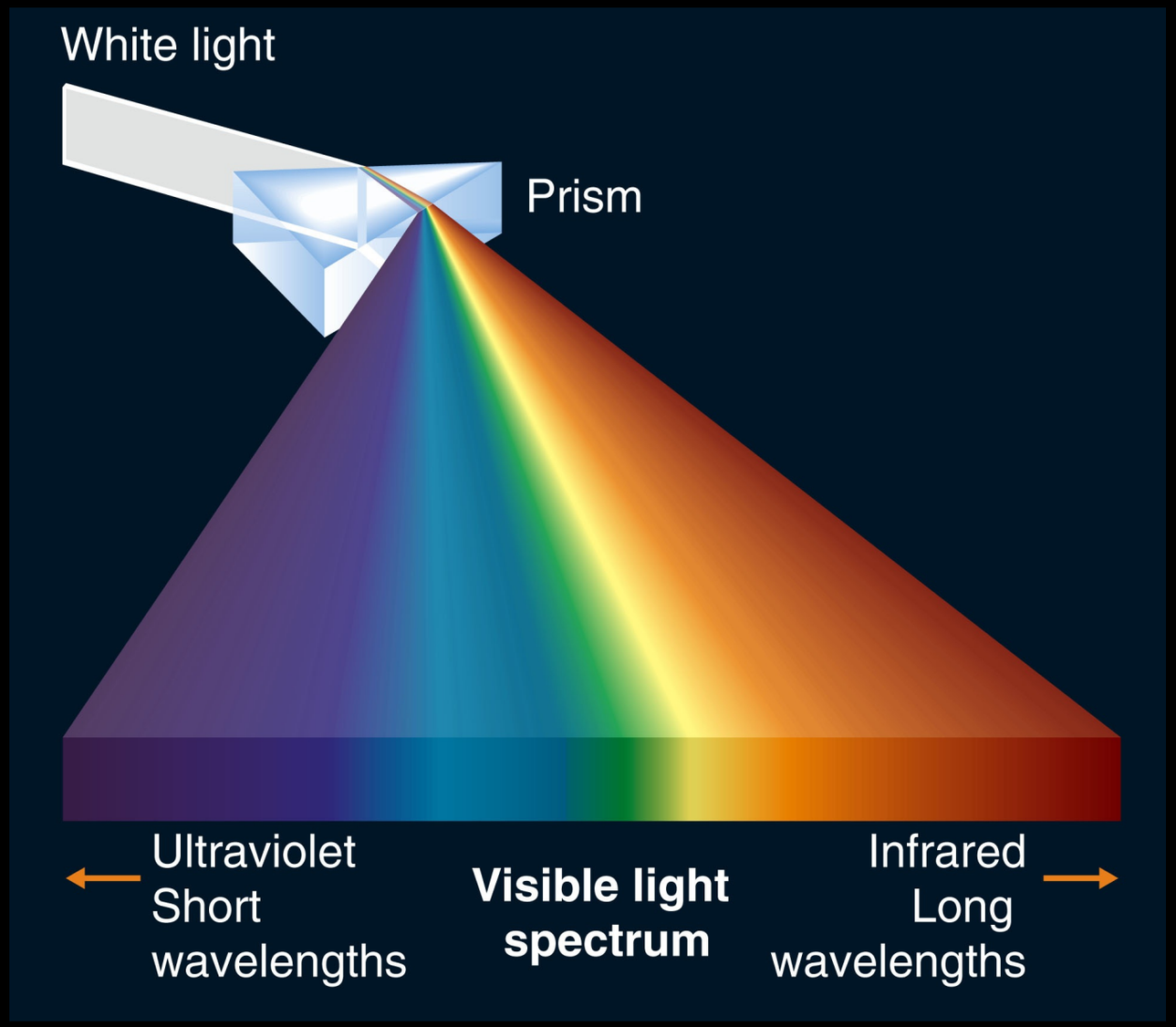
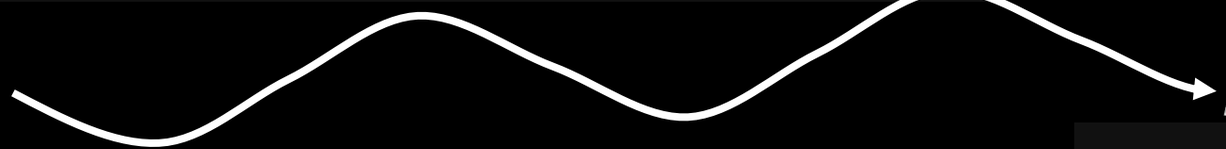

NEVER
TRUST
AN ATOM
They Make Up
Everything

To analyze light in detail, we need to spread the light out according to wavelength into a spectrum—a task performed by a spectrograph.

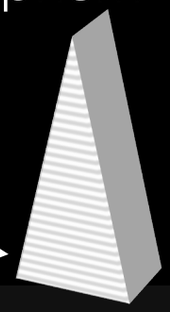


There are three types of spectra!

Hot/Dense Energy Source



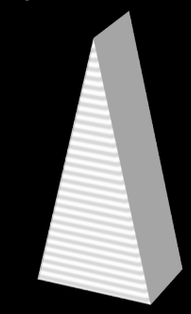
prism



Continuous Spectrum

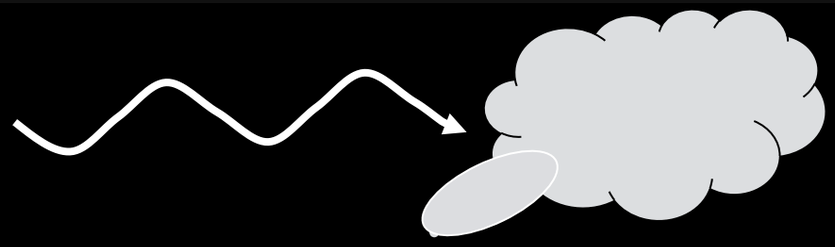
Hot low density cloud of Gas

prism



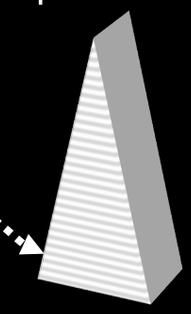
Emission Line Spectrum

Hot/Dense Energy Source



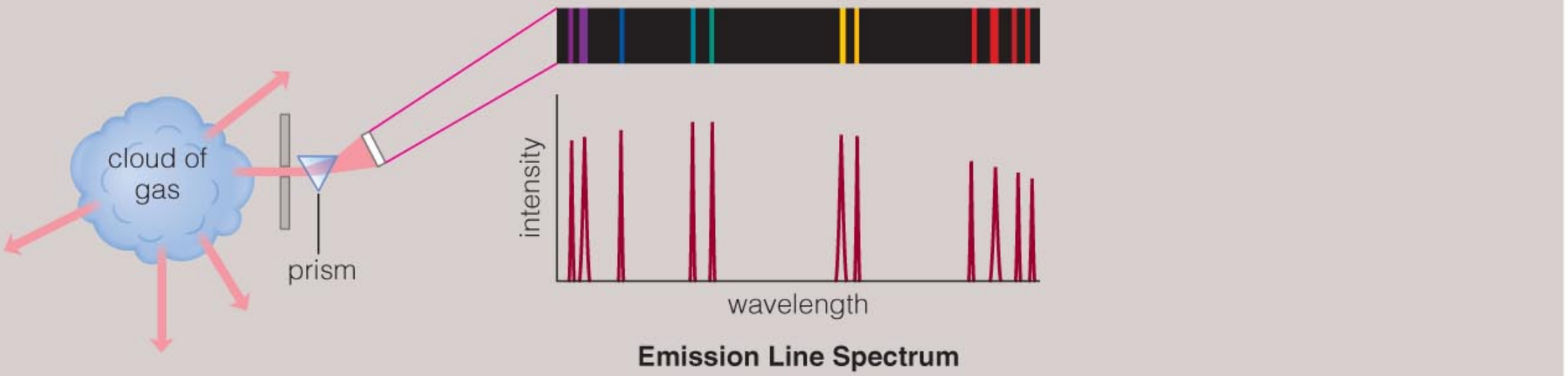
Cooler low density cloud of Gas

prism



Absorption Line Spectrum

Emission Line Spectrum

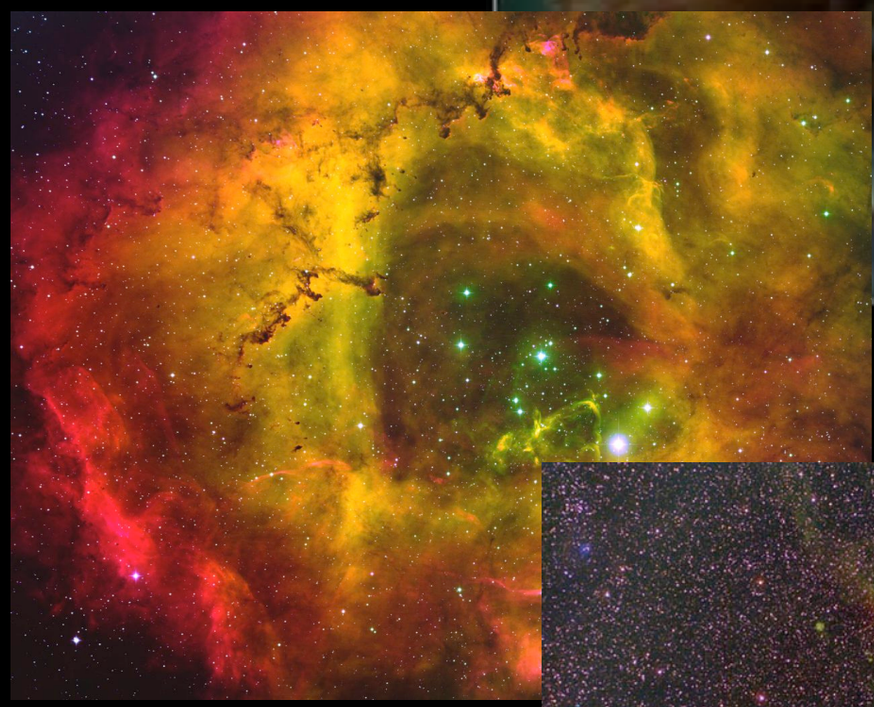


A thin or low-density cloud of gas emits light only at specific wavelengths that depend on its composition and temperature, producing a spectrum with bright emission lines.

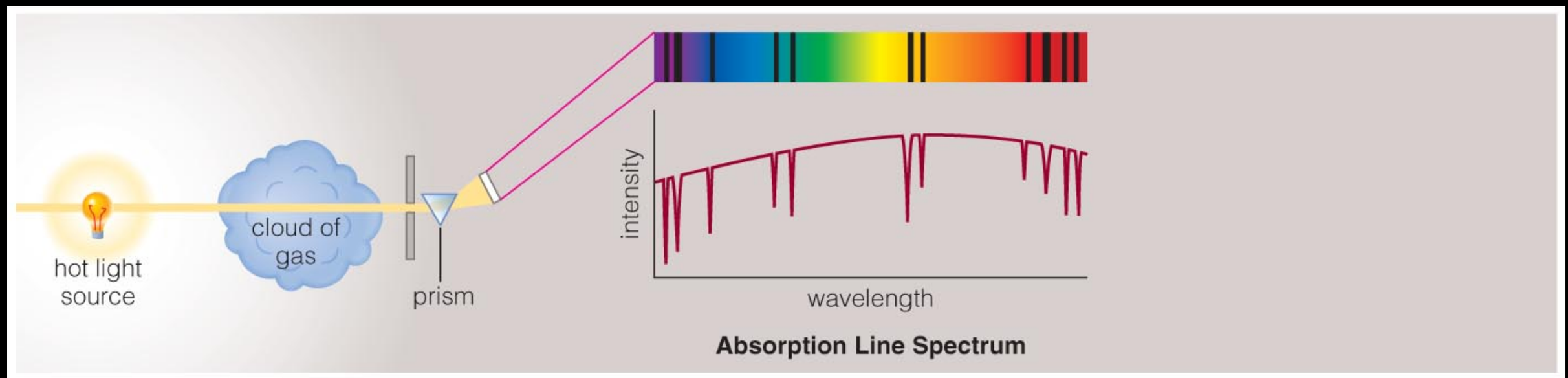
What emits an Emission Line Spectrum?

Neon Sign

Nebula

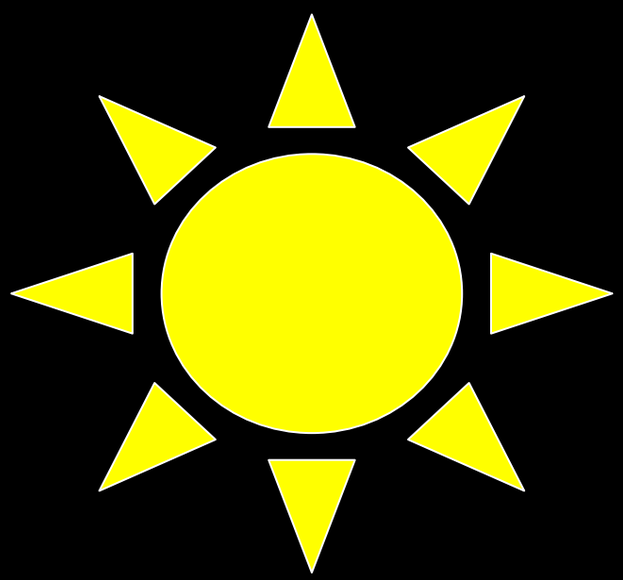


Absorption Line Spectrum

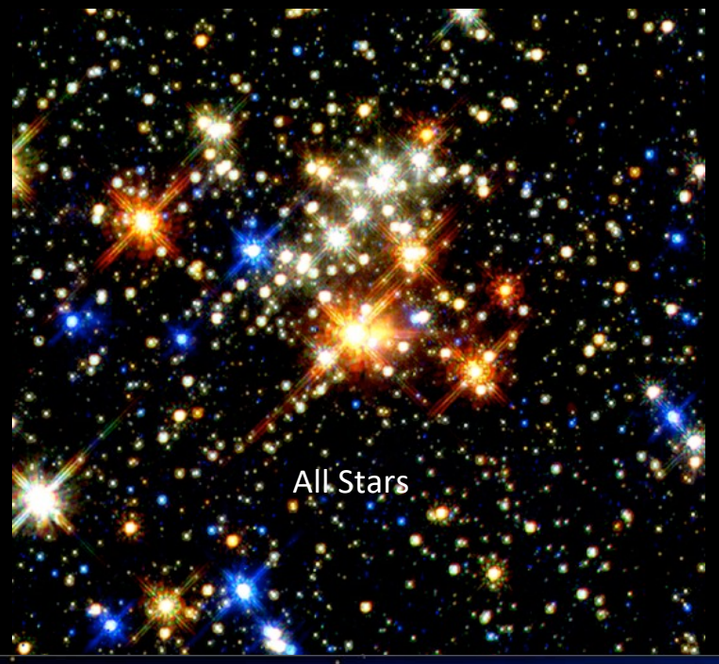


A cloud of gas between us and a light bulb can absorb light of specific wavelengths, leaving dark absorption lines in the spectrum.

What Emits an Absorption Line Spectrum?

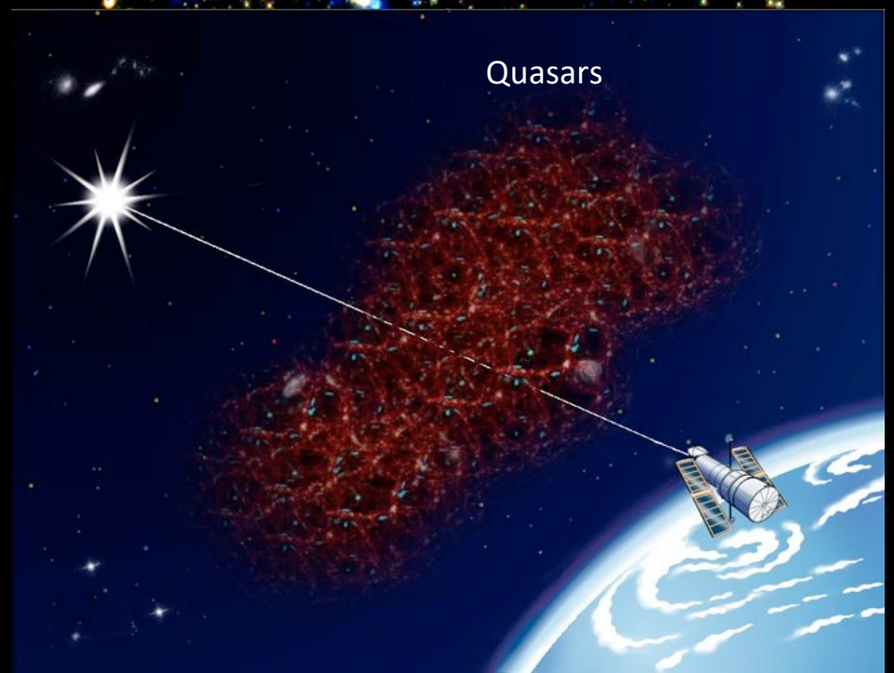


The Sun



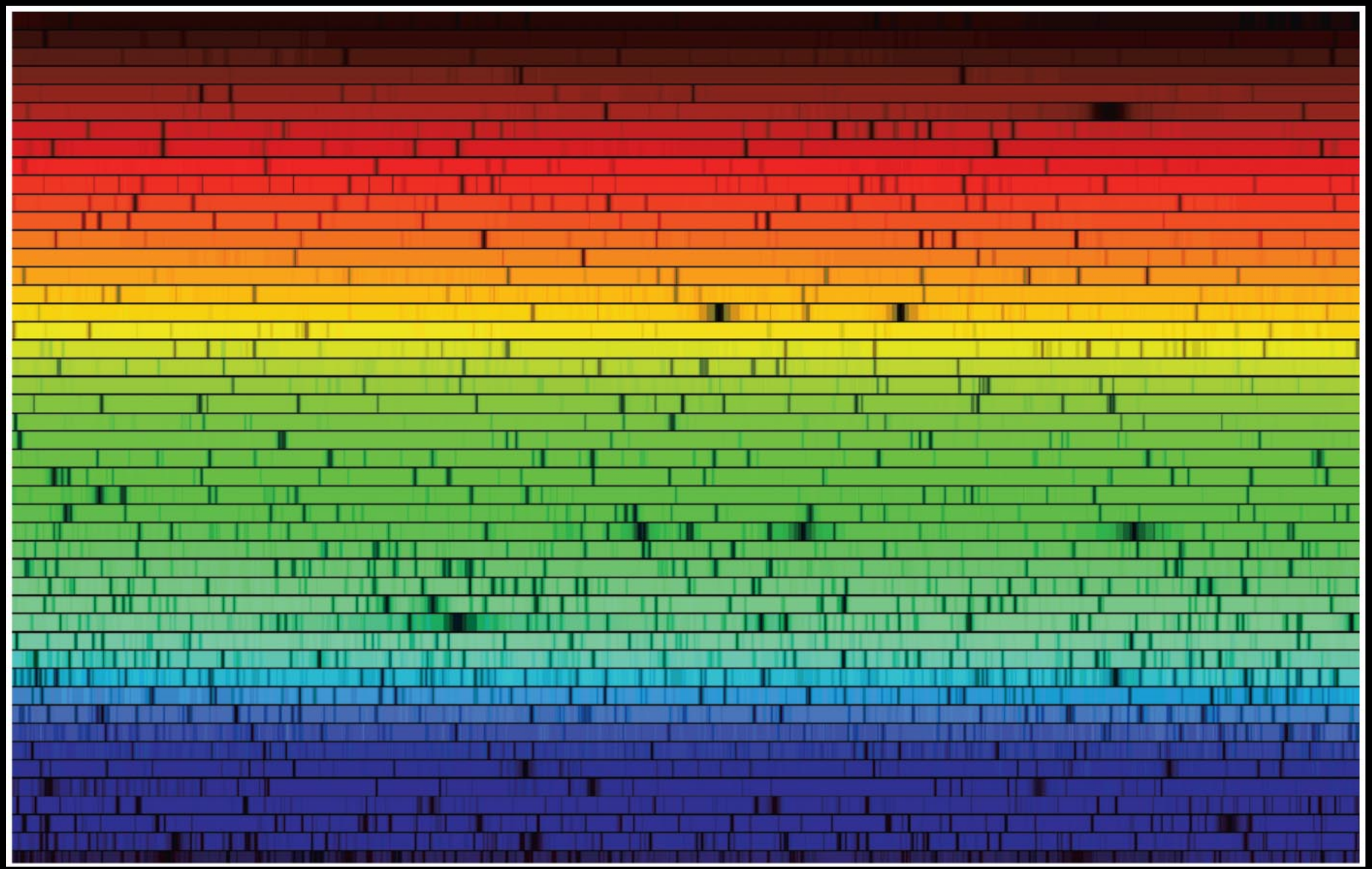
All Stars

Earth's atmosphere



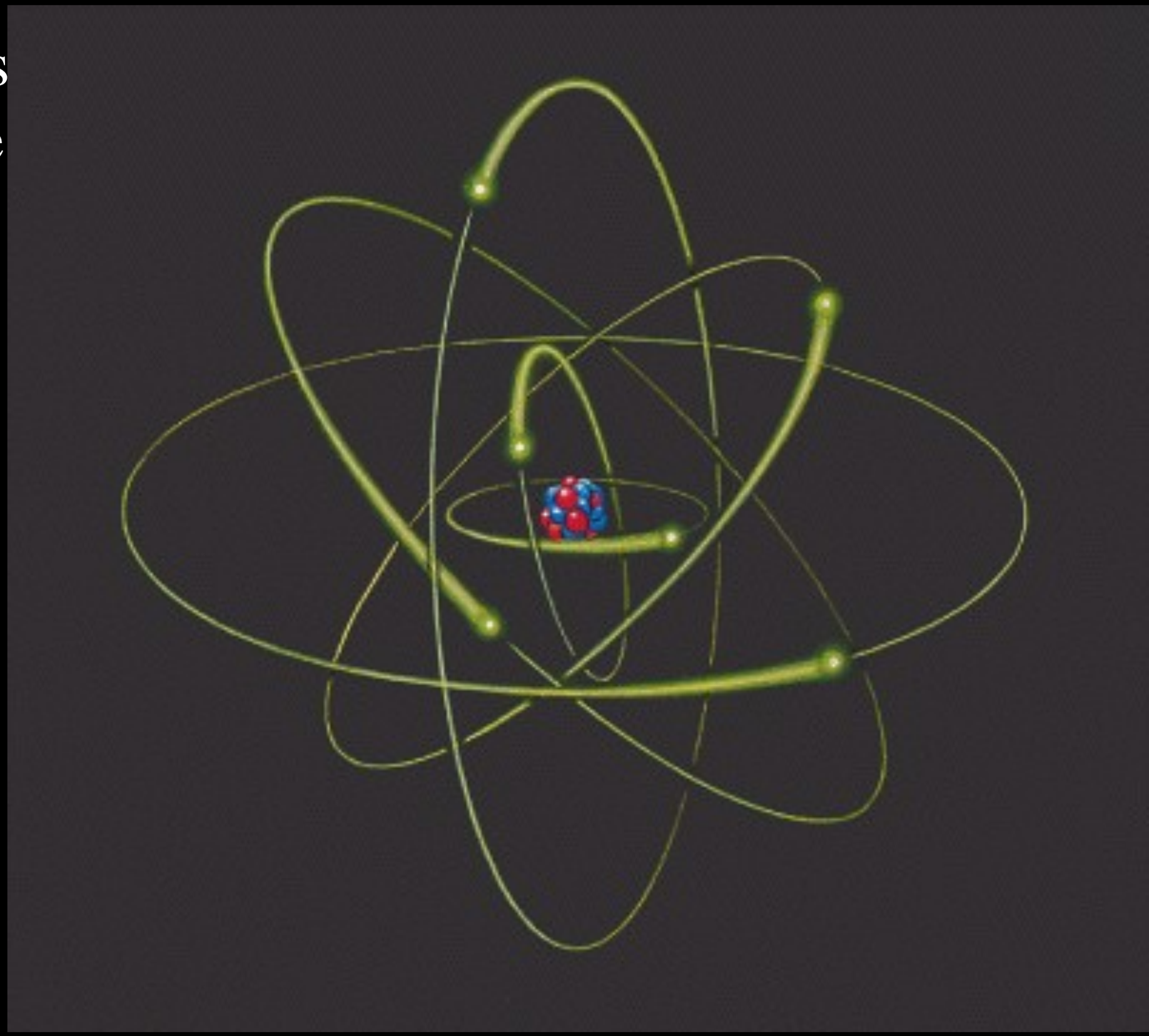
Quasars

How does light tell us what things are made of?



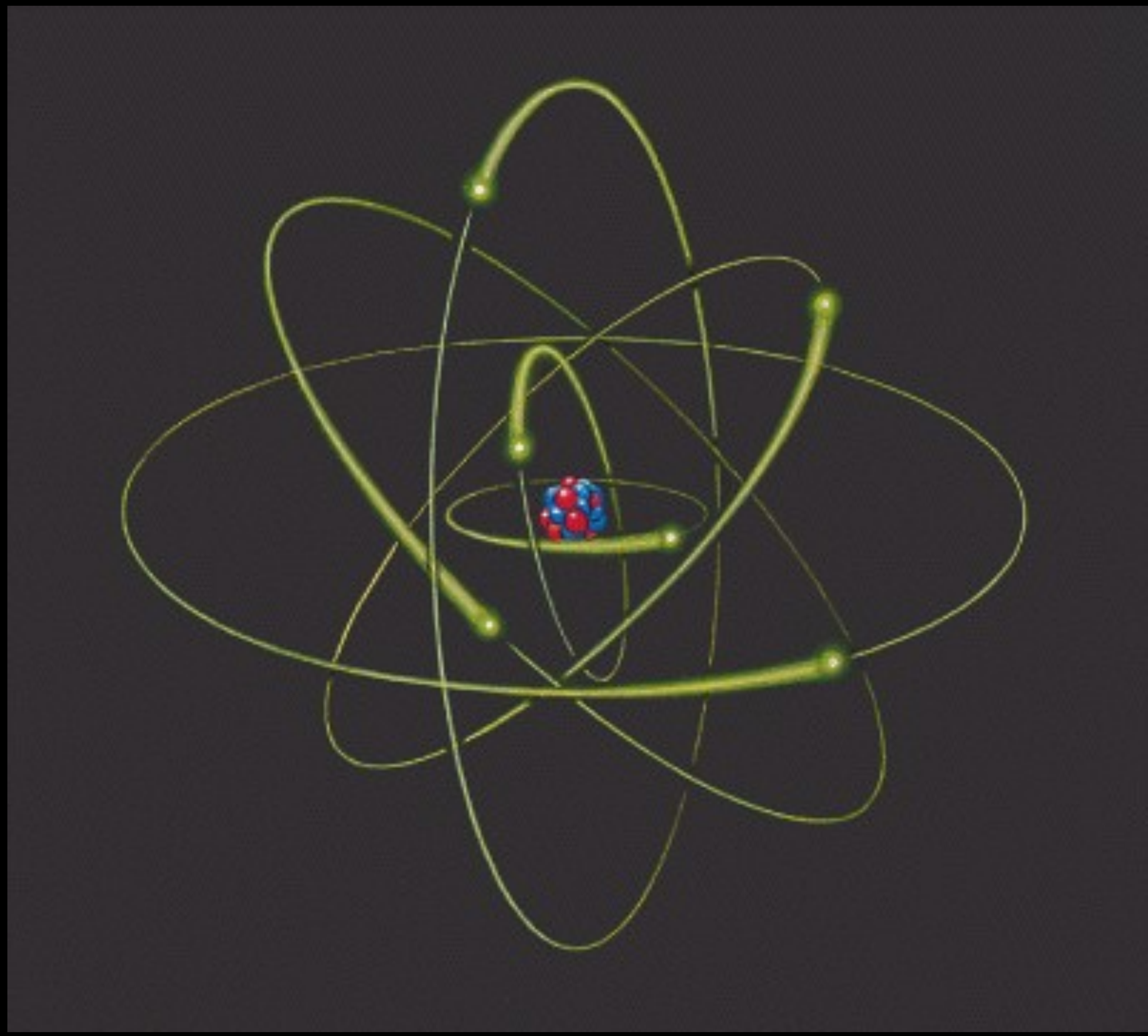
An atom consists of a small, dense nucleus (containing protons and neutrons) surrounded by electrons

- Model Proposed by Niels Bohr 1913

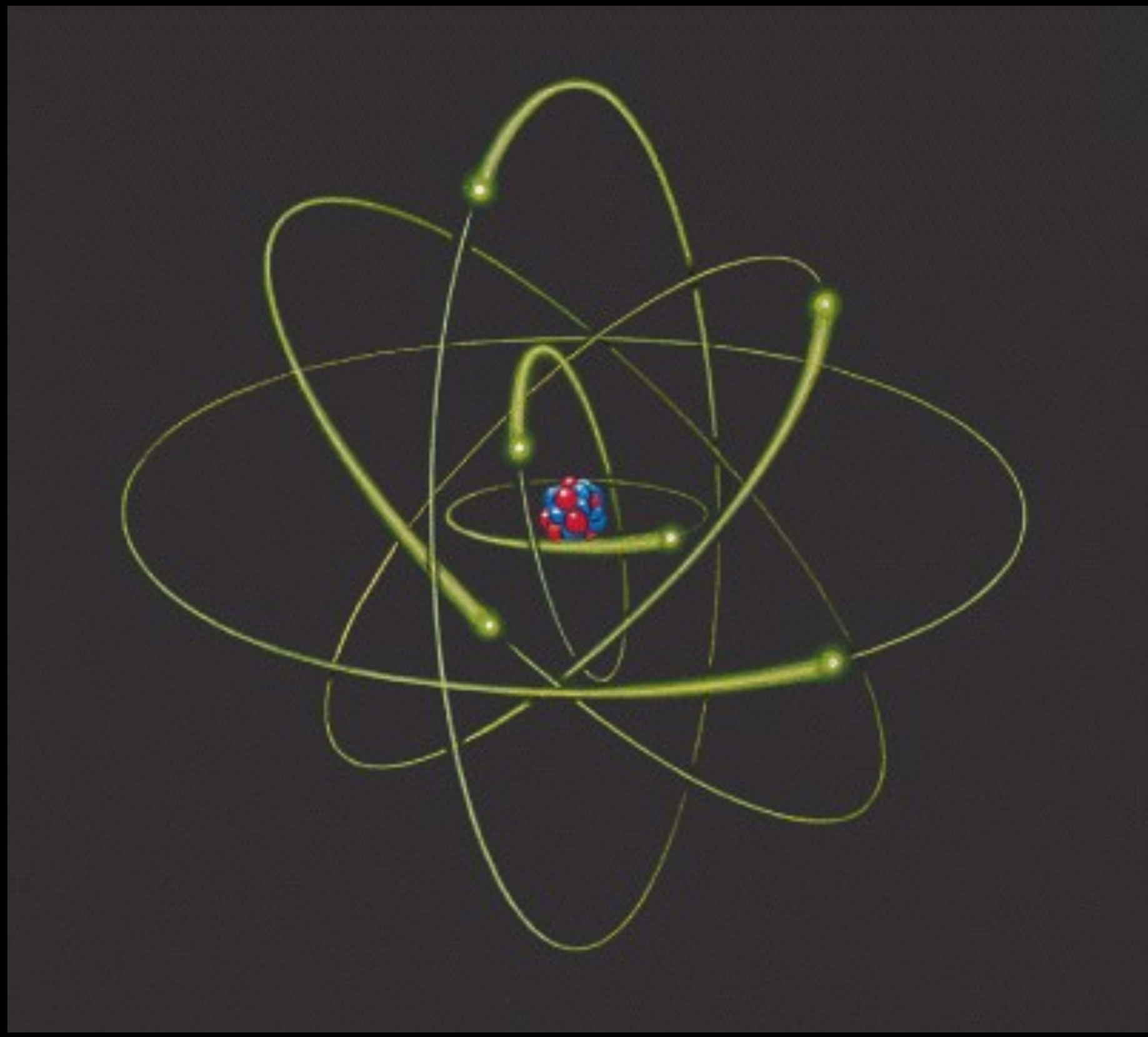


Atoms are mostly empty space

A nucleus is about 10^{-15} m in size and the first electron orbits out at 10^{-10} m from the center of the atom – The size of the electron orbit is 100,000 times greater than the size of the nucleus.

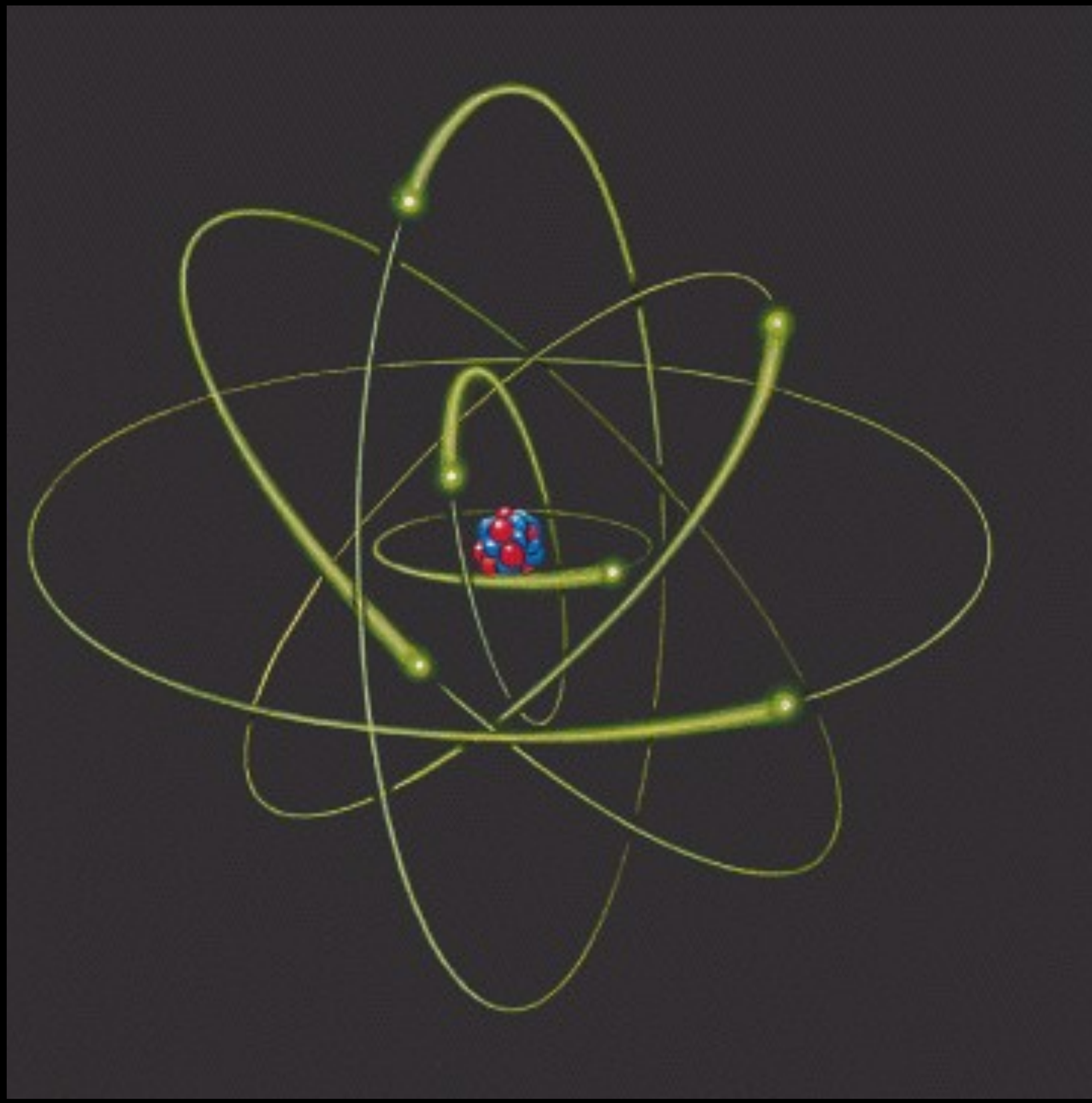


So if a nucleus the size of an orange (10 cm) was located at the center of the athletic field, where would the electron be?
End Zone?
Grandstands?
On Campus?
In Cupertino?



If the electron's orbit is 100,000 times bigger than the nucleus then the electron would be 10,000 m or 6.21 miles away from the center of the field!

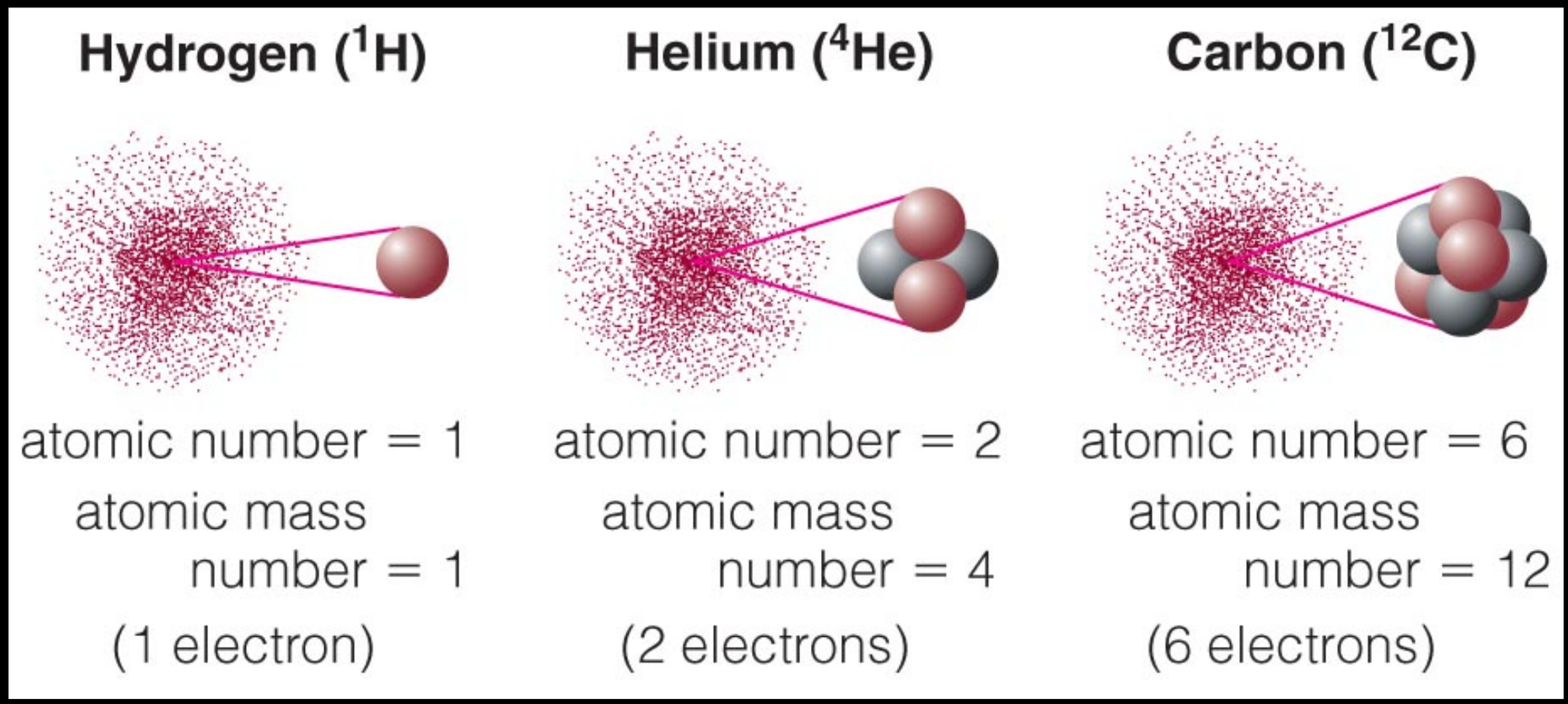
Still in Cupertino, but maybe up in the hills!



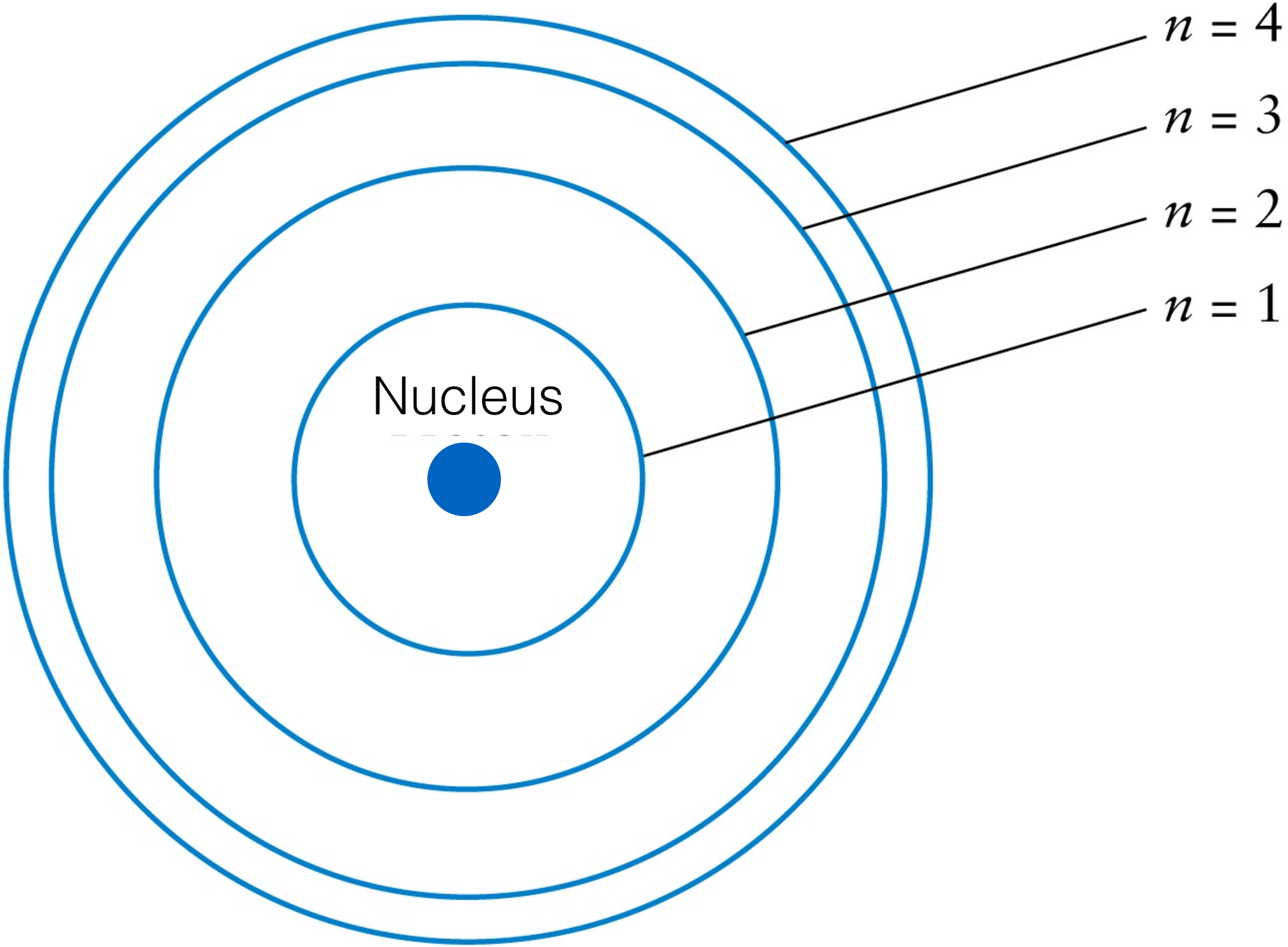
Atomic Terminology

Atomic number = # of protons in nucleus

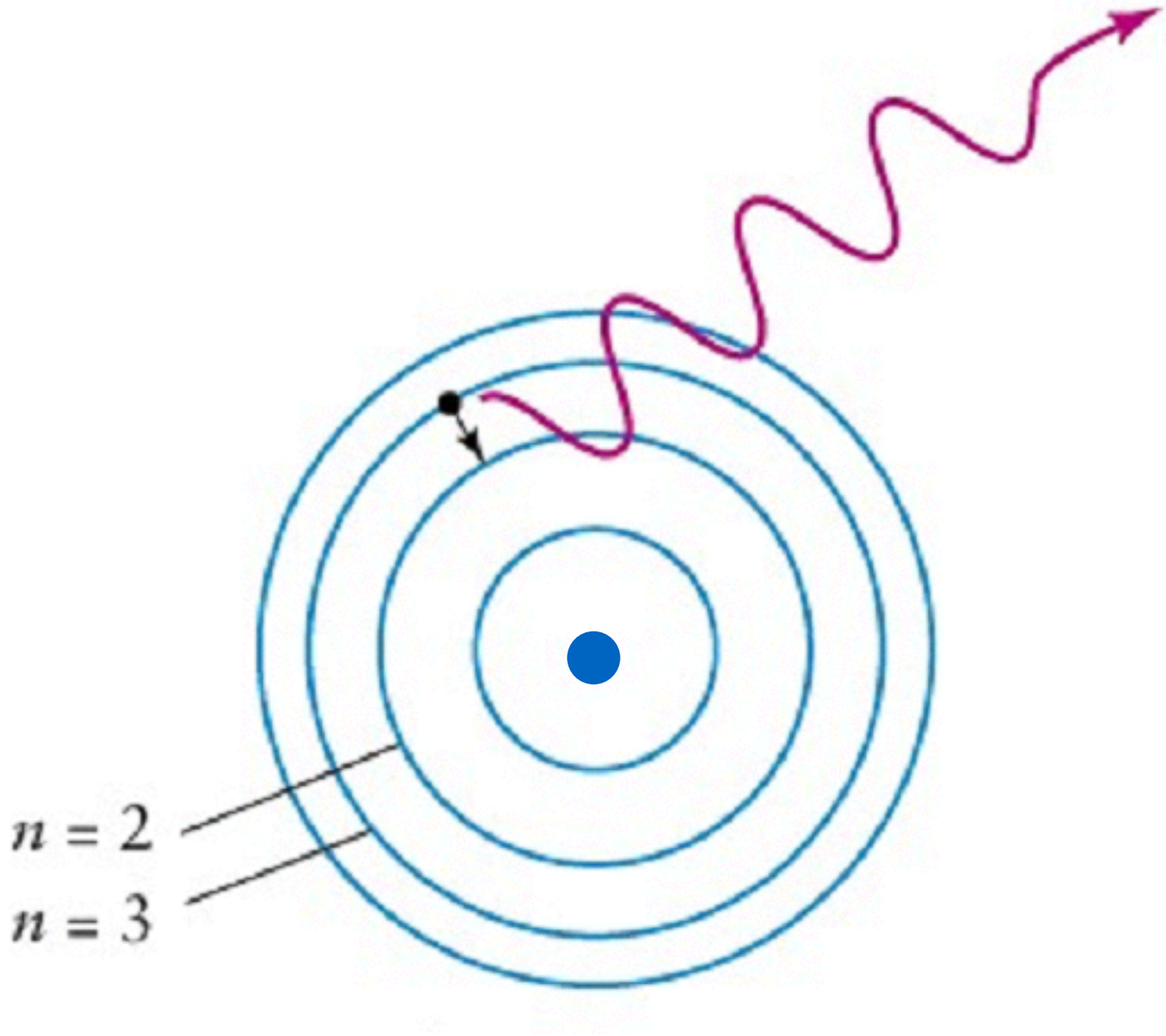
Atomic mass number = # of protons + neutrons



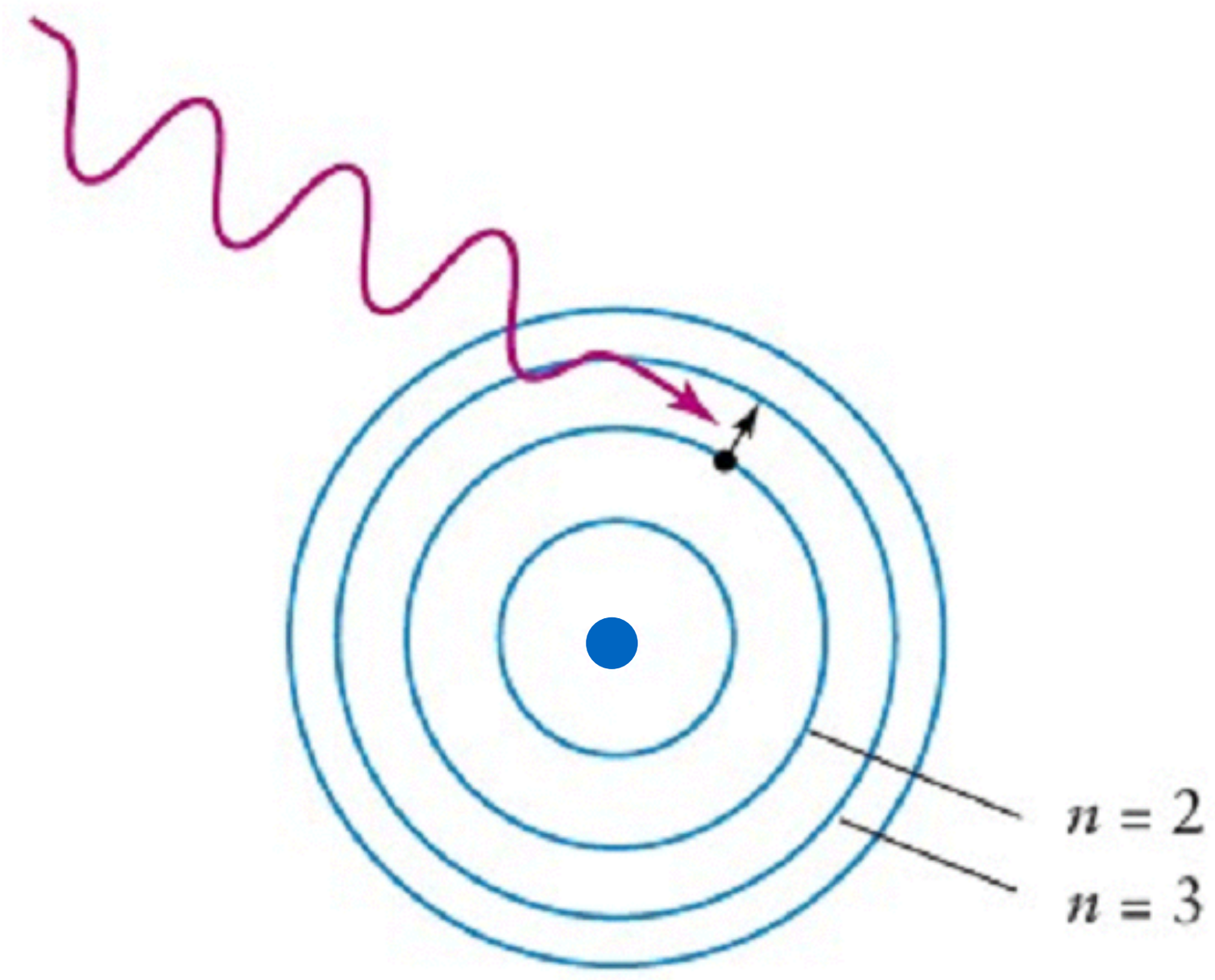
- Molecules: consist of two or more atoms (H_2O, CO_2)


$n = 4$
$n = 3$
$n = 2$
$n = 1$
Nucleus

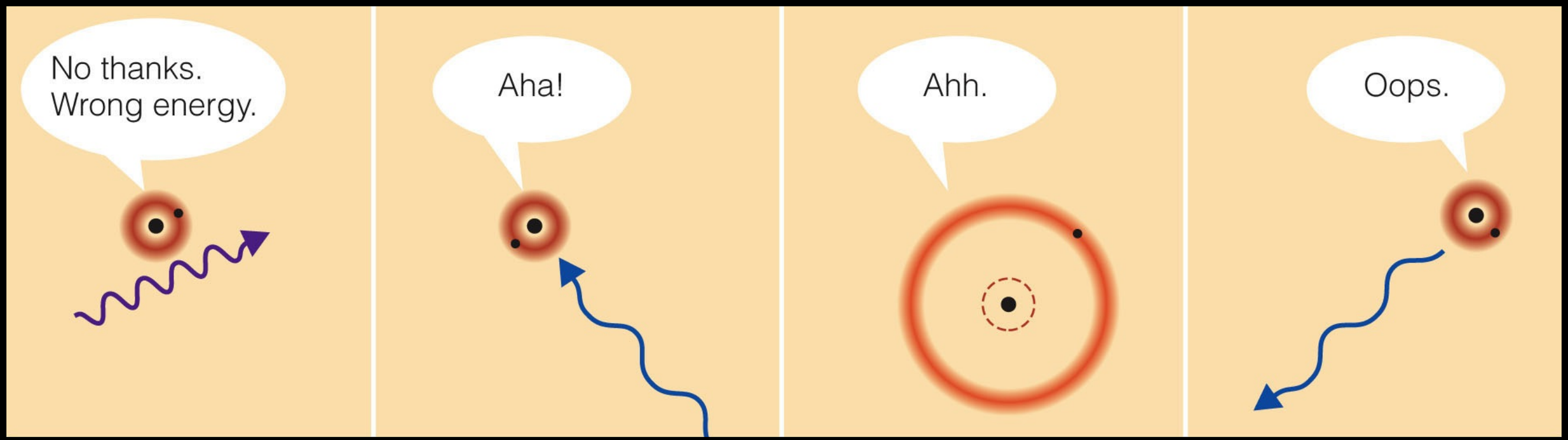
Photons (light-waves) are emitted from an atom when an electron moves from a higher energy level to a lower energy level



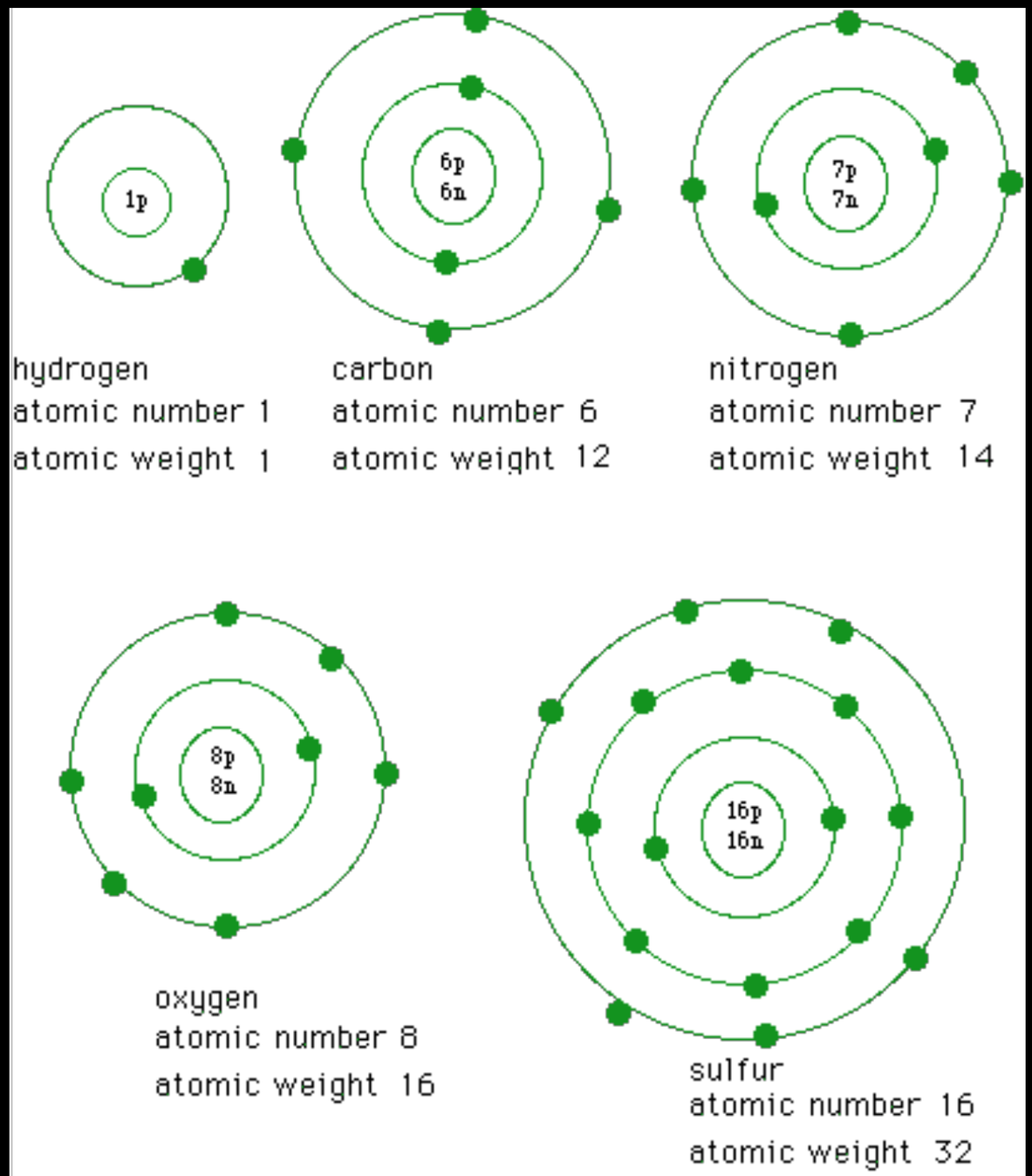
Photons (light-waves) can also be absorbed by an atom when an electron moves from a lower energy level to a higher energy level



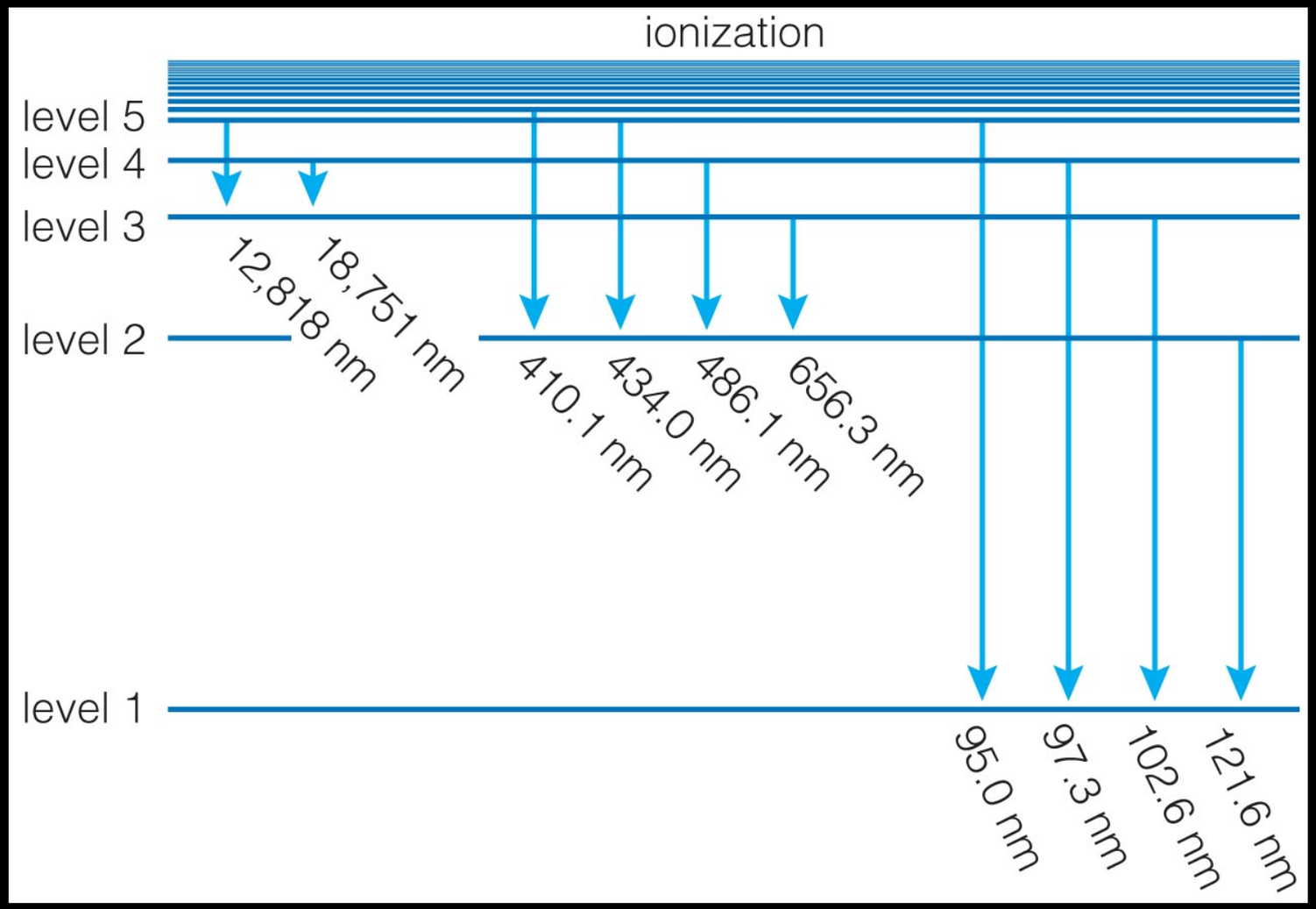
The sequence of events in the figure shows how an atom can absorb and emit photons.



Each type of atom or ion has a unique set of energy levels, thus, each type absorbs and emits photons with a unique set of wavelengths.



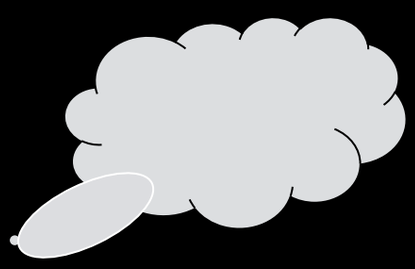
Chemical Fingerprints

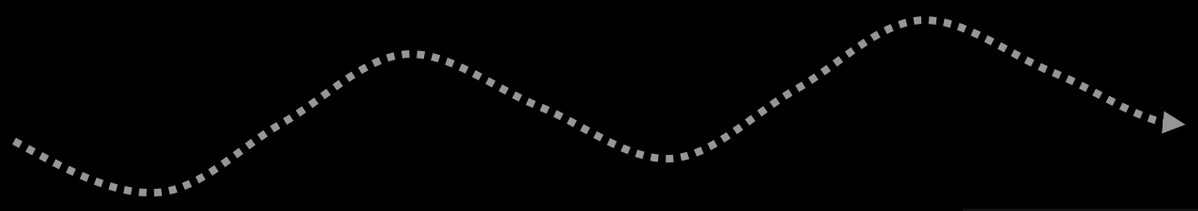


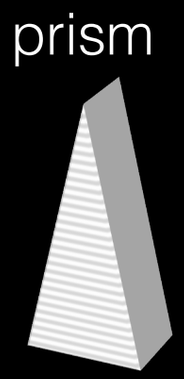
Each transition corresponds to a unique photon energy, frequency, and wavelength.

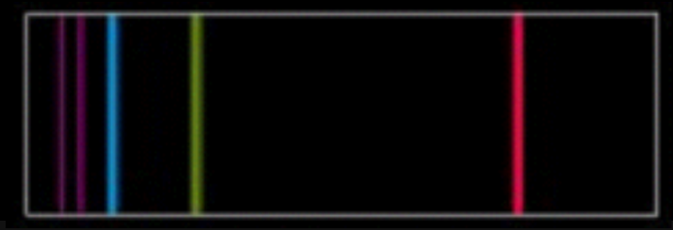
There are three types of spectra!

Hot low density cloud of Gas

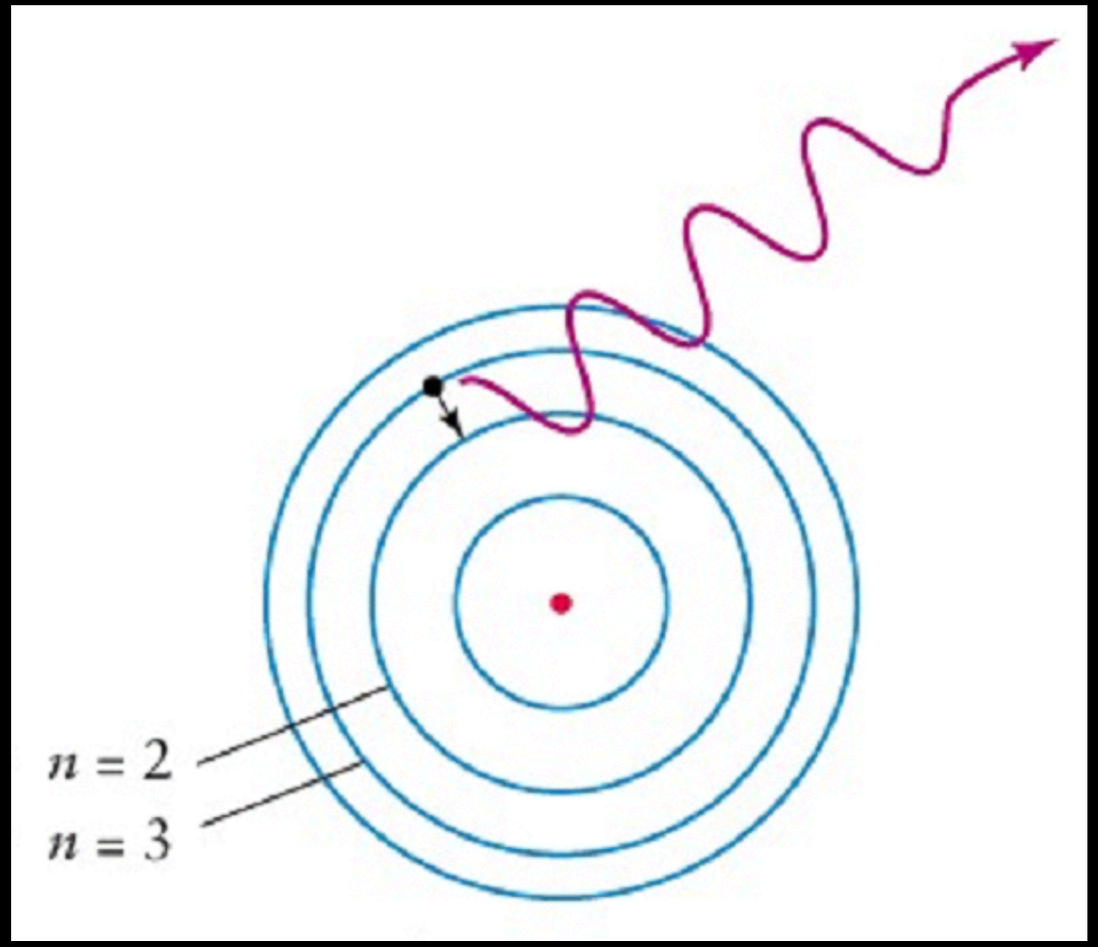








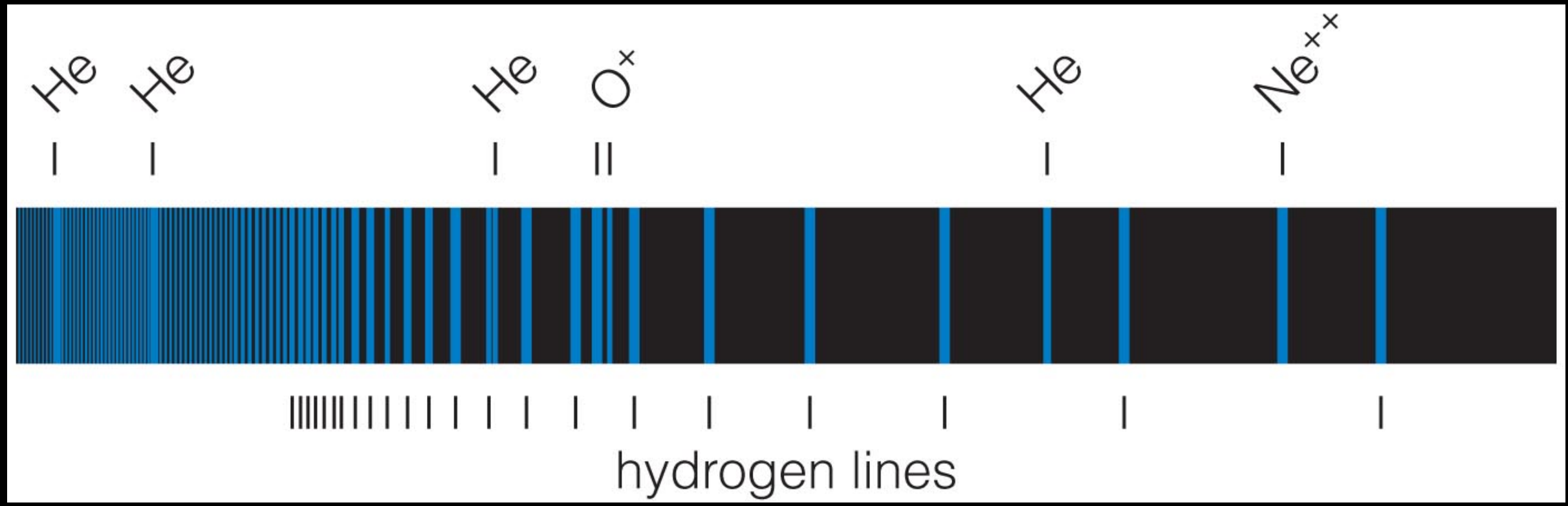
Emission Line Spectrum



Chemical Fingerprints

Each type of atom has a unique spectral fingerprint.

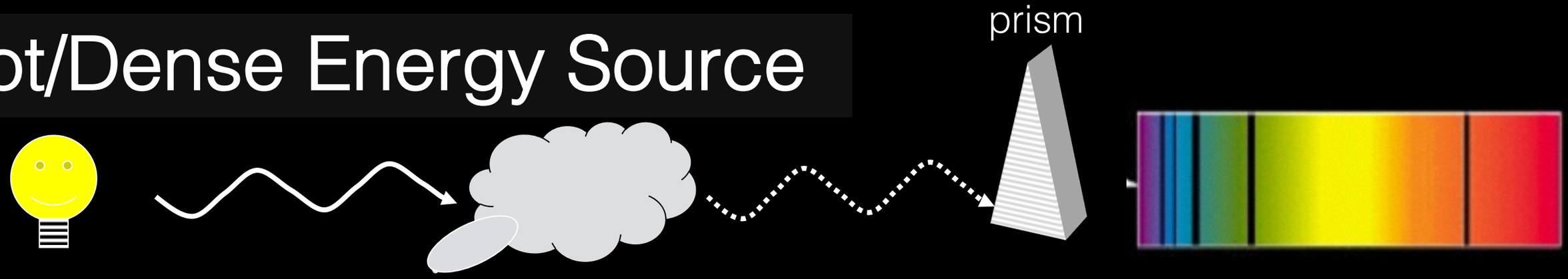
Chemical Fingerprints



Observing the fingerprints in a spectrum tells us which kinds of atoms are present.

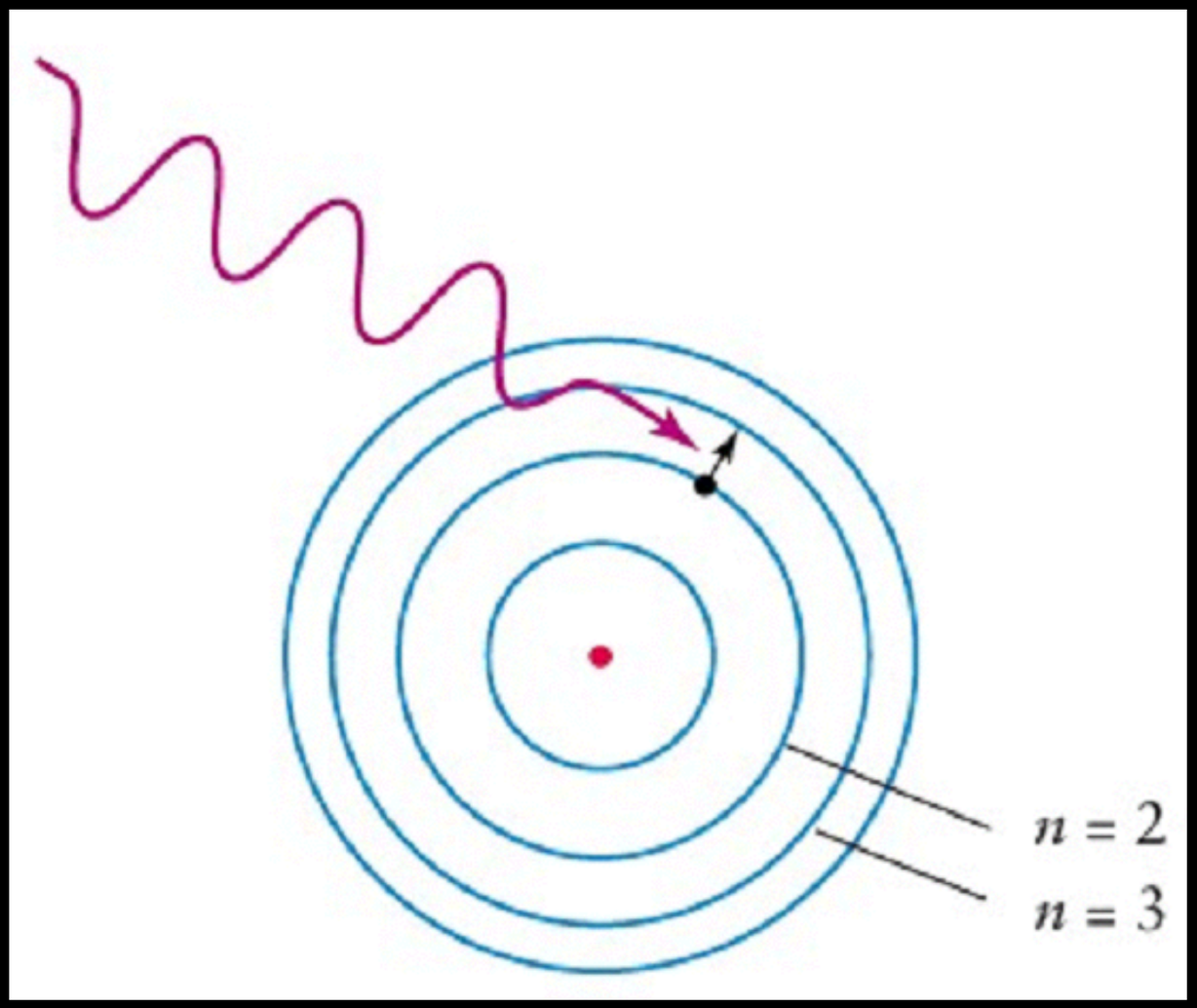
There are three types of spectra!

Hot/Dense Energy Source

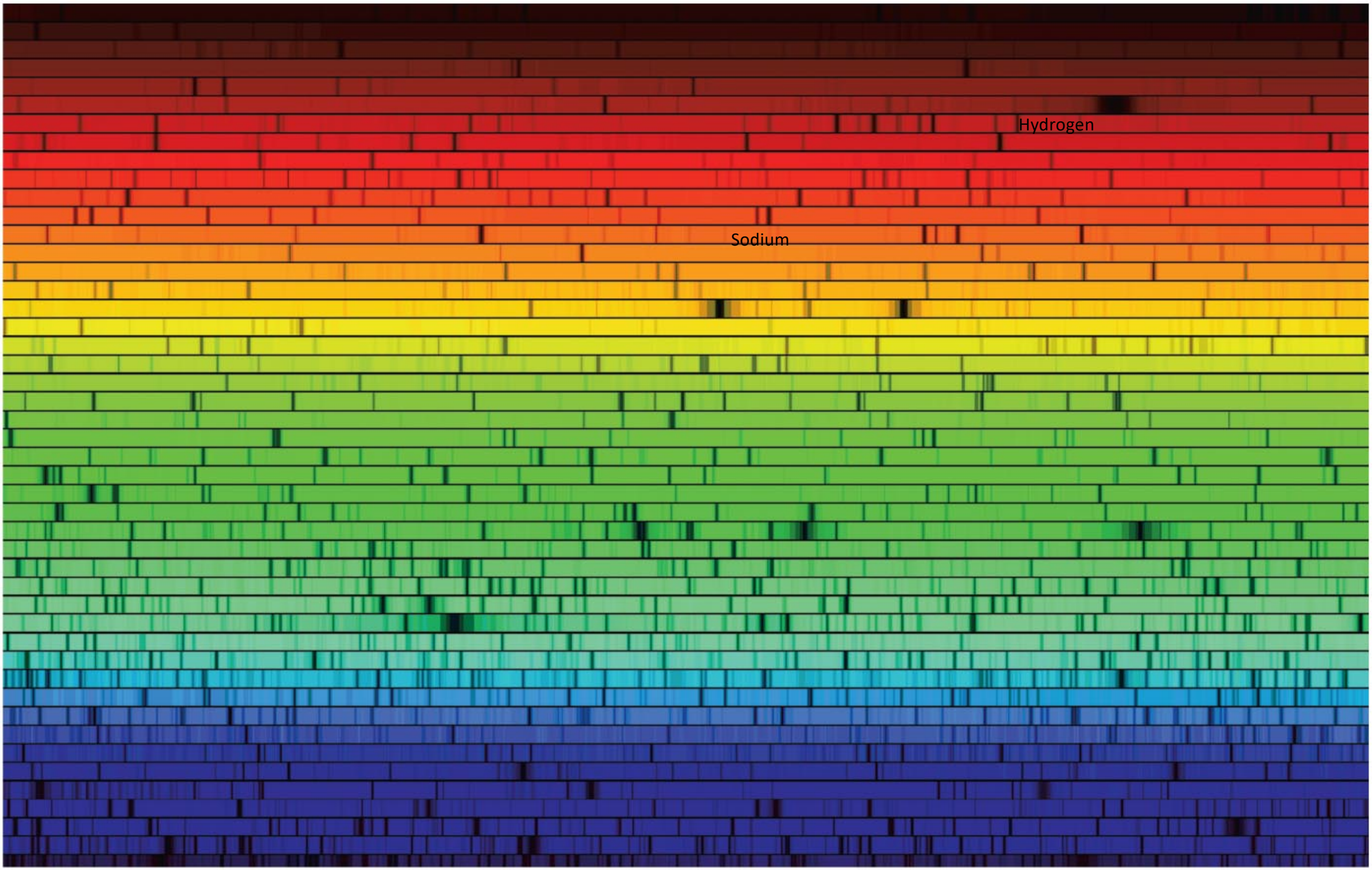


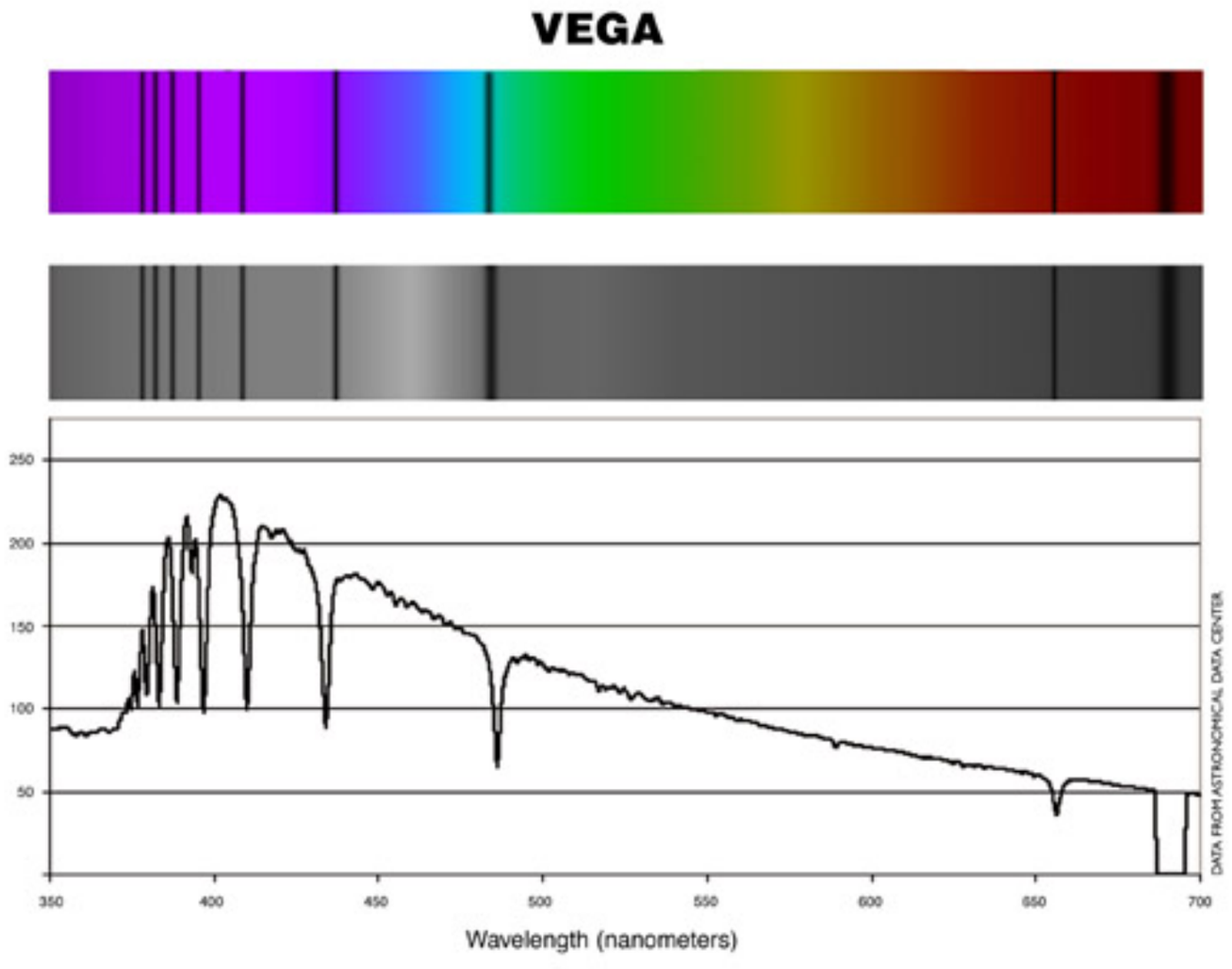
Cooler low density cloud of Gas

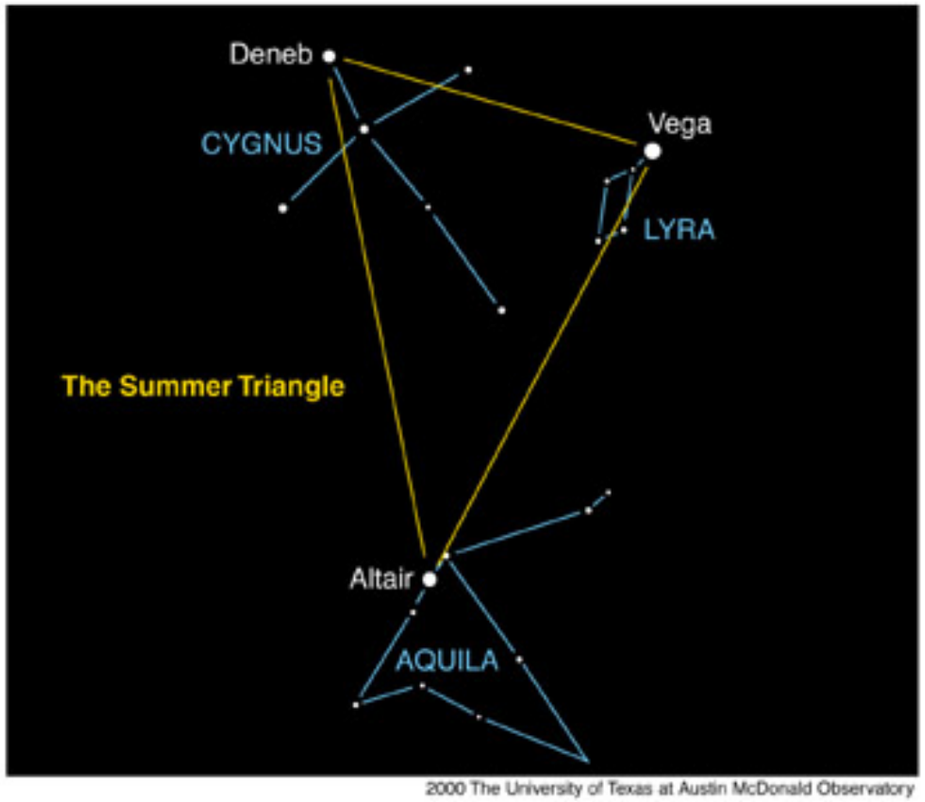
Absorption Line Spectrum



The Sun's Spectrum


Hydrogen
Sodium





All stars produce dark line absorption spectra

What type of spectra (continuous/absorption/ emission) come from these objects?

A. The Sun
B. An incandescent lightbulb
C. A neon sign
D. A distant star

What happens to the spectrum of the Sun after it passes through Earth's atmosphere?

A. It goes from continuous to emission line spectrum
B. It goes from emission to absorption
C. Nothing
D. It remains an absorption line spectrum, but with even more spectral lines