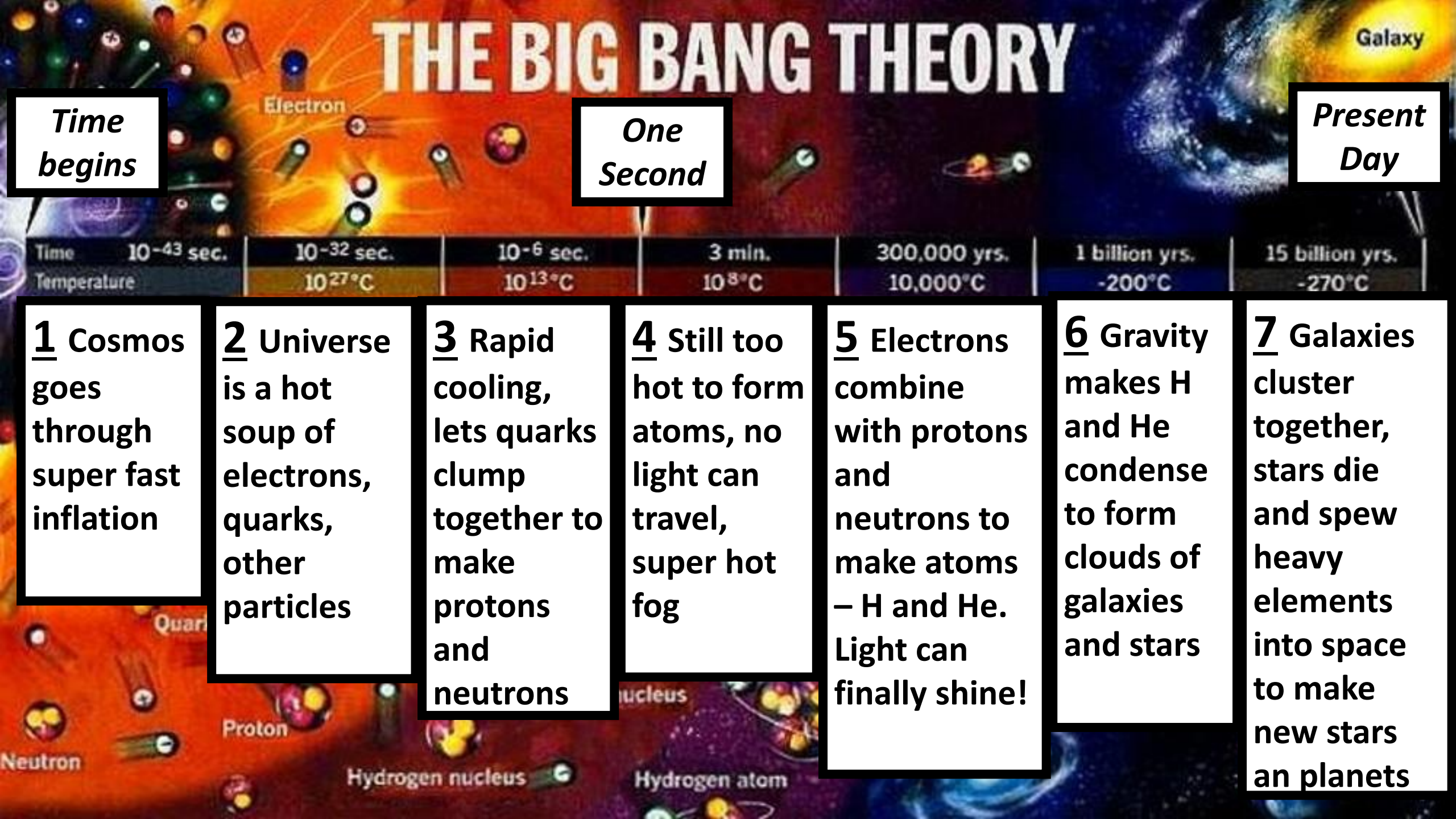
Atomic Absorption & Emission, Line Spectra and the Chemical Composition of Stars

Where did the elements come from?

THE BIG BANG THEORY



1 Cosmos goes through super fast inflation

2 Universe is a hot soup of electrons, quarks, other particles

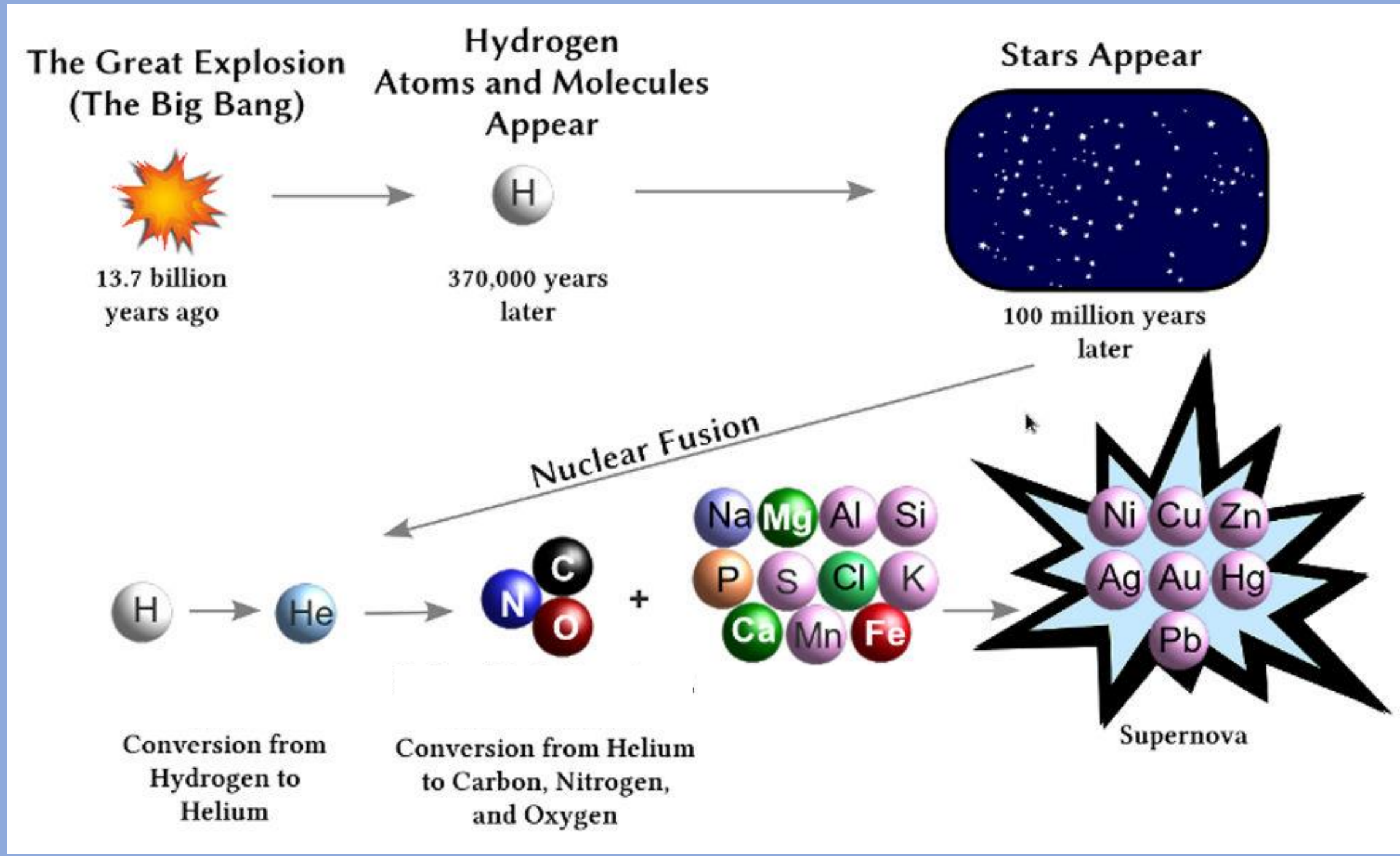
3 Rapid cooling, lets quarks clump together to make protons and neutrons

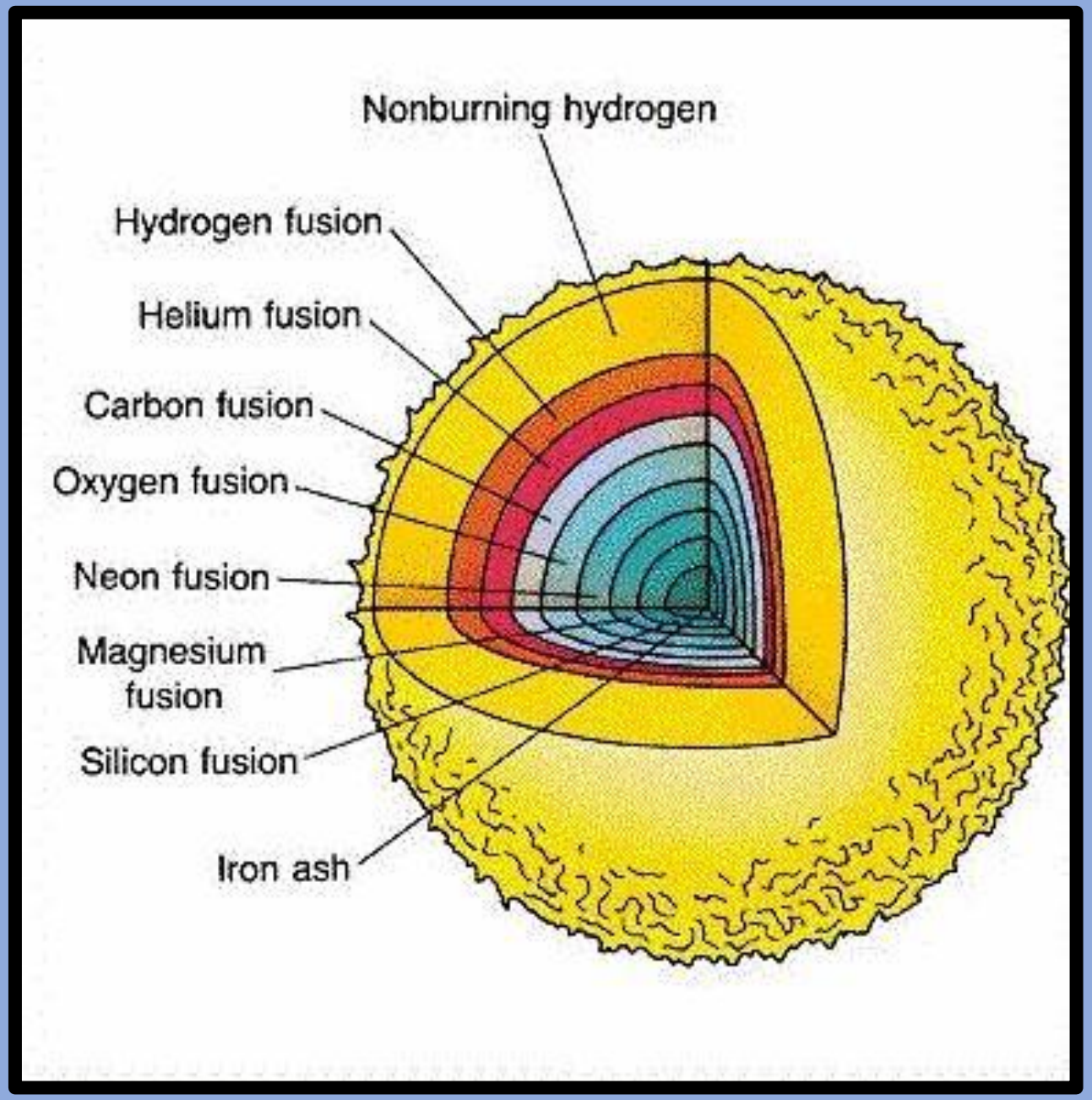
4 Still too hot to form atoms, no light can travel, super hot fog

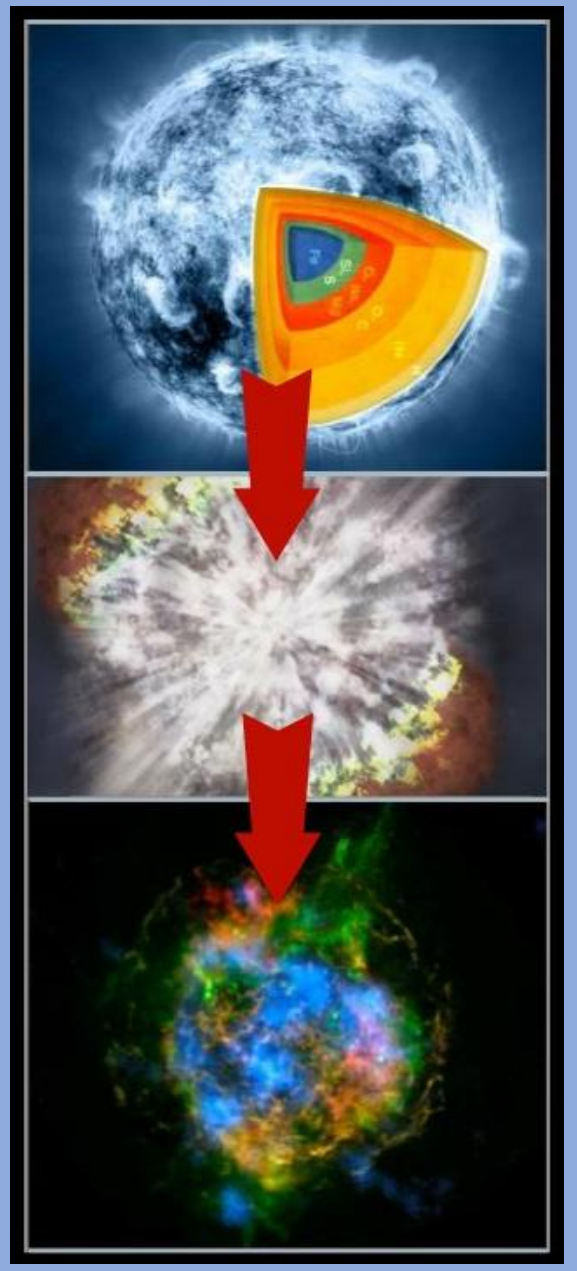
5 Electrons combine with protons and neutrons to make atoms – H and He. Light can finally shine!

6 Gravity makes H and He condense to form clouds of galaxies and stars

7 Galaxies cluster together, stars die and spew heavy elements into space to make new stars an planets


The Great Explosion
(The Big Bang)
13.7 billion
years ago
Hydrogen
Atoms and Molecules
Appear
H
370,000 years
later
Stars Appear
100 million years
later
Nuclear Fusion
H
He
C
N
O
+
Na
Mg
Al
Si
P
S
Cl
K
Ca
Mn
Fe
Ni
Cu
Zn
Ag
Au
Hg
Pb
Conversion from
Hydrogen to
Helium
Conversion from Helium
to Carbon, Nitrogen,
and Oxygen
Supernova





Out of fuel

Implosion

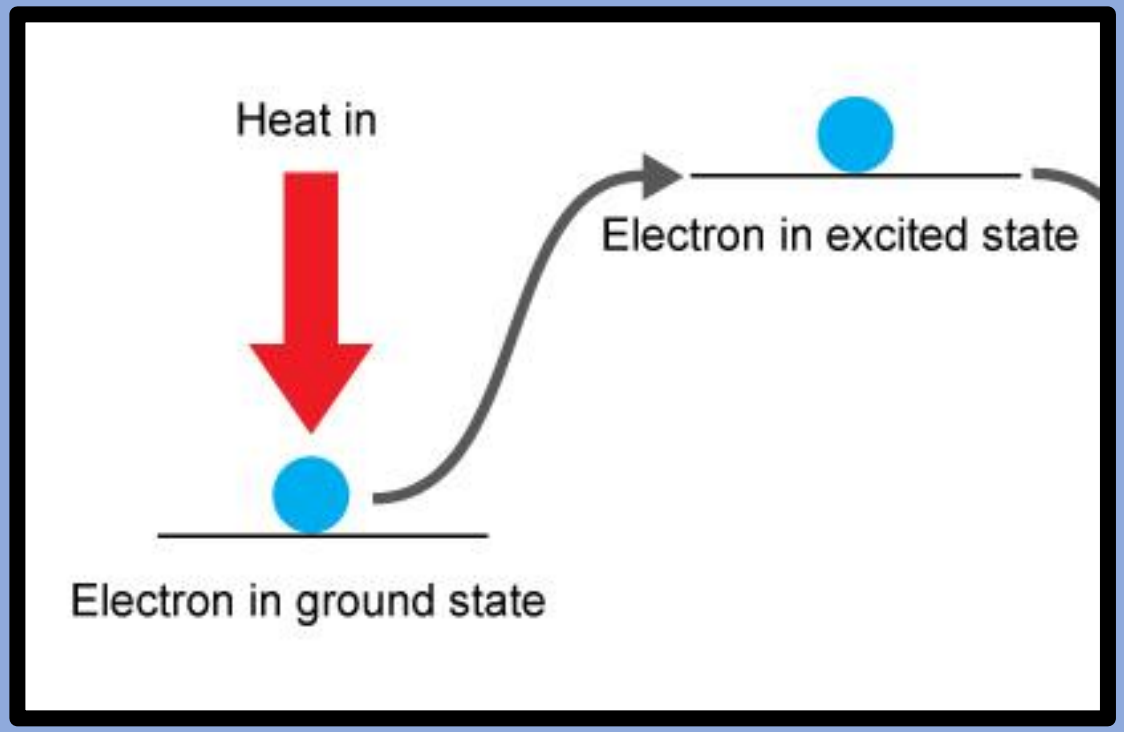
Forms nebula of elements

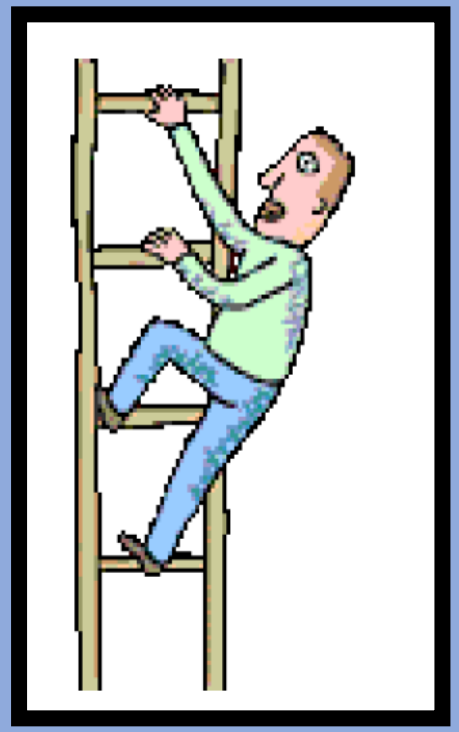
How do we know which stars have which elements?

We can analyze the wavelengths of light that are absorbed or released by the stars

ABSORPTION

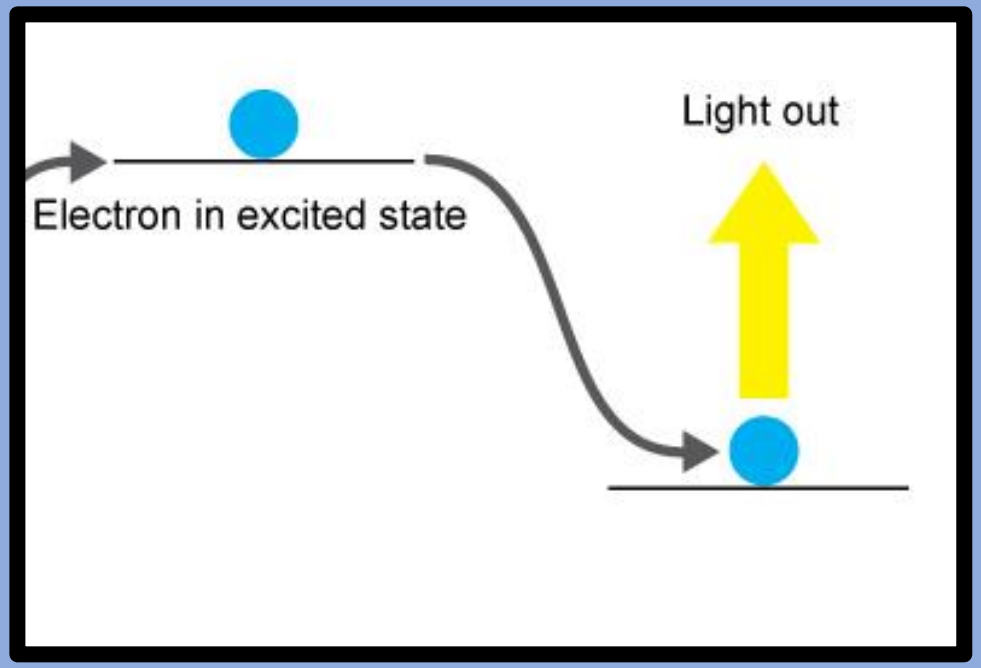
If you give an atom energy, the electron can be pushed up to a higher energy level

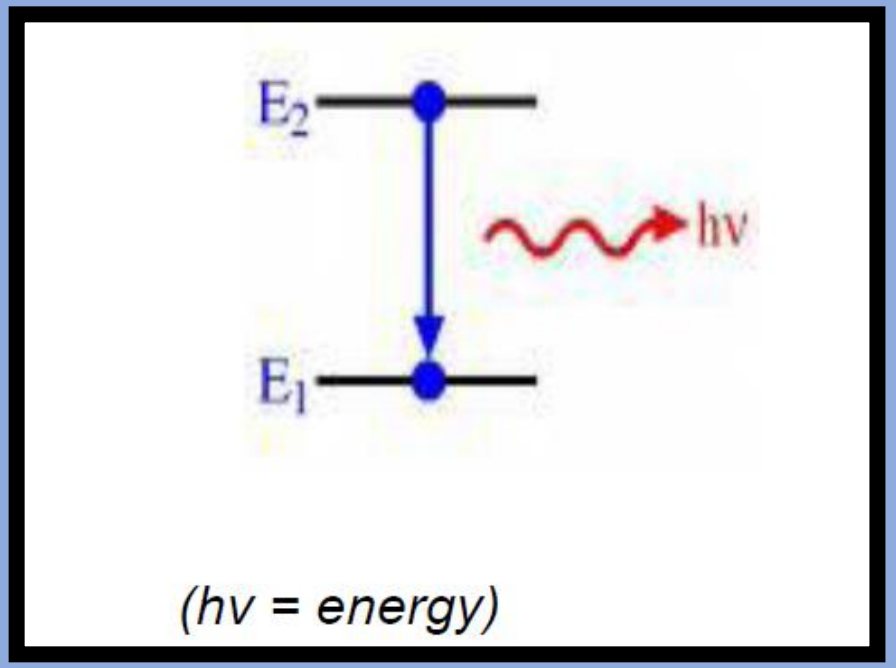




EMISSION

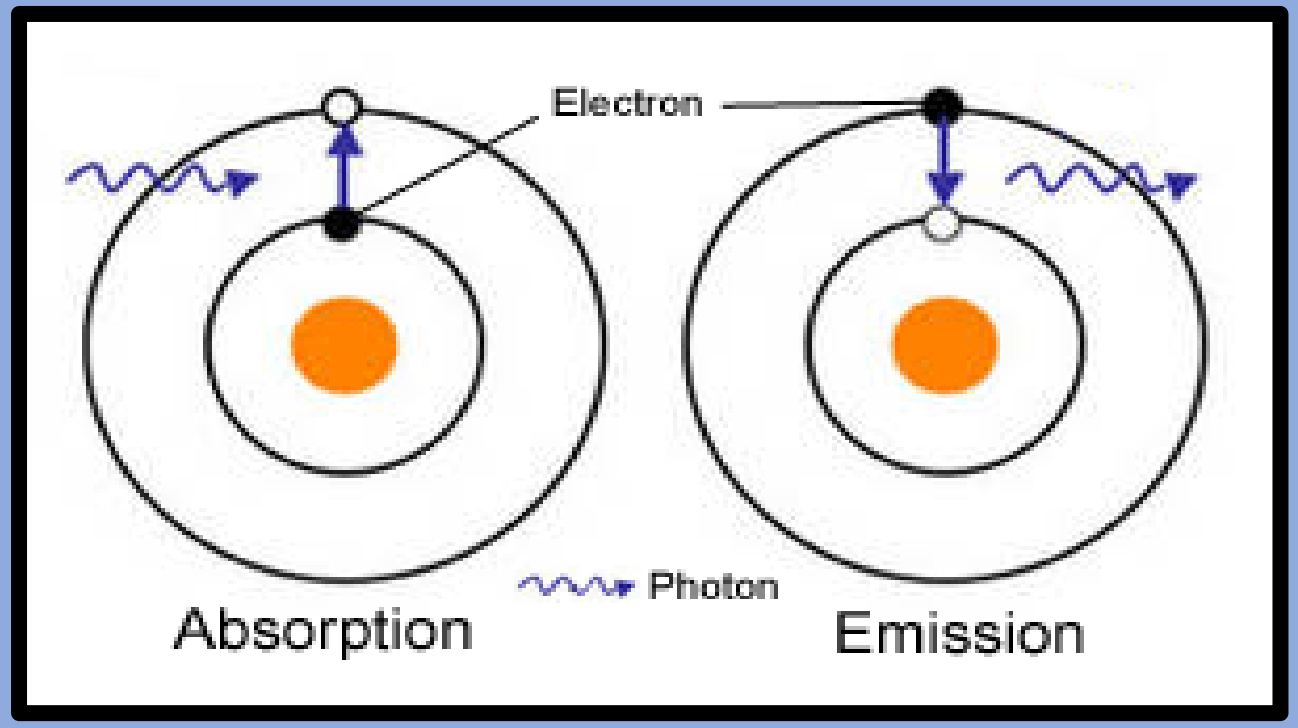
The electron does not want to stay at that higher level (Aufbau Principle!) so it will fall back down.

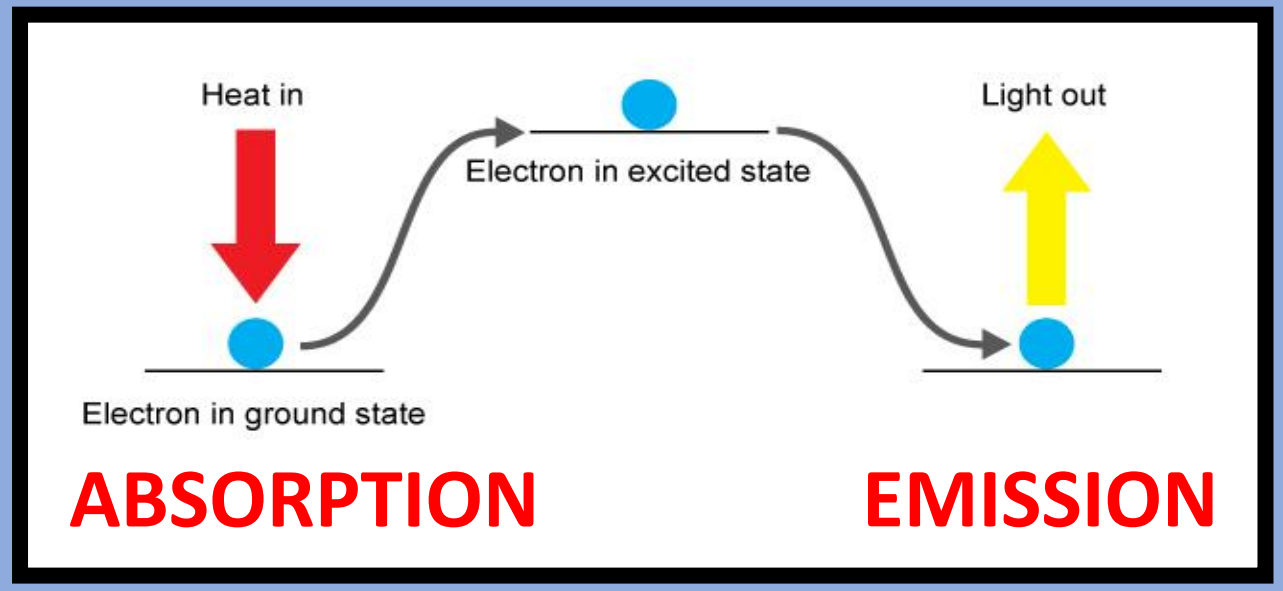




LOTS OF WAYS TO DRAW THIS

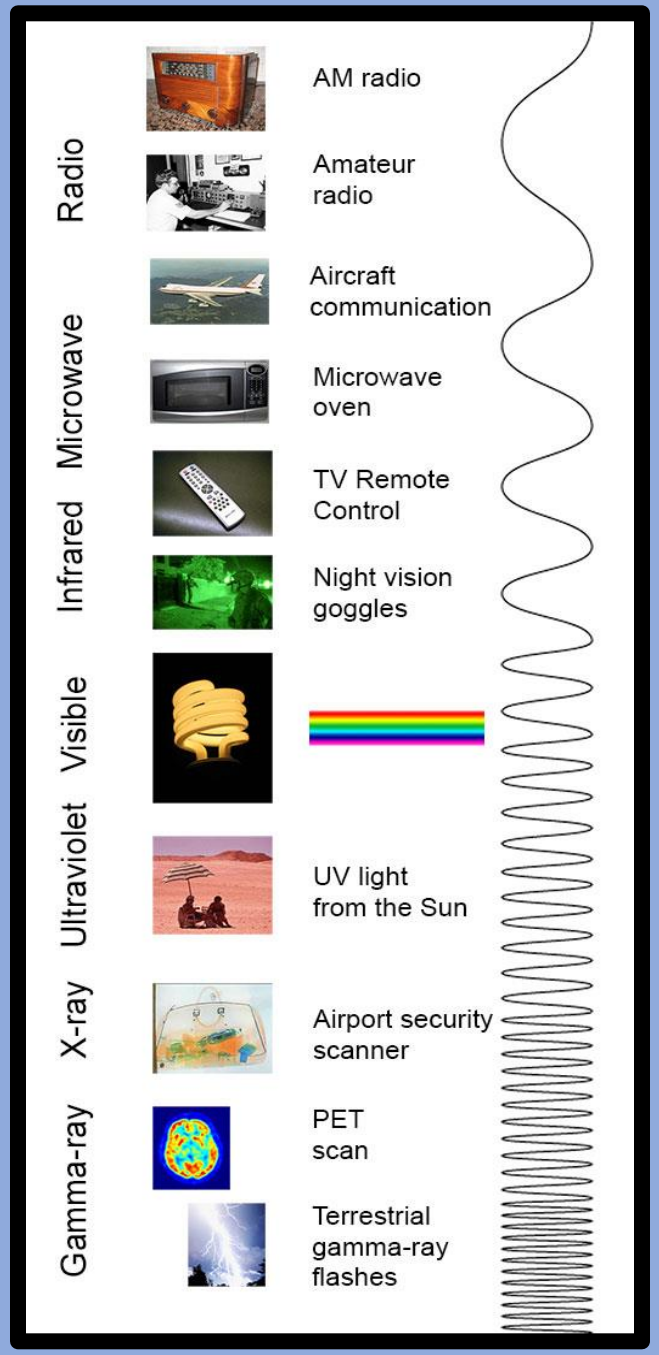
Make sure to show if energy is coming in or out, and which direction the electron is moving.





ENERGY RELEASED DURING EMISSION

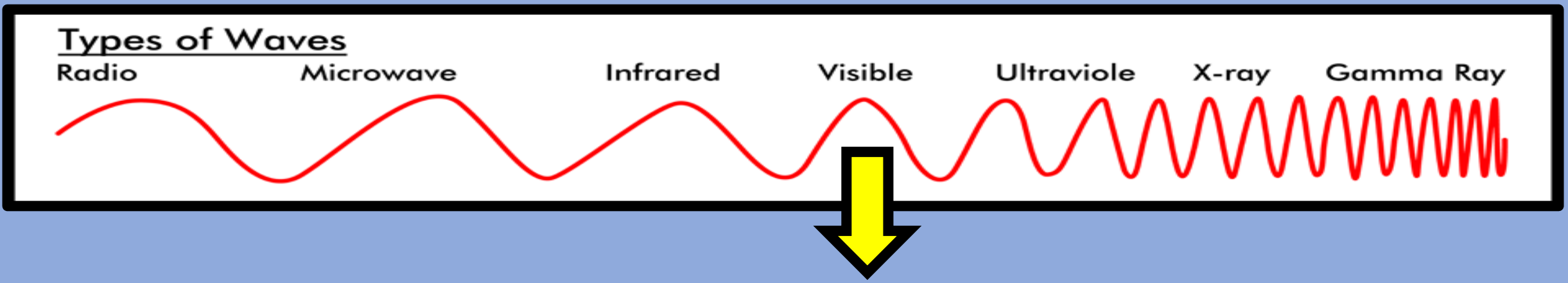
Sometimes **the released energy can be seen as LIGHT! The amount of energy given off depends on which energy levels the electron is falling from.**



We can only see this little range here

ENERGY SPECTRUM

You can measure the exact wavelength and it can tell you how big the energy gap was that the e- fell from



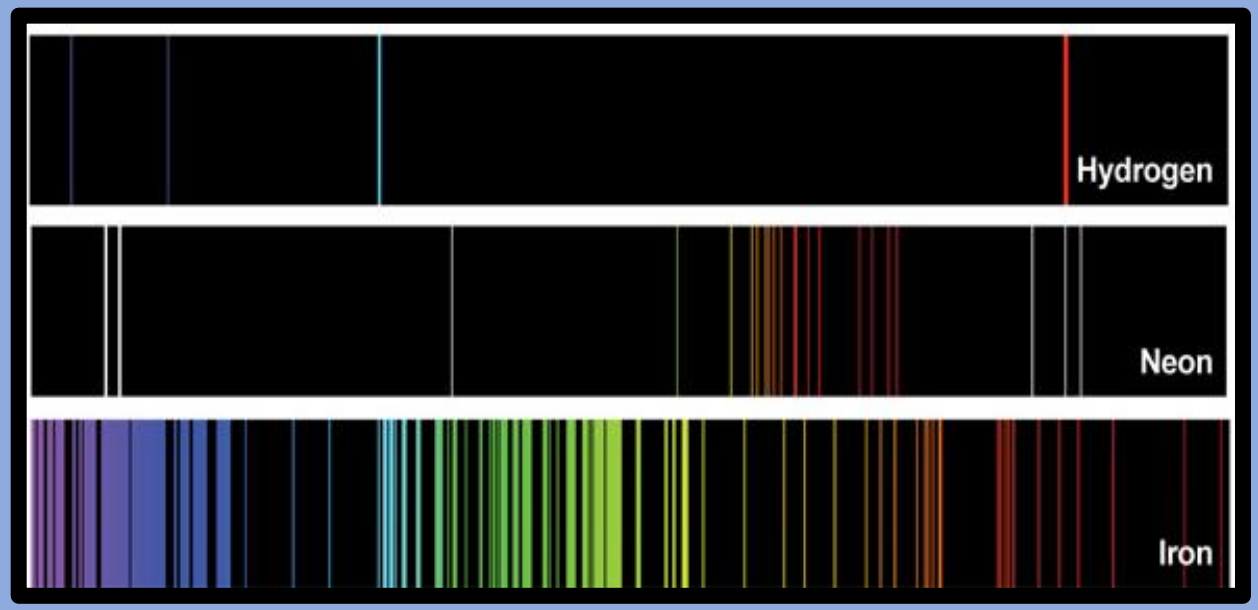
Red Orange Yellow Green Blue Purple

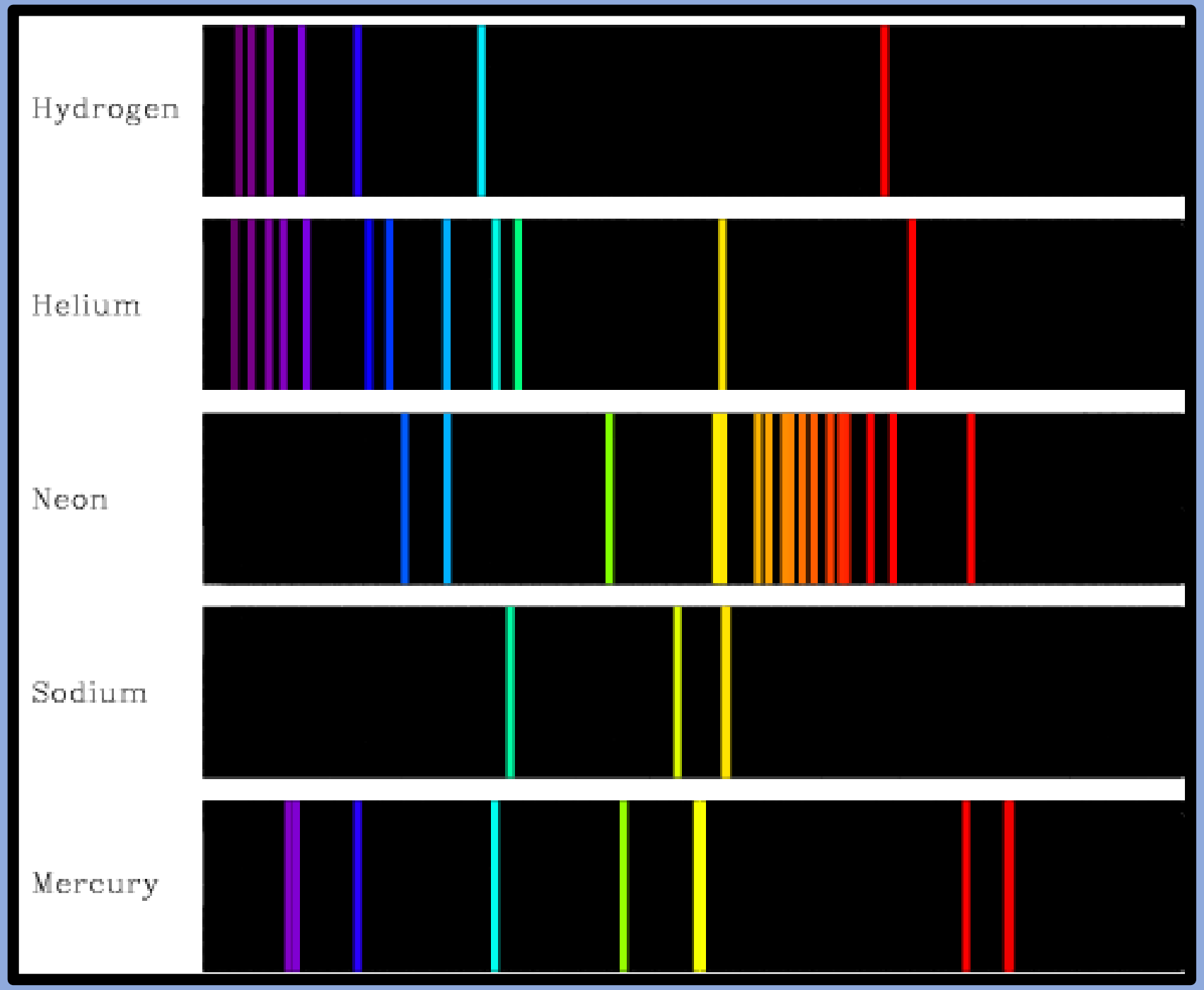
LOW HIGH

energy energy

UNIQUE LIKE A FINGERPRINT

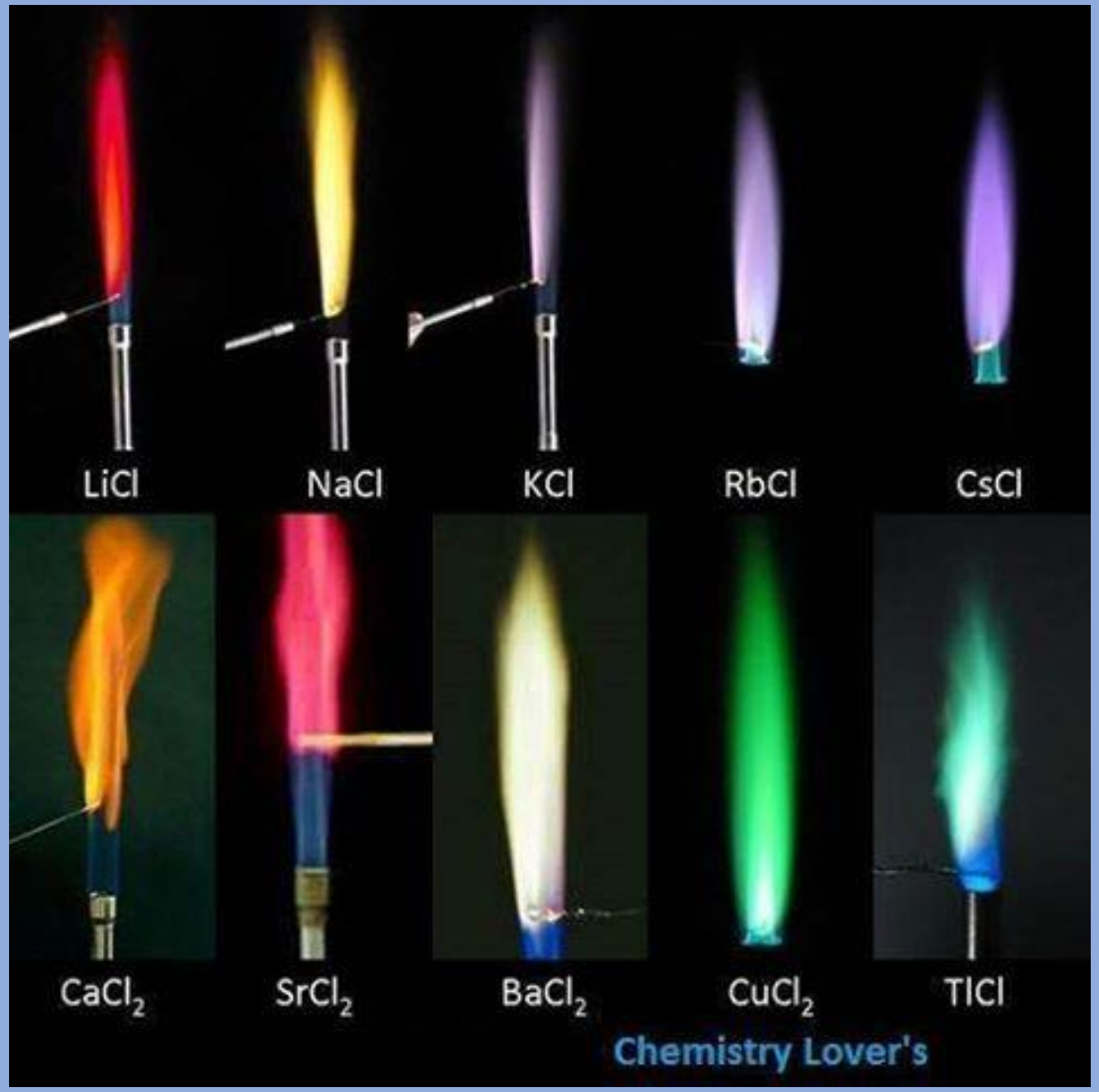
So just like people have unique finger prints, atoms have unique wavelengths they release (or absorb)

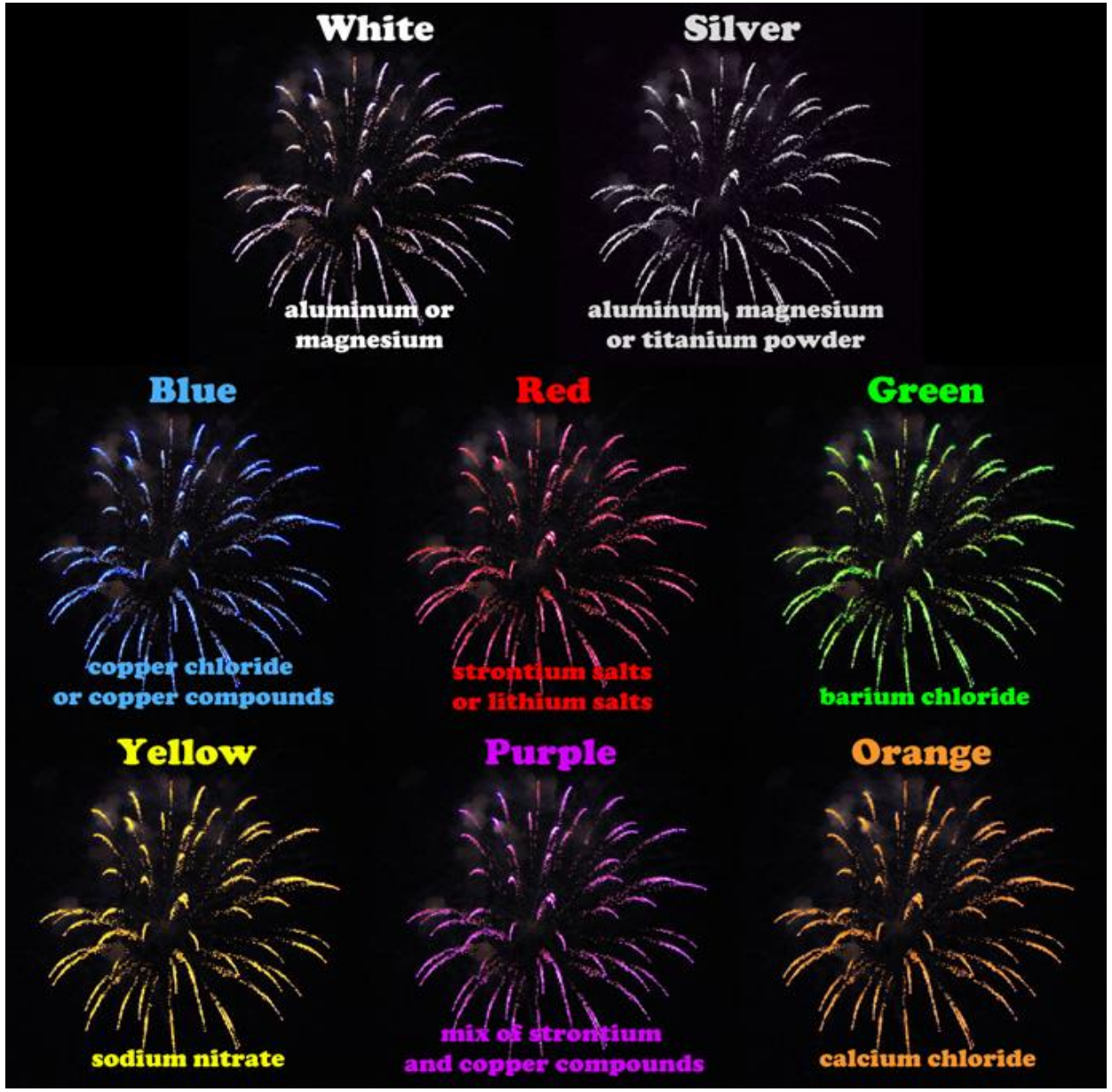


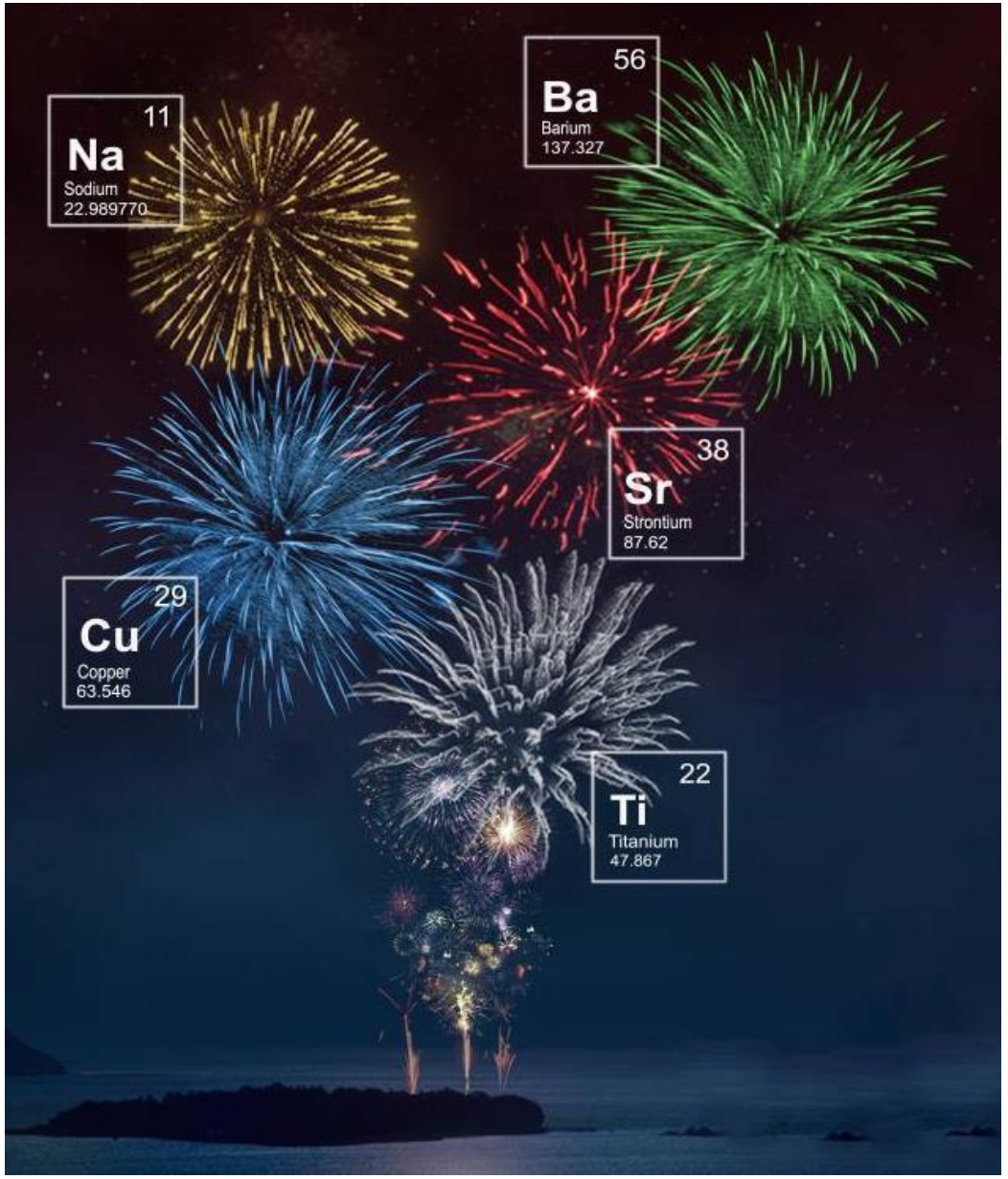

Hydrogen
Helium
Neon
Sodium
Mercury

FLAME TESTS IN THE LAB

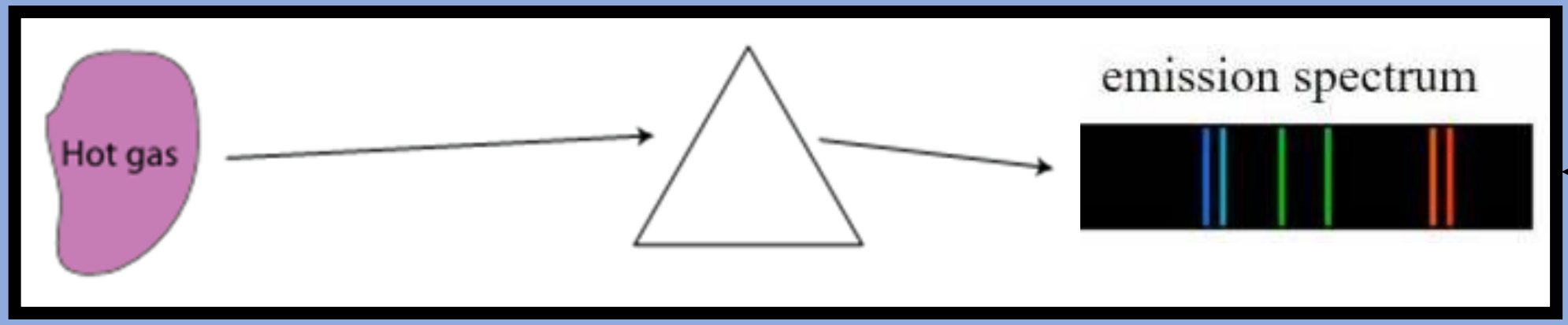
Compounds containing certain ions can be recognized by burning the compound and observing the colors produced




White
aluminum or magnesium
Silver
aluminum, magnesium or titanium powder
Blue
copper chloride or copper compounds
Red
strontium salts or lithium salts
Green
barium chloride
Yellow
sodium nitrate
Purple
mix of strontium and copper compounds
Orange
calcium chloride

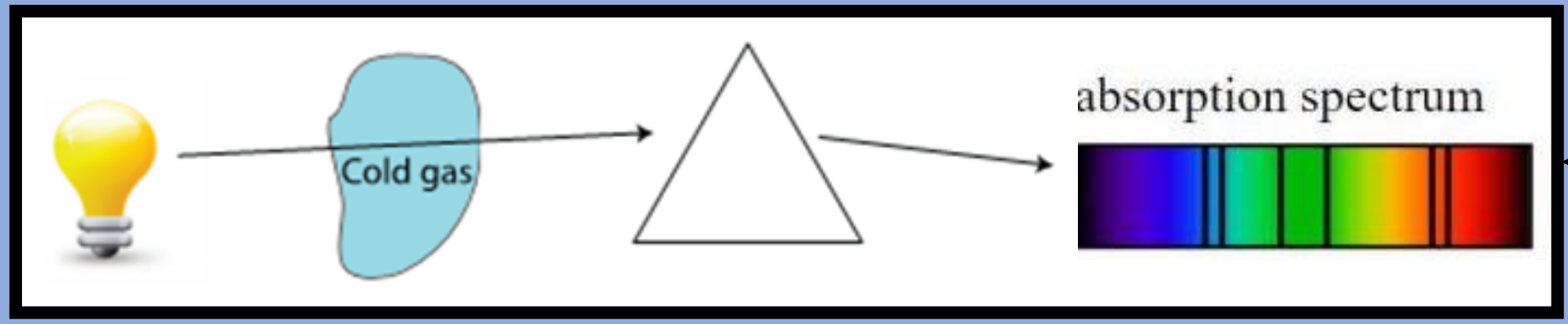

11
Na
Sodium
22.989770
56
Ba
Barium
137.327
38
Sr
Strontium
87.62
29
Cu
Copper
63.546
22
Ti
Titanium
47.867

<u>Emission</u> – seeing wavelengths of energy being RELEASED (emitted)



IN LAB
HEAT
ATOMS

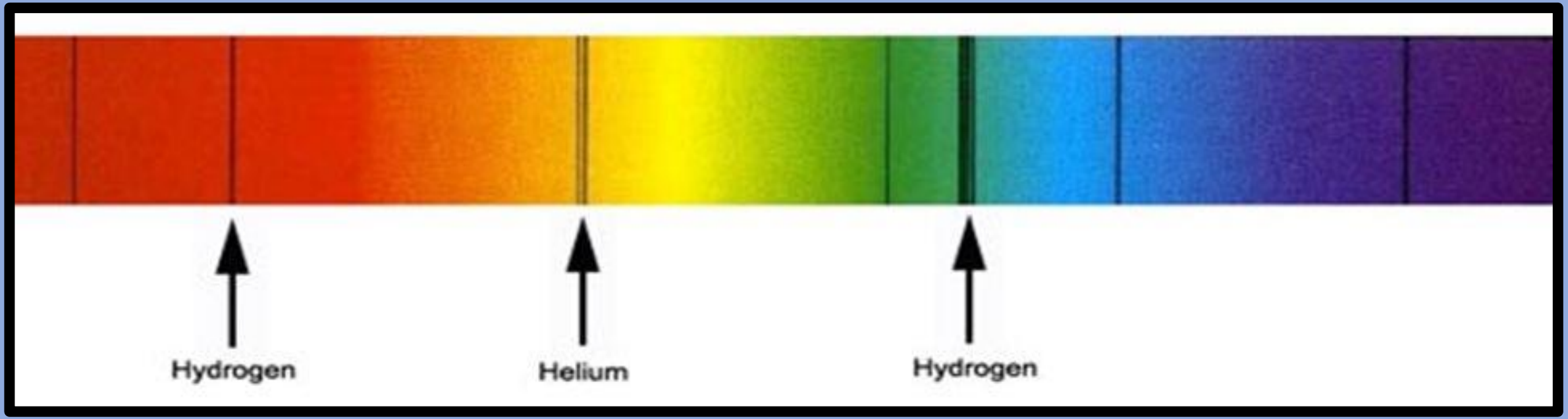
<u>Absorption</u> – seeing MISSING bands of energy being ABSORBED by a cold gas



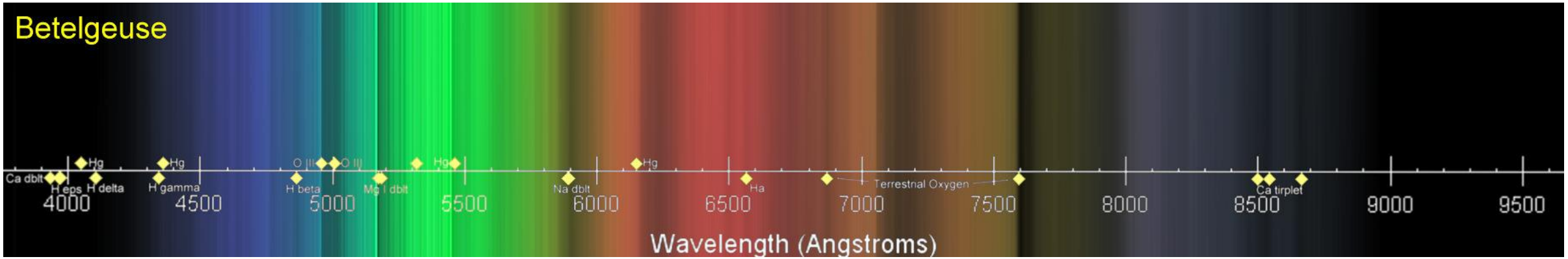
IN THE
STARS

ABSORPTION LINES FOR STARS

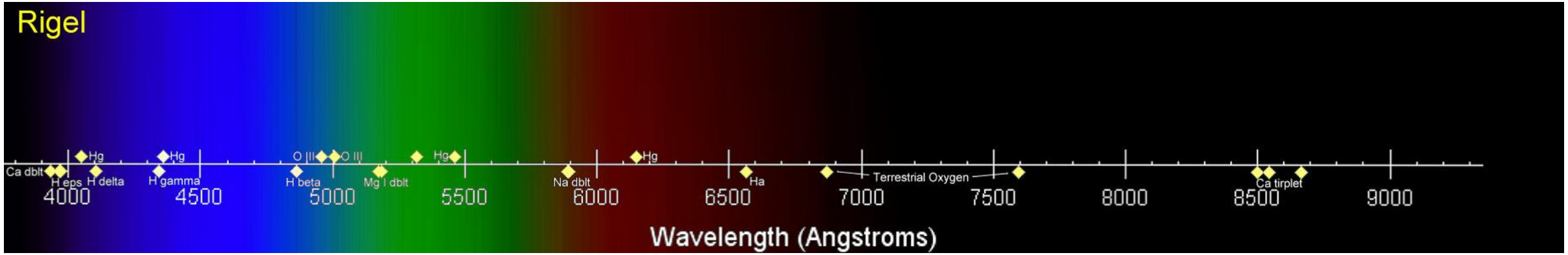
The “colder” outer layers of the stars absorb the emission energy from the hotter inside of the star, so what we can see are absorption lines



Betelgeuse – Old star, lots of absorption lines because lots of elements have been made



Rigel – Young star, few absorption lines because not many elements have been made yet



YouTube Link to Presentation

https://youtu.be/j-kMg-dtRpg