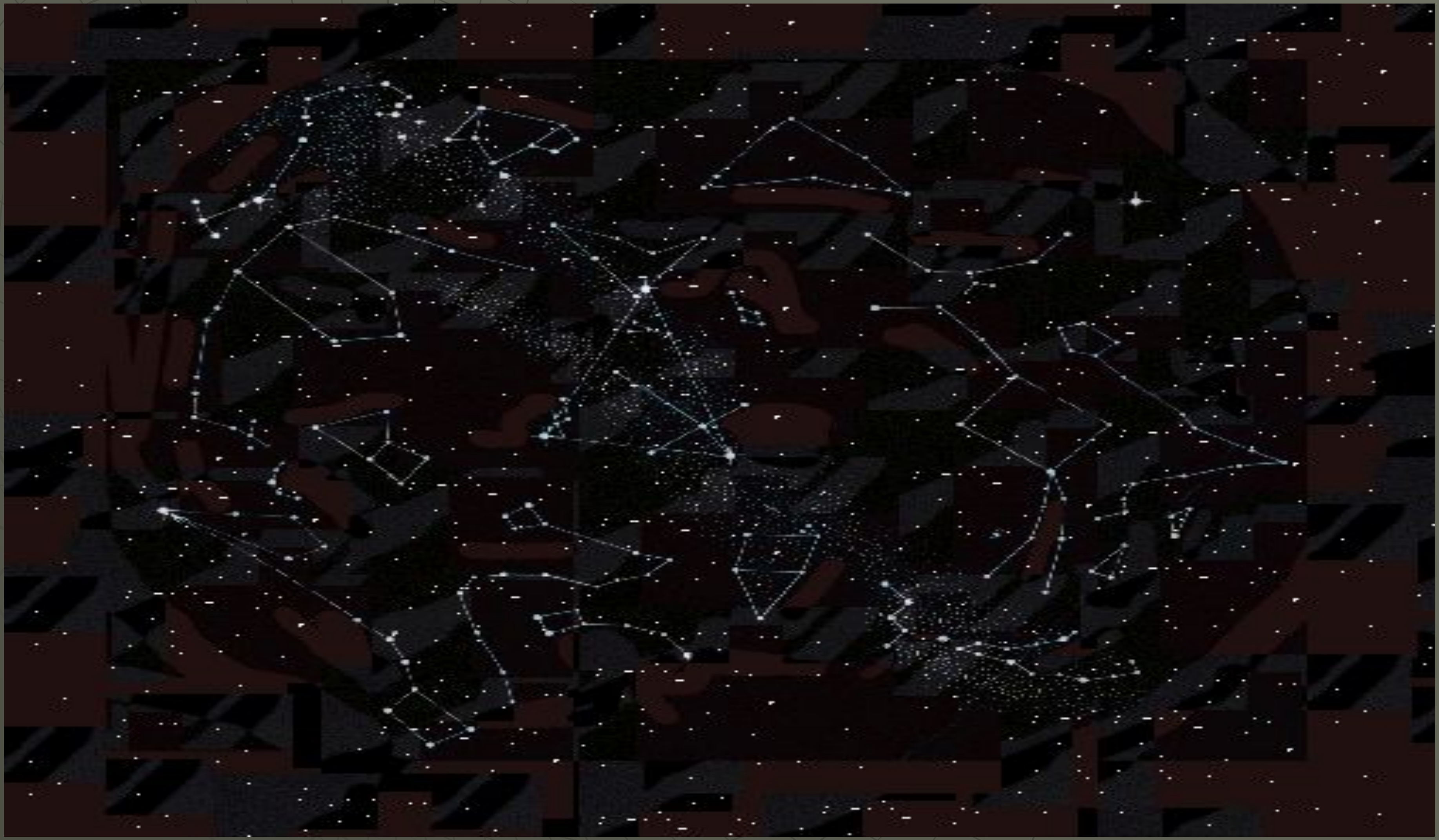
Life & death of Stars

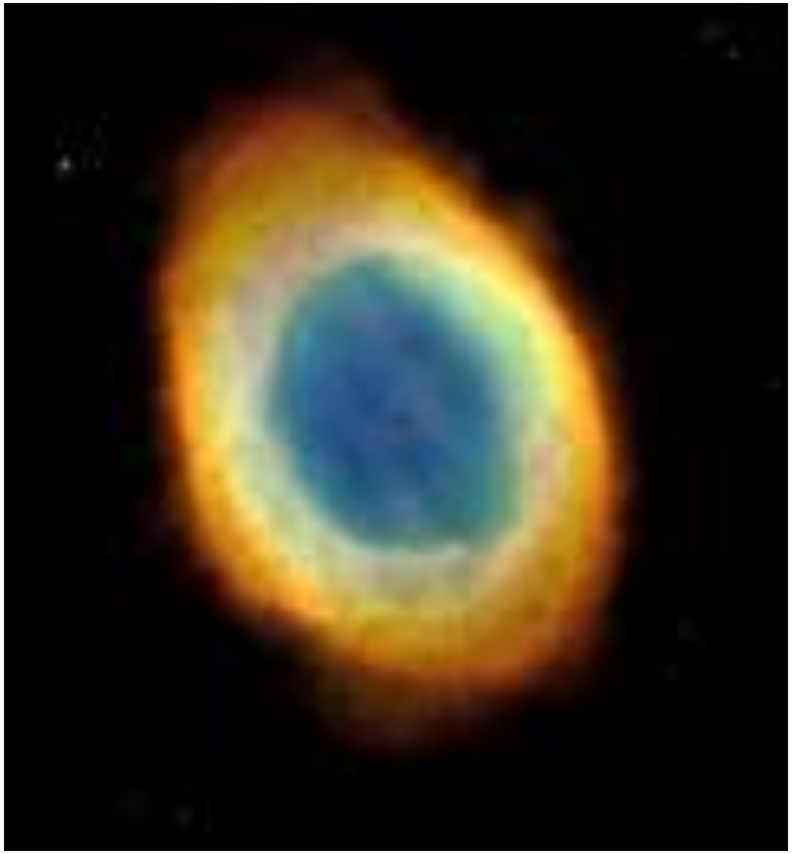


They're born and then they die….

- But what gave birth to them?
- And where do they go when they die?

Stages of Stellar Evolution:

Nebula (clouds)

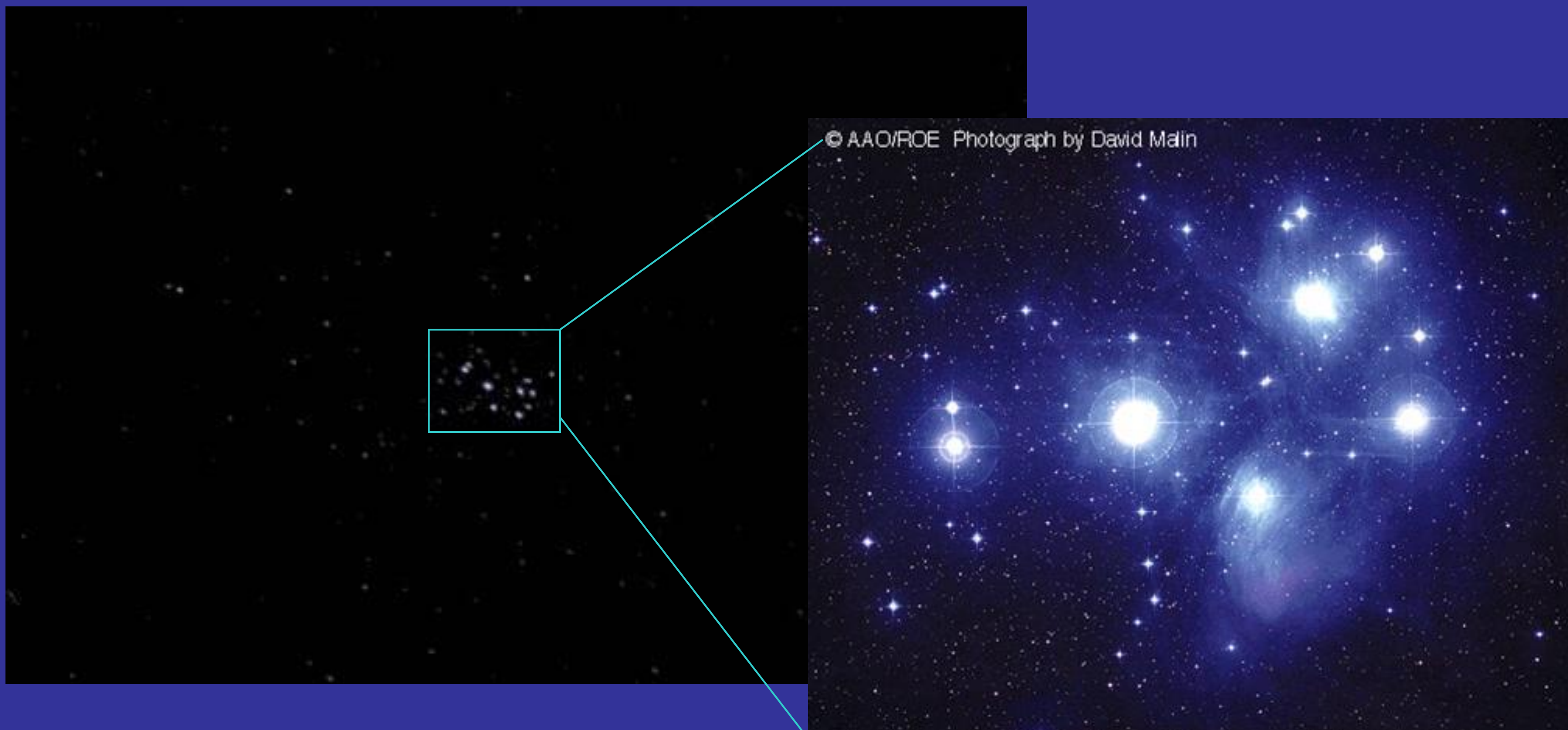


- Nebula - Cloud of swirling dust and gases (mostly hydrogen) and dust --where stars are born

When a disturbance (e.g. supernova shockwave) hits the nebula cloud – a portion of it may begin to contract

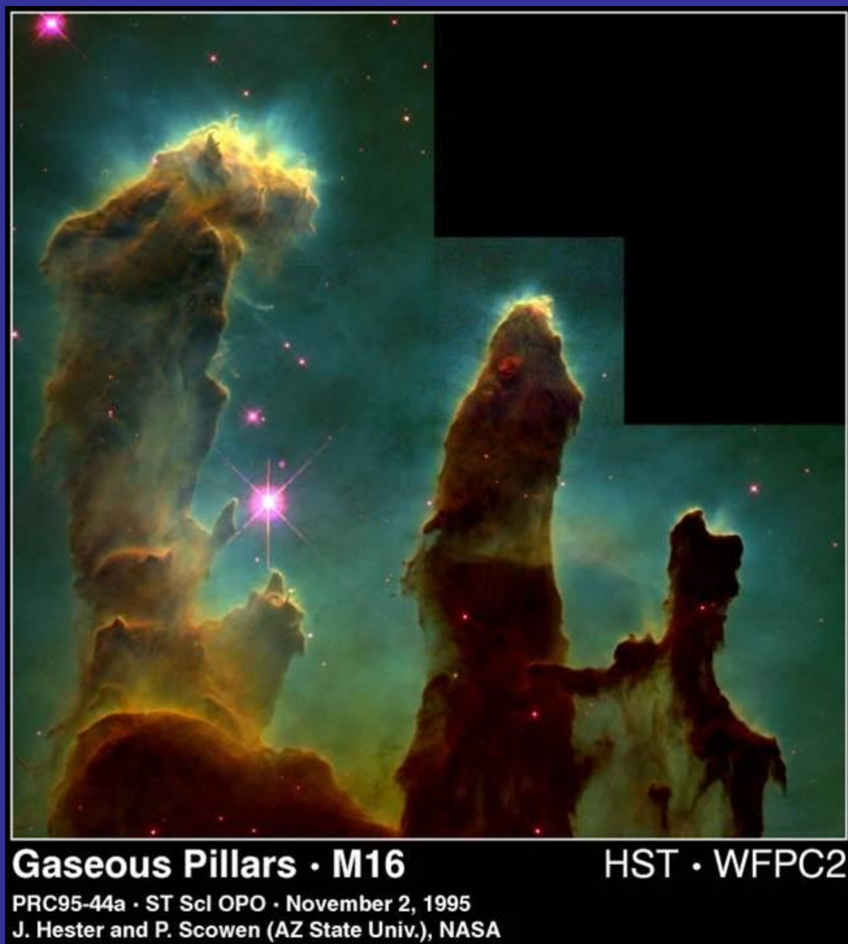
stellar nurseries

Clusters: Pleiades

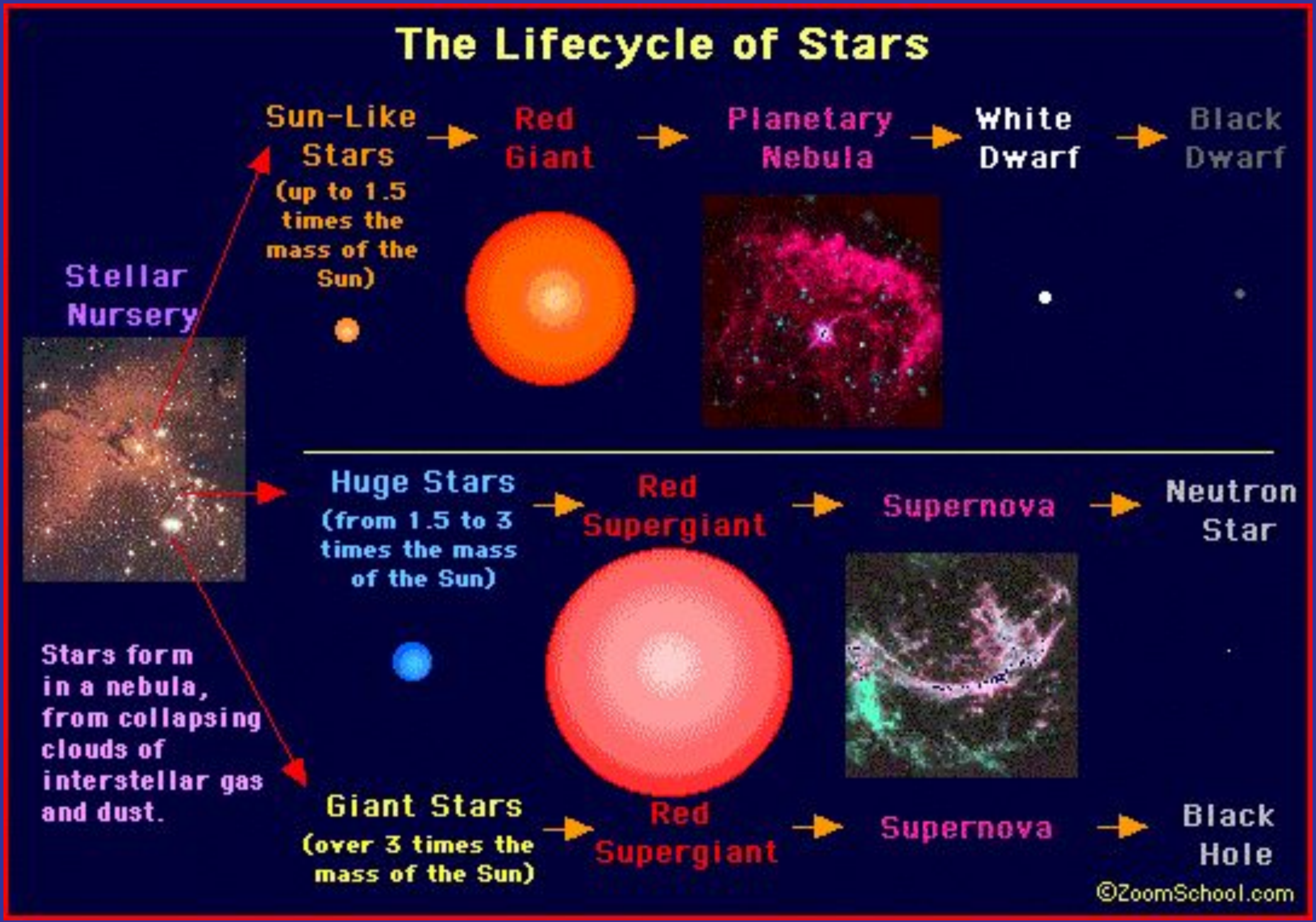


Stellar Nurseries

Optical



Infrared: 30 Doradus in LMC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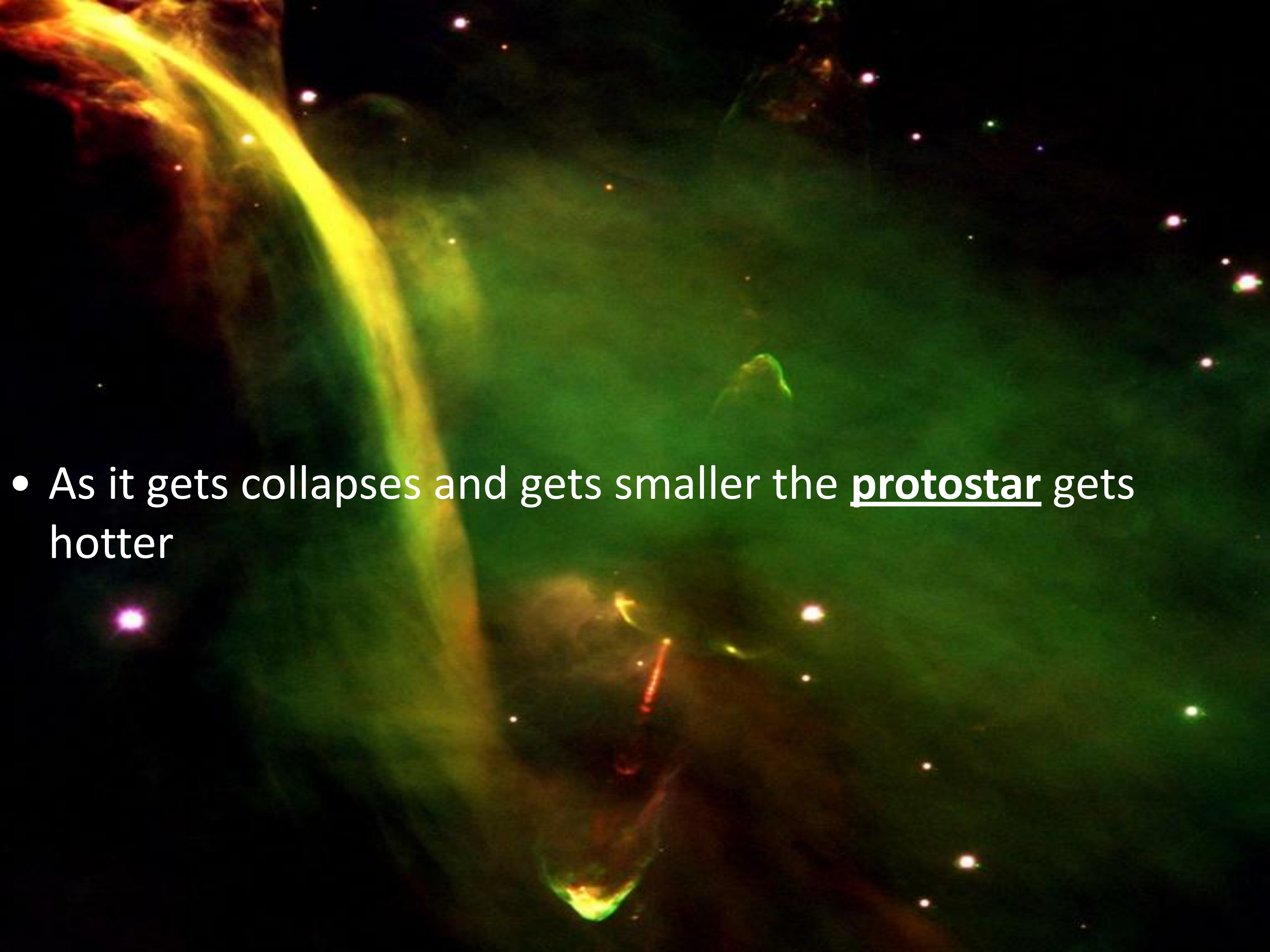
PROTOSTAR

- Once a clump of gas and dust begins to contract, gravity becomes stronger dust and gas collapse protostar.



- As it gets collapses and gets smaller the **<u>protostar</u>** gets hotter

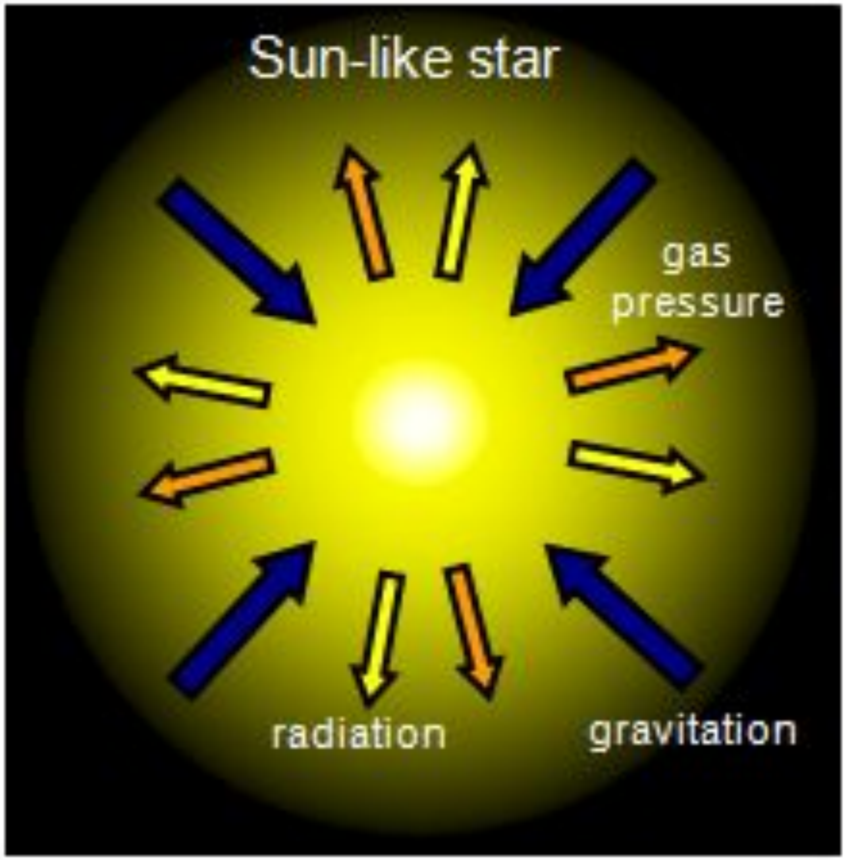
Main Sequence (Stars)

- WHEN THE PROTOSTAR IS DENSE & HOT ENOUGH IT WILL BEGIN nuclear FUSION which releases large amount of energy

- Nuclear Fusion -- HYDROGEN IS BEING COVERTED TO HELIUM
- IT IS NOW A MAIN SEQUENCE STAR!

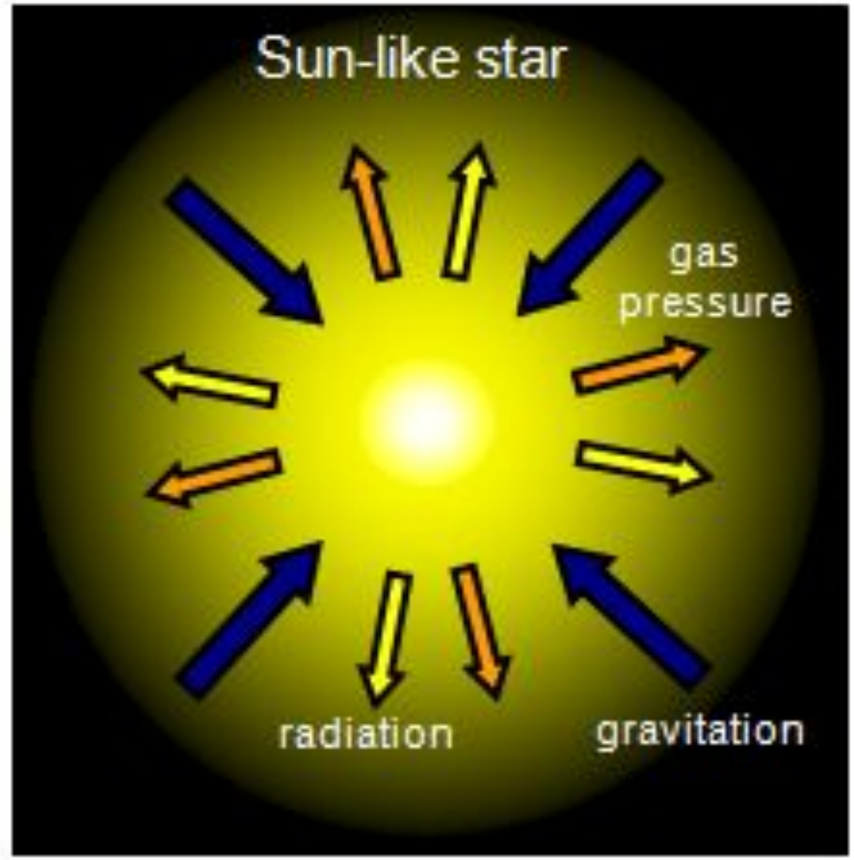
Forces on a star

- Inward forces
  Gravitation attraction between particles contraction
- Outward forces
  Heat and radiation from nuclear fusion expansion of star

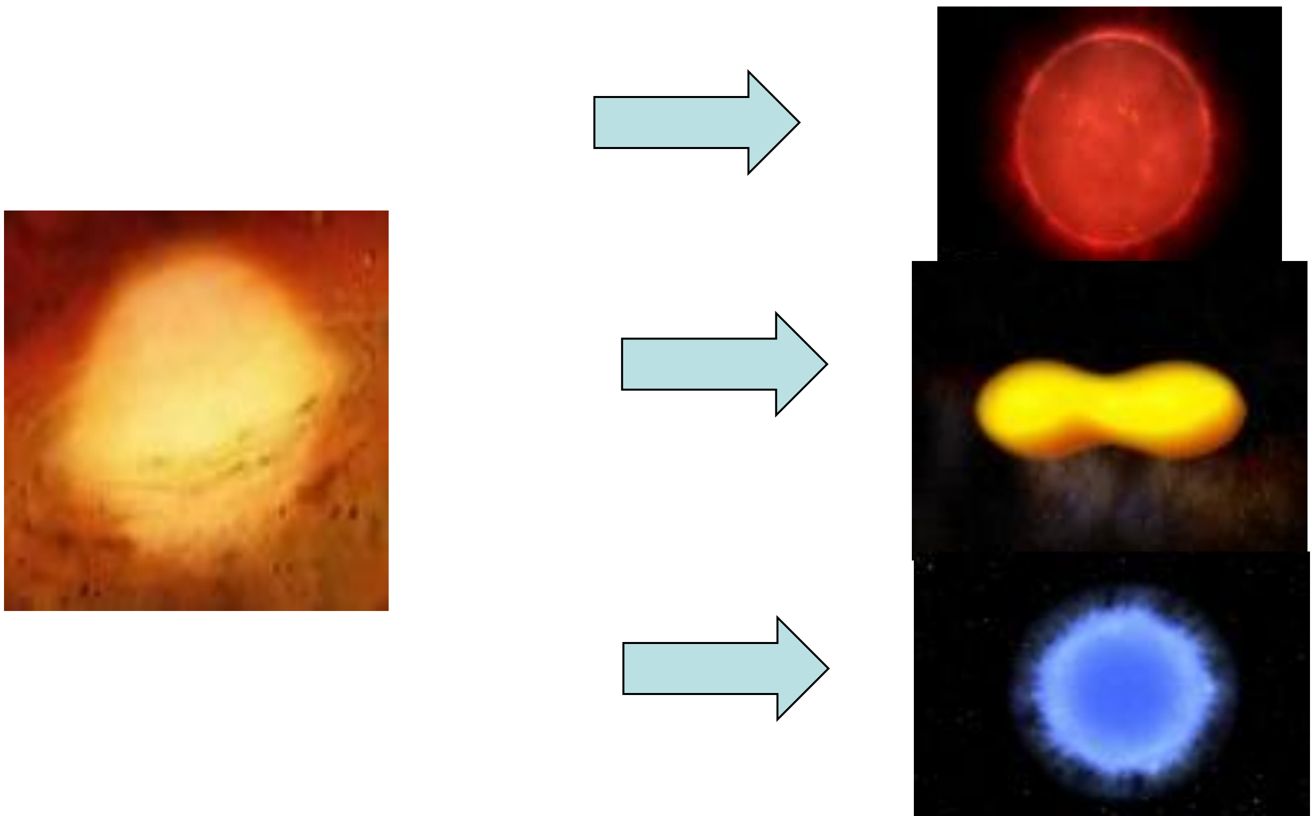


If the star is stable,

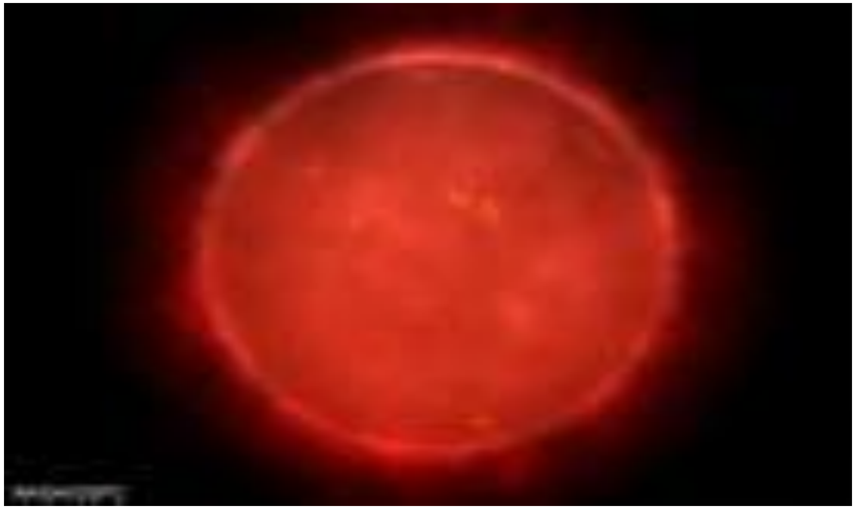
inward gravitational forces = outward forces of gas pressure and radiation.



There are three types of Main sequence stars: Low Mass star (red dwarf), Medium Mass (yellow star) or High Mass (blue giant).



Low Mass MAIN SEQUENCE STARS called -(RED DWARF) STARS



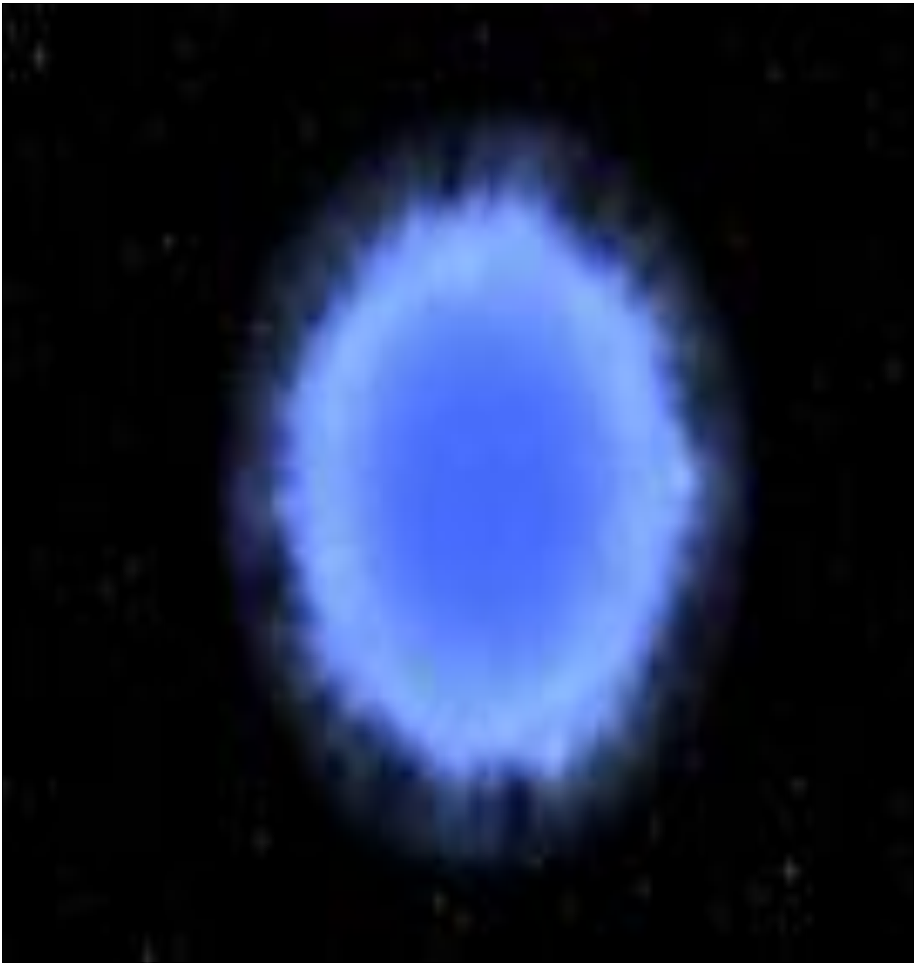
- A small star that lives billions of years
- Mass less than 4 times the mass of our sun

Our sun is a Low Mass Star

Medium Mass - MAIN SEQUENCE STAR – called a YELLOW STAR

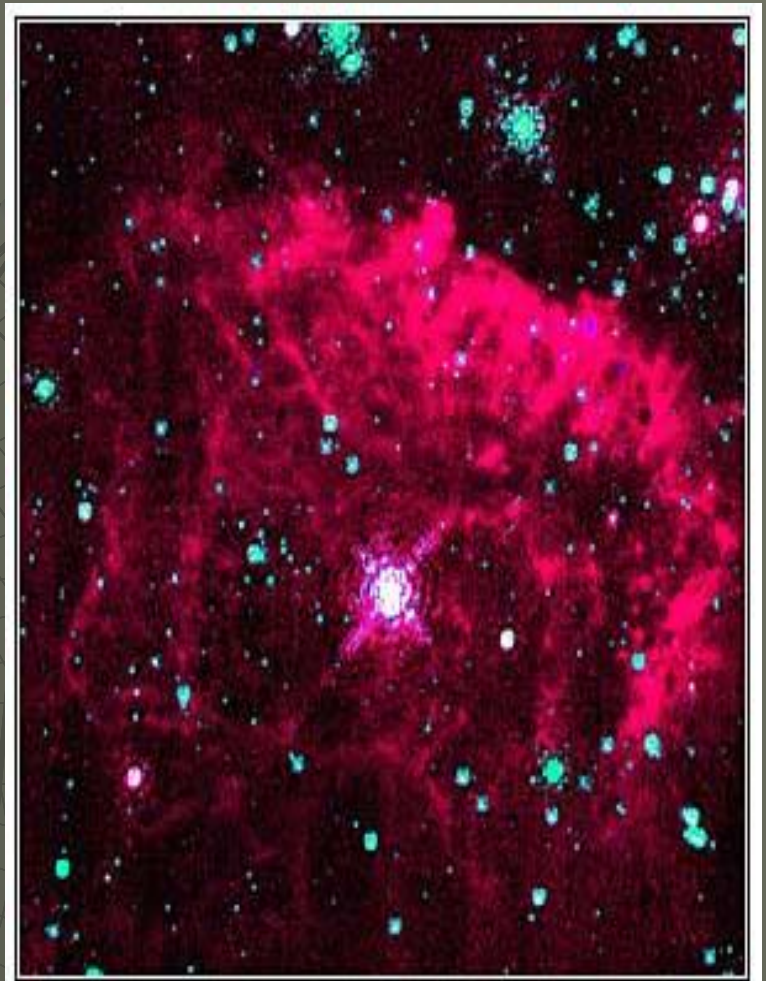
- A medium mass star
- (4-10 times mass of our sun)
- Shorter lived than a red dwarf but still lives billions of years

High Mass (high mass) - MAIN SEQUENCE SIZE
BLUE GIANT STAR



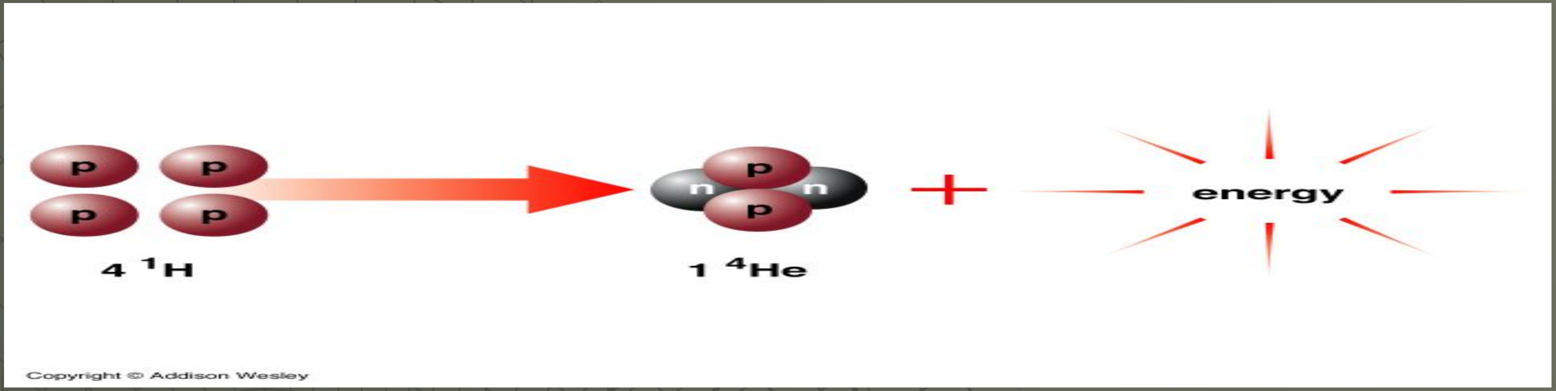
- A large star (>10x mass of our sun)
- It has the shortest life span
- Living only millions of years….

Blue (large) Stars



(AP Photo)

Transition between Main Sequence and Red Giant/Superbiant



- As the Hydrogen Helium nuclear fusion reaction runs out of hydrogen gravity (inwards force) > fusion heat–(outwards force)
- Star starts to shrinks

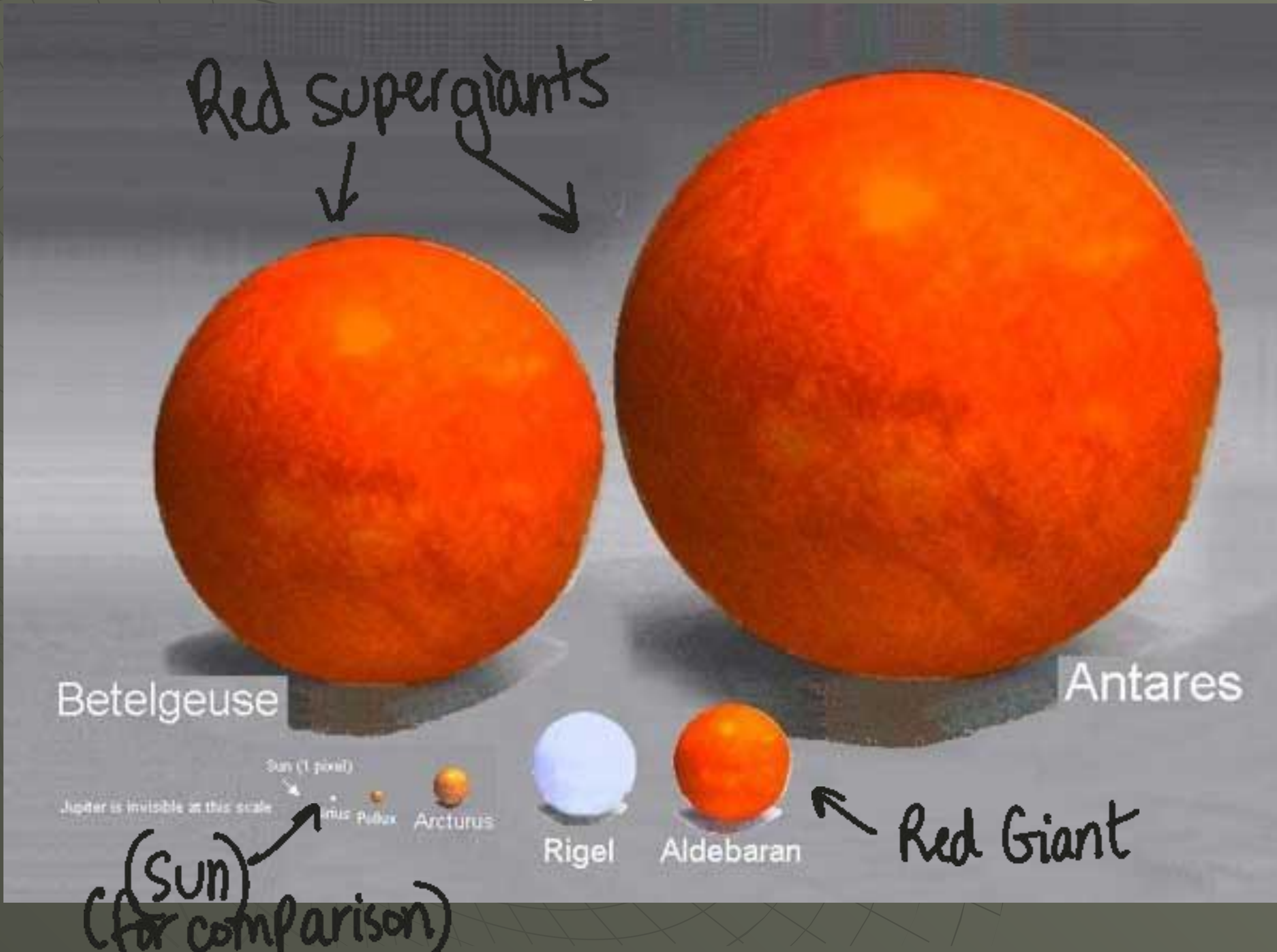
Stars collapse then expands

- Shrinking star□an increase in pressure and temperature □ restarts nuclear fusion with larger molecules. an increase in radiation and luminosity and the star expands □red giants

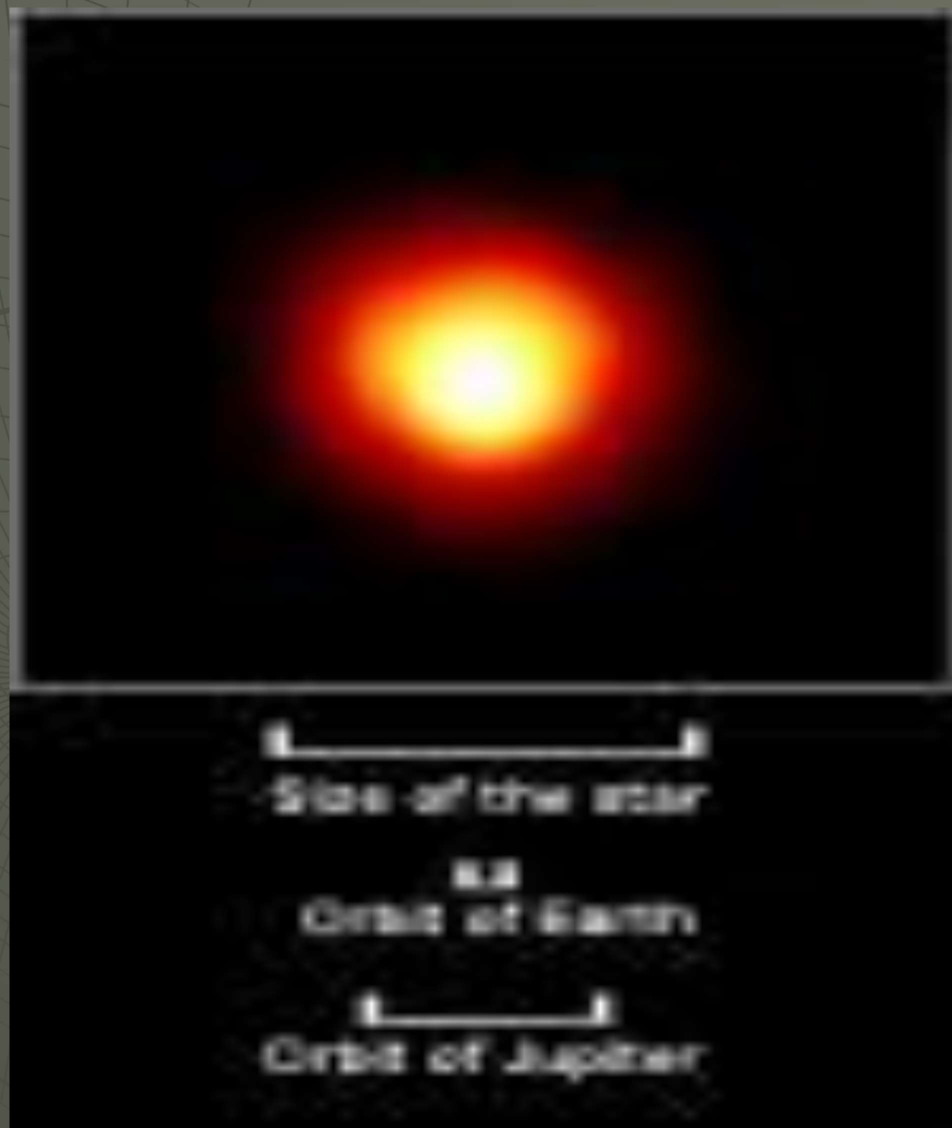
Red Giant Stars

Low Mass stars (Red dwarf) becomes a red giant

Lets compare sizes…



Red Giant

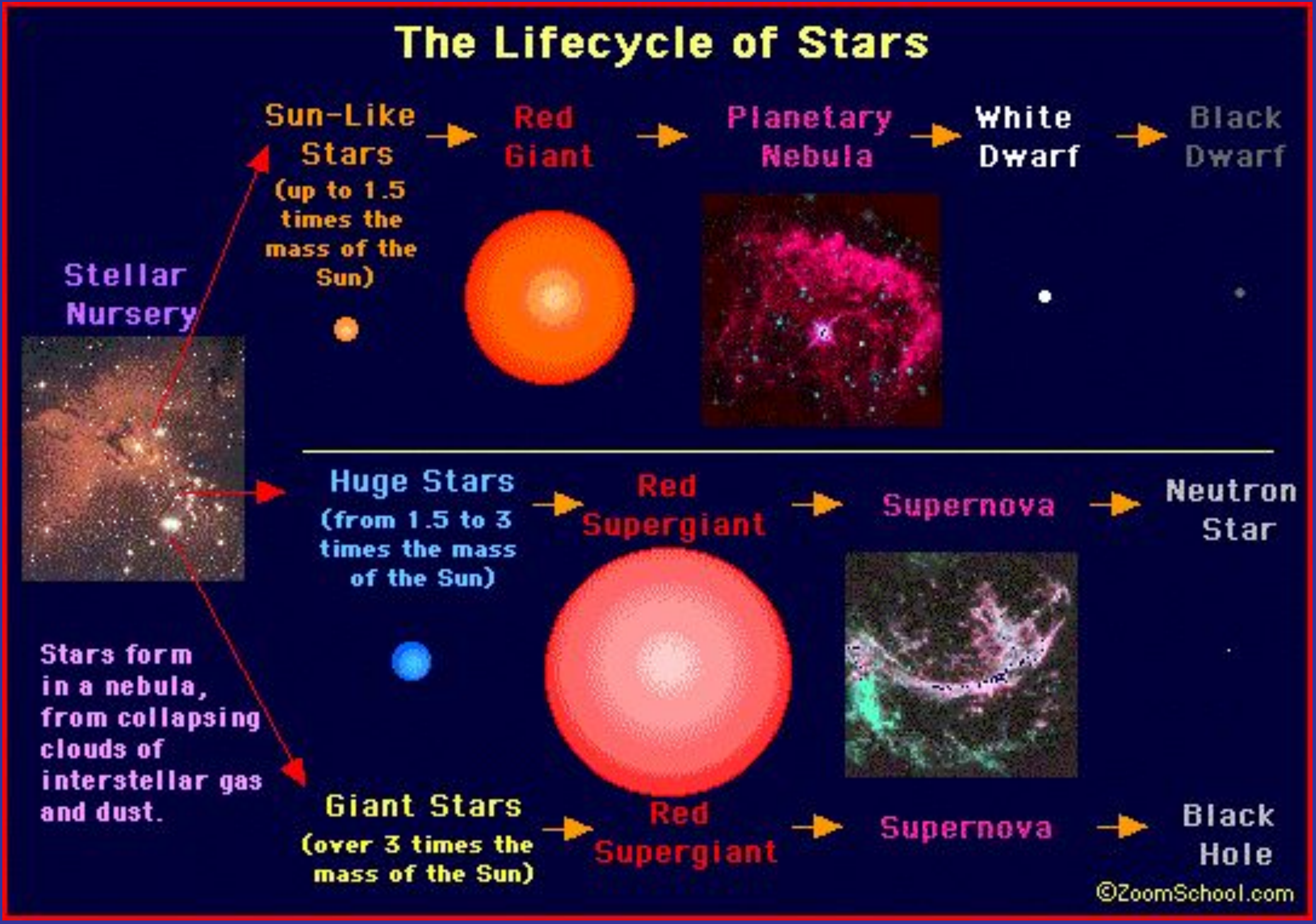


RED GIANTS

- Star turns red – due to cooler temperature.
- Star increases in luminosity (brightness) due to increased size

- Hydrogen has been used up – so Fusion – involves matter fusing into bigger elements

- Helium converts to carbon & oxygen
- Causing star to expand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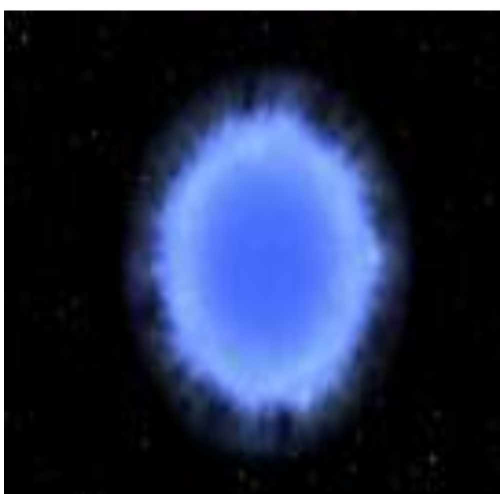
RED SUPERGIANT STARS:

Medium & Large Mass stars

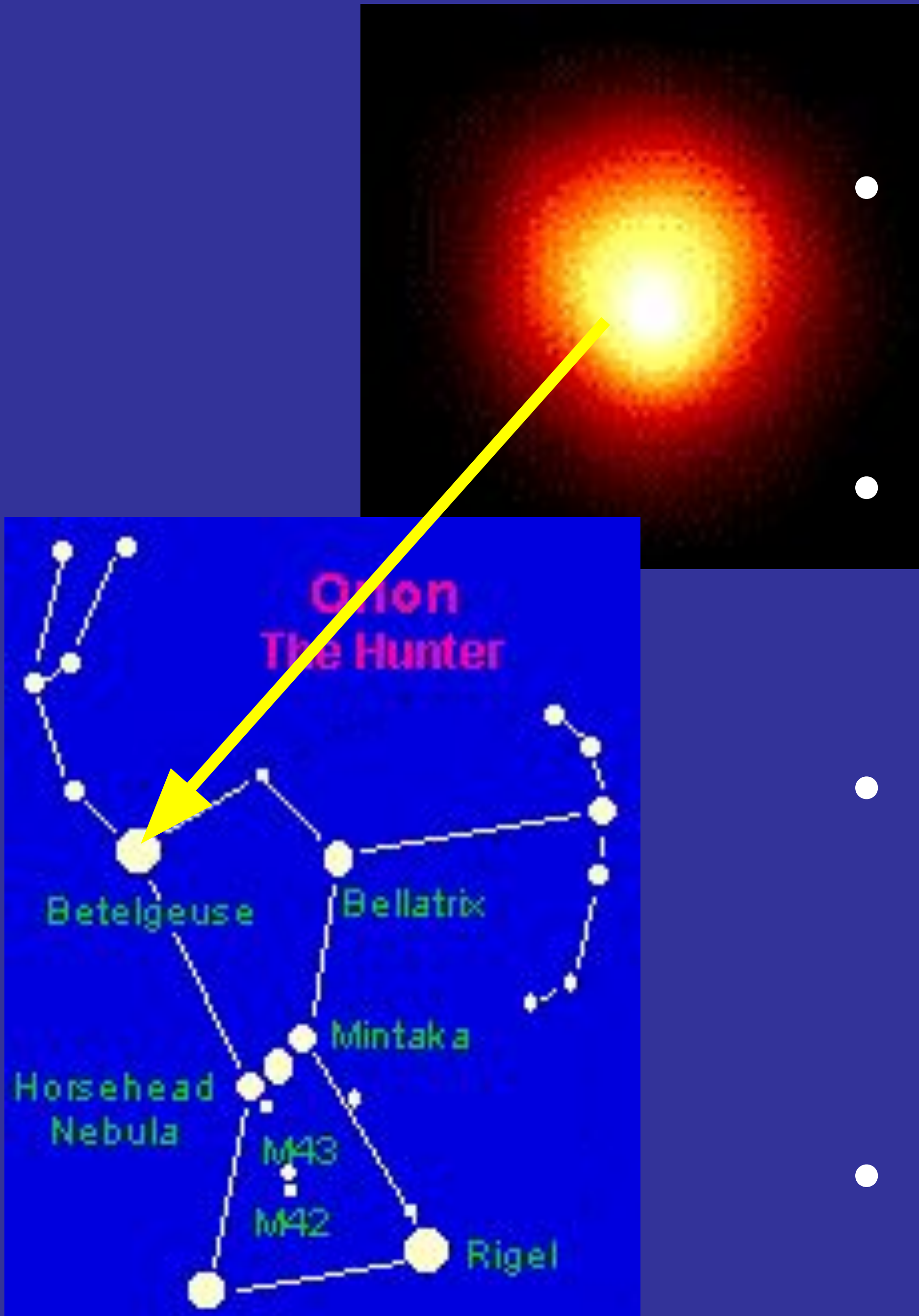
becomes a red super giant



RED SUPER GIANT

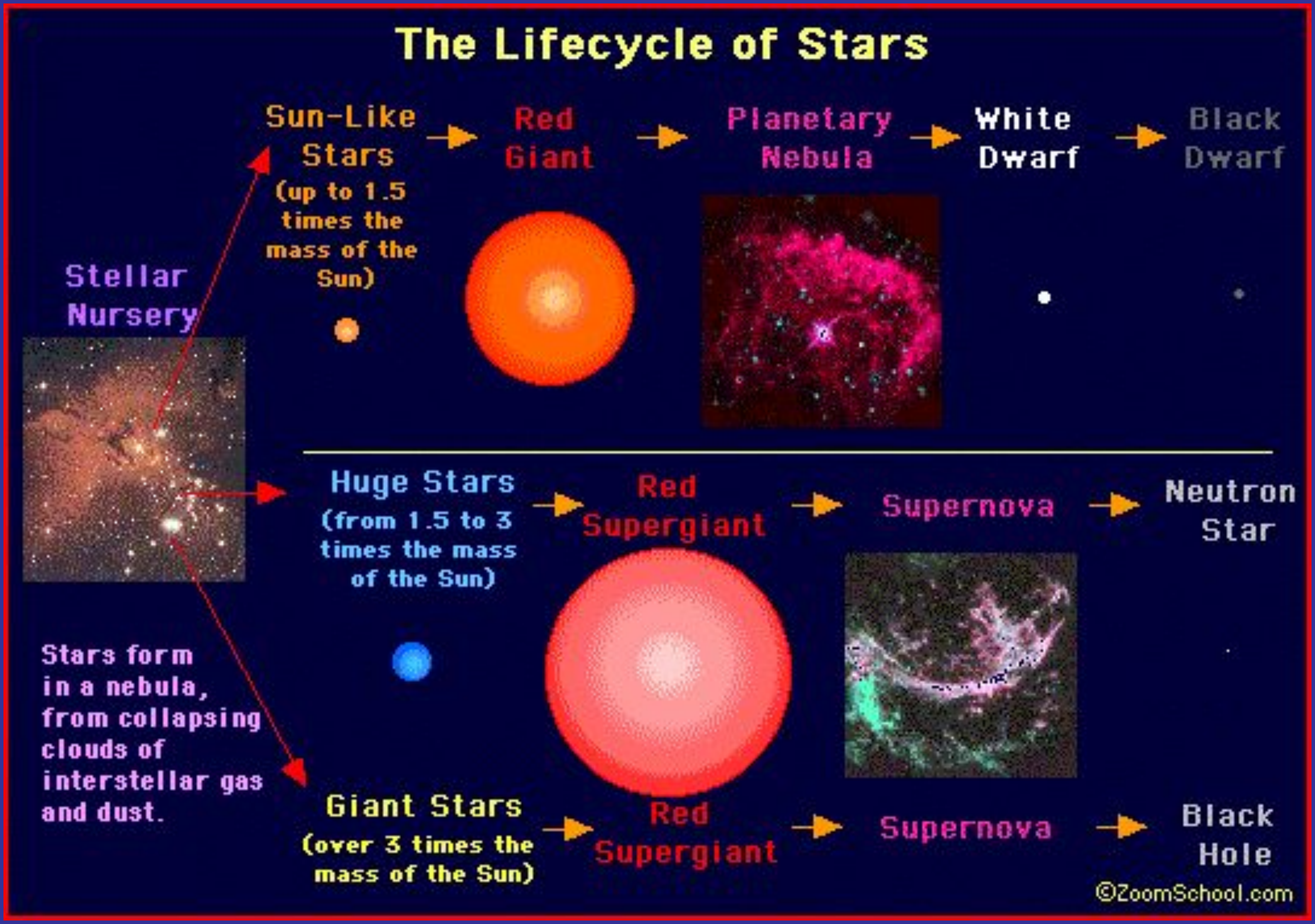
- Loses energy□ cooler □ red colour
- Larger size □ increased luminosity
- Nuclear Fusion He □ Carbon □ oxygen
- It expands engulfing nearby objects

- Fusion □ heat □ further expansion



- Example: Betelgeuse is a red supergiant in the constellation of Orion.
- It is over 600 million miles in diameter (1,000 times bigger than the Sun but cooler).
- If Betelgeuse were at the centre of our Solar System, it would extend beyond the orbit of Jupiter.
- It is 520 light-years from Earth.

Chandra X-ray Center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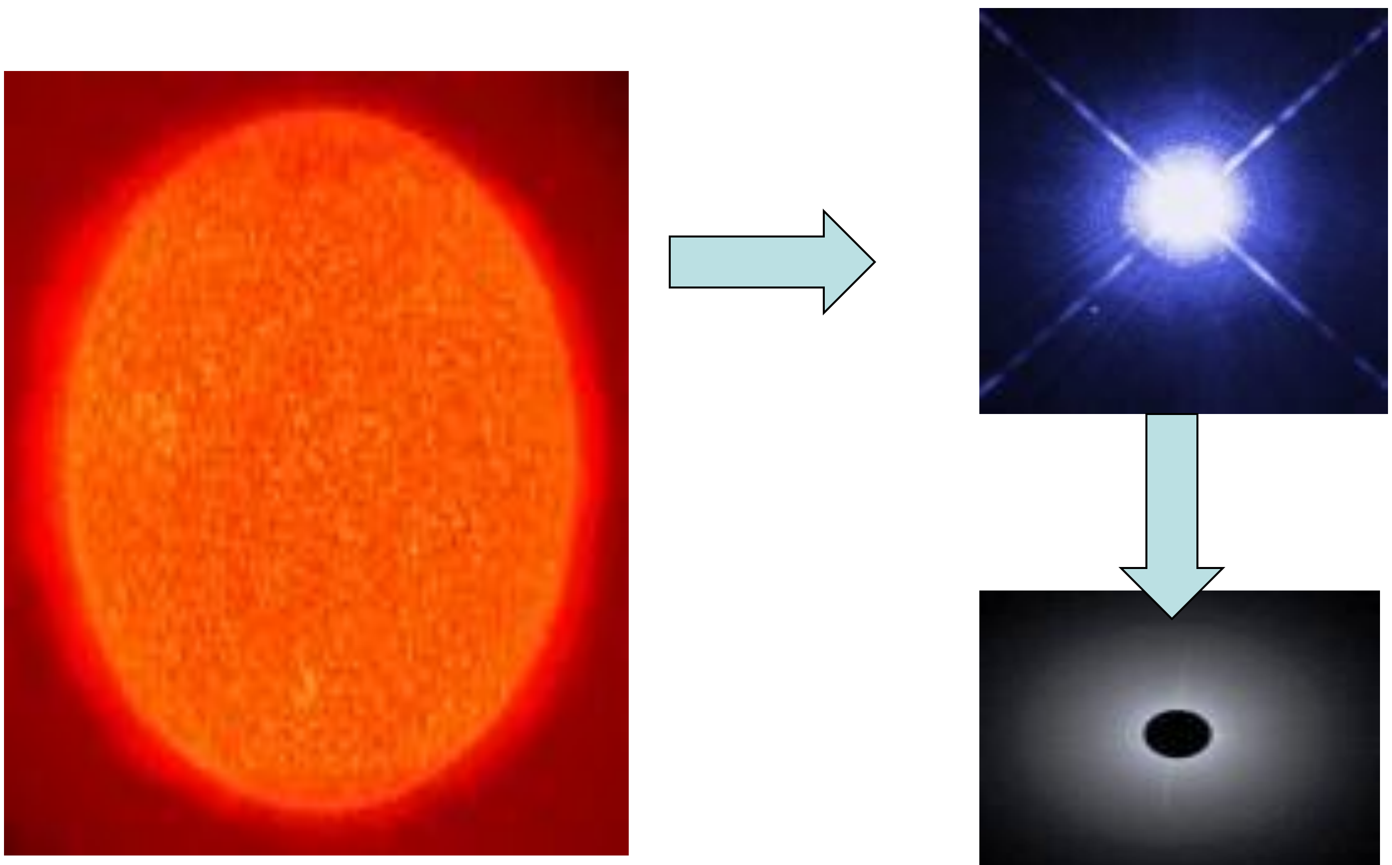
Star DEATH

- When the red giant star is no longer undergoing fusion, it begins to collapse – forces of gravity >> outward forces .
- What happens depends on the original mass of the star.

1. Low Mass Stars □

Red giants □a planetary nebula □a white dwarf □ a black dwarf



Planetary Nebula

a kind of emission nebula consisting of an expanding, glowing shell of ionized gas ejected from old red giant stars late in their lives.

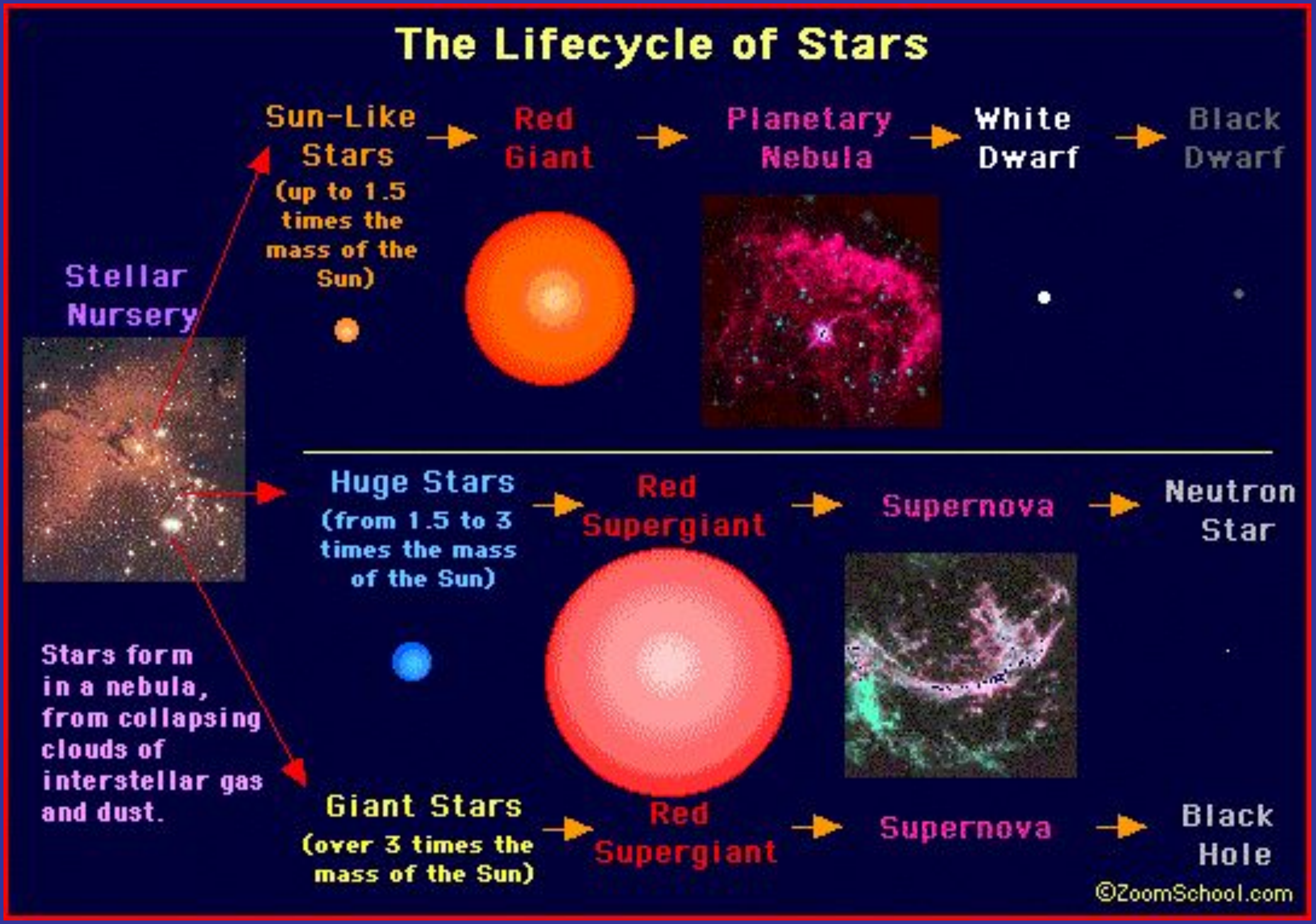
Chandra X-ray Center

A. WHITE DWARF

- It cools and contracts
- Helium runs out & core contracts,
- outer layers leave
- produces this small dense star

B. BLACK DWARF

- Once the White Dwarf has lost all of its heat to space, it no longer radiates heat or light and is cold and dark.
- It becomes a big “charcoal piece” in space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2. <u>Medium Mass Stars</u>:

<u>A. □Supernova □ neutron star</u>

- A **supernova** is the death of a large star. It is a spectacular explosion (appears millions of times brighter).
- Lasts only for a few days. Maybe be visible during the day.

Supernova are rare – once every century in a typical galaxy.

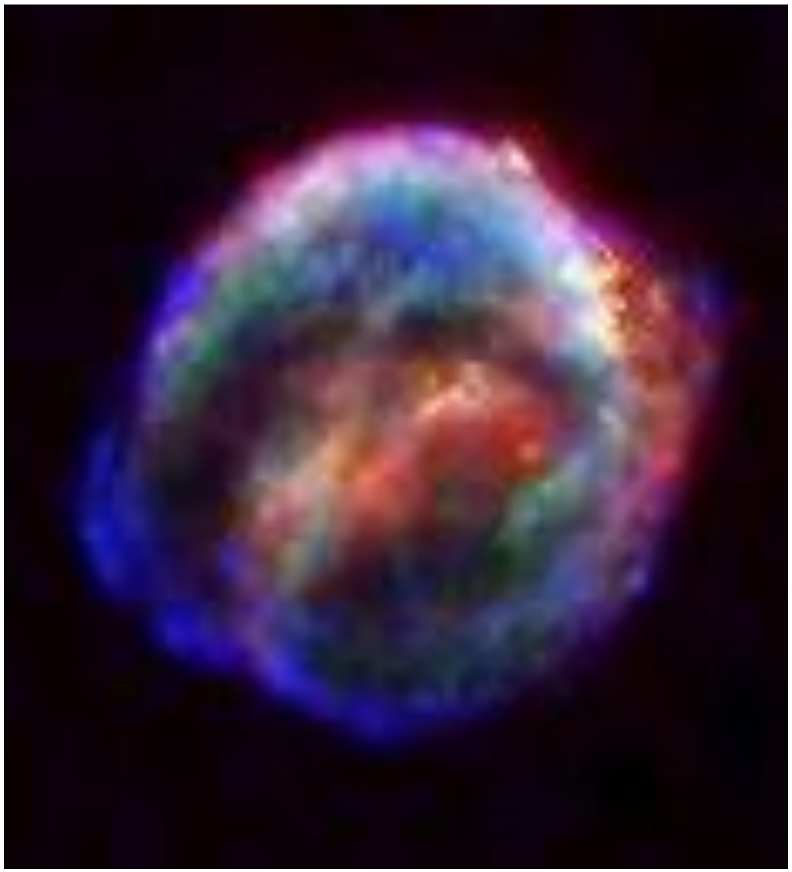
The remnants of a supernova in the constellation Cassiopeia, all that can be seen by astronomers.

But the core remains…

Supernova

- They emit visible, infra red and X ray radiation.
- Temperatures rise to 10 billion K.

SUPER NOVA

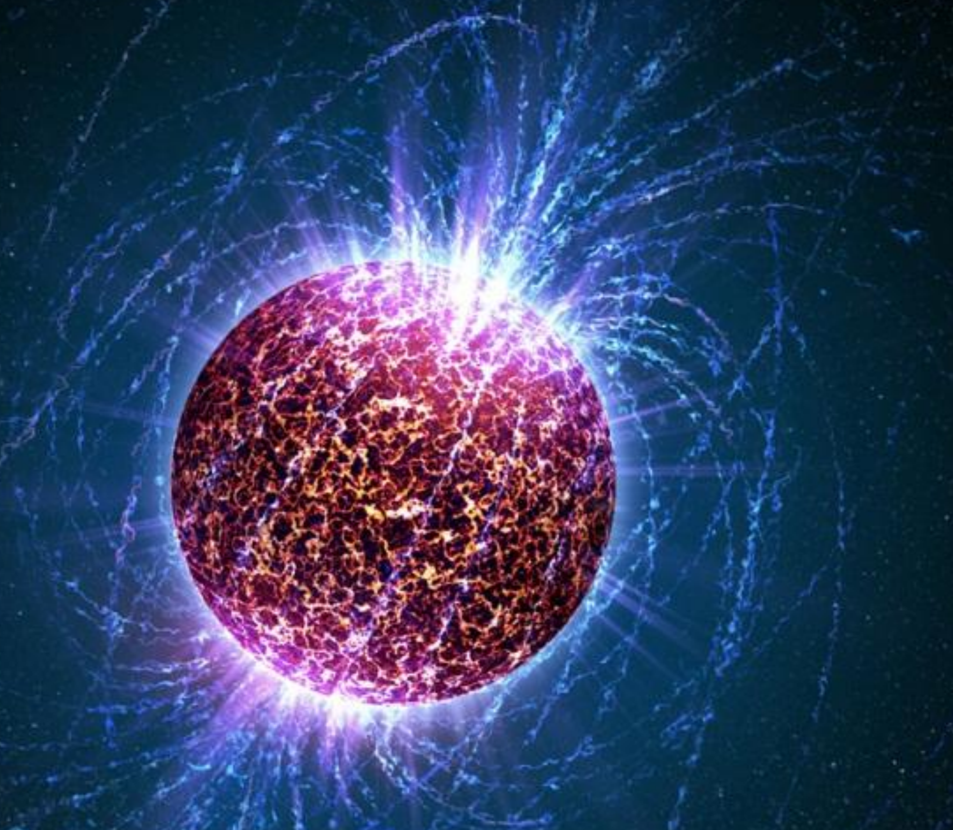


- Enough energy to cause medium weight elements to fuse, forming heavy elements (up to Uranium in the Periodic Table).

B. NEUTRON STAR (Pulsar) – (from Medium Mass stars ☺

- A very dense dead star
- Formed from mass left over after the supernova.

Calvera, the closest <u>neutron star</u> found in Ursa Minor



The gravity is so strong that the electrons and protons combine to form neutrons <u> Neutron Star</u>

3. High Mass Stars

A. Large Supernova

Chandra X-ray Center

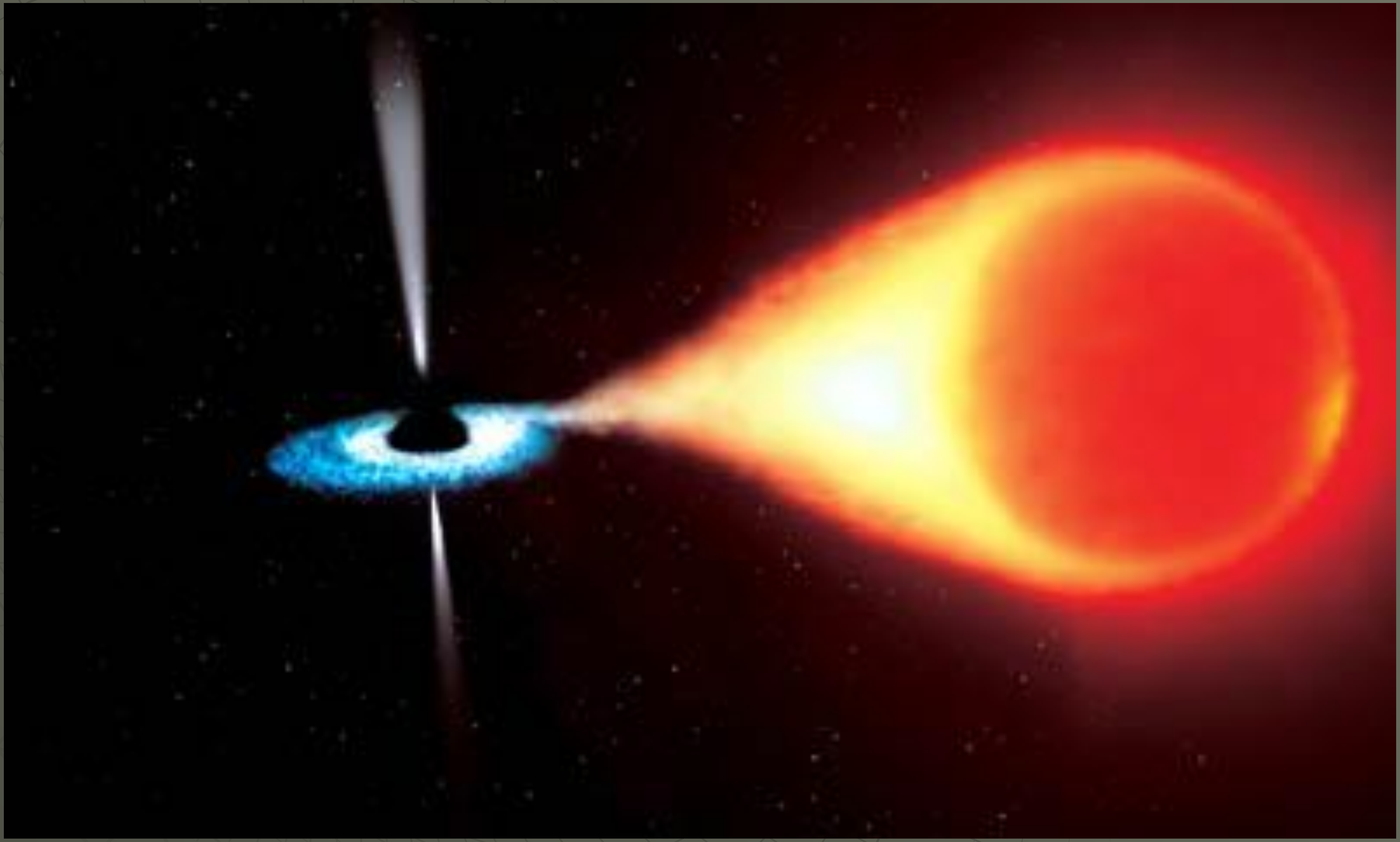
<u>3. High Mass stars □ Large Supernova □ B. Black hole</u>

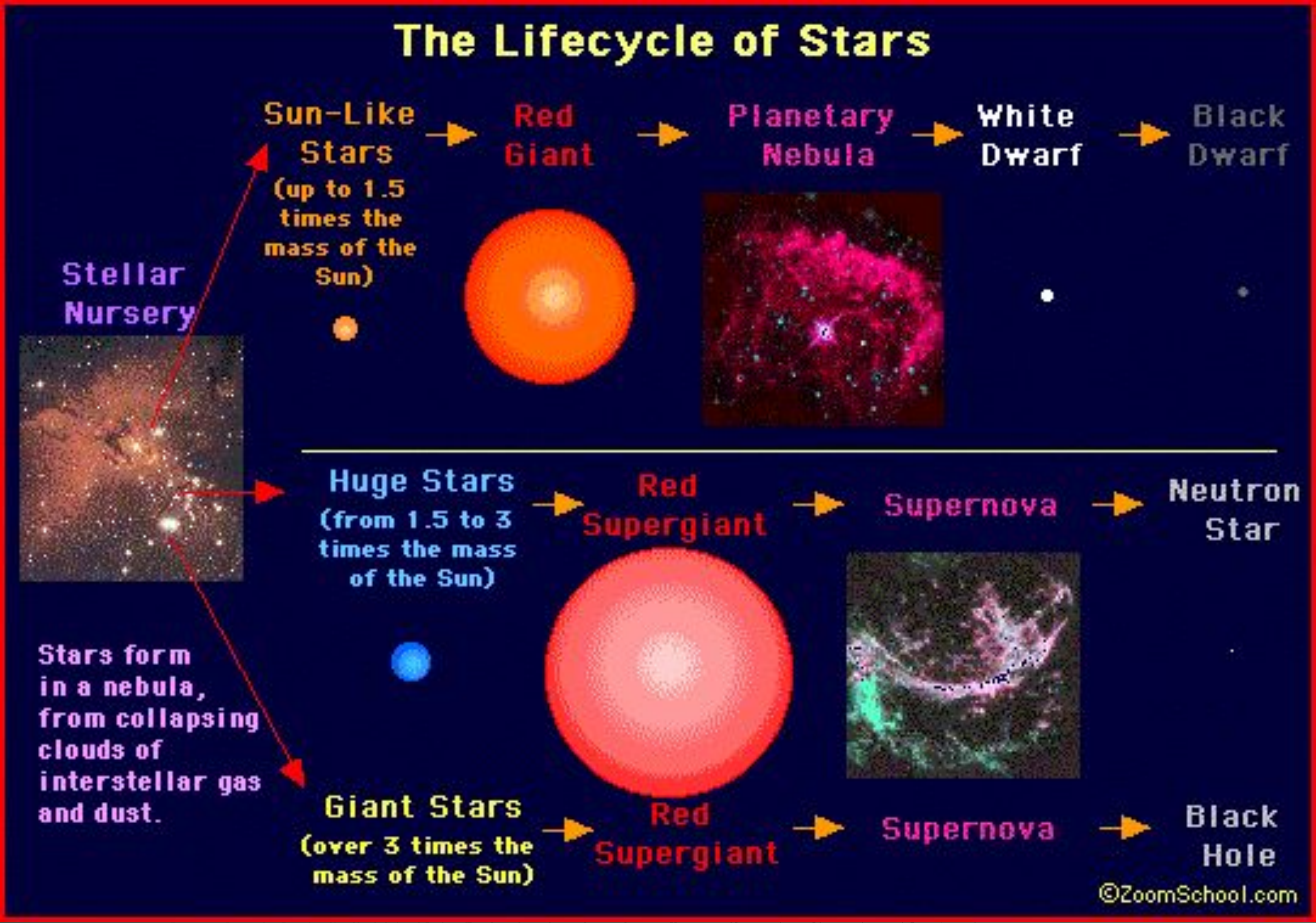
- If the star is very large, the left over star after the supernova is so dense that it forms a *black hole*
- Its gravity is so great that light can not escape from it.

- A **black hole** can be created when a giant star undergoes a supernova.
- A star with a mass greater than 20 times the mass of our Sun may produce a black hole at the end of its life.

- Black holes are objects so dense that not even light can escape their gravity and since nothing can travel faster than light, nothing can escape.

Black Holes – only High mass stars will end up as black holes

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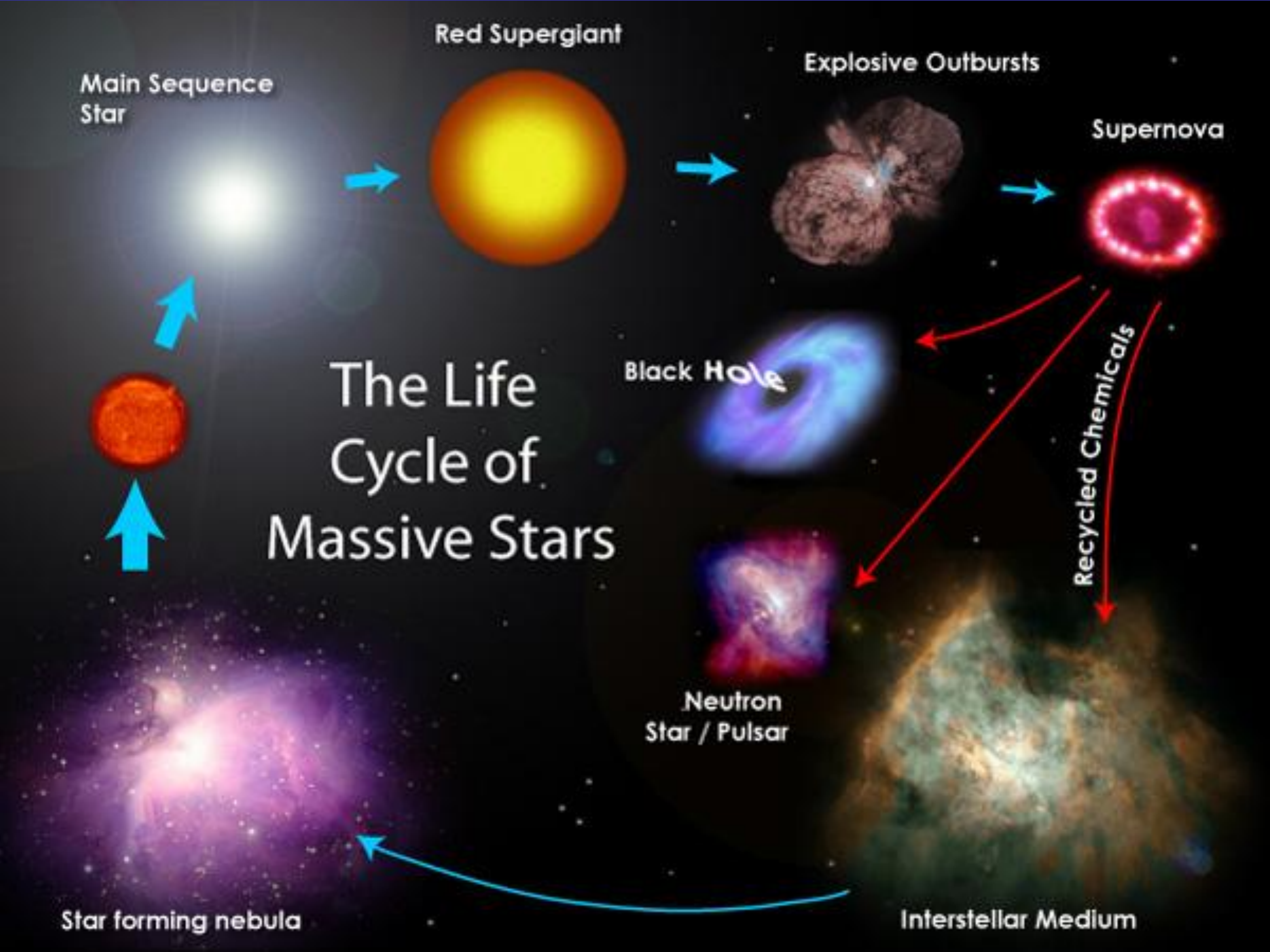
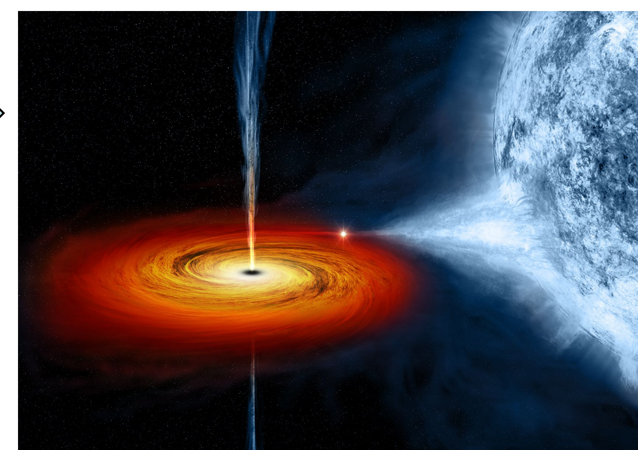


Red Supergiant
Main Sequence Star
Explosive Outbursts
Supernova
The Life Cycle of Massive Stars
Black Hole
Recycled Chemicals
Neutron Star / Pulsar
Star forming nebula
Interstellar Medium

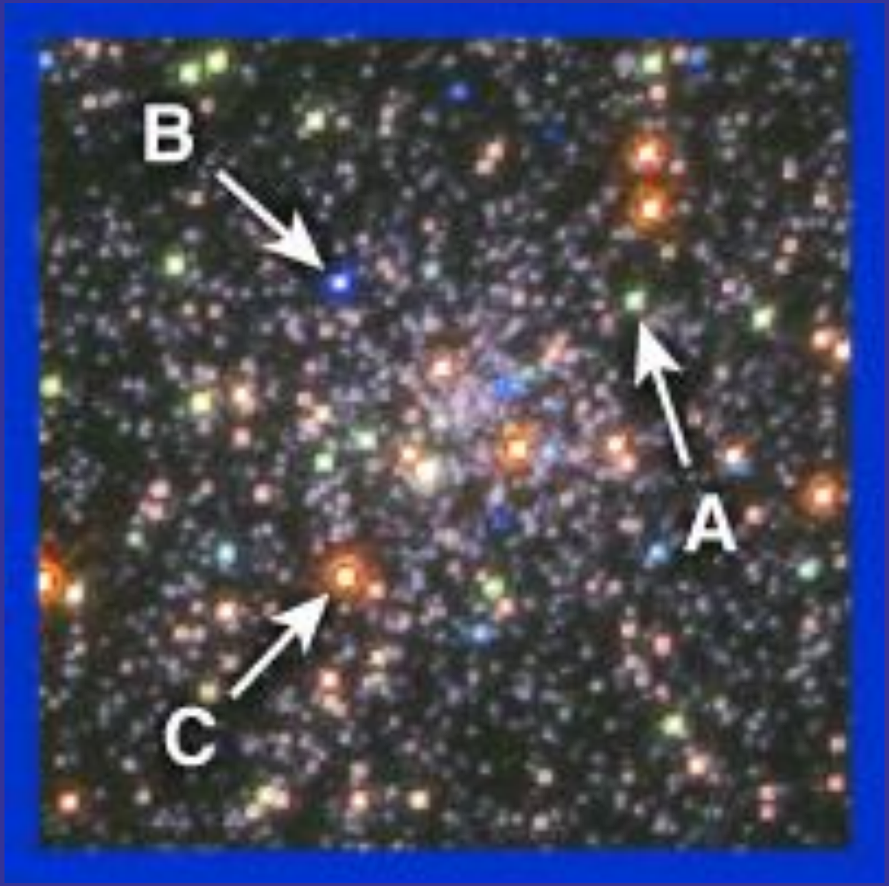
Summary - Red super giant a super nova either a neutron star or a black hole

Neutron star

Black hole

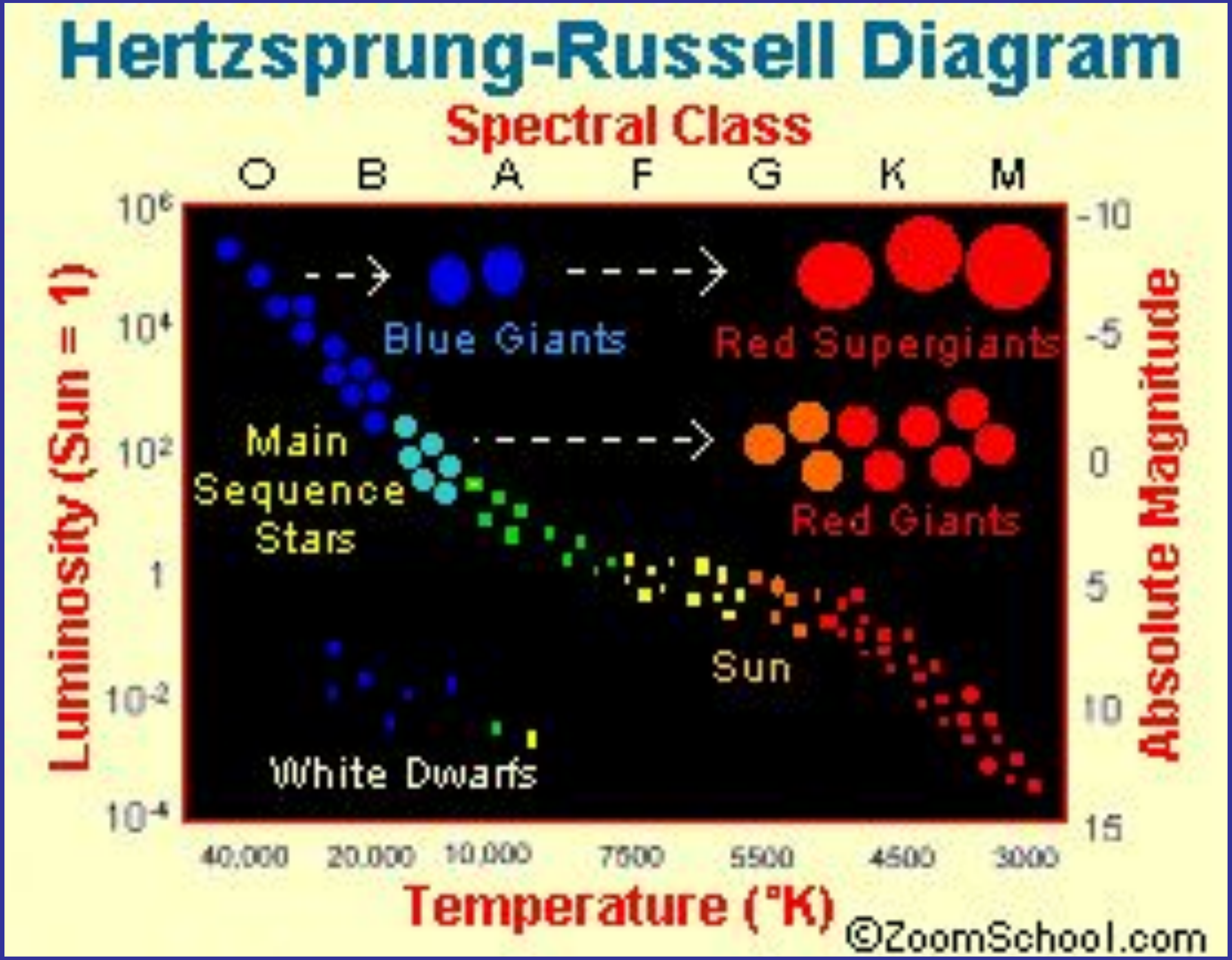


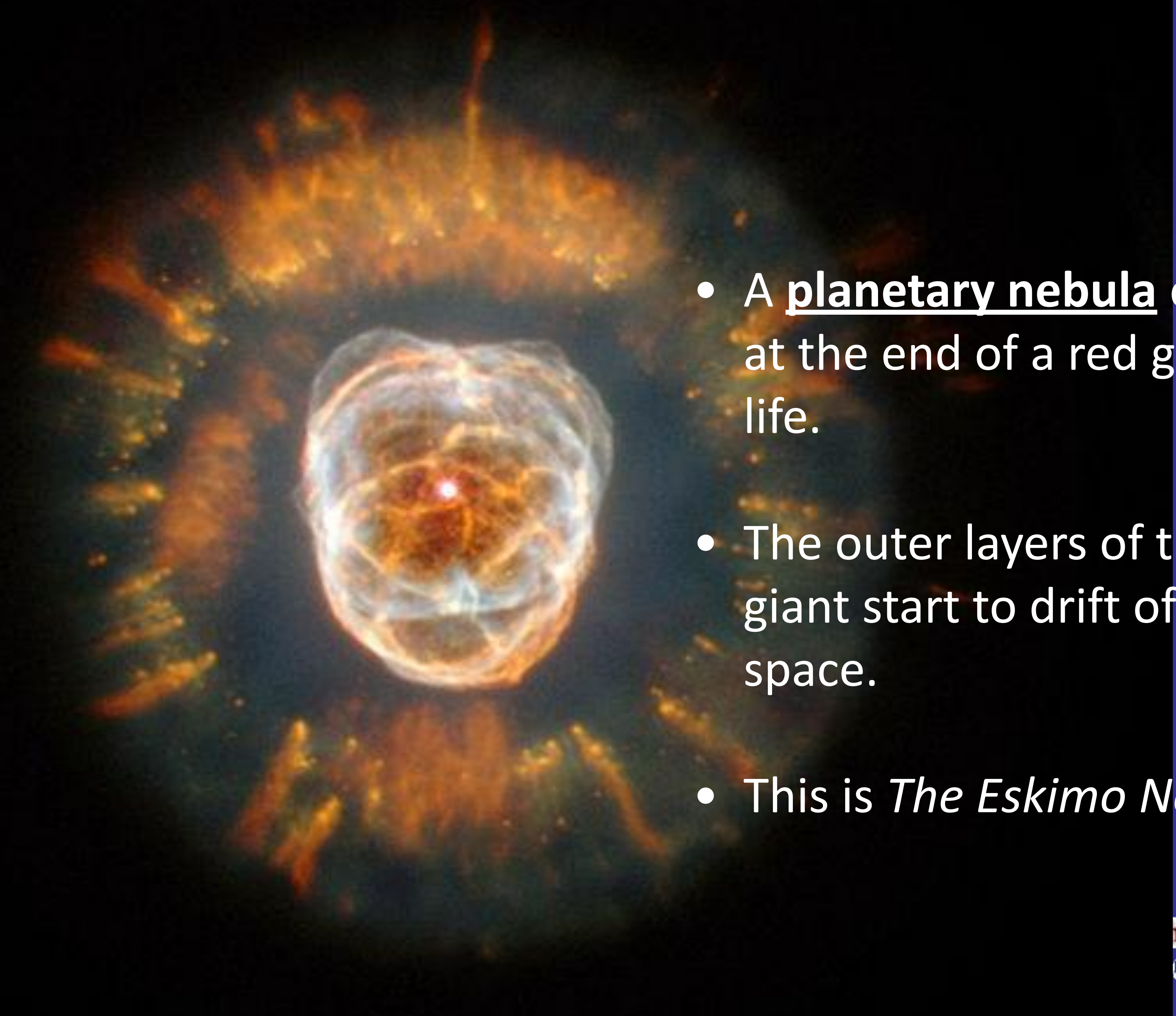
Stars colour relates to its temperature



- B: blue – hottest
- A: green – warm
- C: red - cool

Color, Brightness + Count them

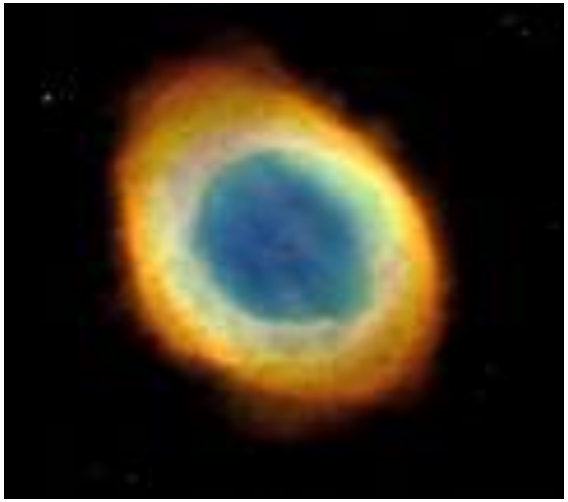


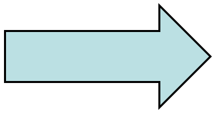


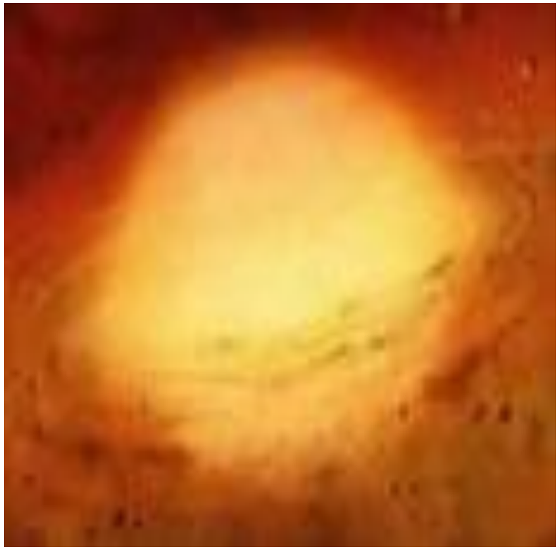
- A **<u>planetary nebula</u>** occurs at the end of a red giant's life.
- The outer layers of the red giant start to drift off into space.
- This is *The Eskimo Nebula*

REVIEW OF STARS LIFE CYCLE

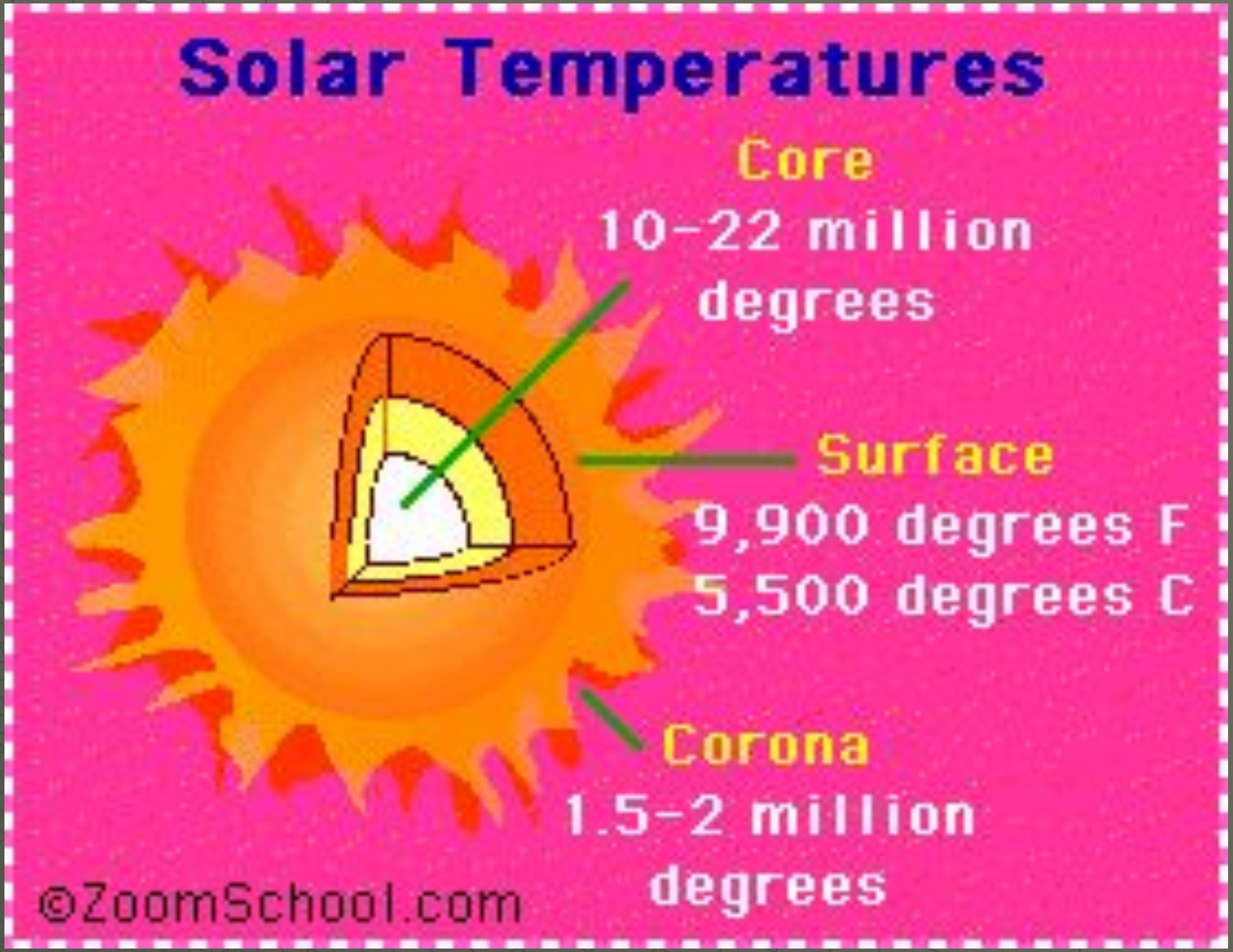
Nebula to proto star







What makes the Sun Shine?



How stars burn

- Main Sequence Star – use nuclear fusion -- H as fuel He
- Giant star – He as fuel O, C, Fe