electron were to lose energy as it orbits it would collapse in towards the positively charged nucleus...

**CHEMIST:** ...because opposite charges attract! Right! But wait a sec, this is not what is observed! Atoms are stable and do not appear to be collapsing.

**PHYSICIST:** That must mean that although electrons are constantly moving, they do not lose energy.

**CHEMIST:** Oh. Well Rutherford's model can't explain this. We need to make some modifications!



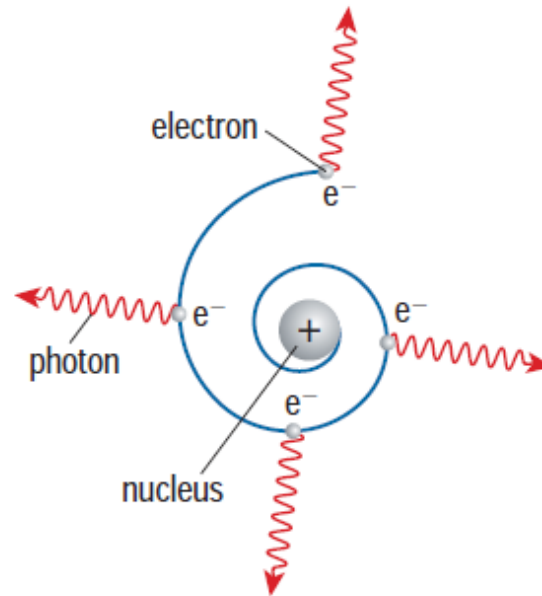
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"I'm a nuclear physicist."



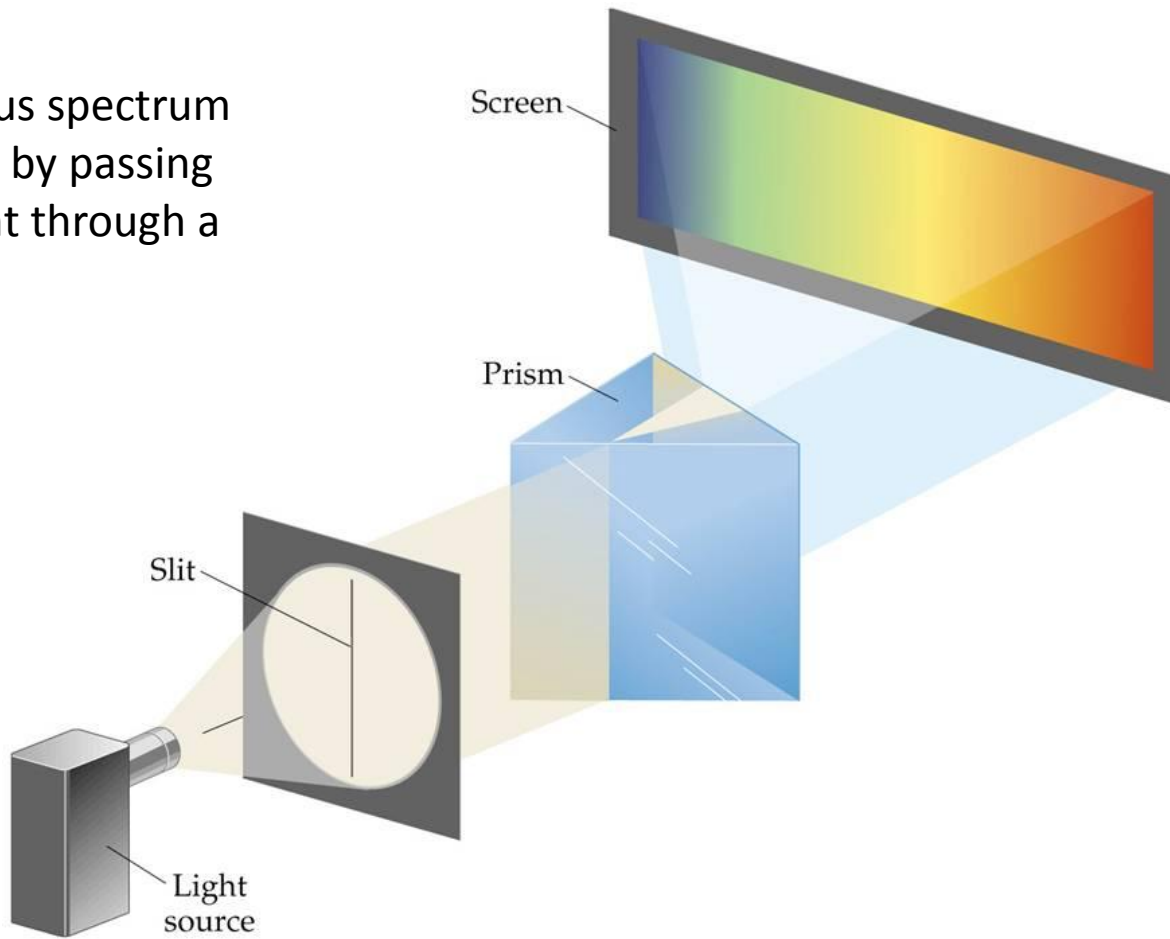
# Limits of the Rutherford Model



**Figure 1** An electron accelerating around the nucleus would continuously emit electromagnetic radiation and lose energy. Therefore, it would eventually fall into the nucleus and the atom would collapse. However, this is not consistent with real-world observations.

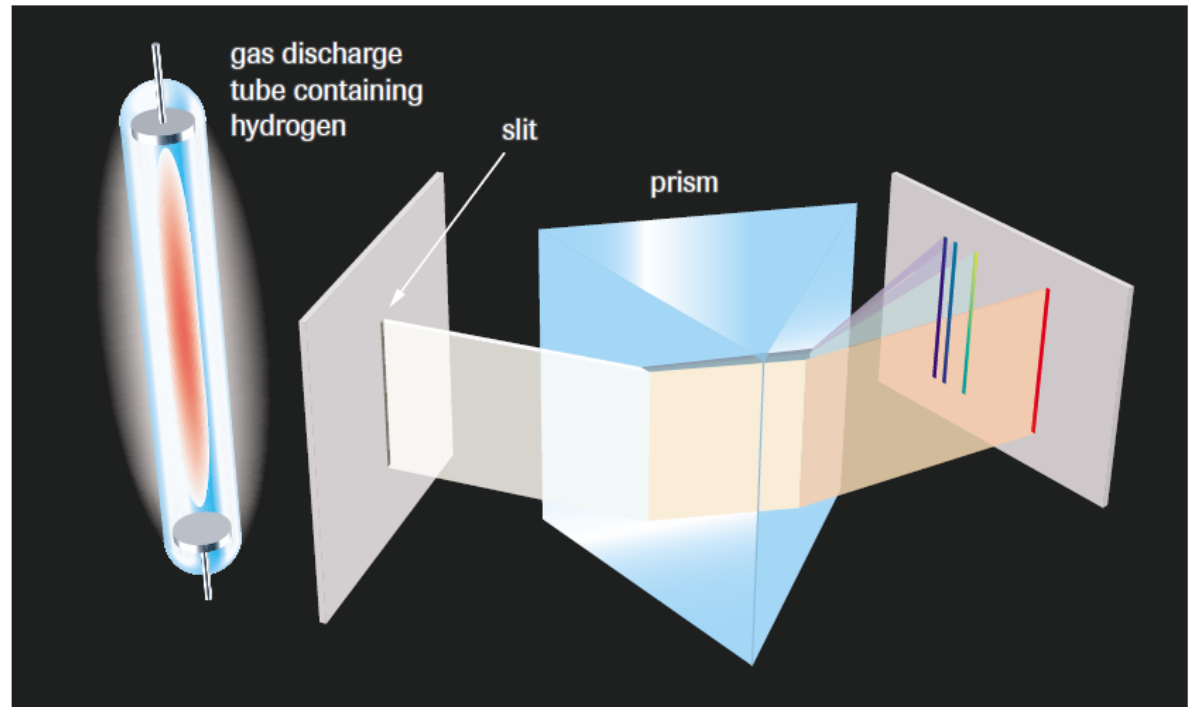
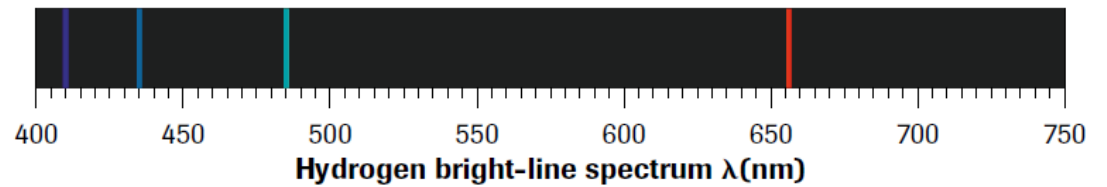
# Atomic Spectra

Continuous spectrum produced by passing white light through a prism



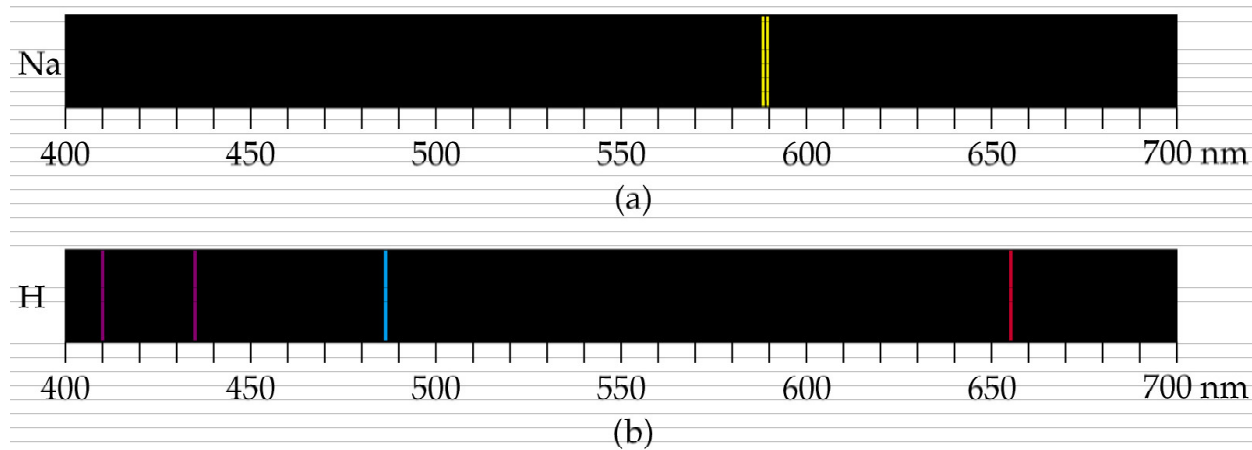
# Atomic Spectra

Emission Spectrum  
(or bright-line spectrum)

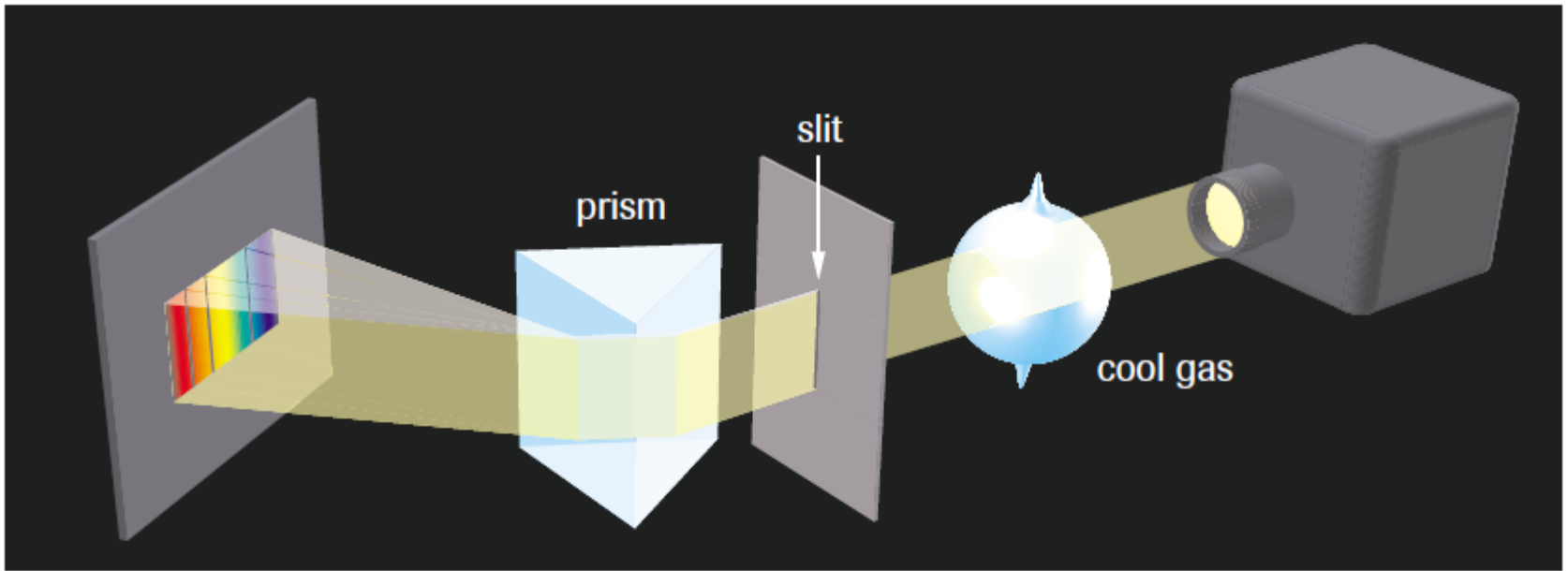


# Atomic Spectra

- The line spectrum is like a fingerprint of a specific element

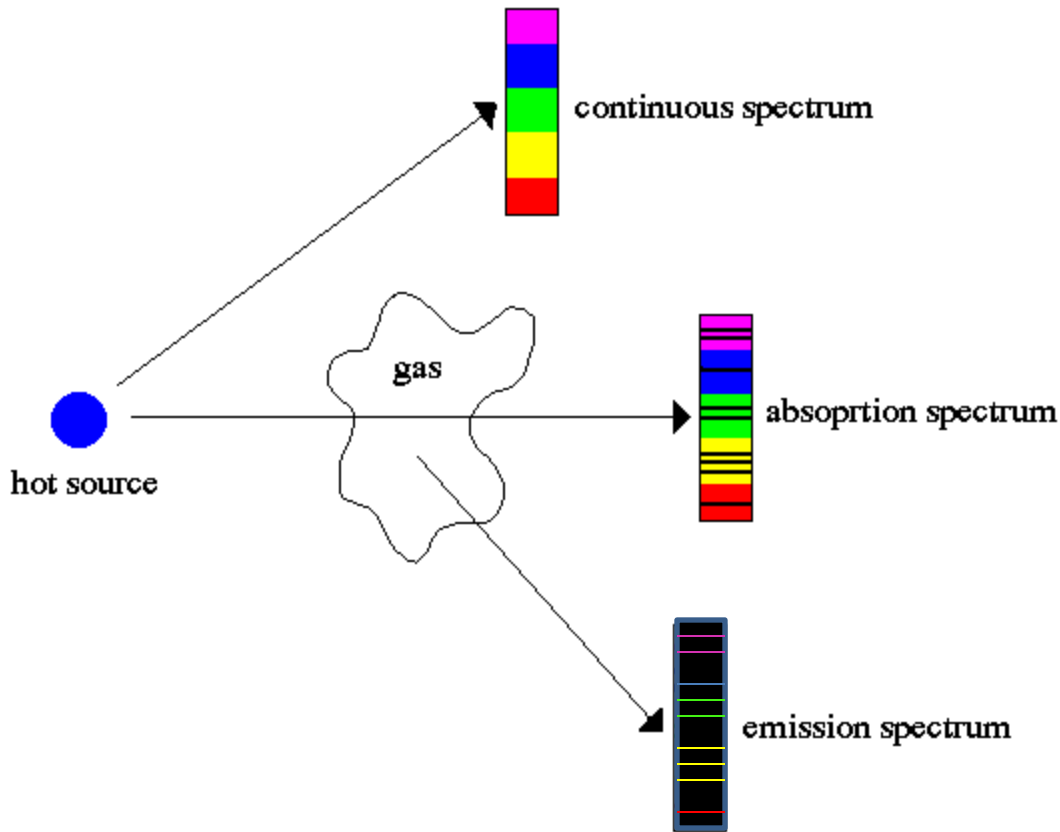


# Atomic Spectra



Absorption Spectrum (or dark-line spectrum)

# Atomic Spectra



Hydrogen Absorption Spectrum



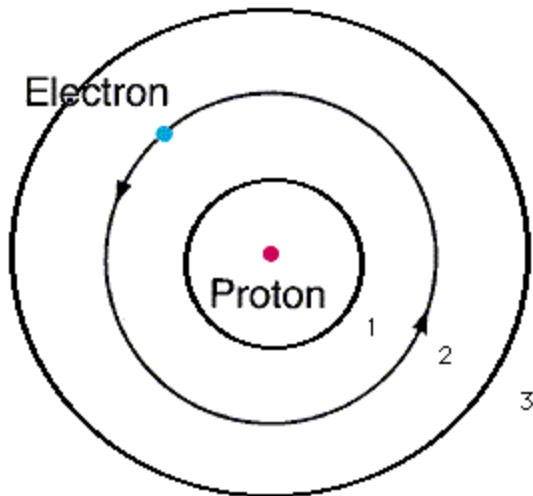
Hydrogen Emission Spectrum





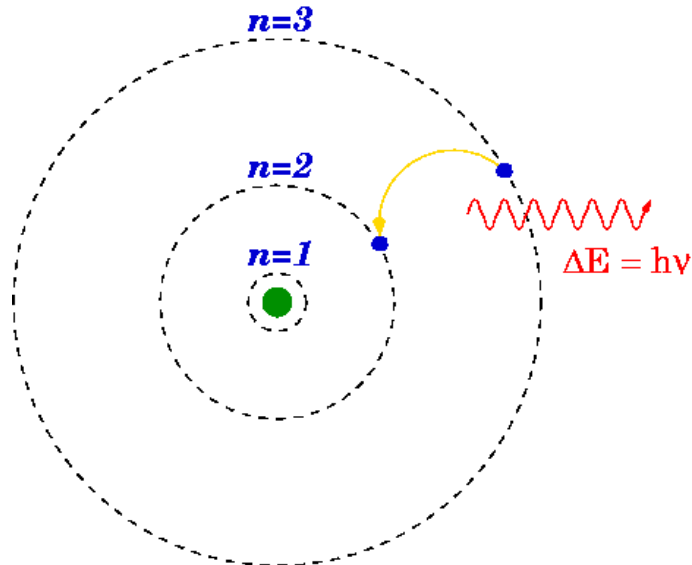
# Niels Bohr

- Bohr used the emission spectrum of the hydrogen atom to develop a quantum model for the hydrogen atom
- He proposed that electrons could move only in specific orbits around the nucleus
- The distance of each orbit from the nucleus corresponded to the energy level of that orbit

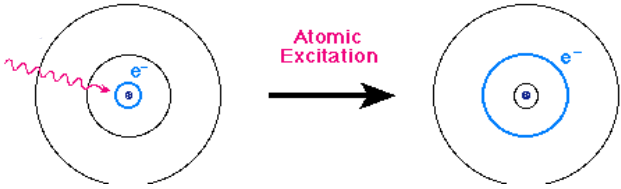
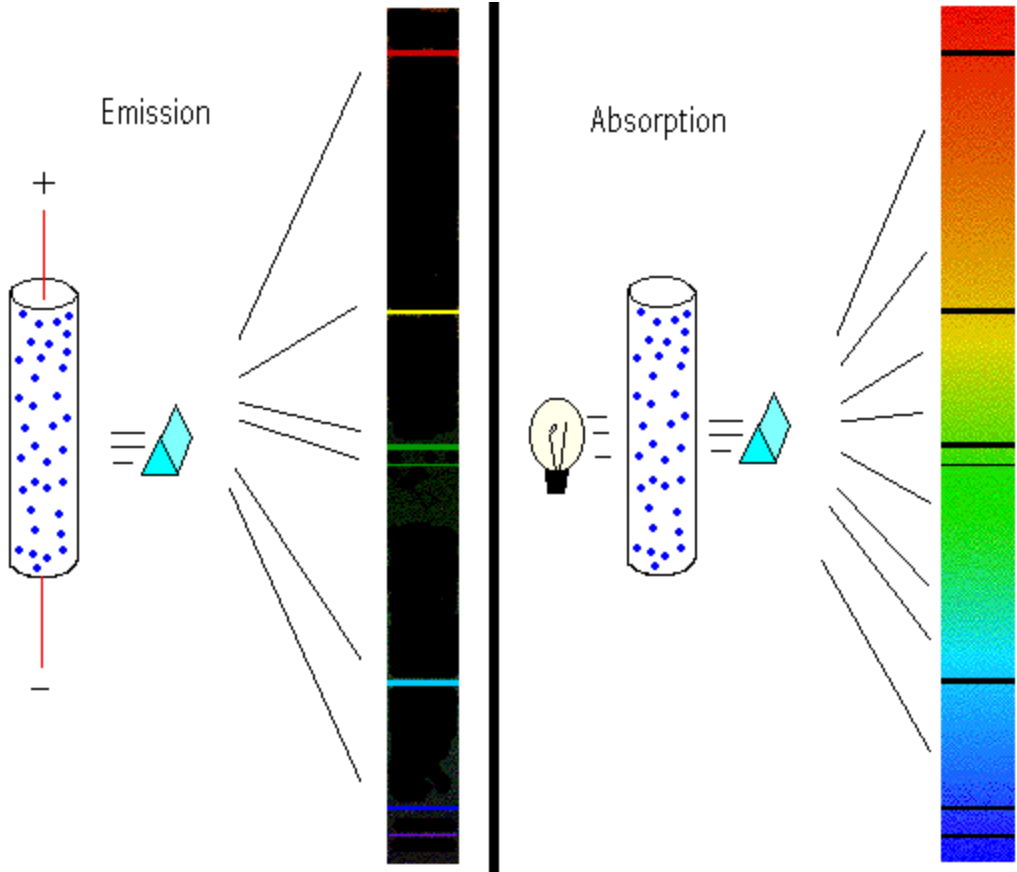


# Neils Bohr

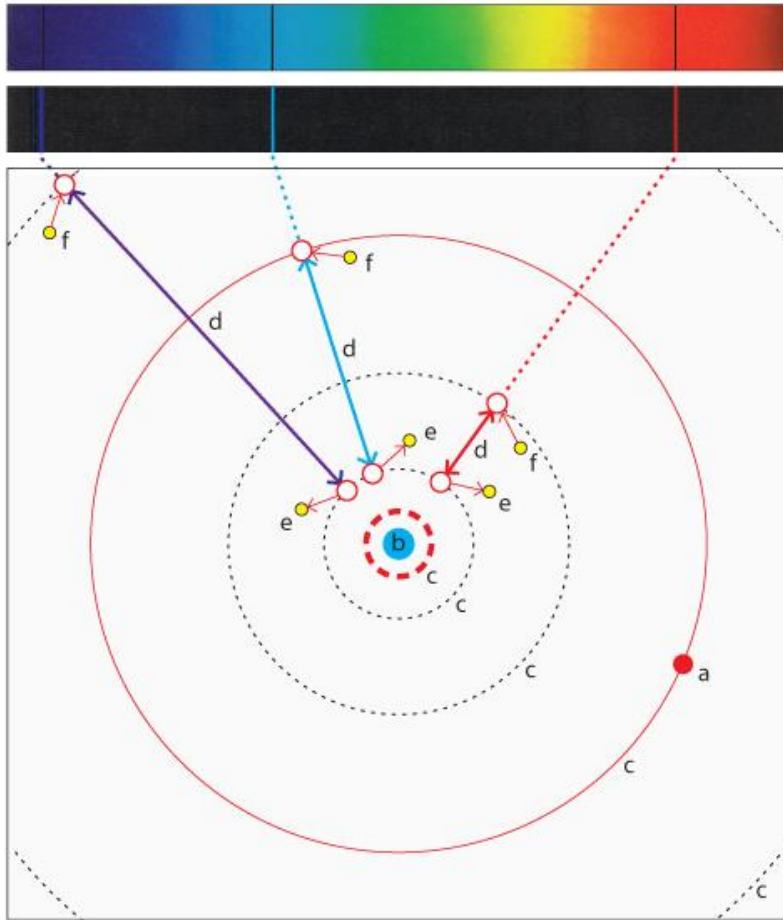
- The movement of an electron from one energy level to another is called a **transition**
- The **ground state** is the lowest energy state for an atom
- When an atom gains energy it moves into an **excited state**
- The transition from a lower energy level to a higher energy level *requires* a quantized amount of energy (which corresponds to a photon of a specific wavelength)
- The transition from a higher energy level to a lower energy level *releases* a quantized amount of energy (which corresponds to a photon of a specific wavelength)



# Niels Bohr



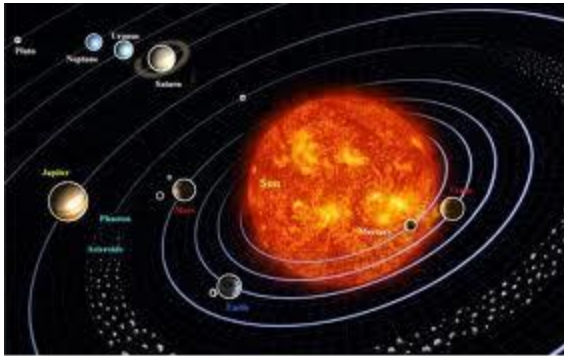
# Niels Bohr



- Bohr's model incorporated three postulates:
  1. Only orbits of certain radii are allowed. These radii correspond to specific energies.
  2. An electron in a permitted orbit has this specific energy, an "allowed" energy state. Electrons will not radiate energy, into a state that is not "allowed", so will not spiral into the nucleus.
  3. Energy is only emitted or absorbed by an electron as it moves from one "allowed" state to another. This energy is emitted or absorbed as a photon,  $E = h\nu$ .

# Bohr's Model of The Atom

## Solar System



Electrons orbit the nucleus like the planets orbit the sun



# Limitations of Bohr's Model

- The Bohr Model can only explain the line spectrum of hydrogen (an atom with only one electron) adequately
- Beyond the first 20 elements, Bohr-Rutherford diagrams become too cumbersome to be useful
- Scientists eventually concluded that Bohr's model did not fully describe the structure of an atom

# HOMework

Required Reading:

p. 132-142

(remember to supplement your notes!)

Questions:

p. 142 #1-8, 10

