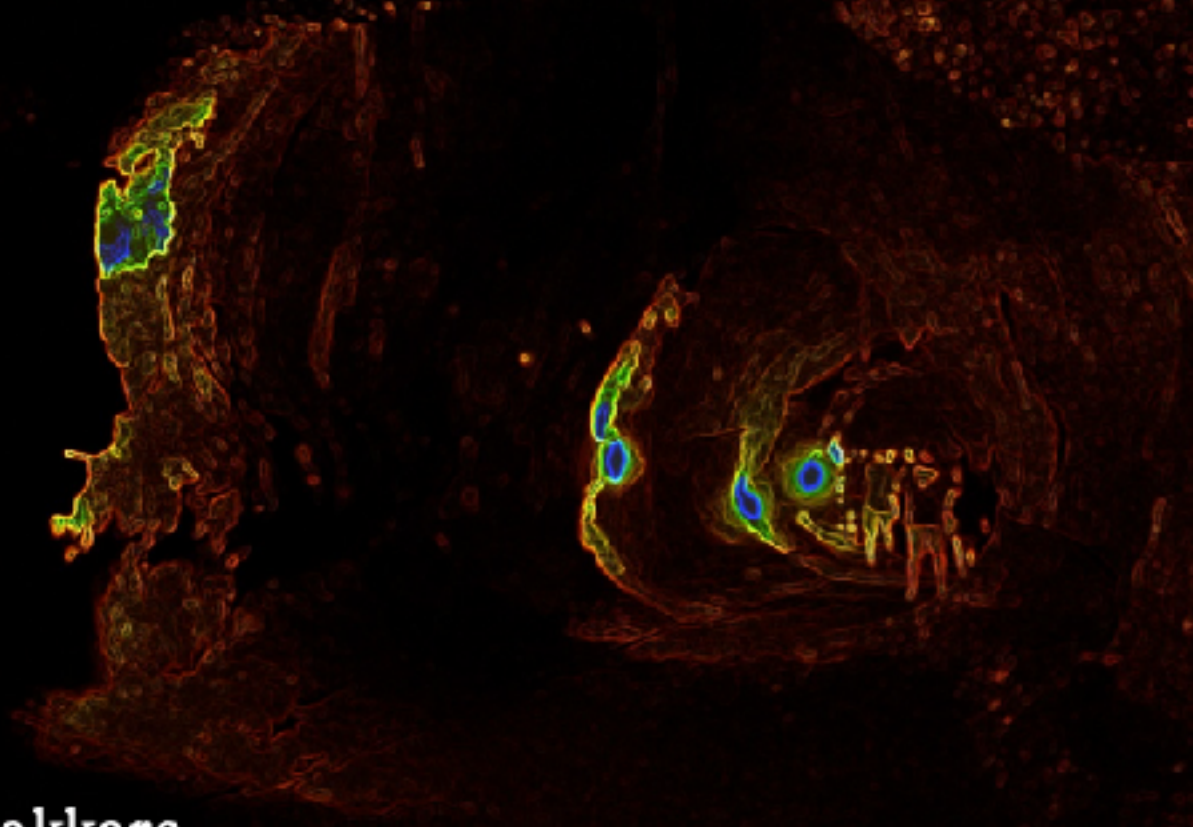
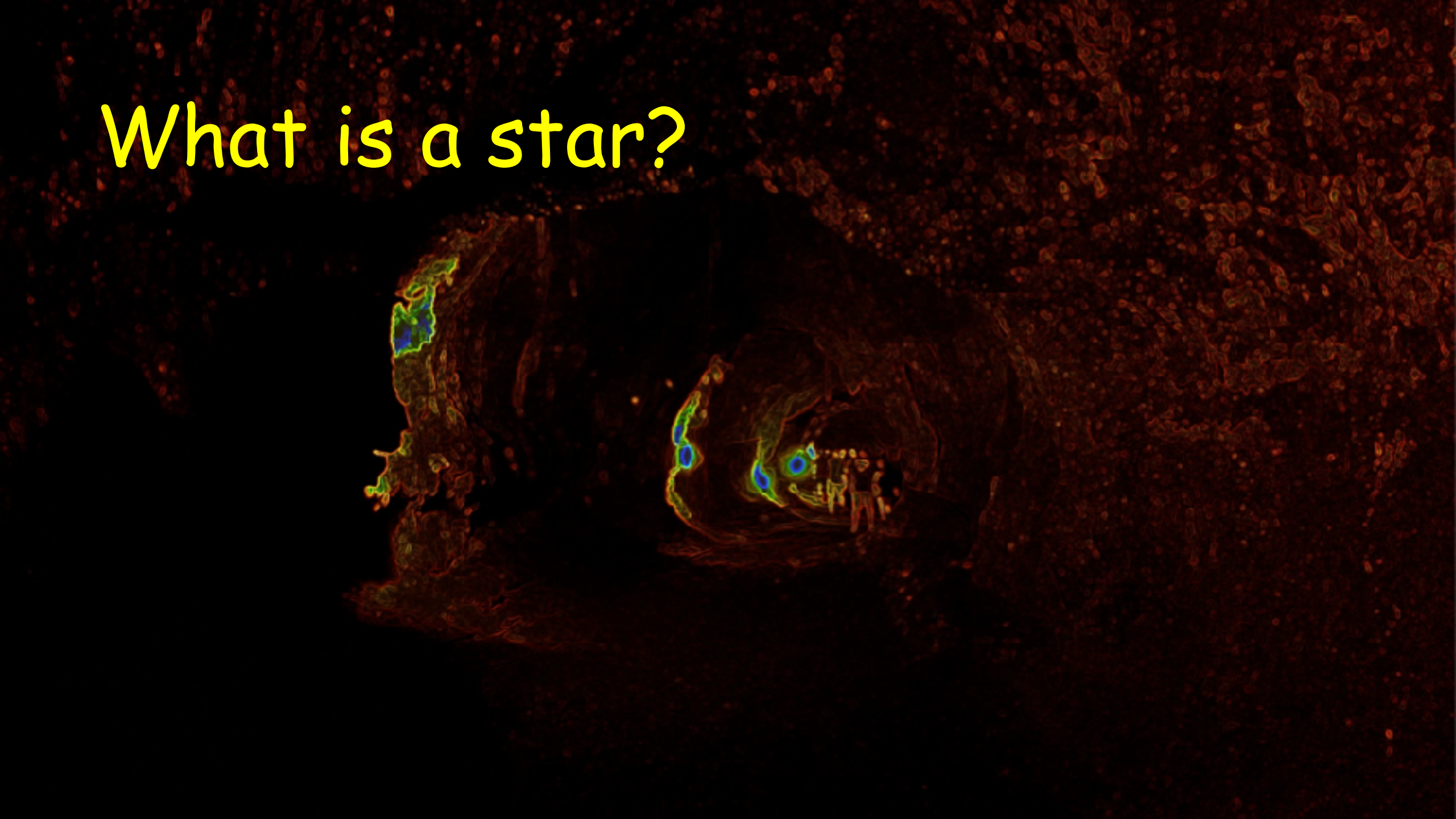
The journey of a star



Themiya Nanayakkara
@themiyan

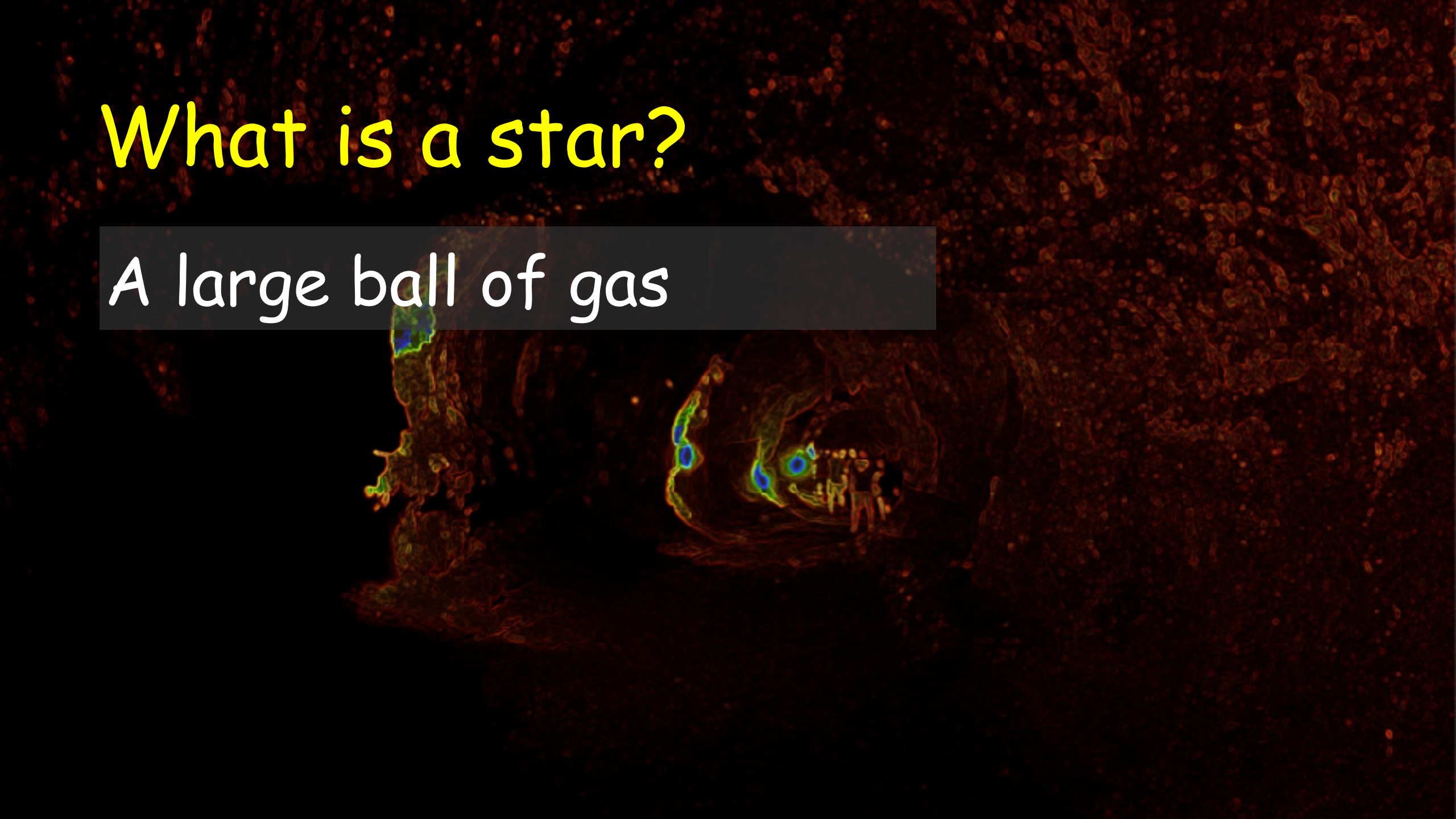
Sterrewacht Leiden

What is a star?



What is a star?

A large ball of gas



What is a star?

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- Mostly made out of Hydrogen and Helium

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- Comes in order of billions in each galaxy

What is a star?

A large ball of gas

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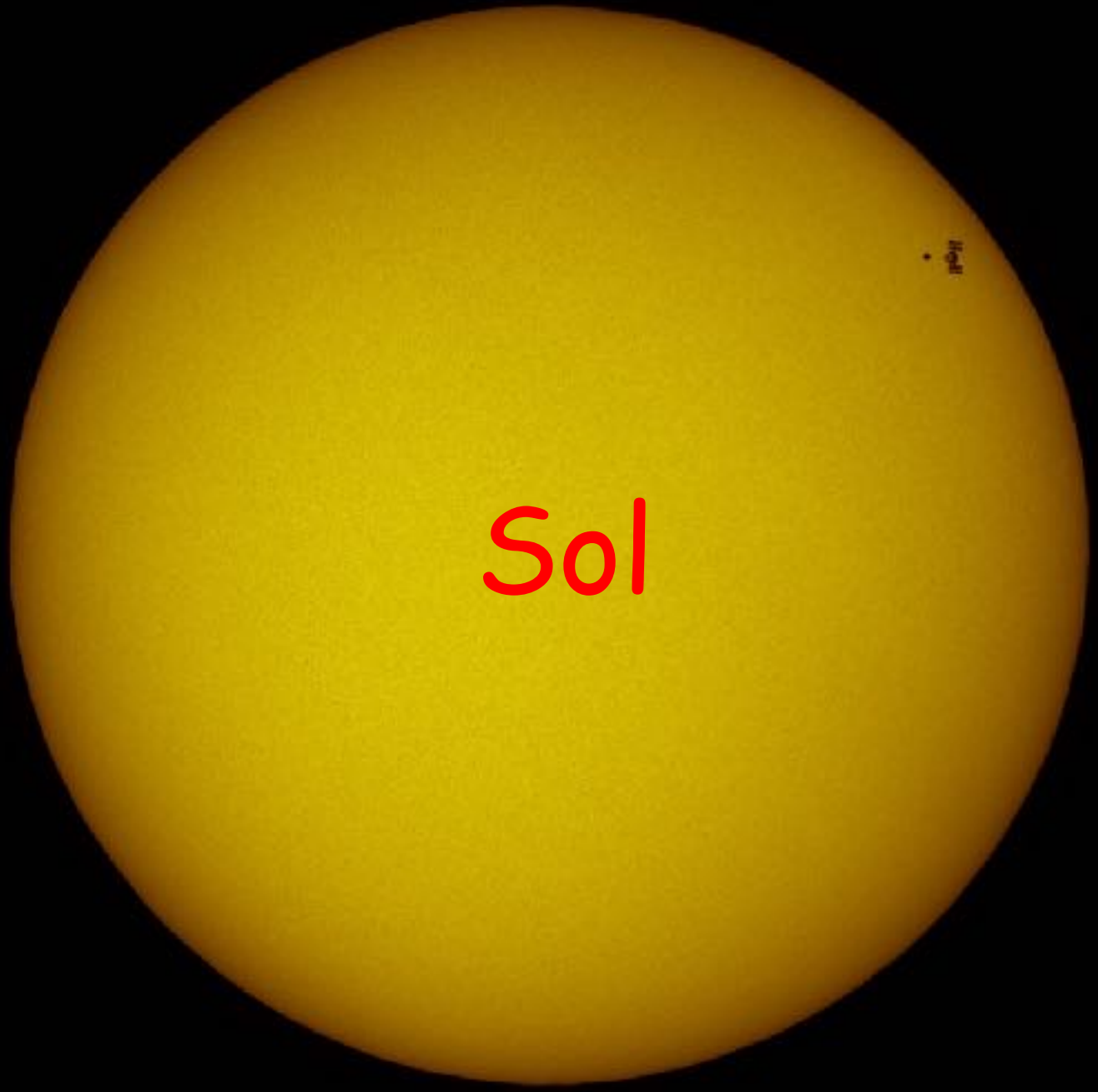
So what is the closest star to us?

Sun or …?

Sun or …?



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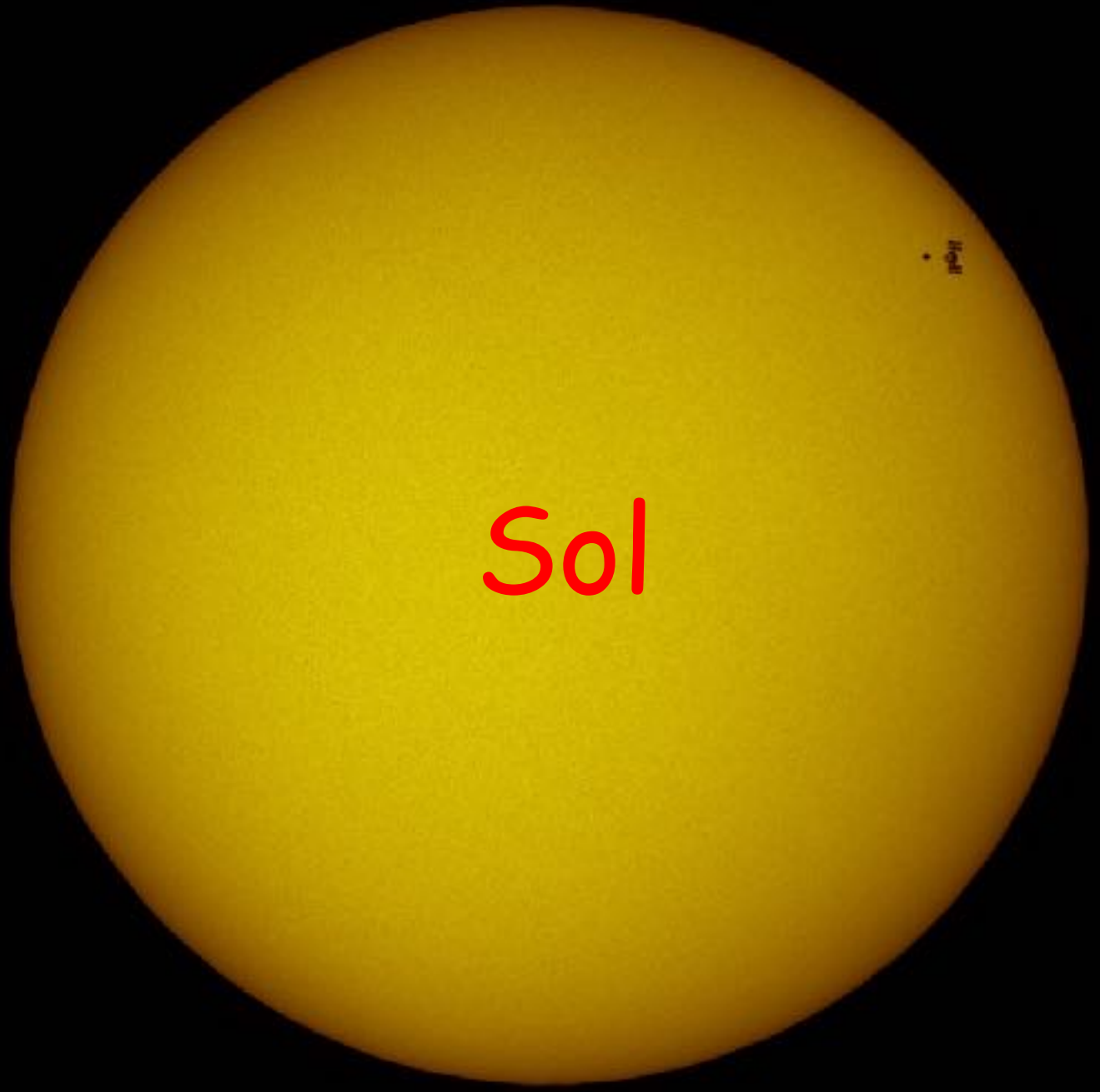

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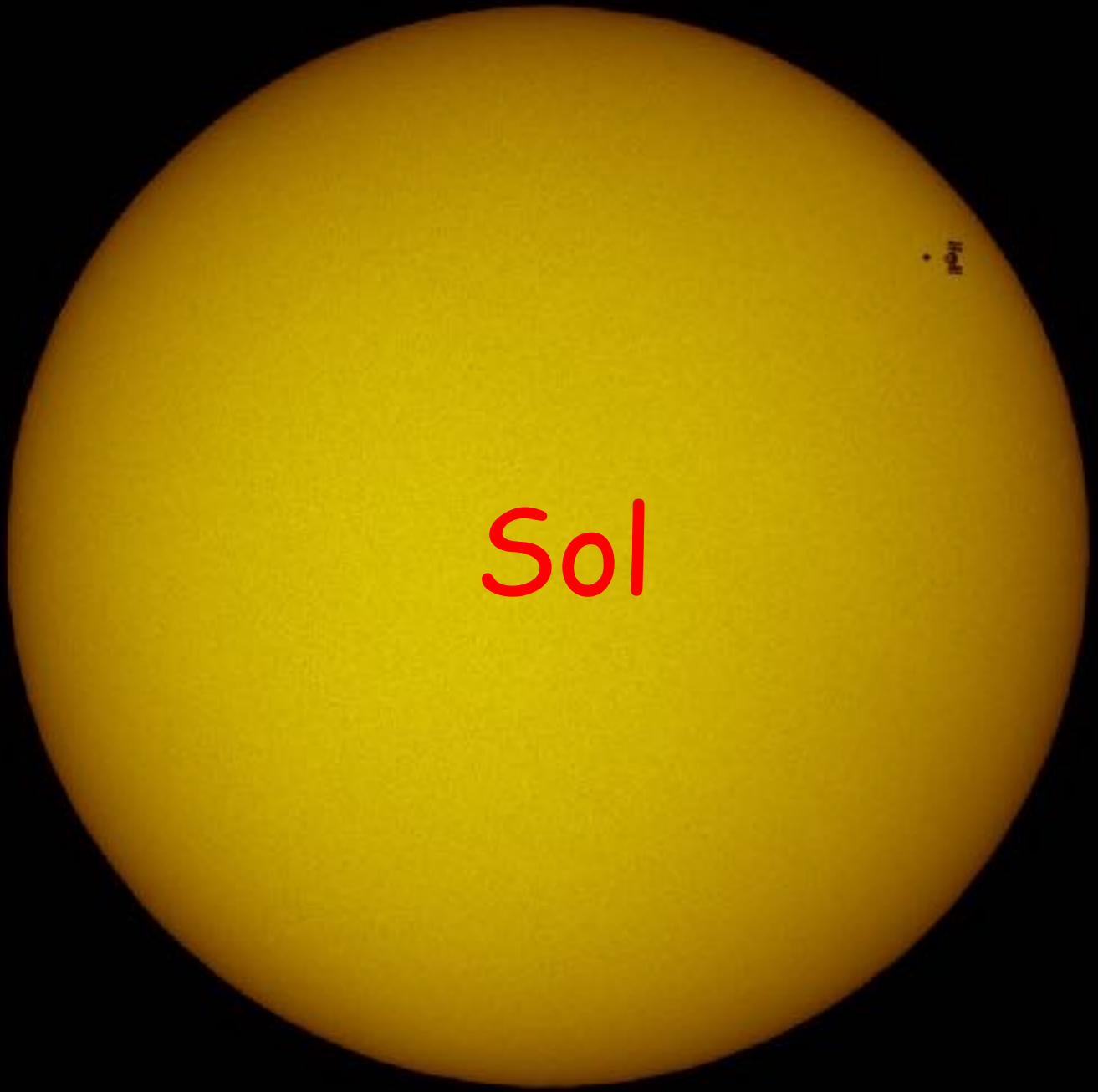

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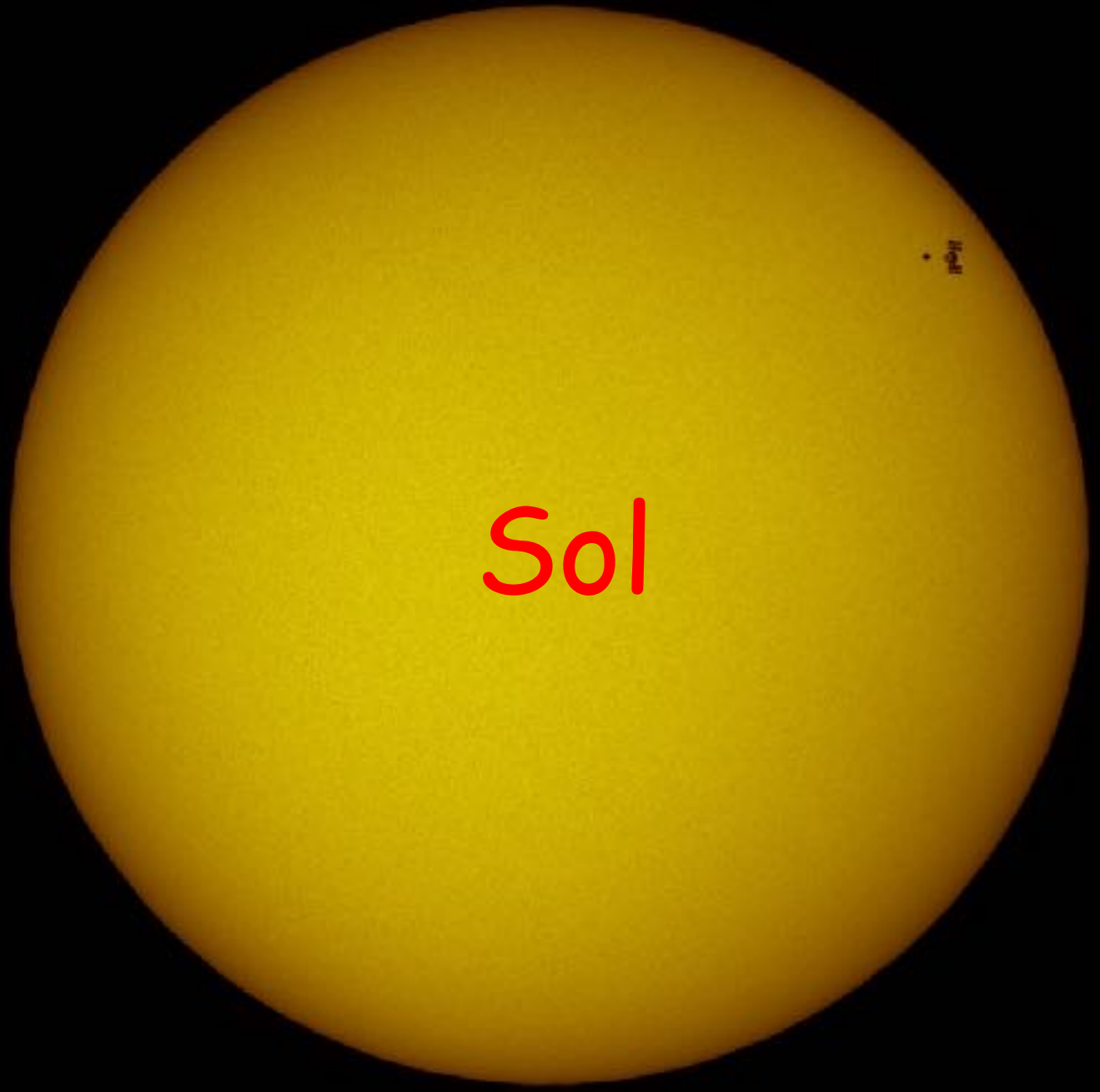

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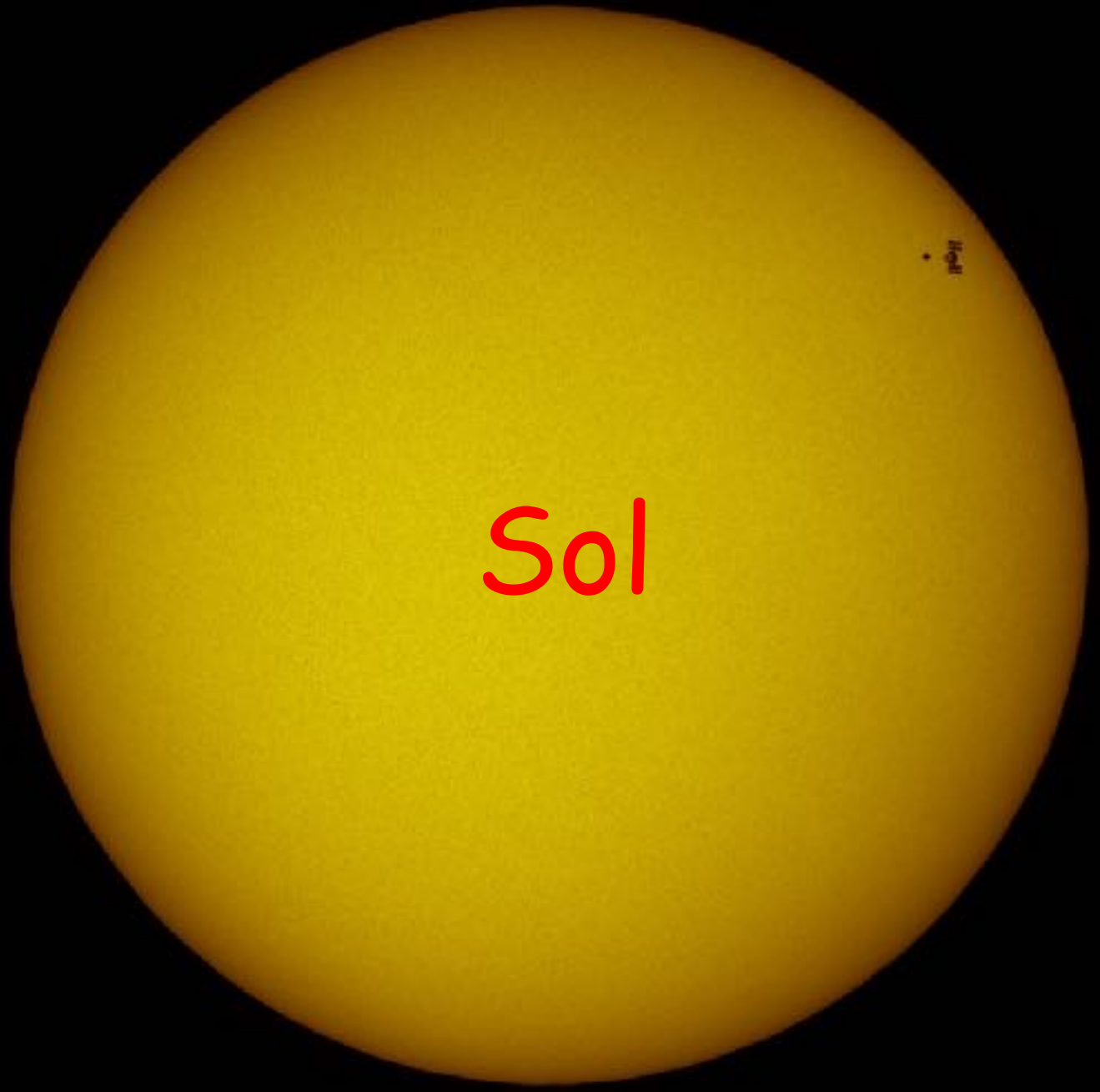

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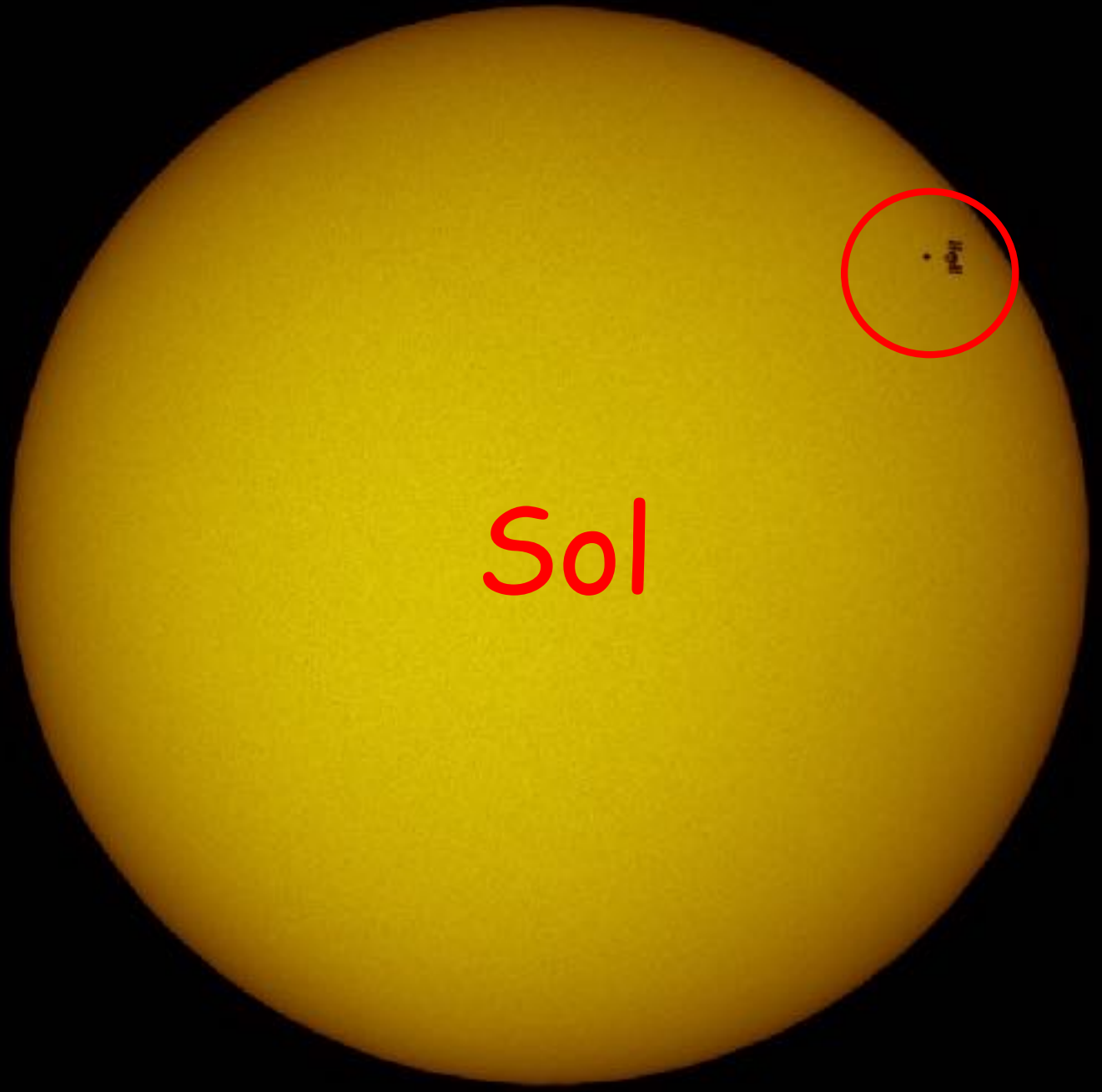

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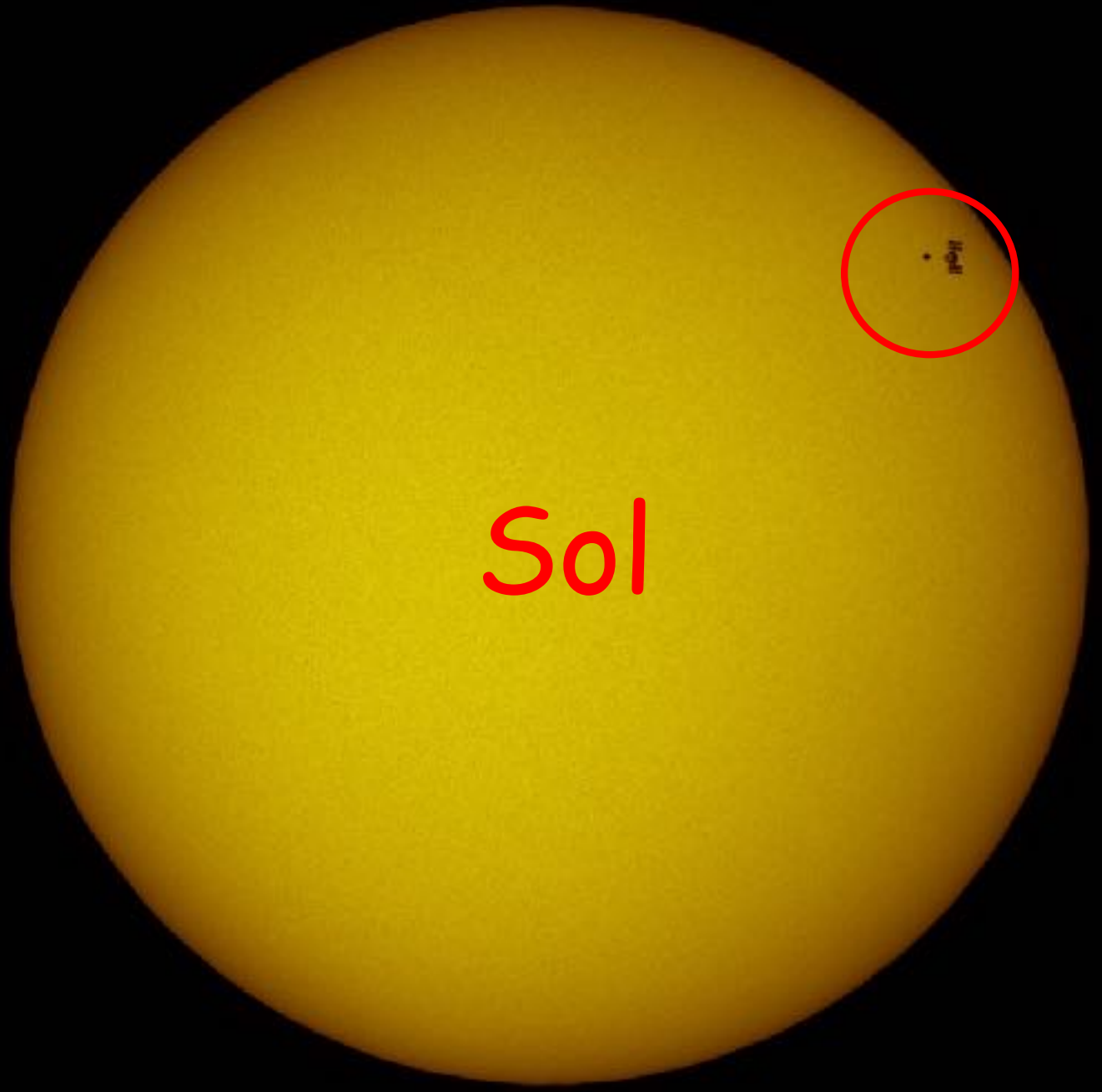
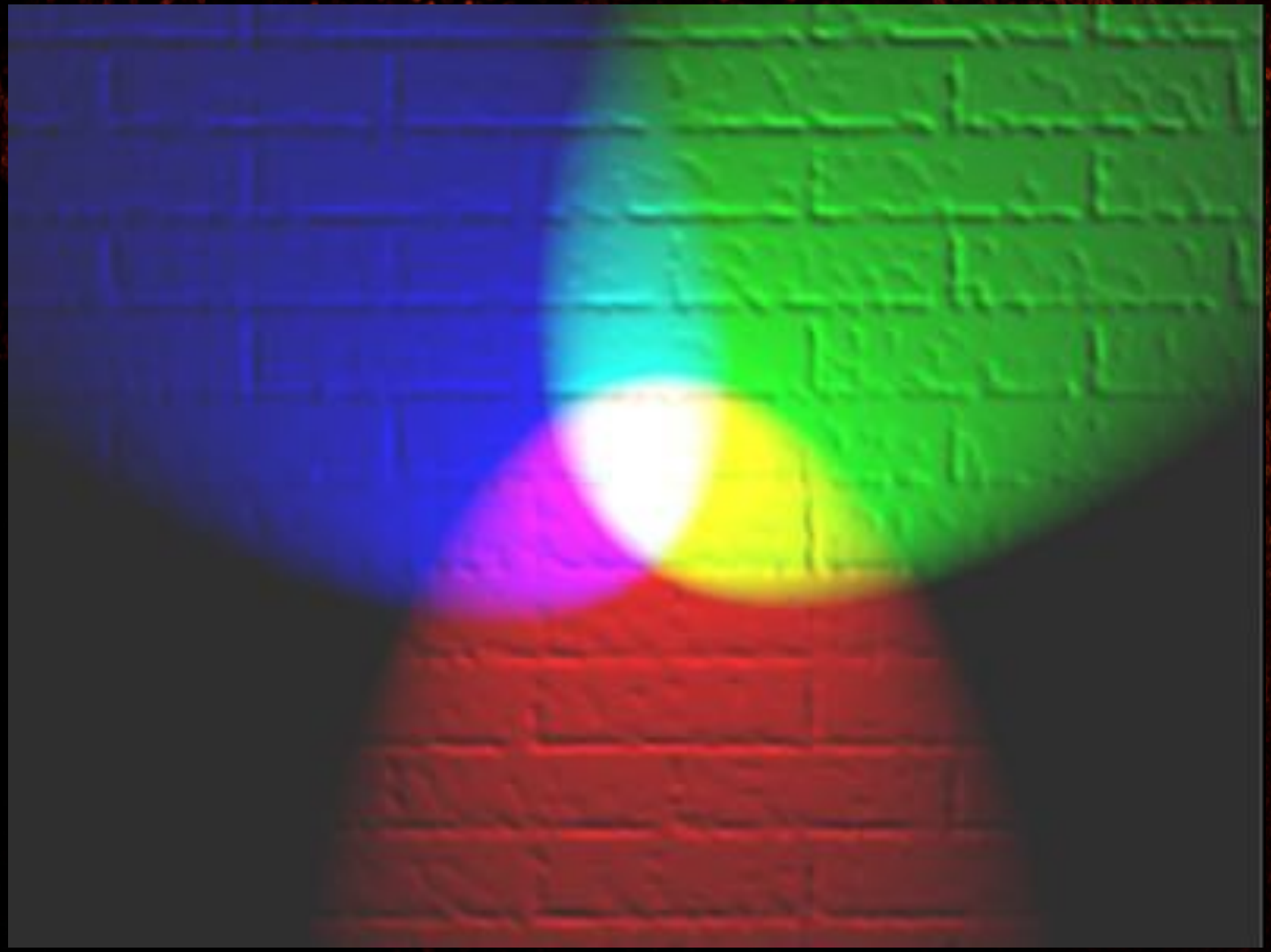
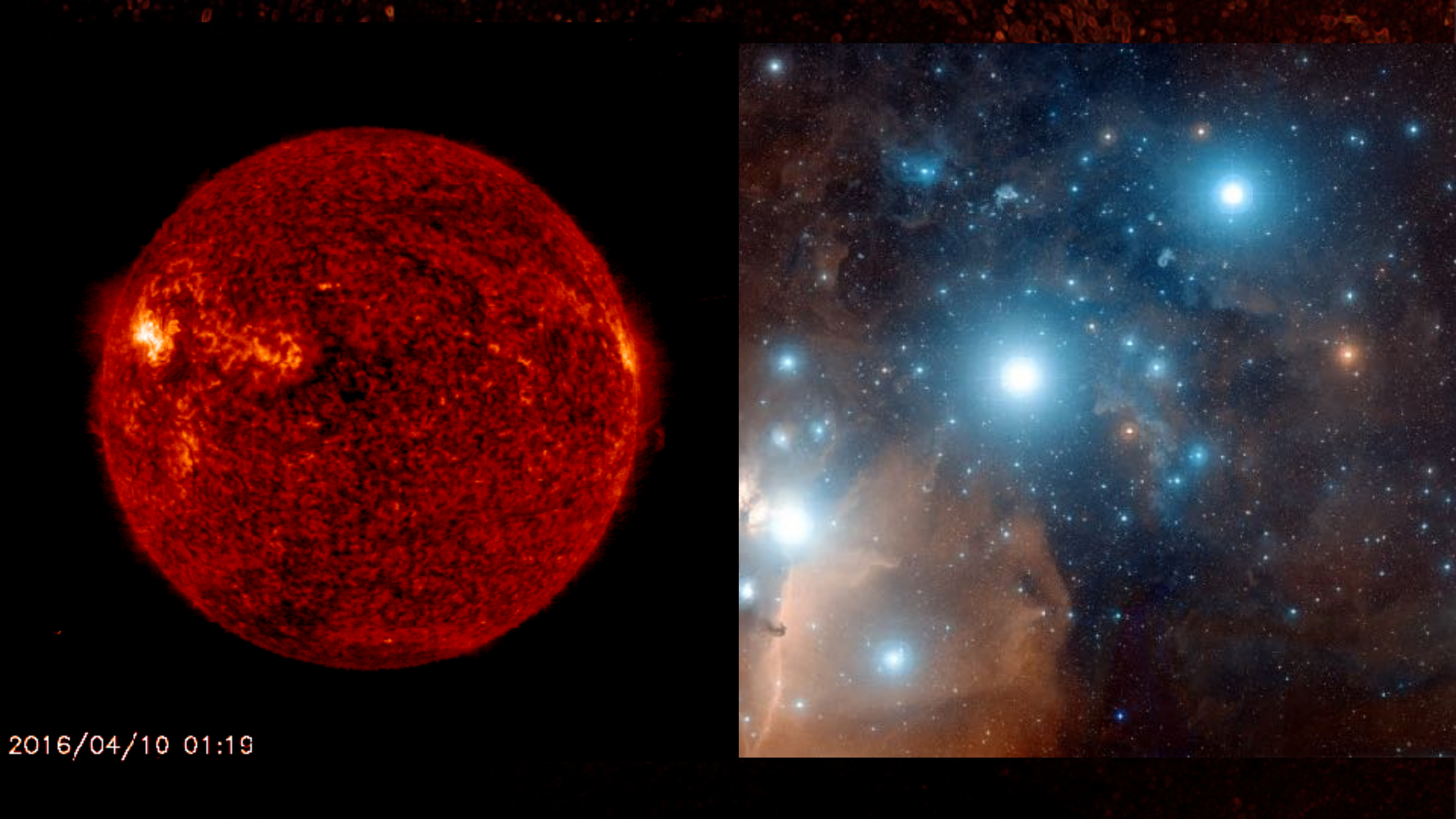
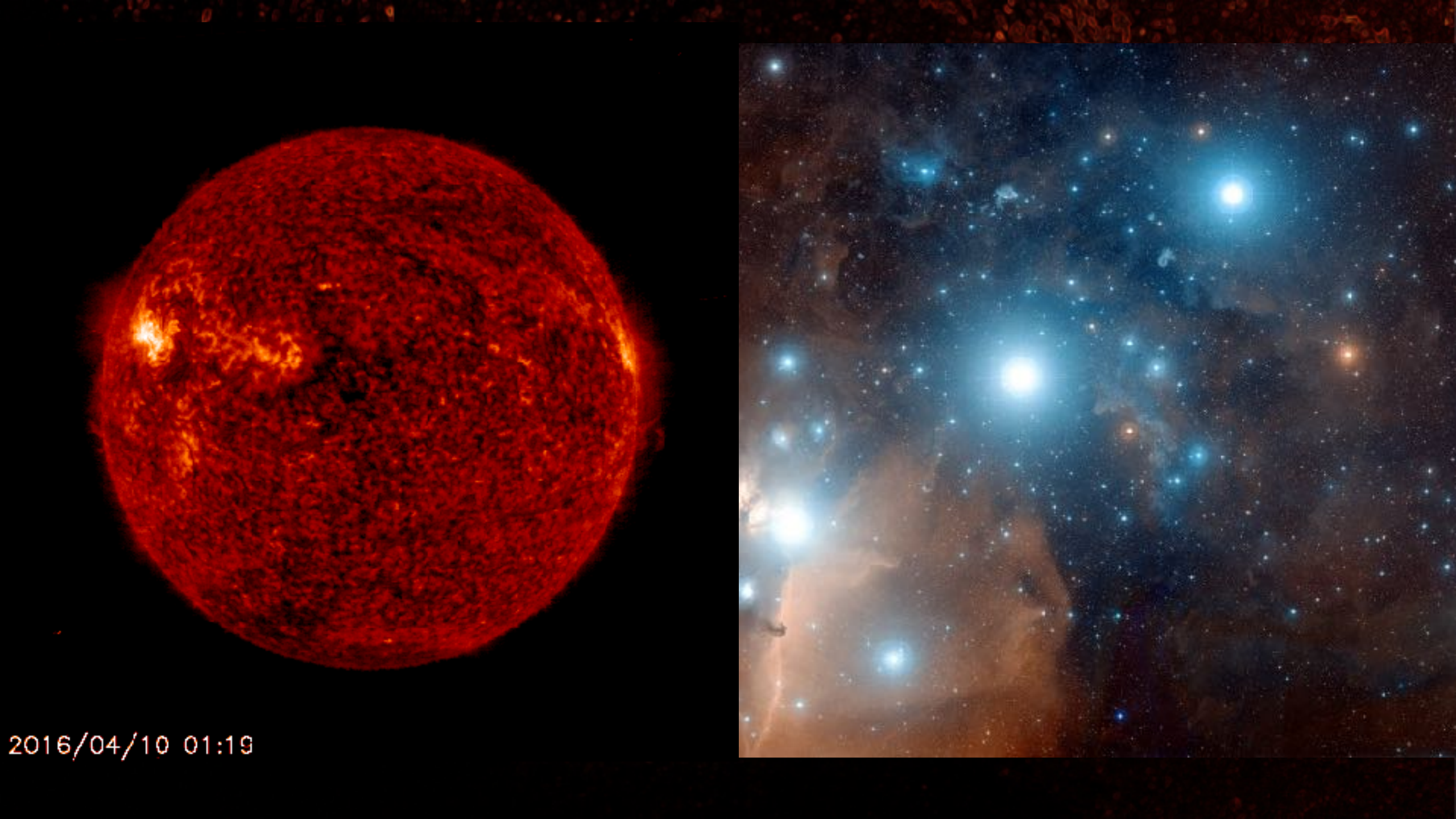
- Is the sun yellow or white?






2016/04/10 01:19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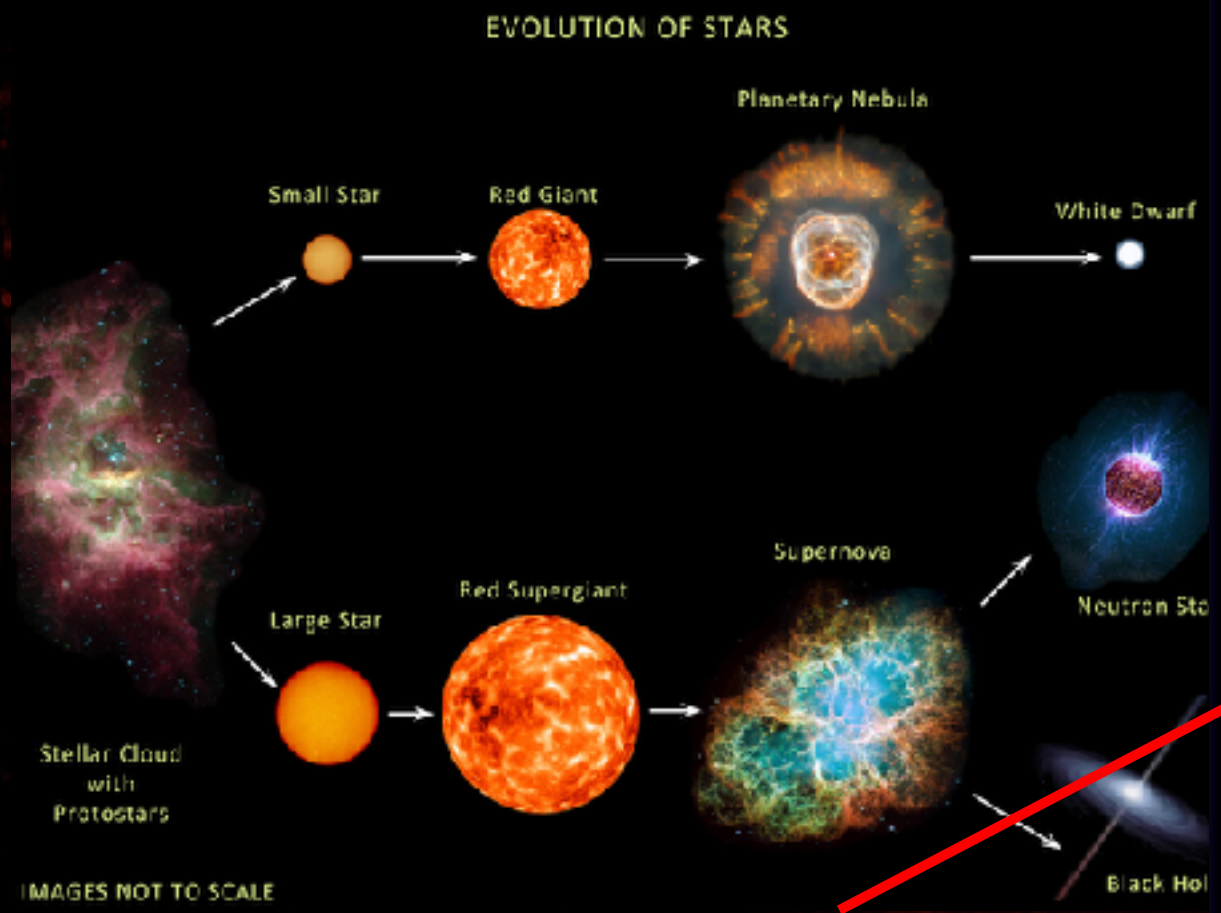
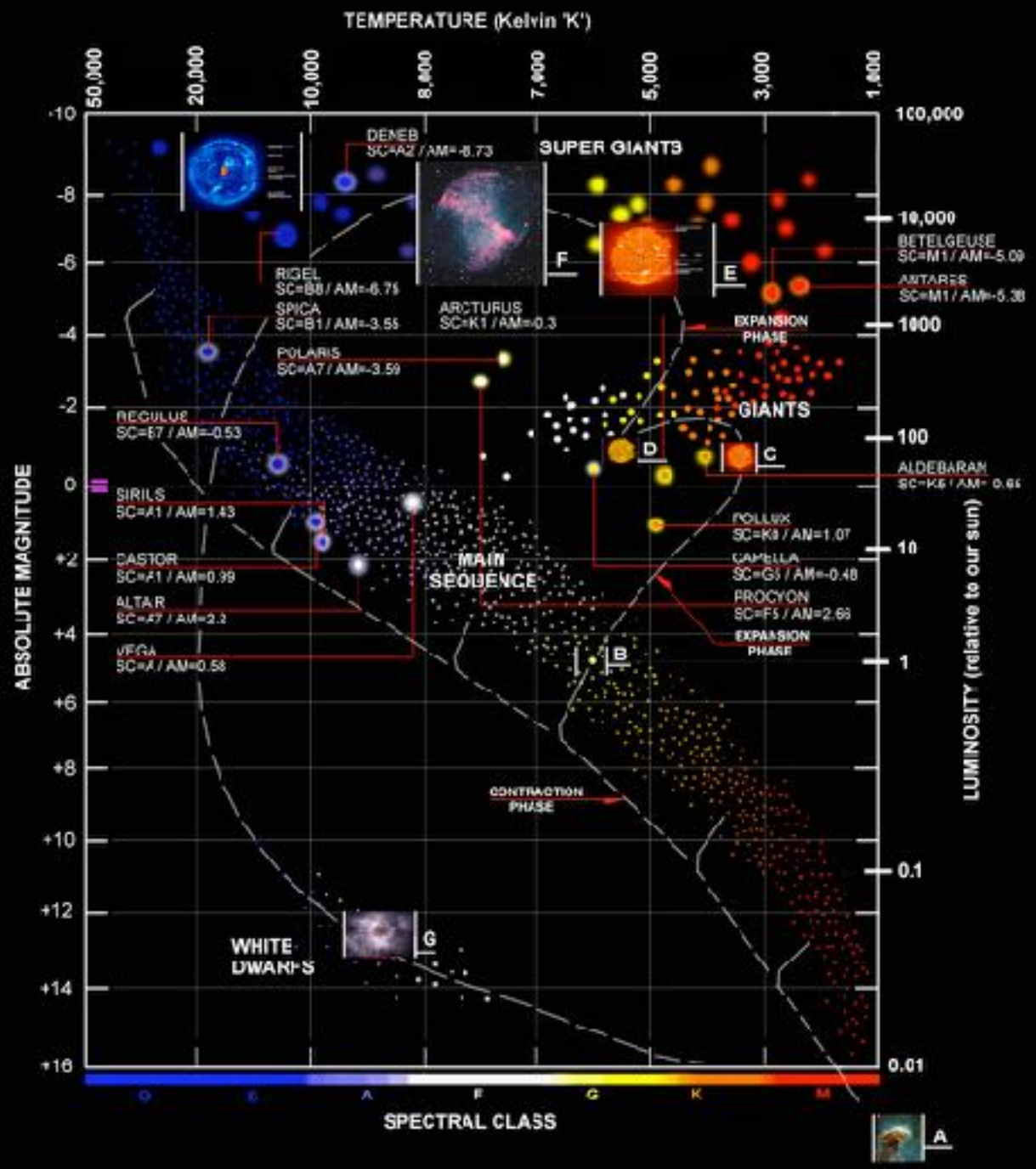
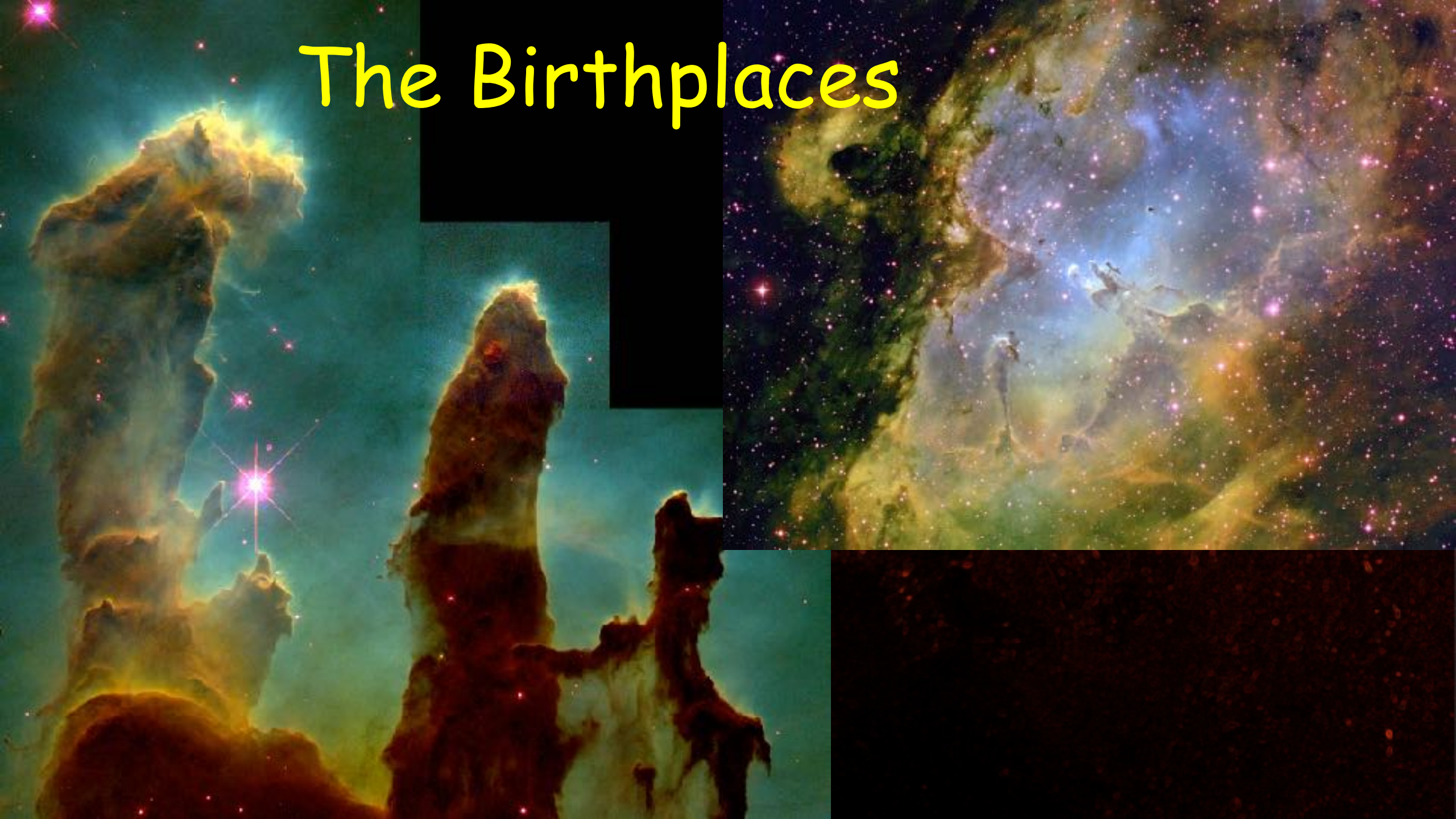
Life of a star





Lets decrypt this

The Birthplaces

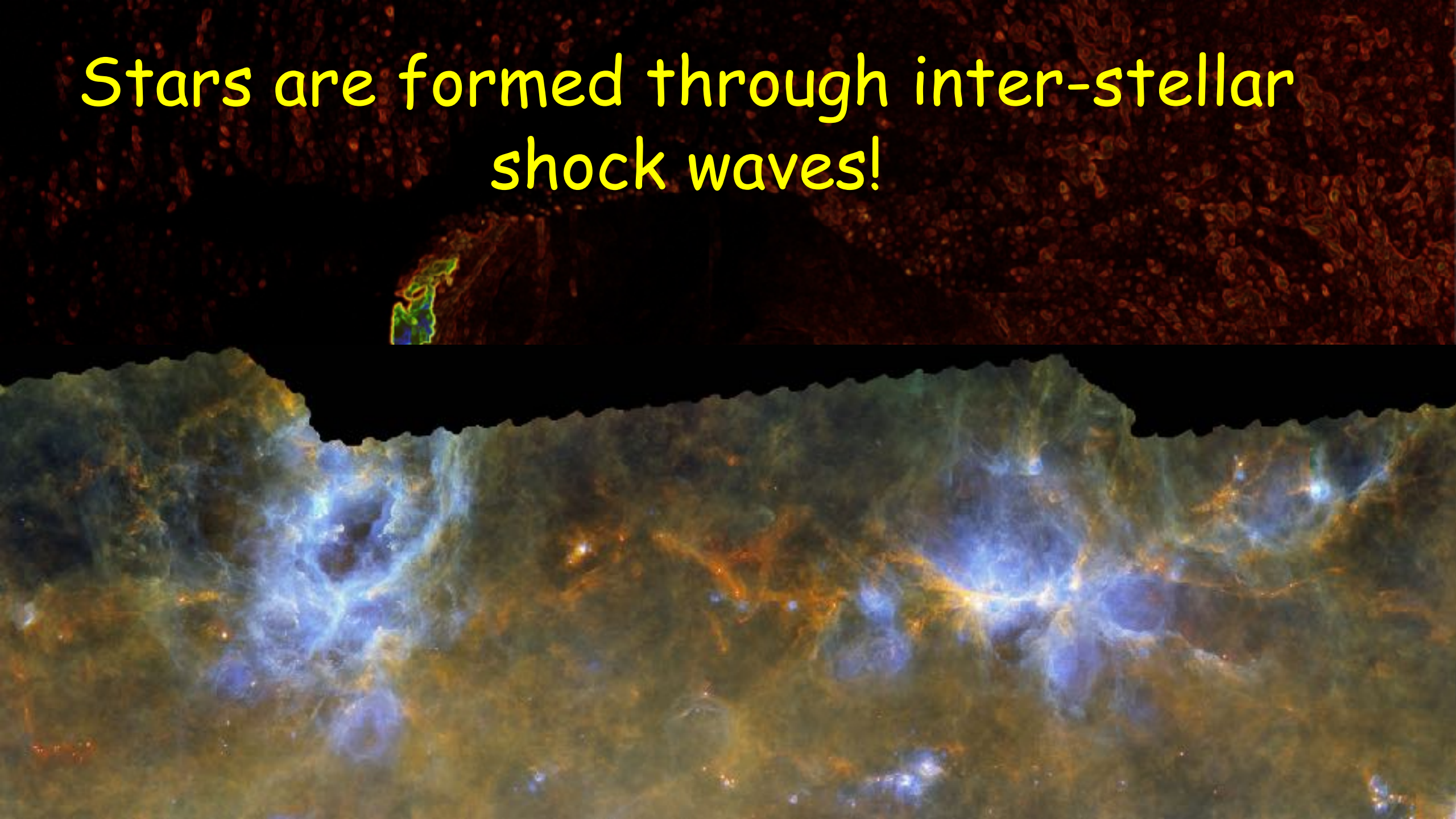


The Birthplaces

Formed in molecular clouds

- Masses from few 10-millions of solar masses
- ~70% H_2
- ~28% He
- ~2%-> metals (O, C, Ne, N…)

Stars are formed through inter-stellar shock waves!



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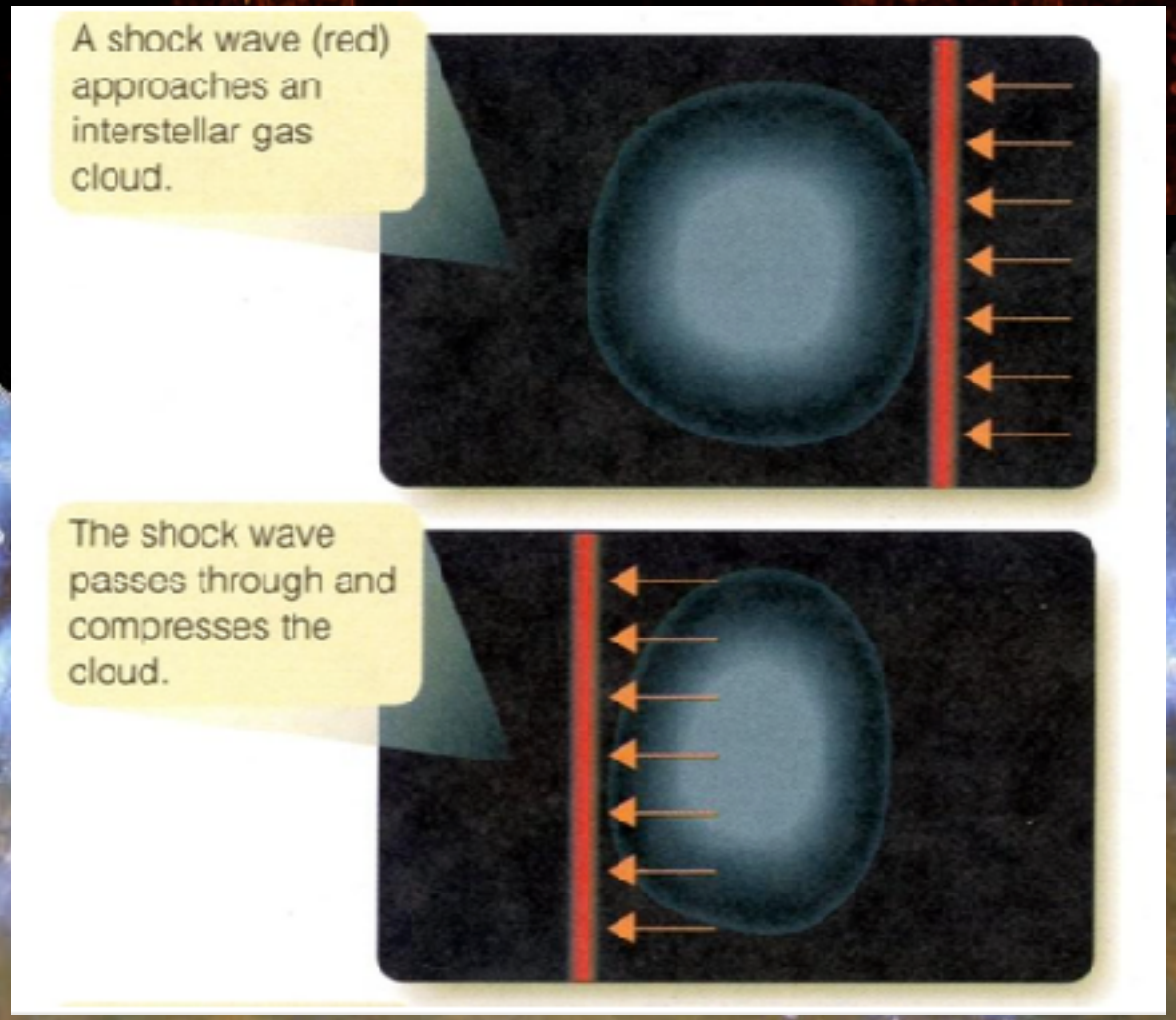

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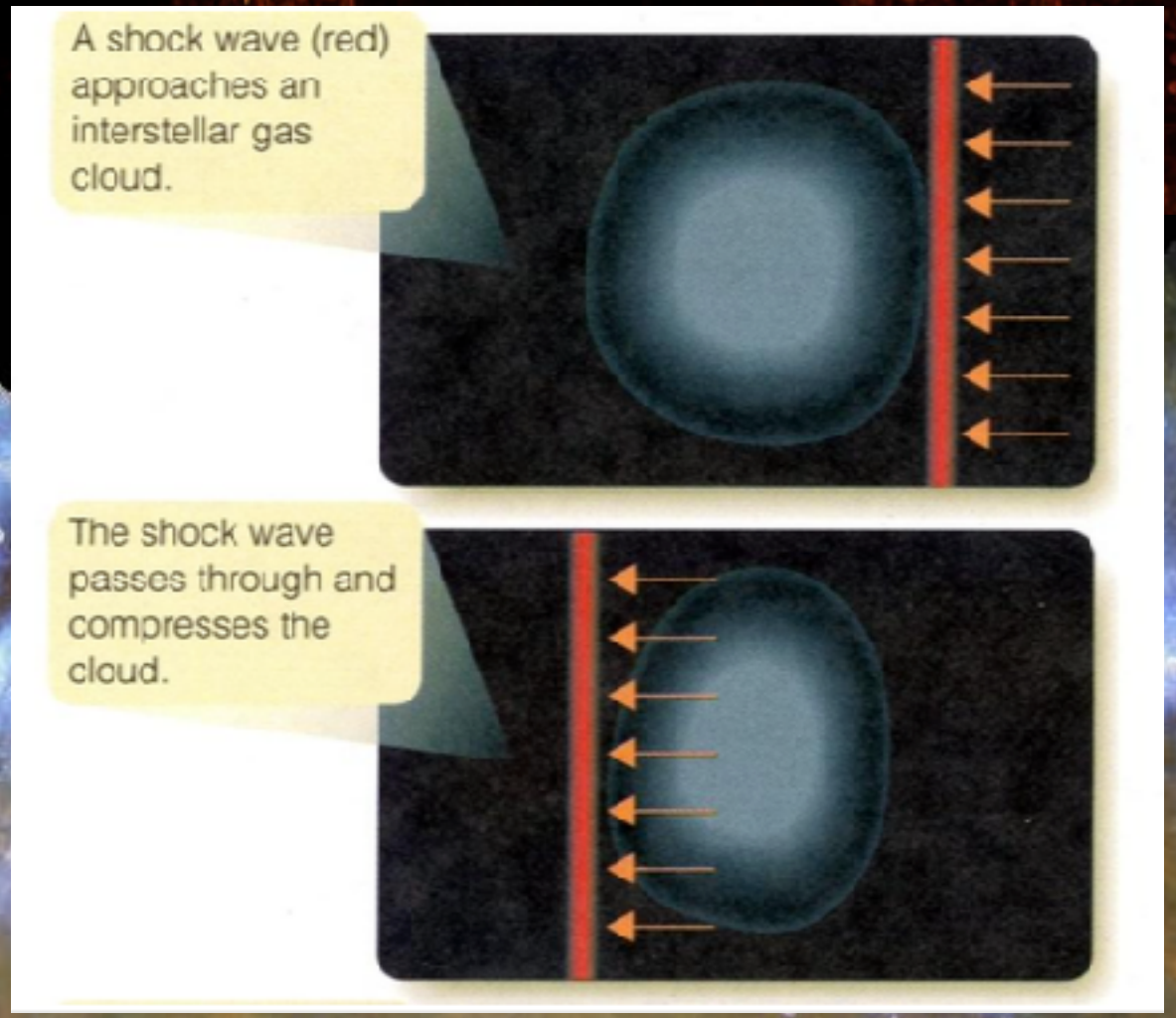
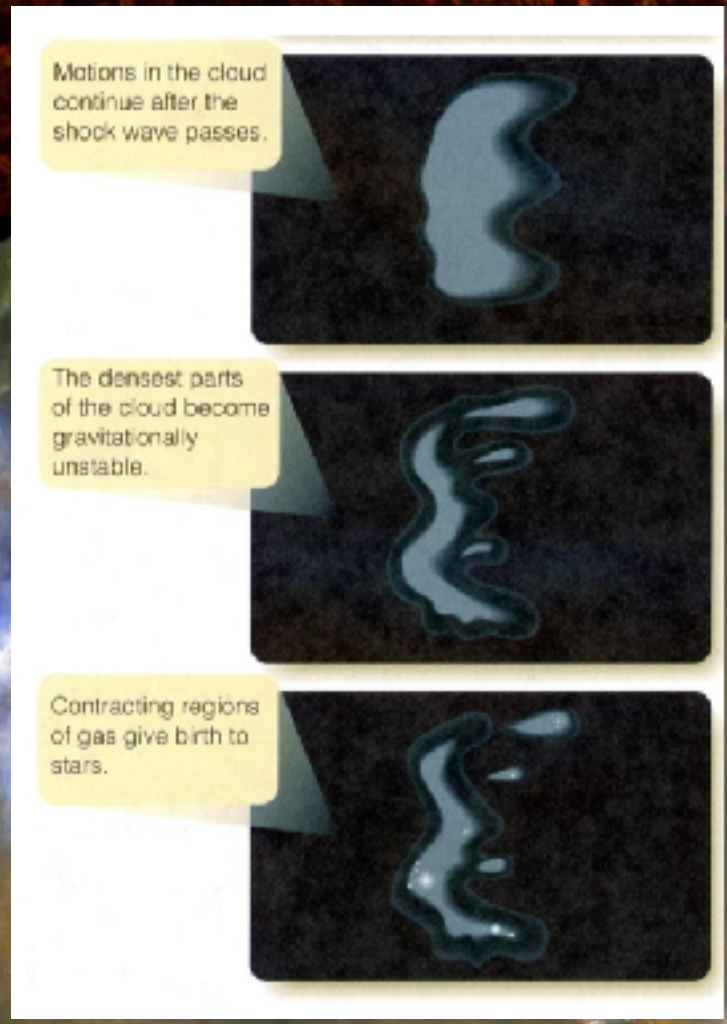
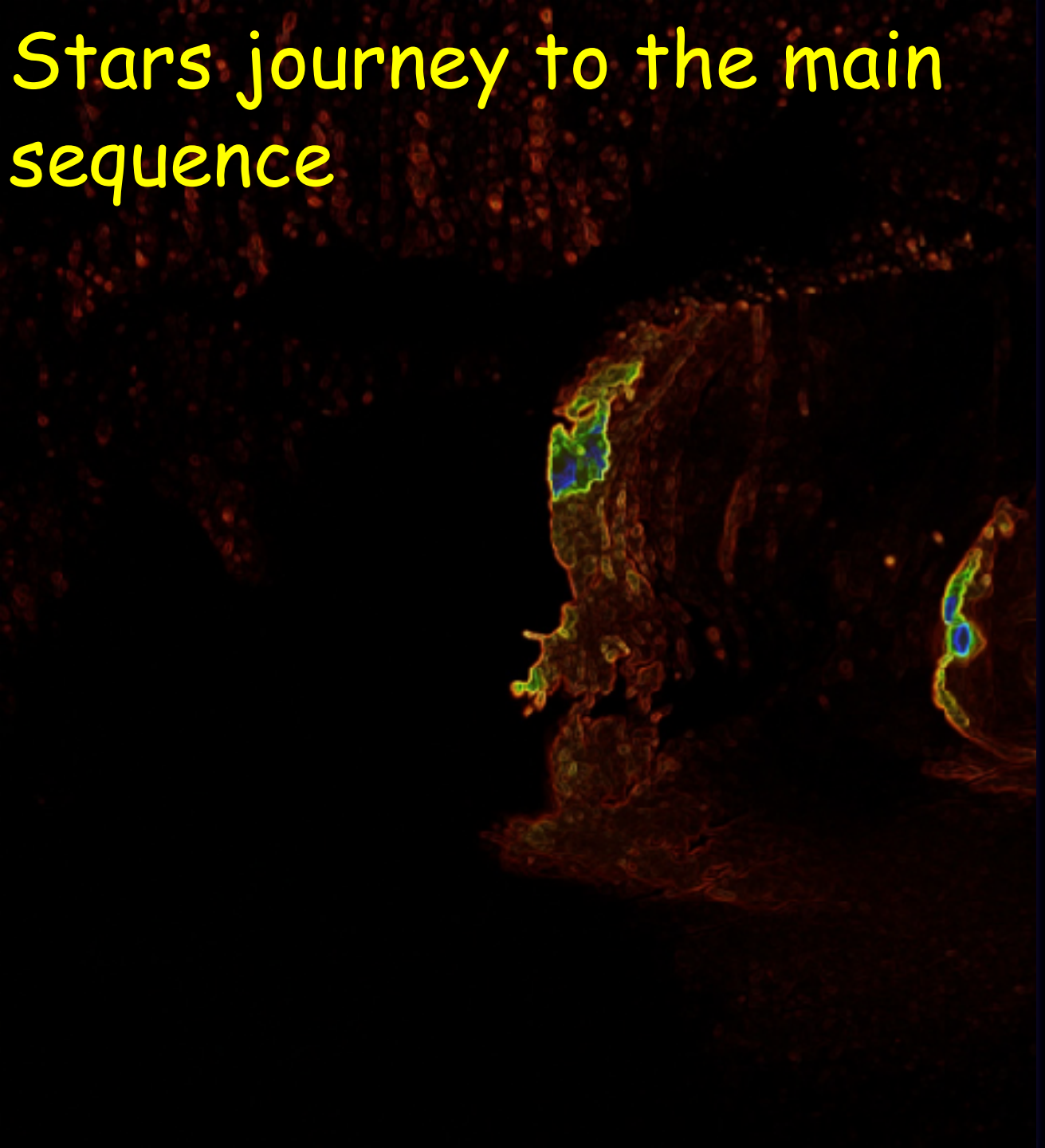
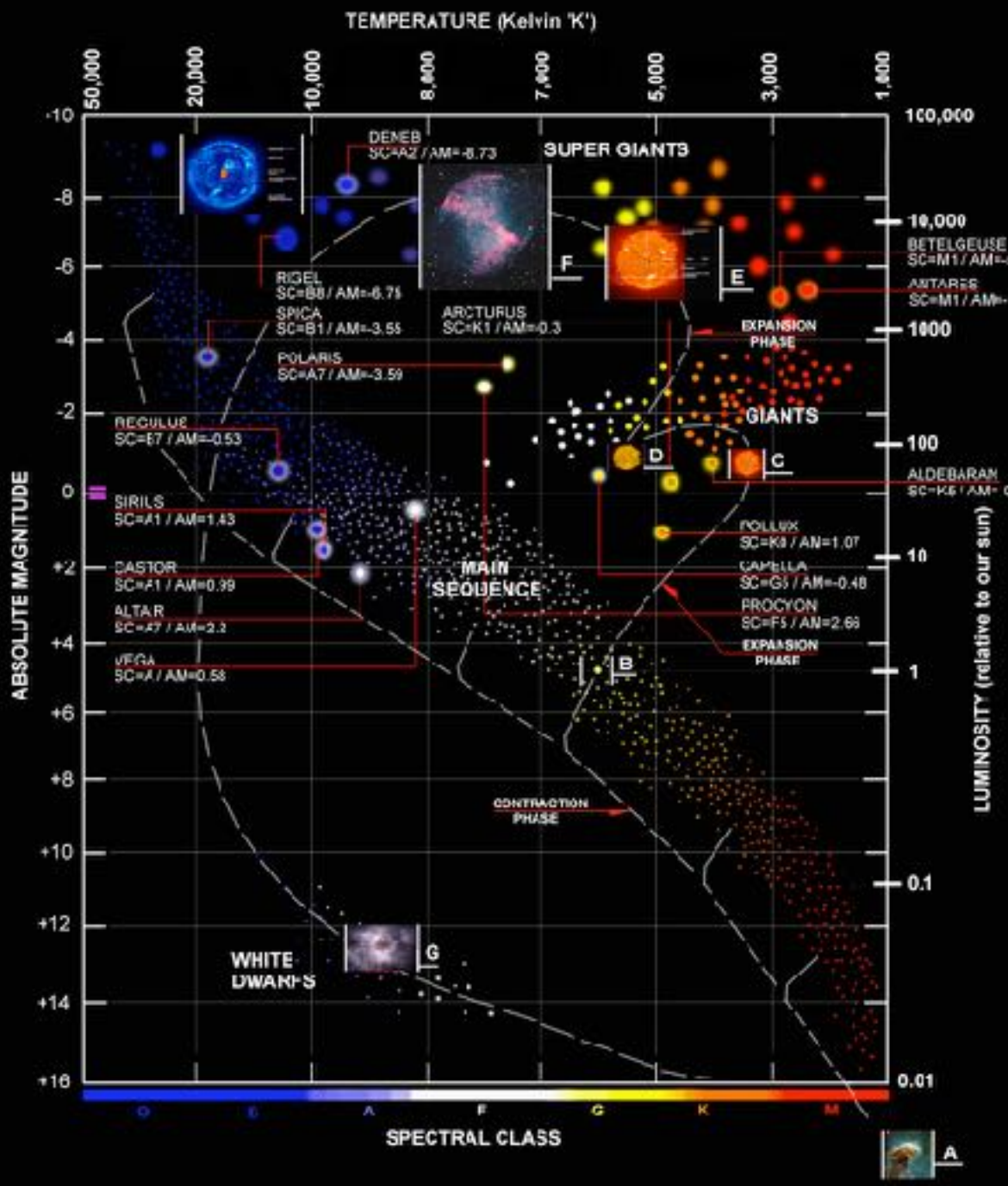




Stars journey to the main sequence





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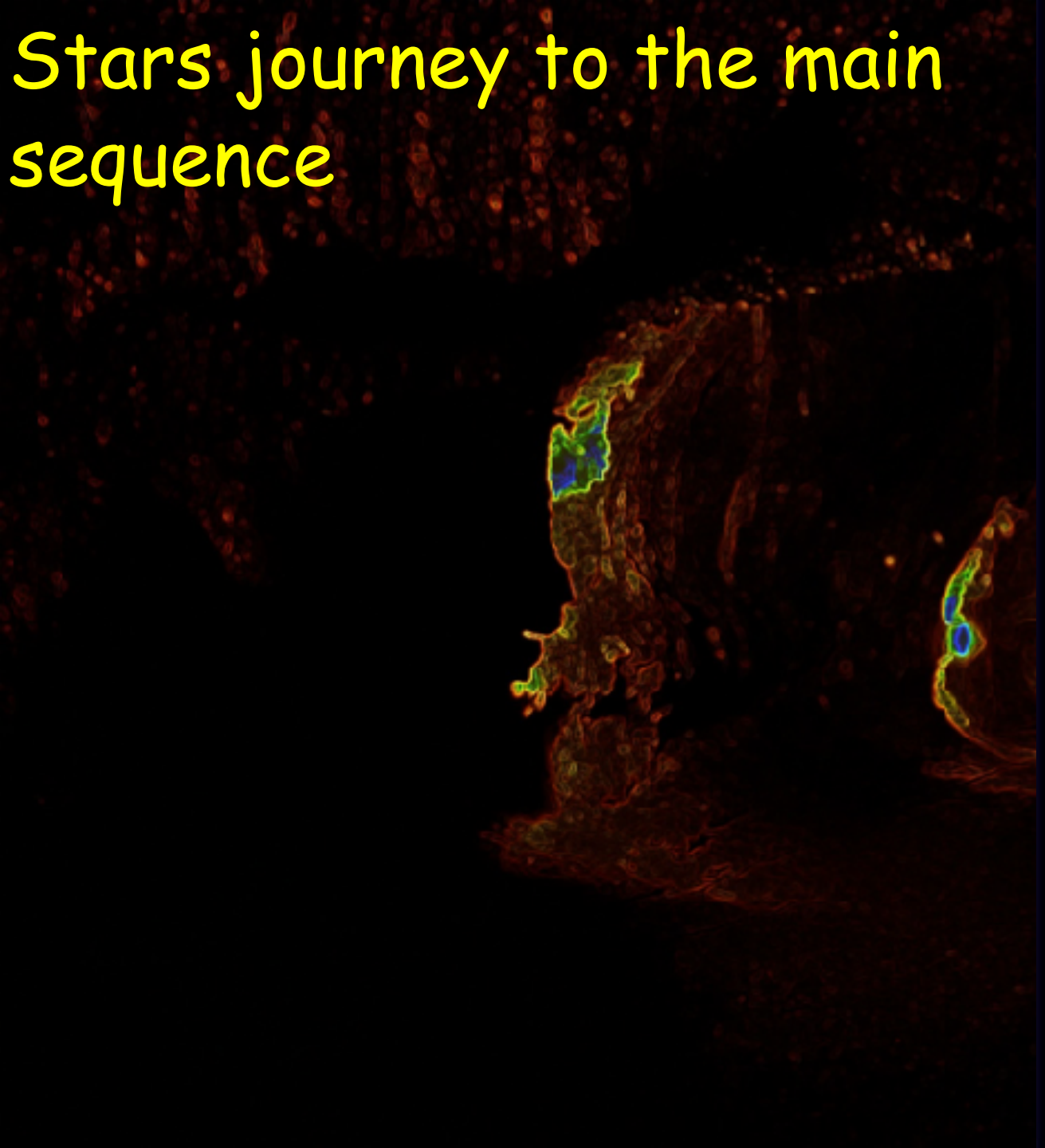

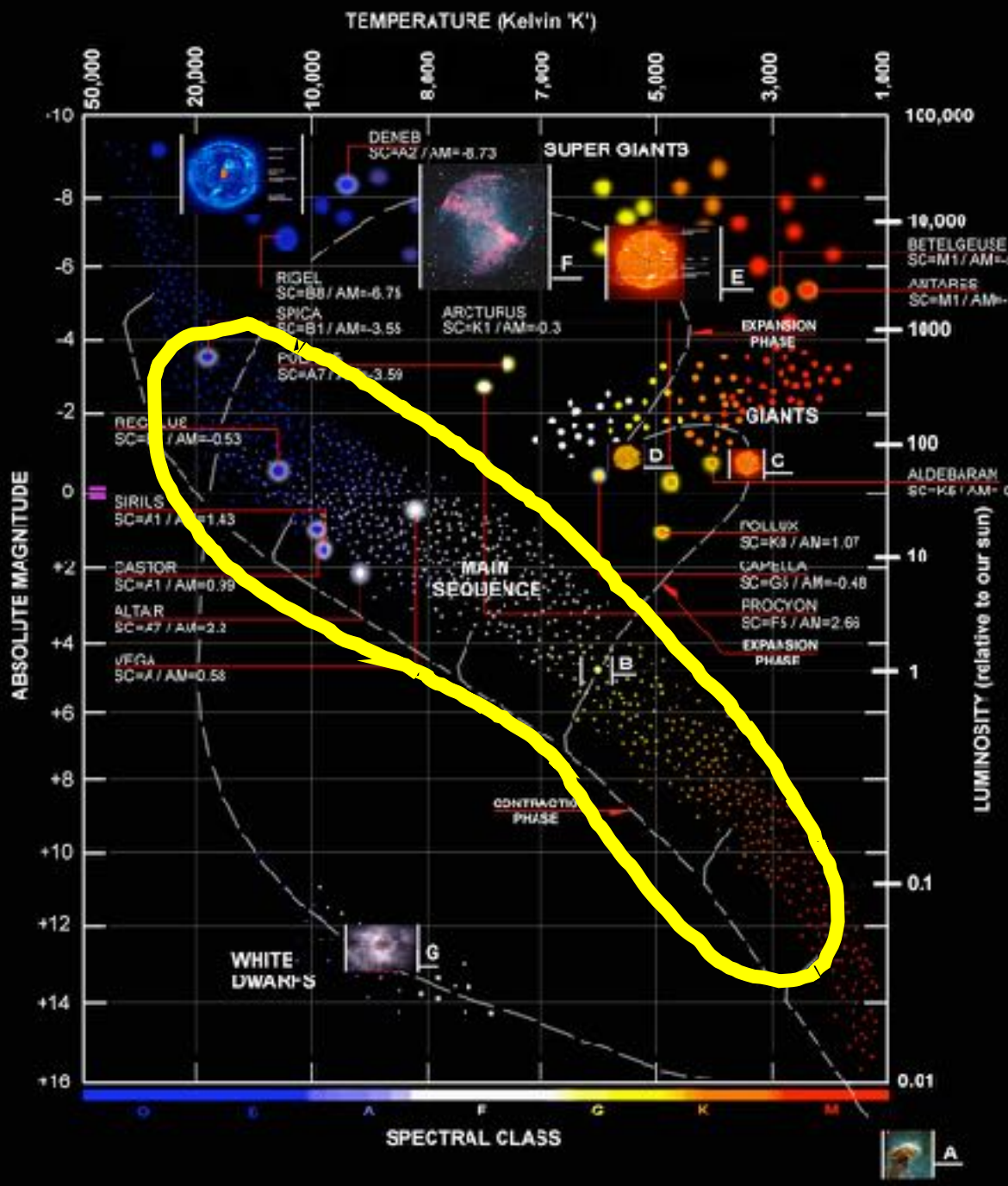

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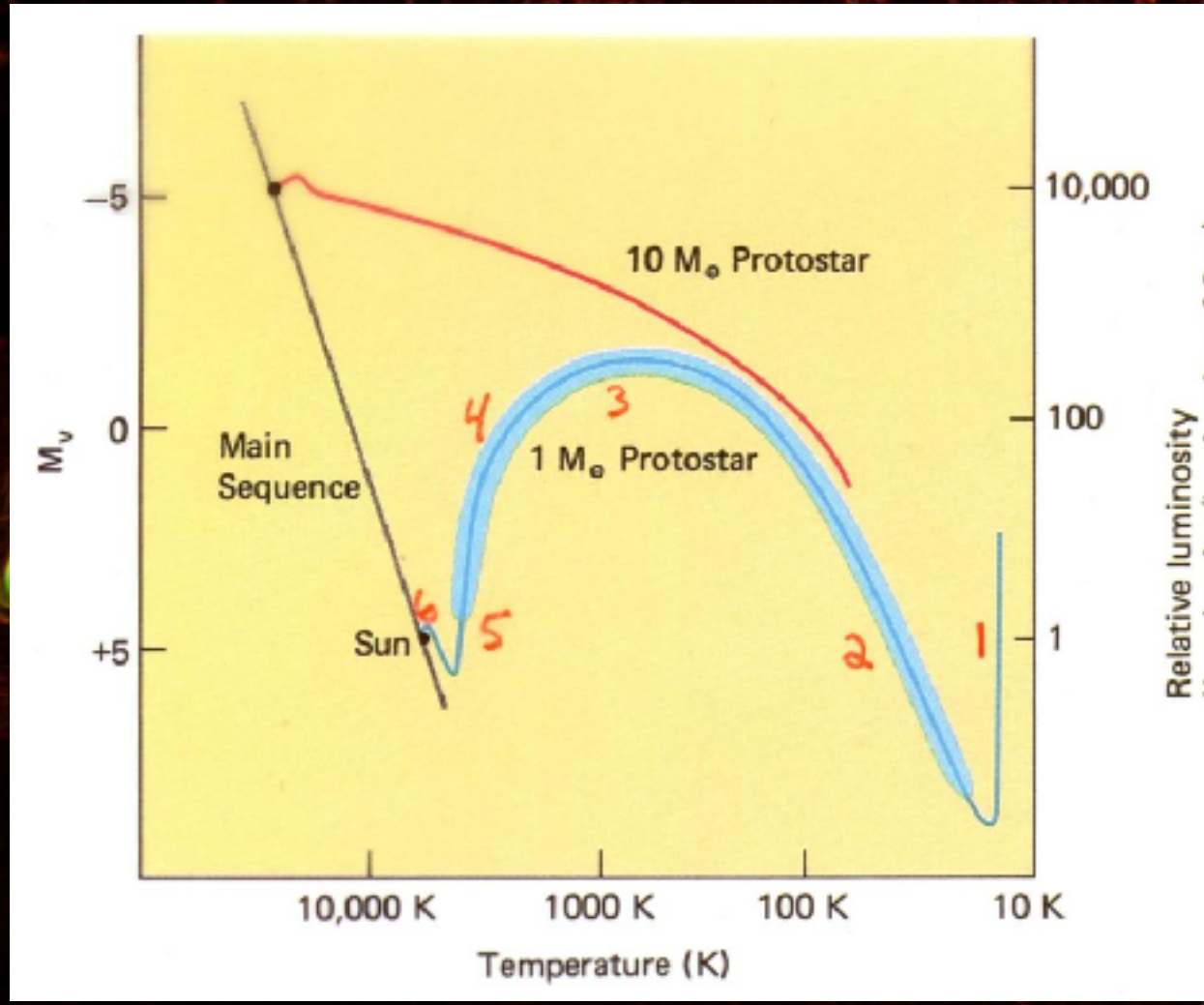

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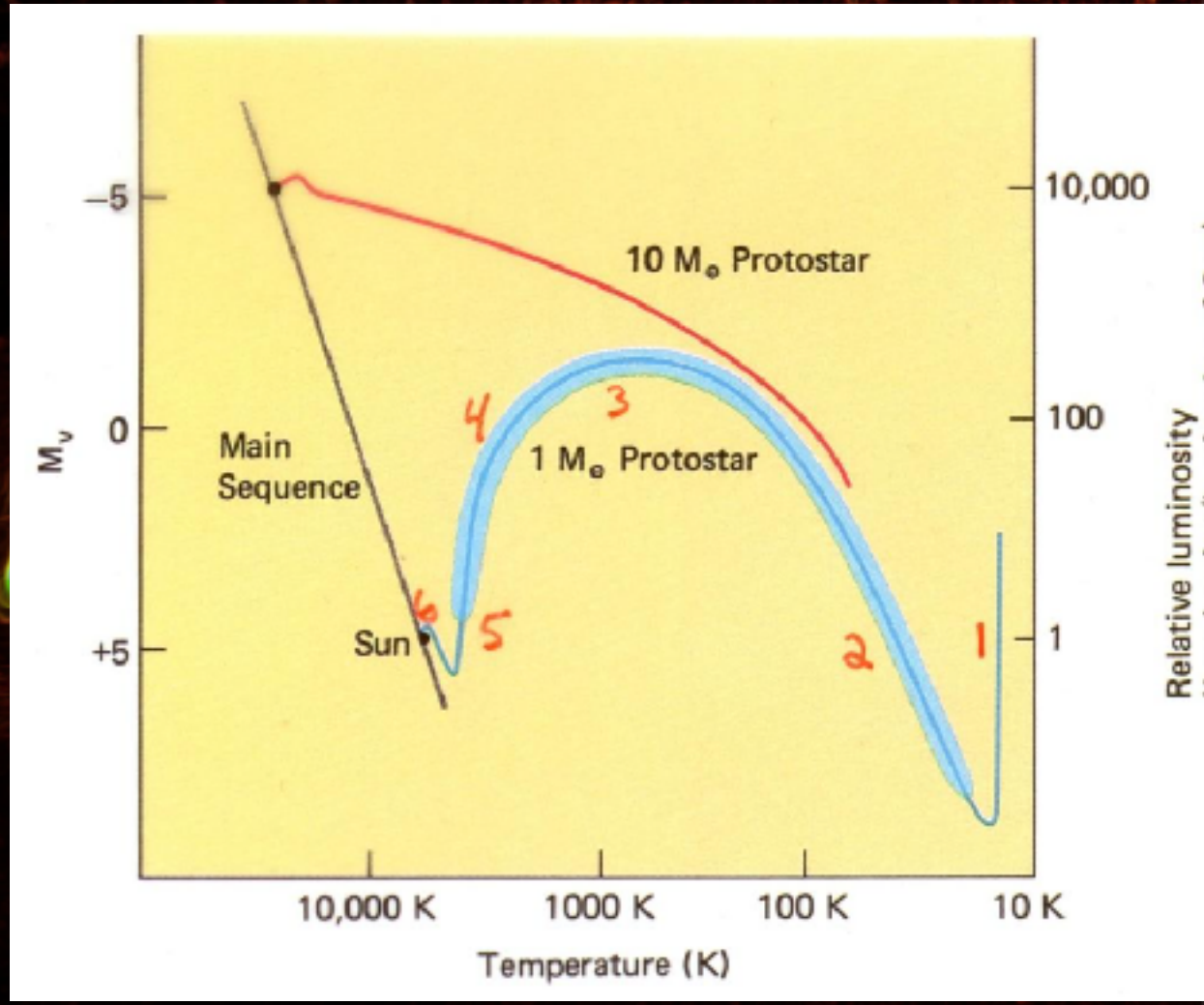
1. Free fall collapse→ cloud cools and collapses (~1000-10,000 years)



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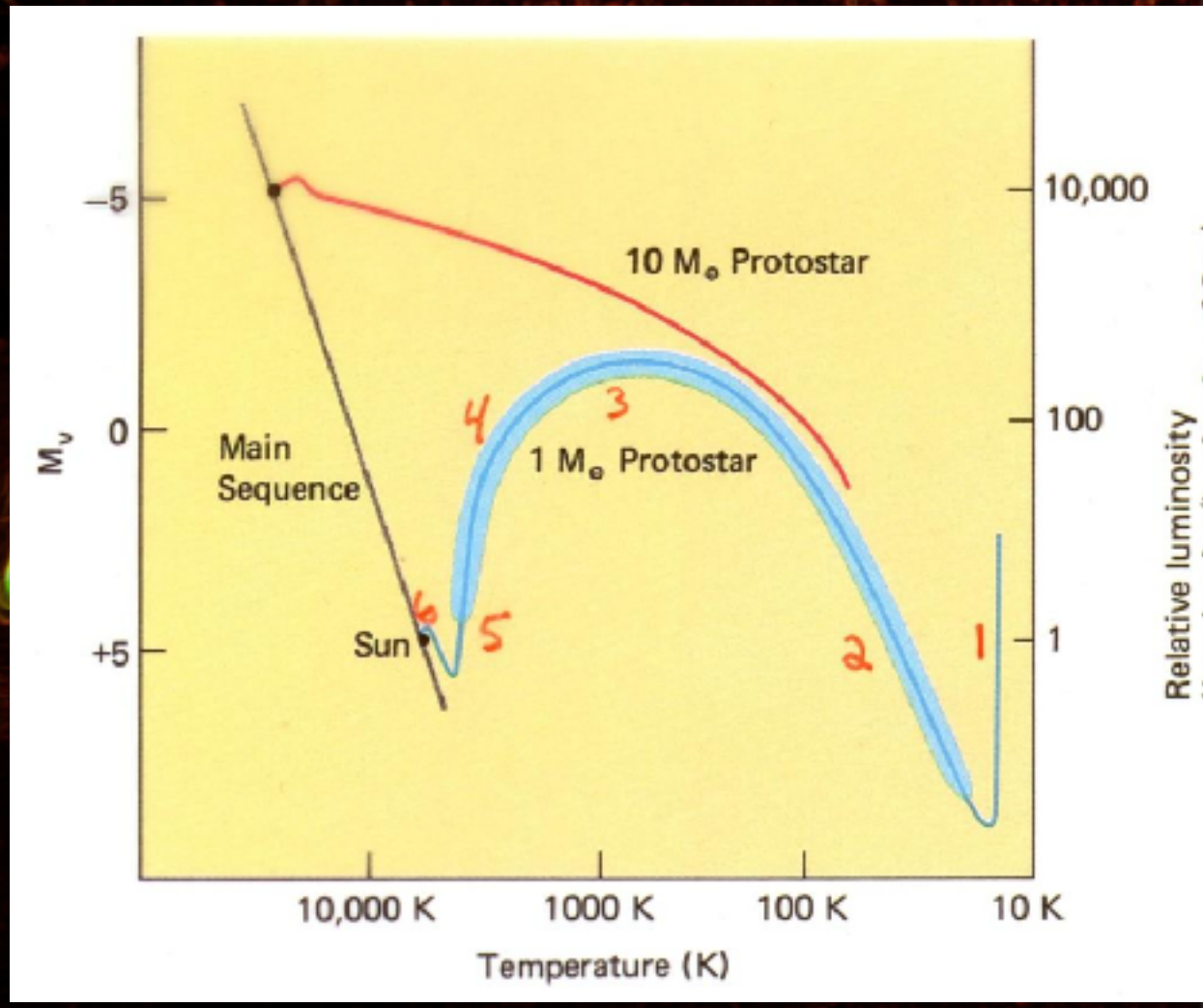

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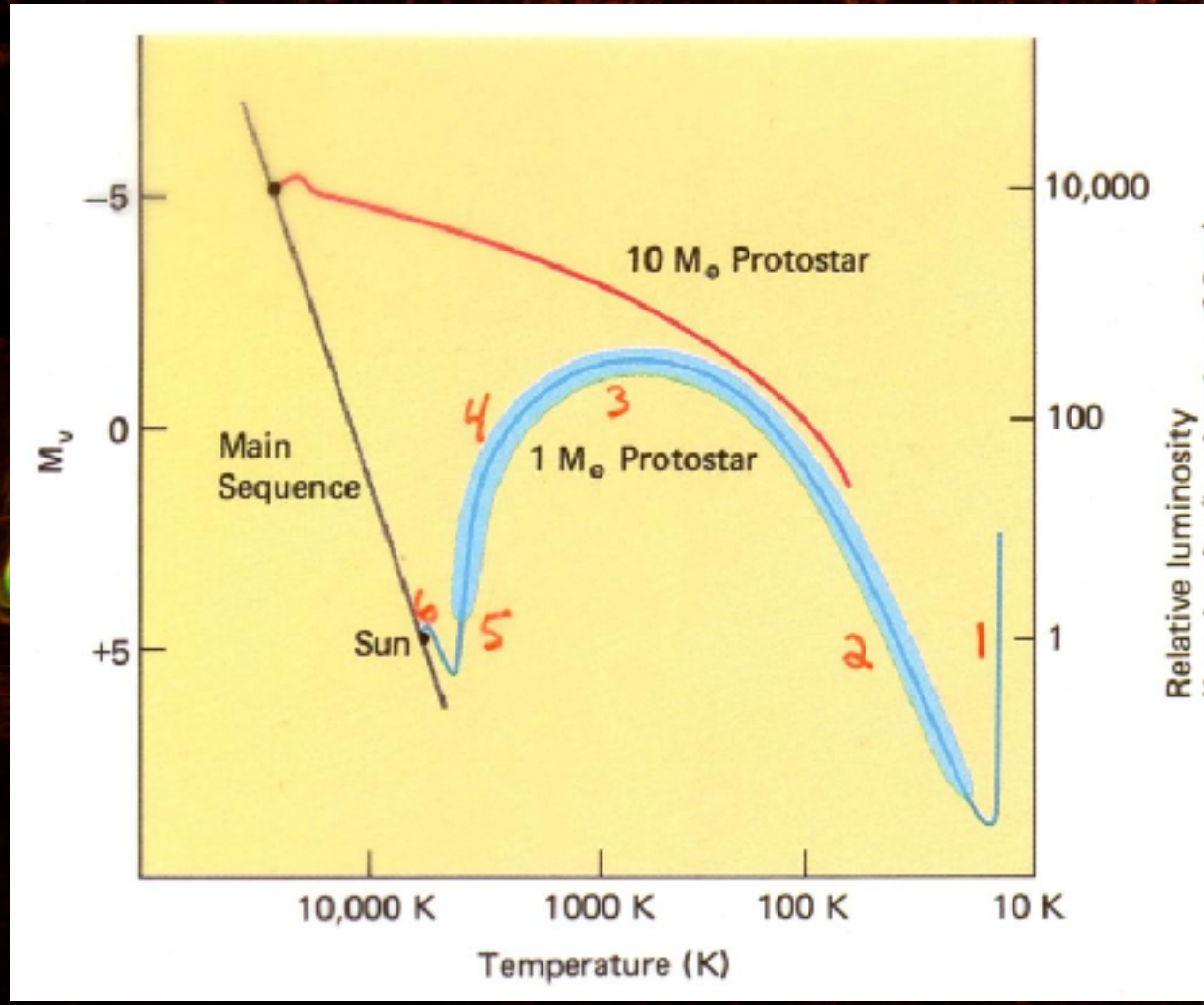

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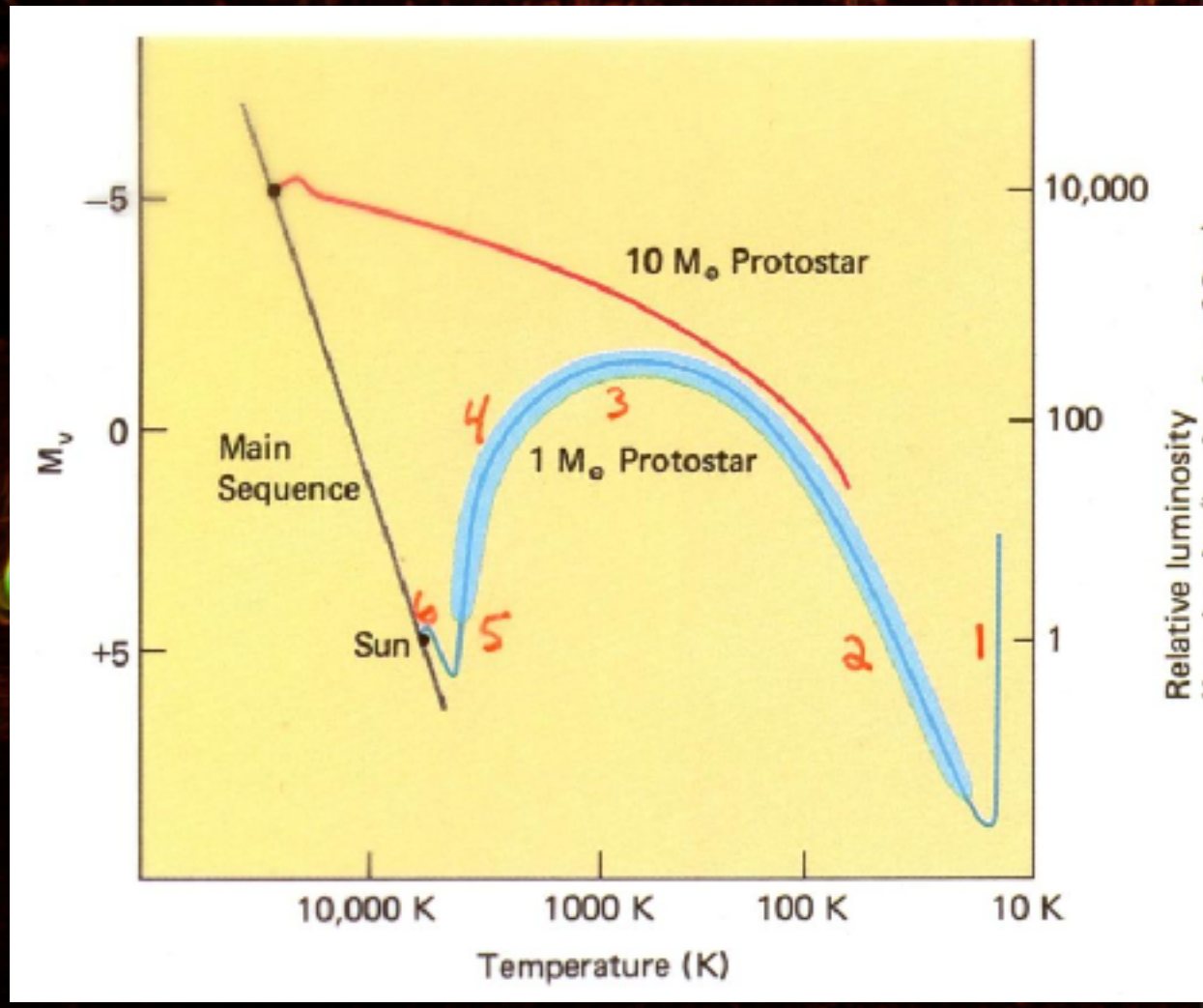

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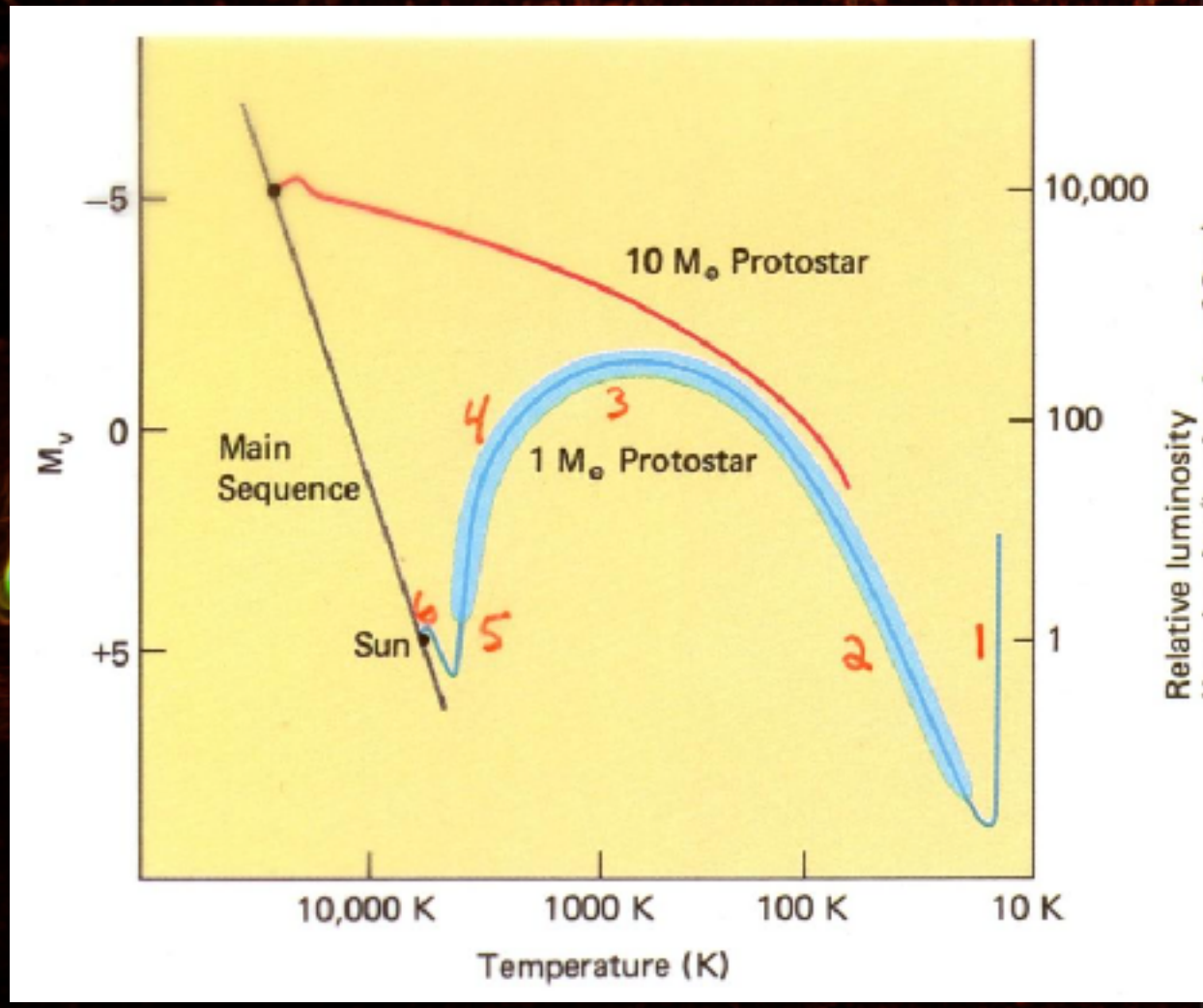

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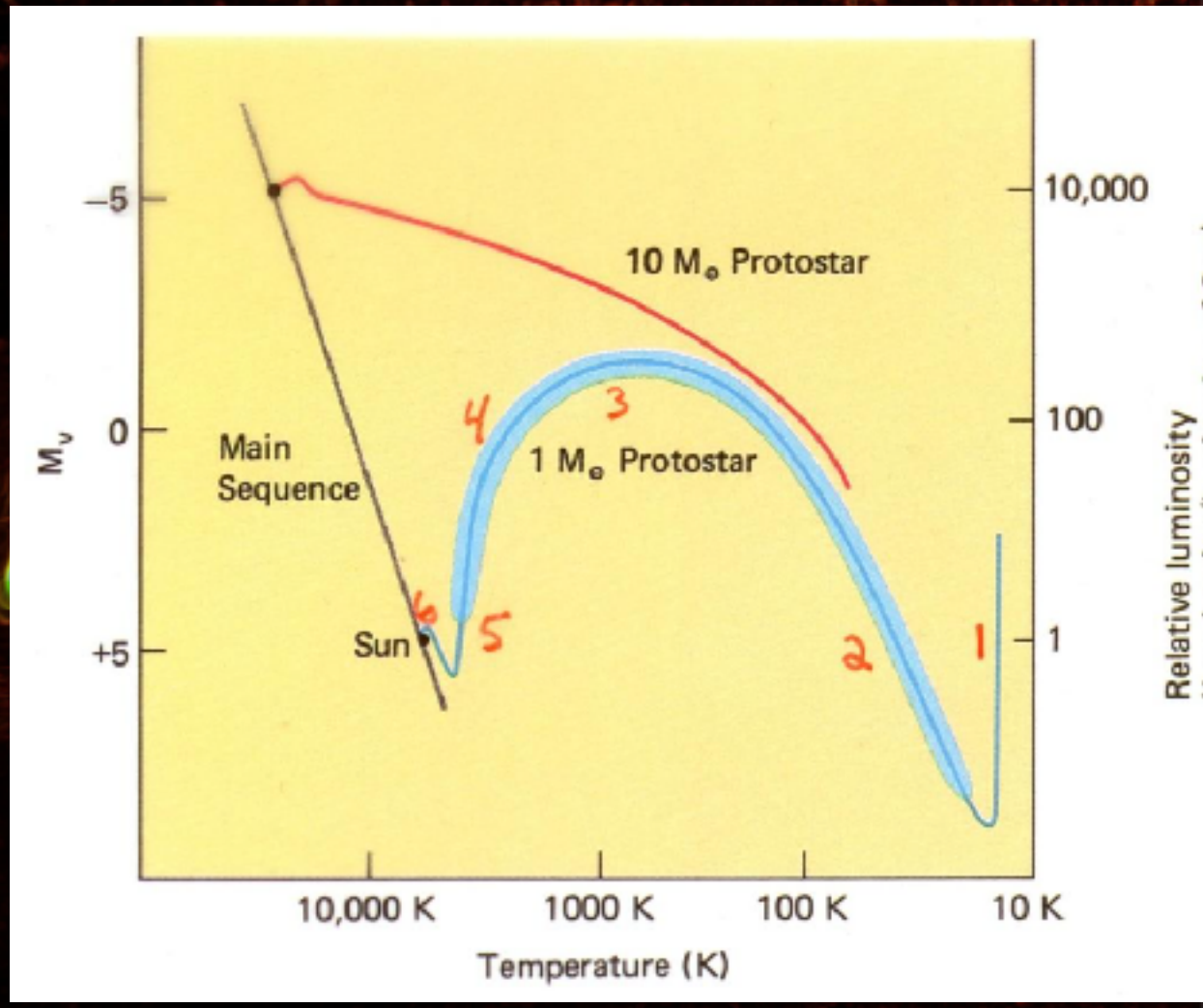
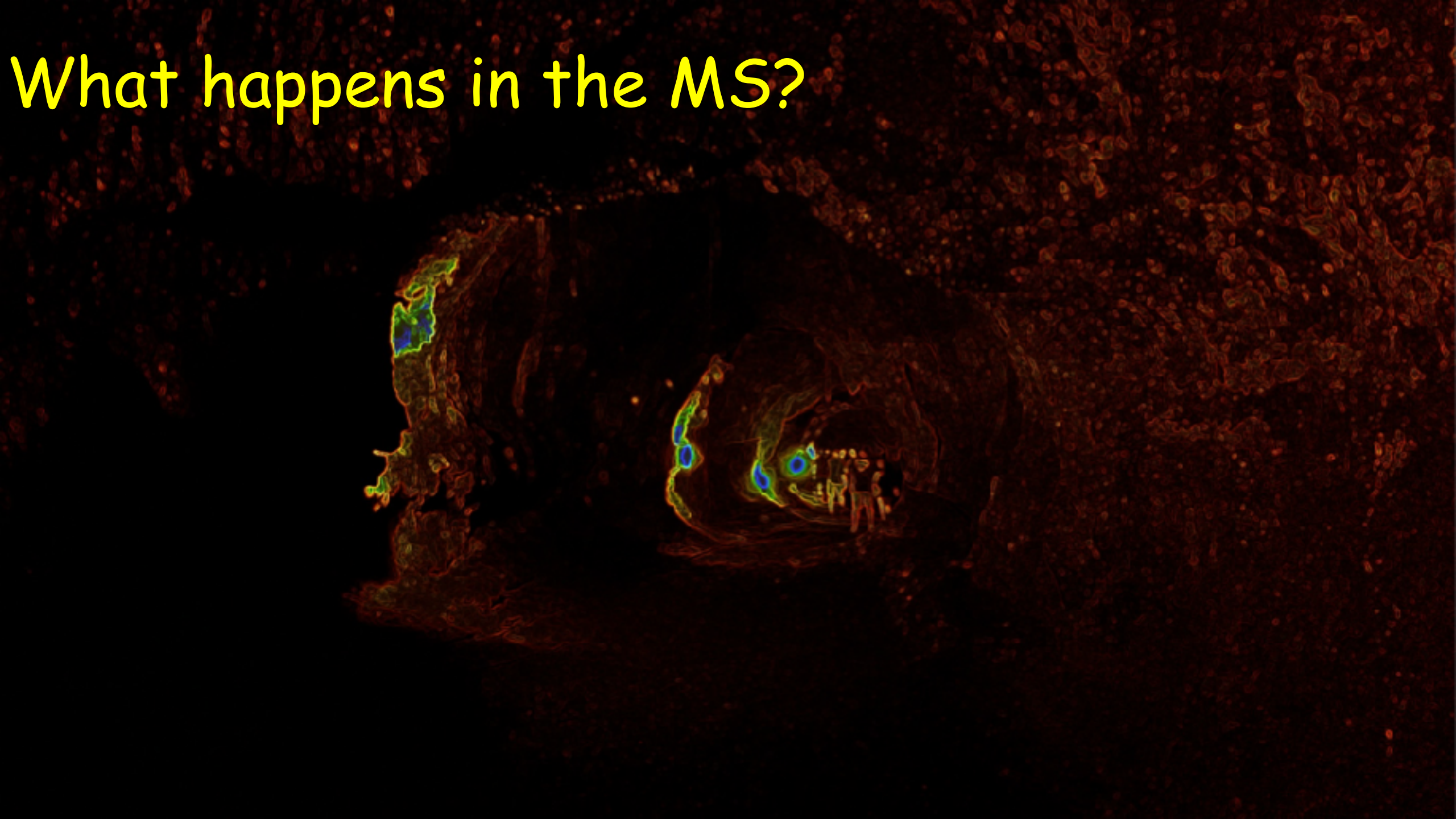
6. Reaches MS!!! Energy lost by surface = Energy from fusion



How long does it take?

- 0.2Xsun → 1 billion years
- 1 X sun → 50 million years
- 15 X sun → 160,000 years
- 50 X sun → 10,000 years

What happens in the MS?



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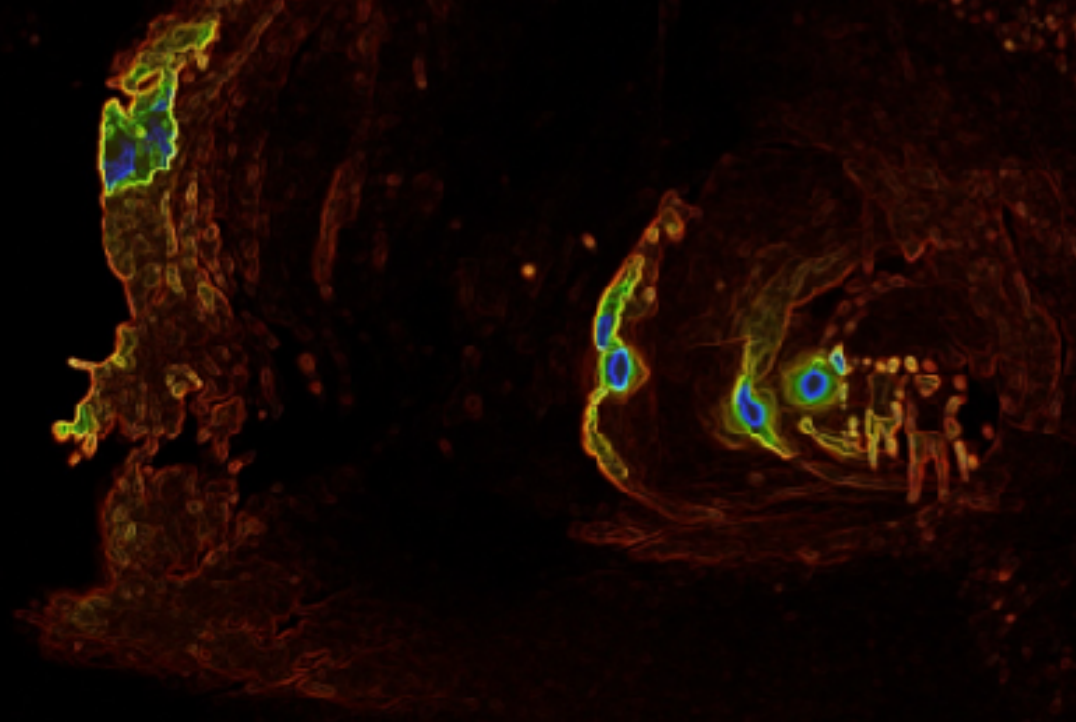
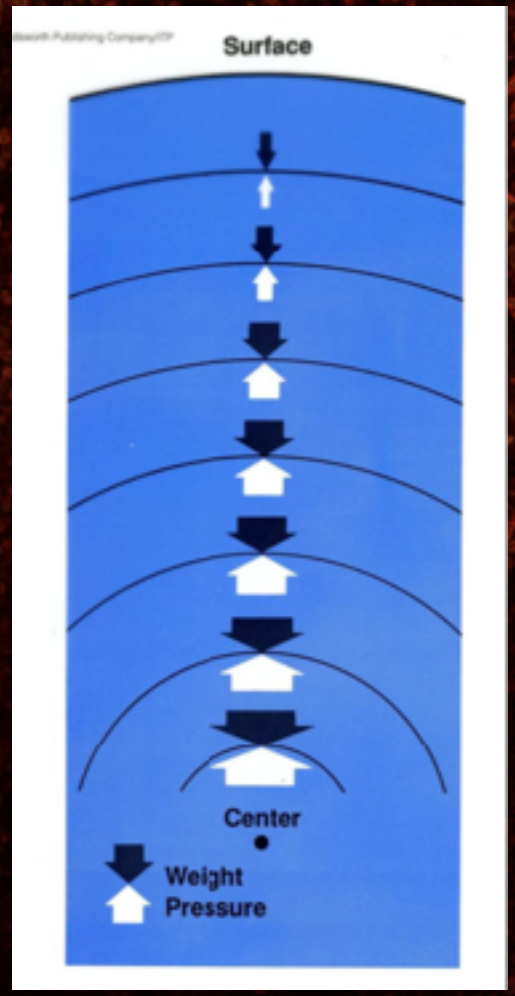
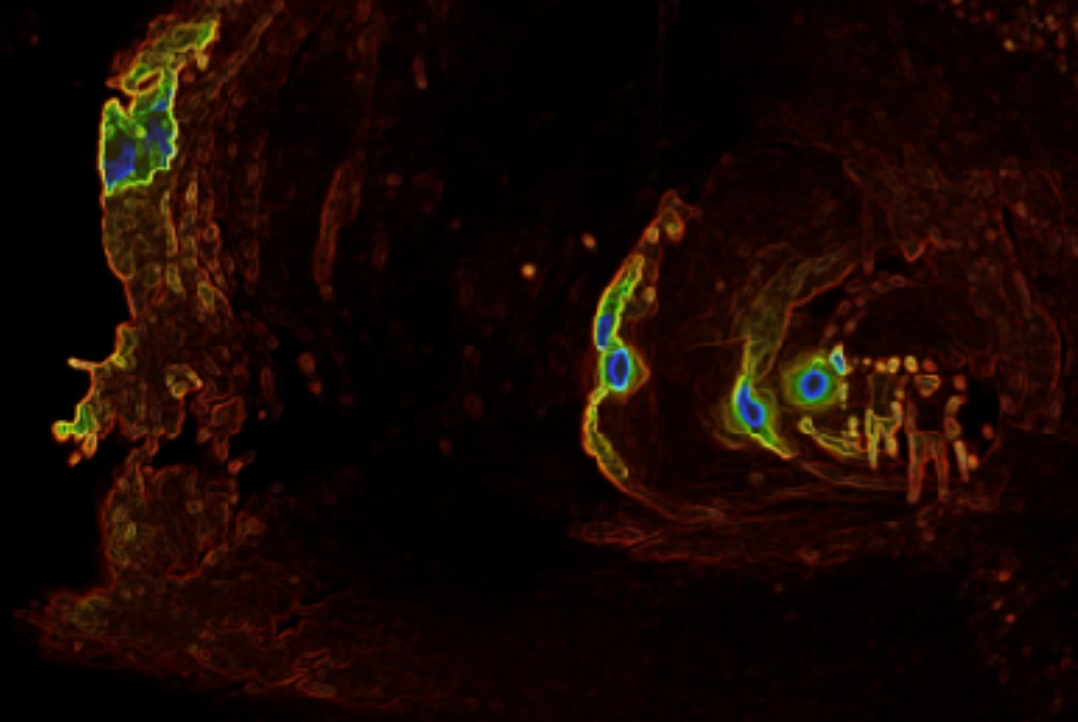
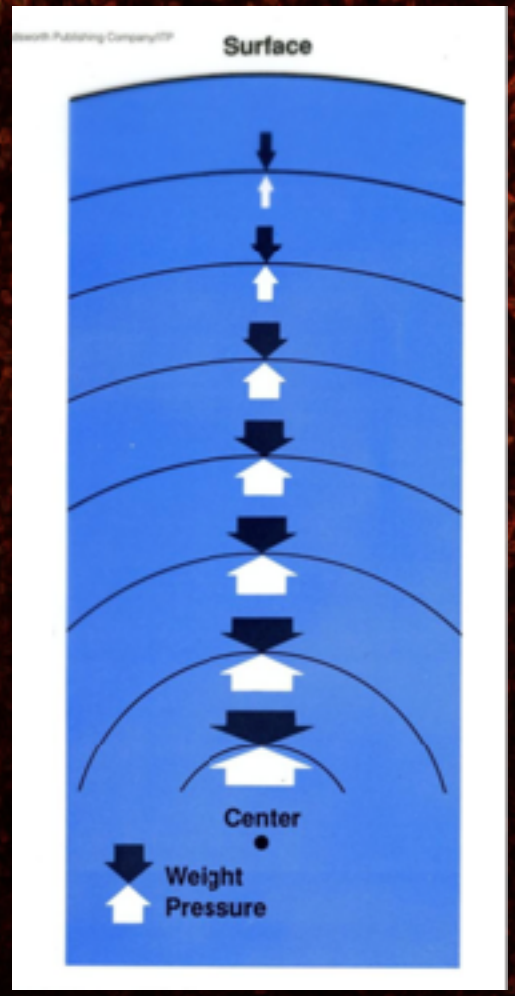




What happens in the MS?

- It's a fight between gravity and pressure





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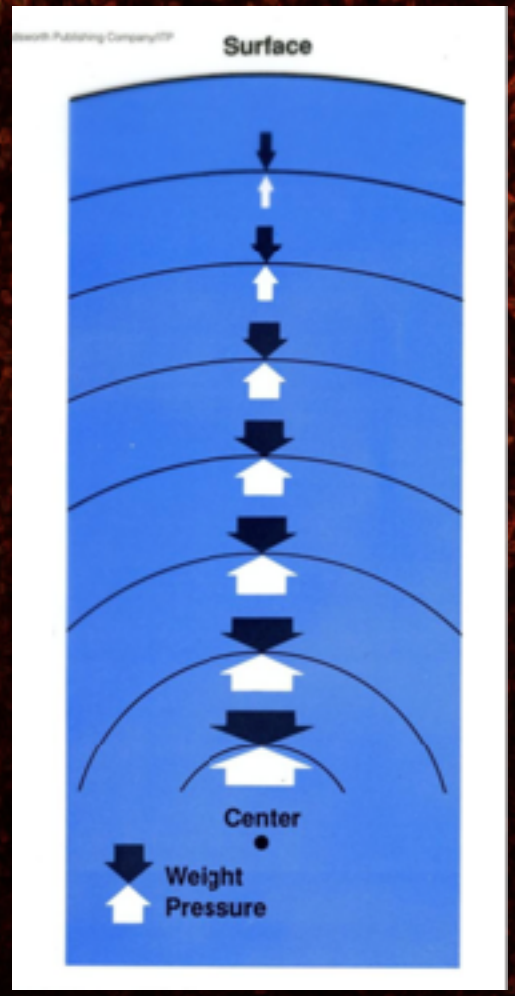
  - Solar like stars: PP chain (H→ He)
  - Large stars: CNO cycle + PP chain



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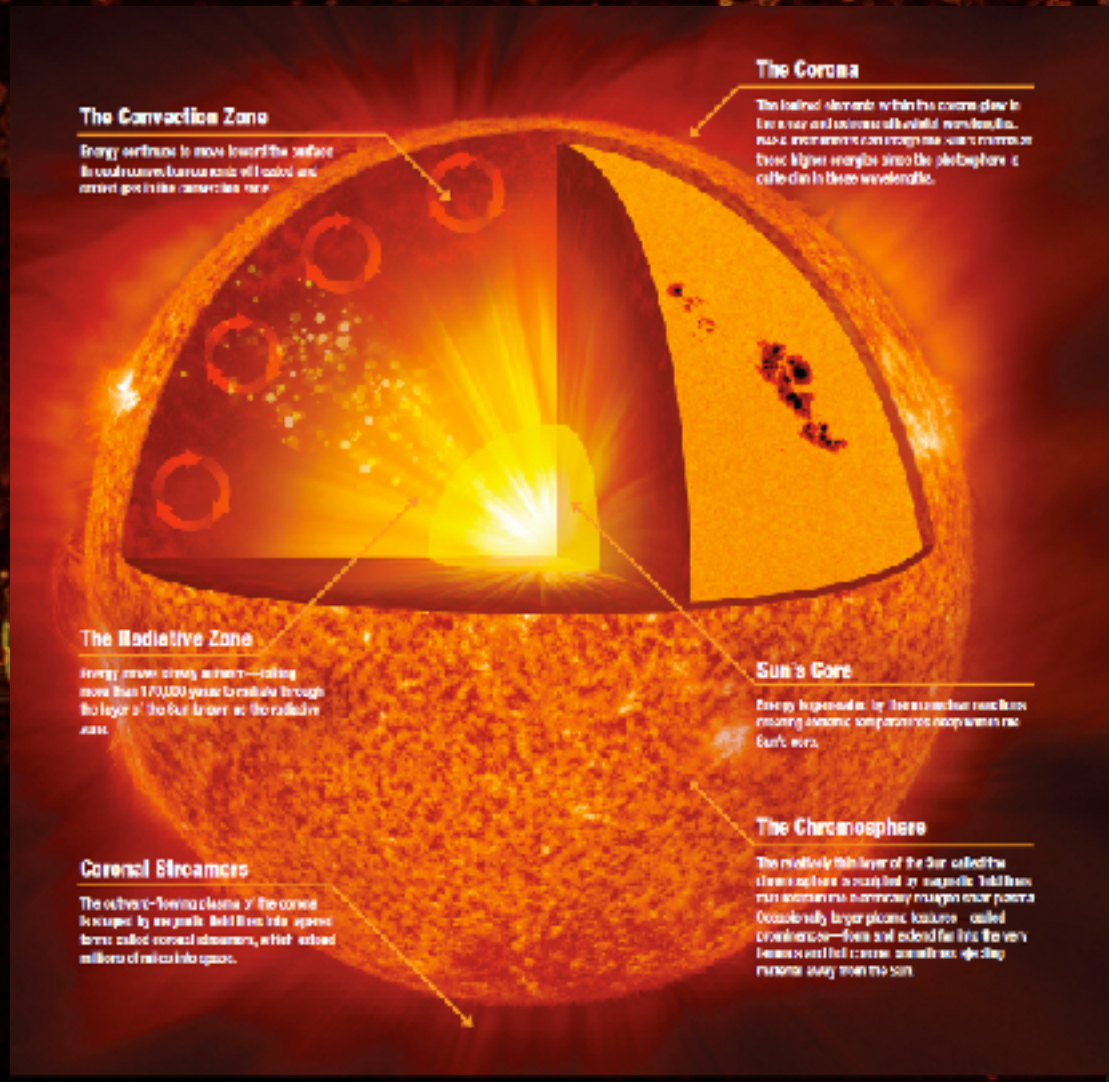

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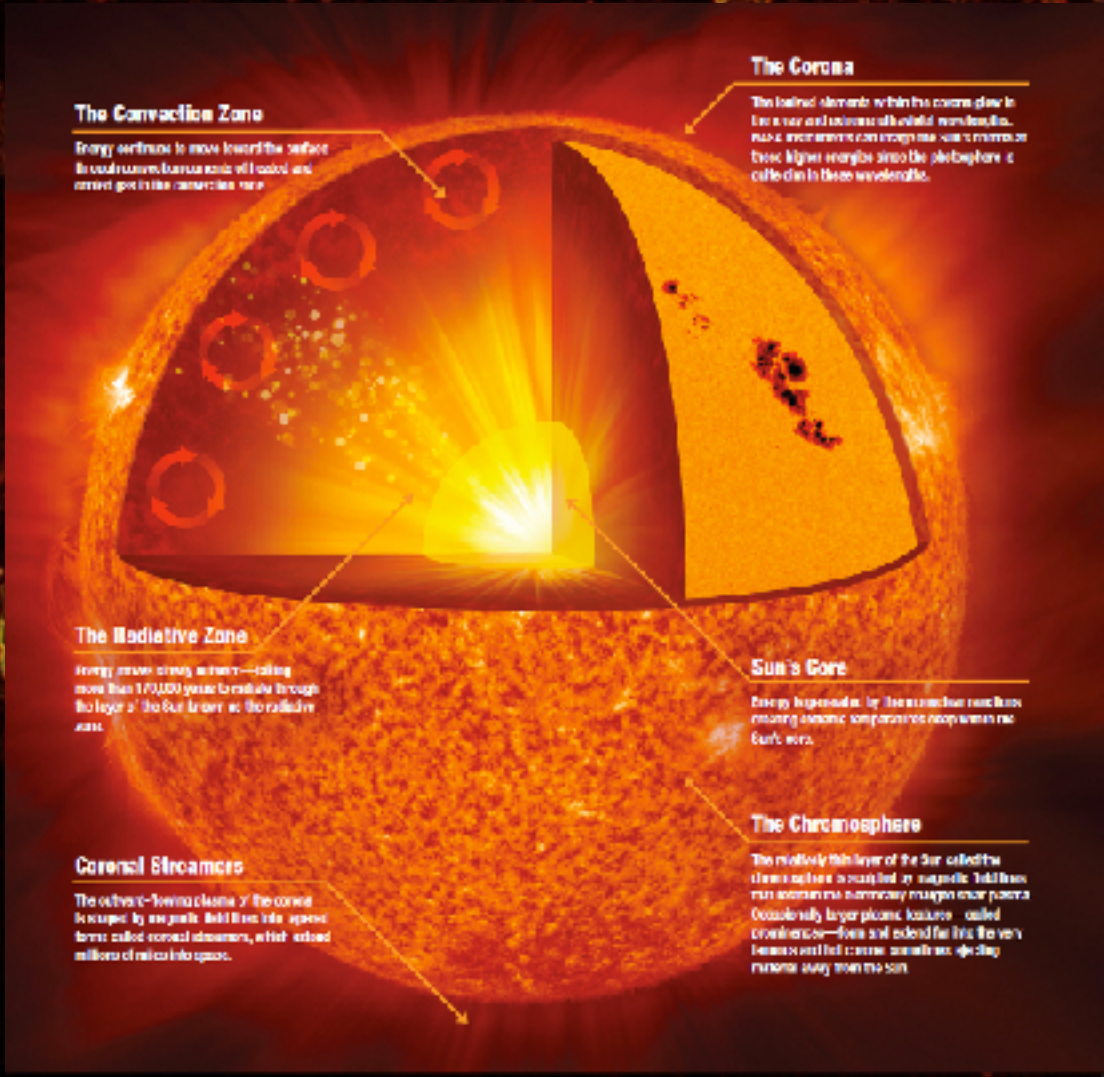
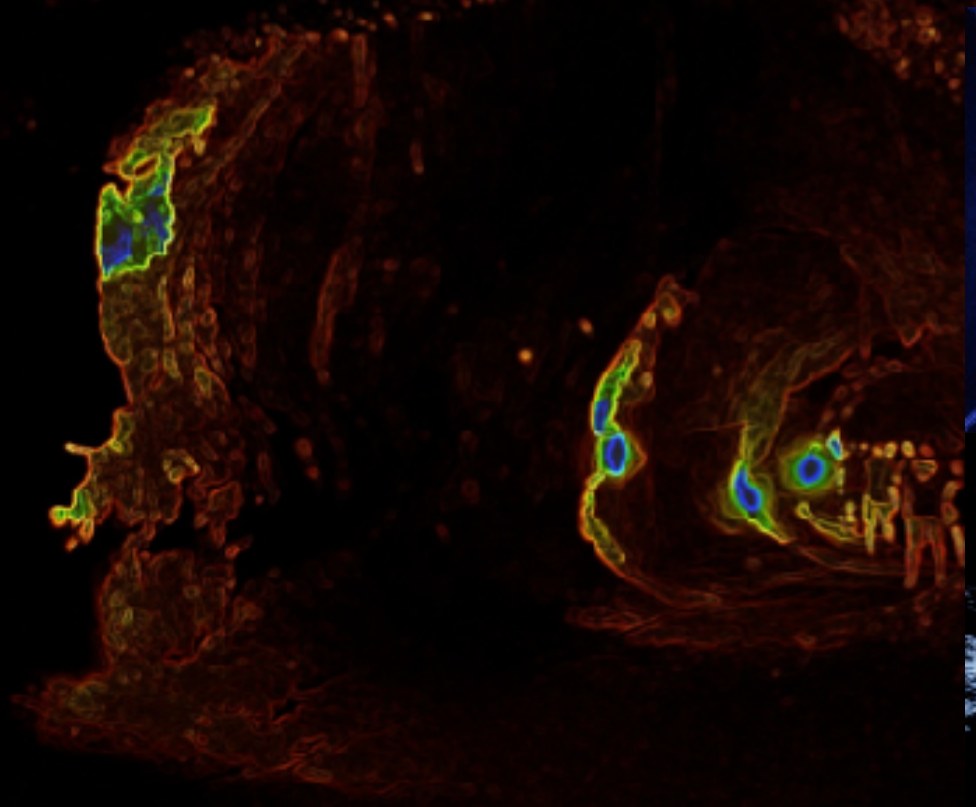
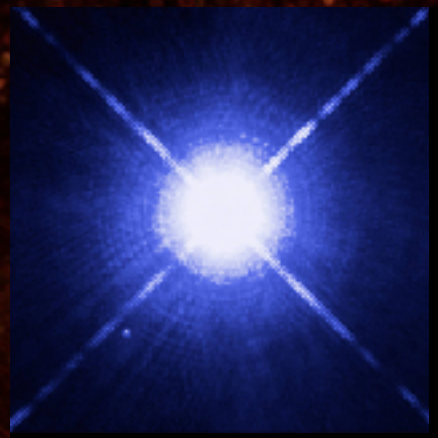
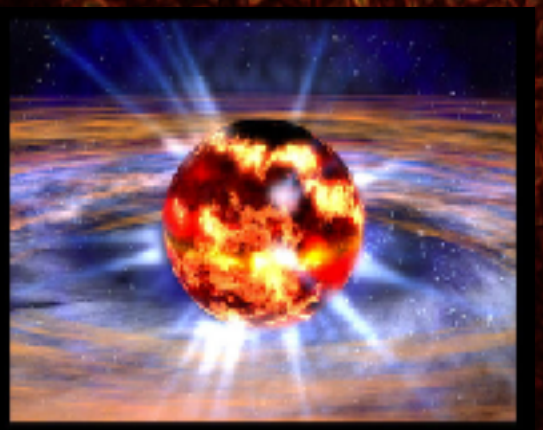
- particles → 1 4
- R (core) T P = const L R(star)
- Sun has been here for 5 billion years and for 5 billion more
  - At the end luminosity X 2 → radius will extend to X 10-100

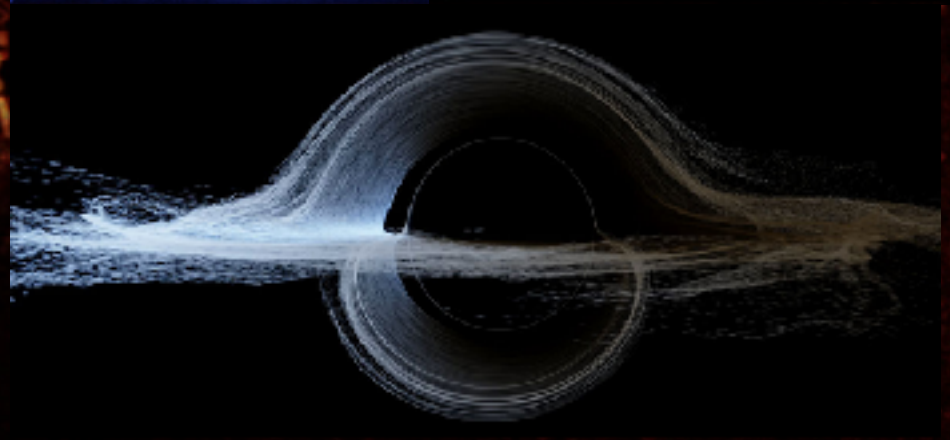


What happens after the MS?





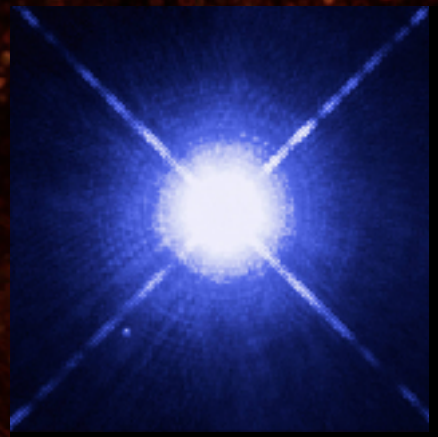


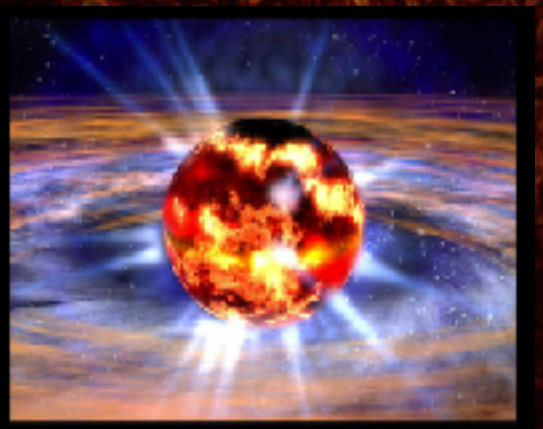


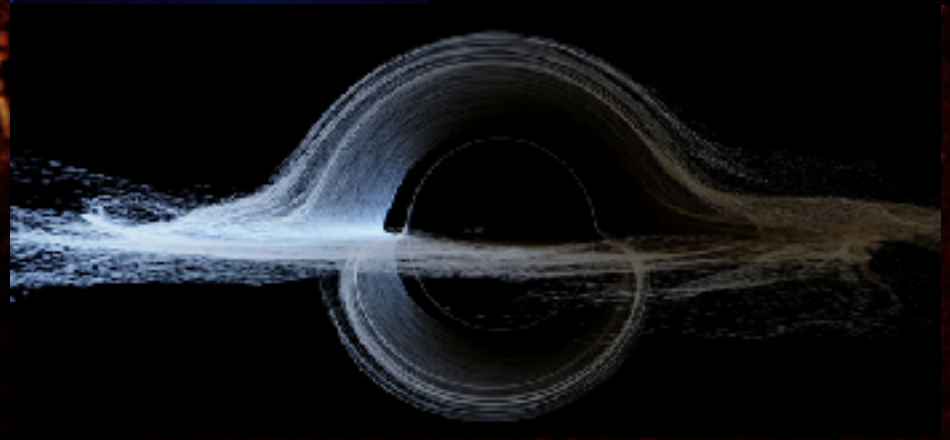
What happens after the MS?

- 4 final stages depending on mass:
  1. White dwarf
  2. Neutron stars
  3. Black holes
  4. Nothing!

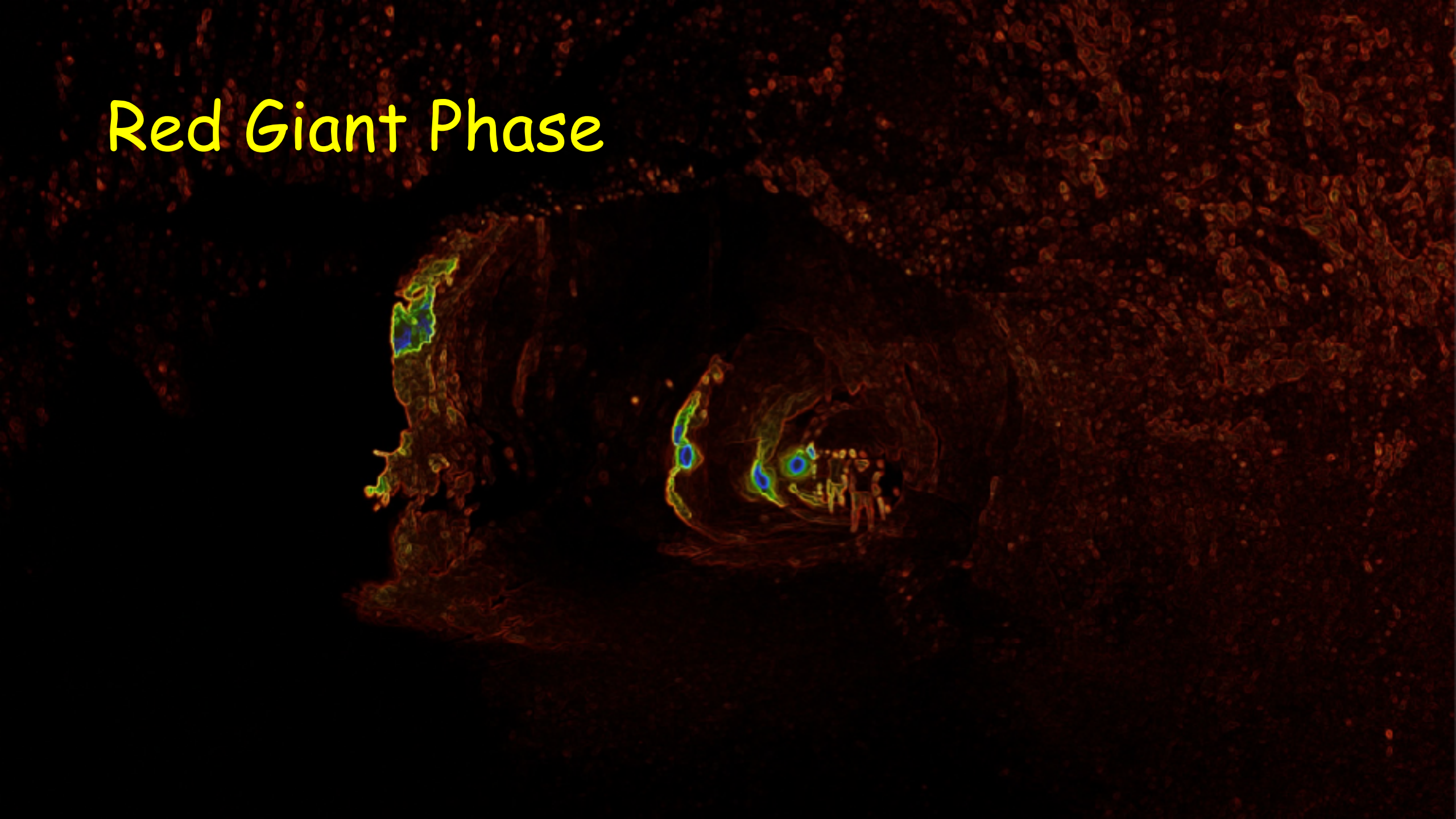
- Time scale will depend on mass too
  1. High mass ~ few million years → supernova!
  2. Low mass ~ few billion years → white dwarf







Red Giant Phase



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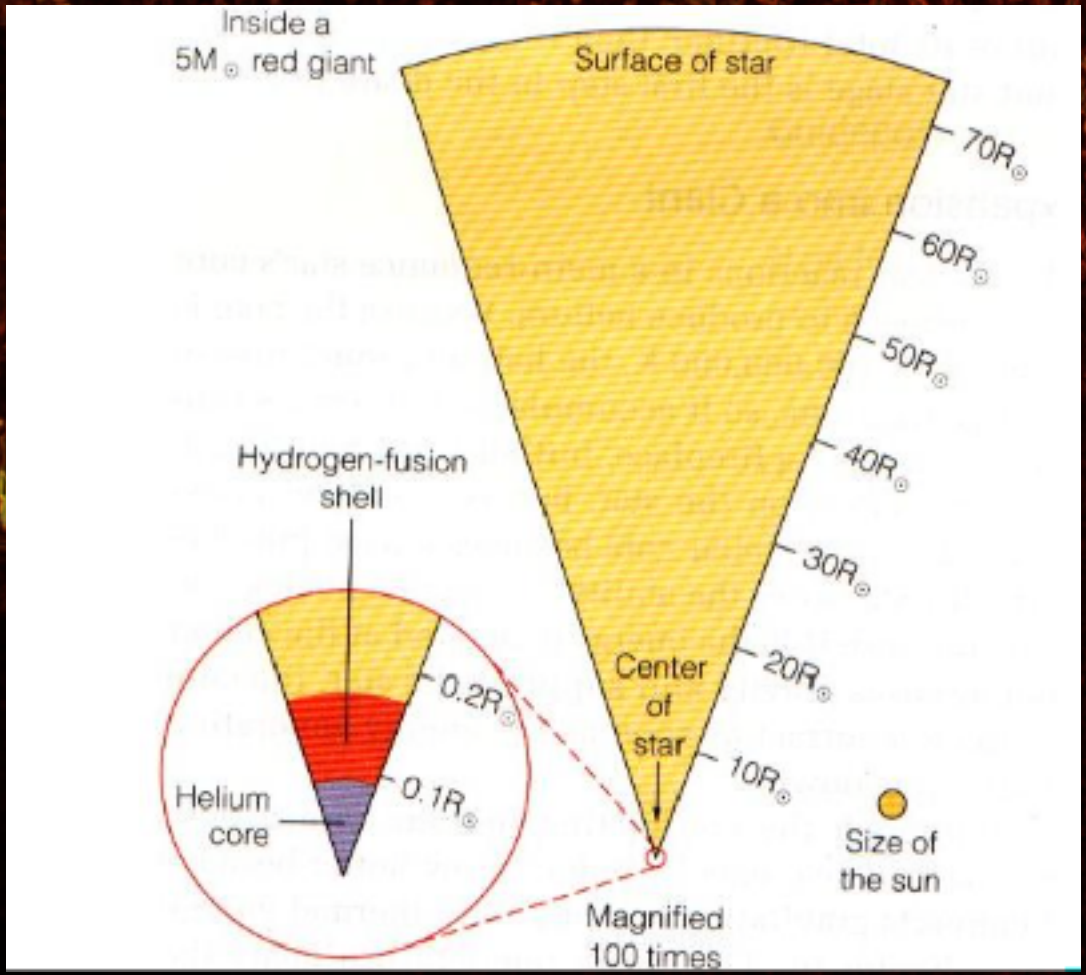

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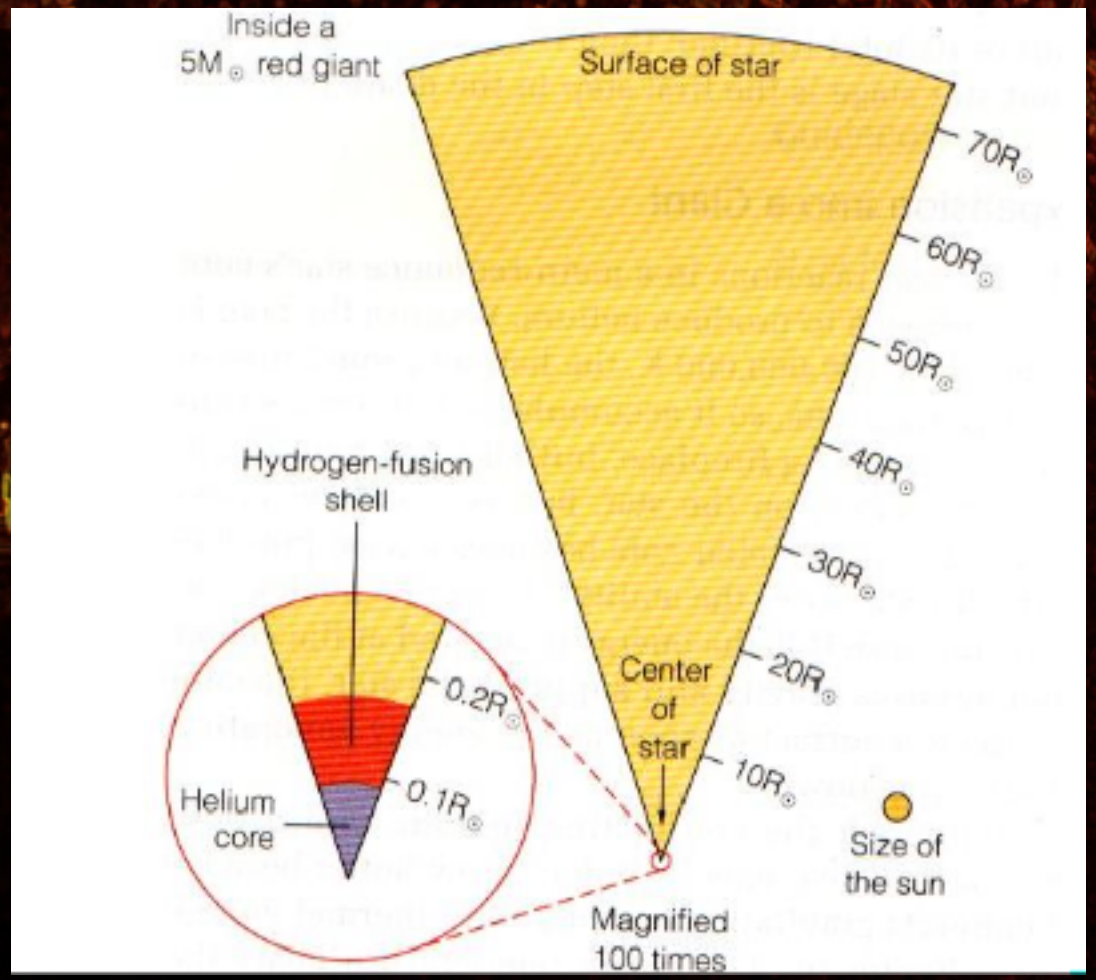

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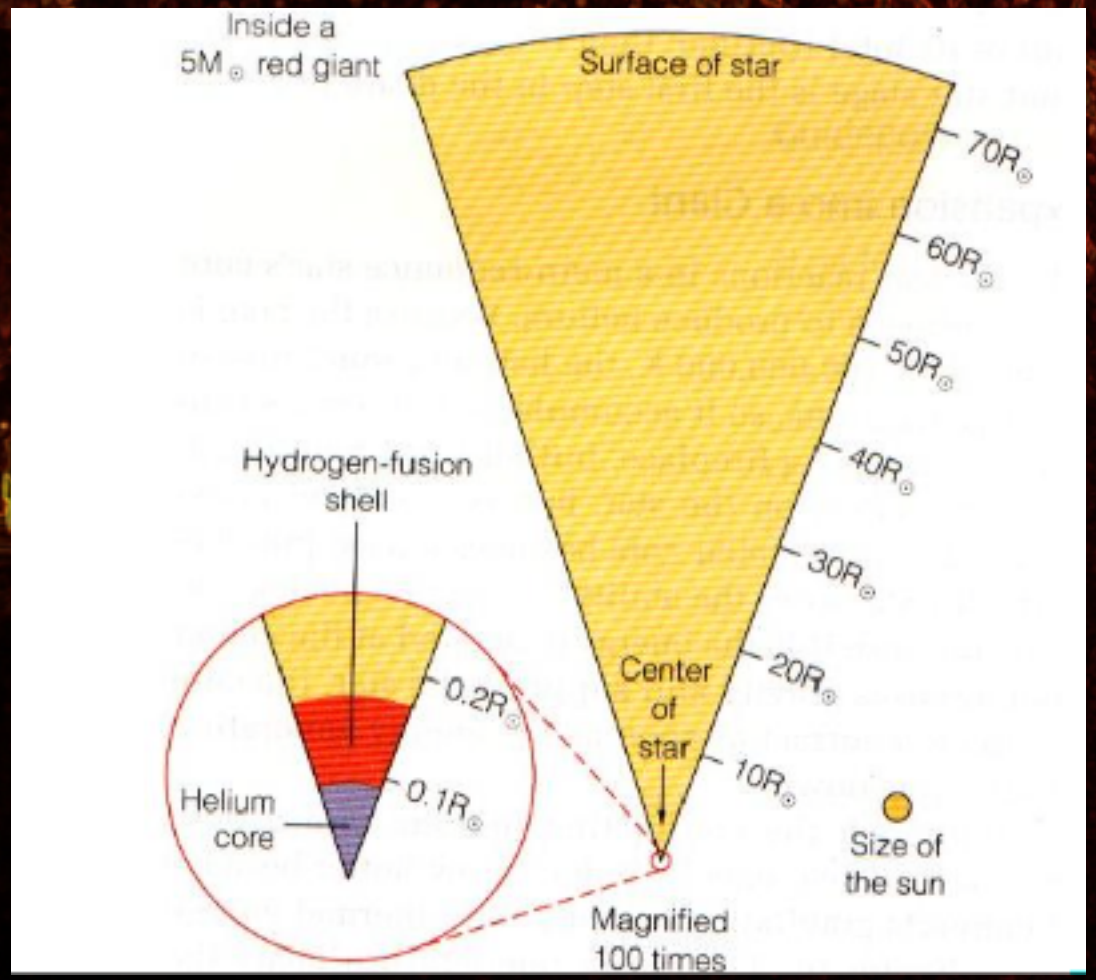
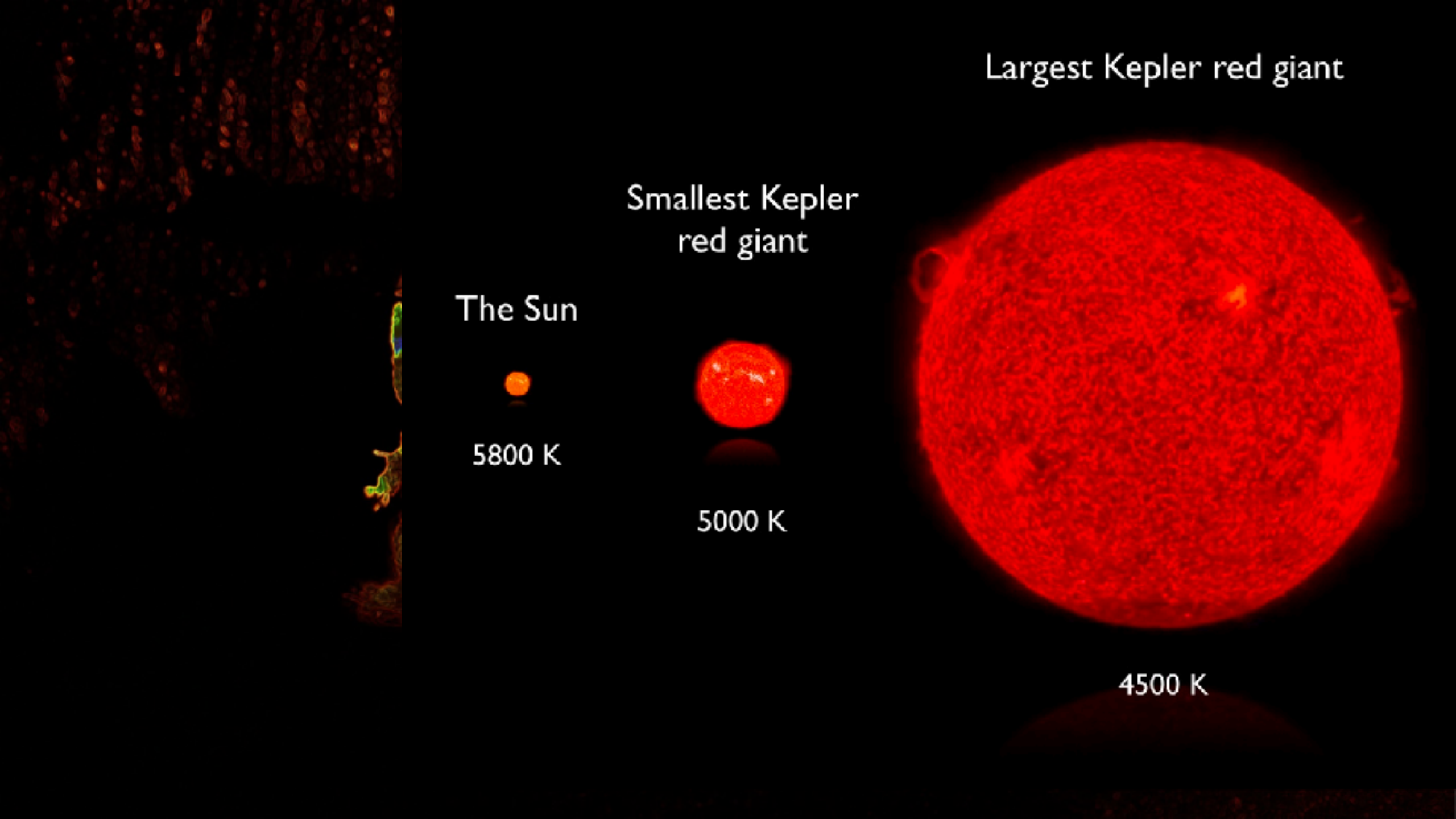
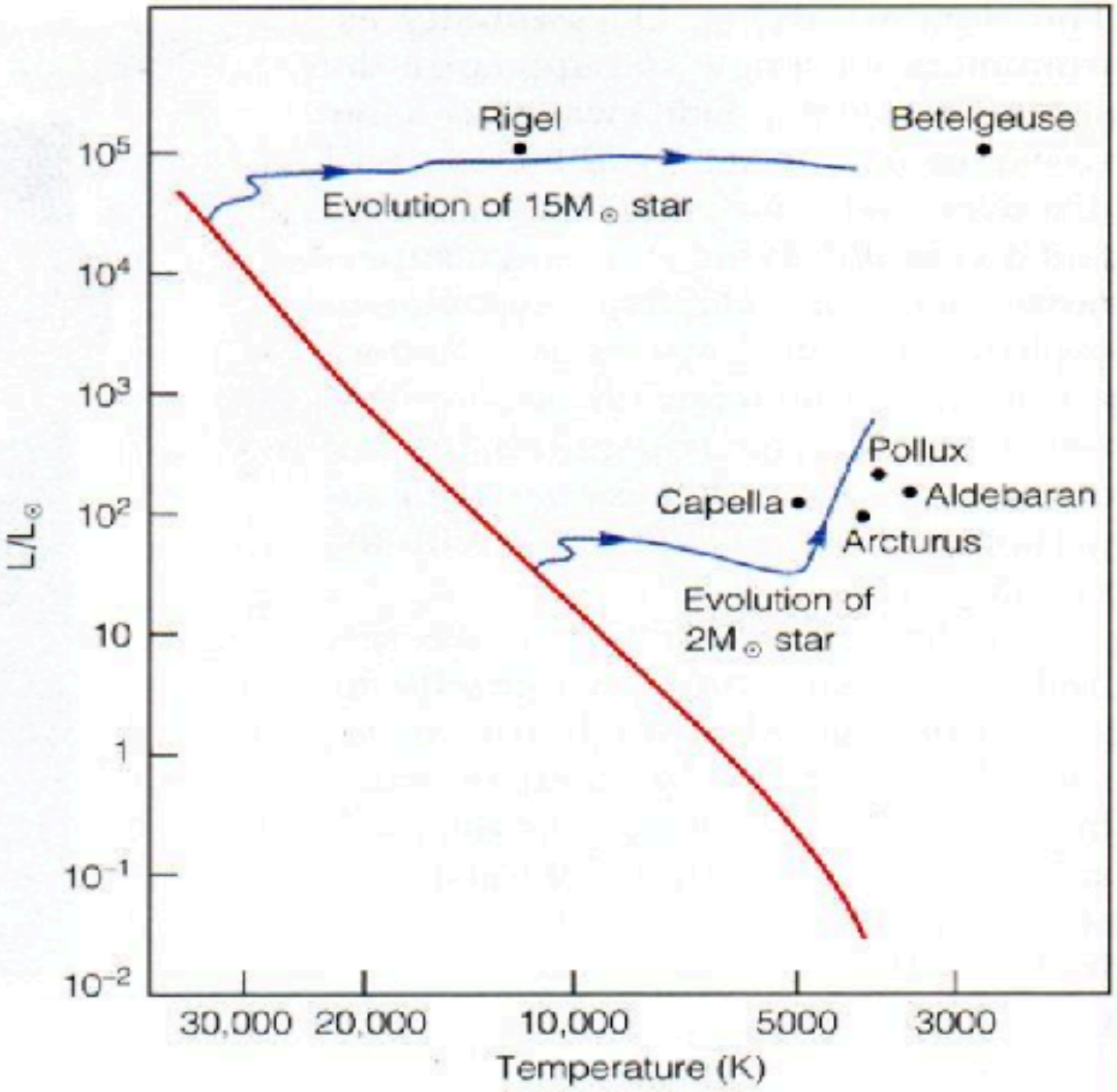
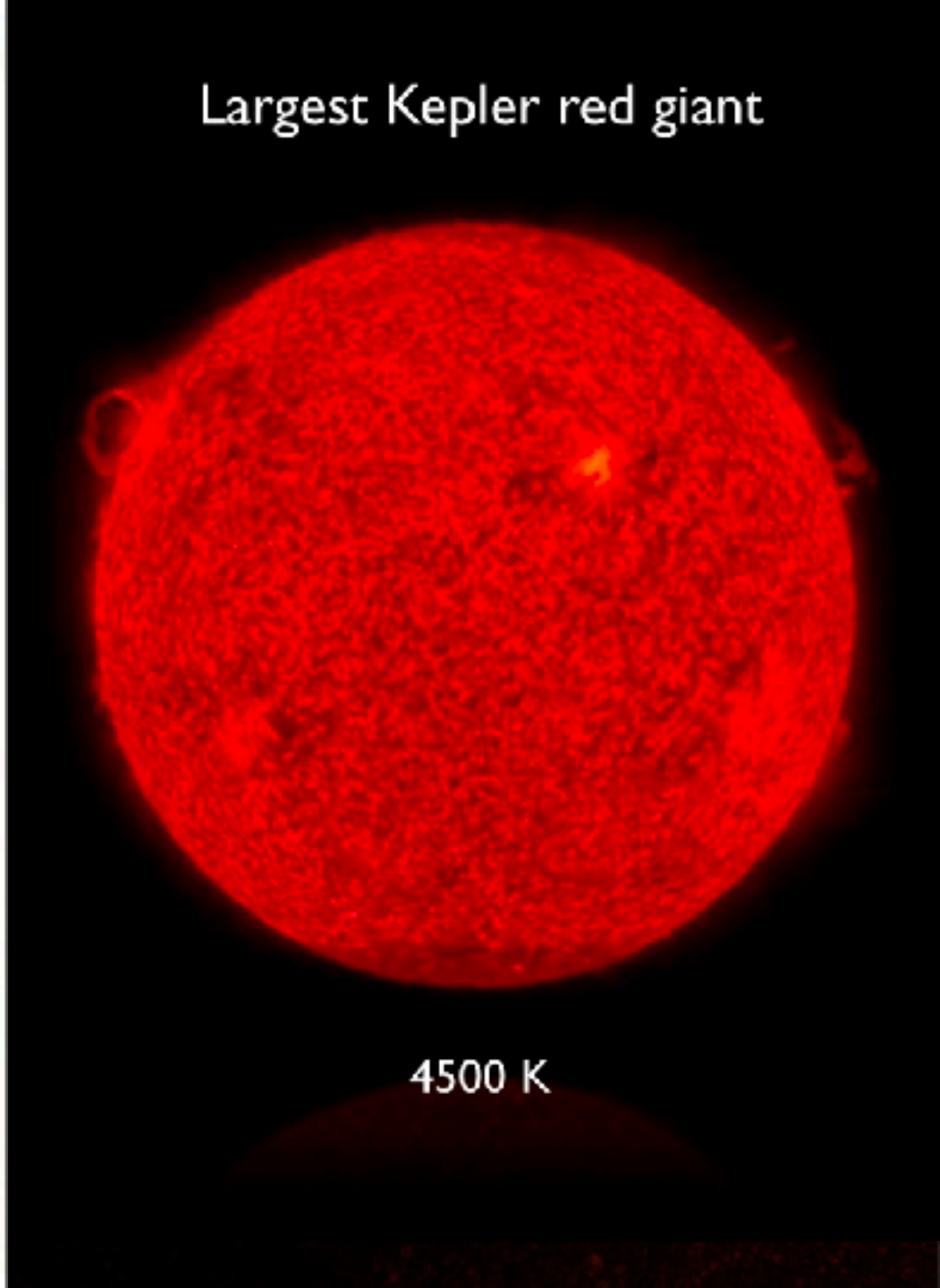
- Surface T ~3000K → looks RED




Largest Kepler red giant
Smallest Kepler red giant
The Sun
5800 K
5000 K
4500 K


Rigel
Betelgeuse
Evolution of 15M⊙ star
Pollux
Capella
Aldebaran
Arcturus
Evolution of
2M⊙ star
L/L⊙
10^5
10^4
10^3
10^2
10
1
10^-1
10^-2
30,000
20,000
10,000
5000
3000
Temperature (K)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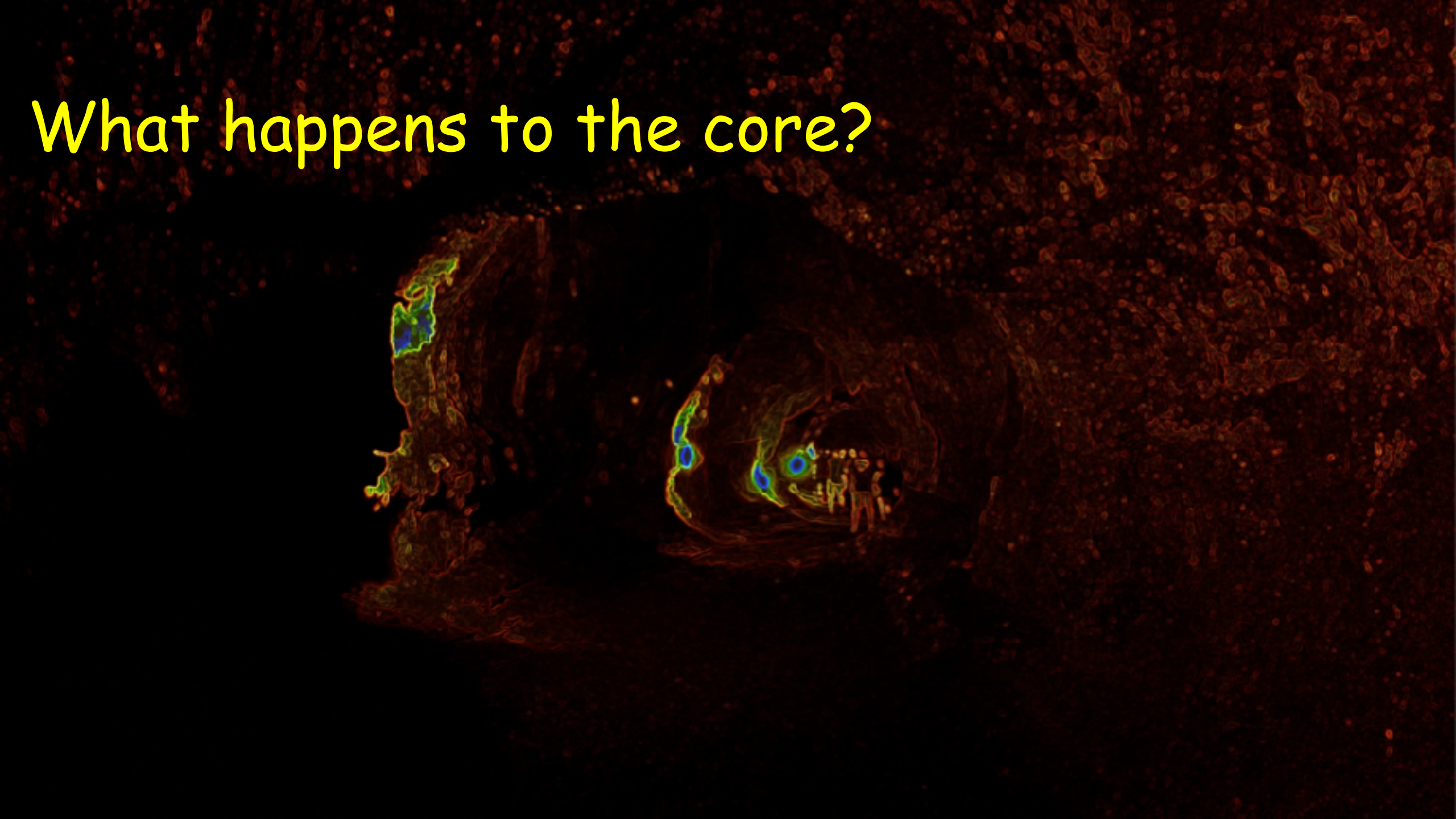

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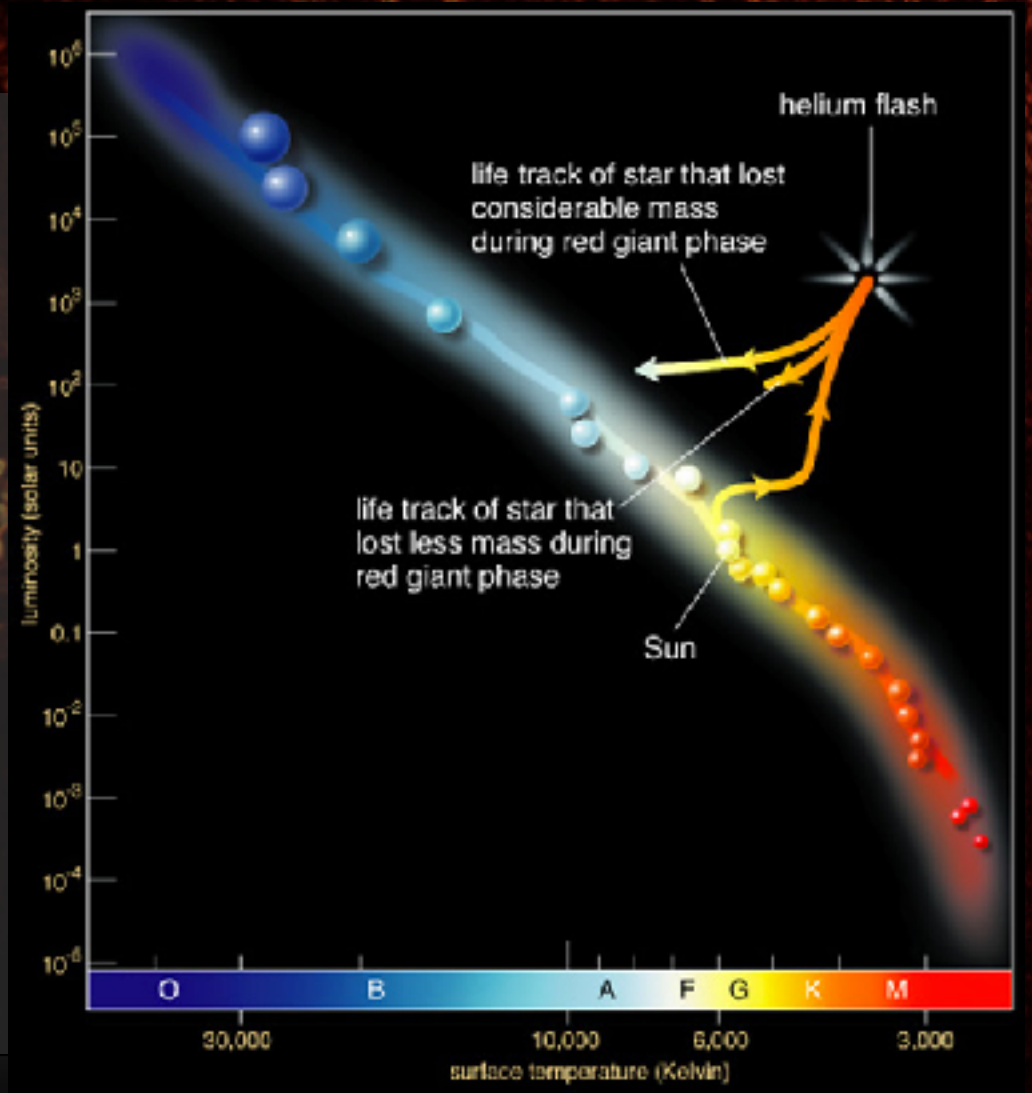
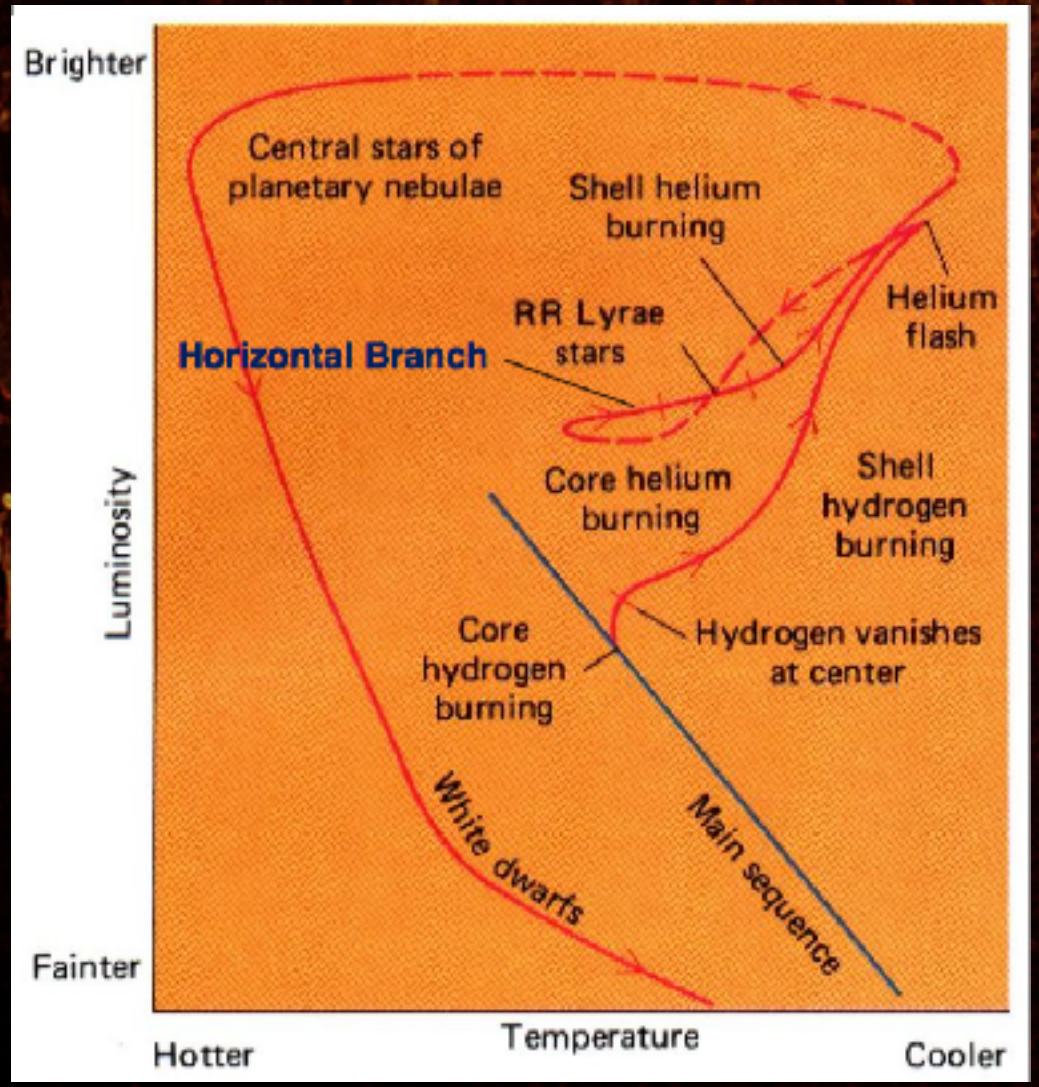
  2. H bruns in the shell

  Stays for few million years



Asymptotic Giant Branch



Asymptotic Giant Branch

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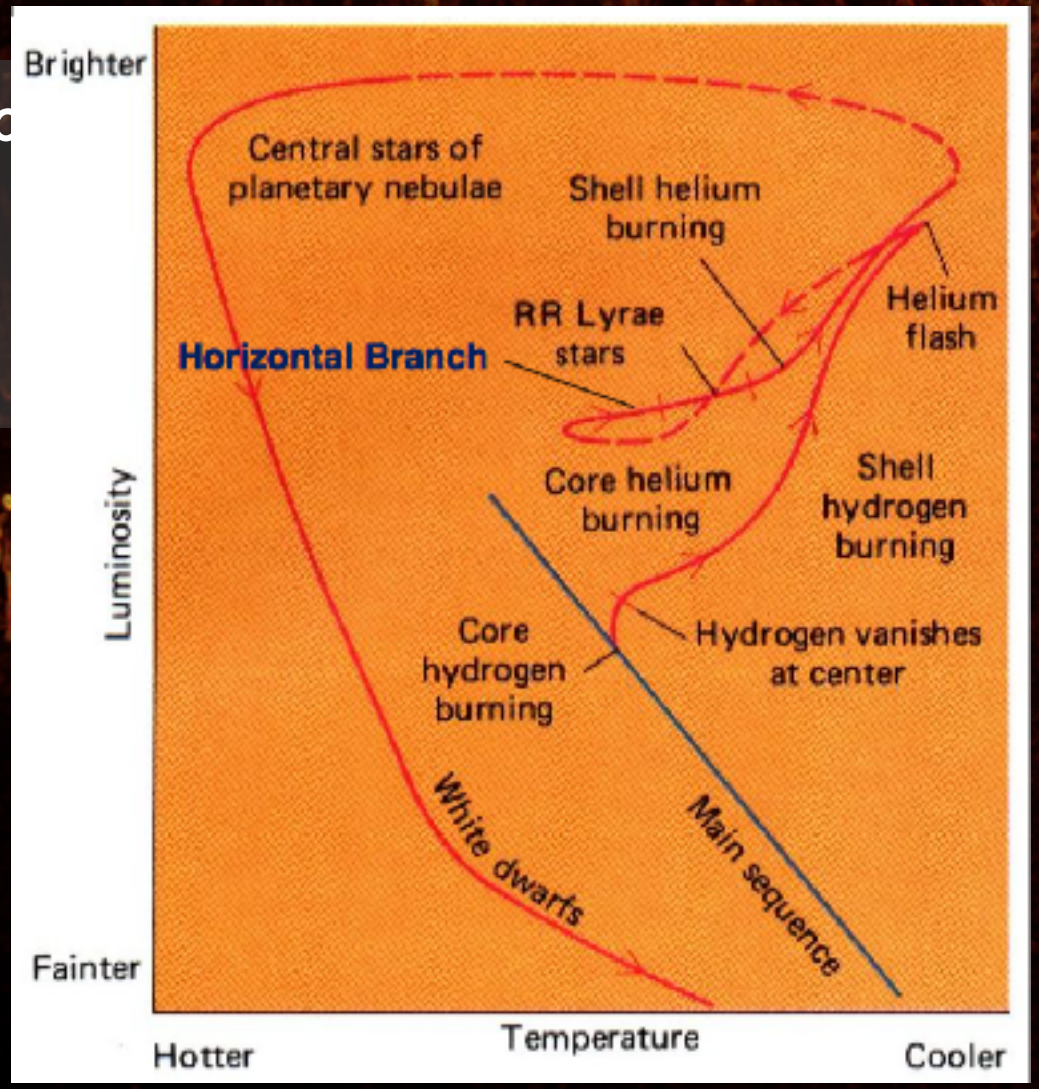

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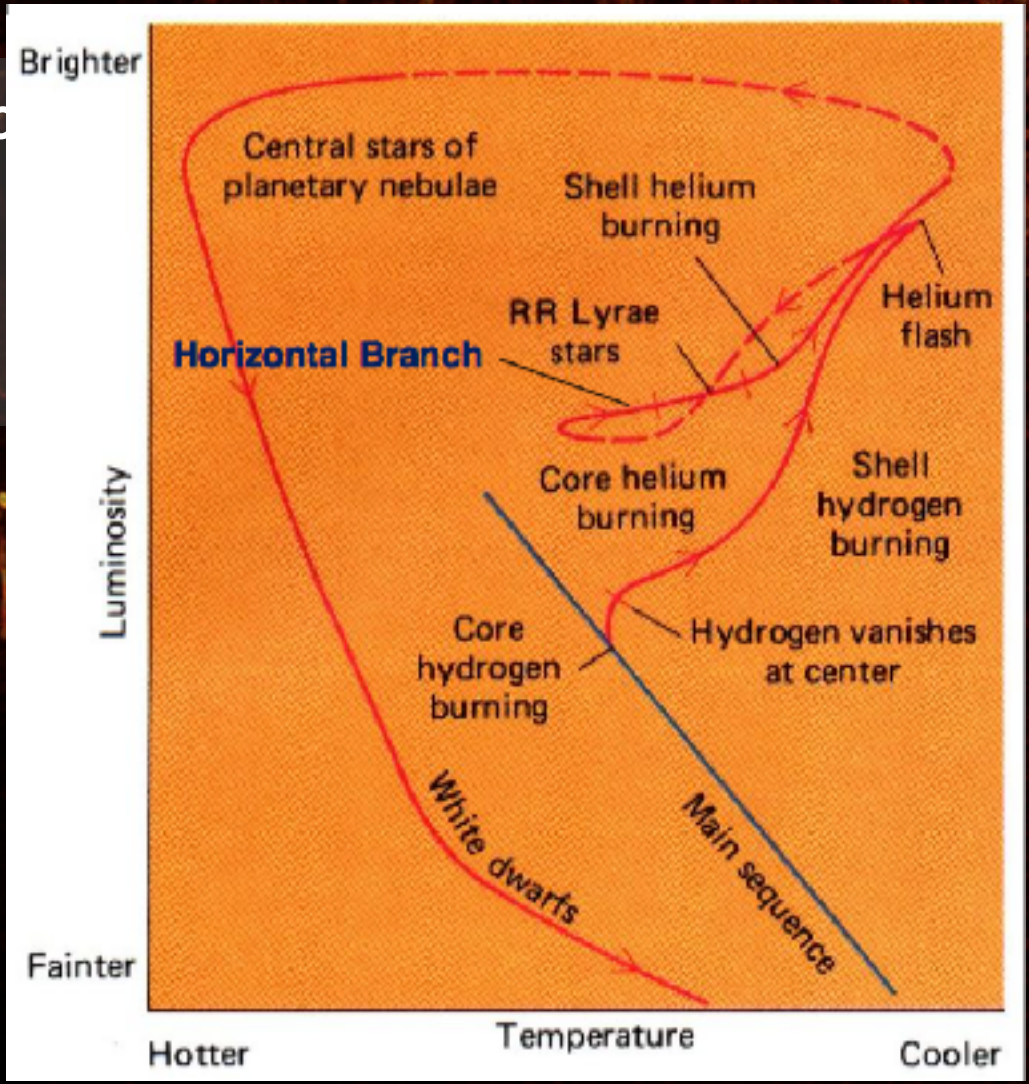

Asymptotic Giant Branch

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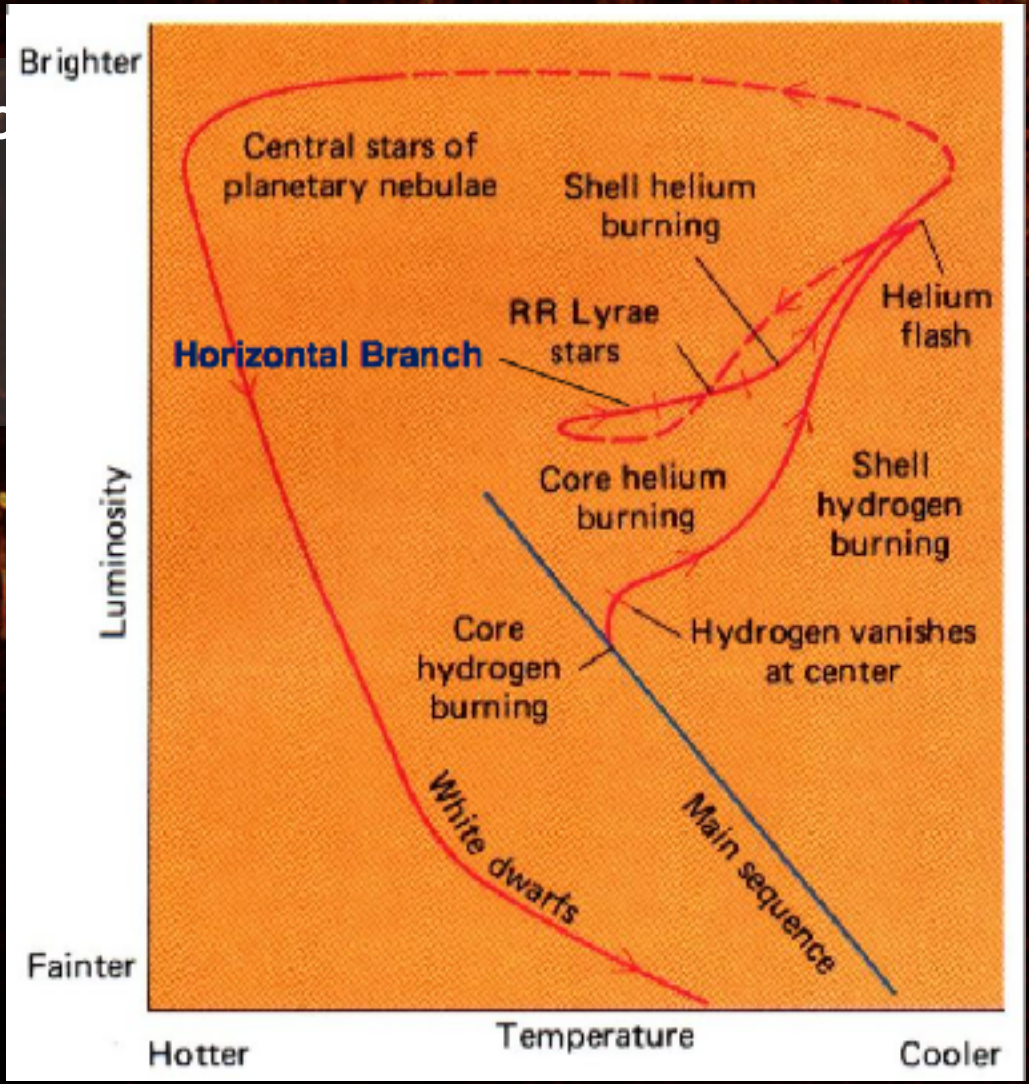
- Envelope becomes bigger and bigger



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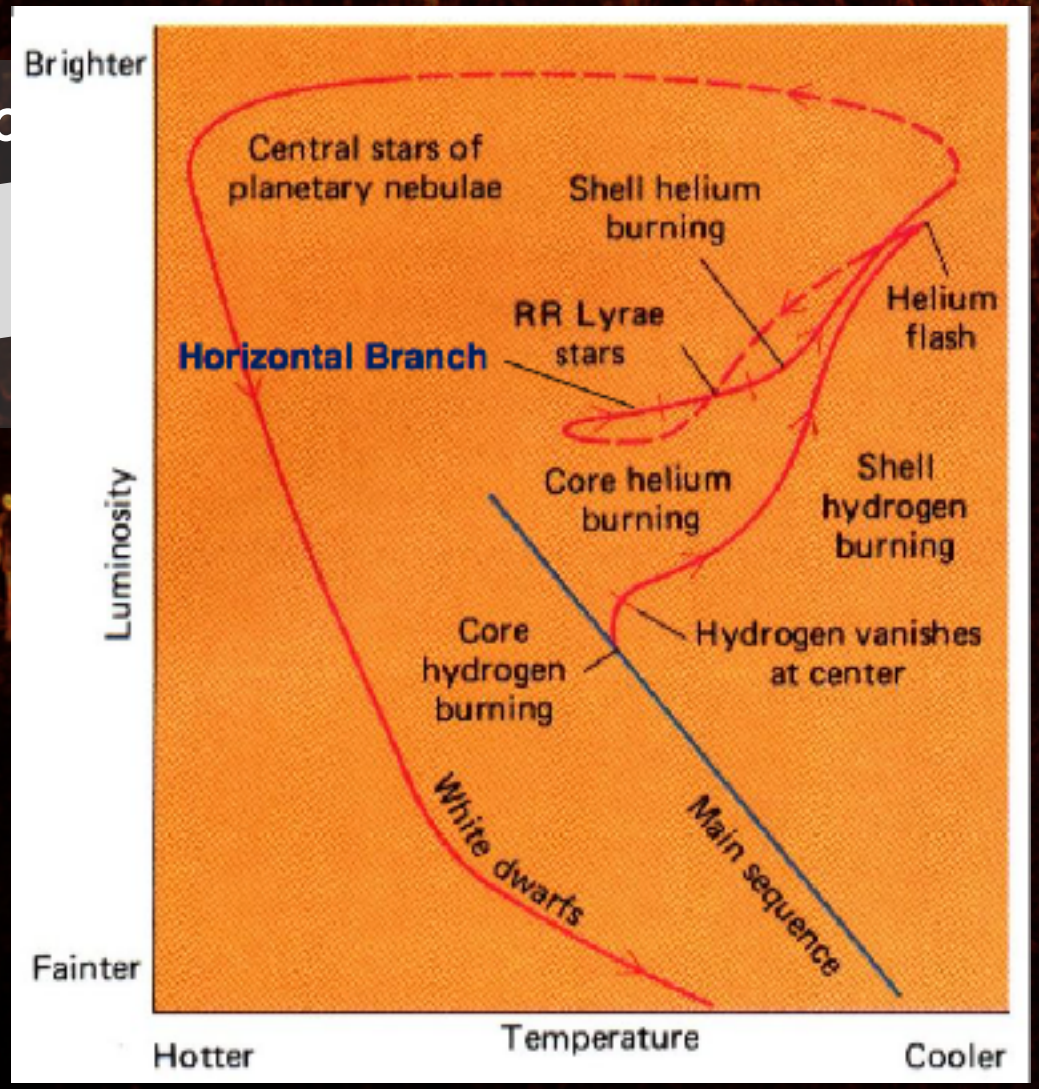

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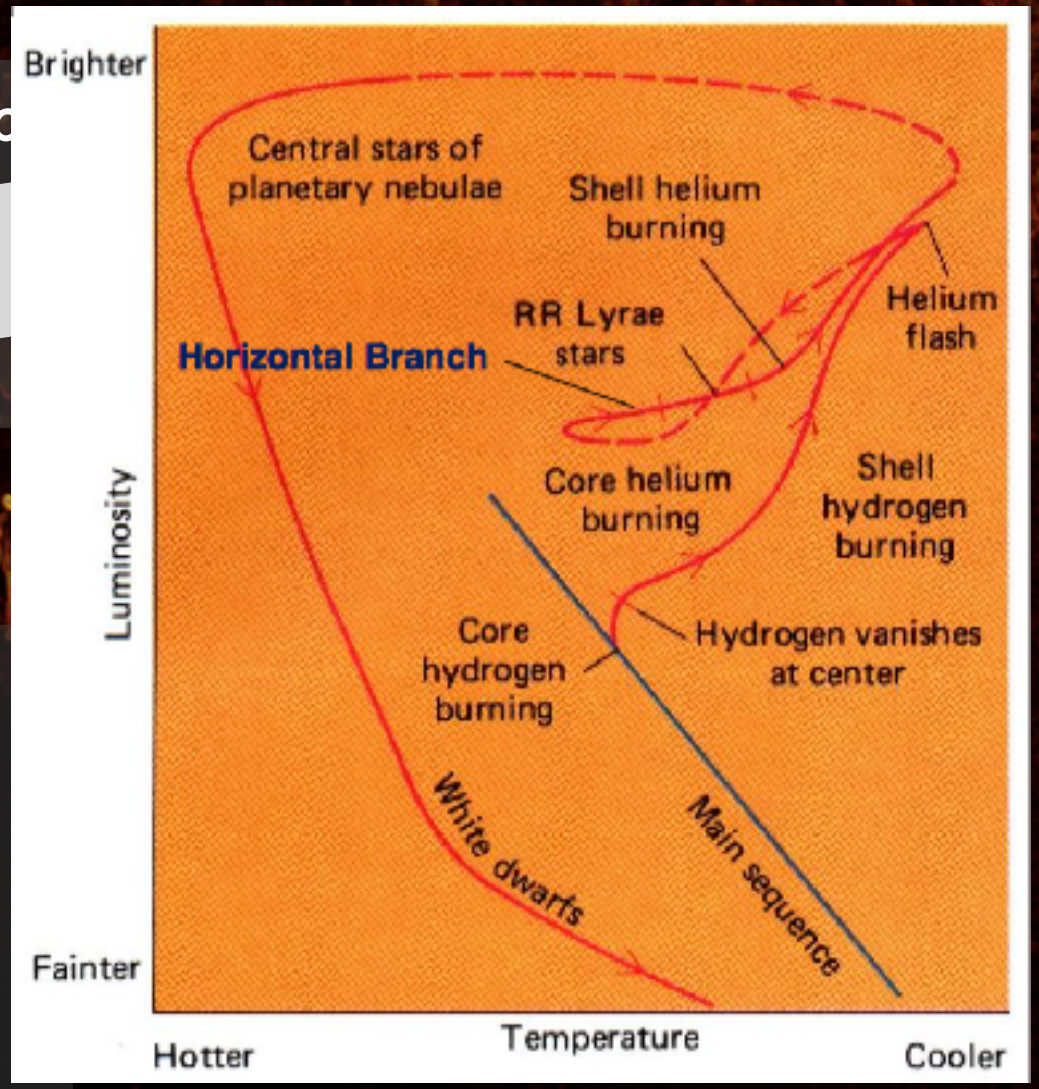

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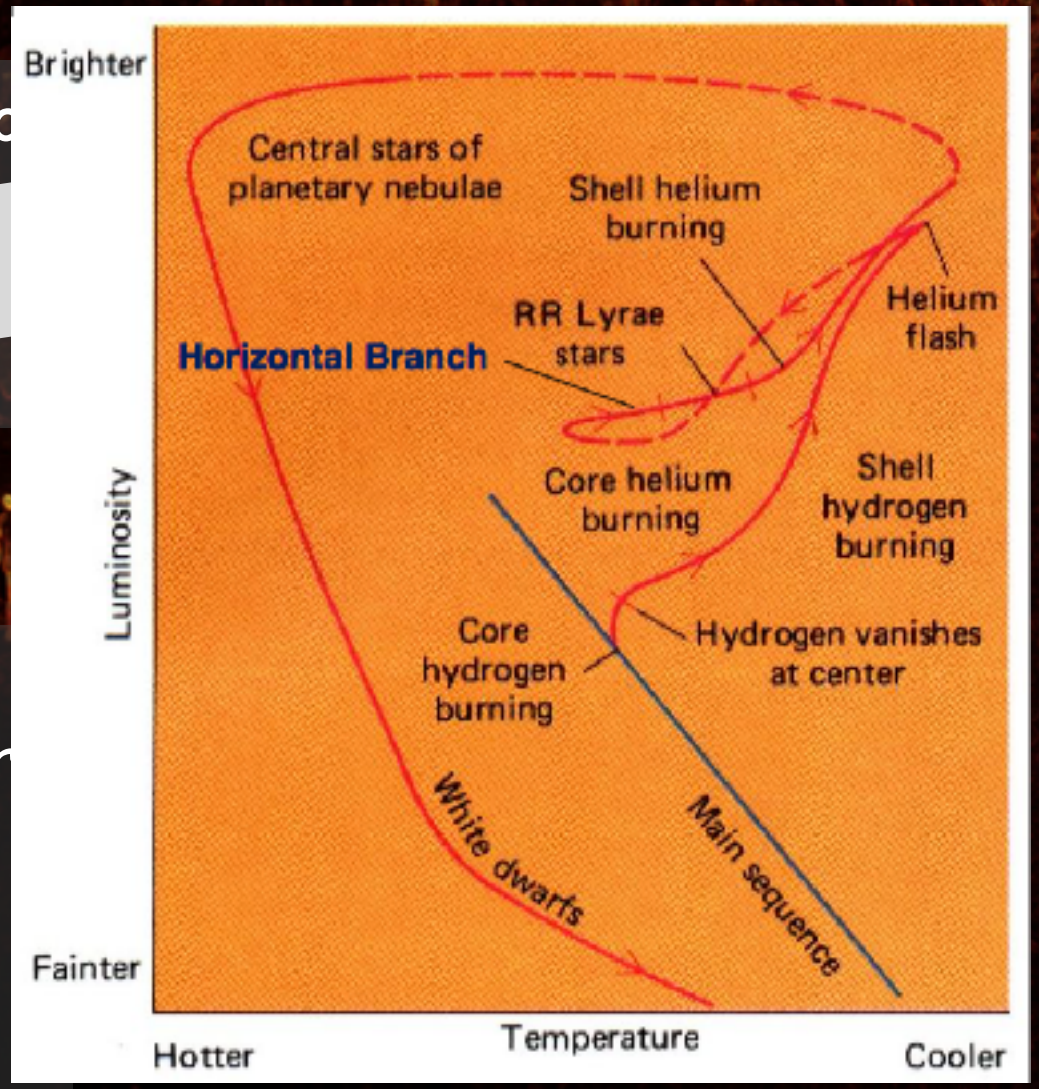

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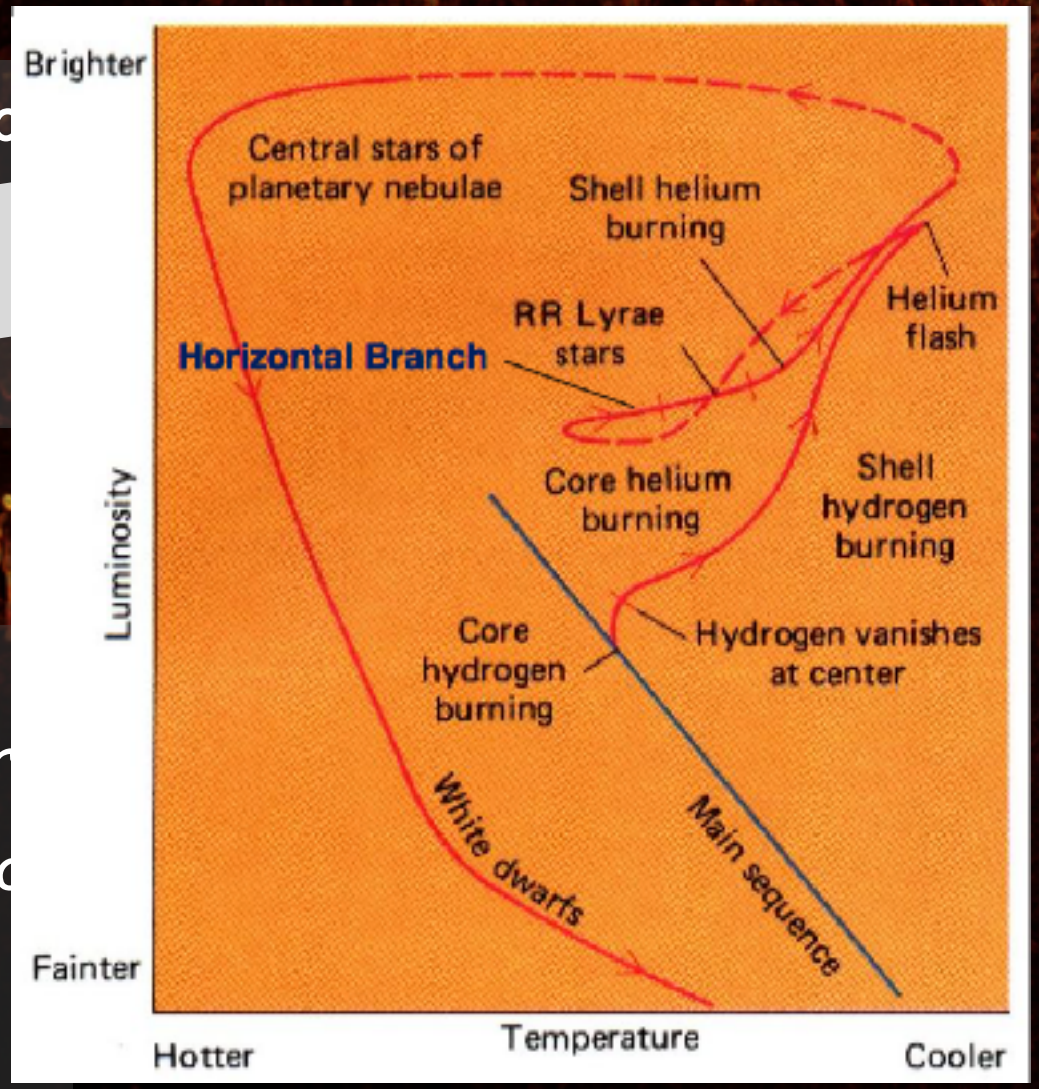
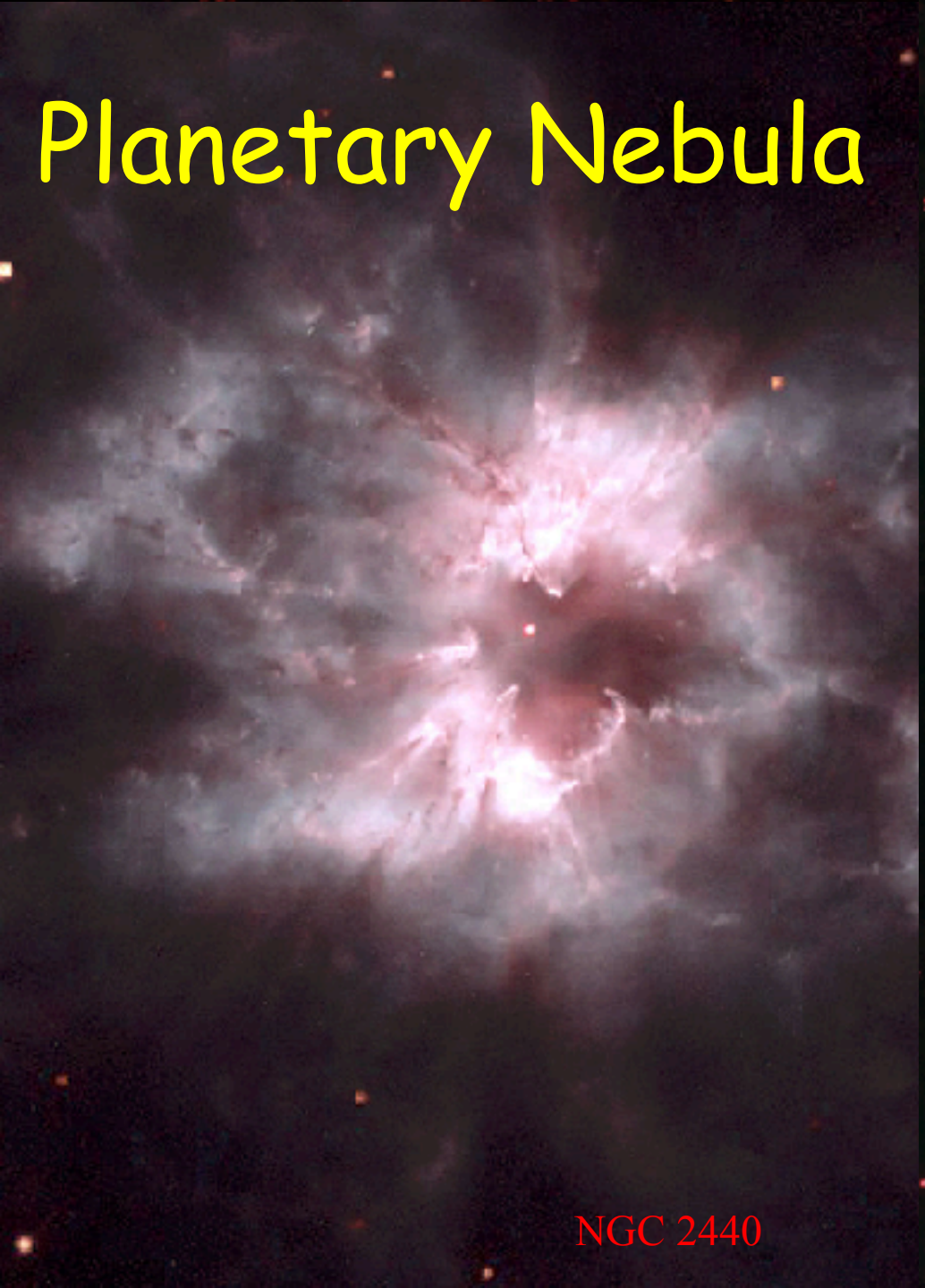
- We end up with a Planetary Nebula and a

White Dwarf



Planetary Nebula

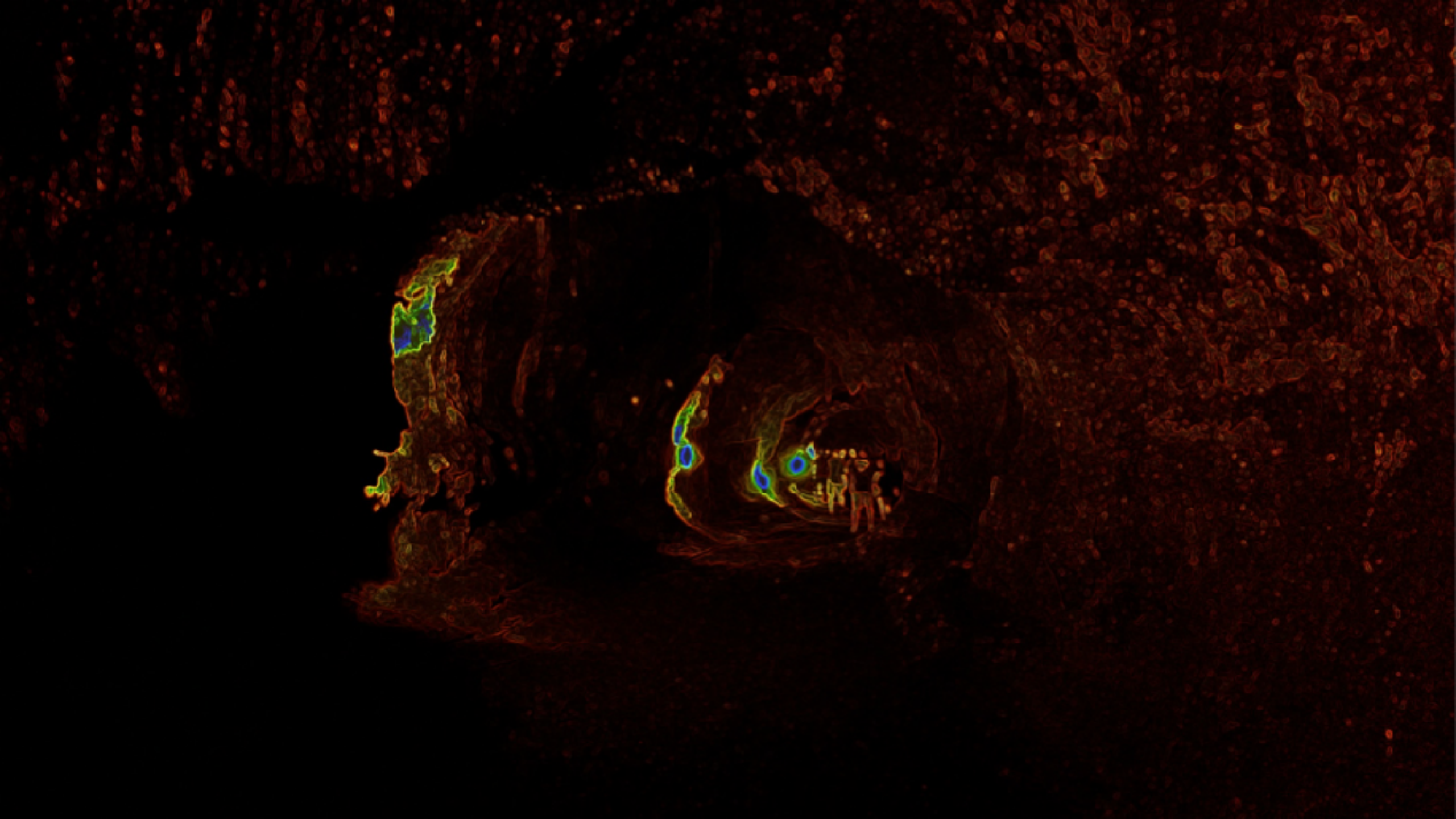


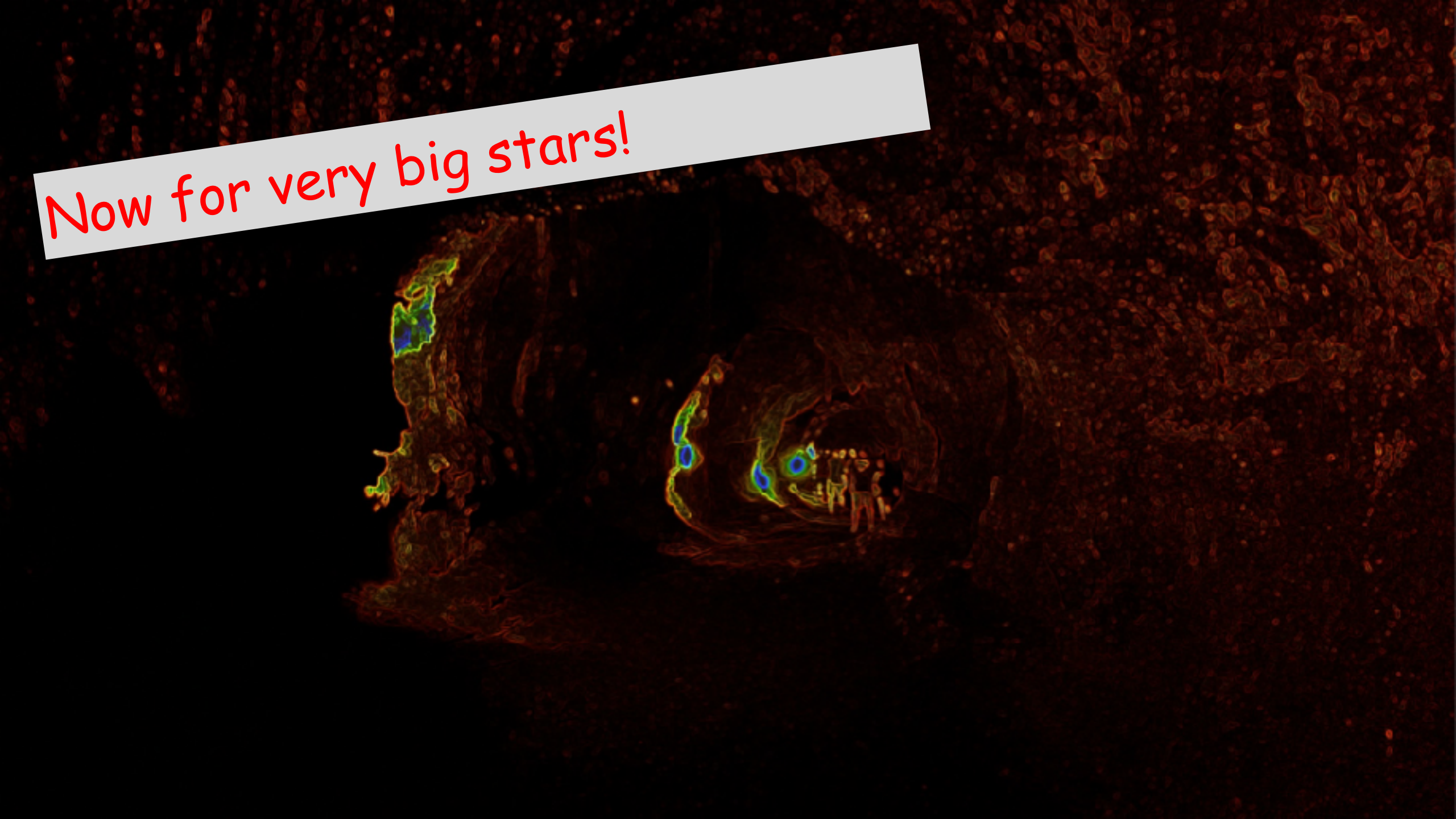
NGC 2440

Ring Nebula

White Dwarf

- Has He, C, O
- Supported by electron degeneracy pressure
- Starts up very hot→ cools quickly → cannot shrink

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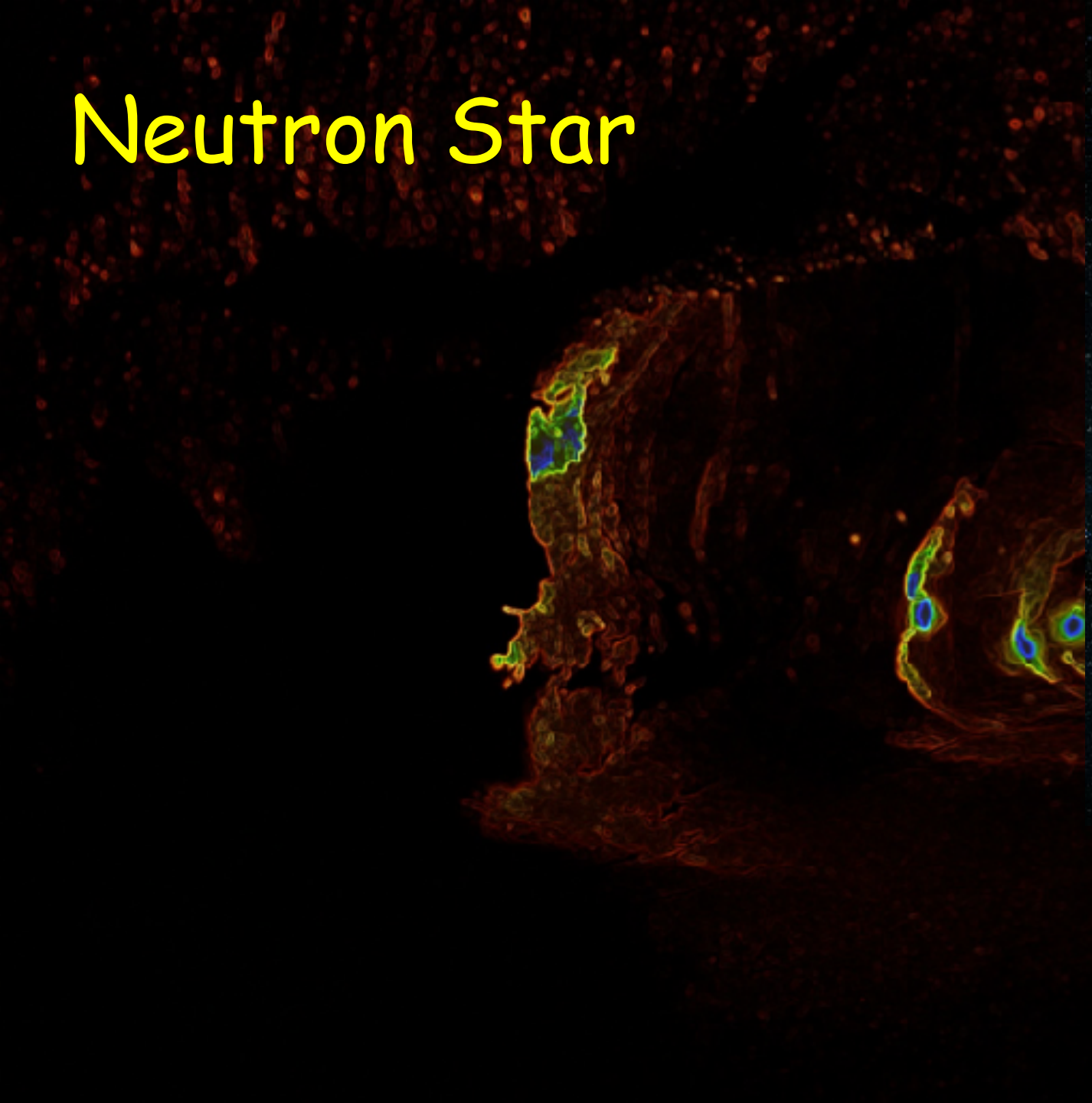

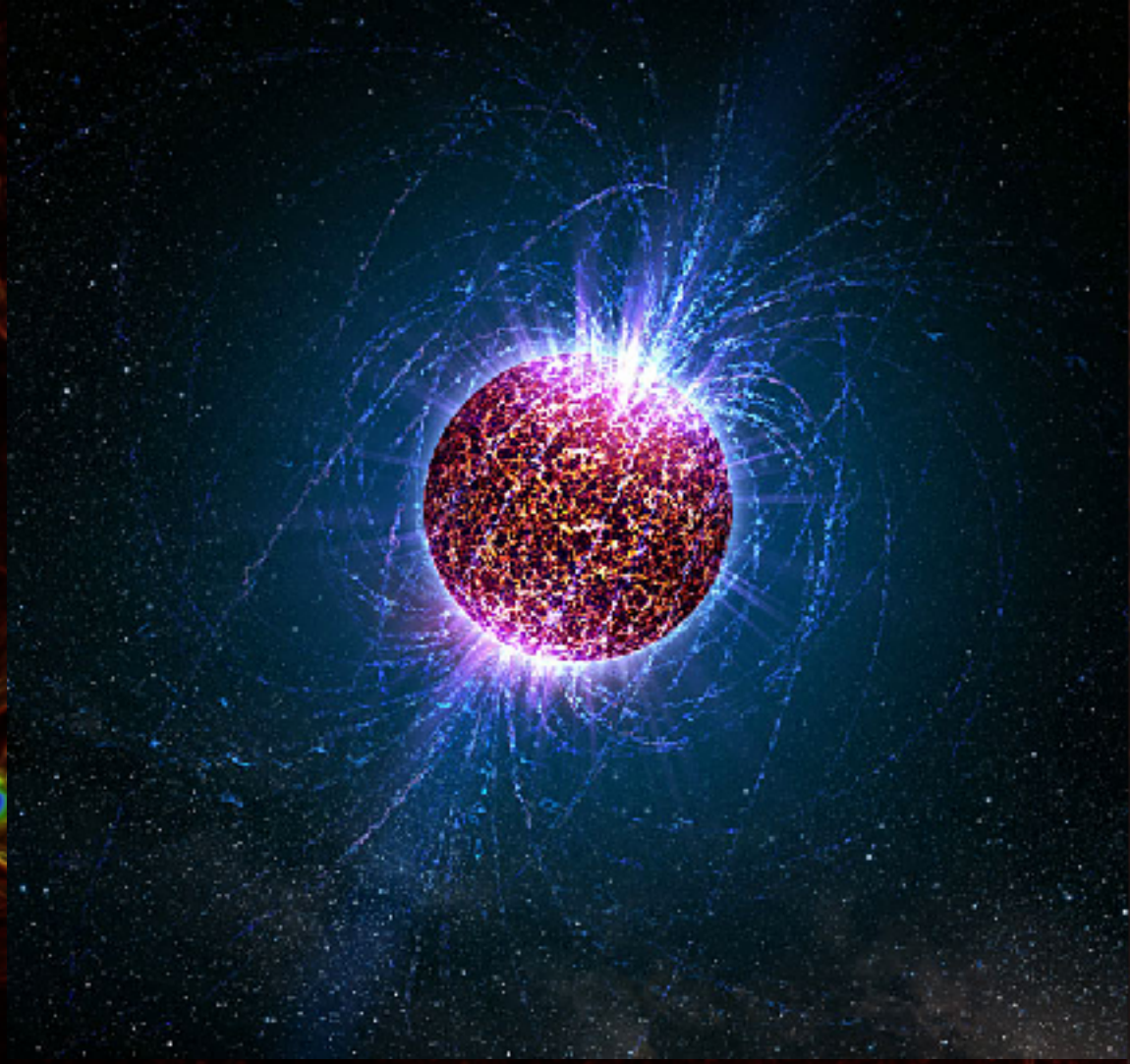

Neutron Star

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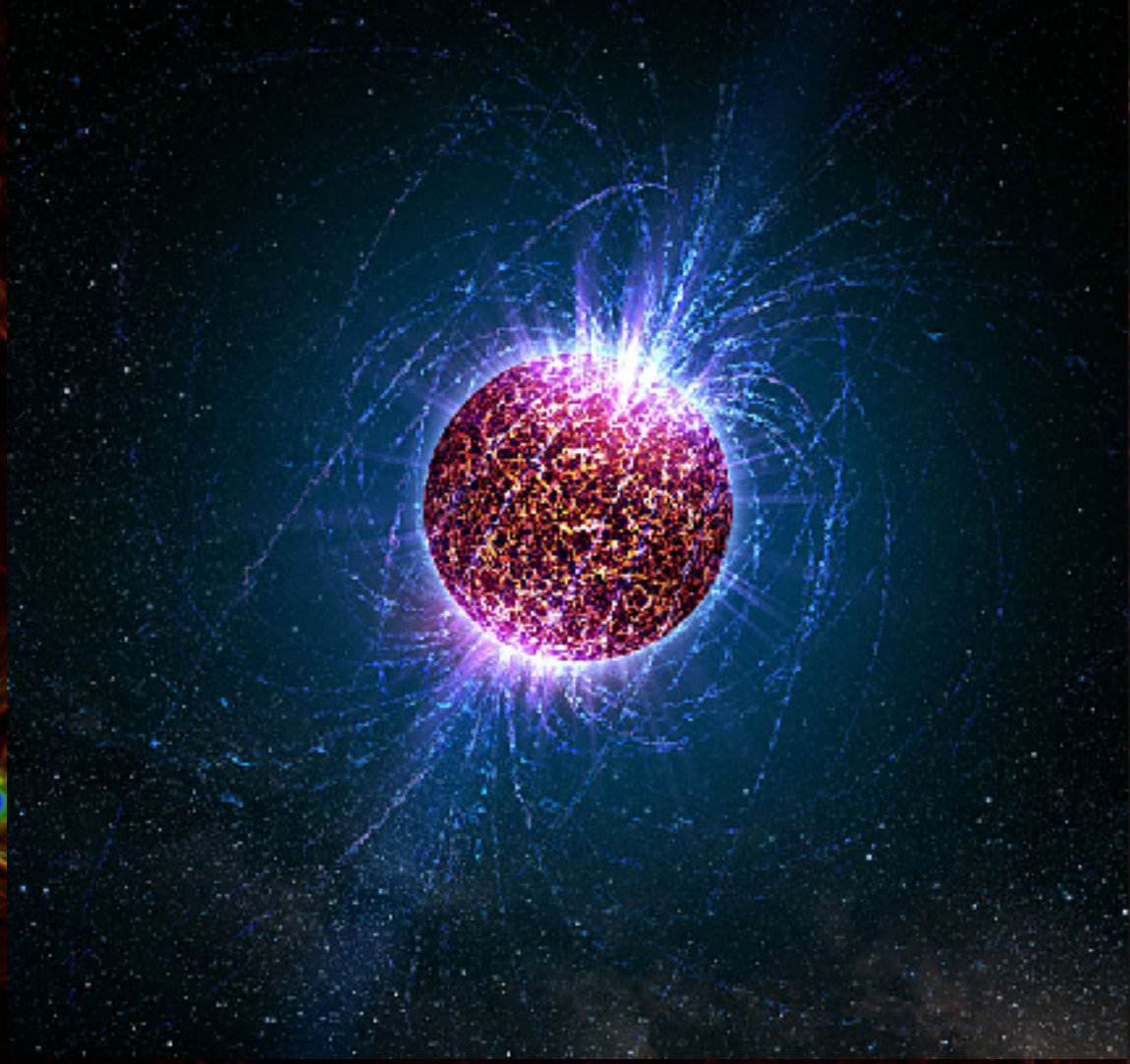

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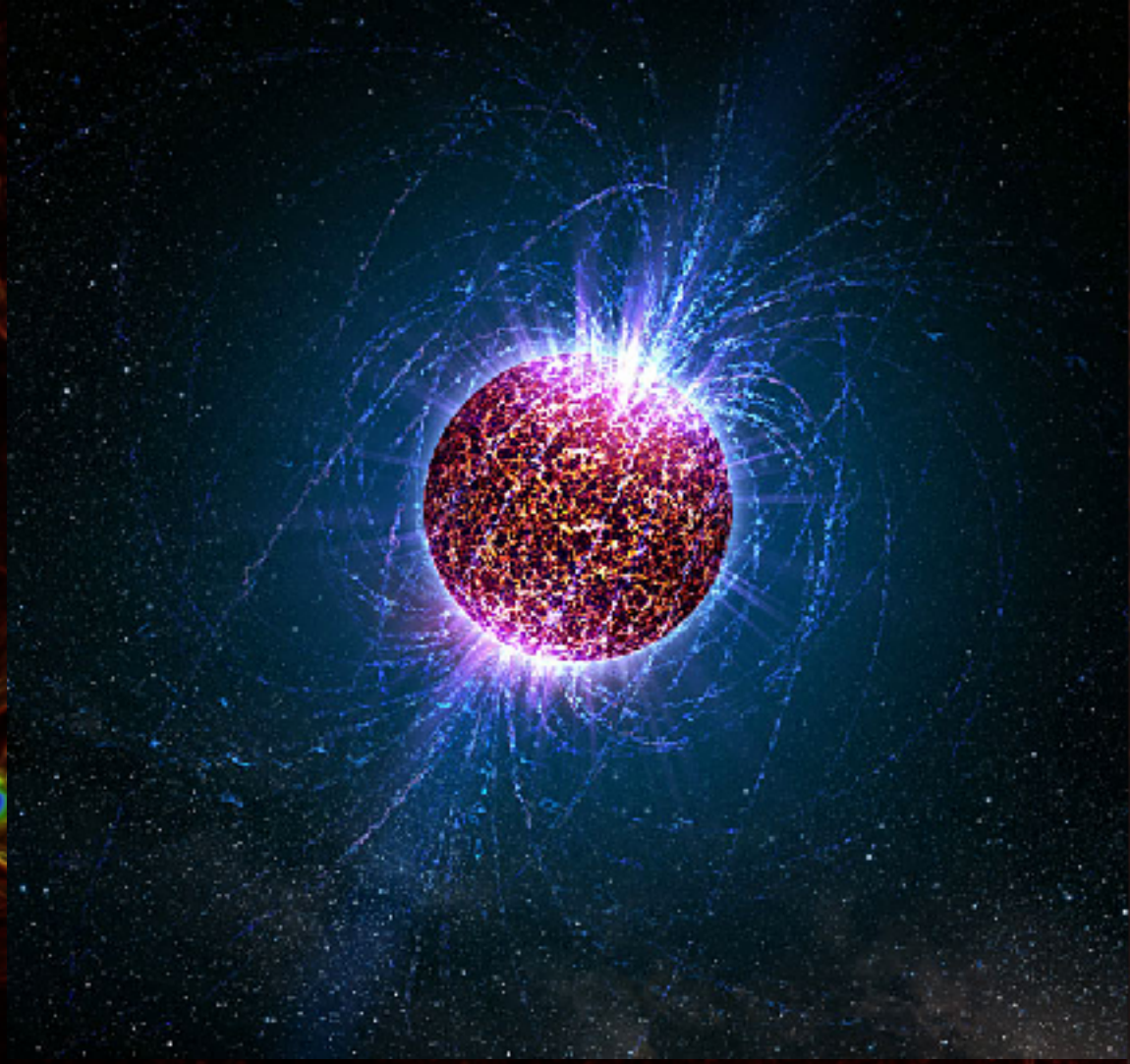

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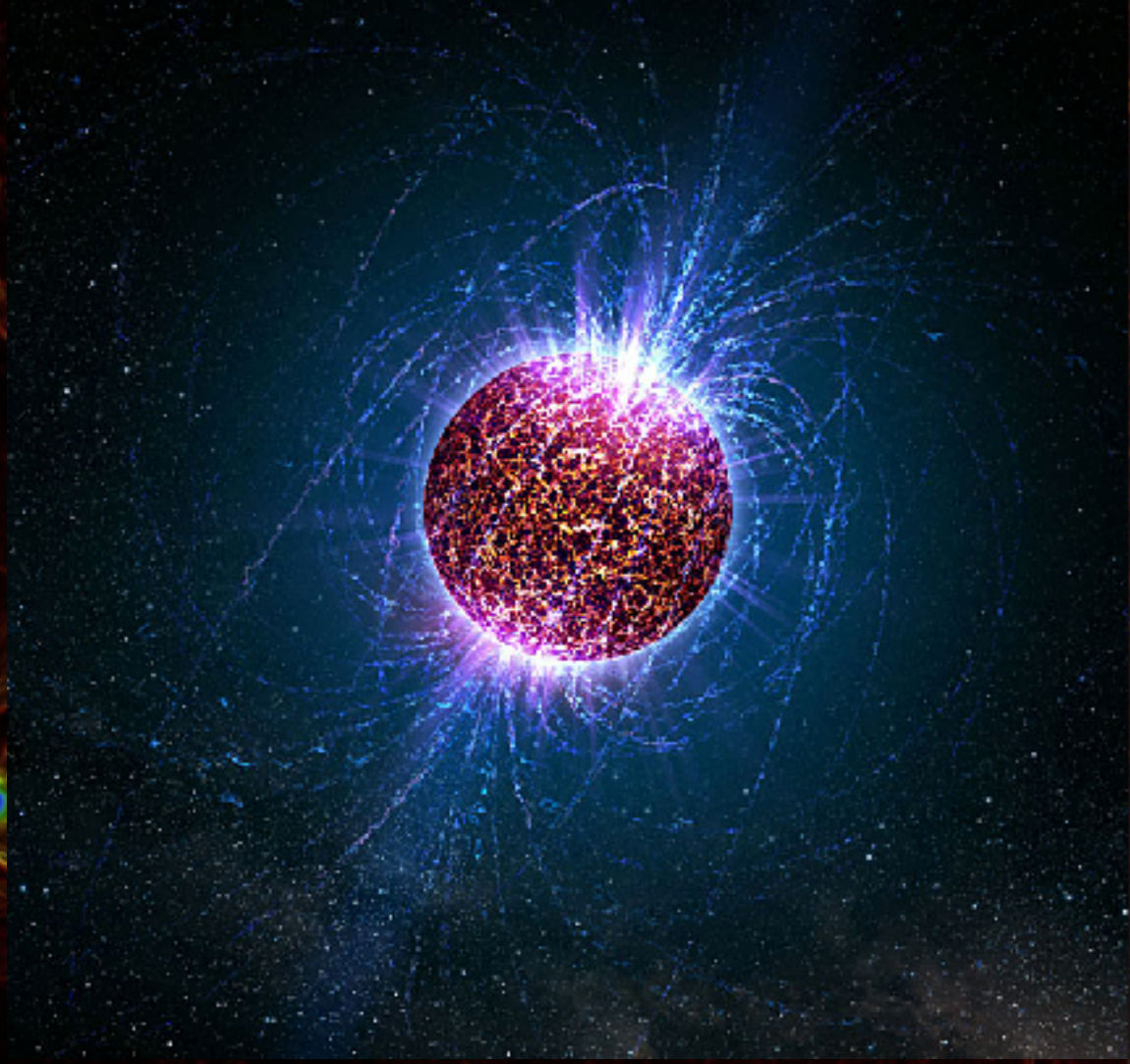

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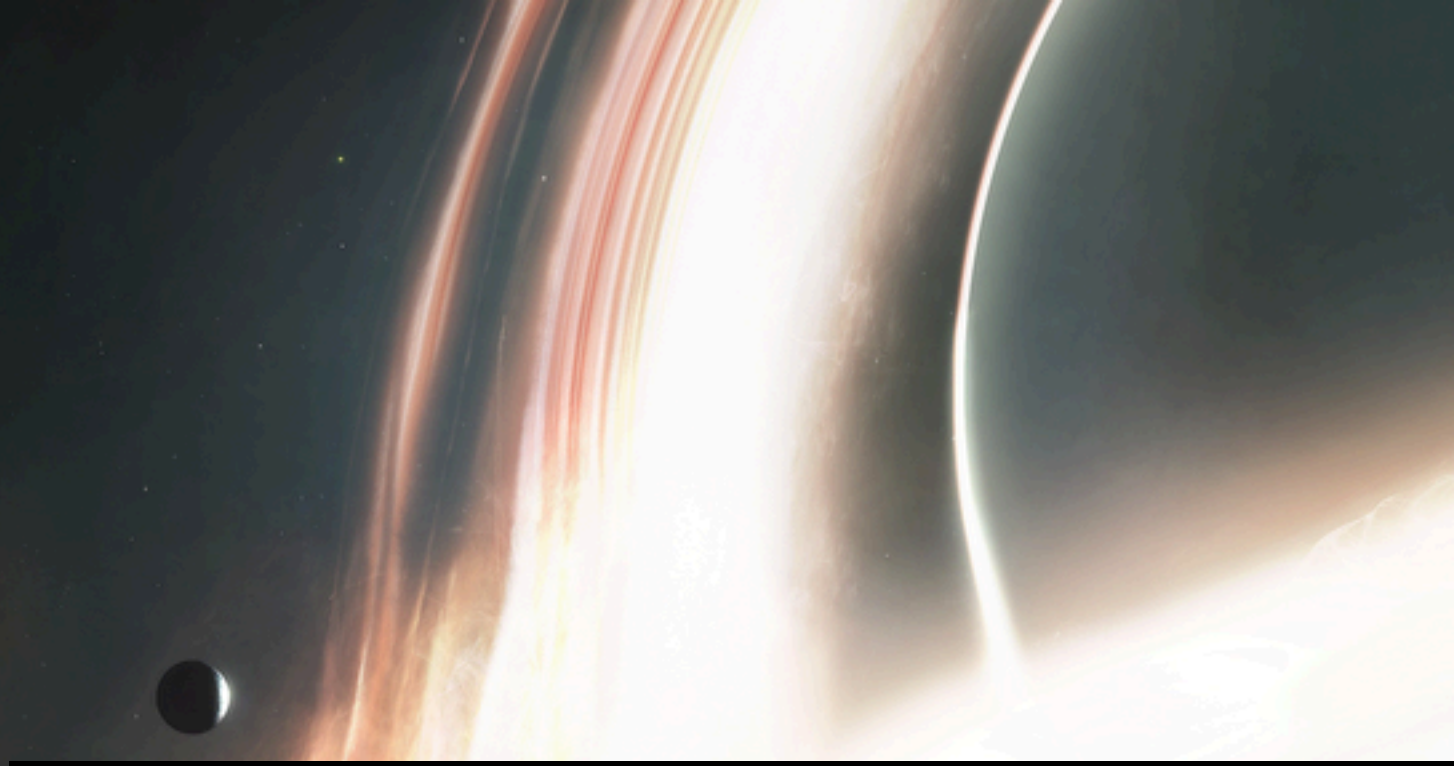
But this is not the end of the story

Black Hole

- Forms is the core of the collapsing star > 3 X mass of the sun
- Radius → 0
- Extremely strong gravity: even light cannot escape from the centre

Black Hole



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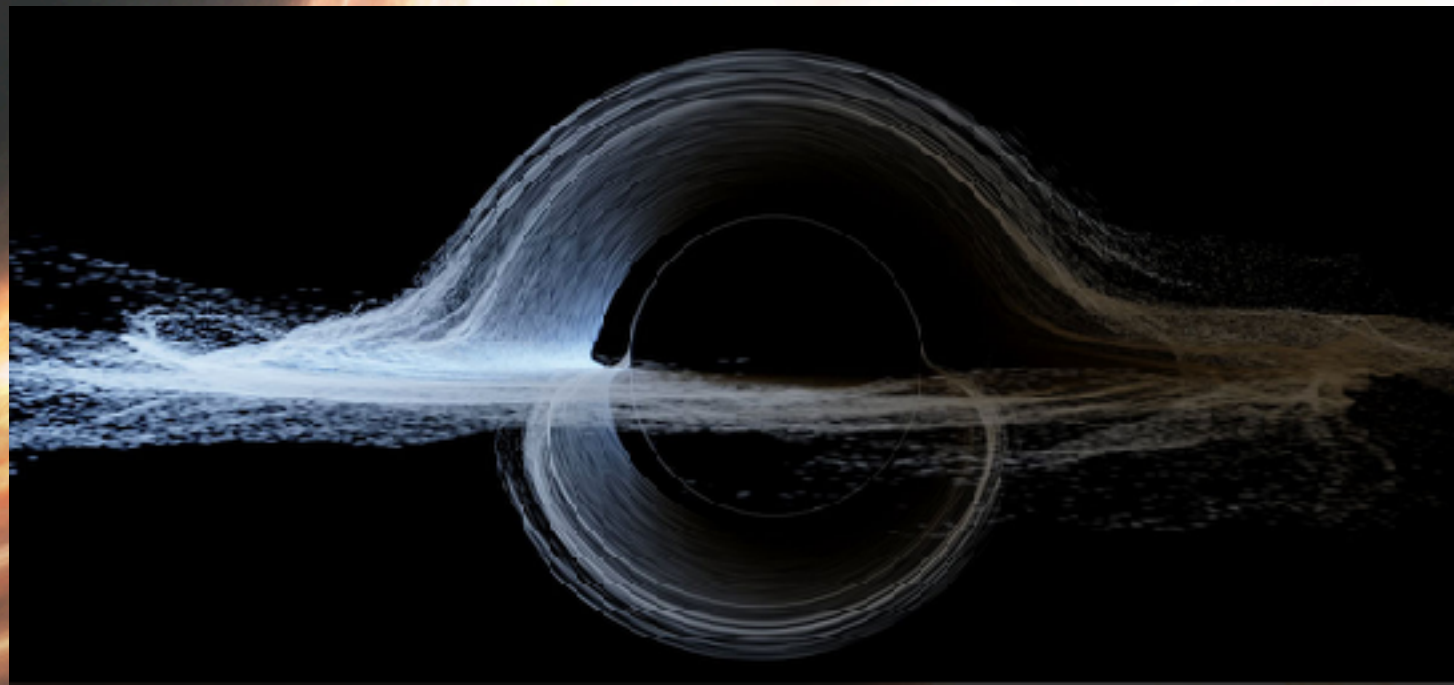
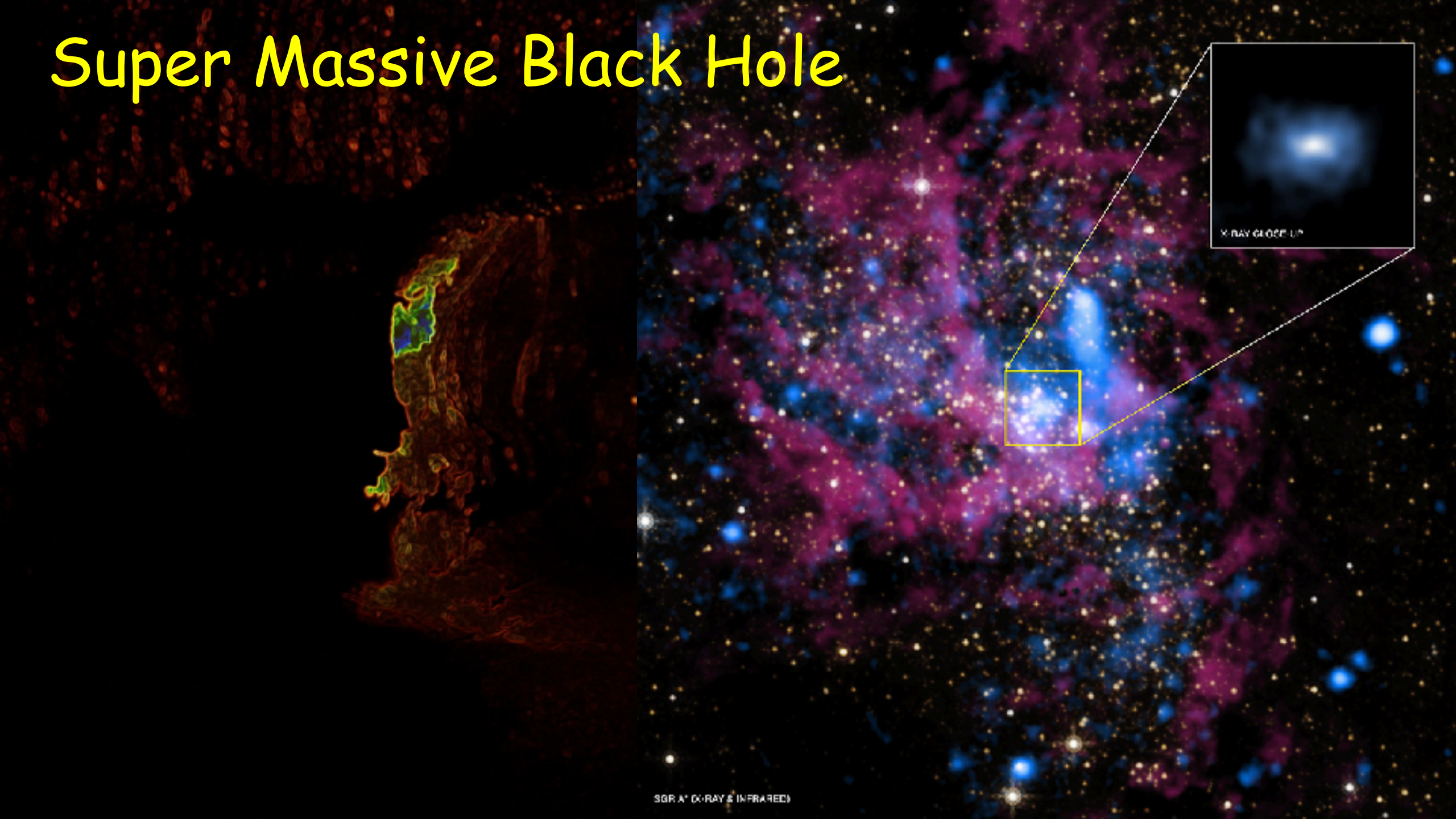


Super Massive Black Hole



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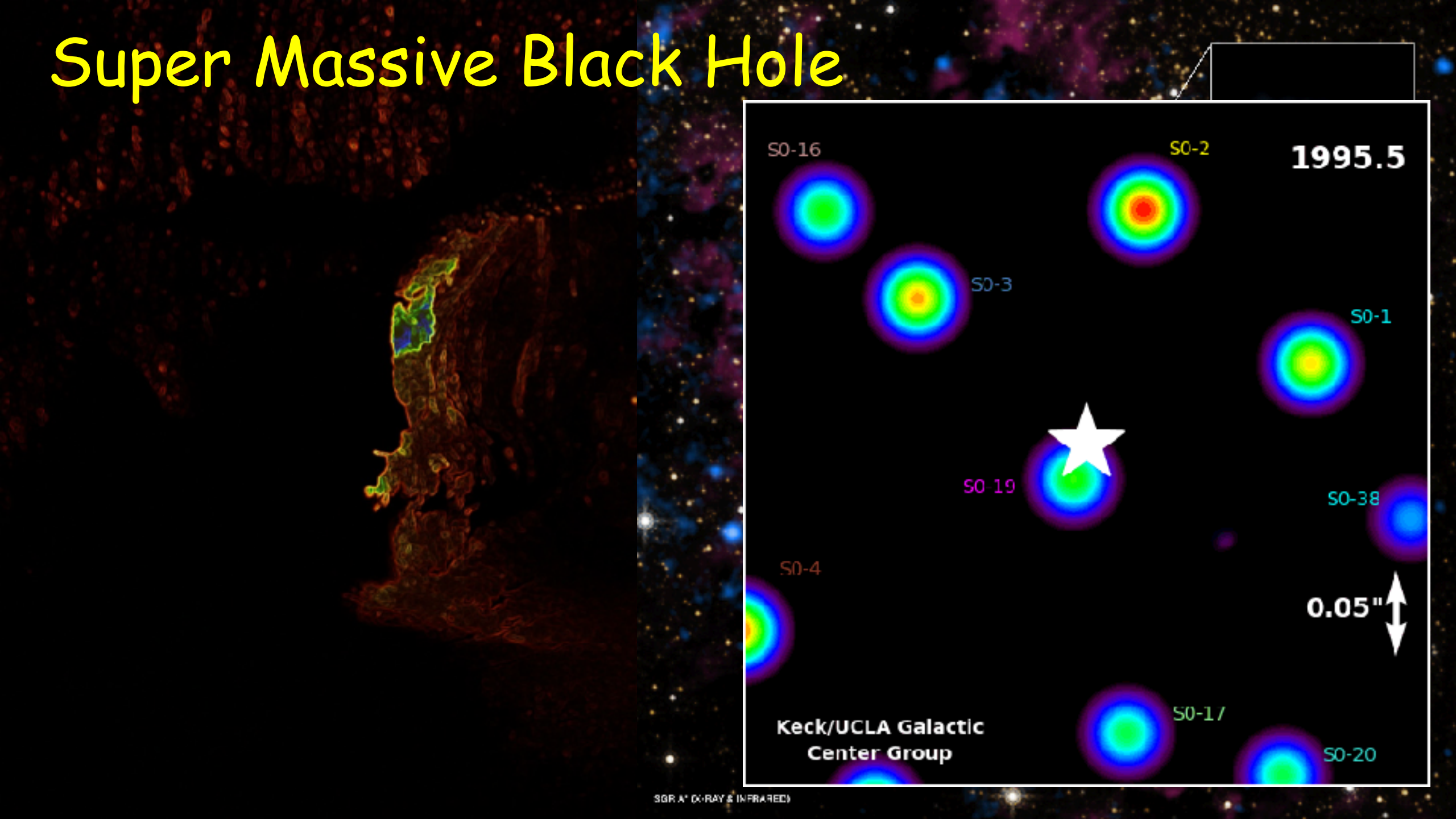

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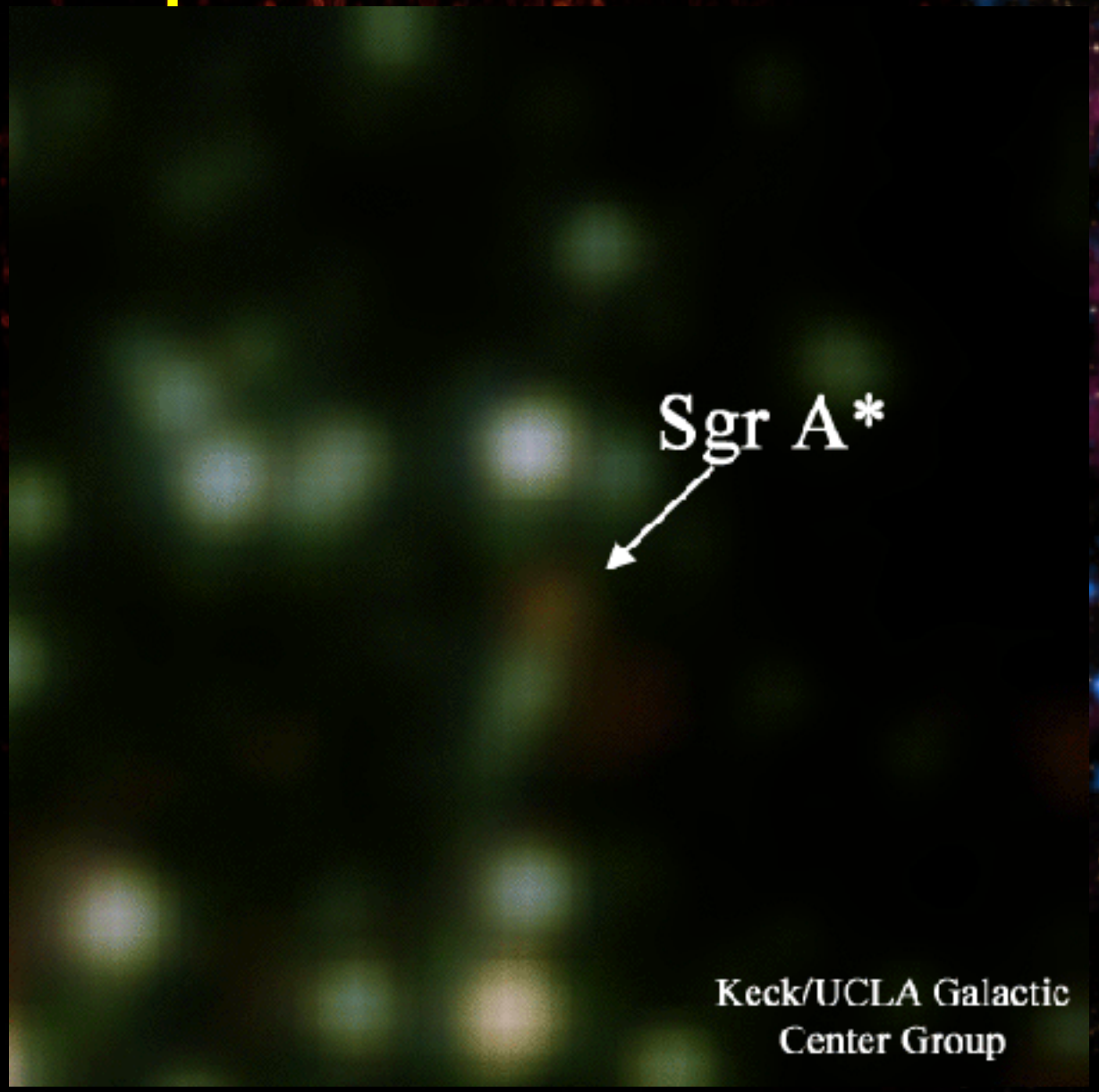
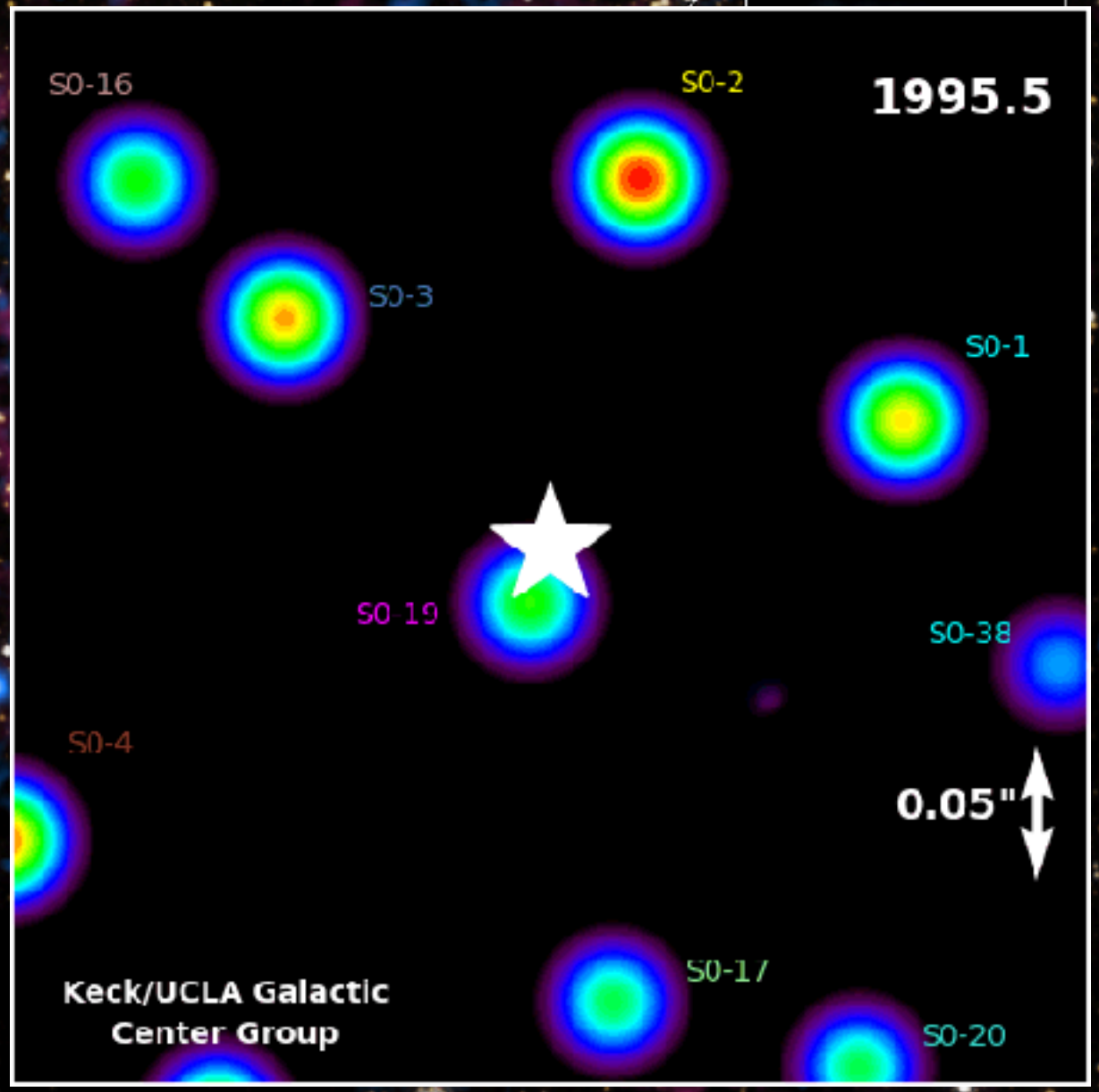
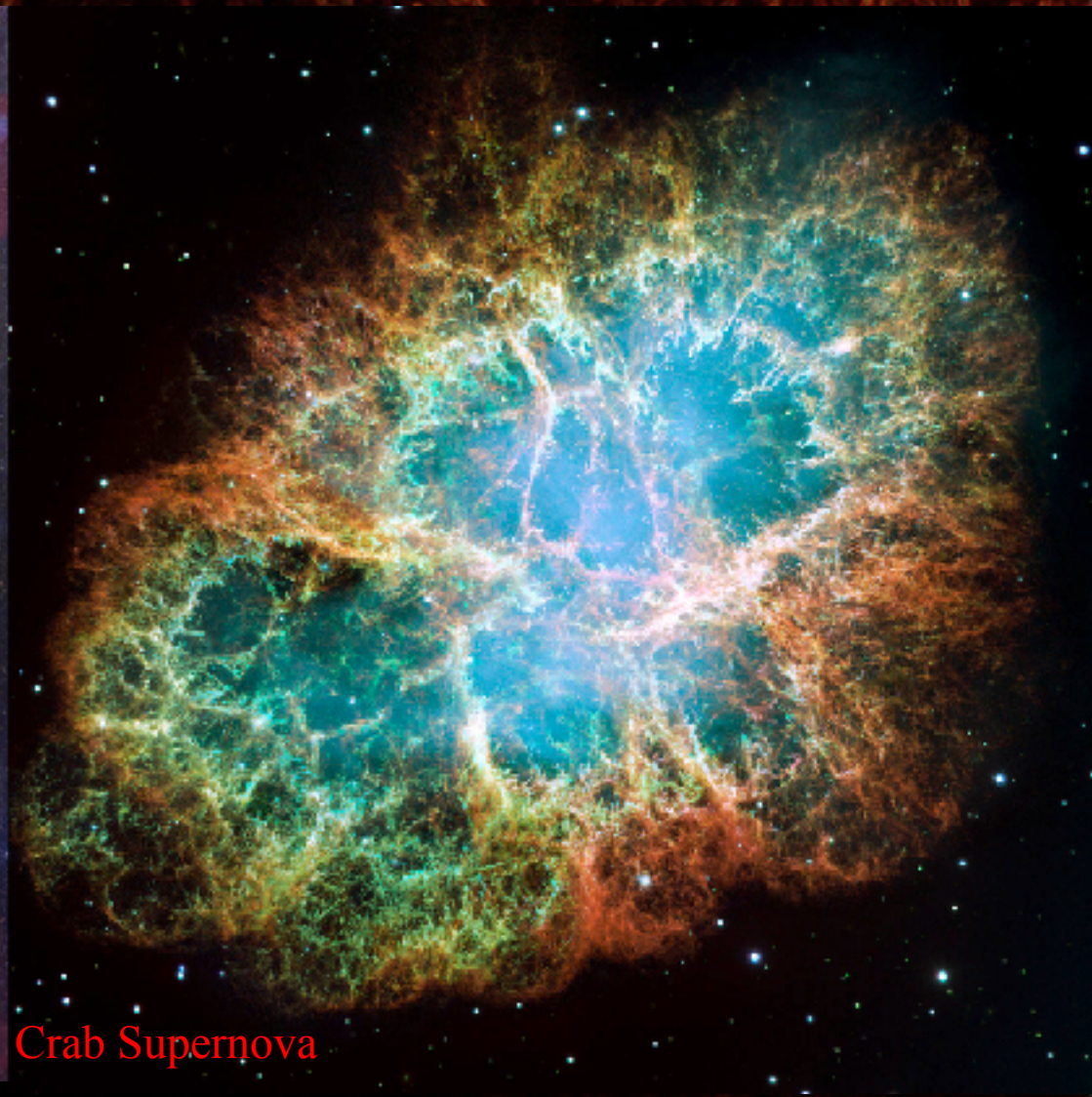




SGR A* (X-RAY & INFRARED)

These are made through spectacular events called Supernovae

Vela Supernova



Crab Supernova

These are made through spectacular events called Supernovae

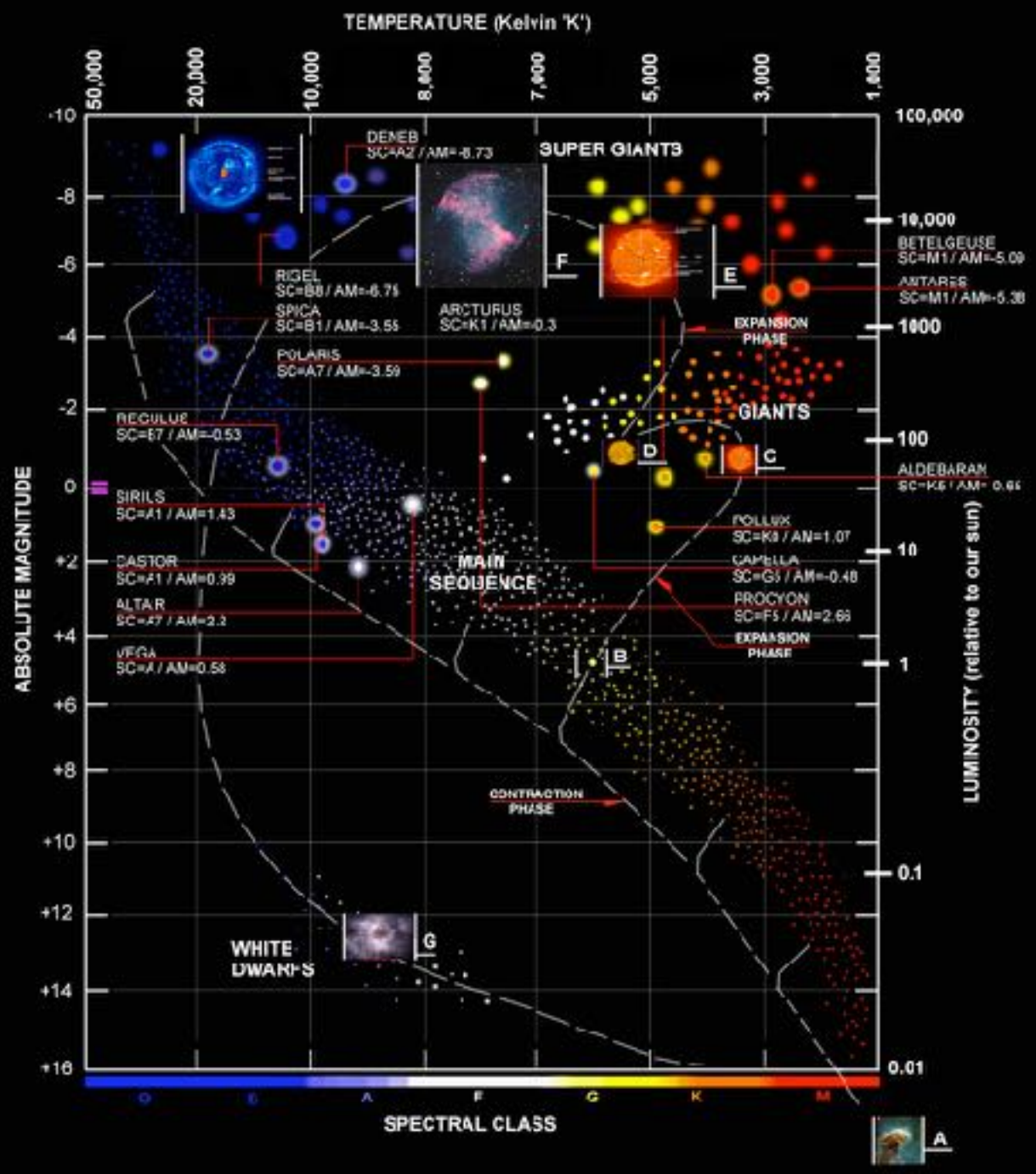
And We all are made out of these stuff

STAR DUST

Vela Supernova

Crab Supernova

- Mass of a star determines its eventual fate
- HR diagram helps understand this evolution
- The universe is a really good recycler!
- Everything we see around us is made through supernovae.



Earth

Sterrewacht
Leiden

Earth

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