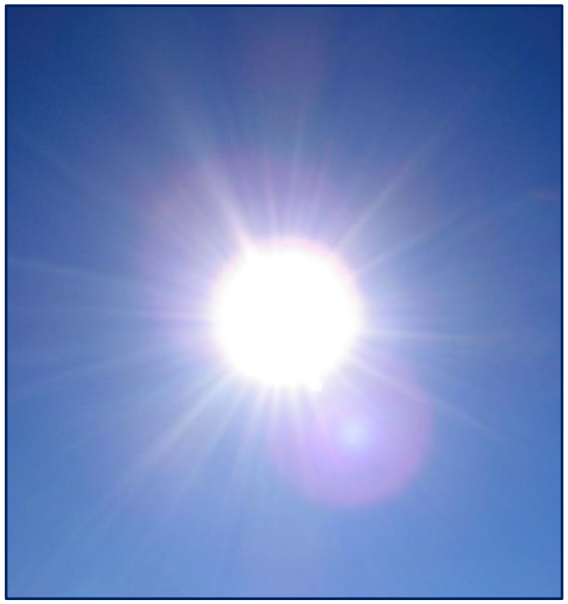
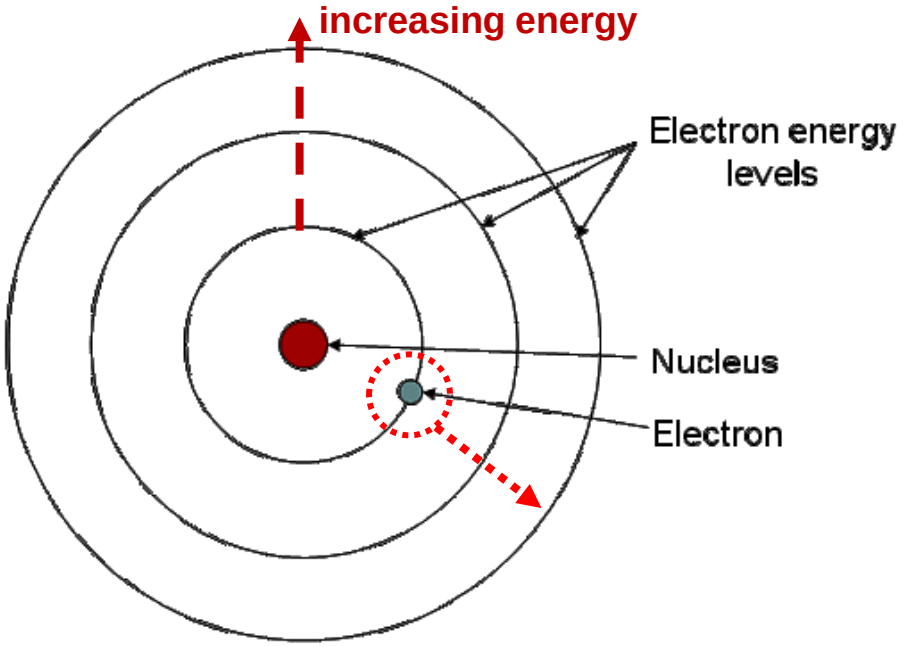
How to Make Light?



How to Make Light?

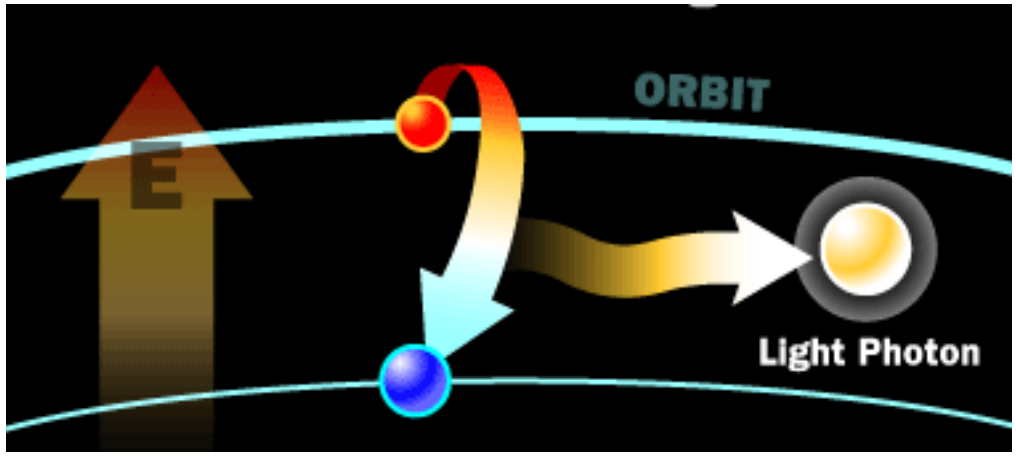
Electrons in Atoms

Electrons in atoms exist in one or more <u>energy levels</u> (*orbitals*) around the nucleus.



- **When matter gains energy, for example by being heated, the additional energy pushes the electrons in atoms to <u>higher energy orbitals</u>.**

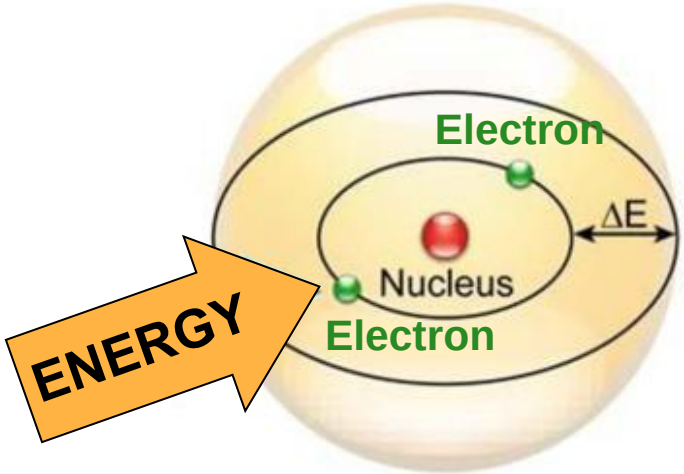
- **Electrons tend to <u>return back</u> to their initial orbitals; their "extra" energy is emitted in the form of a *particle-like packet of electromagnetic radiation* called a photon.**



Emission of Light

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

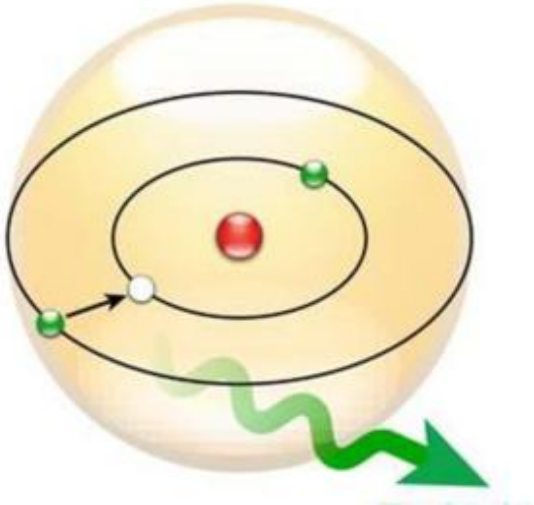
ground state ("cool")



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

excited state ("hot")

back to ground state

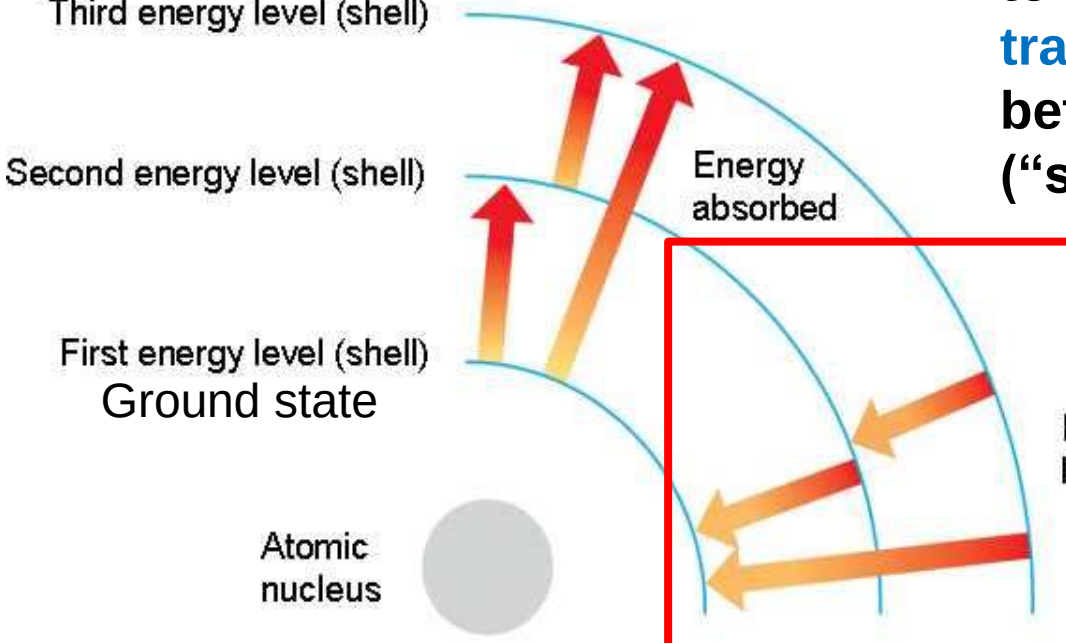


LIGHT

(ENERGY!)

A *ball bouncing down a flight of stairs* provides an analogy for <u>energy levels of electrons in atoms</u>:

it can only rest on each step, not between steps;
the lowest possible step is "ground".

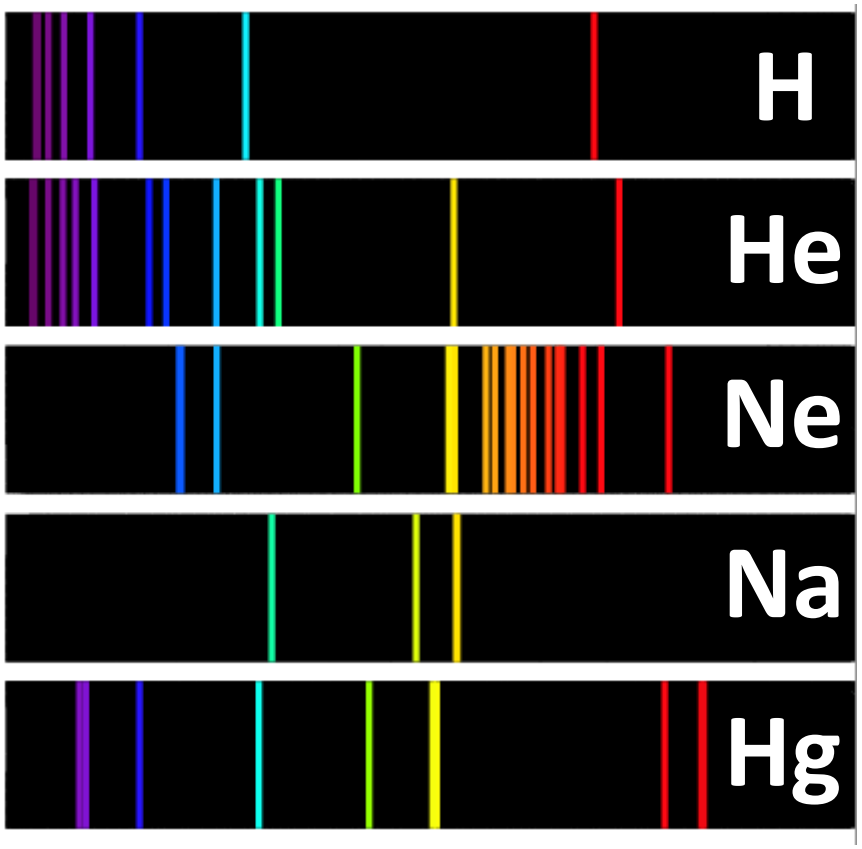


- **An <u>isolated atom</u> will only have light emissions of certain colors corresponding to all the allowed transitions of electrons between energy levels ("steps").**

- **This set of <u>distinct colors</u> is called line emission spectrum**

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.**

Flame Test

A flame test is an analytic procedure used in chemistry to detect the presence of certain elements, primarily metal ions, based on their unique emission spectrum.

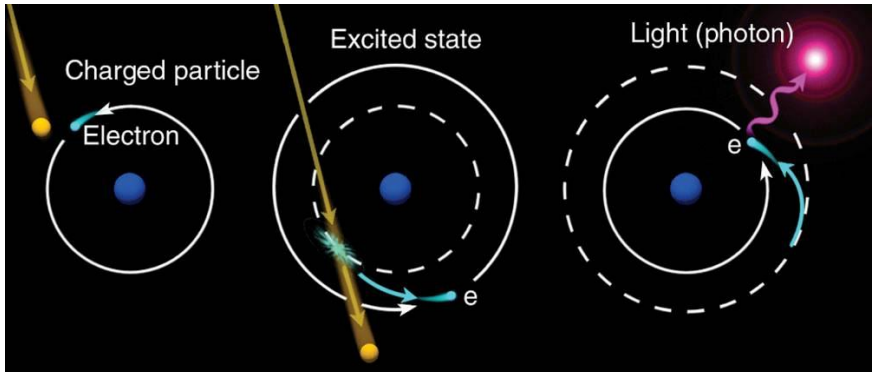
The idea:

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

Fireworks

Aurora (Northern Lights)

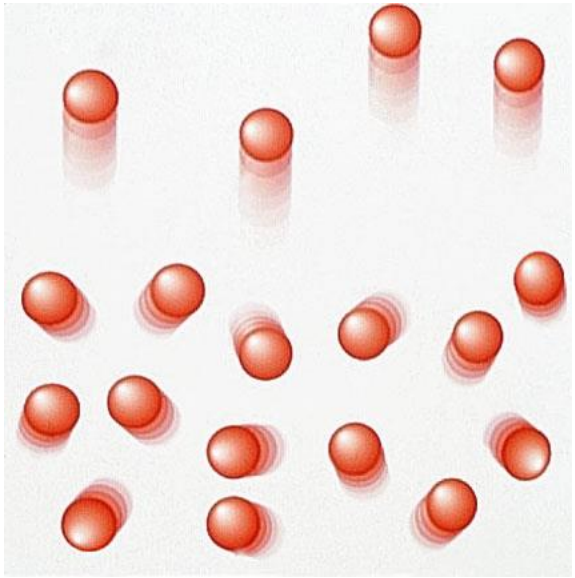
The aurora forms when charged particles emitted from the Sun (solar wind) get caught up in the Earth's magnetic field and collide with atoms and molecules in the top of the atmosphere.



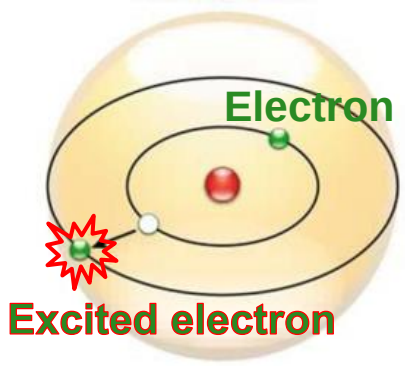
Different colors of the aurora are produced by different atmospheric components:

- **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

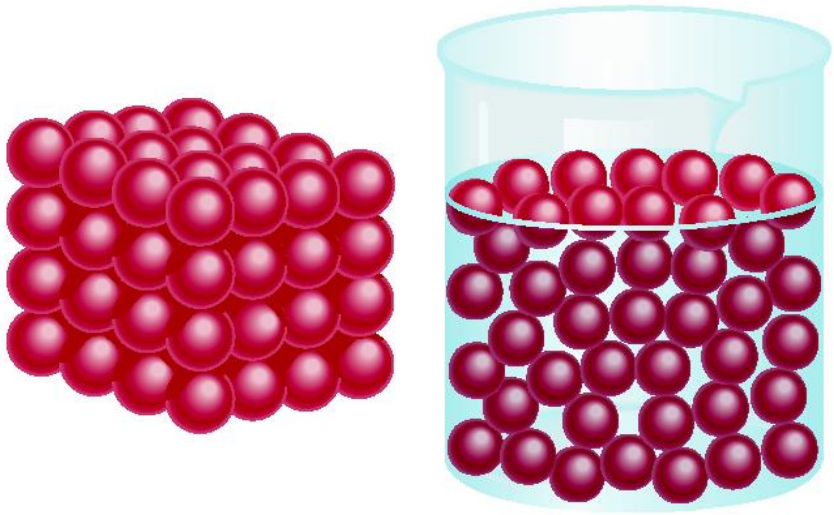


atoms far apart



VS

Solids/Liquids



atoms close to each other