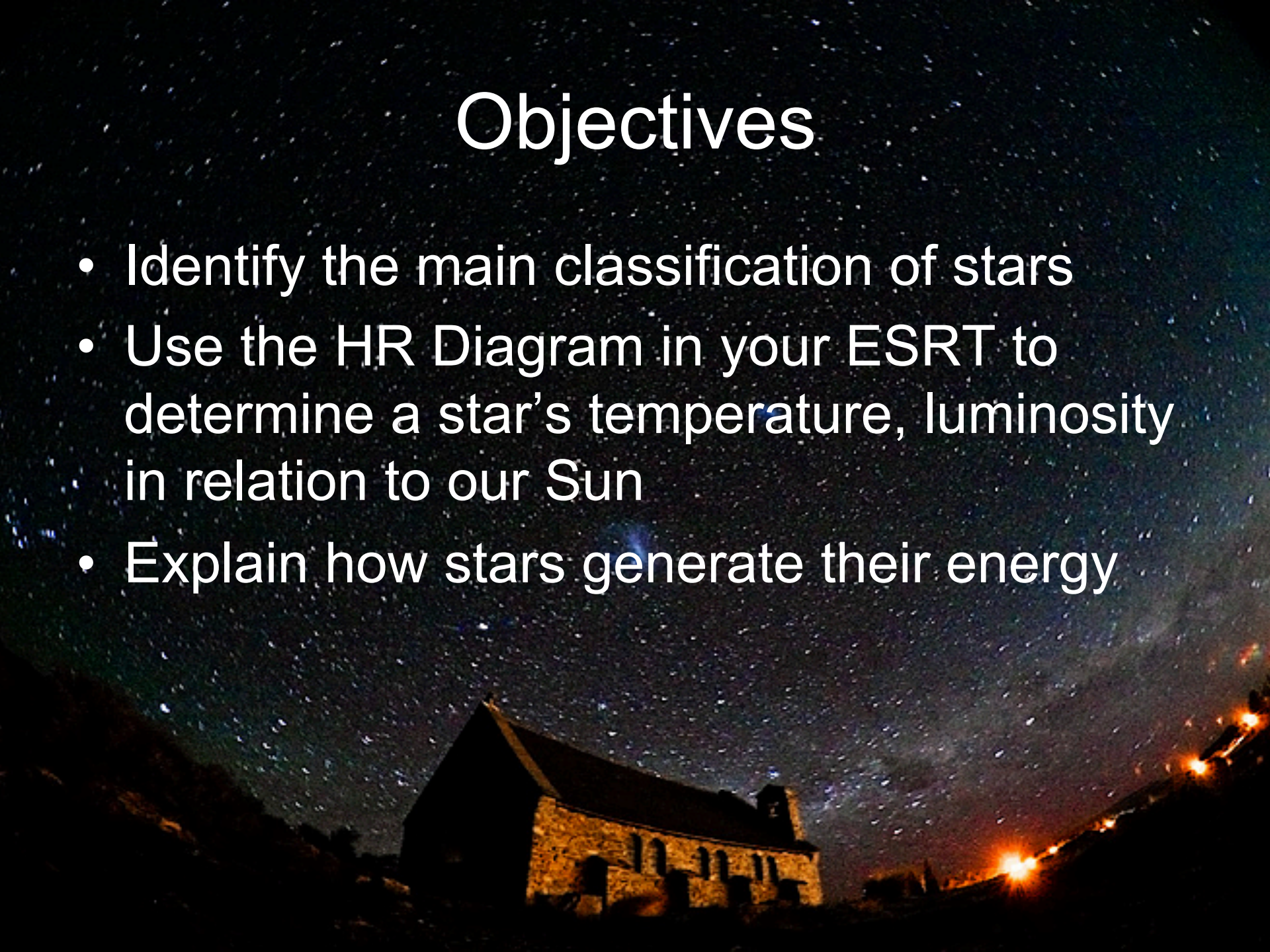
Astronomy Notes

Stars

Objectives

- Identify the main classification of stars
- Use the HR Diagram in your ESRT to determine a star's temperature, luminosity in relation to our Sun
- Explain how stars generate their energy

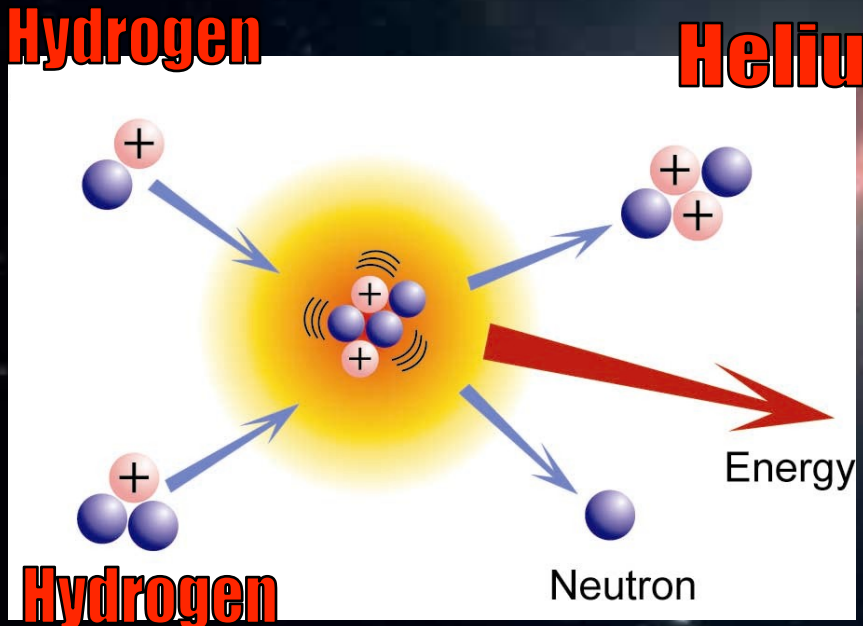


What is a star?

- Large ball of gas held together by gravity that produces LARGE amounts of energy and shines

- Star is born as a cloud of gas and dust called a **nebula & then becomes a protostar**
- Our sun is the closest star and dominant gravitational force

How do stars generate their energy?



- Nuclear Fusion- combining nuclei of small elements to make nuclei of bigger elements + energy
- Hydrogen (H) → Helium (He)

Nuclear Fusion

Star Formation

- Stars exist because of gravity
- Two opposing forces in a star are
  - Gravity – contracts
  - Nuclear fusion – expands
- Determine stage in star's life cycle

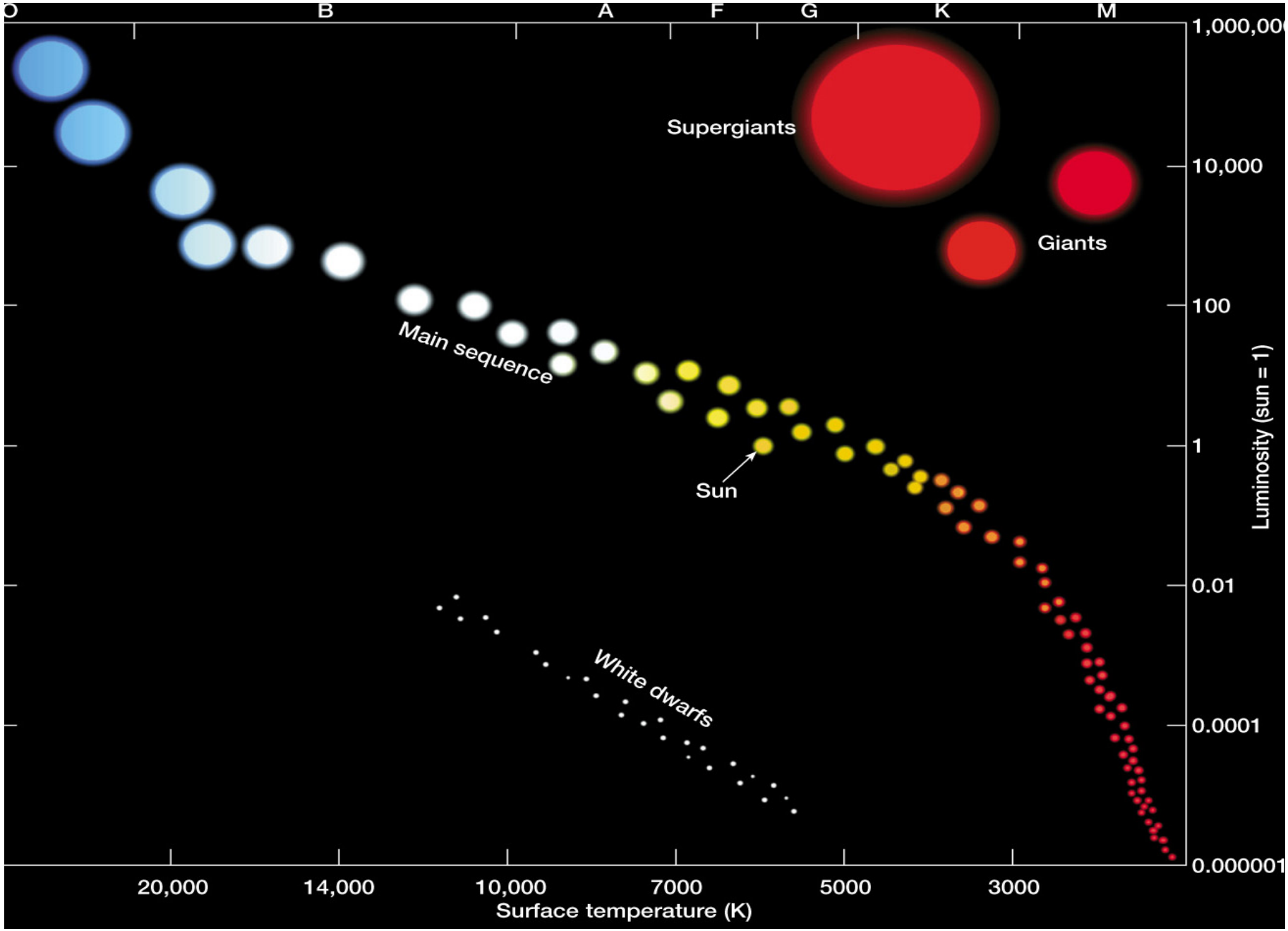
What two characteristics are used to classify stars?

Luminosity

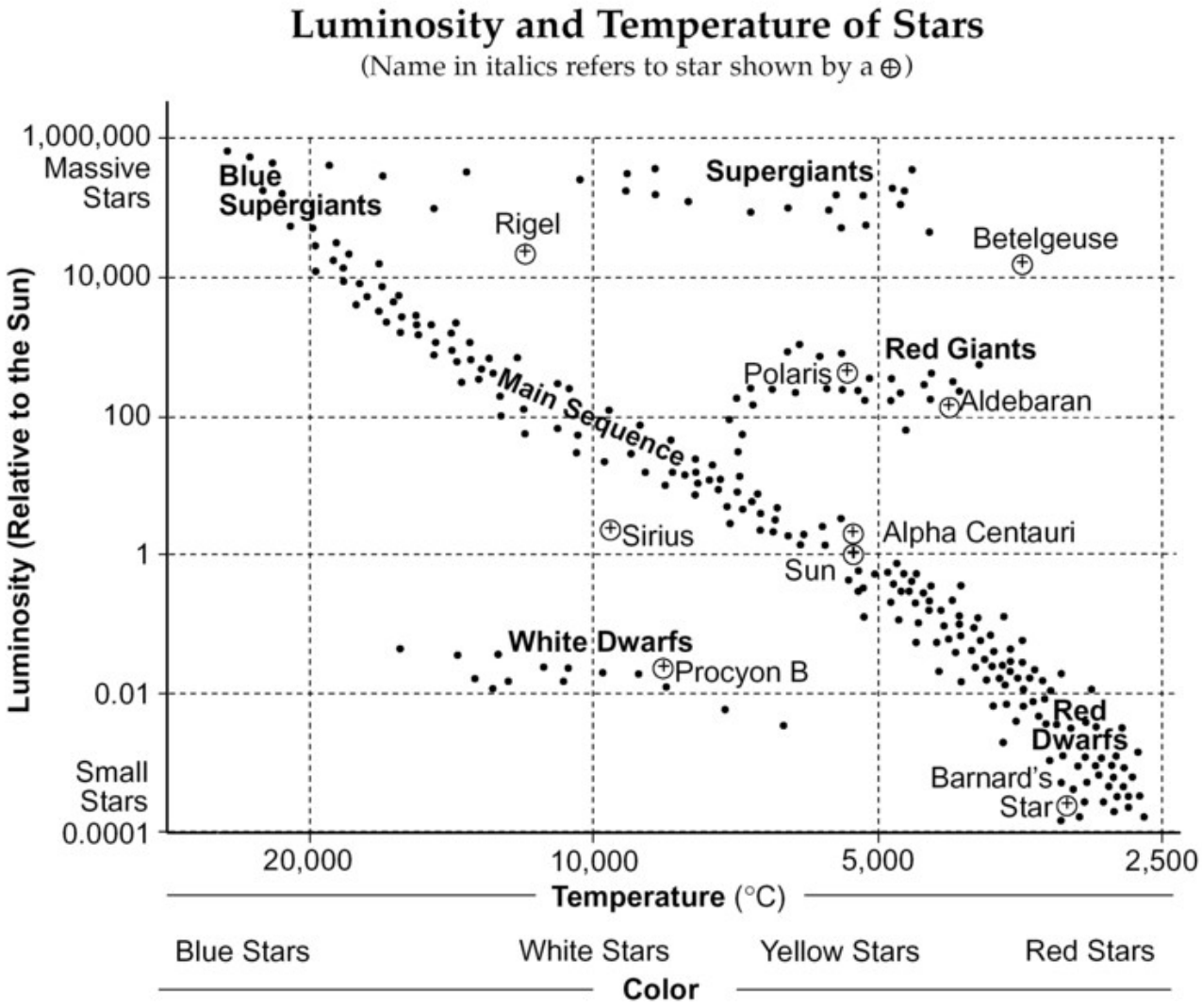
Temperature

What is luminosity?

- Actual brightness of a star compared to the sun
- Do all stars have same luminosity?
- Does distance affect the luminosity of a star?


O
B
A
F
G
K
M
Supergiants
Giants
Main sequence
Sun
White dwarfs
1,000,000
10,000
100
1
0.01
0.0001
0.000001
Luminosity (sun = 1)
20,000
14,000
10,000
7000
5000
3000
Surface temperature (K)

ESRT



Luminosity is the brightness of stars compared to the brightness of our Sun as seen from the same distance from the observer.

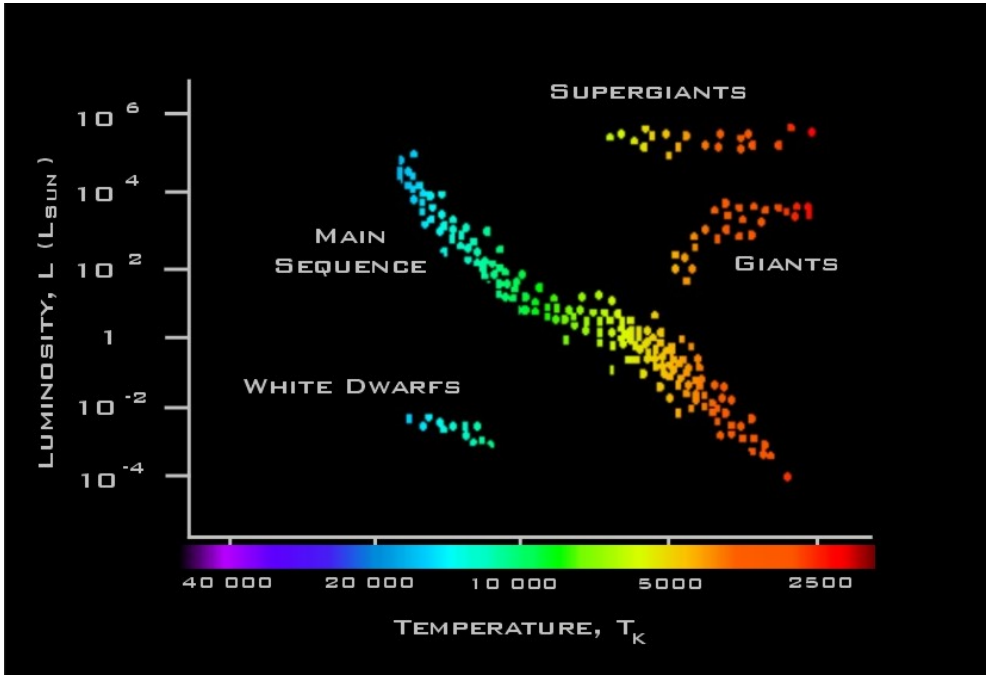
Hertzsprung-Russell Diagram aka Luminosity and Temperature of Stars Diagram – NOT A MAP

- DIAGRAM IS A USEFUL WAY TO FOLLOW CHANGES THAT TAKE PLACE AS THE STARS LIVE OUT THEIR LIVES

- Diagram is made by plotting (graphing) each star's LUMINOSITY (brightness) and TEMPERATURE (as reflected by color) COMPARED TO THE SUN

How do stars compare in temperature?

- Hotter stars = blue
- Cooler stars = red




What are the main classifications of stars?
Blue Supergiants
Red Giants
Main Sequence
White Dwarfs
Red Dwarfs
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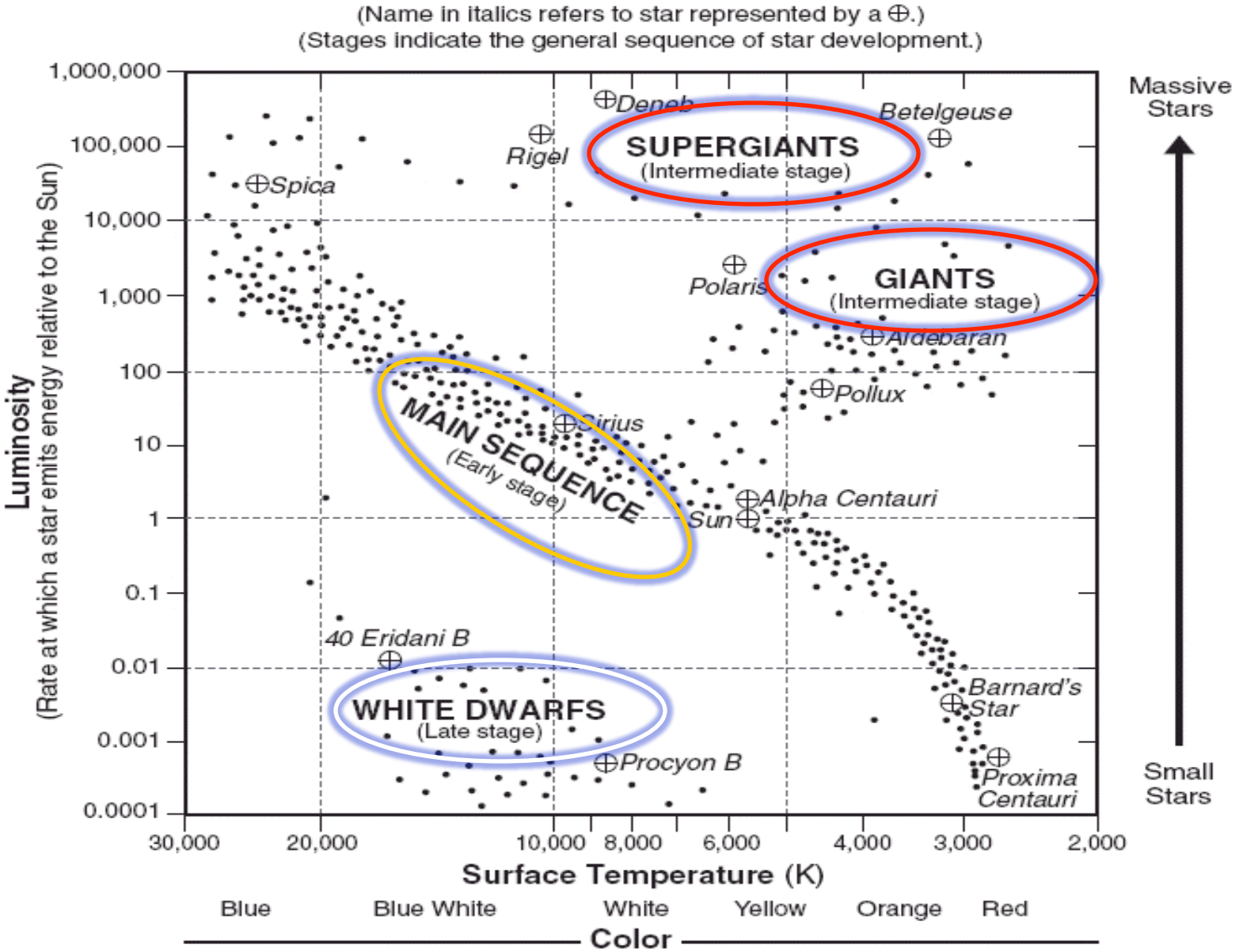
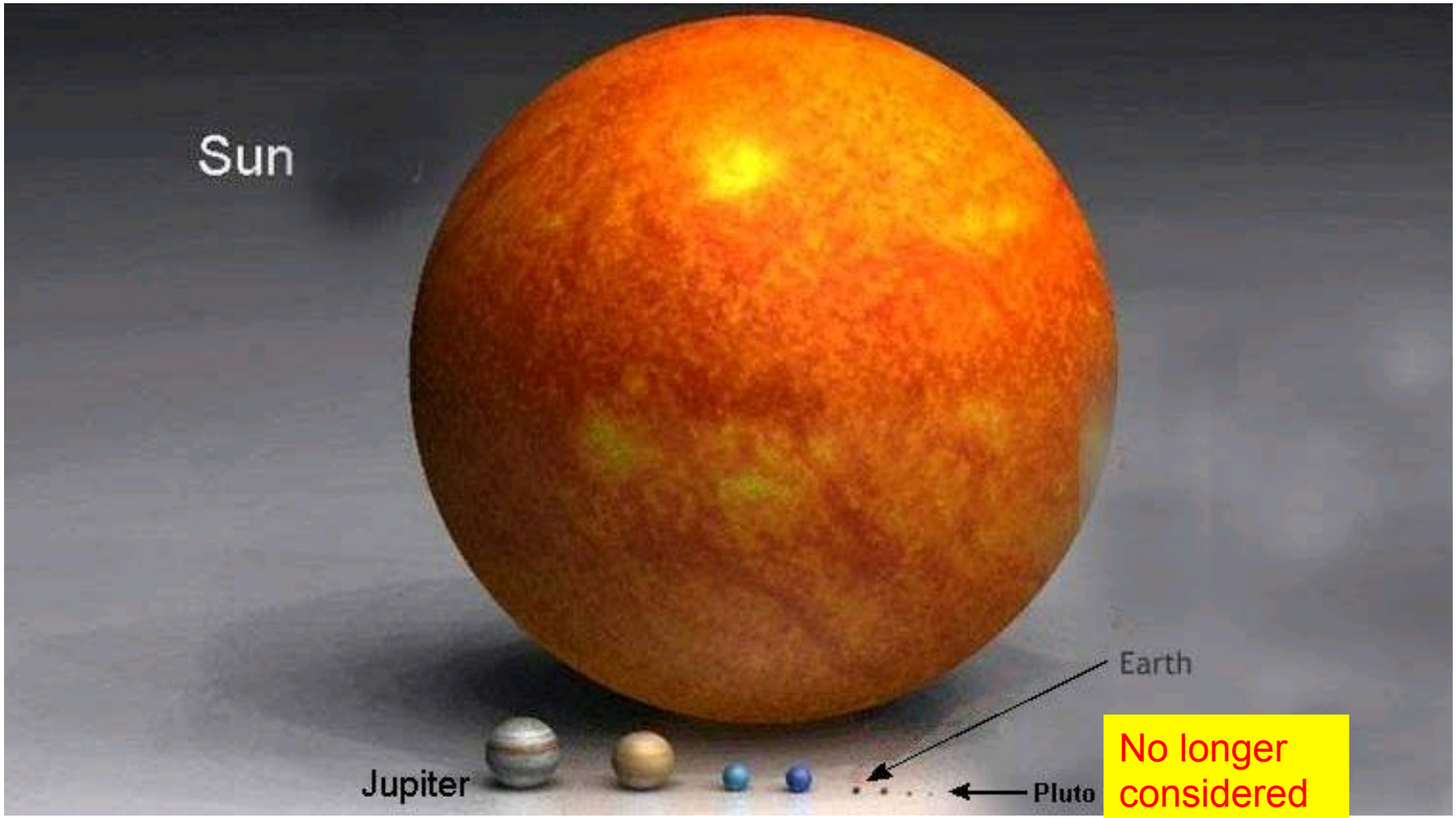
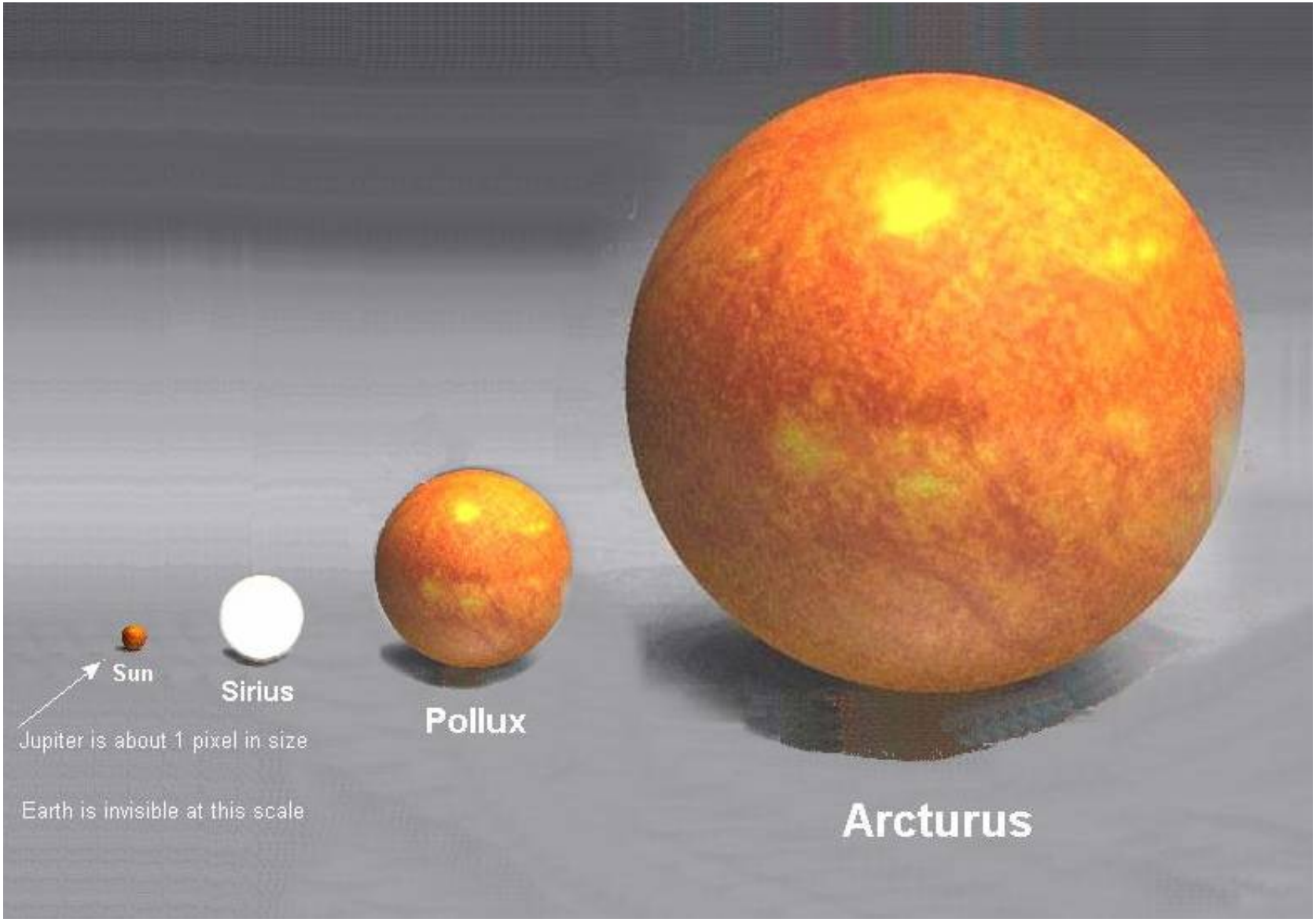
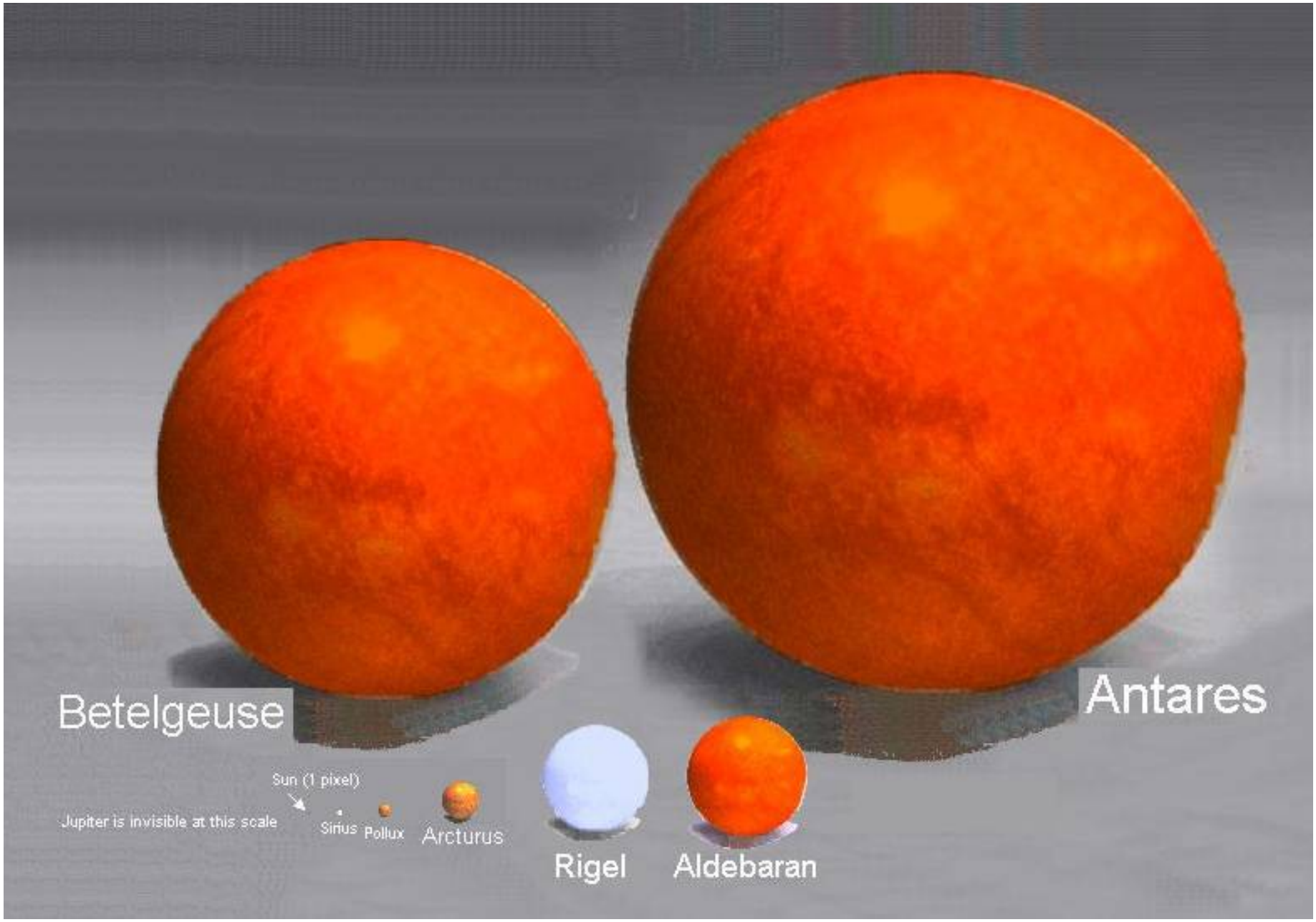
ESRT


(Name in italics refers to star represented by a ⊕.)
(Stages indicate the general sequence of star development.)
Luminosity
(Rate at which a star emits energy relative to the Sun)
1,000,000
100,000
10,000
1,000
100
10
1
0.1
0.01
0.001
0.0001
Deneb
Betelgeuse
Rigel
SUPERGIANTS
(Intermediate stage)
Spica
Polaris
GIANTS
(Intermediate stage)
Aldebaran
Pollux
MAIN SEQUENCE
(Early stage)
Sirius
Alpha Centauri
Sun
40 Eridani B
WHITE DWARFS
(Late stage)
Barnard's Star
Procyon B
Proxima Centauri
Massive Stars
Small Stars
30,000
20,000
10,000
8,000
6,000
4,000
3,000
2,000
Surface Temperature (K)
Blue
Blue White
White
Yellow
Orange
Red
Color

All planets compared to Our Sun




Sun
Sirius
Pollux
Arcturus
Jupiter is about 1 pixel in size
Earth is invisible at this scale


Betelgeuse
Antares
Sun (1 pixel)
Jupiter is invisible at this scale
Sirius
Pollux
Arcturus
Rigel
Aldebaran

What type of star is our Sun classified as?

Main Sequence

Circle where it is on the chart

- Identify 2 Stars Hotter than our Sun
- Identify 2 Stars Cooler than our Sun
- Identify 2 stars that are brighter than our sun
- Identify 2 stars that are dimmer than our sun

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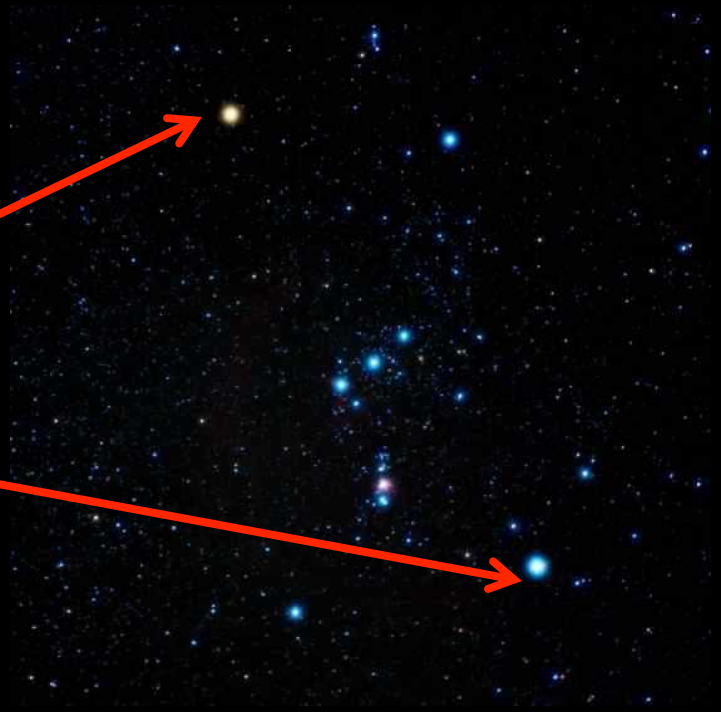
Orion

- What color are the stars in the constellation Orion?
  - Betelguese is RED
  - Rigel is BLUE



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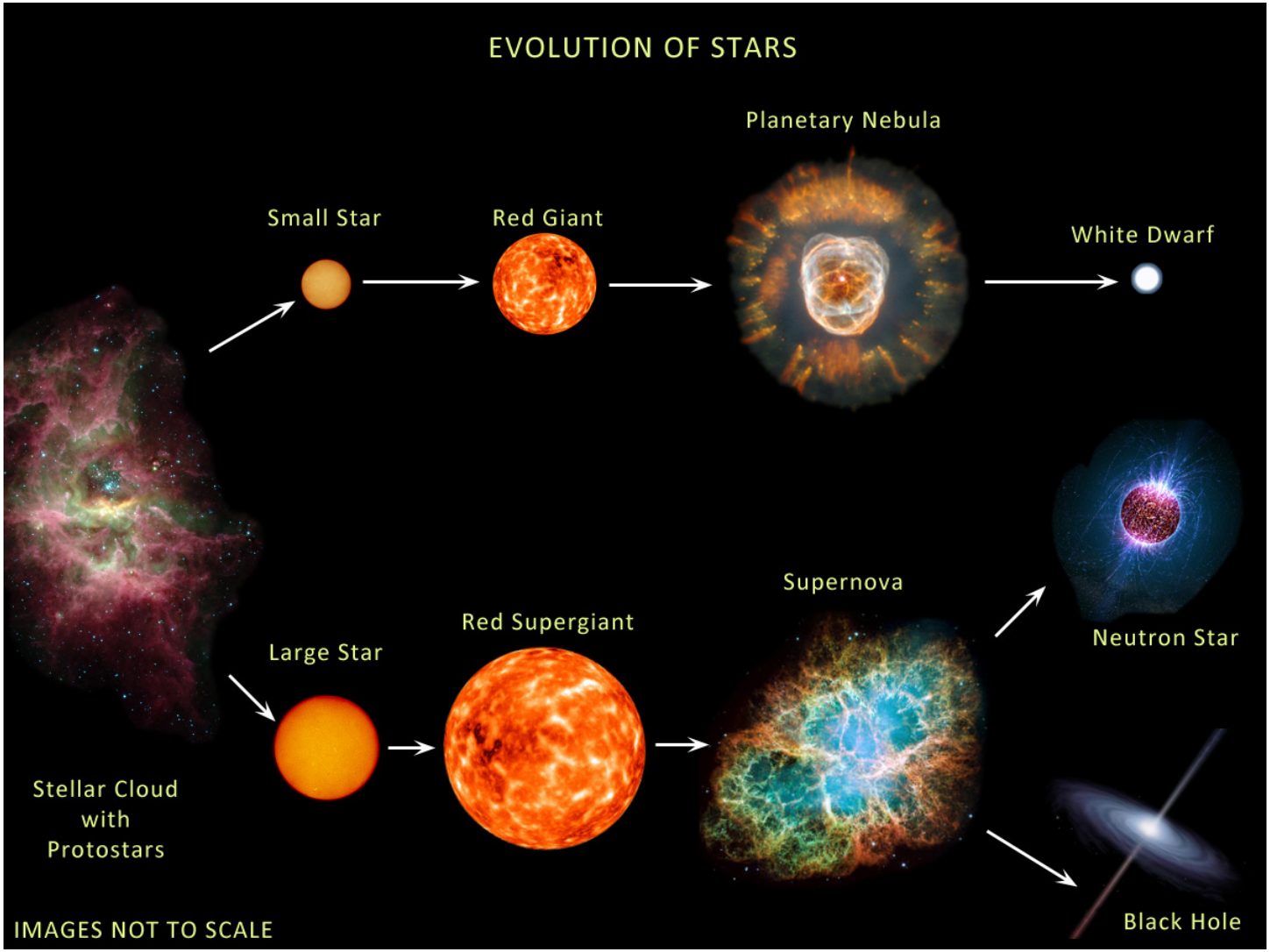
Star Types & HR Diagram

- 90% of stars in the **Main Sequence**
  - Run upper left to lower right
  - Currently fusing H into He
  - Our sun!
- Above the main sequence
  - **Giants (10-100X) and supergiants (100x+)**
- Below the main sequence
  - **Dwarfs**

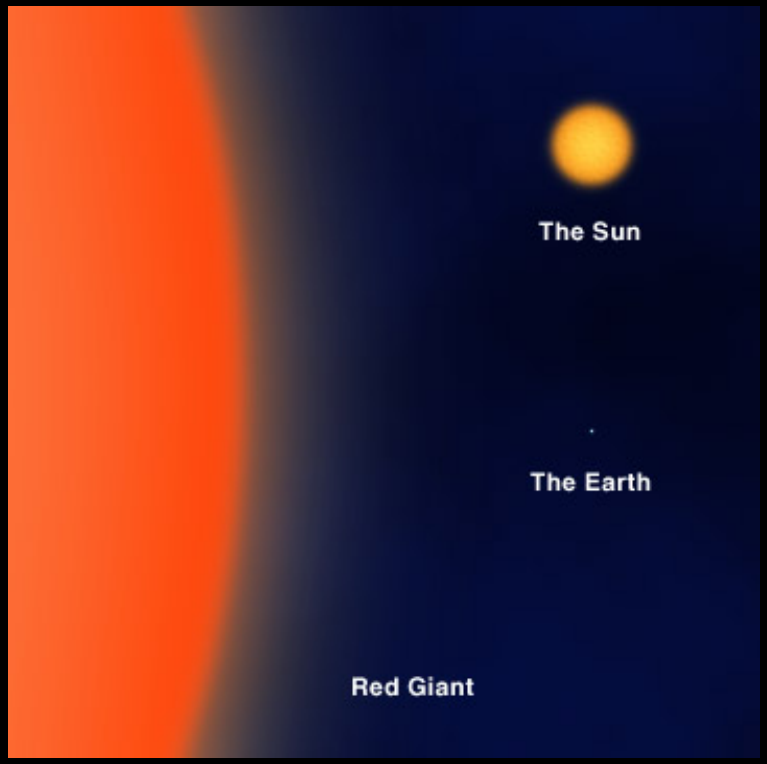
- HR Diagram Online

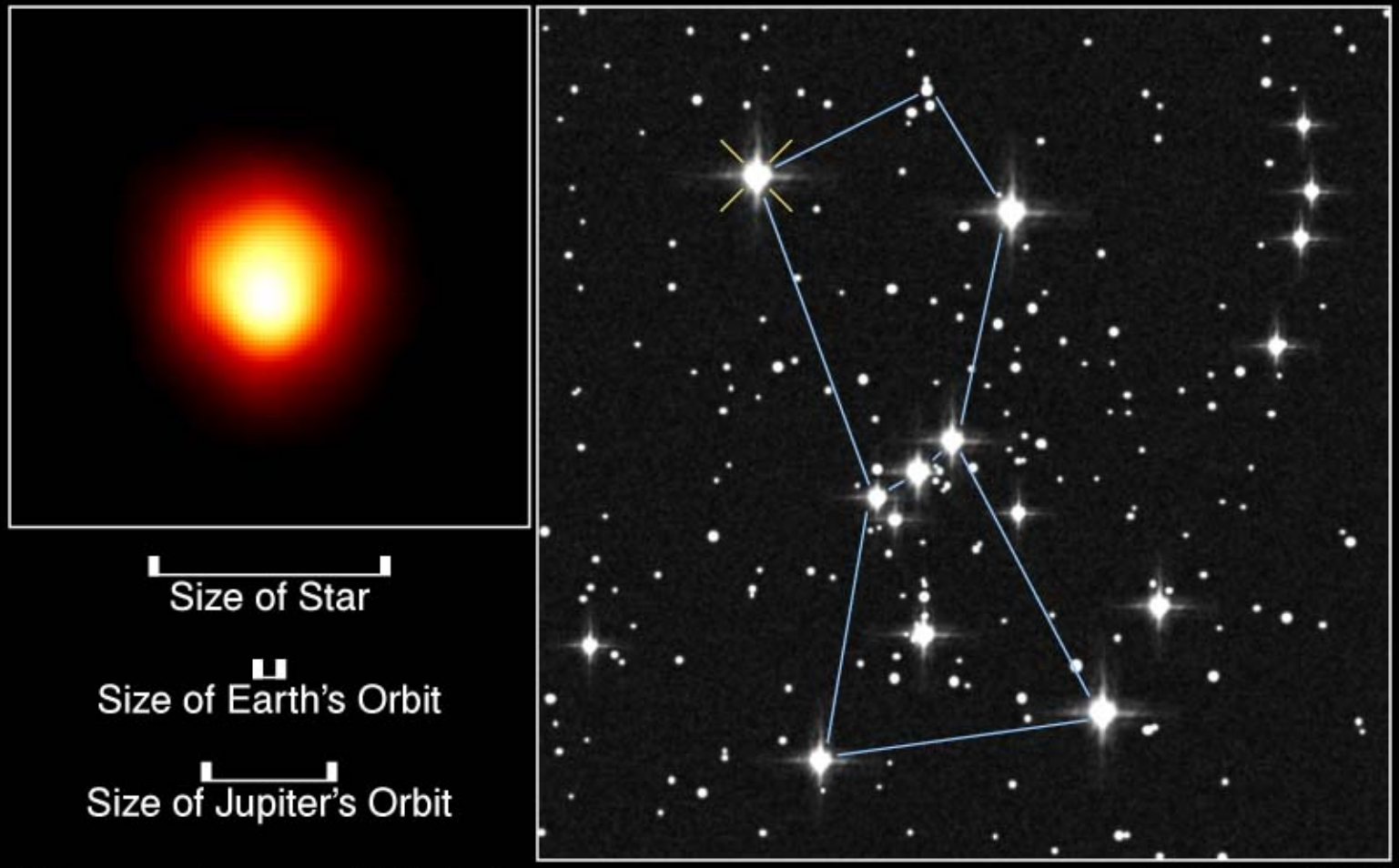
Life Cycle of Stars & the HR Diagram



Hertzsprung-Russell Diagram Star Evolution

- Giants (or red giants)
  - Very luminous
  - Low Temperature
  - Late evolution of medium-sized main sequence stars when they greatly expand in size





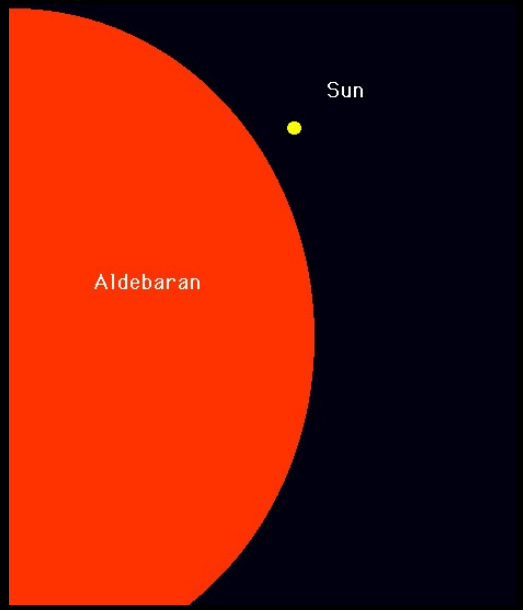
Atmosphere of Betelgeuse

HST · FOC

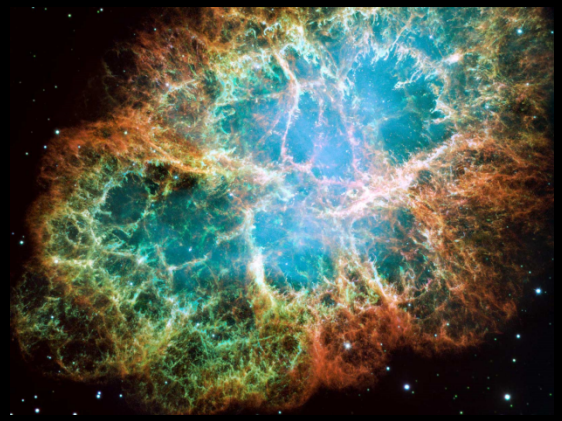
PRC96-04 · ST ScI OPO · January 15, 1995 · A. Dupree (CfA), NASA

Hertzsprung-Russell Diagram
Star Evolution

- Super Giants
  - Very few stars



- Late evolution of stars more massive than the sun.



- Usually explode in a supernova event

H-R Diagram – Star Evolution

White dwarfs

- Small (approximate the size of Earth)
- Hot
- Low in luminosity (due to their small size)
- Planetary nebula: The resulting glowing halo of gases that forms when a white dwarf's layers give off visible light
- Black dwarfs – dead stars

Life Cycle of Stars – Depends upon their original mass

- After they spend their life as main sequence star ….
- Sun size > expand to red giant in about 5 billion years > white dwarf > black dwarf
- Super giant > supernova >

  very high mass – black hole

  high mass – neutron star

Evolution of a Star like our Sun