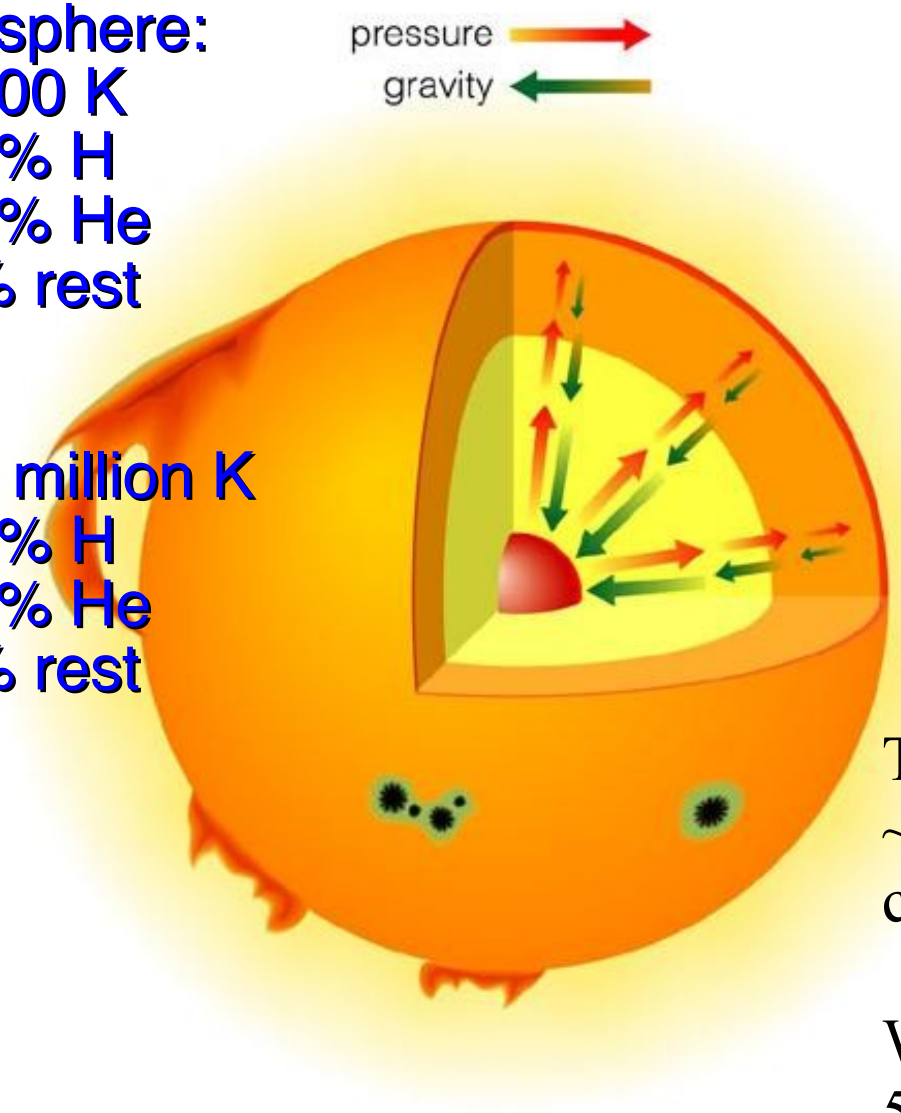
The Sun in neutrinos

You are seeing core of the Sun!

Life of a star: a protracted battle with gravity

Photosphere:
- 5800 K
- 70% H
- 28% He
- 2% rest

Core:
- 15 million K
- 33% H
- 65% He
- 2% rest



ALWAYS: To support weight:

need high pressure

MOSTLY:

⇒ need high temperature

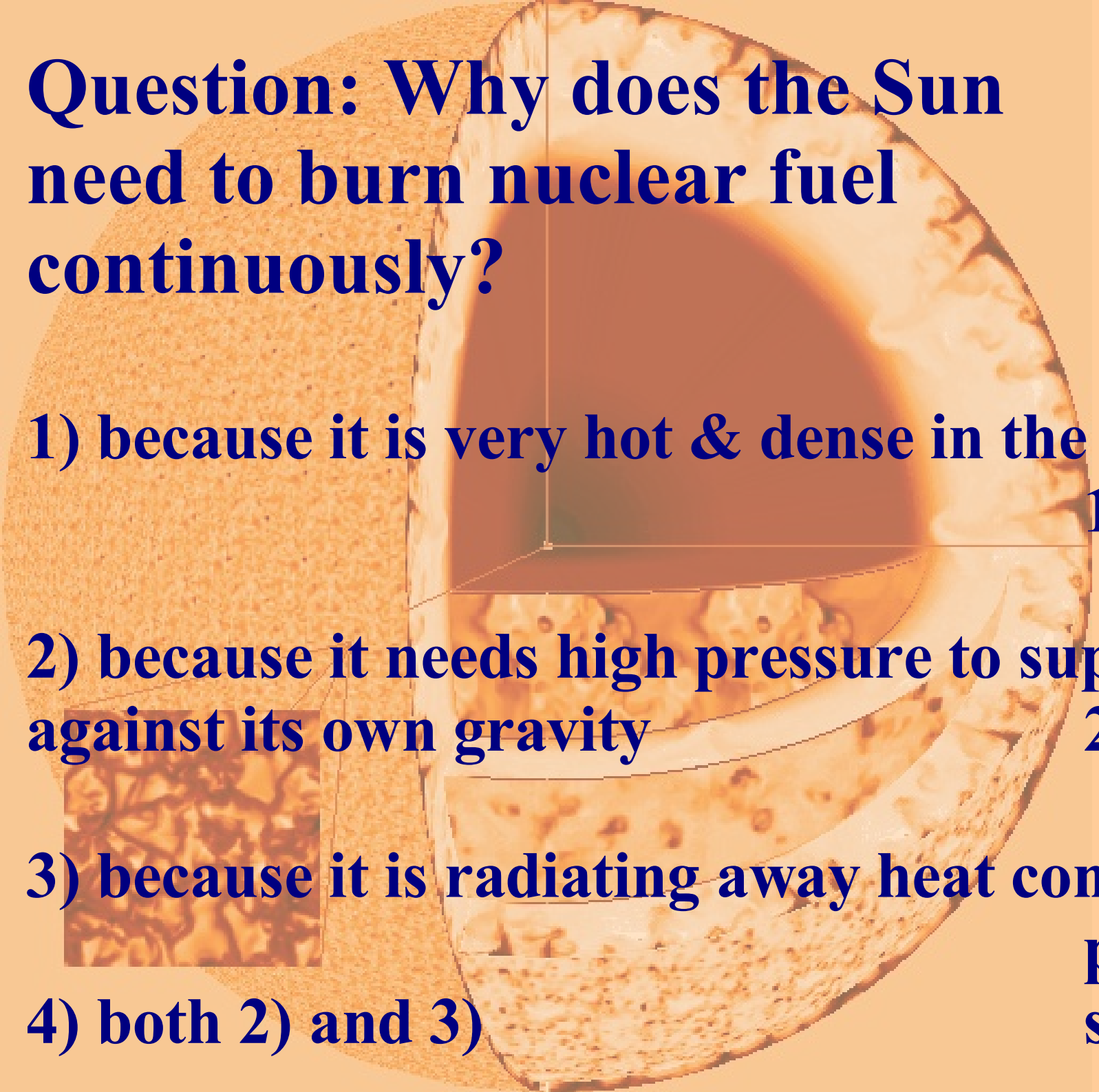
⇒ will loose energy

⇒ need energy source

nuclear fusion

The Sun has converted ~ 50% of hydrogen in its core into helium (5 Gyrs)

What happens when, in another 5 Gyrs, hydrogen in the core is exhausted?



Question: Why does the Sun need to burn nuclear fuel continuously?

Photosphere:
- 5800 K
- 70% H
- 28% He
- 2% rest

Core:
- 15 million K
- 33% H
- 65% He
- 2% rest

1) because it is very hot & dense in the core.
1-hand up

2) because it needs high pressure to support against its own gravity
2 hands up

3) because it is radiating away heat continuously
pray sign

4) both 2) and 3)
stop sign

The Sun is getting hotter…

- 4 H particles ◊ 1 He particle
  - causes solar core to shrink in size
- fusion rate must increase to maintain *hydrostatic balance*
- solar core gets gradually hotter
- the Sun is about 30 percent hotter now than it was 4.6 billion years ago

Stars:

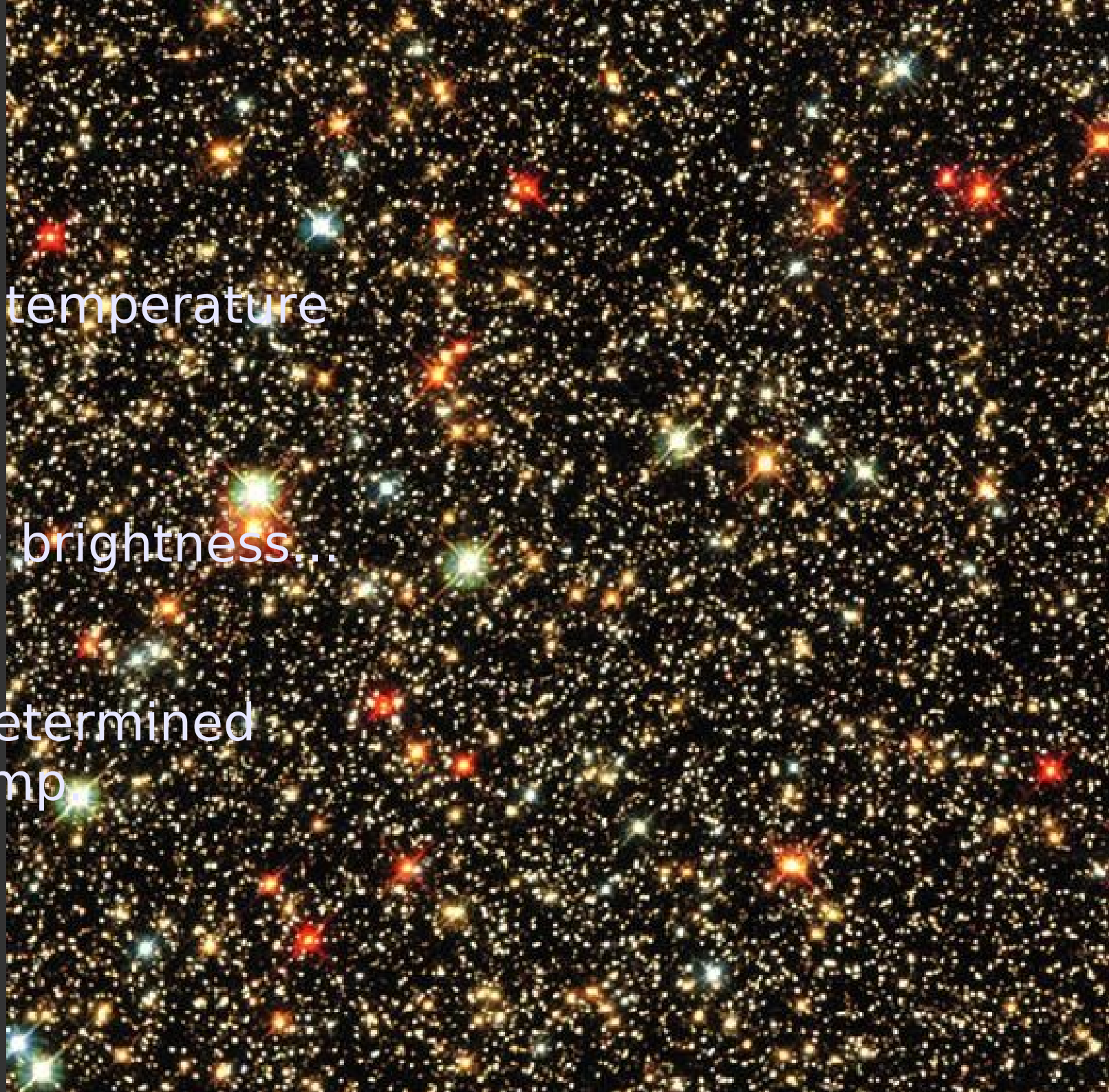
differ

... in surface temperature

... in size

... in intrinsic brightness...

brightness determined
by size & Temp.

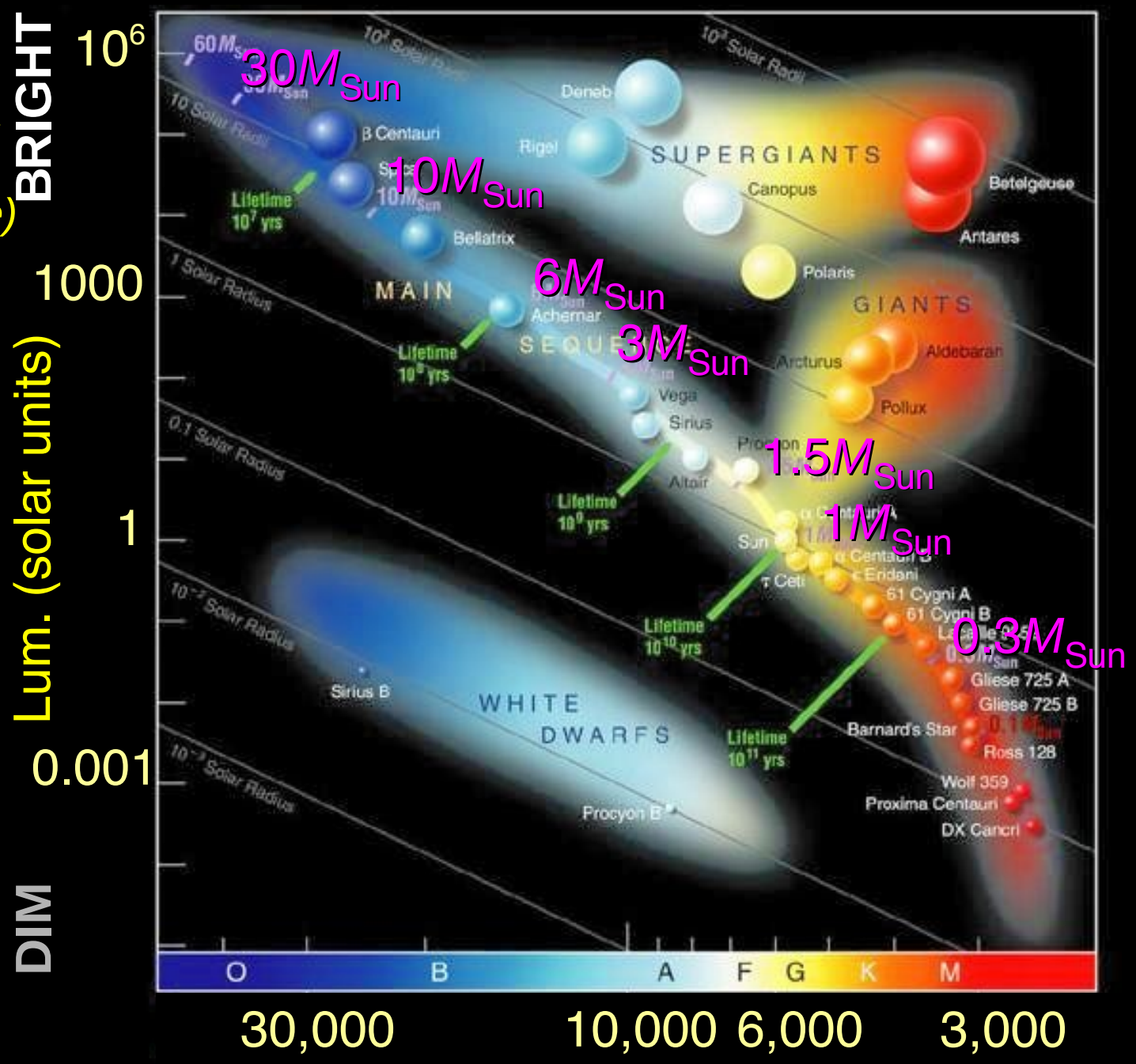


Hertzsprung-Russel Diagram

Along the **Main Sequence** *(stage in life where star burns hydrogen into helium in its core)*

Hotter, Brighter
⇒ More Massive

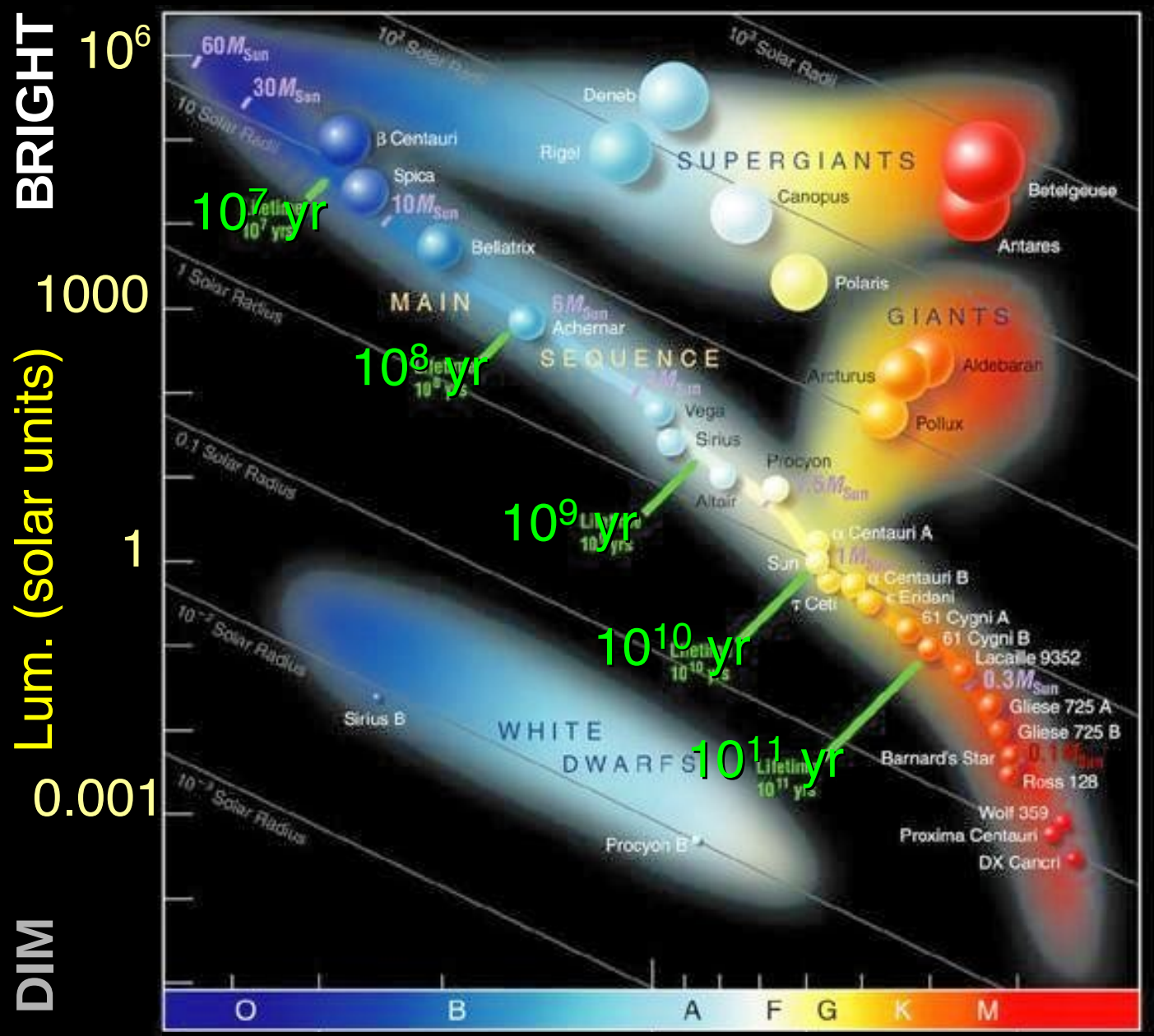
Cooler, Dimmer
⇒ Less Massive



Hertzsprung-Russel Diagram

Along the Main Sequence:

More Massive
⇒ Much Brighter
⇒ Burns Faster
⇒ Lives Shorter

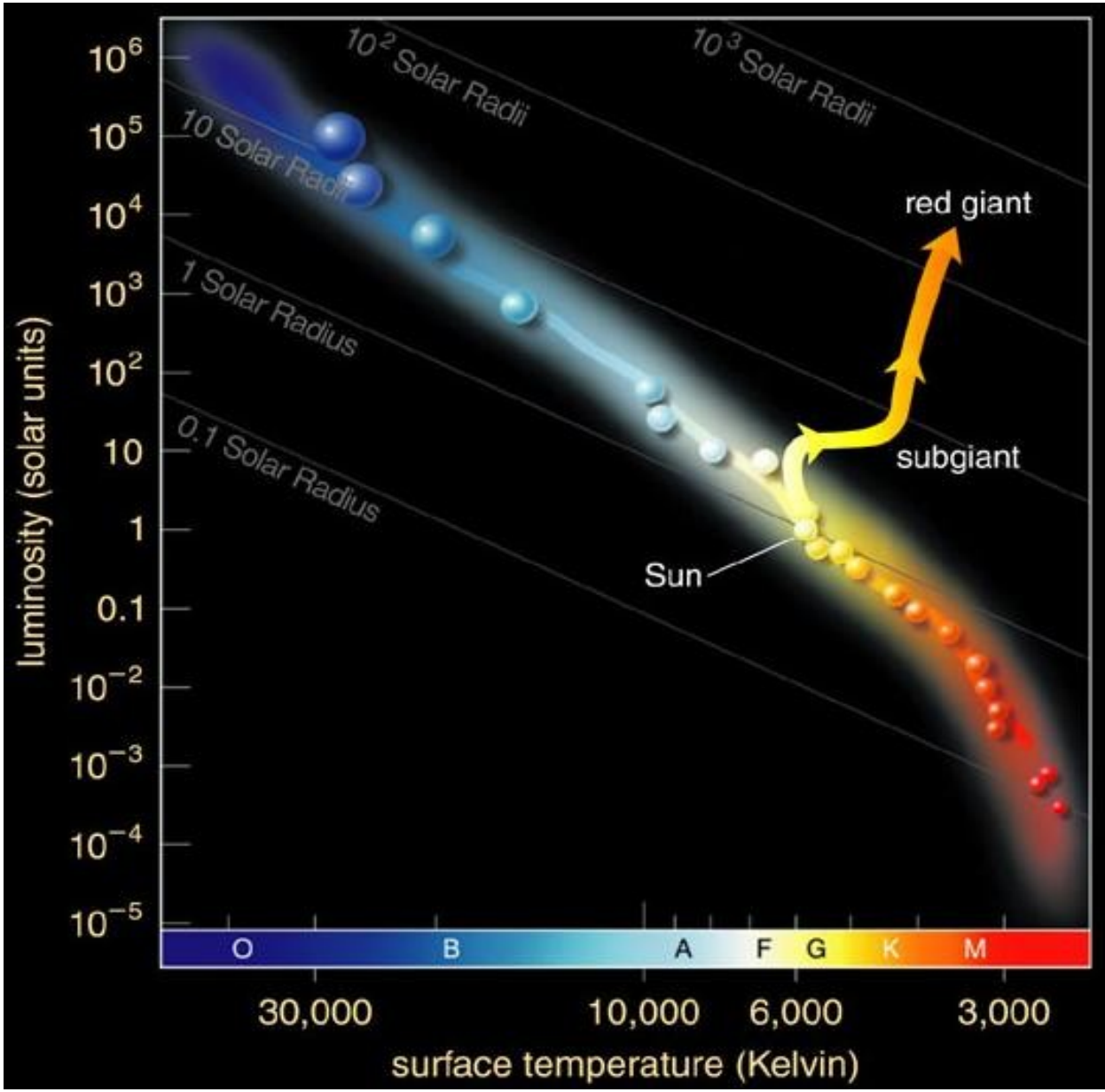


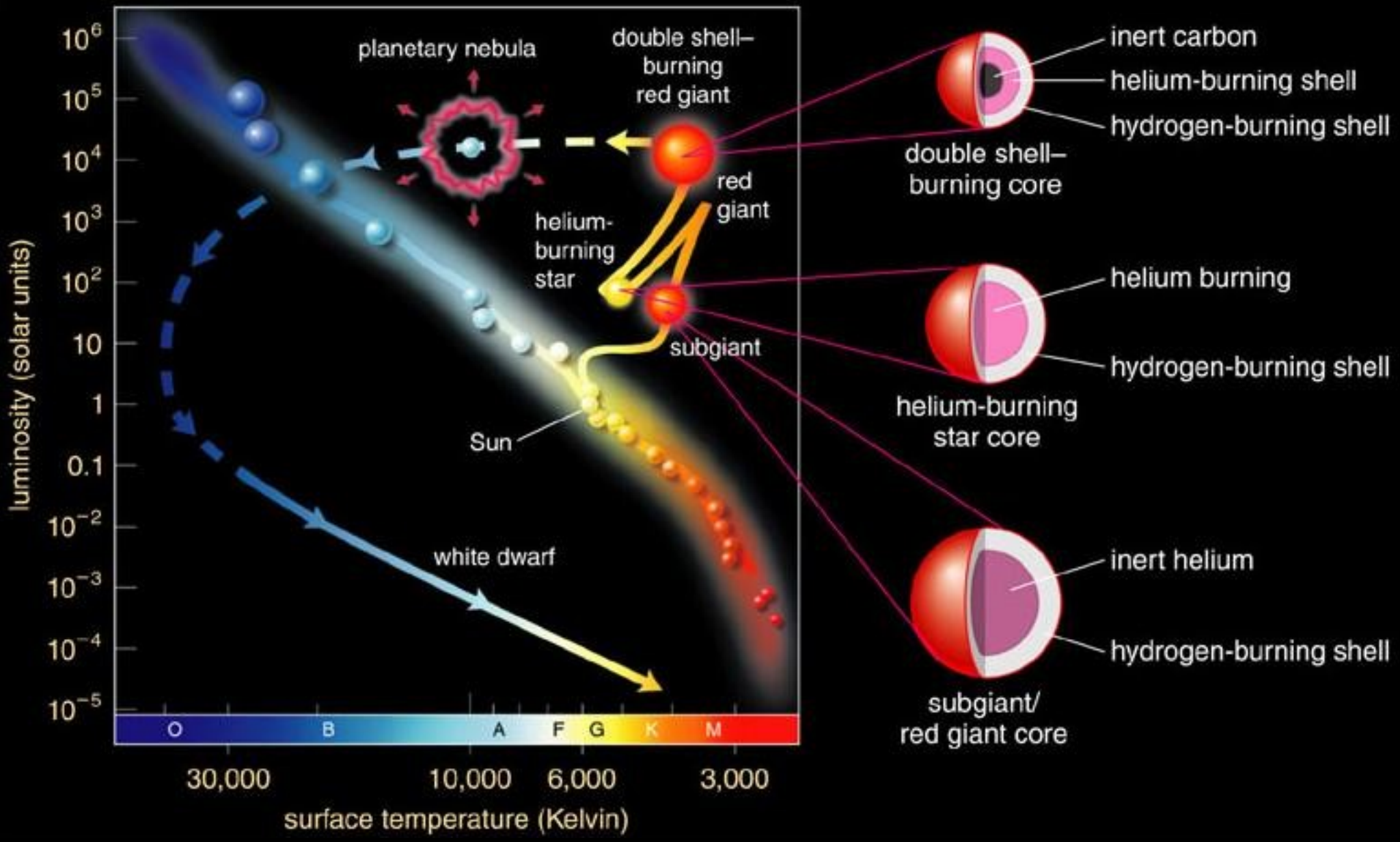
At the end of the Sun's main-sequence life, its center becomes so hot it can start fusing helium into carbon and oxygen...

this gives enormous power output and the Sun becomes a GIANT.

the Sun spends a few hundred million years being a GIANT, visible to the end of the Galaxy

but the end is close...

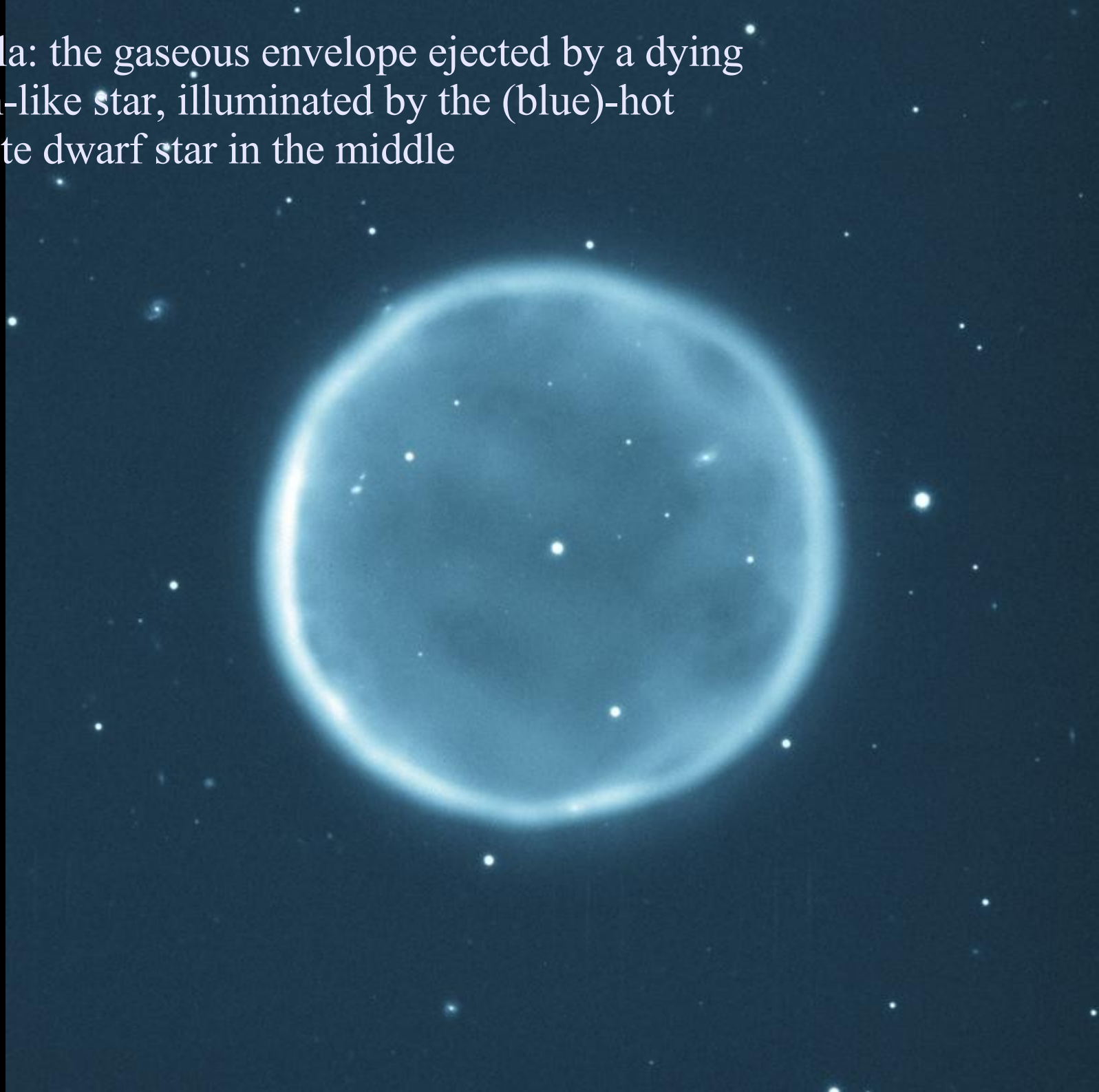




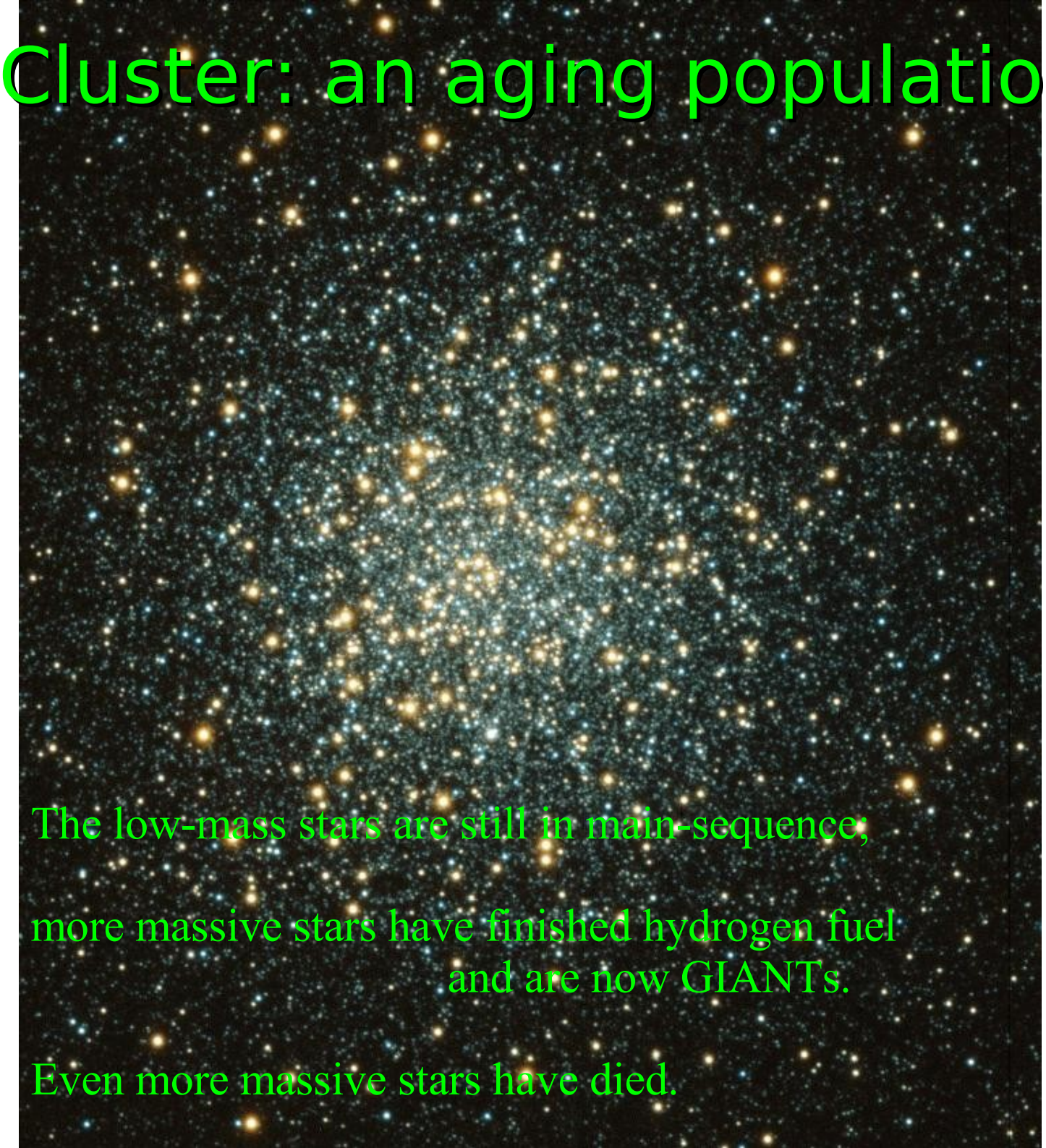
At some point, all burnable fuel is burned.
And the Sun dies in a boom.

Planetary nebula: the gaseous envelope ejected by a dying Sun-like star, illuminated by the (blue)-hot white dwarf star in the middle

Abell 39



Star Cluster: an aging population

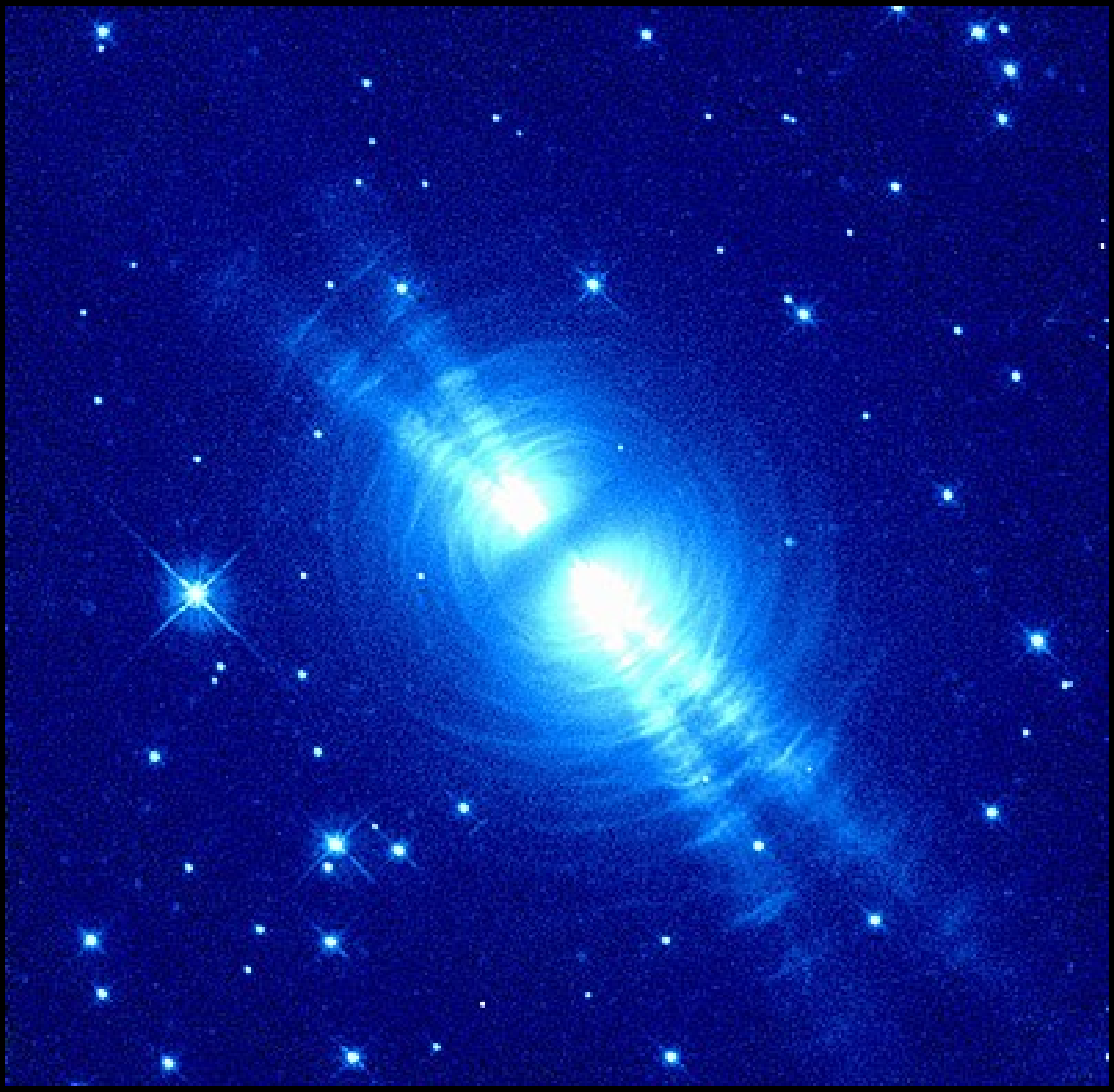


The low-mass stars are still in main-sequence;

more massive stars have finished hydrogen fuel
and are now GIANTs.

Even more massive stars have died.

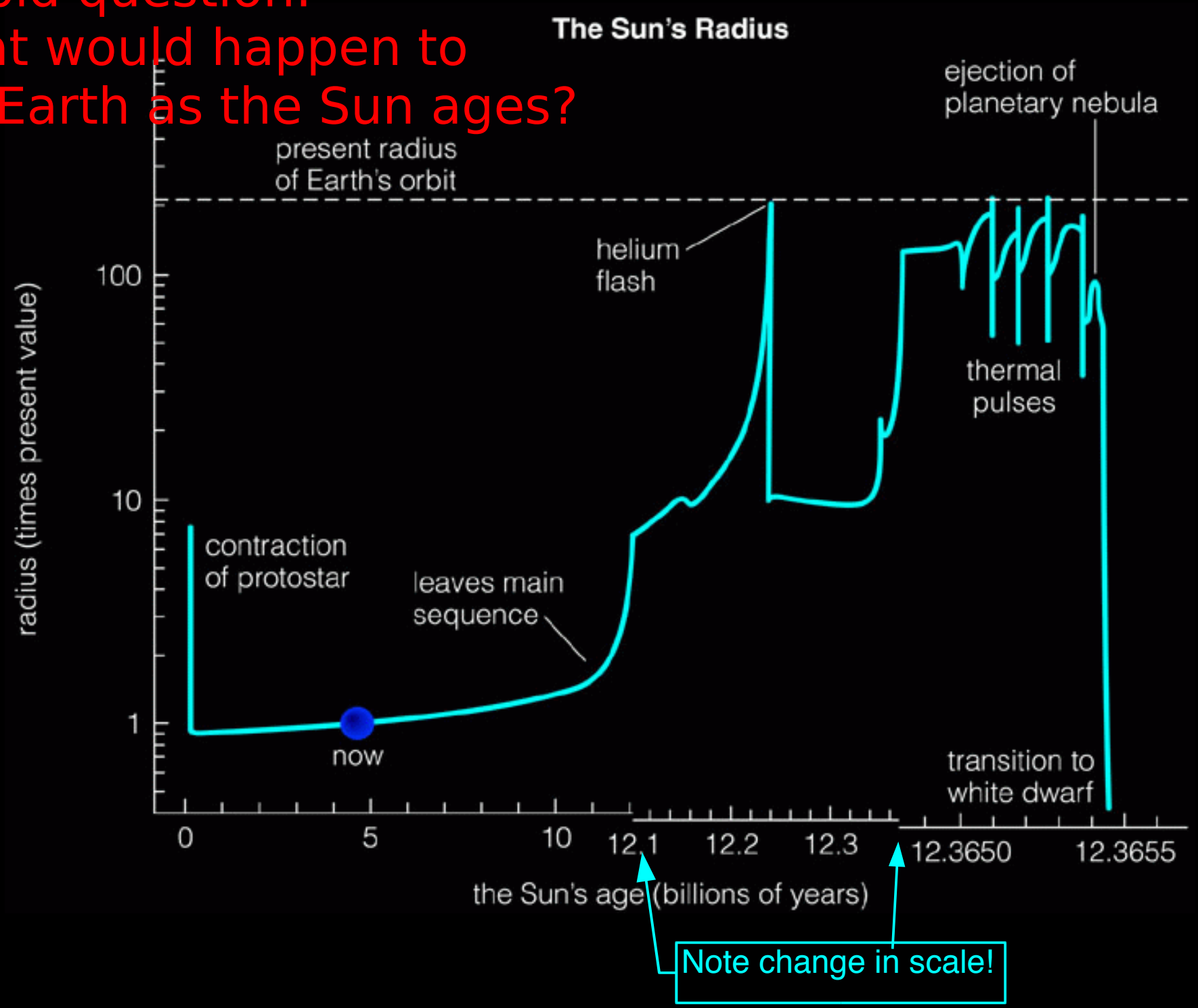
Planetary Nebulae

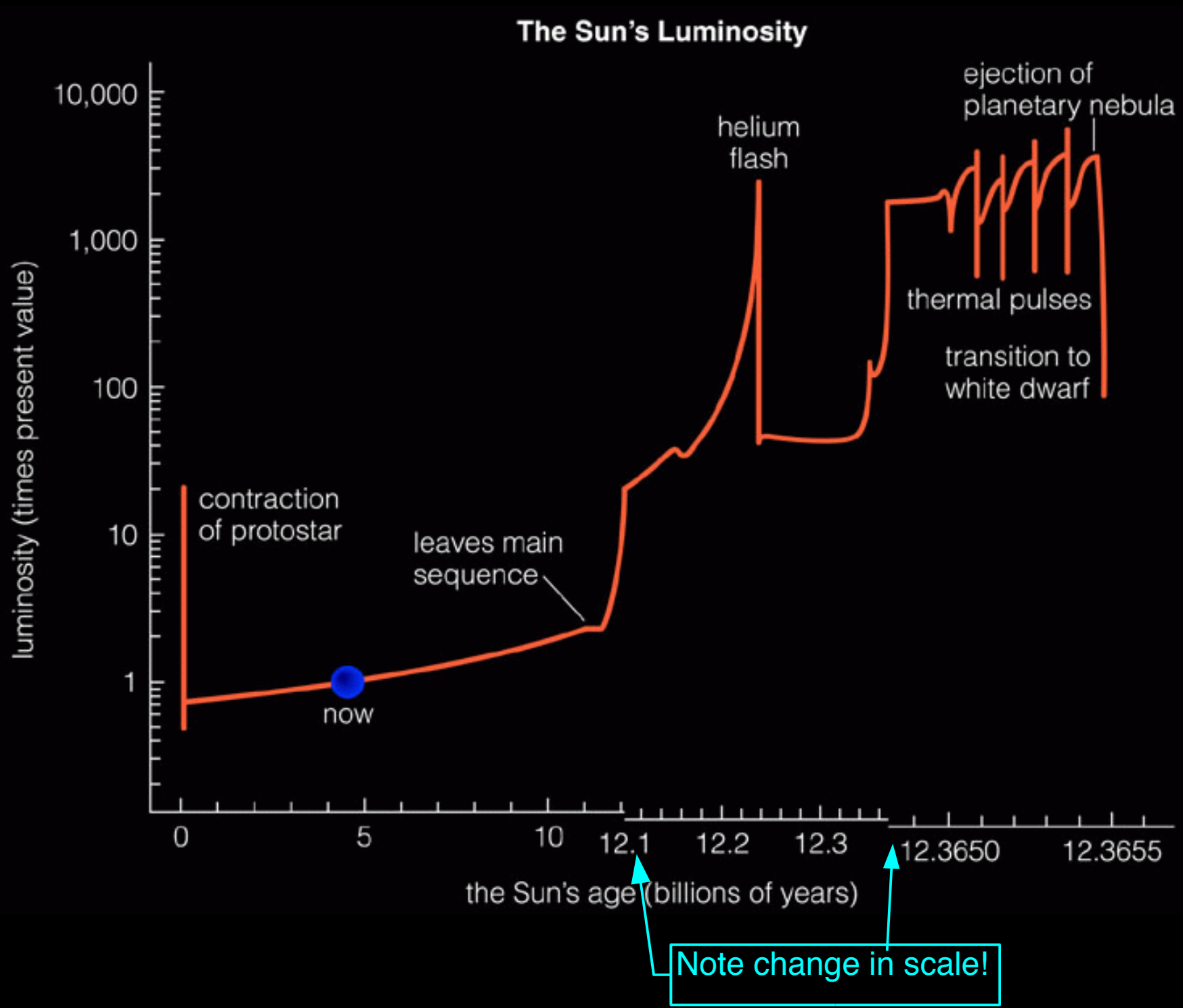


Planetary Nebulae

Planetary Nebulae

A morbid question:
What would happen to the Earth as the Sun ages?




The Sun's Luminosity
10,000
1,000
100
10
1
luminosity (times present value)
ejection of
planetary nebula
helium
flash
thermal pulses
transition to
white dwarf
contraction
of protostar
leaves main
sequence
now
0
5
10
12.1
12.2
12.3
12.3650
12.3655
the Sun's age (billions of years)
Note change in scale!