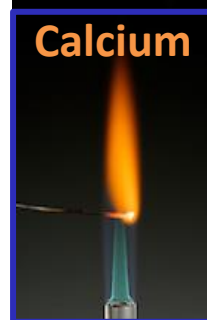


Light Emission



Flame Test

- an **analytic procedure** used in chemistry to **detect the presence of certain elements**, primarily metal ions.



The idea:

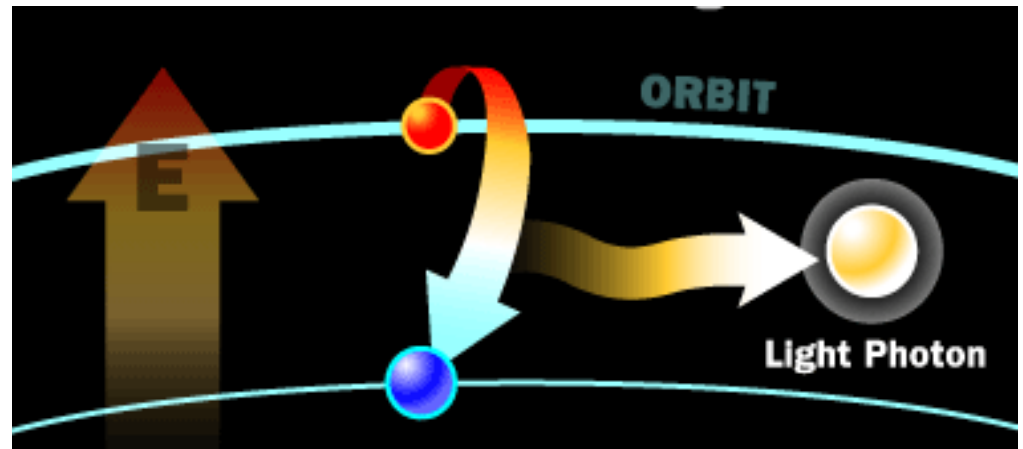
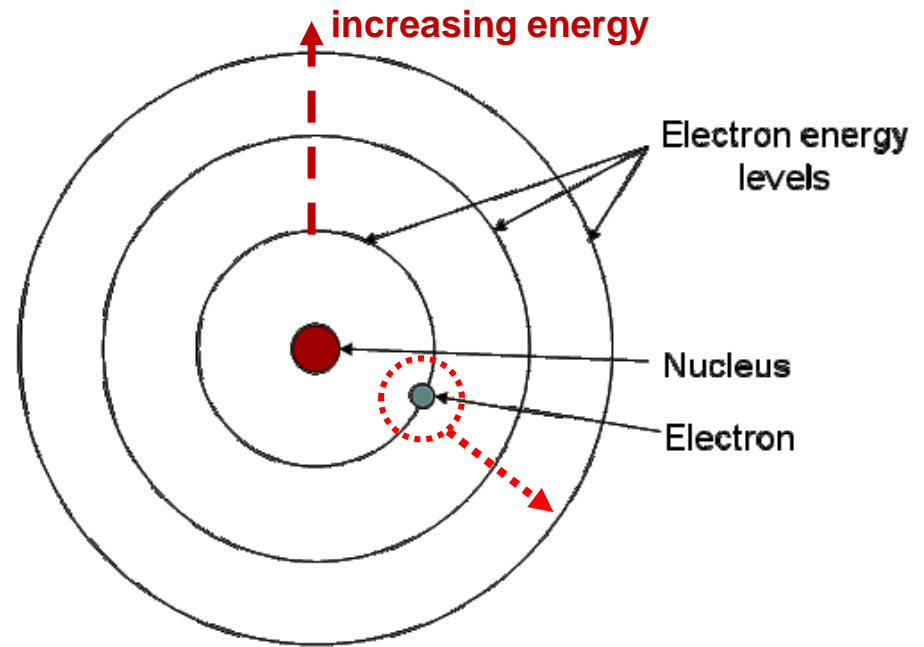
- introduce a sample into flame to *heat*
- sample atoms *sublimate* (get *isolated*)
- since they are *hot*, they emit light
- specific colors are observed...

WHY?

Electrons in Atoms

Electrons in atoms exist in one or more energy levels (orbitals) around the nucleus.

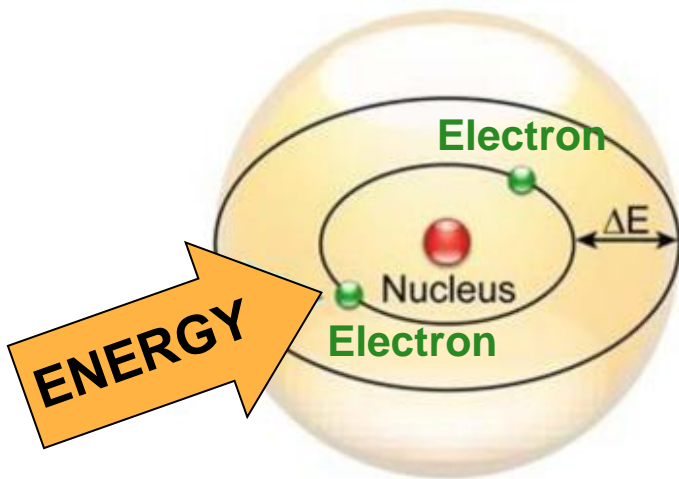
- When matter gains energy, for example by **being heated**, the additional energy pushes the electrons in atoms to higher energy orbitals.
- Electrons tend to return back to their initial orbitals; their “extra” **energy is emitted** in the form of a *particle-like packet of electromagnetic radiation* called a **photon**.



Emission of Light

results from **oscillations of electrons** (“jumps” back and forth between energy levels in atoms)

ground state
 (“cool”)

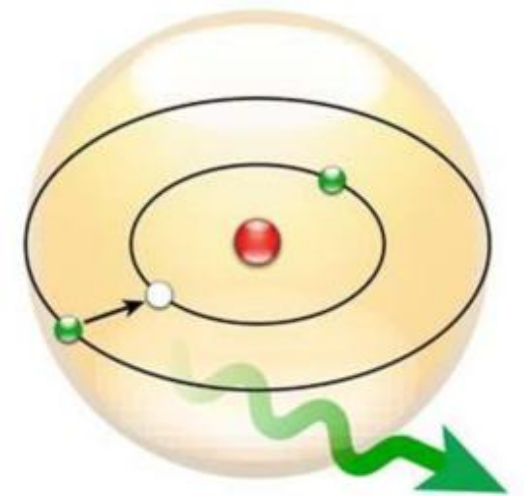


(ANY ENERGY: heat, kinetic/collision, chemical, electromagnetic)

excited state
 (“hot”)



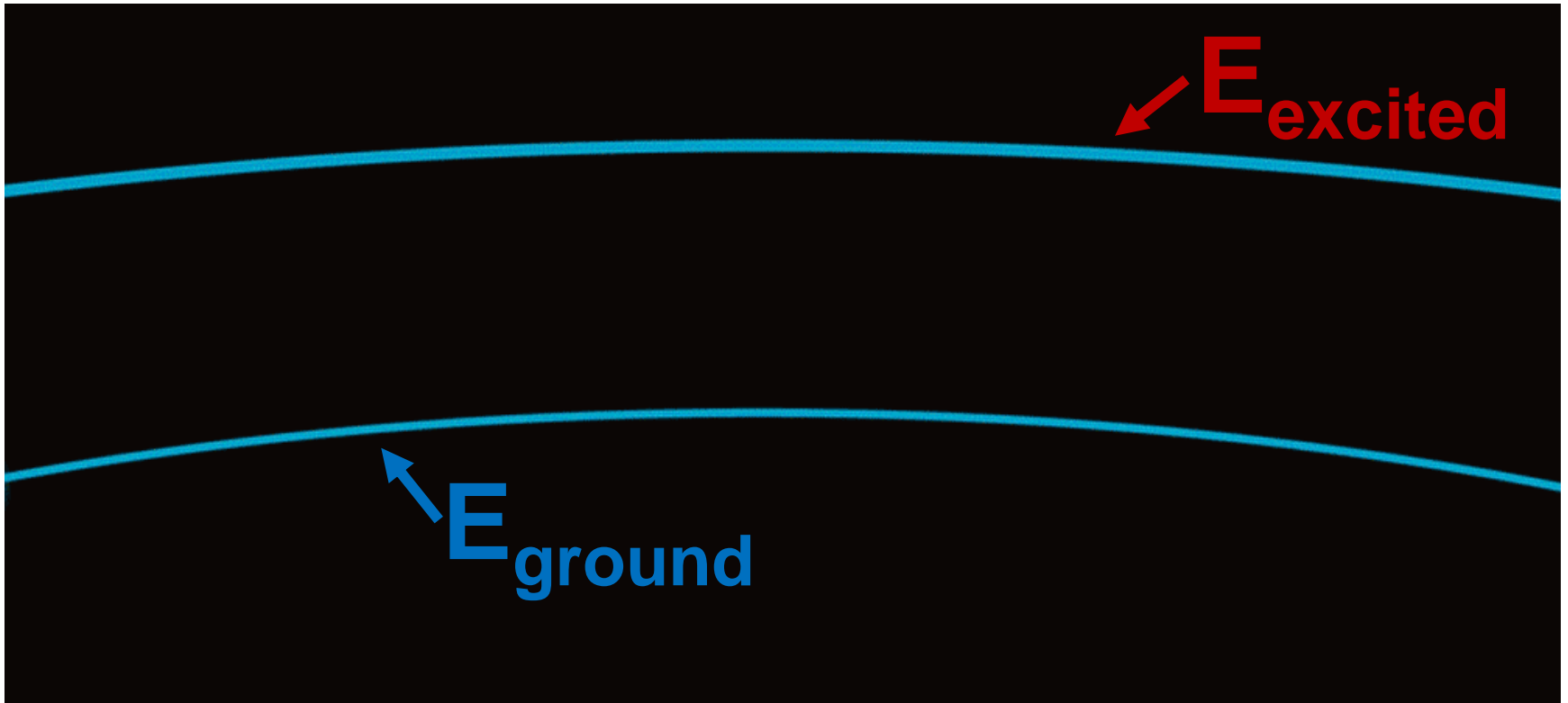
back to
 ground state



LIGHT
 (ENERGY!)

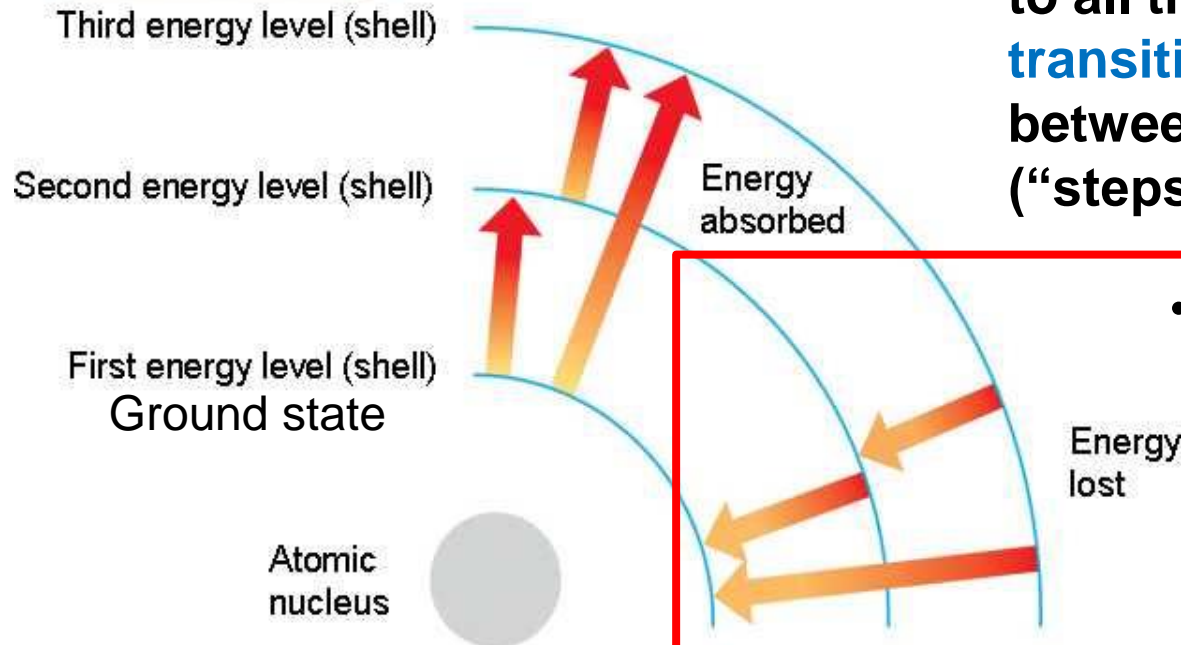
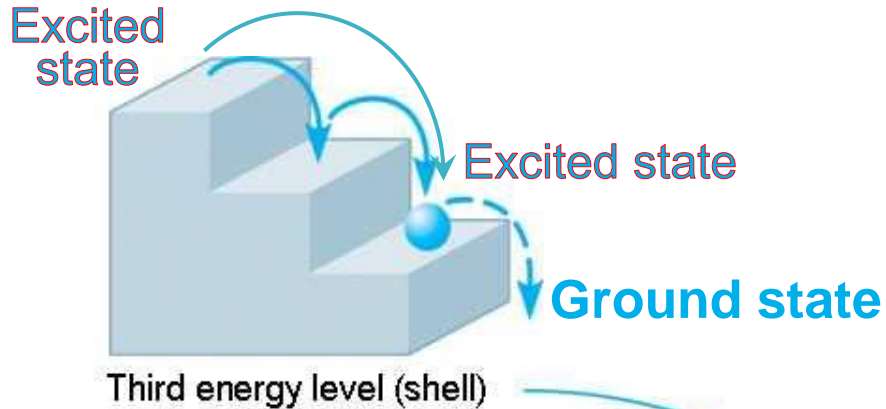
Color of Light

is defined by electron transition



$$\text{Photon Frequency} \sim E_{\text{photon}} = E_{\text{excited}} - E_{\text{ground}}$$

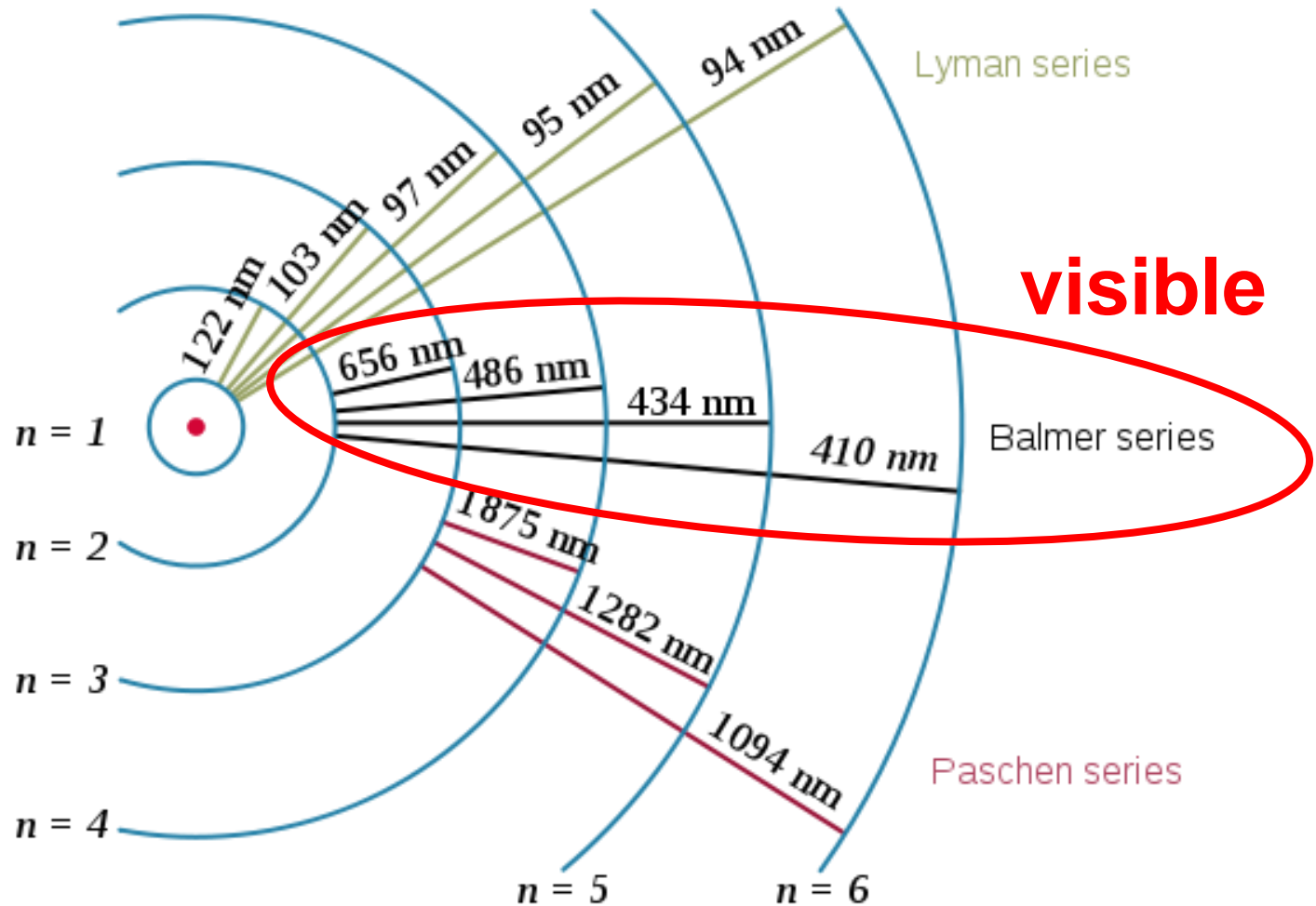
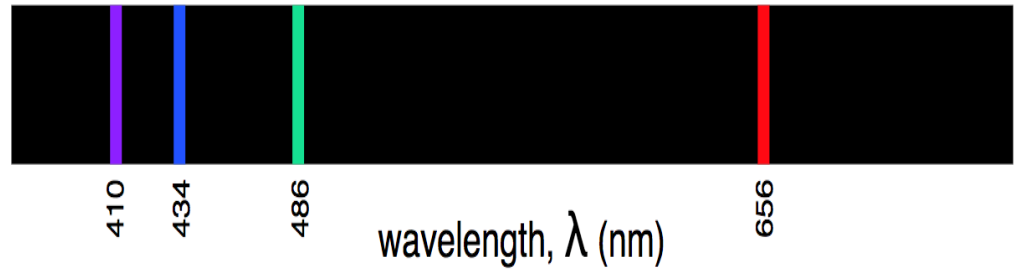
A **ball bouncing down a flight of stairs** provides an analogy for energy levels of electrons in atoms: it can only rest on each step, not between steps; the lowest possible step is “ground”.



- An isolated atom will only have light emissions of **certain colors** corresponding to all the **allowed transitions** of electrons between energy levels (“steps”).

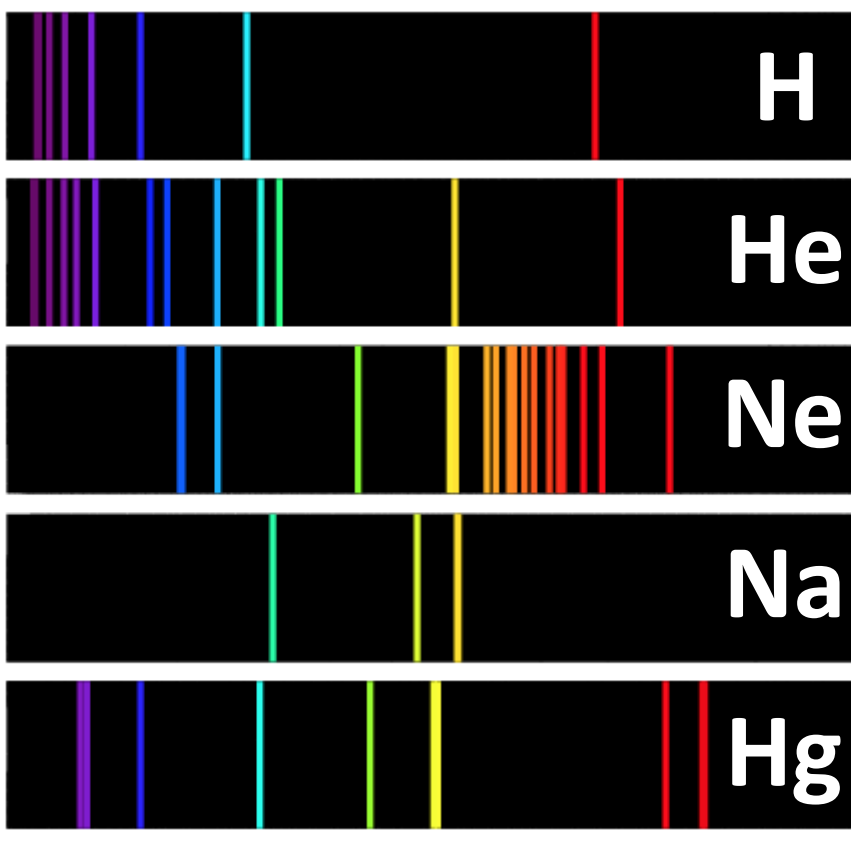
- This set of distinct colors is called **line emission spectrum**

Hydrogen Atom



Atomic Spectrum

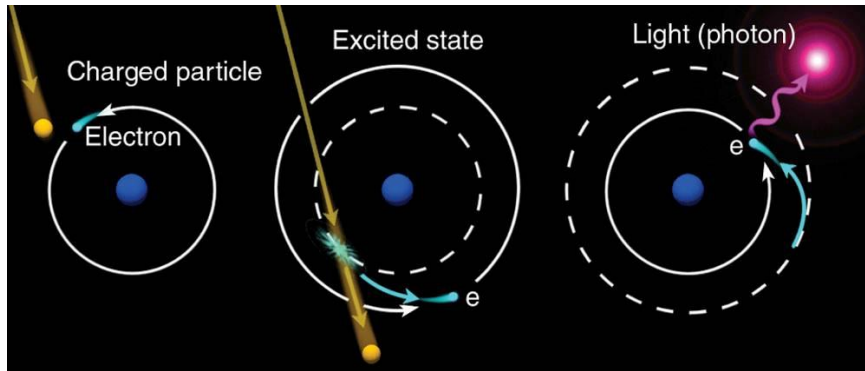
Each particular chemical element has a unique electron configuration and hence its own **unique line emission spectrum**, also called atomic spectrum.



- **Spectroscopy** can be used to **identify the elements** in matter of unknown composition.
- Similarly, the **emission spectra of simple molecules** can be used in **chemical analysis of substances**.
- Emission spectra are given by **matter in a gaseous state**: the atoms or molecules are so far apart that they behave like they are isolated.

Aurora (Northern Lights)

The aurora forms when **charged particles** emitted from the Sun (solar wind) get caught up in the Earth's magnetic field and **collide with atoms and molecules** in the top of the atmosphere.

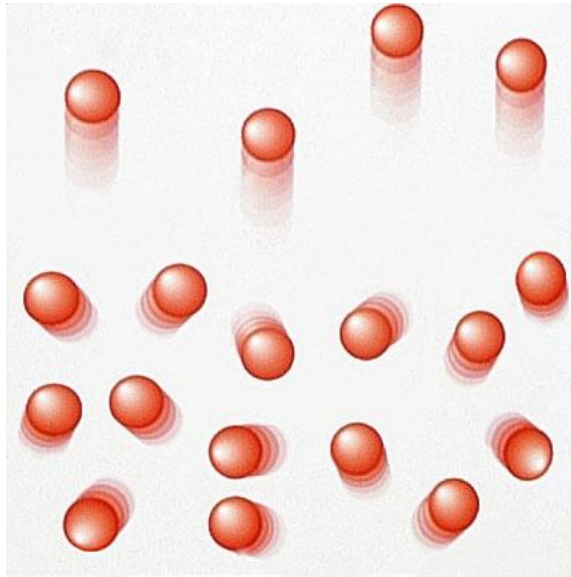


Different colors of the aurora are produced by different atmospheric components:

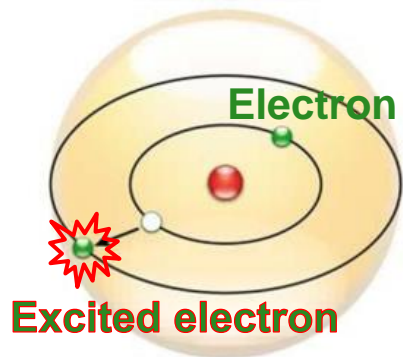
- **Red** – oxygen atoms at ~200 miles high
- **Blue** – ionized nitrogen molecules
- **Green-Yellow** – oxygen atoms at ~60 miles high – **most common!**
- **Pink/crimson/purple** – mix of the above



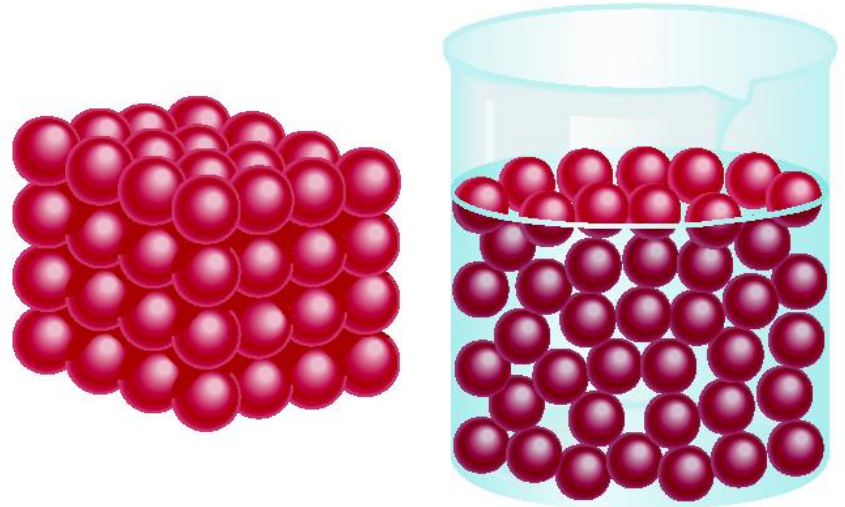
Gases



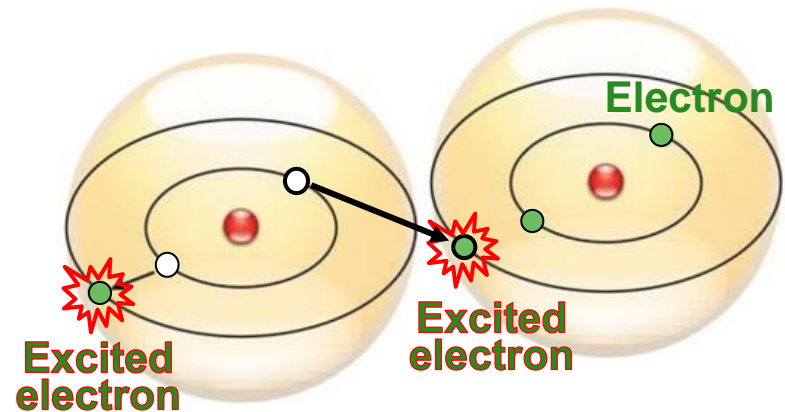
atoms far apart



Solids/Liquids

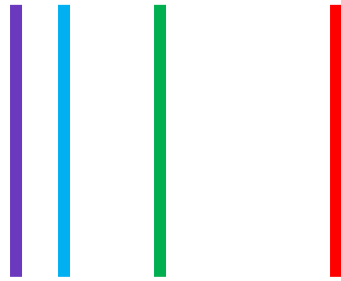


atoms close to each other

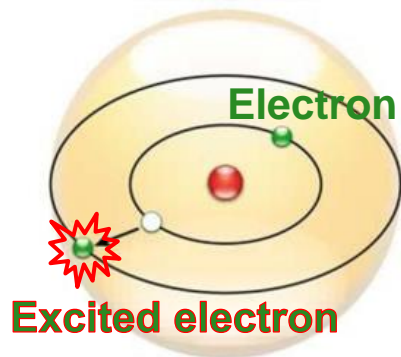


Gases

atoms far apart



limited set of distinct colors



VS

Solids/Liquids

atoms close to each other



much greater number of possible colors

