

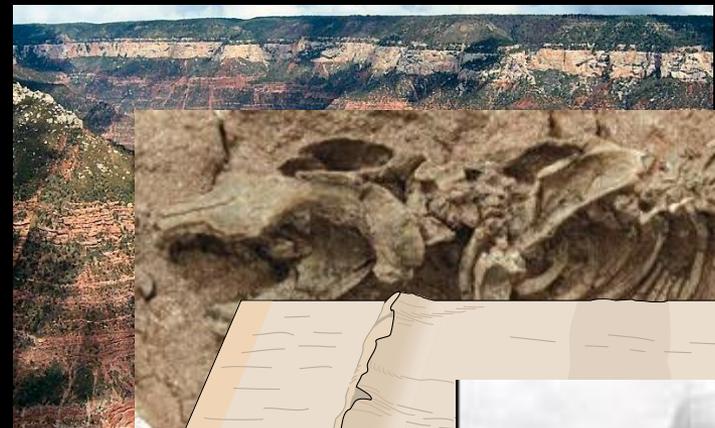
The Earth in the Universe

(OCR)

Evidence for the age of the Earth

Scientists once thought that the Earth was only 6000 years old. Rocks have provided lots of evidence for the world being older.

- 1) Erosion
- 2) Craters
- 3) Mountains
- 4) Fossils
- 5) Folding
- 6) Radioactive dating

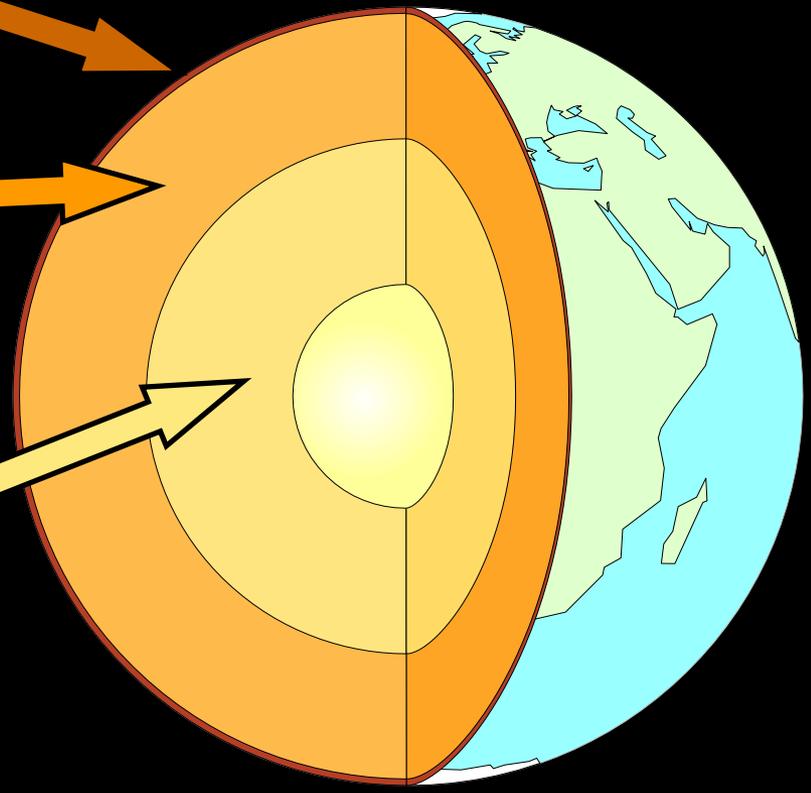


The Structure of the Earth

A thin crust - 10-100km thick and not very dense

A mantle - extends almost halfway to the centre, hot and dense

A core - made of molten nickel and iron. Outer part is liquid and inner part is solid. Gets hot due to radioactive decay.



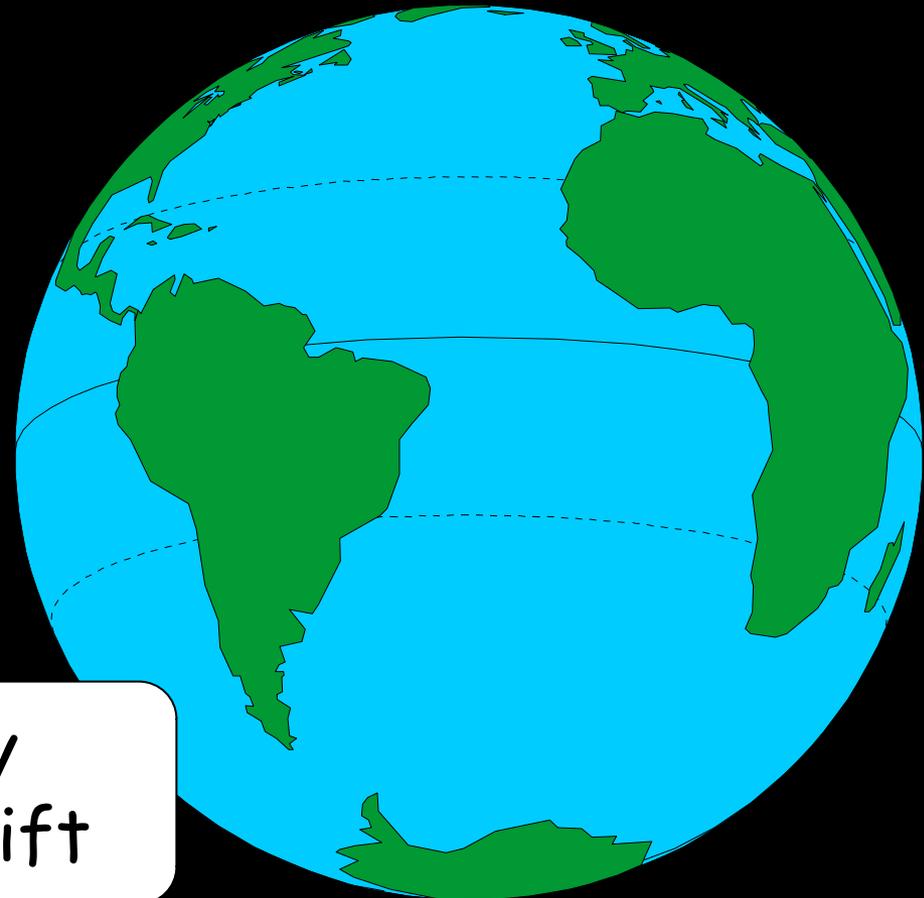
The Earth is believed to be 4500 million years old

Continental Drift



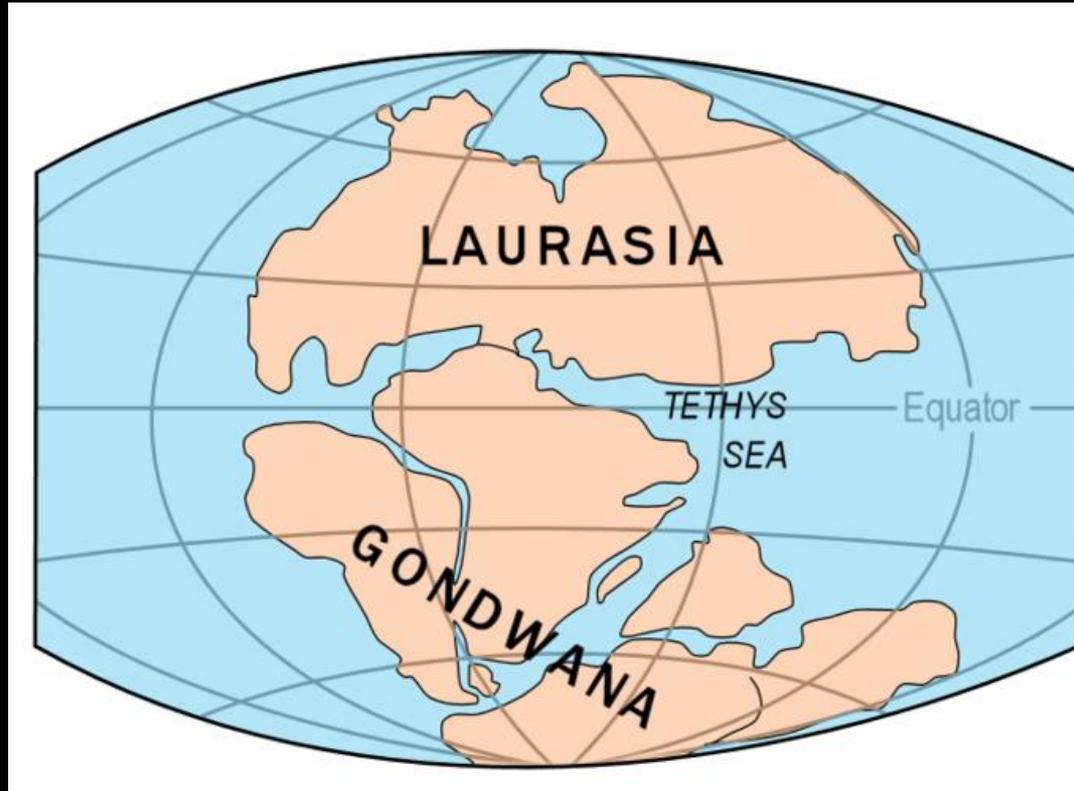
Look at the coastlines of South America and Africa. I wonder if they used to fit together...

Alfred Wegener



I'm going to call this my Theory of Continental Drift

Tectonic theory

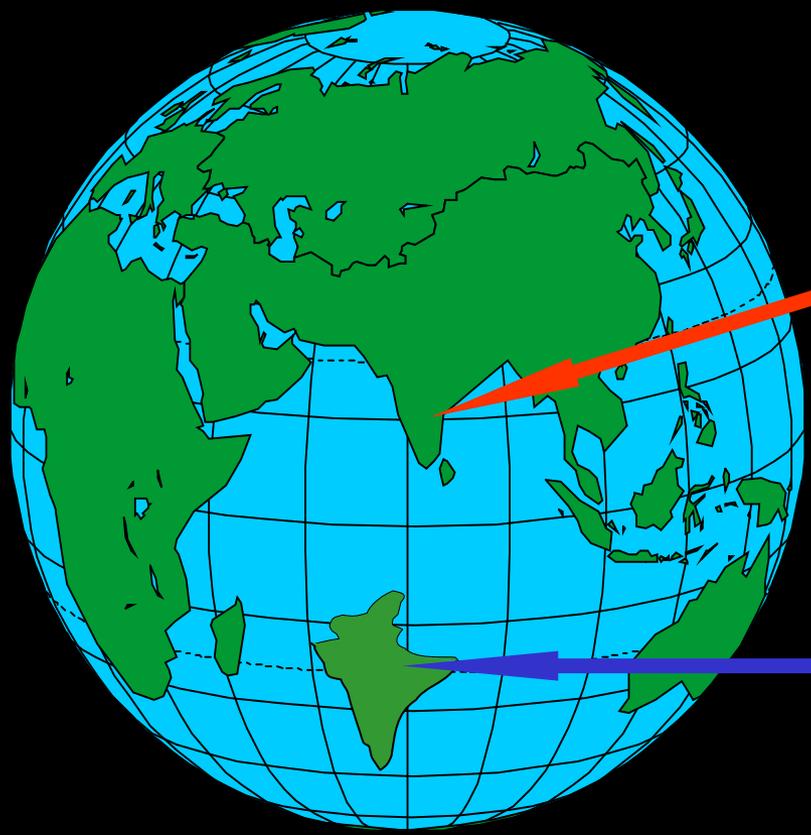


What's my evidence for this? Three things:

- 1) The "jigsaw fit"
- 2) Each continent has similar rocks and fossils
- 3) Each continent has similar animal species

Another Example of Continental Drift

The formation of mountain ranges can be explained by tectonic theory. Consider the Himalayas at the top of India:



This is where India is now

This is where India was millions of years ago

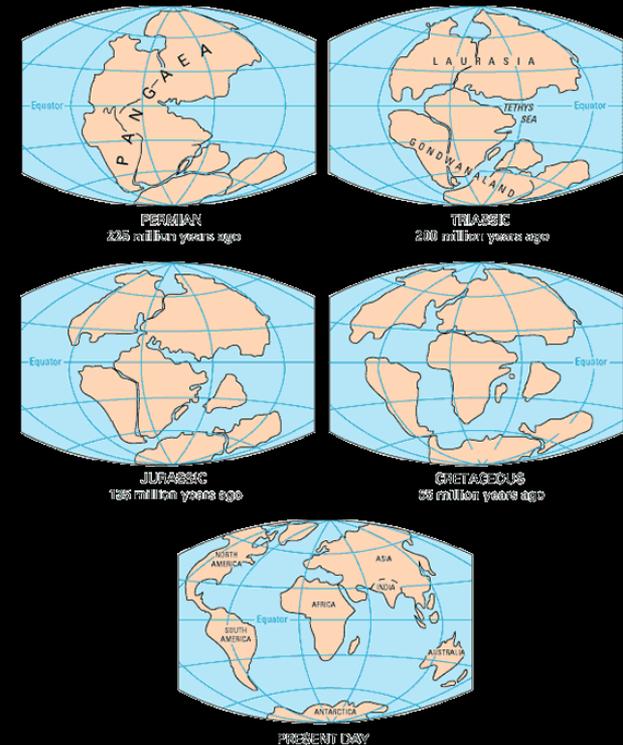
Tectonic theory

The Evidence:

- 1) Some continents look like they used to "fit" together
- 2) Similar rock patterns and fossil records

The Problems:

Wegener couldn't explain how continental drift happened or provide evidence so nobody believed him. Also, he wasn't a geologist so he had no credibility.



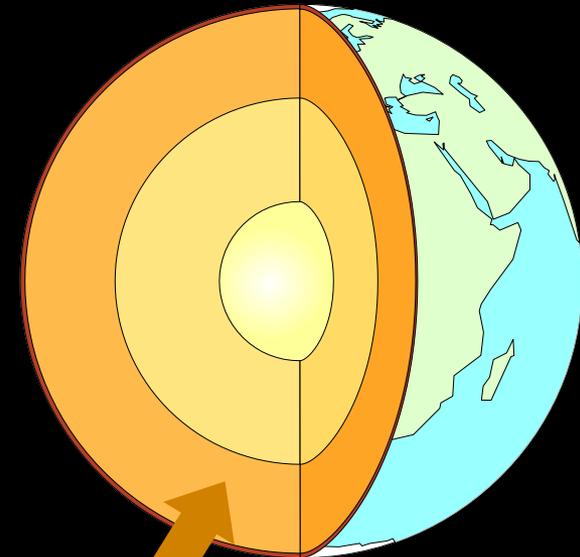
The Answer:

Scientists discovered 50 years later that the Earth generates massive amounts of heat through radioactive decay in the core. This heat generated convection currents in the mantle causing the crust to move.

Conclusion - scientists now believe Wegener's Tectonic Theory

Movement of the Lithosphere

The Earth's LITHOSPHERE (i.e. the _____) is split up into different sections called _____ plates:



These plates are moving _____ from each other a few centimetres every _____. They can slide past each other, move apart from each other or move towards each other, causing volcanoes and _____.

Words - earthquakes, crust, apart, tectonic, year

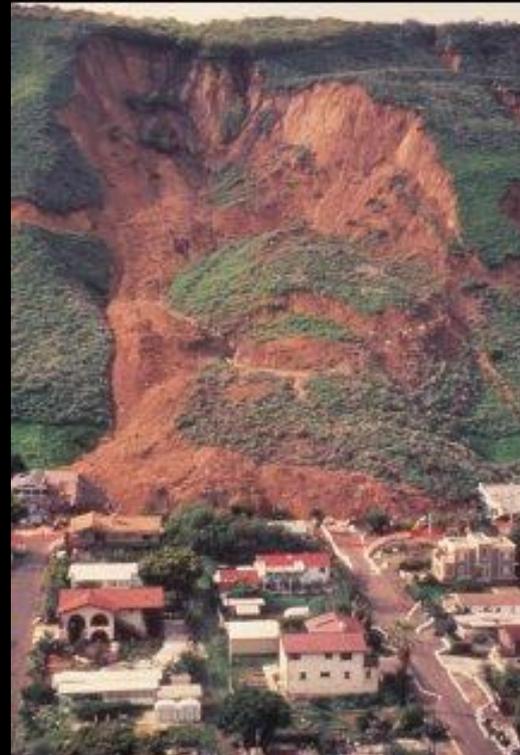
Geohazards

A geohazard is a natural hazard associated with the Earth, e.g.

Earthquakes



Flood

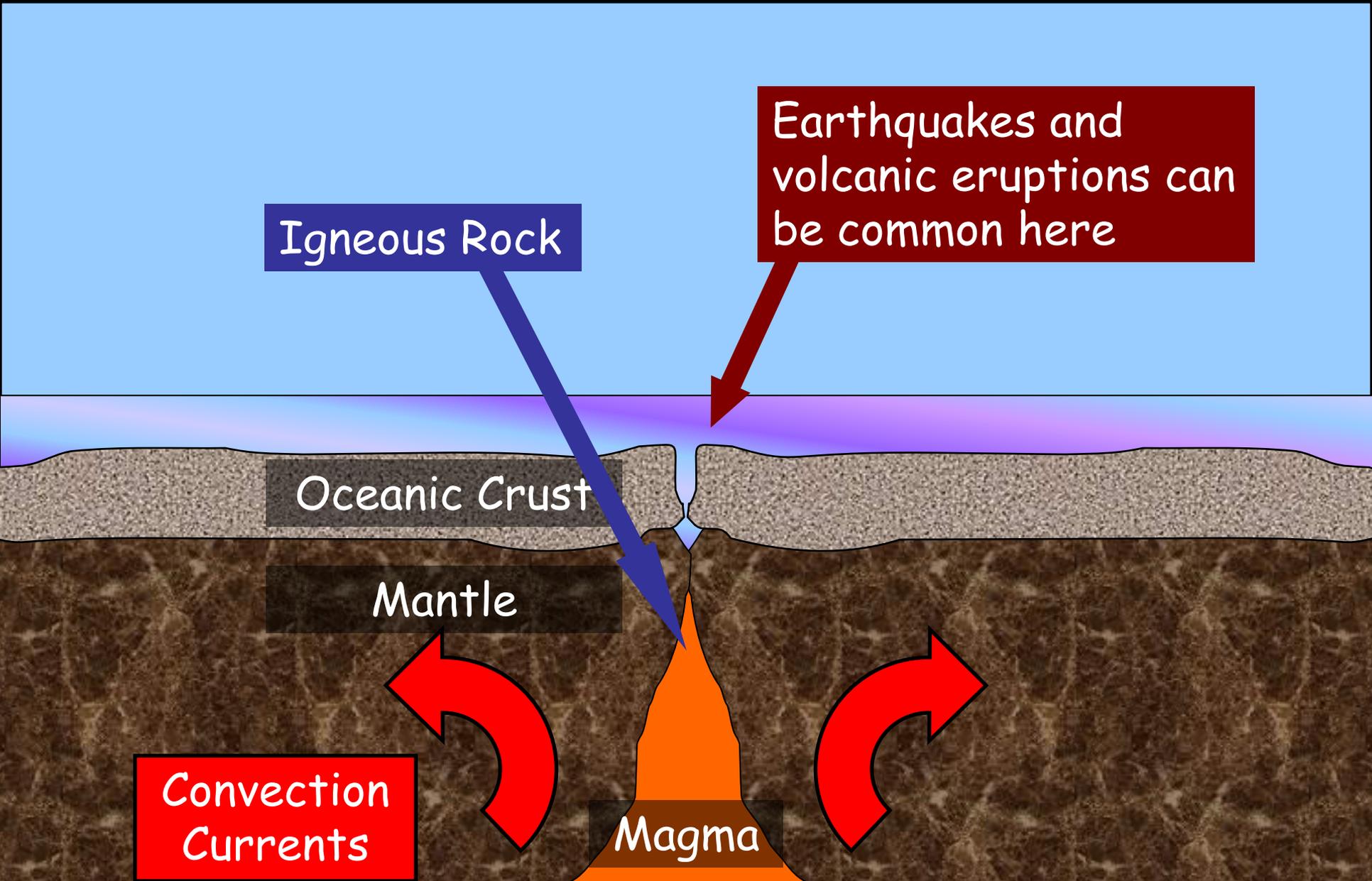


Landslide

Volcano

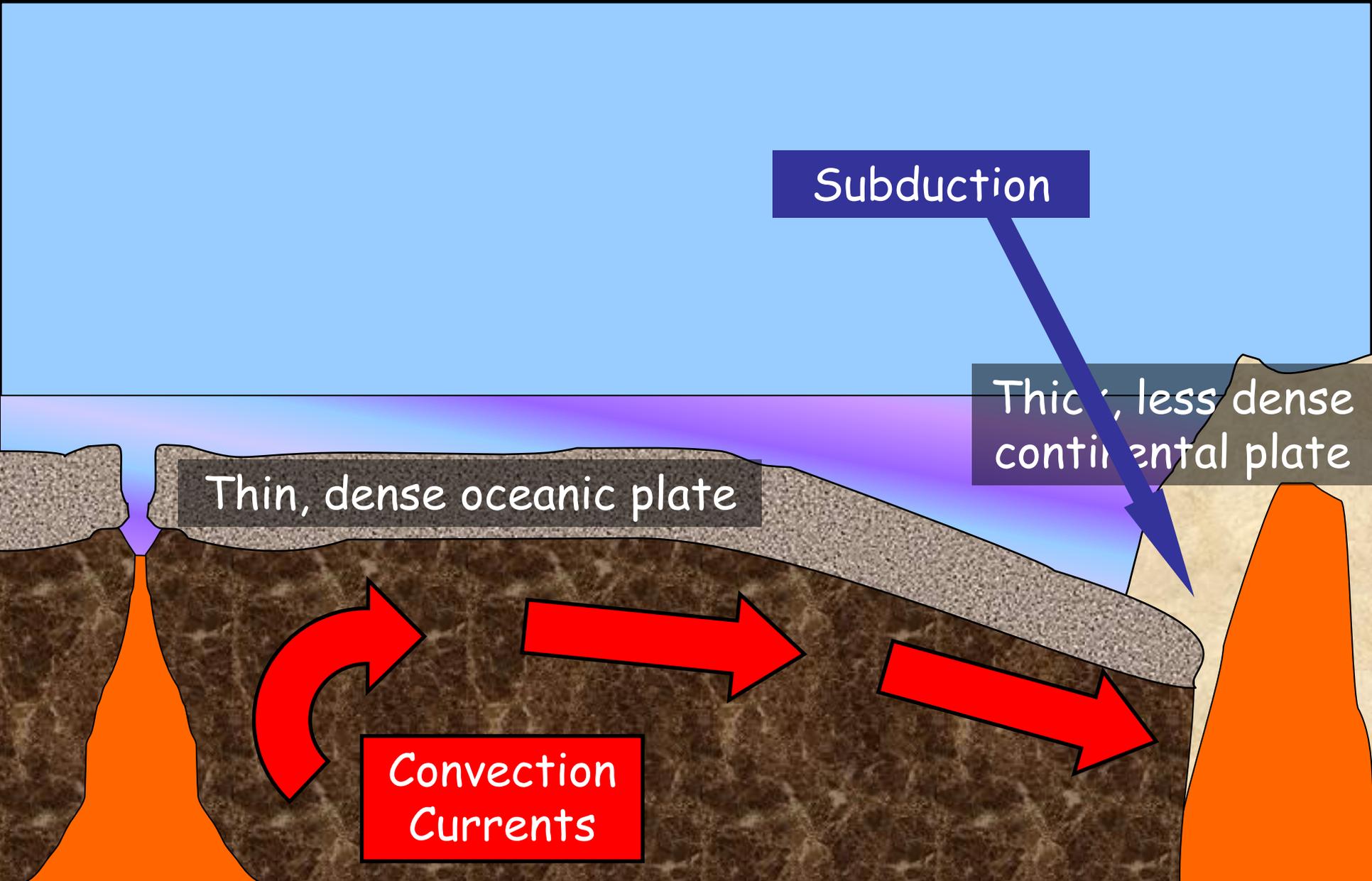


Sea Floor Spreading



More on Plate Movements

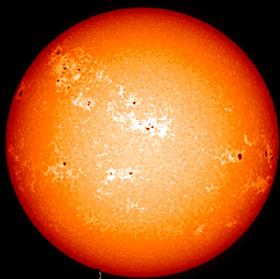
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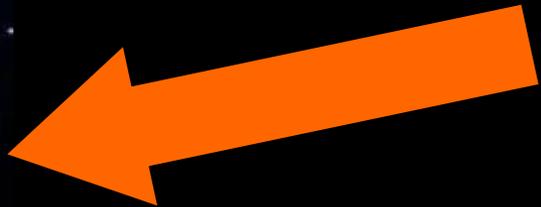
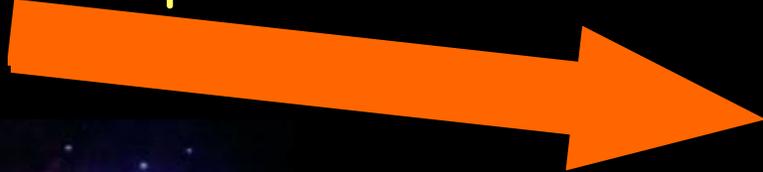
Solar systems, galaxies and the Universe



Our planet (around 13,000km diameter and 4500 million years old) is pretty small compared to...



OUR SUN (100 times wider), which is small compared to...



THE MILKY WAY, which contains at least 200 billion stars and is 100,000 light years across, which is small compared to...

THE UNIVERSE, which contains billions of galaxies and is 14,000 million years old.

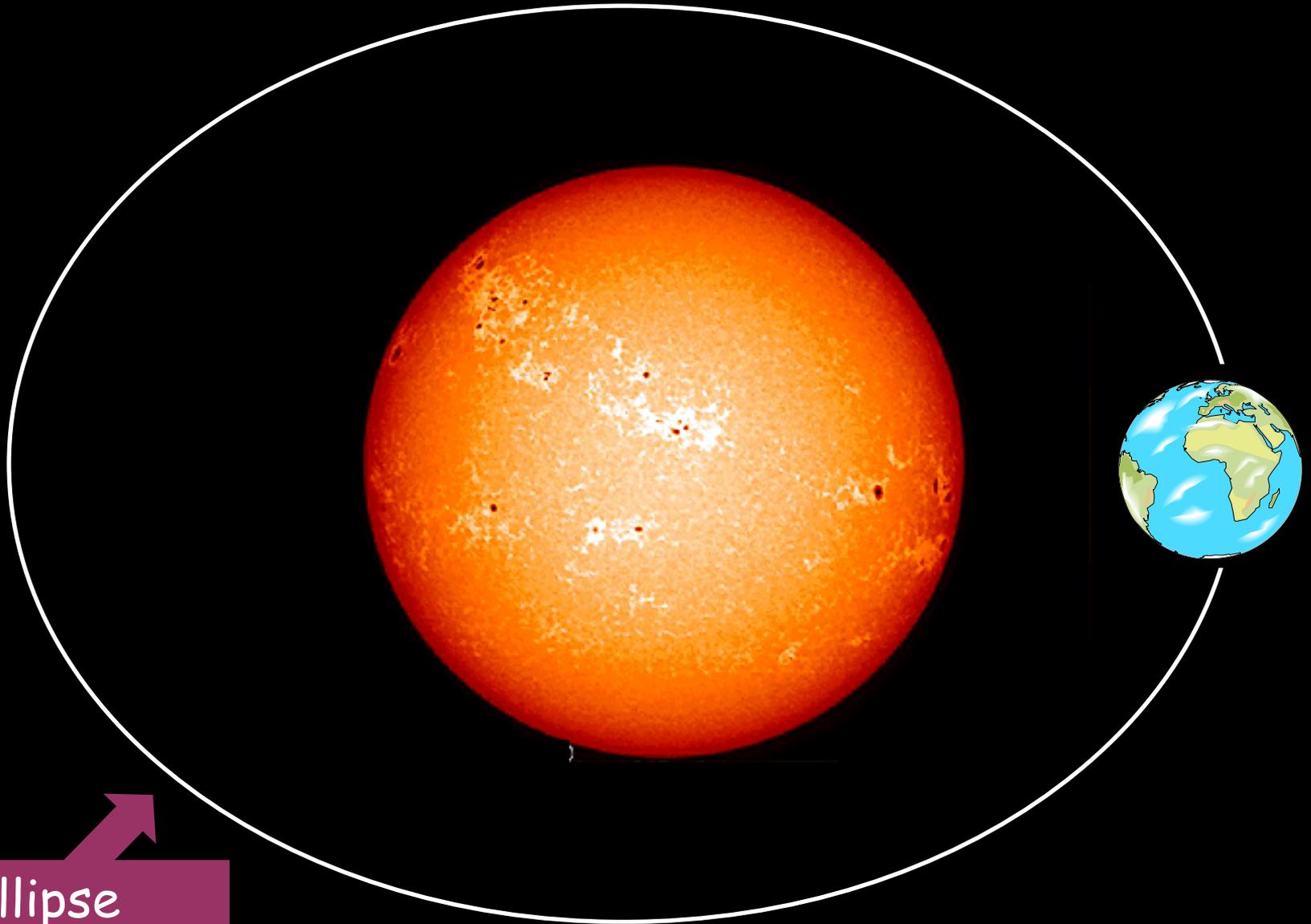
The Light Year

Distances in space are so big that they are measured in units called "light years":

1 light year = the distance travelled by light in one year

If light travels at $300,000,000\text{m/s}$ how far is one light year?

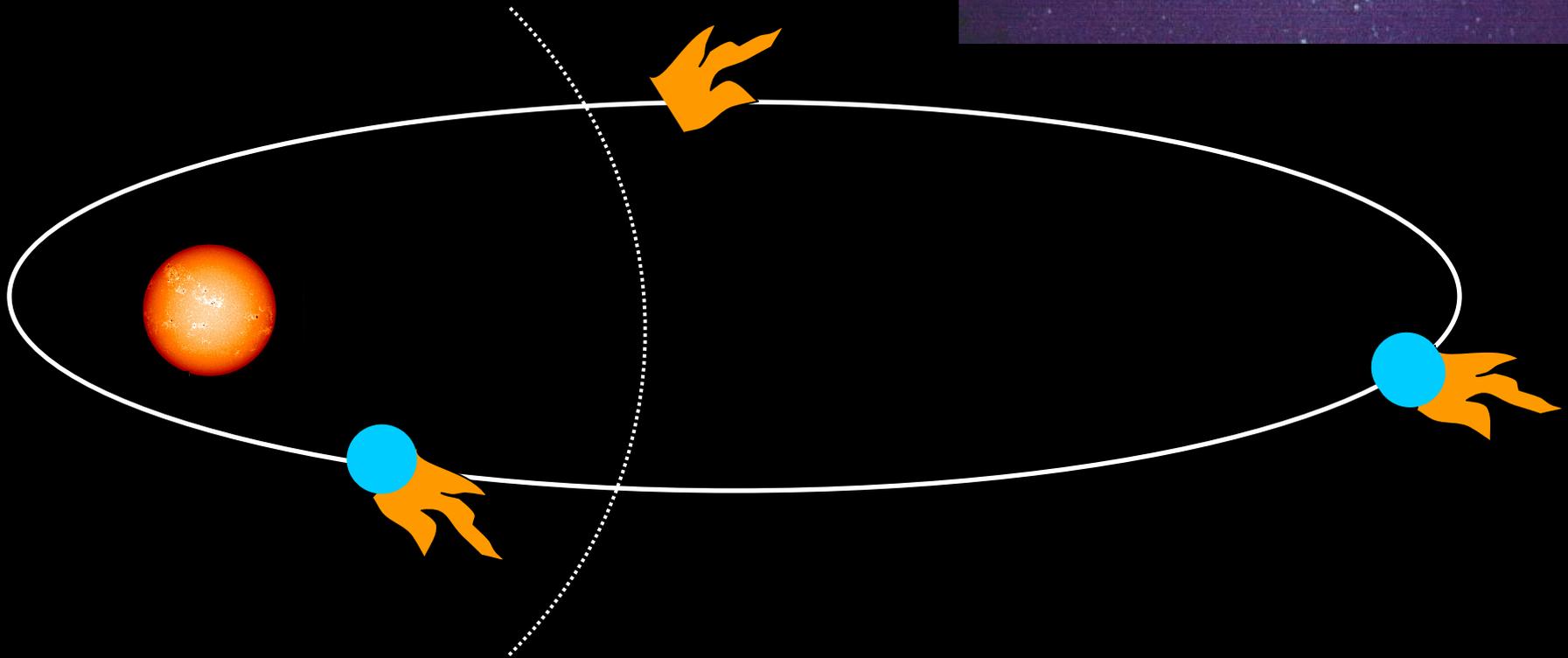
The Earth's Orbit



Ellipse

Comets

Comets are balls of dust and frozen gas. They have very elliptical orbits:



How to make a solar system ^{15/12/2011}



Stage 1: Nebulae

A nebulae is a collection of dust, gas and rock.

Some examples of nebulae...



Dark nebula



Emission nebula



Planetary nebula



Reflection nebula

Stage 2: Throw the nebula together

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Gravity will slowly pull these particles together...



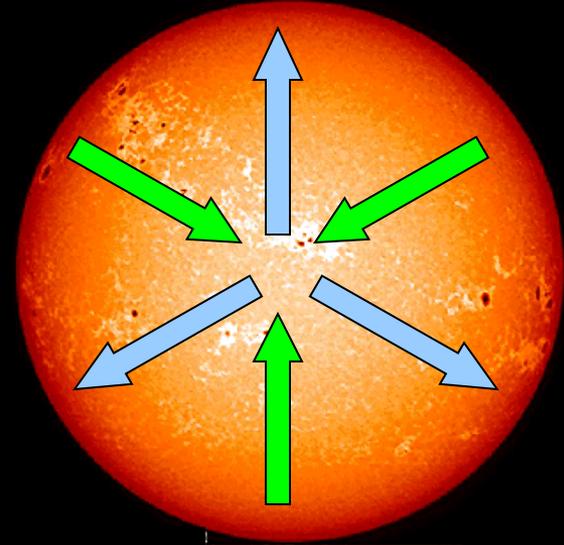
As they move inwards their gravitational potential energy is converted into heat and a big object (PROTOSTAR) or smaller objects (planets, asteroids etc) are formed



Stage 3: Make a star

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In a star the forces of gravitational attraction pulling the particles inwards are _____ by forces acting outwards due to the huge _____ inside the star.



Stars are basically _____ reactors that use _____ as a fuel. During its main sequence a star will release energy by combining hydrogen and helium nuclei (light elements) into _____ elements.

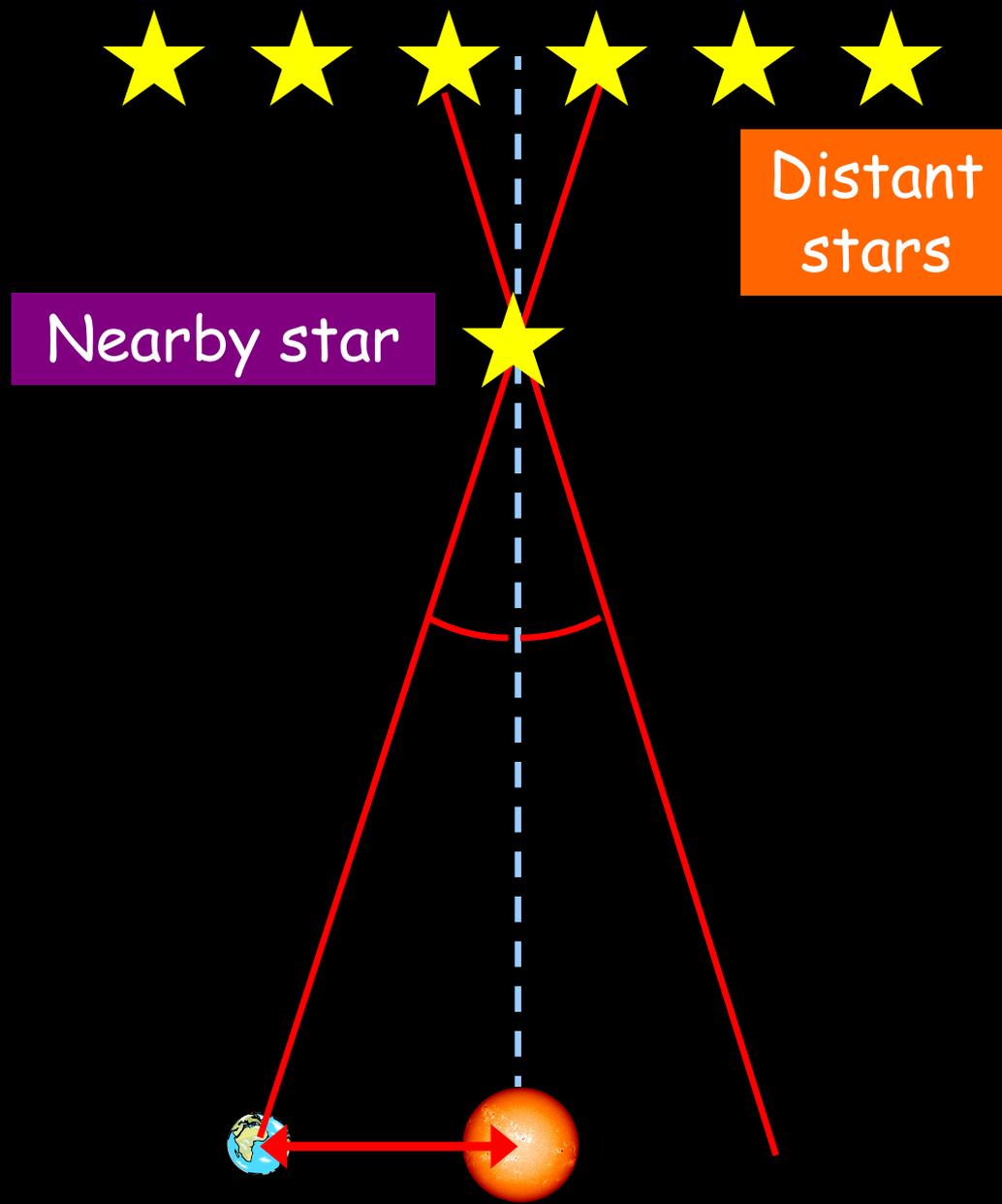
Our sun is an example of a main sequence star - it's in the middle of a 10 billion year life span

Words - heavier, balanced, hydrogen, nuclear, temperatures

Measuring distances to stars

1) Relative Brightness
The further away a star is the dimmer it is. Simple.

2) The Parallax



Hubble Space Telescope (HST)

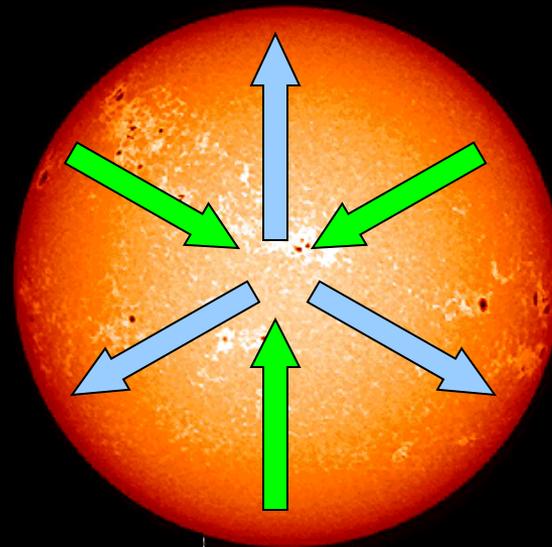
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- Launched in 1990, due to finish operating in 2010
- Takes images in the visible light, ultra-violet and near infra red regions
- Orbits the Earth every 97 minutes at a distance of 600km

How stars die

Recall how a star produces energy by converting hydrogen and helium into heavier elements:



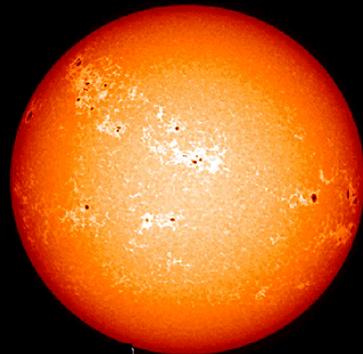
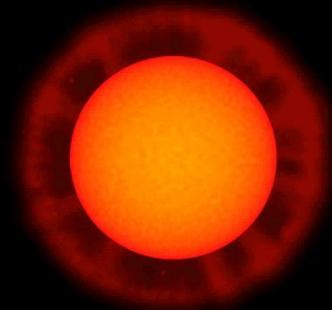
What happens when the hydrogen and helium run out?

Red Giant

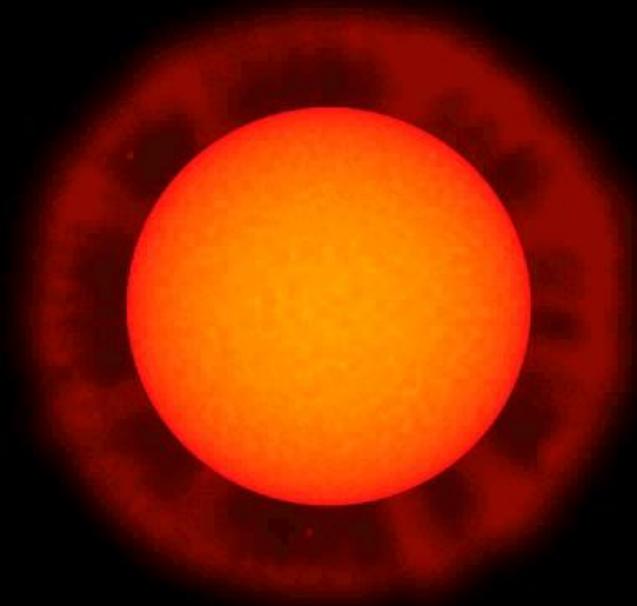
When the hydrogen and helium run out the star will become colder and redder and start to swell...



If the star is relatively small
(like our sun) the star will
become a RED GIANT



If the star is big (at
least 4 times the size of
our sun) it will become a
RED SUPERGIANT



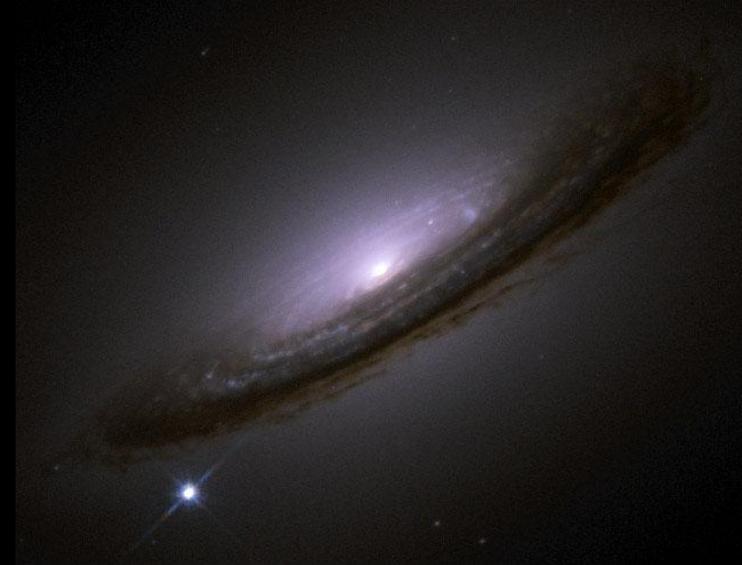
White and Black Dwarfs 15/12/2011

What happens at this point depends on the size of the star...

1) For *SMALL* stars the red giant will collapse under its own gravity and form a very dense white dwarf:



2) *If the star was a RED SUPERGIANT it will shrink and then EXPLODE, releasing massive amounts of energy, dust and gas.*

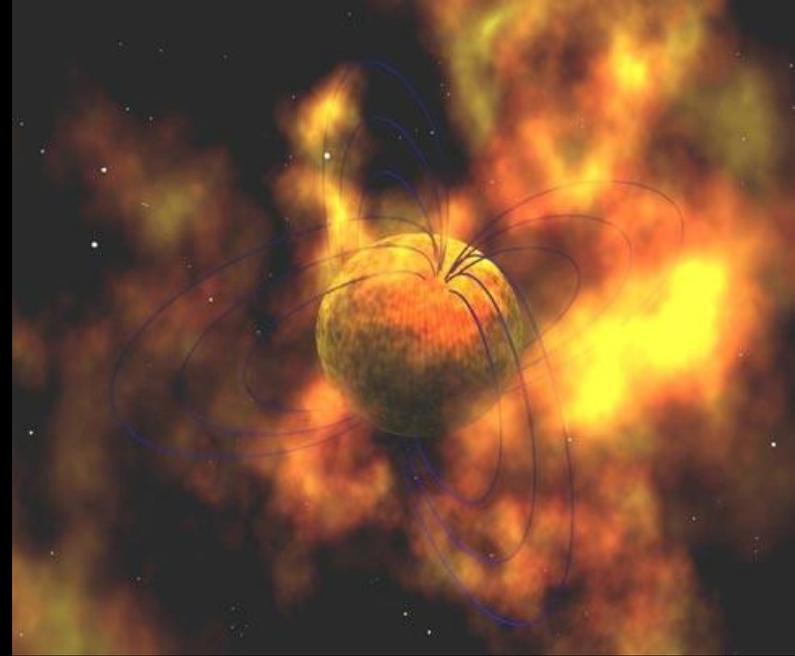


This explosion is called a SUPERNOVA

Before

After

The dust and gas on the outside of the supernova are thrown away by the explosion and the remaining core turns into a **NEUTRON STAR**.



If the star is big enough (bigger than ten times our sun) it could become a **BLACK HOLE**.

Second generation stars

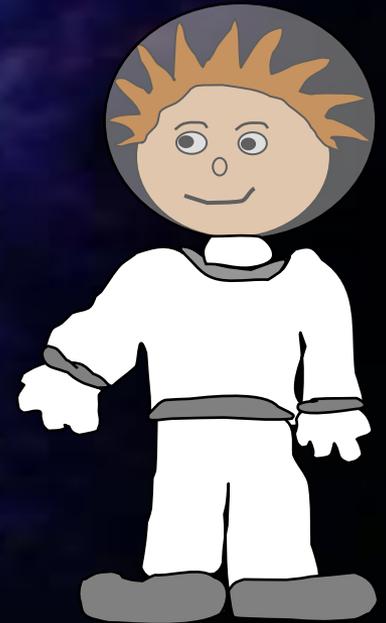
The dust and gas thrown out by a supernova can be used to form a new star...



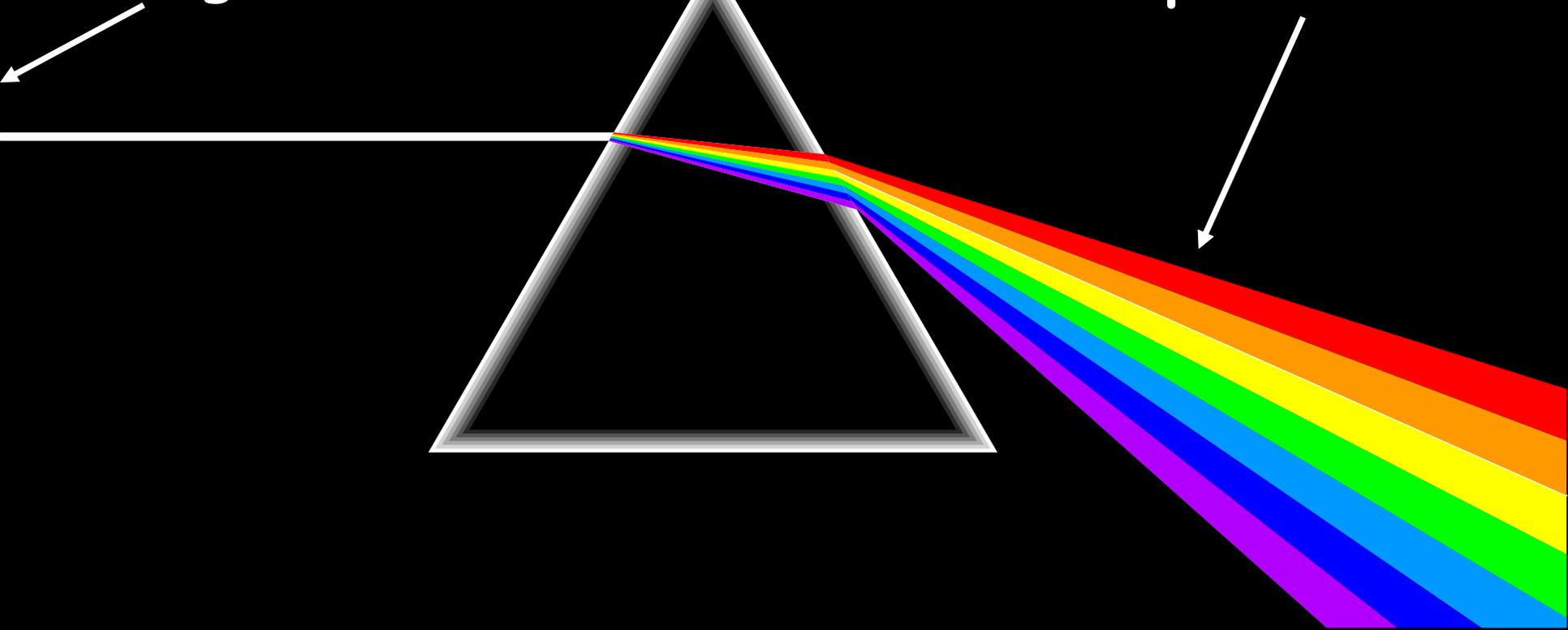
Our sun is believed to be a "_____ star" - this is because it contains some _____ elements along with hydrogen and _____. These heavier elements would have been the products of a previous star that have been thrown out by a _____. These heavier elements are also found on planets, indicating that they might have been made from remains of previous _____ as well.

Words - helium, heavier, second generation, stars, supernova

Evidence about the origins of the universe...

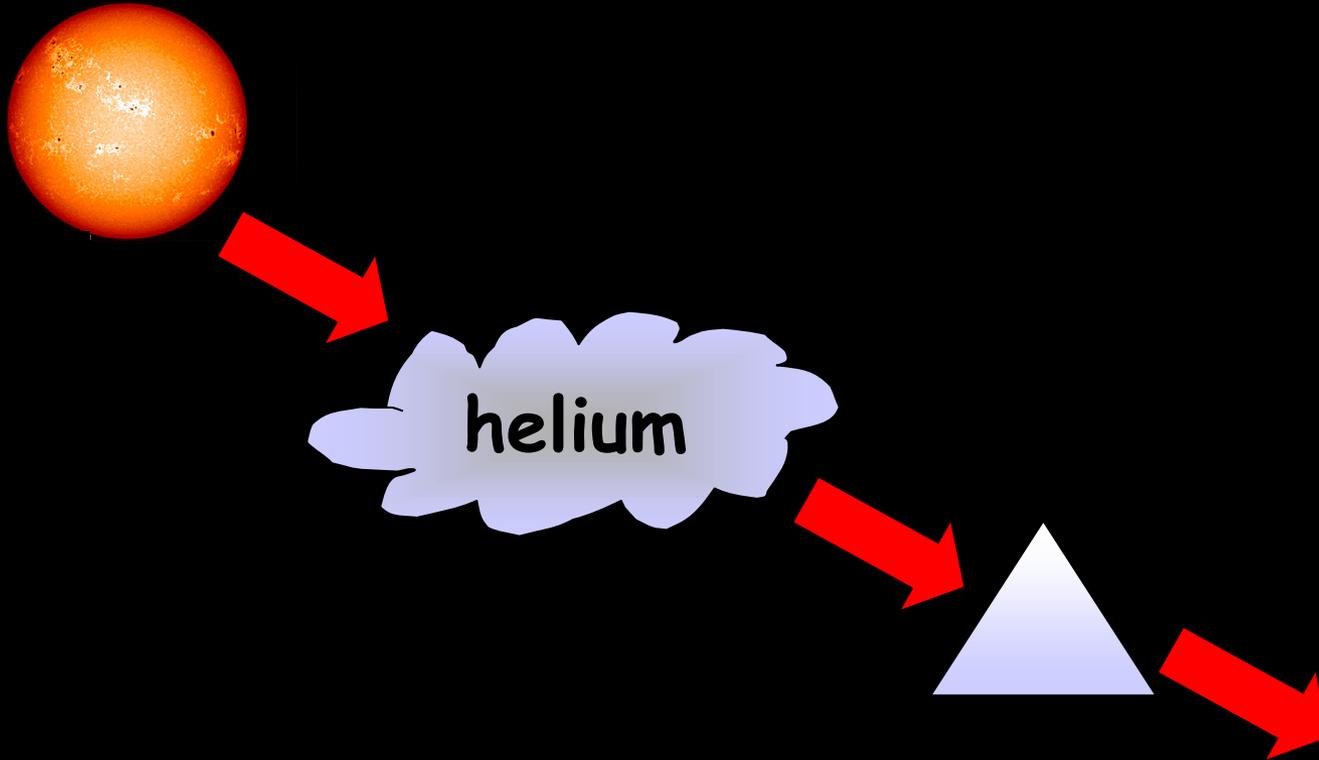


Source of light

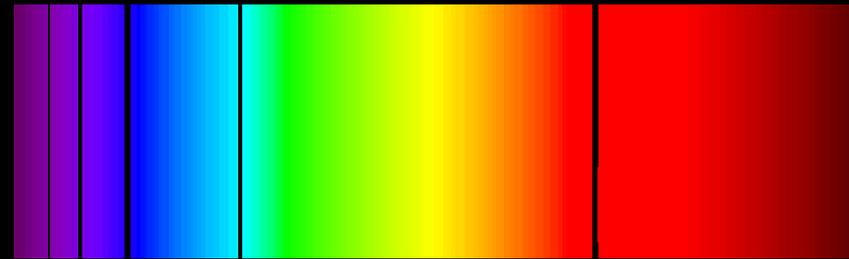


"Spectra"

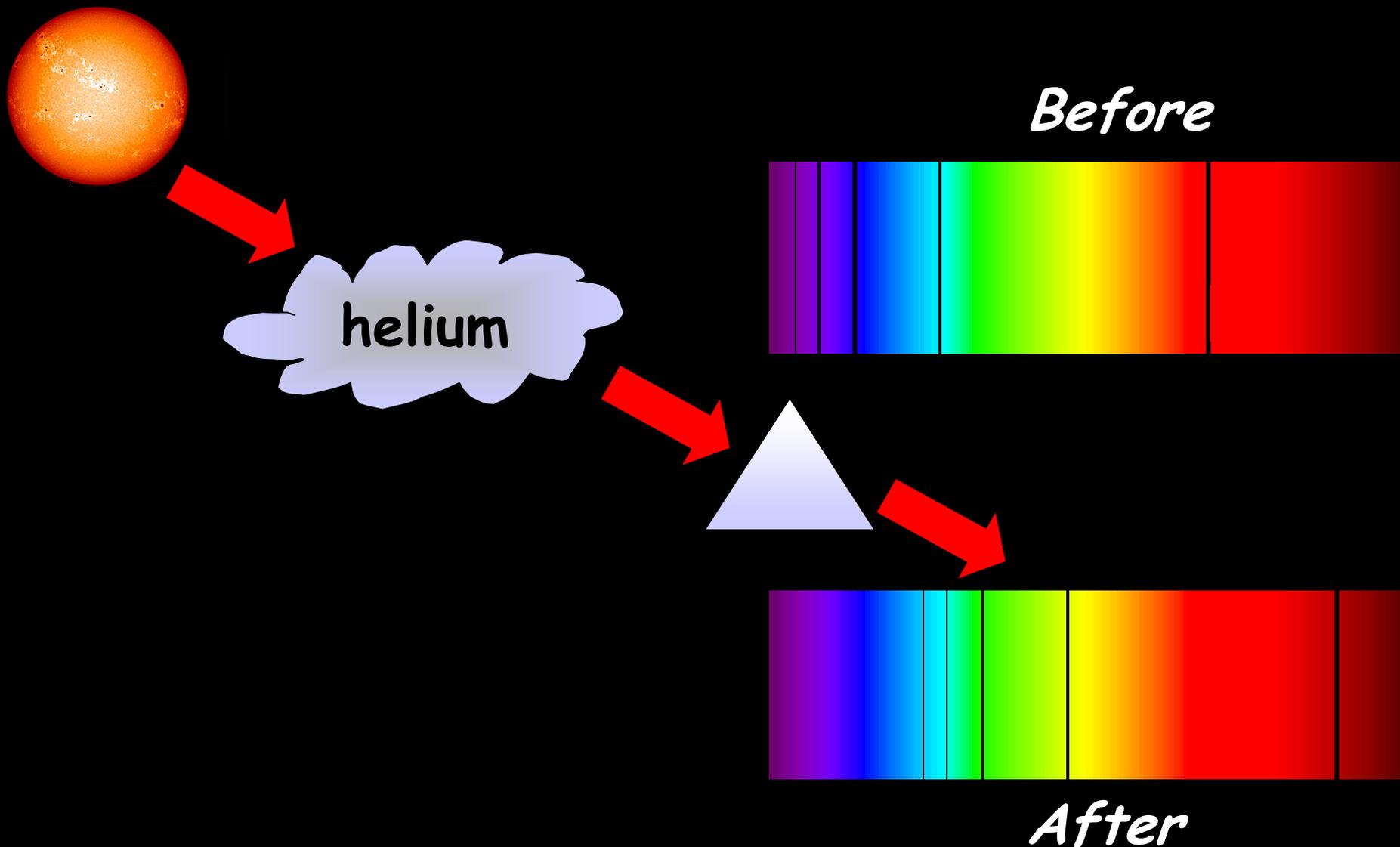
If you pass the light through a gas something different is seen...



Some wavelengths of light are absorbed by the gas - an "absorption spectrum".

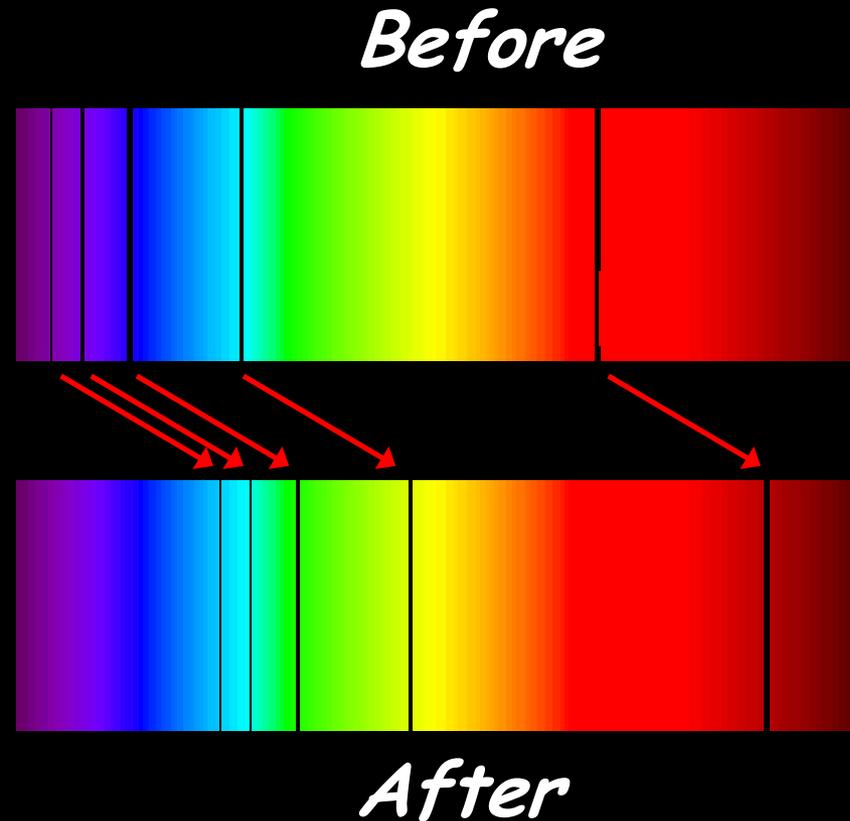


If the light source is moving away the absorption spectra look a little different...

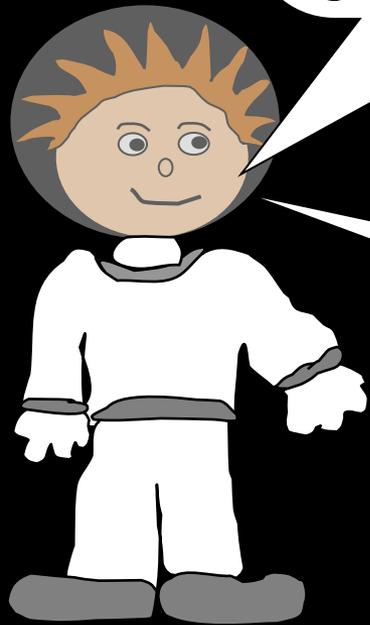


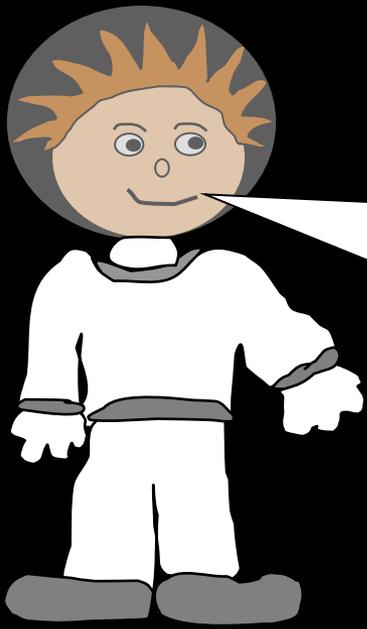
The absorption lines have all been "shifted" towards the longer wavelength end (red end)...

This is called red shift. The faster the light source moves the further its light will be "shifted"

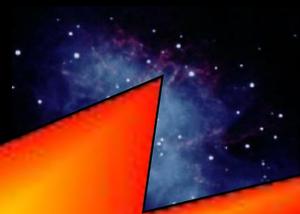


A similar effect happens with sound - this is called "The Doppler Effect"





Light from different stars and from the edge of the universe also shows this "red-shift". This suggests that everything in the universe is moving away from a single point.



This is the BIG BANG theory

Red shift summary

Light from other galaxies has a longer _____ than expected. This shows that these galaxies are moving _____ from us very quickly. This effect is seen to a greater extent in galaxies that are _____ away from us. This indicates that the further away the galaxy is, the _____ it is moving.

This evidence seems to suggest that everything in the universe is moving away from a single point, and that this process started around 15 _____ years ago. This is the _____ Theory.

Words to use - faster, away, big bang, billion, wavelength, further

Hubble's Law



The speed at which galaxies are moving away from us is proportional to their distance from us.

In other words, the further away they are, the faster they go.

Edwin Hubble

1889-1953

The formation of the universe

There are two main theories about how the universe started:



The "Steady State" theory

This theory states that the universe has always existed as it does now and hasn't changed. The trouble is that the night sky would be completely lit up because of the billions of stars, but it's not, so...

The "Big Bang" theory

This theory states that the universe started off with an explosion and everything has been moving away ever since. There are two main pieces of evidence for this: background microwave radiation and red shift.

The end of the Universe

15/12/2011

There are some theories about how the universe will end:



"The big crunch" - if there is too much mass (i.e. too much matter) the universe will collapse under its own gravity. It may then do another "big bang" - this is the "oscillating universe" theory.

"Expanding Universe" - if there isn't enough mass in the universe then it will just keep on expanding forever.

If there is just the right mass in the universe then it will reach a fixed size.

SETI

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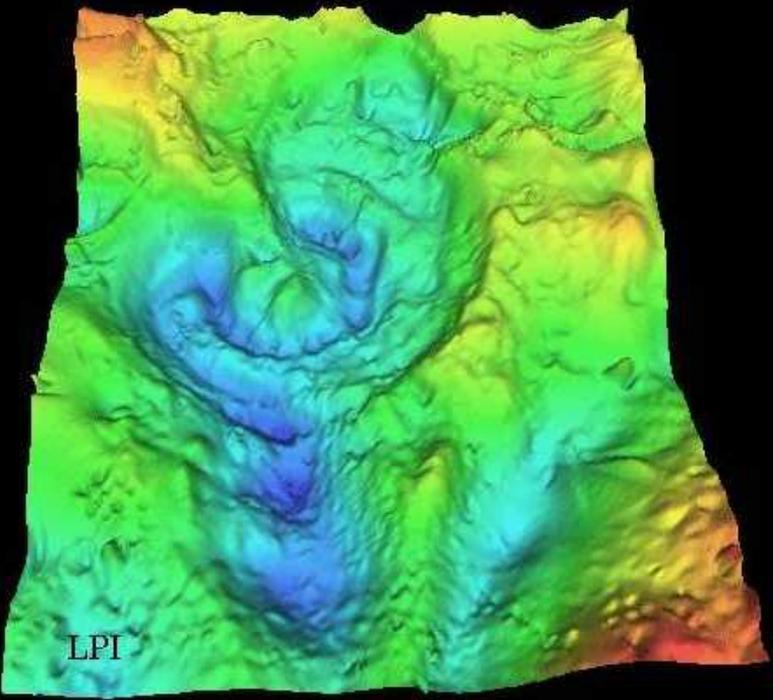


Does other life exist?

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ET - is it possible?

What killed the dinosaurs?



The Chicxulub crater, Mexico (10km in diameter, formed 65 million years ago and with the power of all the world's nuclear weapons combined times 10,000)

Growl

Oh no!

