Chapter 11 (The Sun)

The sun is entirely composed of gas, from its core to its atmosphere the extreme temperature causes all its matter to remain in a gaseous state, making it a ball of gas

LAYERS OF THE SUN

1-photosphere

-Innermost layer of the sun,being so bright that we cannot see it with the naked eye, making everything behind it the suns core.

-appears darkest in colour near the outer edges of the sphere, due to temperature differentiation→ This effect is known as limb darkening, an optical effect seen in stars, where the central part of the disk appears brighter than the edge, or limb.

-the photosphere is hottest at its base, giving the centre its apparent brightness

-The photosphere is composed of

granules→ columns of rising and falling gas, moved through convective motion out of the sun at all points.

2-cromosphere

-Located directly above the photosphere, and can only be seen during the event of a total solar eclipse→ occurs when a portion of the Earth is engulfed in a shadow cast by the Moon which fully or partially blocks sunlight

-Extremely hot spicules of gas--> a dynamic jet of plasma that radiate outwards from the cromosphere, due to the suns magnetic field. Rising gas from the granules that is extremely hot escapes into space as jets at about 15-110km/h

-these outwards flows of trapped gas help to vent the suns inner layer

3-Corona

-Hottest layer of the sun, the corona is a transition zone between the cromosphere and space

-due to extreme temperatures the corona layer is where gas from the sun ionizes making the layer very dim and not very apparent to the observer.

THE SUNS TRANSIT FEATURES

Sun Spots

-darkblotches that appear on the suns photosphere, which appear due to the distribution of heat across the suns surface

-tend to form in groups of two or more

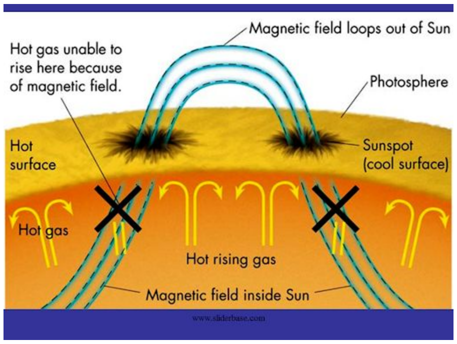
-in 1610 Gallieo first discovered sunspots and used them to help map the rotation of the sun on its axis.

-Sun spots appear on the sun in an 22 year period, with a maximum peak of sunspots occuring in the 11 year before gradually decreasing

-sunspots contain a dark centre(umbra) and a lighter outer ring (penumbra)

- the sun experiences differential rotation, although the core revolves as a rigid body.

-due to the suns magnetic fields certain regions are unable to allow for the escape of gas causing them to remain cooler than the rest of the surrounding area



Suns Magnetic field

-Due to ionization in the suns corona of plasma, the sun has a very strong capacity to house a magnetic field.

-because the sun rotates at different speeds at its centre compared to the poles,the magnetic field strength is amplified ,as differential rotation 'wraps' magnetic field lines around its body

-the convective forces in the photosphere further tangles field lines inside the atmosphere of the sun, which causes sunspots to group together due to attraction.

- Solar irradiance→ the output of light energy from the entire disk of the Sun, measured at the Earth. It is looking at the Sun as we would a star rather than as an image. The **solar** spectral **irradiance** is a measure of the brightness of the entire Sun at a wavelength of light

Solar Plages

-bright areas in the suns chromosphere, seen before sunspots or around

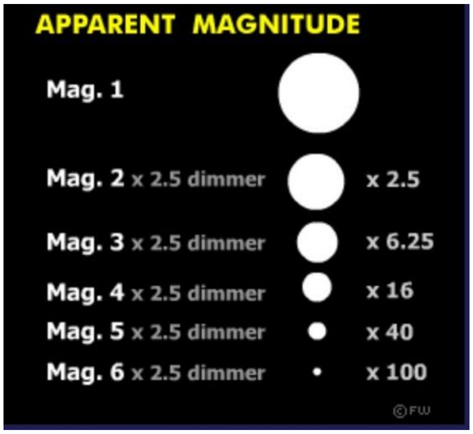
-created by magnetic fields in the photosphere which compress and heat gas in the chromosphere above.

Solar filaments and prominences

-a stream of gas that extends from the photosphere well up into the corona of the sun, when this feature is viewed from a profile perspective its referred to as a prominence

Solar Flares

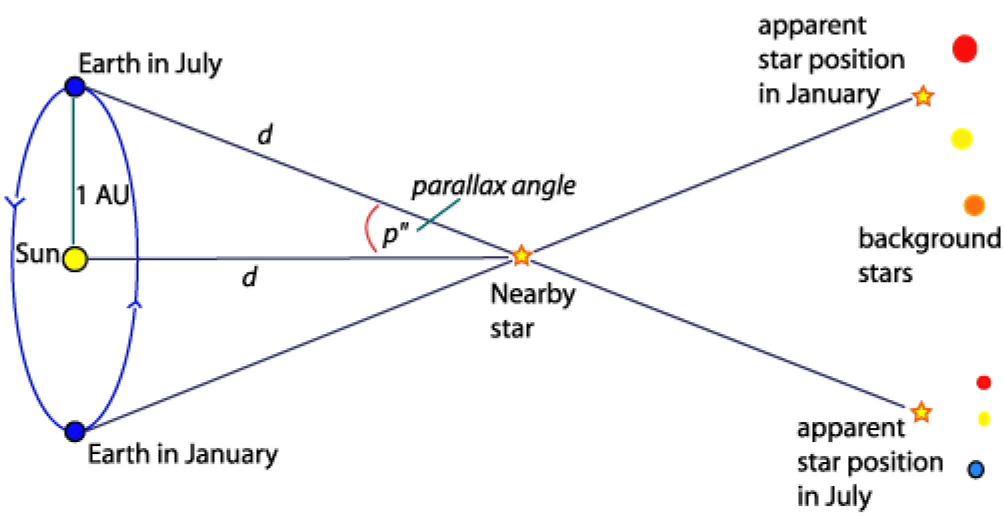
-sudden burst of energy released in the form of radiation from the surface of the sun, triggered by the magnetic energy associated with the suns corona



The brightness of a star or true luminosity can not be measured as distance affects how we observe the light.

Inverse square law→ a stars brightness is inversely pro[portional to the square of its distance from the observer.

Parallax→ defined as the apparent displacement of an object relative to more distant objects, as the boservers location changes.

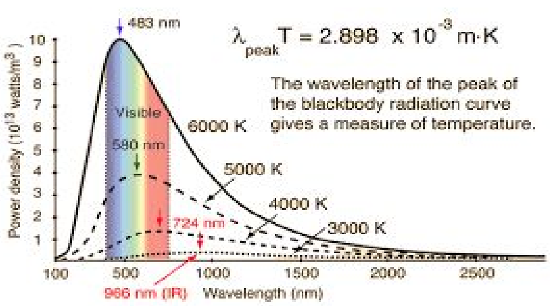


Parallax of nearby star

Absolute magnitude (M)→ the apparent magnitude that a stellar object would have if it were located 10pc away from the observer

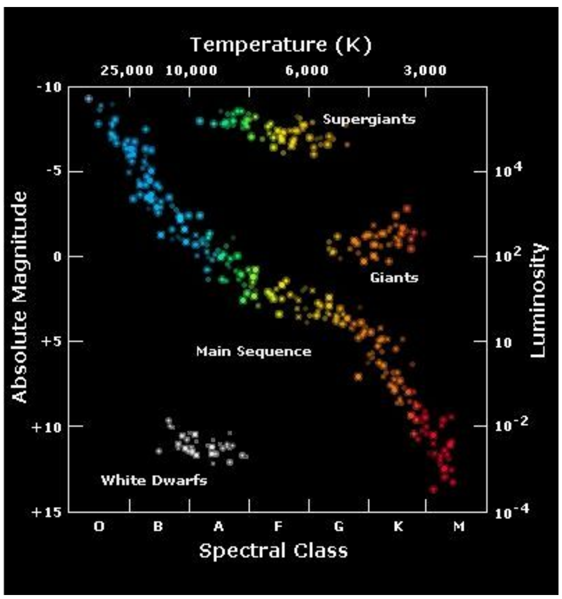
To find absolute magnitude, we must use the stars apparent magnitude (m) and its distance from us (d).

$$M= m-5\log(d/10pc)$$



A stars temperature and peak wavelength helps to indicate its visible colour to the observer. Longer peak wavelengths in the lover temperature indicate a raddish star, whereas short extremely high temperature wavelengths denote very bright and hot blue stars.

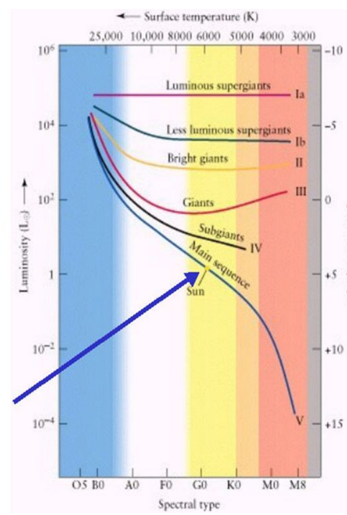
Type	Color	Approximate Surface Temperature	Main Characteristics	Examples
O		> 25,000 K	Singly ionized helium lines either in emission or absorption. Strong ultraviolet continuum.	10 Lacertra
B		11,000 - 25,000	Neutral helium lines in absorption.	Rigel Spica
A		7,500 - 11,000	Hydrogen lines at maximum strength for A0 stars, decreasing thereafter.	Sirius Vega
F		6,000 - 7,500	Metallic lines become noticeable.	Canopus Procyon
G		5,000 - 6,000	Solar-type spectra. Absorption lines of neutral metallic atoms and ions (e.g. once-ionized calcium) grow in strength.	Sun Capella
K		3,500 - 5,000	Metallic lines dominate. Weak blue continuum.	Arcturus Aldebaran
M		< 3,500	Molecular bands of titanium oxide noticeable.	Betelgeuse Antares



Luminosity classes

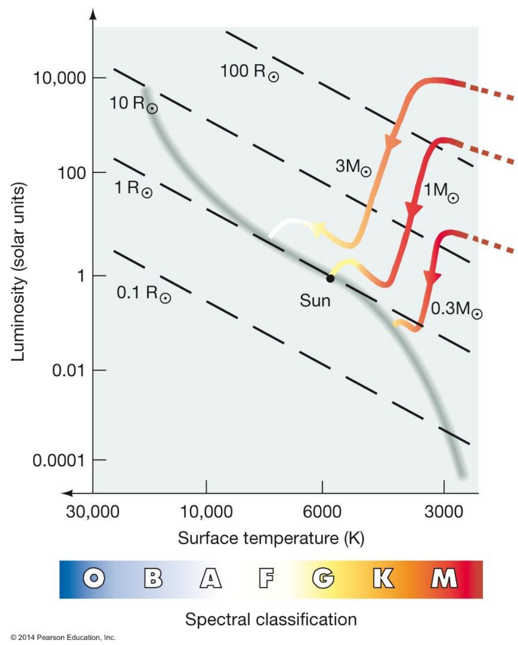
- Class Ia,b : Supergiant
- Class II: Bright giant
- Class III: Giant
- Class IV: Sub-giant
- Class V: Dwarf

The Sun is a G2 V star



Chapter 13 (Lives of Stars)

ISM, or interstellar medium, known as nebula reflects blue light because dust particles scatter light at extremely short wavelengths causing them to release blue light.
Reddening→ the phenomenon caused by the scattering of star light through ISM, as light travels for extremely long distances wavelengths become stretched and appear redder than their true colour.



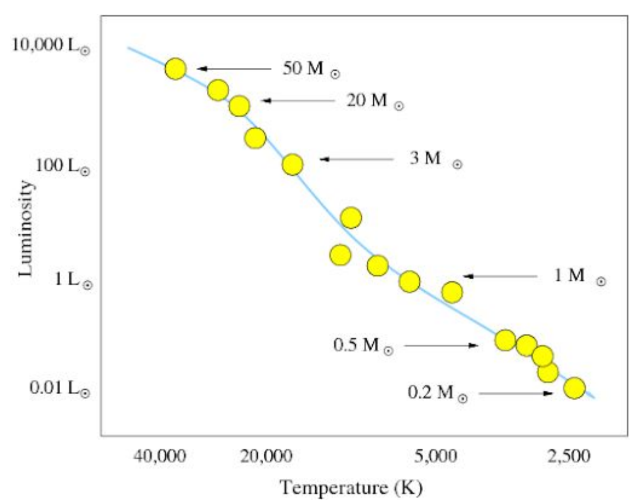
ISM are the birthplace for stars as they are composed of cold gasses (hydrogen/helium) as the gas cloud exists in space, it gravitationally condenses its matter in the centre through slow convective processes. As the core can no longer support the dance centre it collapses, causing the protostars gas to heat and begin to expand

At this point the star is considered to be a pre main sequence star.as it continues to heat the star shrinks in size as it begins to consume its matter, upon reaching 10 million K in degrees the birth of a new star has taken place and it enters the main sequence.

Main sequence stars are very stable, as they fuse hydrogen into helium in their cores at a constant rate.because pressure as well as gravity remain balanced, stars along the main sequence are stable throughout their journey on the main sequence.

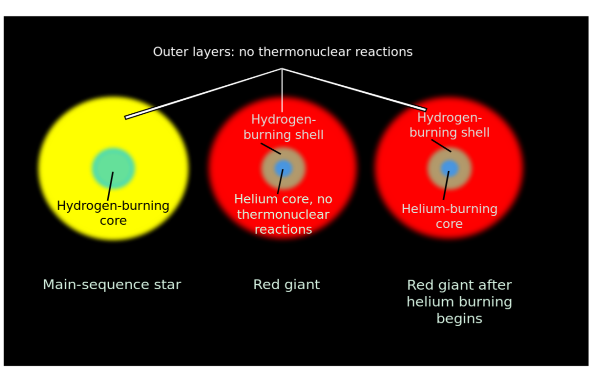
The main sequence is a journey of mass, high mass stars are hot and luminous where as low mass main sequence stars are cool and faint in luminosity

The mass of stars along the main sequence ranges from about 0.08 M to 150 M



LEAVING THE SEQUENCE

Red dwarf ranging in size from 0.08M to 0.4 M have the abil;ity to fuse all their matter into energy, resulting in the death of the star



Stars with stellar mass greater than 0.4 M leaving the main sequence become red giants. As they run out of helium fusing core, the core of the star collapses and it begins to burn off its hydrogen shell. stars which fuse helium in their cores are relatively stable

Chapter 14 (Death of Stars)

Death of starts categorized by mass

Main sequence stars with mass 0.08-0.4M end their lives as helium cores which are no longer hot enough to undergo fusion

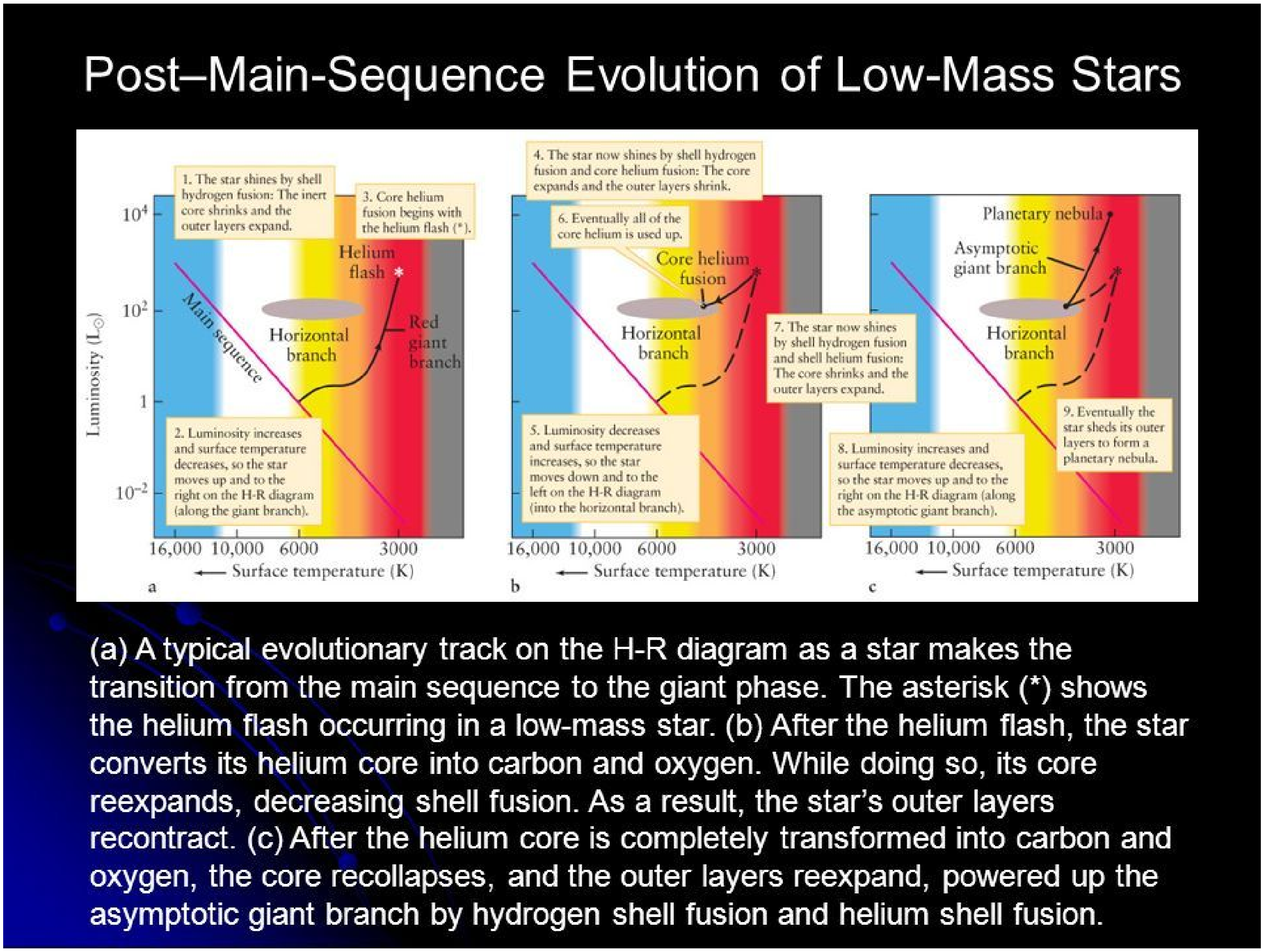
-will cool and fade over time, commonly known as helium dwarfs

Main sequence masses 0.4-8M will eventually fuse helium into carbon and than oxygen

-will never be hot enough to initiate carbon fusion, and will end their lives as low mass stars

Main sequence stars greater than 8M will complete all stages of fusion until it fuses all the carbon its produced, and will end their lives as high mass stars

LOW MASS STARS POST MAIN SEQUENCE



As AGB stars burn out, their cores become clouds of gas called planetary nebula
Lasting for about 100,000 years until the gas eventually fades leaving behind nothing but a white dwarf

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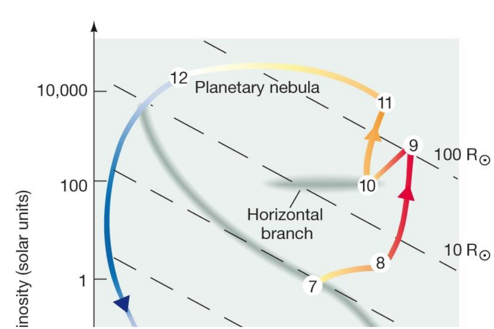
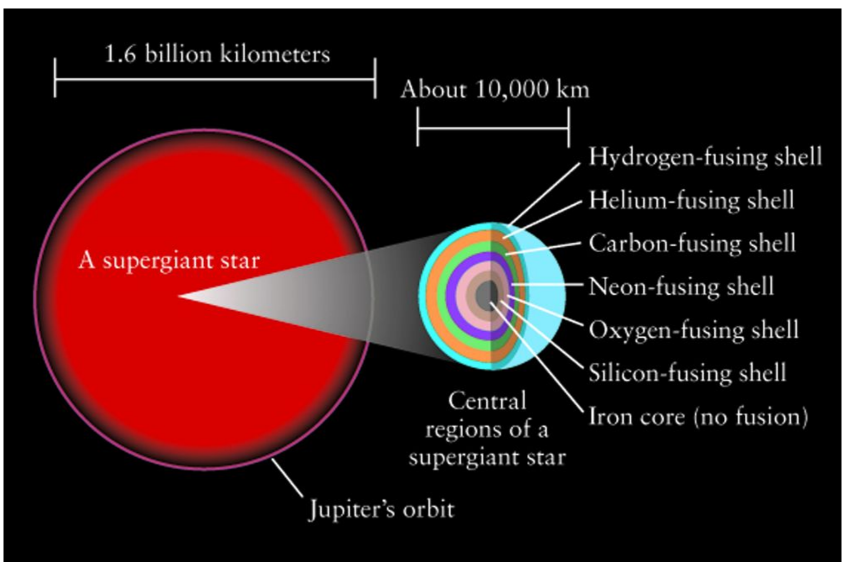


White dwarfs extremely dense mass occurs as it contracts due to lack of outward pressure sustained by the energy of core fusion and burning

HIGH MASS STARS POST MAIN SEQUENCE

Due to the size difference in low mass stars, high mass stars have to temperature associated with luminosity to continue fusion in the form of burning its carbon

These stars undergo substantial mass loss as they continue to burn off heavier elements such as :neon, oxygen, magnesium, and silicon.



Eventually the high mass star will create an iron core, which it is no longer hot enough or large enough to sustain, and will collapse inwards.

-rising temperatures in the solid core causes for photons to break up the remaining heavy elements leaving behind photons, neutrons and electrons

-as the neutrons come into contact with each other during the core collapse they repel each other at extremely high speeds outwards in all directions.

- this blast is referred to as core bounce sending a powerful shockwave into space as a supernova

NOVAE

If enough matter builds up on its surface, the hydrogen gas will ignite and undergo thermonuclear fusion
-This will cause the white dwarf to brighten dramatically for a few days, before gradually fading back to normal ! This phenomenon is referred to as a nova.

NEUTRON STARS

During a core collapse supernova, a dense core of matter is left behind resulting in a tiny composition of extremely dense neutrons. Even though this star is now longer undergoing fusion it is still considered stars
-Neutron stars are extremely dense, They are typically about 20 km across, but more massive than the Sun They are a billion times denser than white dwarfs, and 10 trillion times denser than the Earth
-due their small size neutron stars are very faint compared to other stellar objects

PULSARS

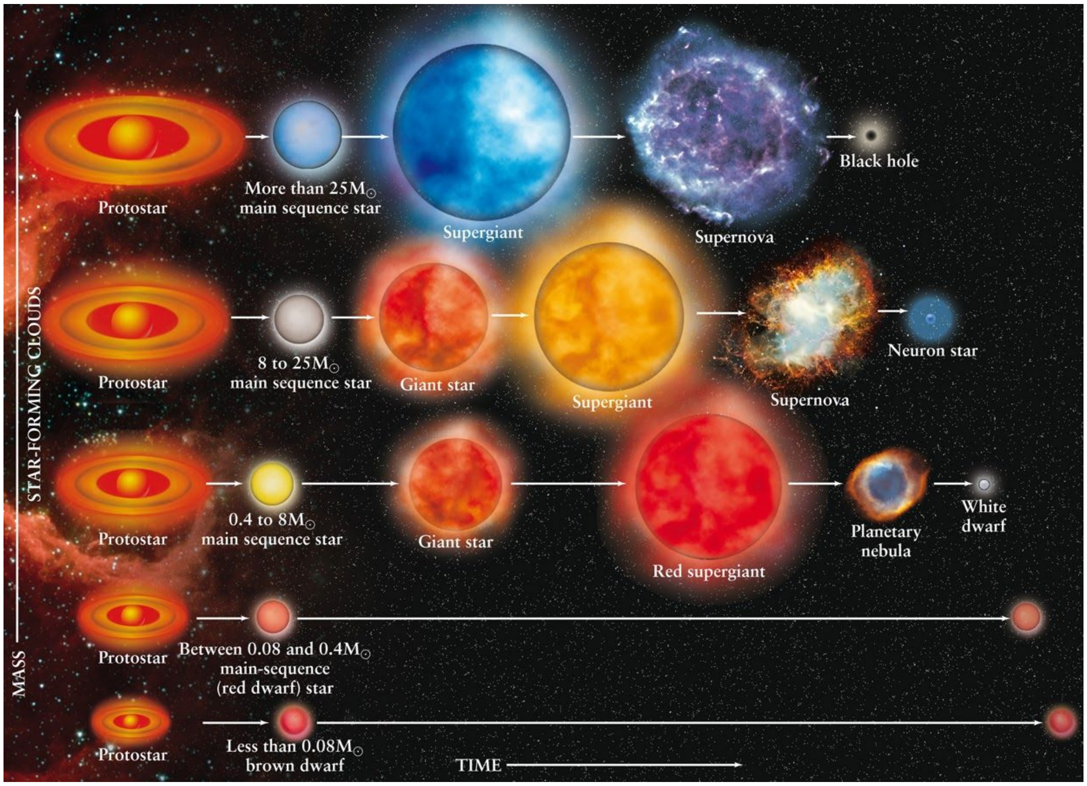
Pulsars are rotating neutron stars, having strong magnetic fields radiating from their poles resulting is radio emissions
-due to the rapid core collapse, angular momentum helps them remain in rotation at rapid rates, and as the poles of the magnetic field are not in line with the axis of rotation, the stars exhibit irregular pulses of radiation into space, hence the name pulsars.(like a lighthouse)

RELATION BETWEEN NEUTRON STARS AND PULSARS

The difference between pulsars and neutron stars is its orientation to the observer or (earth), if a neutron star is located with its magnetic poles pointing towards earth during its rotation it is referred to as a pulsar.
Pulsars rapid rotation does begin to slow ultimately to a hult after a few ten thousand years as do its magnetic fields.

Chapter 15 (black holes)

As low mass stars end their lives as white dwarfs, the highest mass stars become black holes

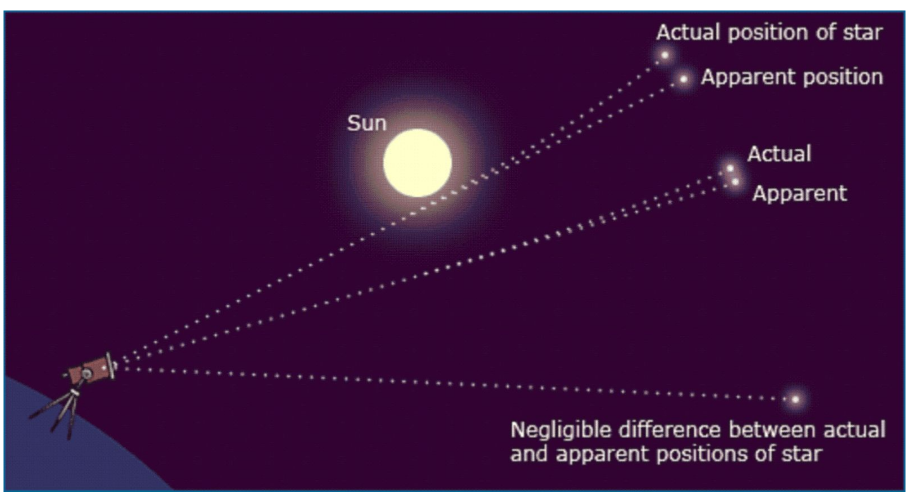


Neutron stars however also hold the potential to become black holes if their mass exceeds 3M, the Objects overcome their neutrons pressures and collapse inwards to form black holes

As the matter becomes so densely packed light cannot escape or pass through it, resulting in the name of "black hole"

GENERAL RELATIVITY

A theory of how space, time, and matter are interrelated; inferring that matter has the ability to curve space which results in a distortion of time. This theory although not predicted affects the movement of light through space.



CONSEQUENCES OF GENERAL RELATIVITY

Gravitational Redshift

The effect of photons being shifted to be observed at longer wavelengths due to the influence of a massive stellar object.

-the result is “reddening” of light observed most effectively for light travelling around black holes.

-Light radiating off of objects near black holes will be heavily red shifted due their gravitational influence.(and will lose energy and intensity)

EVENT HORIZONS

The event horizon of a black hole is the radial diameter which light cannot escape

- the distance from the black holes centre, to the edge of the event horizon is known as the Schwarzschild Radius.

The size of a blackholes schwarzschild radius is equal to the mass of the black hole

TIME DILATION

The effect of the slowing or bending of time under the influence of massive objects such as black holes.