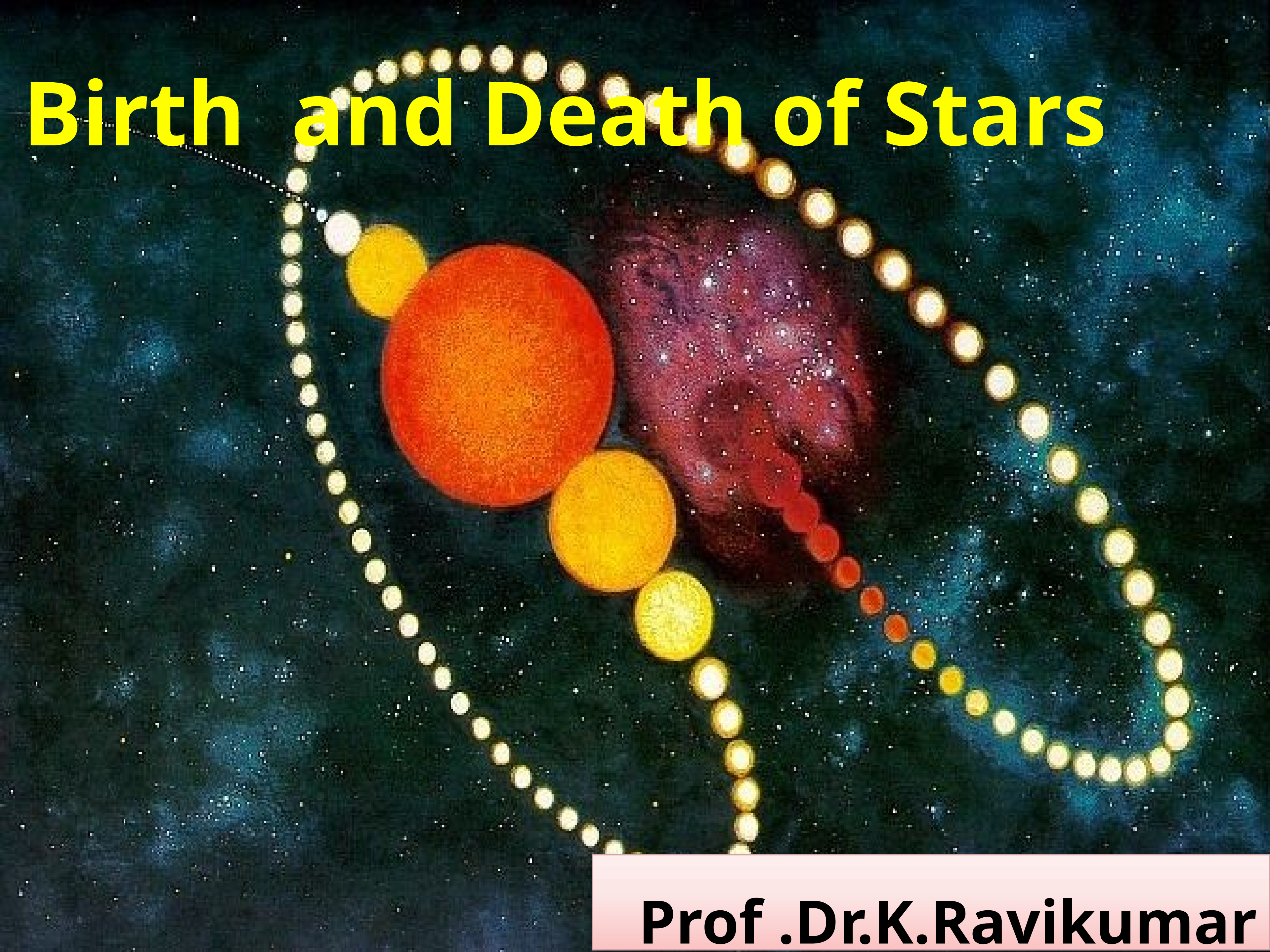
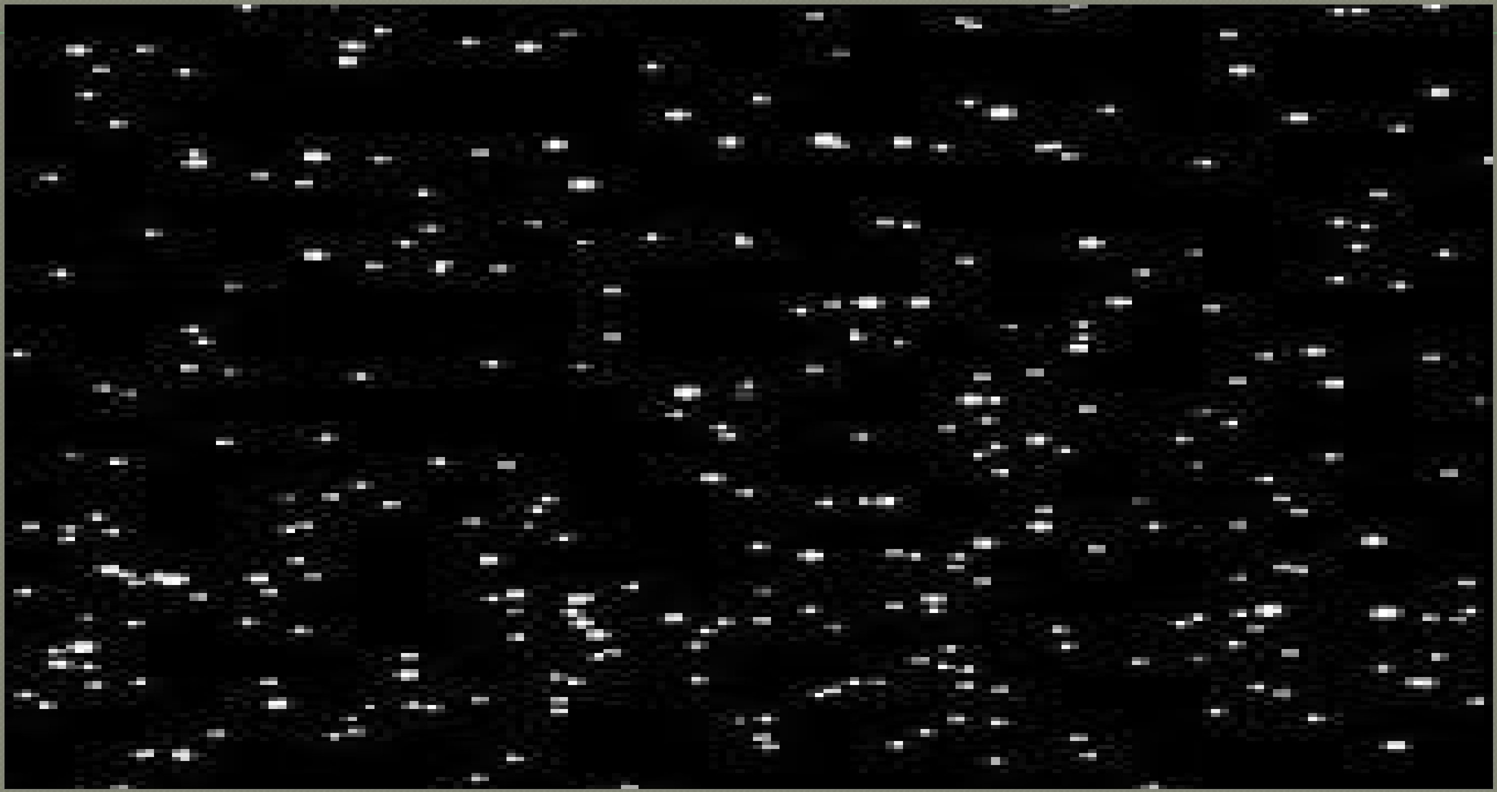
Birth and Death of Stars



Prof .Dr.K.Ravikumar

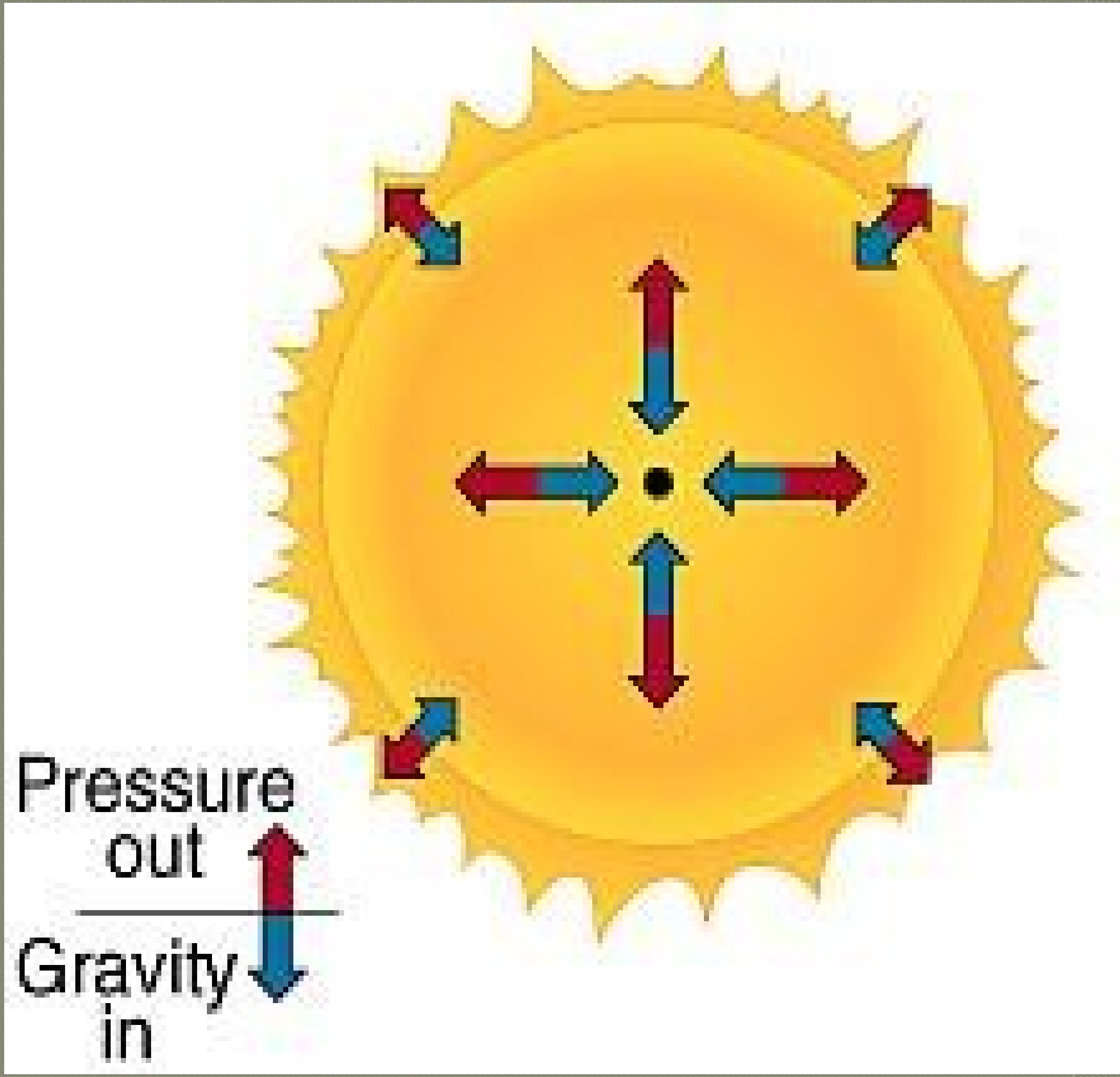
What is a star



A **star** is a massive, luminous ball of burning gas. held together by gravity. The nearest star to Earth is the Sun.

How does a gas have a spherical shape?

Burning gas held together by gravity


Pressure
out
Gravity
in

Life span of the star

1.Nebula -Photo star – star formation

2.Main sequence star (sun)

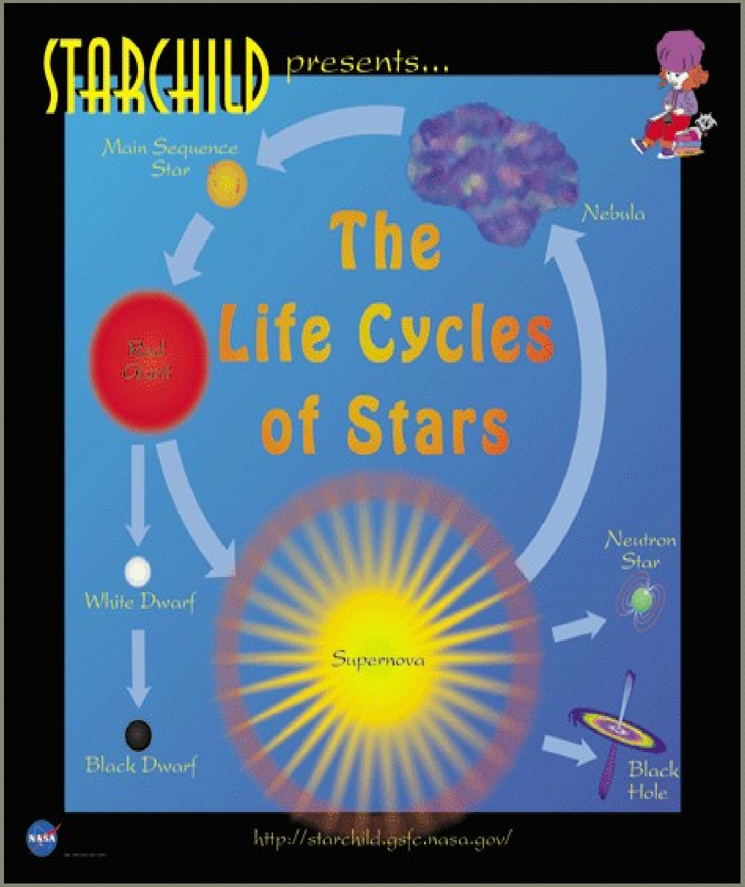
3.Red giant

4.White dwarf

5.Super nova (new star)

6.Neutron star

7.Black hole



1.NEBULA

*.**gravitational collapse** of a **giant molecular cloud** (GMC).

*GMC size **100 light-years (9.5×10^{14} km)**

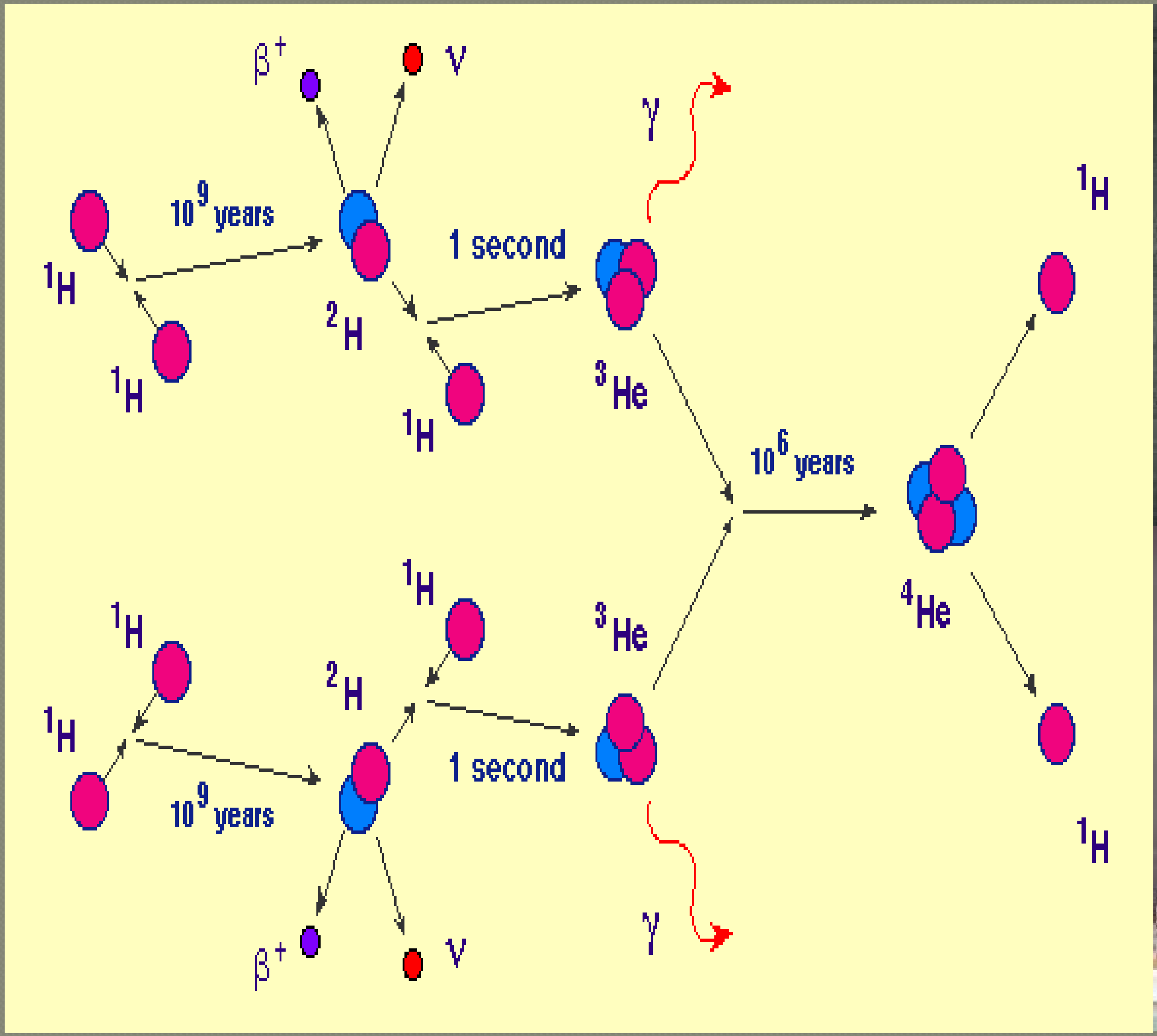
*** M**ass up **60,00,000solarmasses(1×10^{37}kg).**

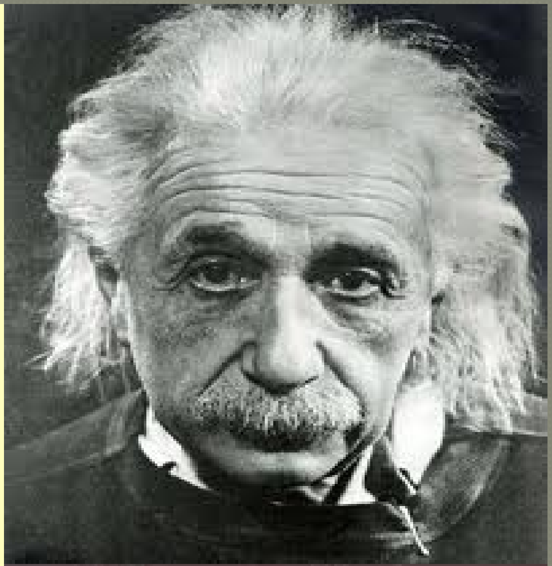
*As its temperature and pressure increase, a fragment condenses into a rotating sphere of superhot gas known as a **protostars**.

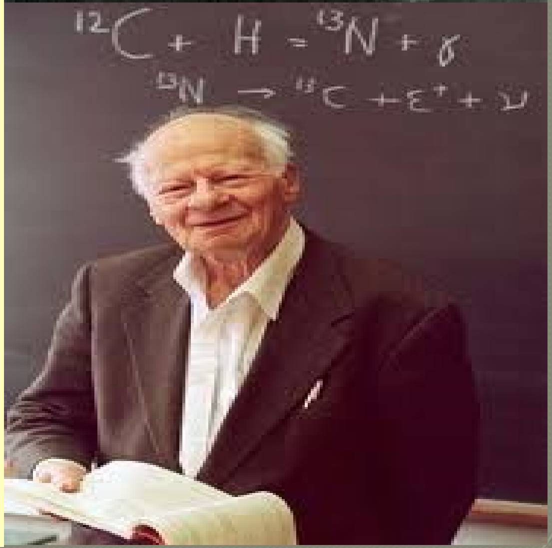
*Protostars with masses less than roughly **0.08 $M_\odot$ (1.6×10^{29} kg)** never reach temperatures high enough for **nuclear fusion** of hydrogen to begin.

Nebulas-photos

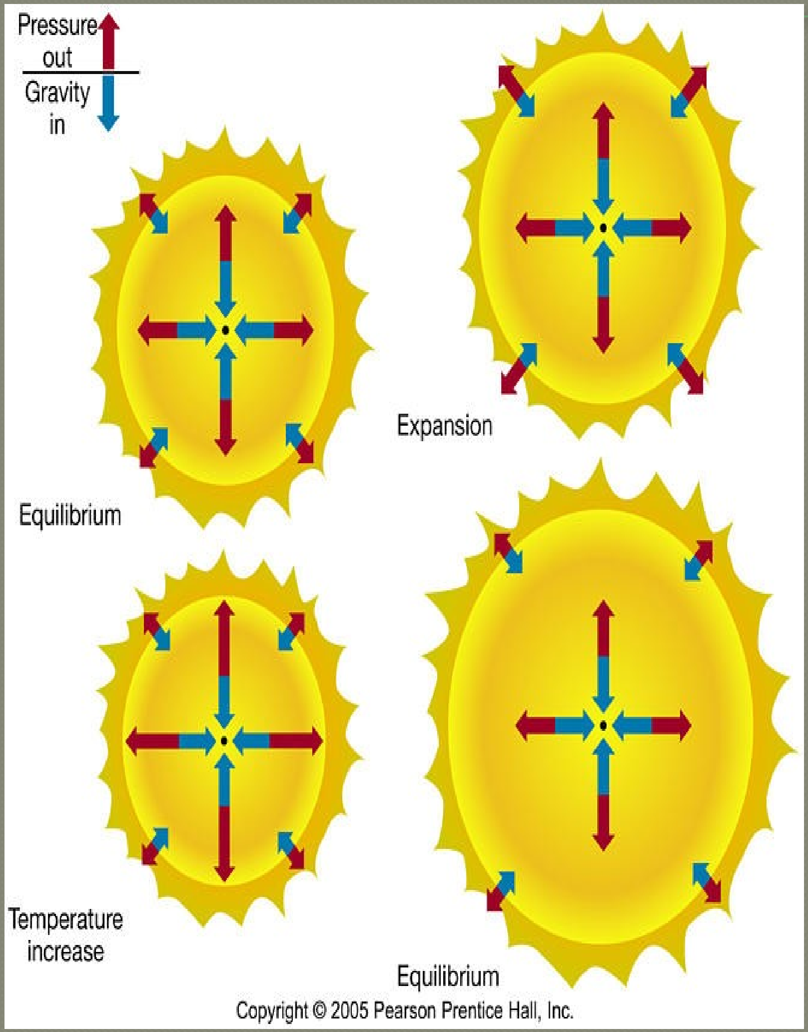
Energy production

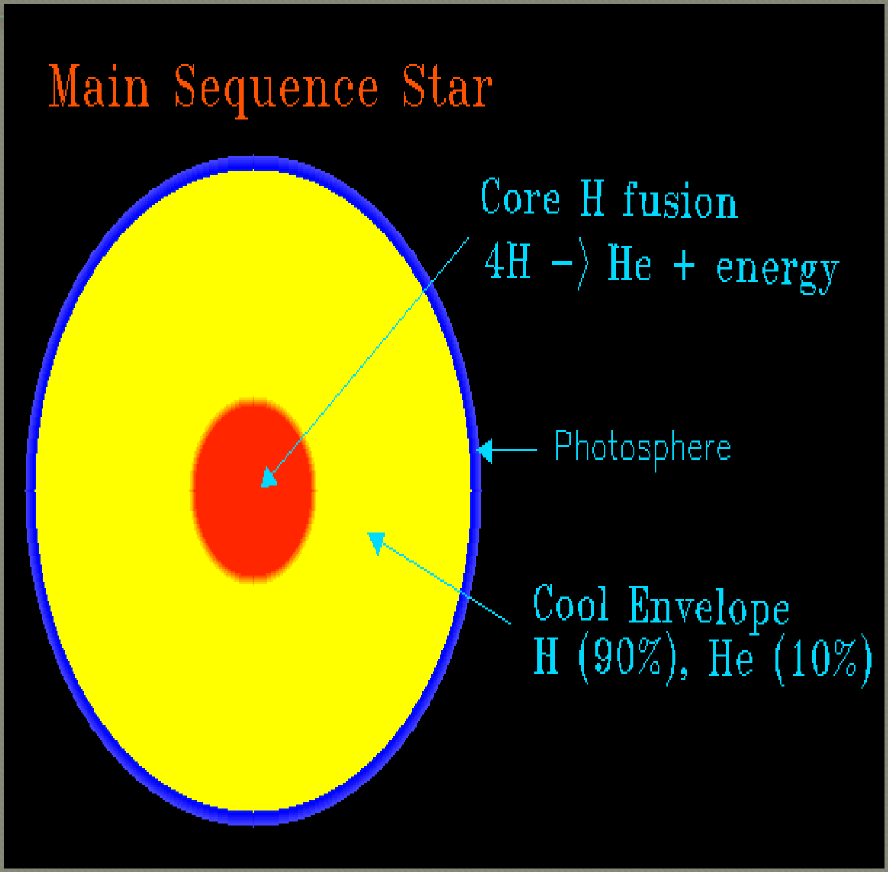






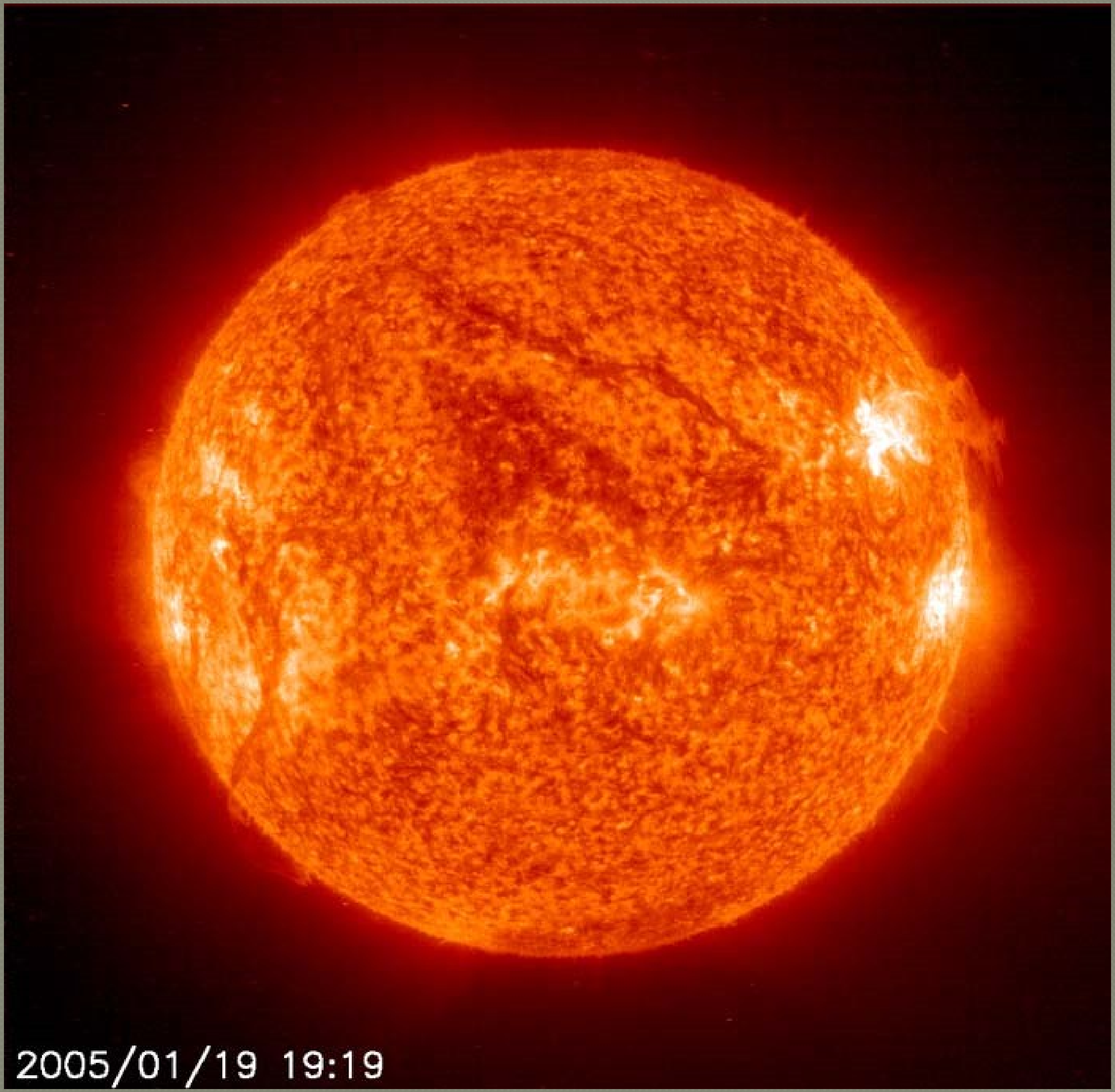
2.Main sequence star





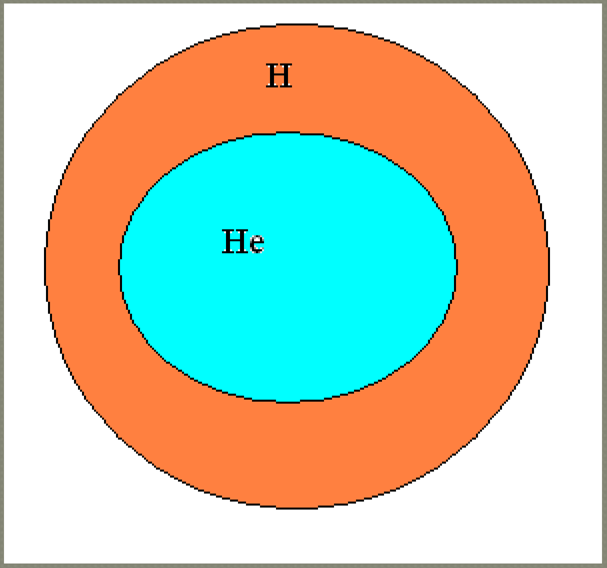
$$F_G = P_g$$

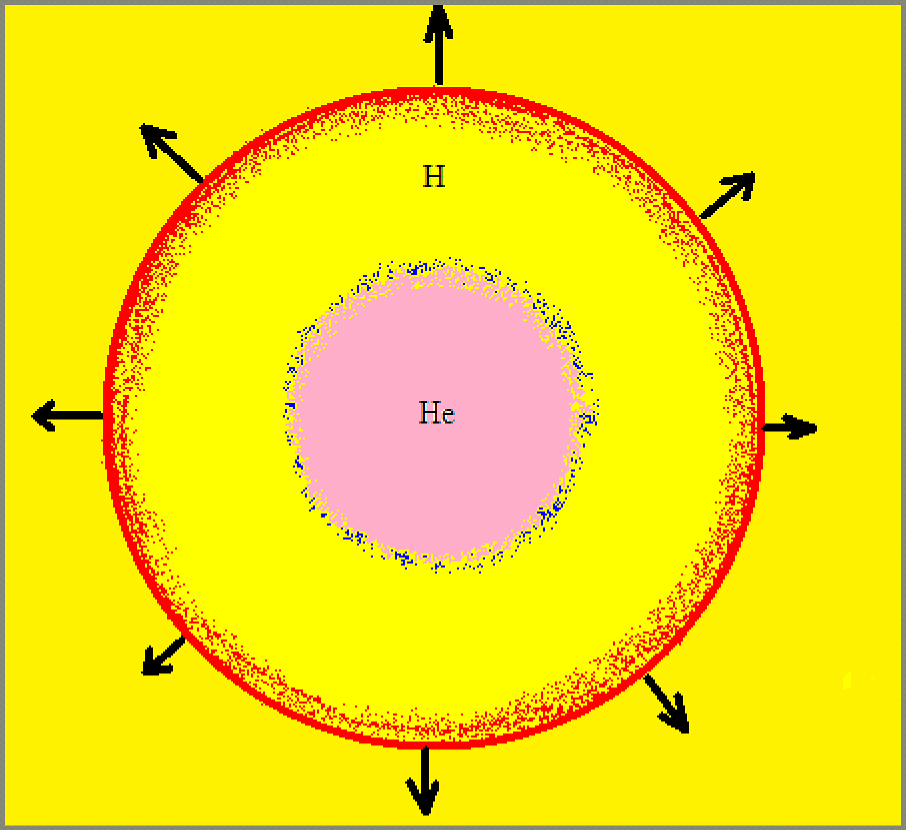
Main sequence star- sun



3.Red giant

What is happen if all hydrogen is totally exhausted ?

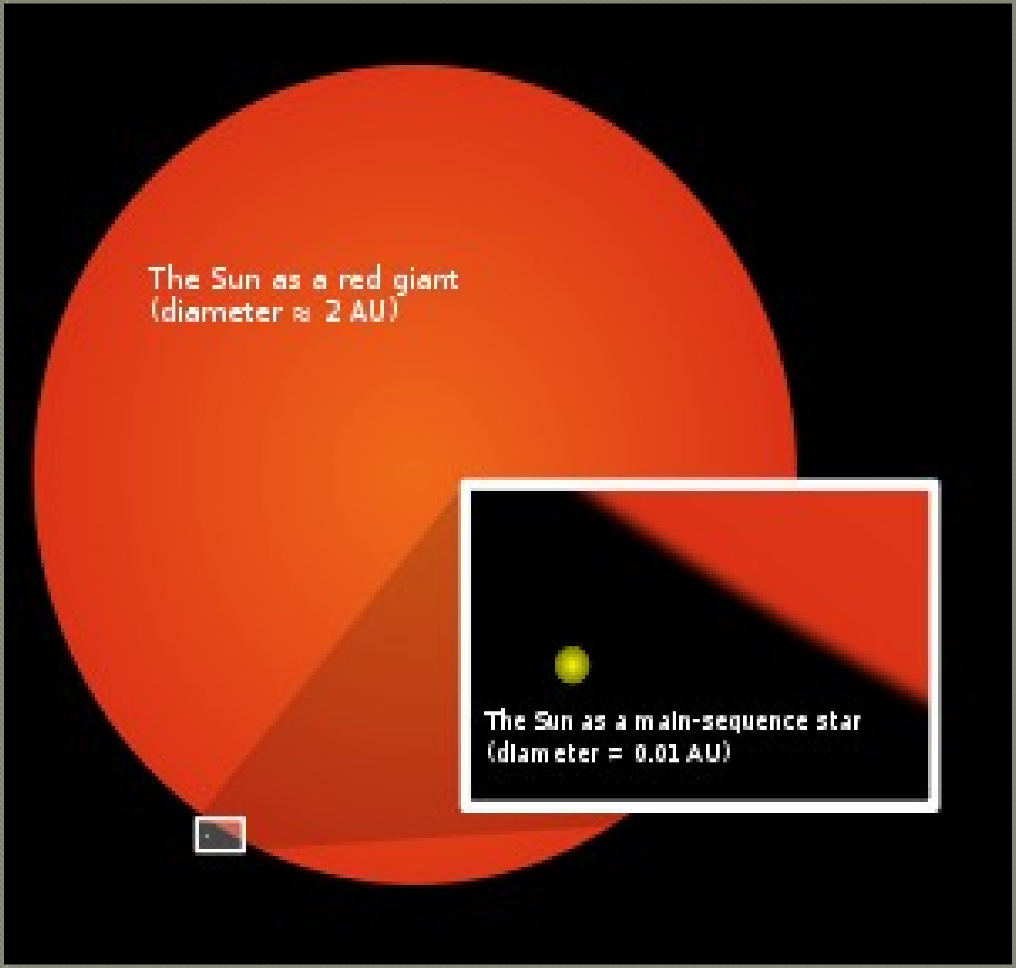




$$P_g > F_G$$

STAR STARTS TO EXPANDS

Red giant

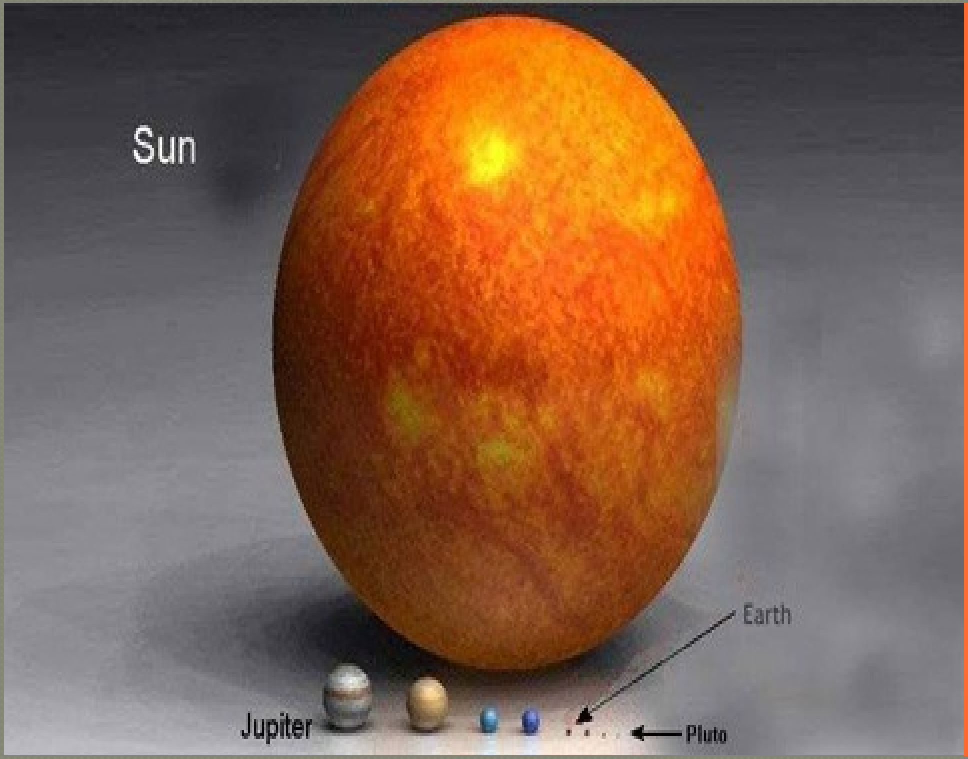


The Sun become a red giant after 5billion year
radius will expand to 200 times

The Sun will lose a significant fraction of its mass.

Surface temperature is low 5000K

Red giant-solar system



4.White dwarf

$F_G > P_g$

*A **white dwarf is** small star composed mostly of electron.

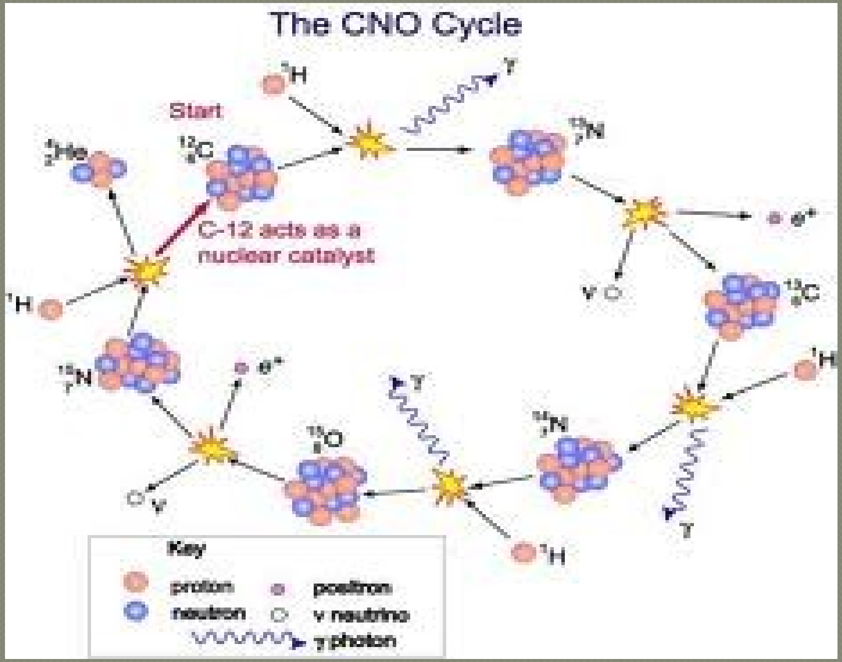
STAR STARTS TO CONTRACTS

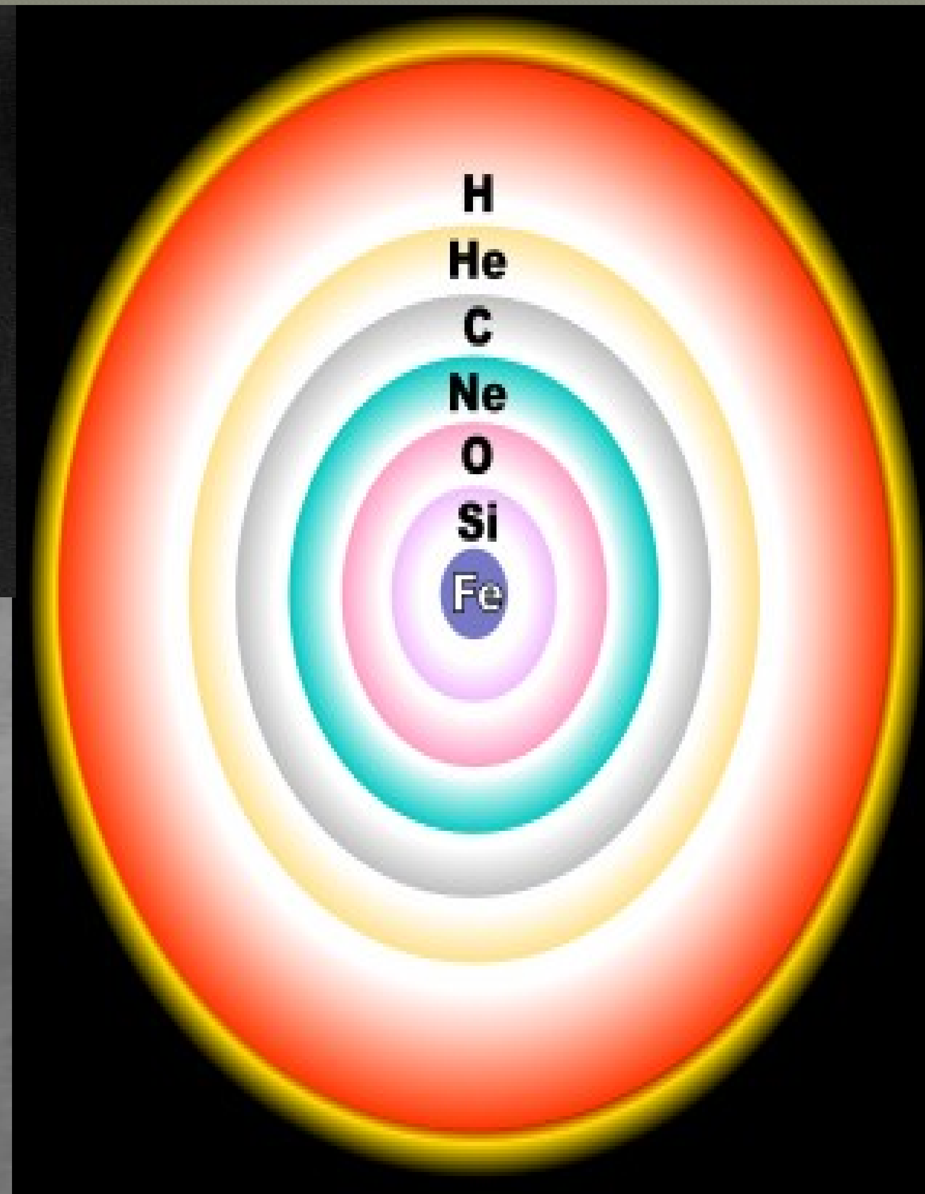
*They are very dense (10^9 Kg/m^3)

*white dwarf's mass is equal to of the Sun ($M < 1.4M_0$).

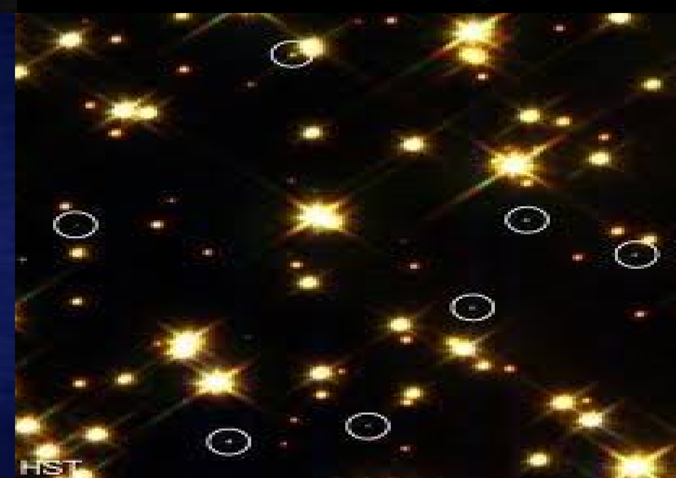
* Radius 1000 times smaller the sun

*Temperatures 7000K




H
He
C
Ne
O
Si
Fe

White dwarf -photos

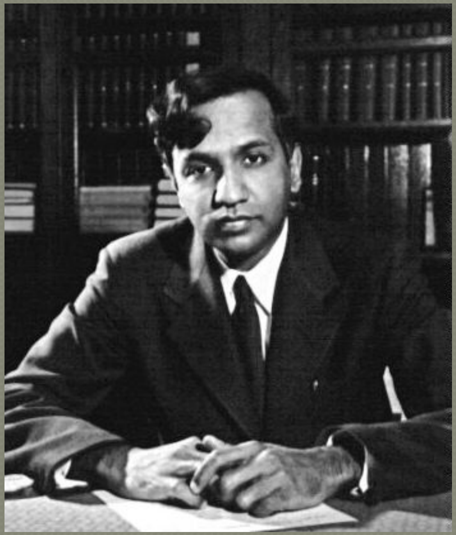


White dwarf materials

White dwarf is the end stage of star?

Chandrasekhar limit

Degenerate pressure (P_d) of electron due to **Pauli's exclusion principle** will resist the contraction of the white dwarf and explode into small pieces, this known as **super nova** $F_G < F_P + P_d$



VS

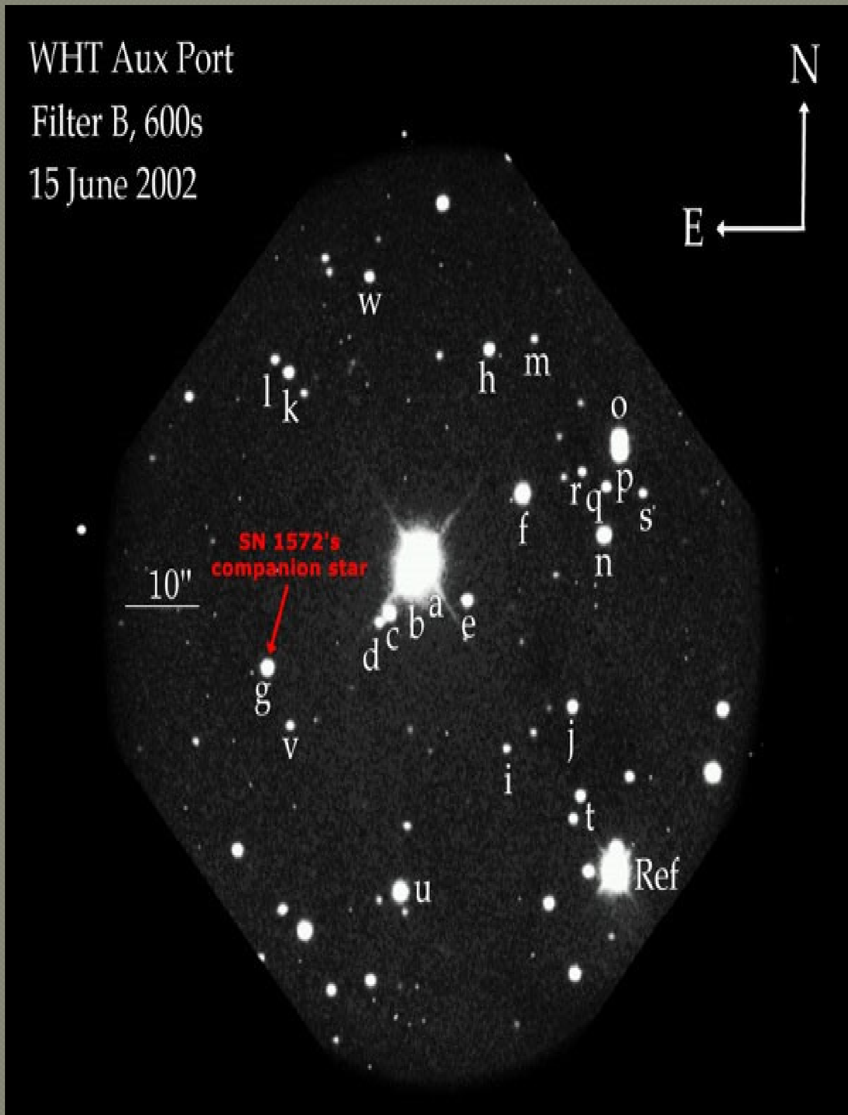
If mass of the mass supernovae pieces more then the **1.4** times of solar mass ($M = 1.4M_0$) then it can not maintain is white dwarf state,

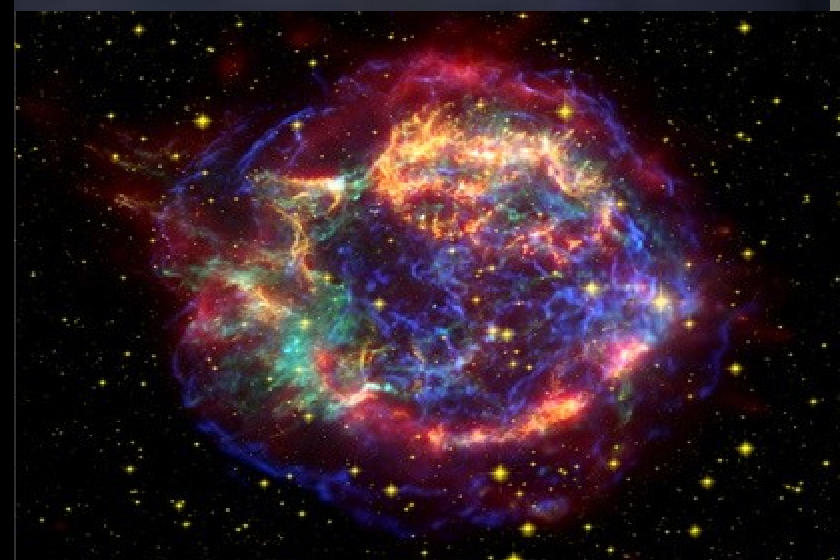
5.Supernova

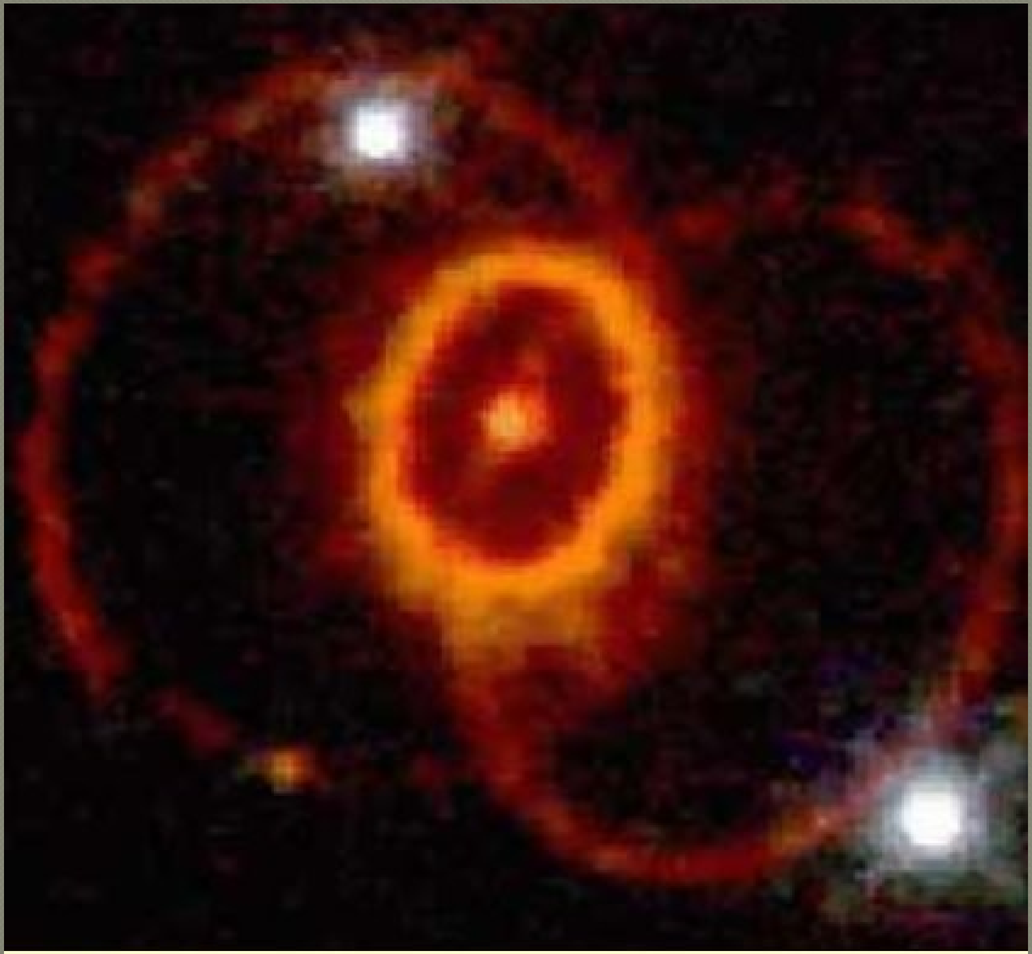
Remnant of Tycho brahe 's Nova, SN 1572

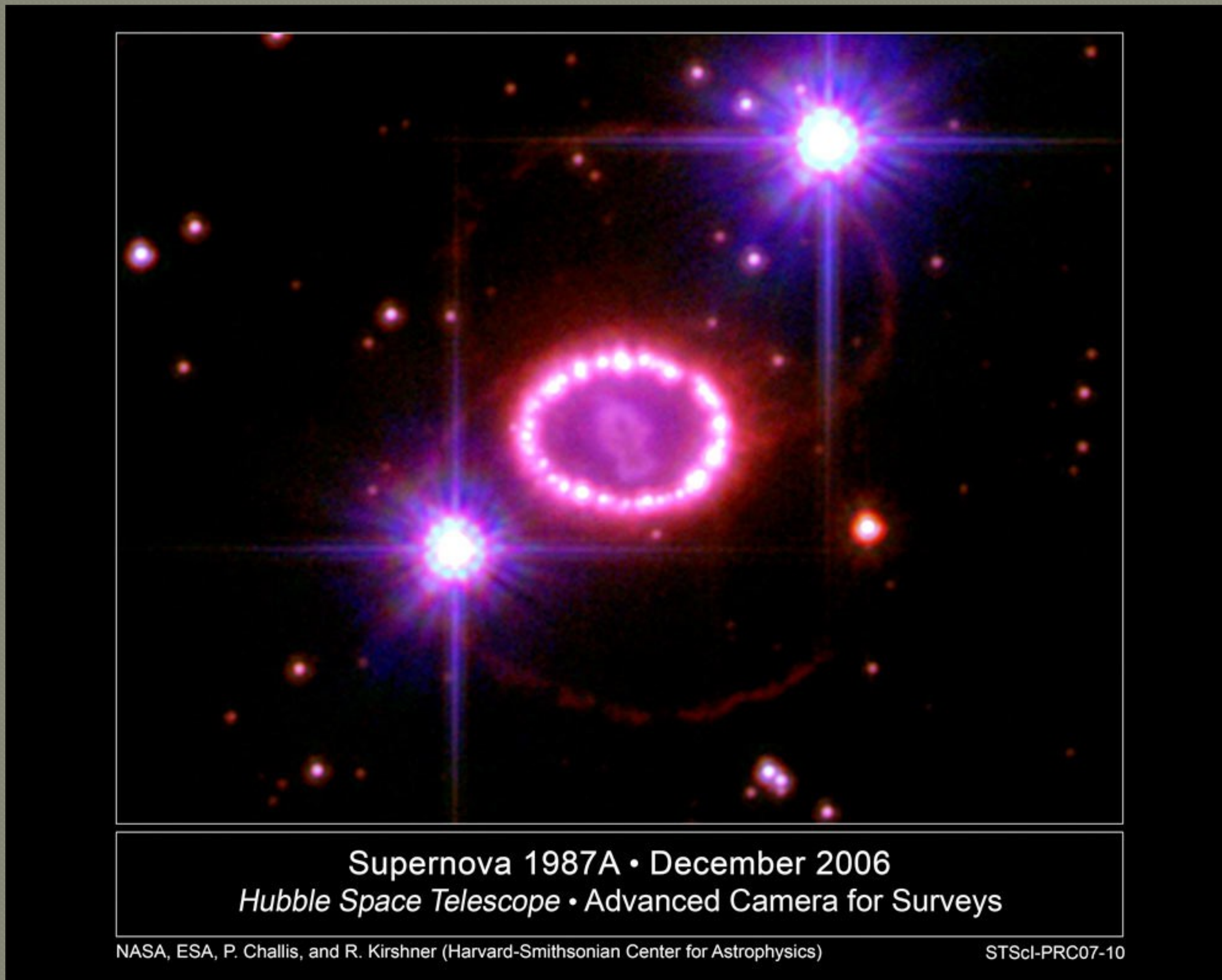
Remnant of Kepler's Supernova, SN 1604

Supernova-photos






The 1987 supernova


Supernova 1987A • December 2006
Hubble Space Telescope • Advanced Camera for Surveys
NASA, ESA, P. Challis, and R. Kirshner (Harvard-Smithsonian Center for Astrophysics)
STScI-PRC07-10

Remnant of supernova

A. Upto 1.4 M_0

White draft

B. above 1.4 to 3.2 M_0

Neutron star

C. Above 3.2M0

Black holes

6. Neutron Stars

*A neutron star is a type of stellar remnant that can result from the gravitational collapse of a massive star during a supernova event.

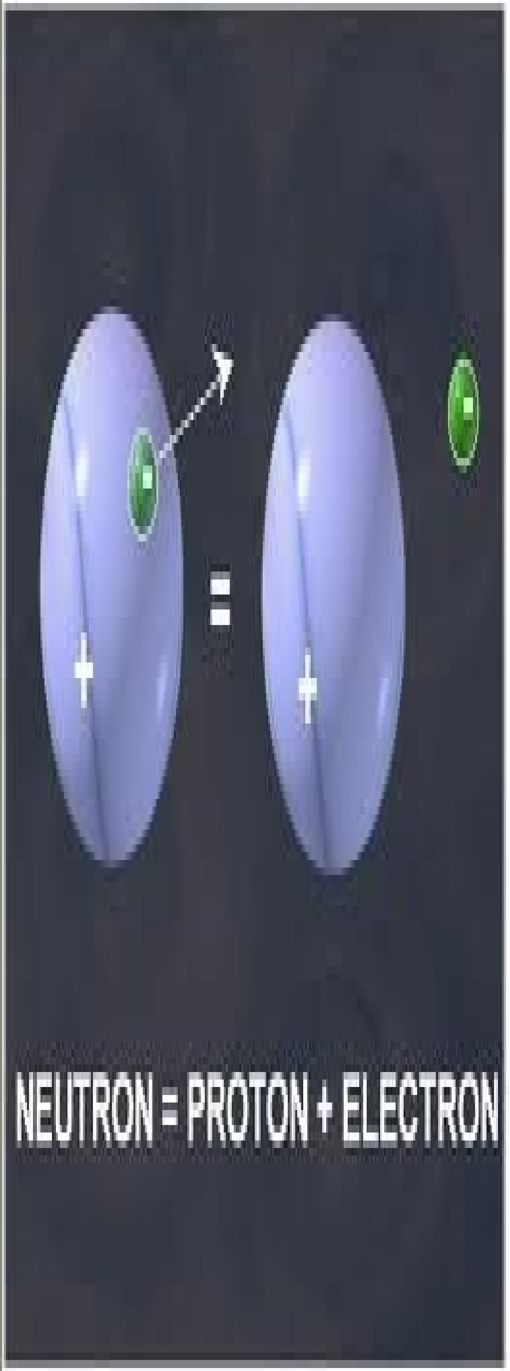
*Such stars are composed almost entirely of neutrons.

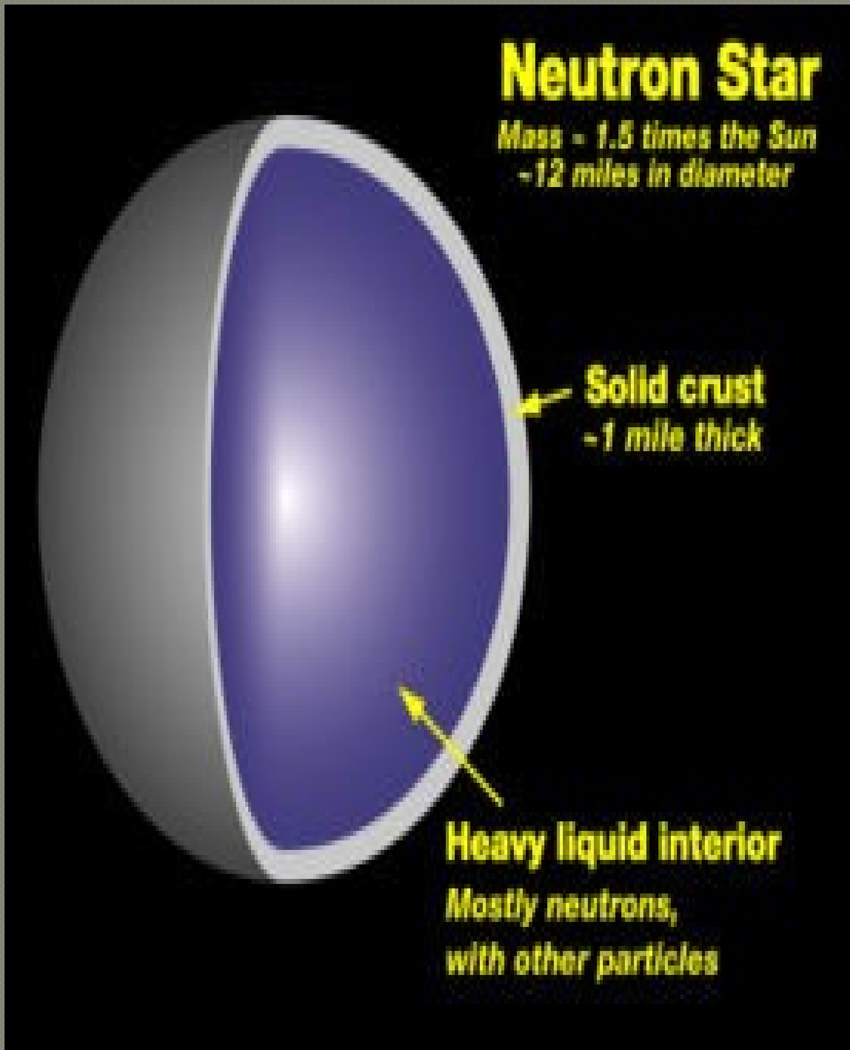
*Neutron stars are very hot and are supported against further collapse because of the Pauli exclusion principle,

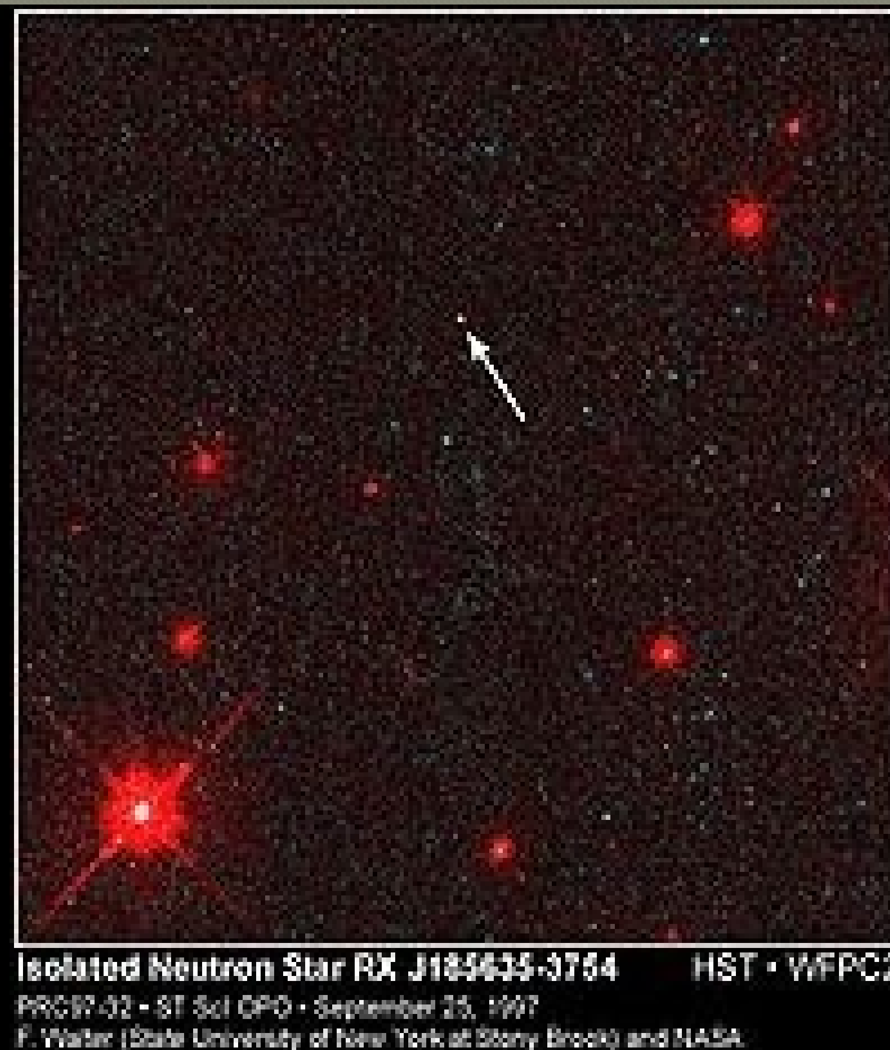
*Mass = 1.5 to 2.1 solar masses,Radius = 12 km, Escape velocity of around 100,000 km/s (about 33% of the speed of light), Temperature 10^{11} to 10^{12} K

*Density = 10^{16} – 10^{18} kg/m^3 (This density is approximately equivalent to the mass of the entire human population compressed to the size of a sugar cube)

*surface gravity up to 7×10^{12} m/s^2 with typical values of a few $\times 10^{12}$ m/s^2 (that is more than 10^{11} times of that of Earth)




Neutron Star
Mass ~ 1.5 times the Sun
~12 miles in diameter
Solid crust
~1 mile thick
Heavy liquid interior
Mostly neutrons,
with other particles


Isolated Neutron Star RX J185635-3754
HST • WFPC2
PRC97-32 • ST ScI OPO • September 25, 1997
F. Walter (State University of New York at Stony Brook) and NASA

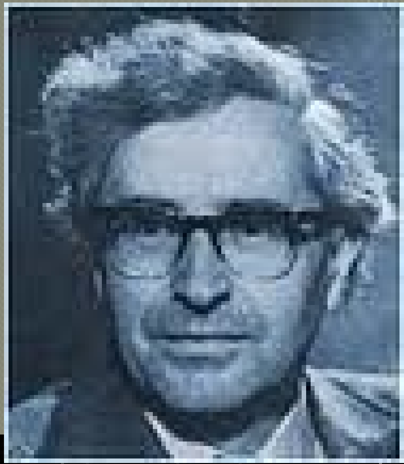
Pulsars (Spinning Neutron Stars)

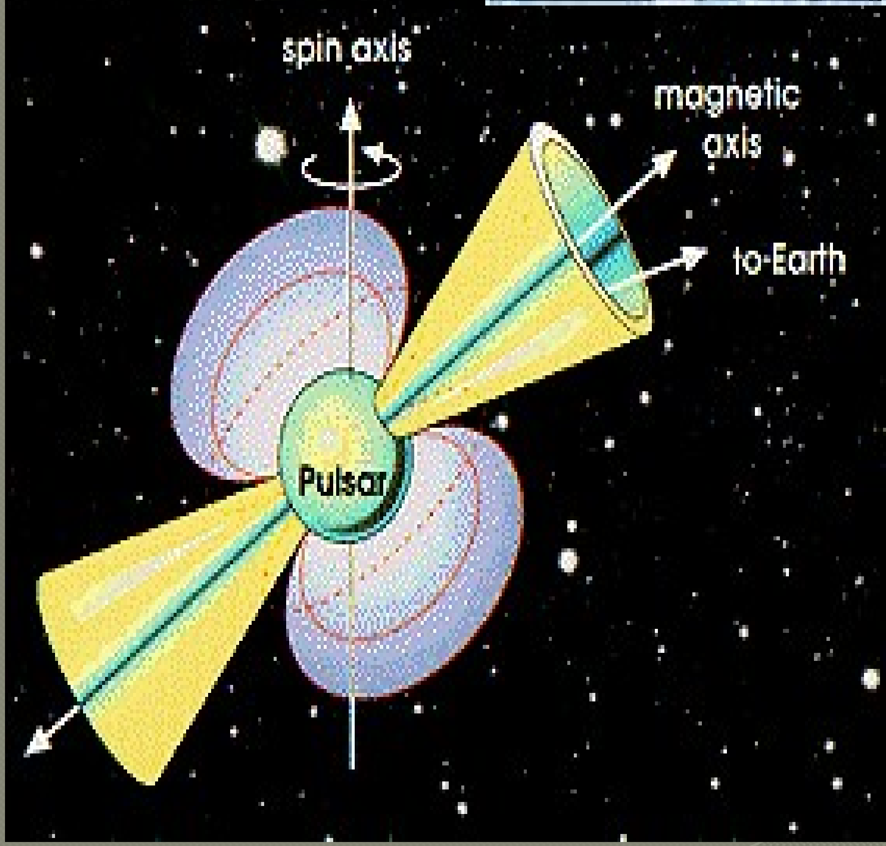
In 1967 **Jocelyn Bell** and her teacher **Anthony Hewish** discover rapidly pulsating radio sources . Called "**Pulsars**" = Pulsating Radio Sources

Pulsars emitted sharp pulses at an extremely repeatable rate 1.4 ms to 30 seconds

Anthony Hewish got 1974 Nobel Prize for Physics for his role in the discovery of pulsars.

© Julia Hedgecoe / University of Cambridge





7.Black holes

A **black hole** is a super dense object that has an intense gravitational pull from which nothing**, not even light can escape**.

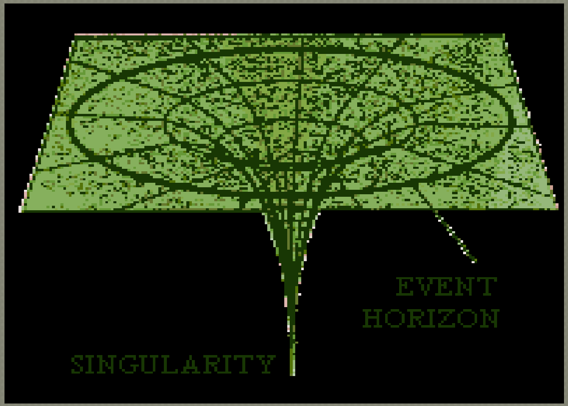
There are two parts to a black hole, a **singularity** and a **event horizon**. If you were to take a slice of a black hole right through its center it would look like this:

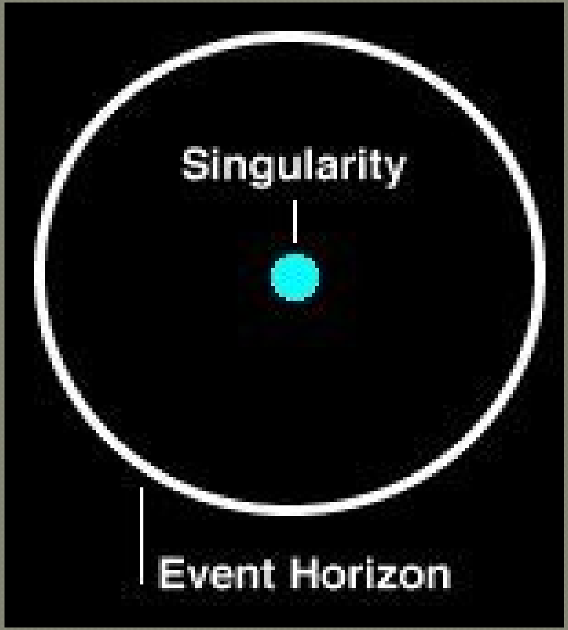
Density $=4 \times 10^{17}$ kg/m^3

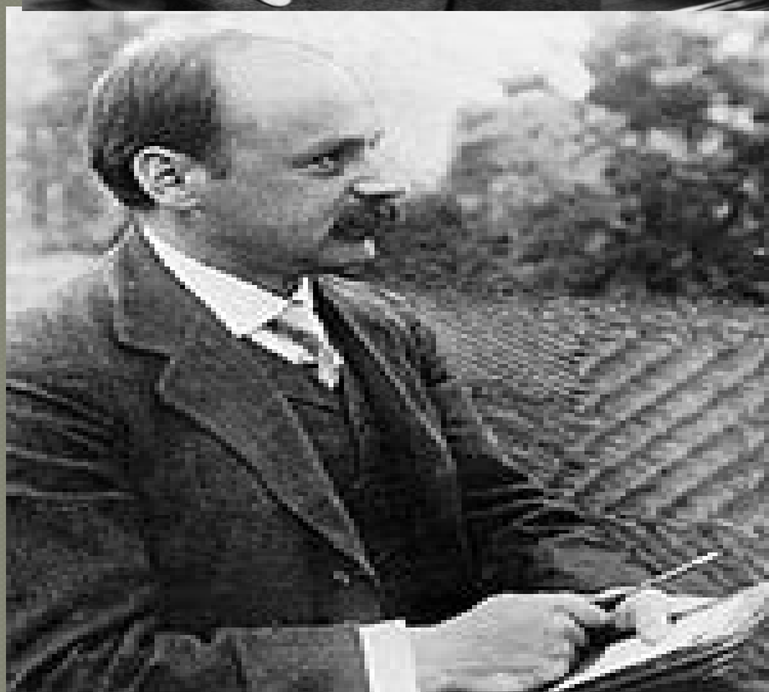
Mass = more then 3.4 M_0

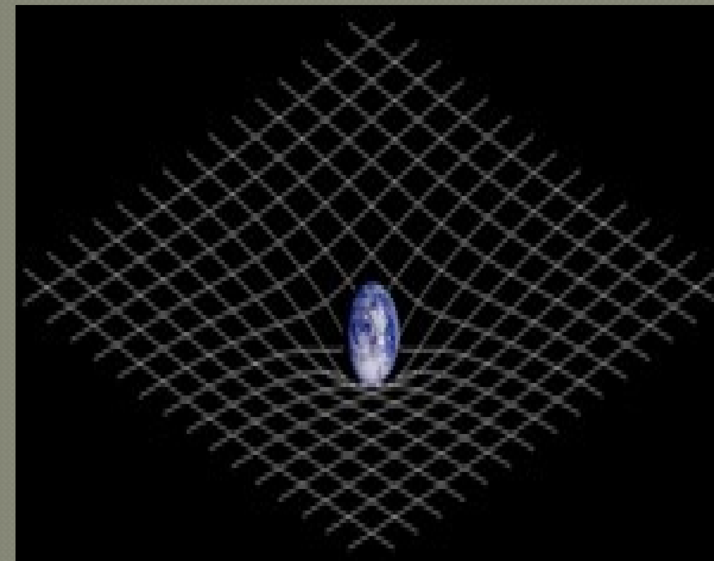
Radius = 2km (3 times smaller then the neutron star)

Escape velosity = More then the speed of light



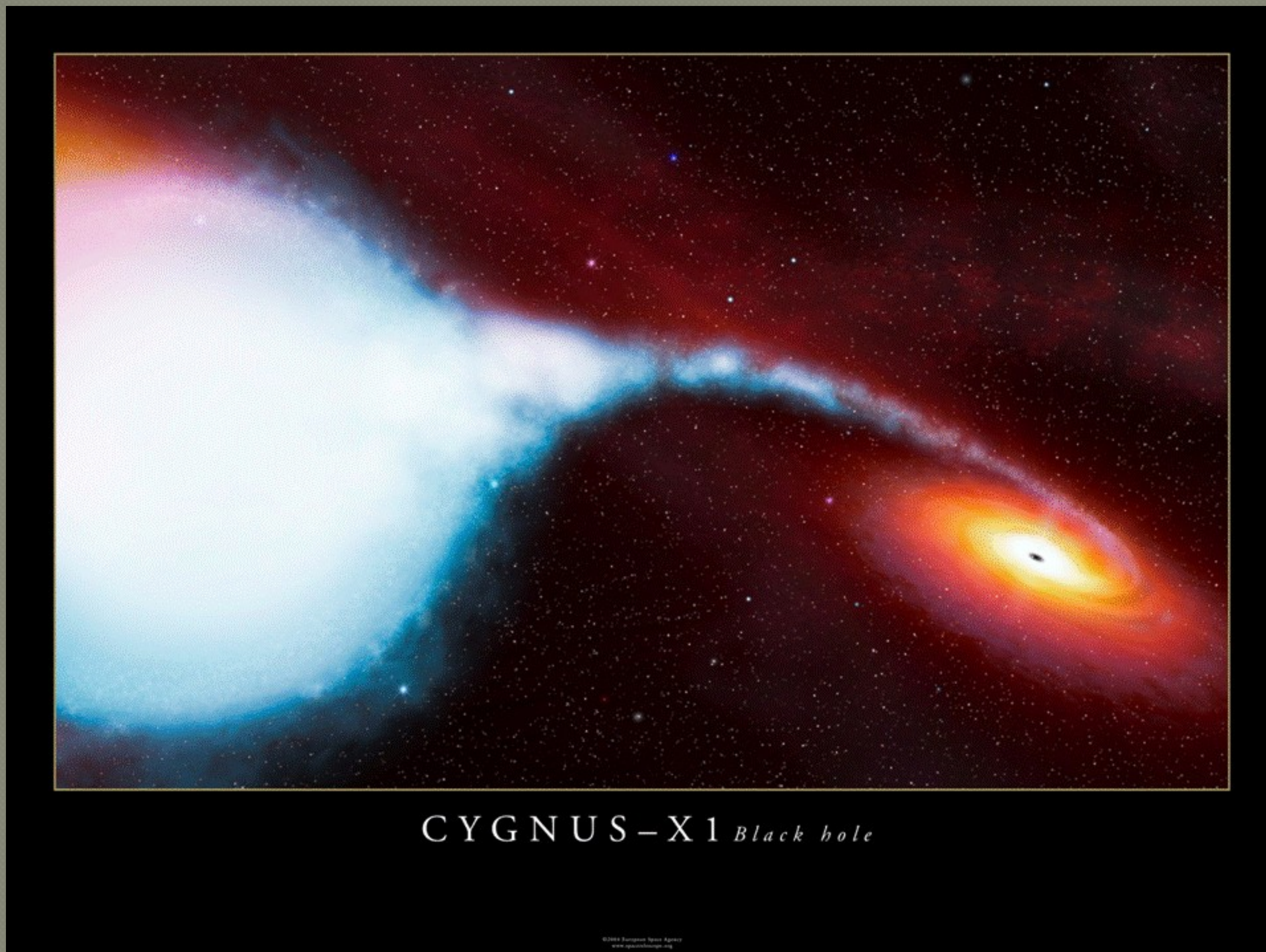




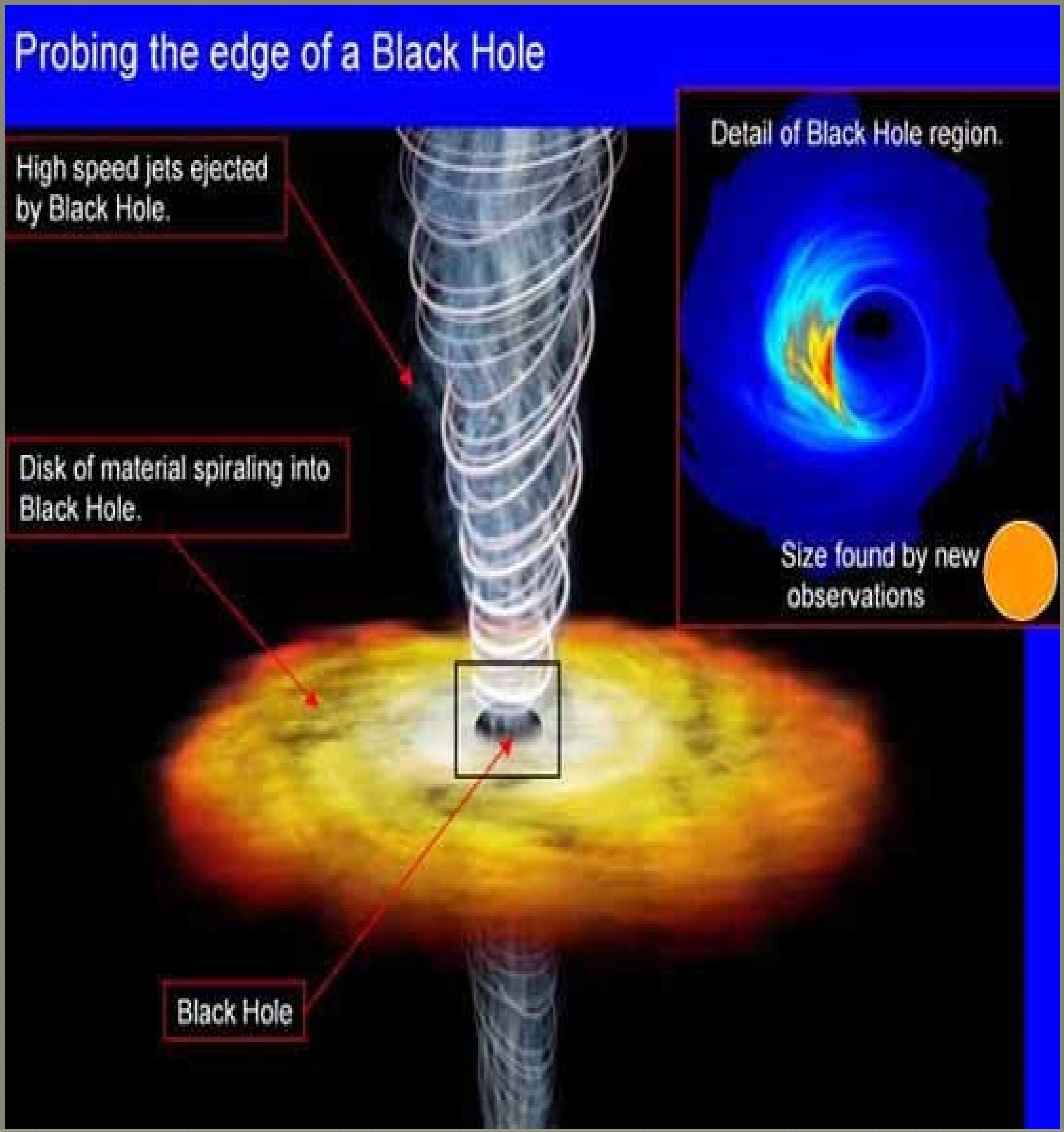


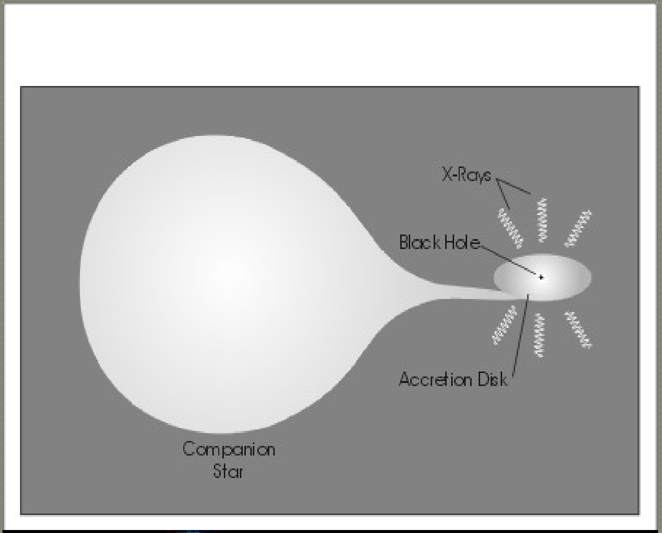
in 1916 Schwarzschild radius of black holes

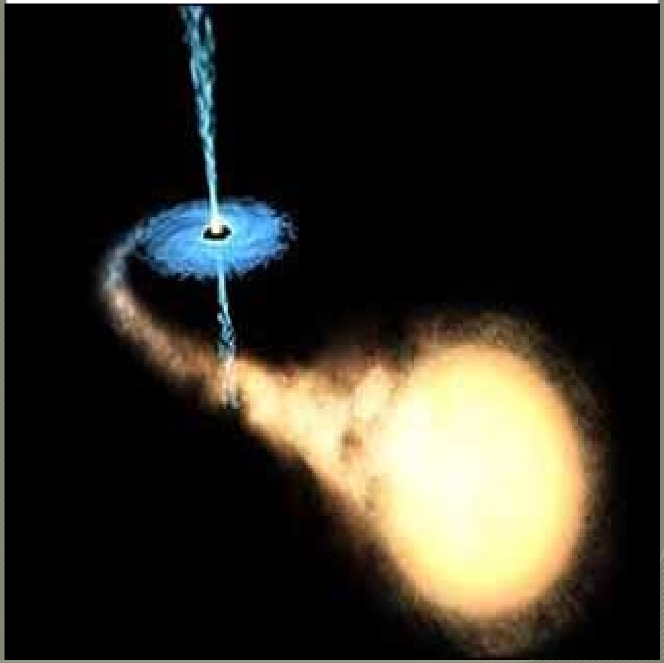
$$R_s = \frac{2GM}{c^2}$$


CYGNUS–X1 Black hole

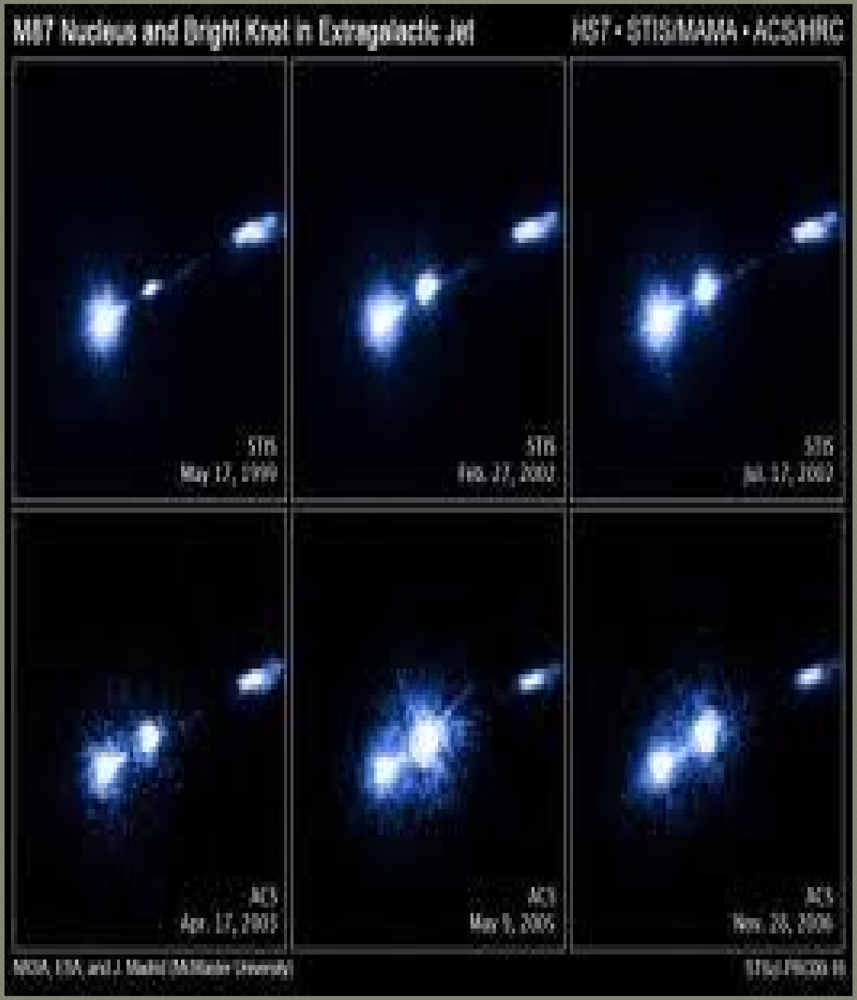
How to detect the black holes?







Chandra telescope

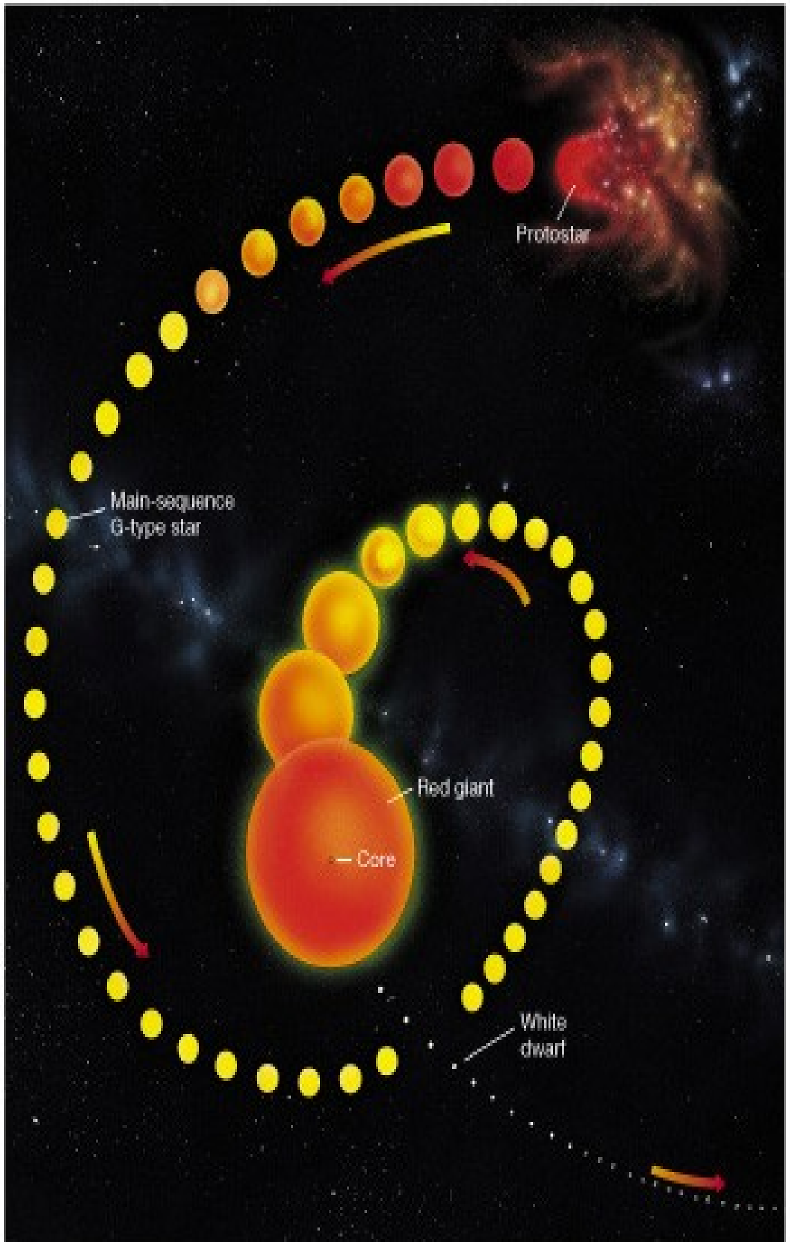


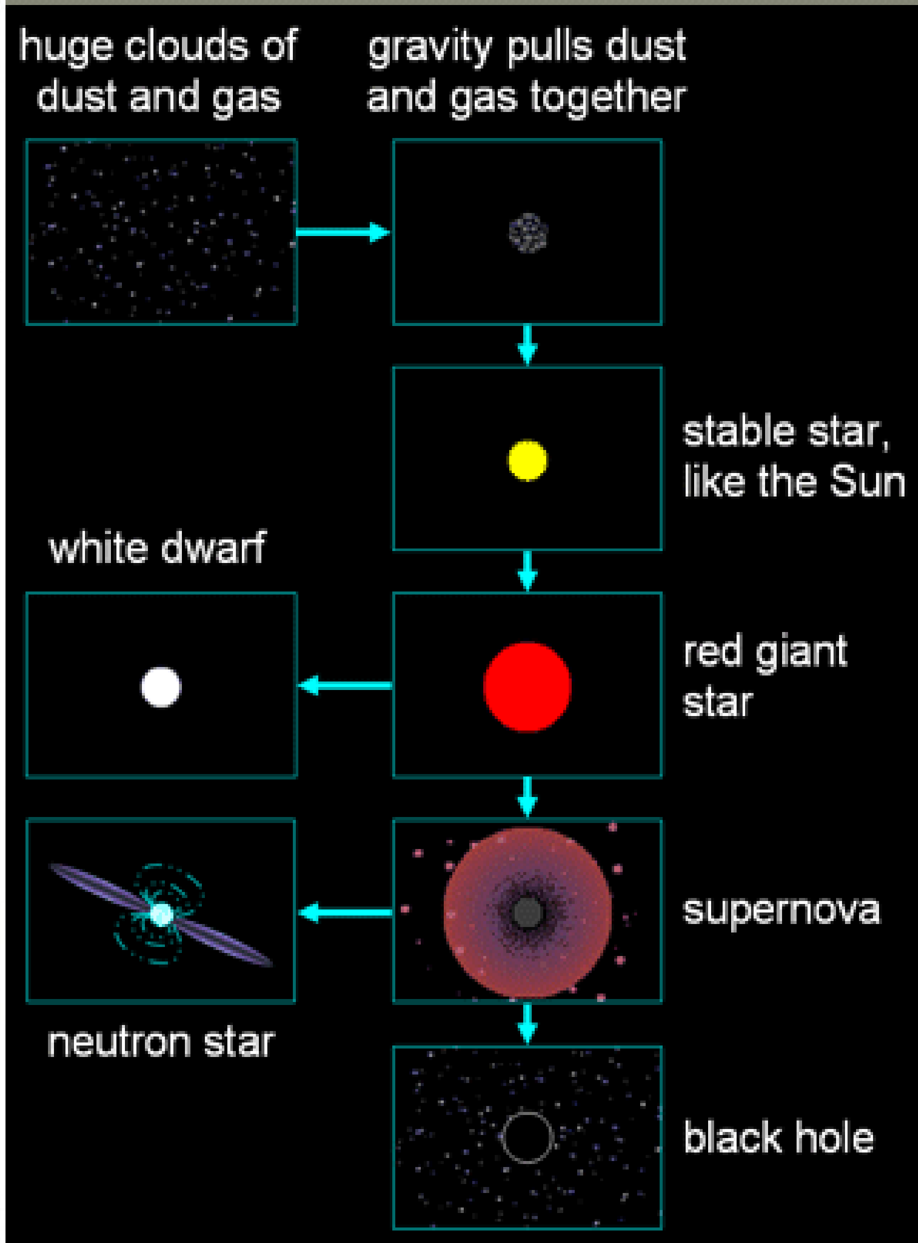
Hawking radiation

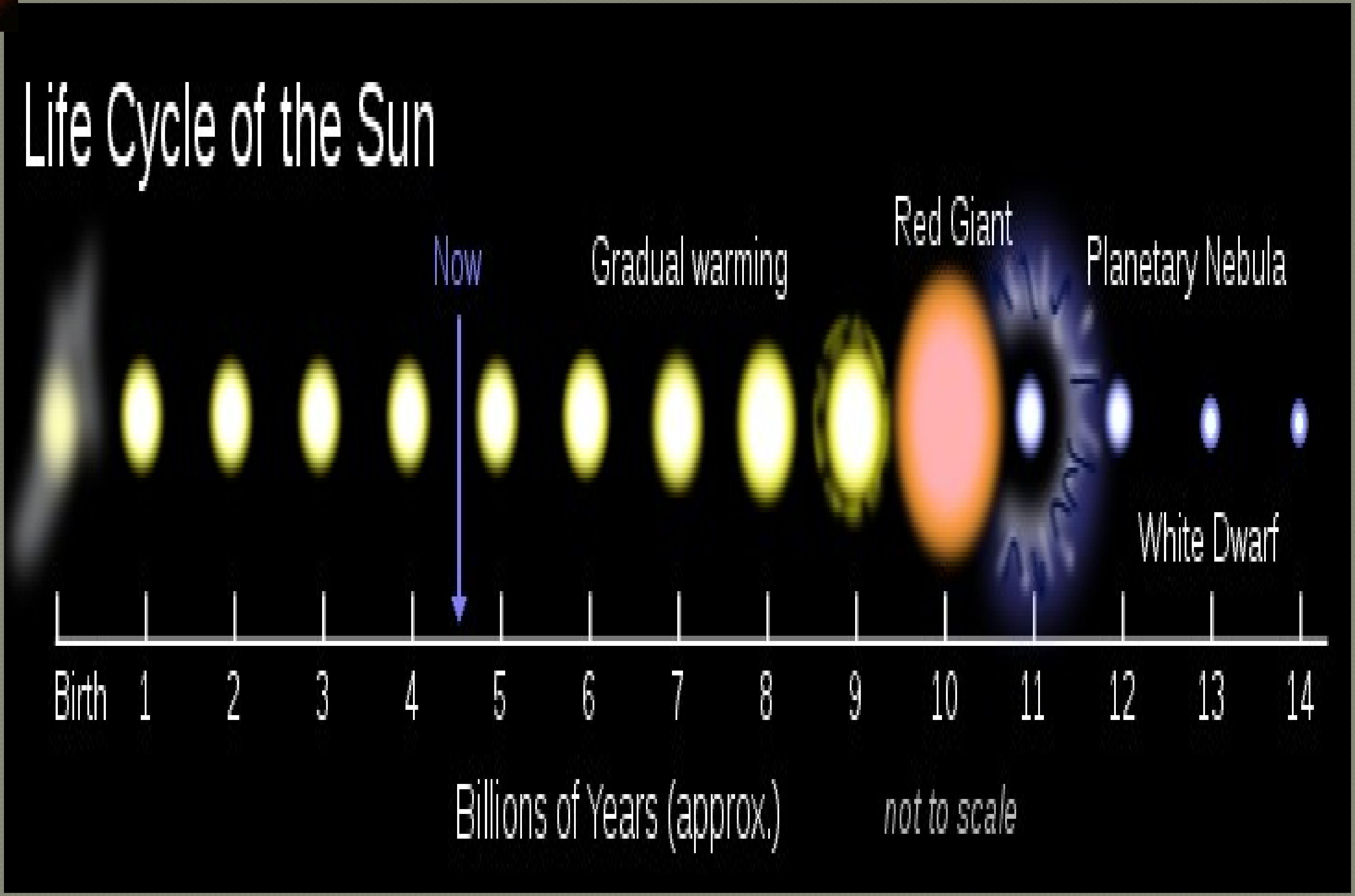
* black hole of one solar mass has a Hawking temperature of about 100 X10^{-9} K
(This is far less than the 2.7 K temperature of the cosmic microwave background)

* If a black hole is very small the radiation effects are expected to become very strong. Even a black hole that is heavy compared to a human would evaporate in an instant.

* A black hole the weight of a car would only take a nanosecond to evaporate,


Protostar
Main-sequence G-type star
Red giant
Core
White dwarf


huge clouds of dust and gas
gravity pulls dust and gas together
stable star, like the Sun
white dwarf
red giant star
neutron star
supernova
black hole

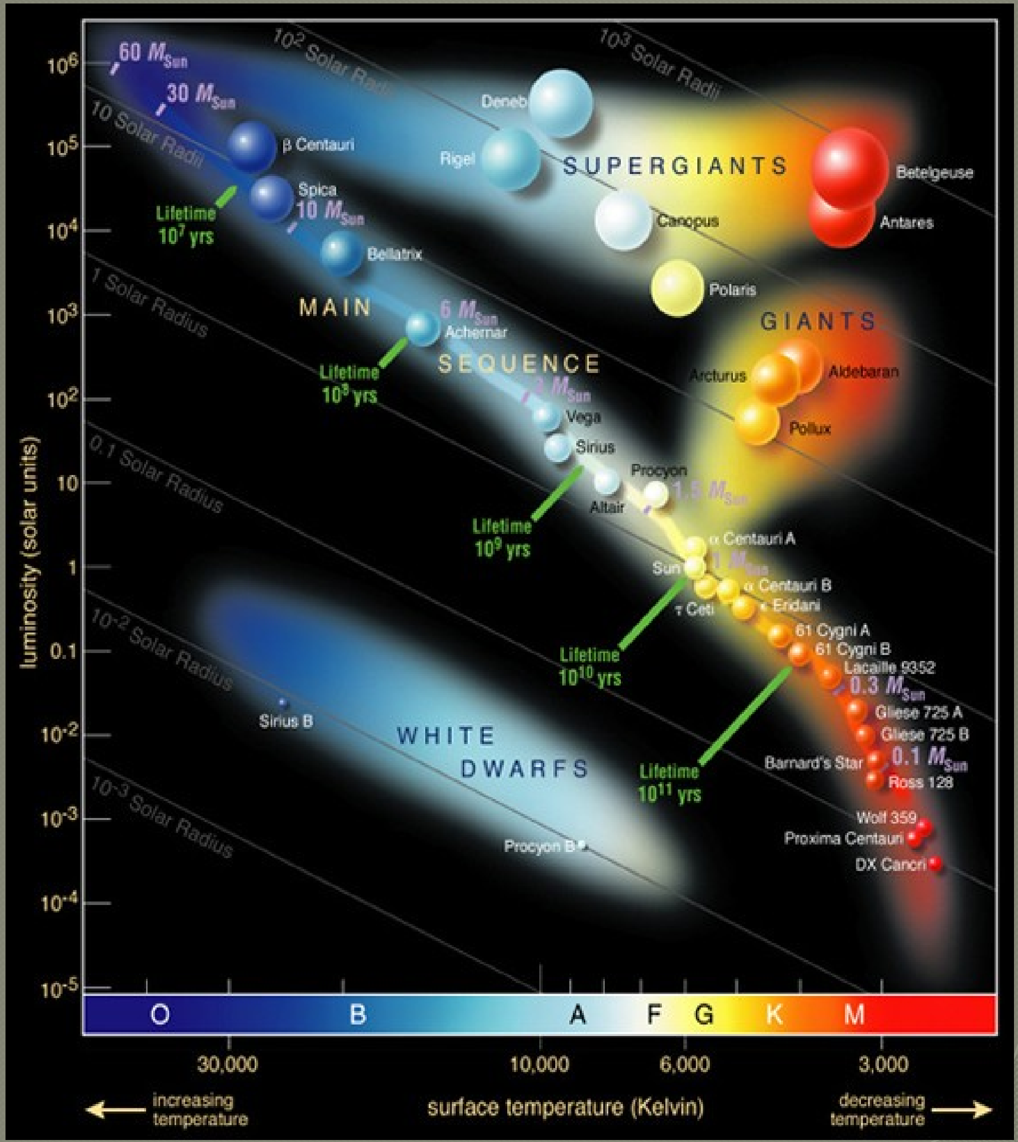


Life Cycle of the Sun
Now
Gradual warming
Red Giant
Planetary Nebula
White Dwarf
Birth
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Billions of Years (approx.)
not to scale

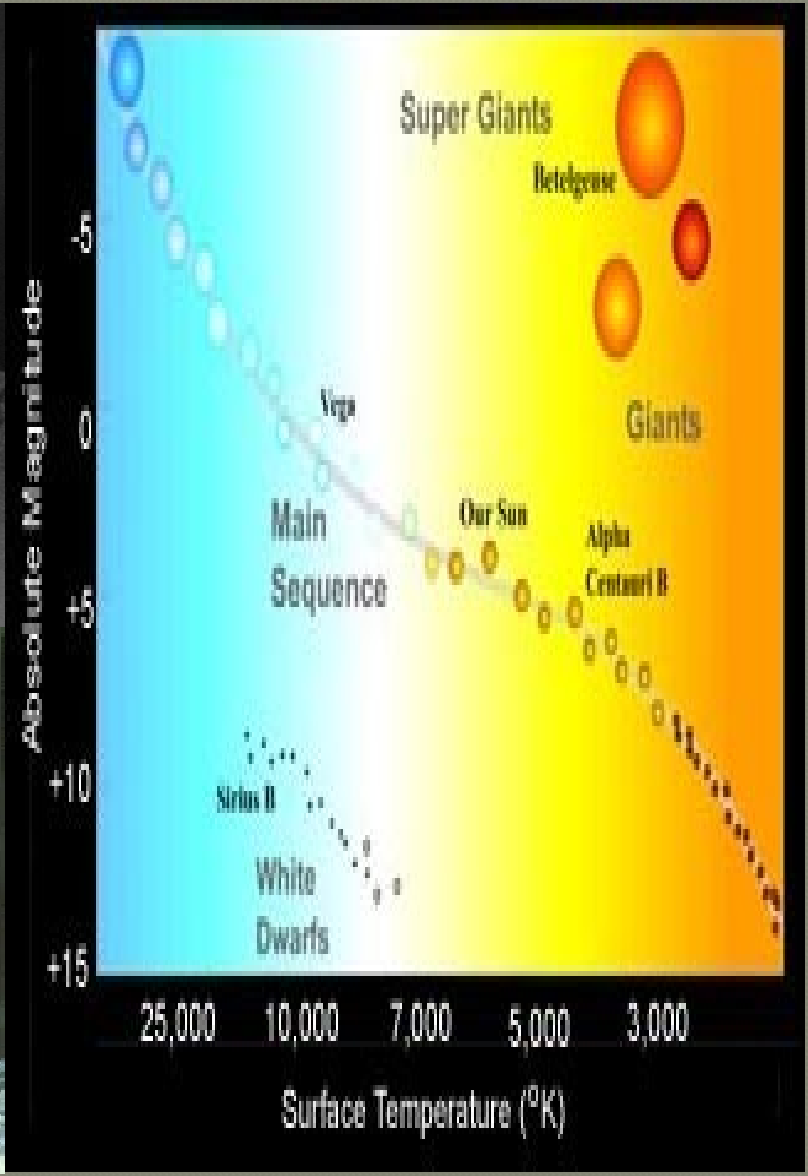
Ejnar Hertzsprung- Henry Norris Russell-Diagram

*A graph of the **absolute magnitude** of stars plotted against their **surface temperature** or color,

*used in the study of **stellar evolution**.



Ejnar Hertzsprung- Henry Norris Russell-Diagram



THANK YOU

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