



The Life and Death of Stars

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The birth of a star

2×10^6 yr

3×10^4 yr

10^5 yr

10^7 yr

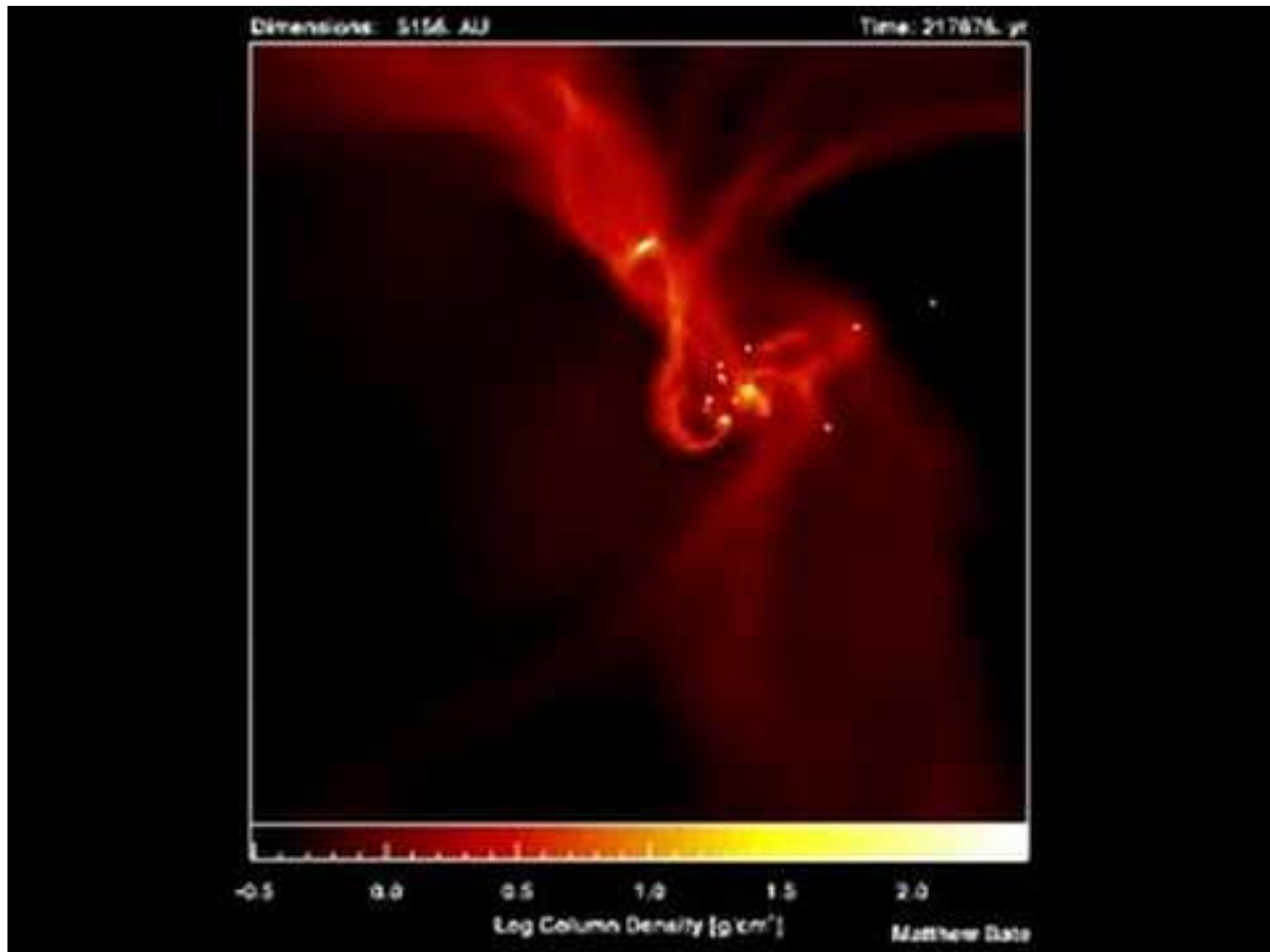
Time

Stage 1

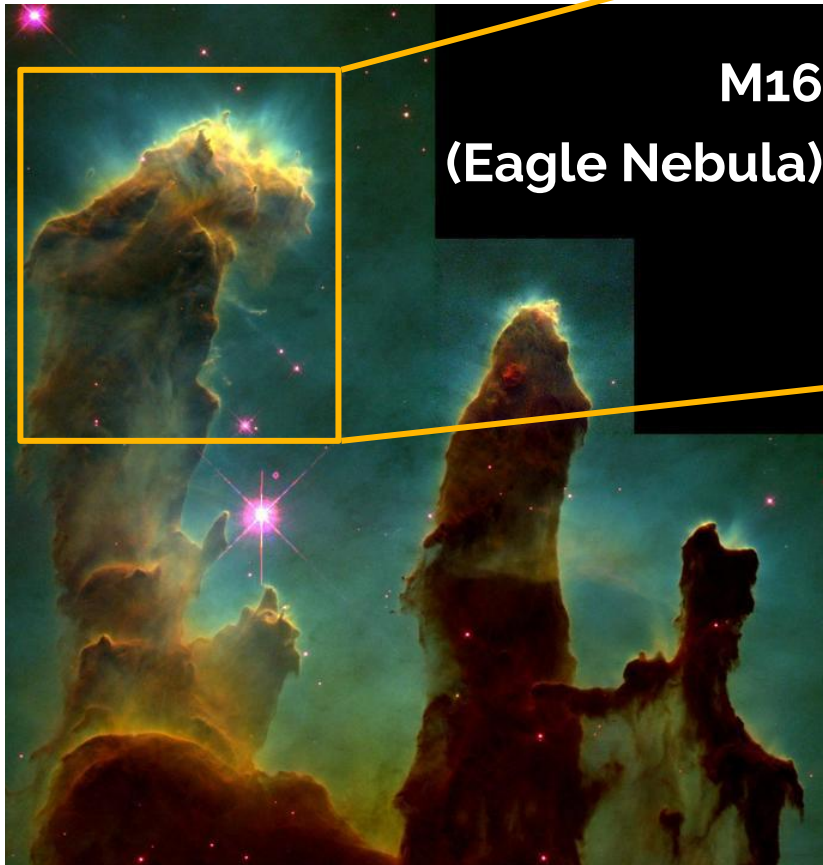
Stage 2

Stage 3/4

Stage 5



The birth of a **many** stars

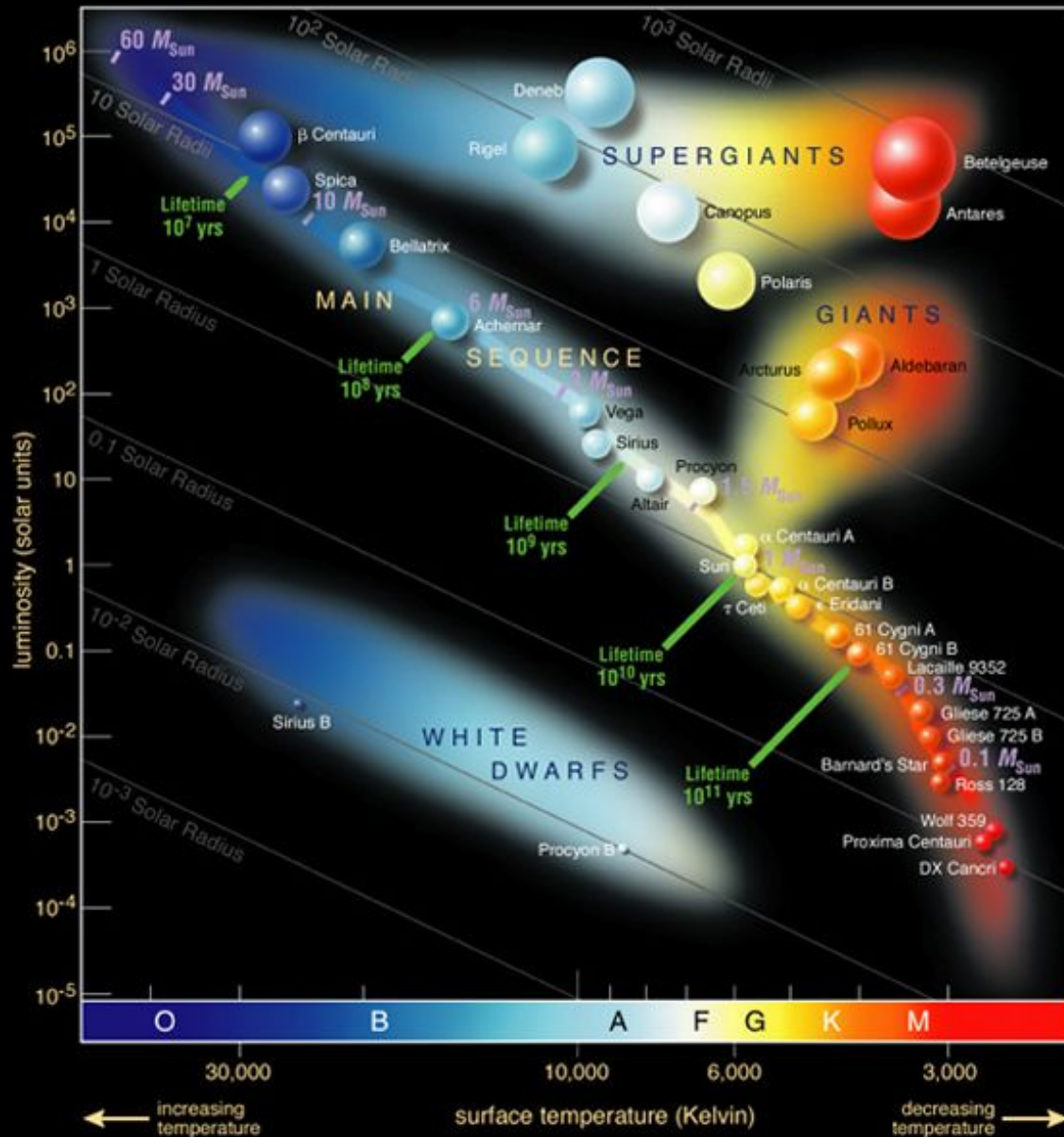


The birth of a **many** stars

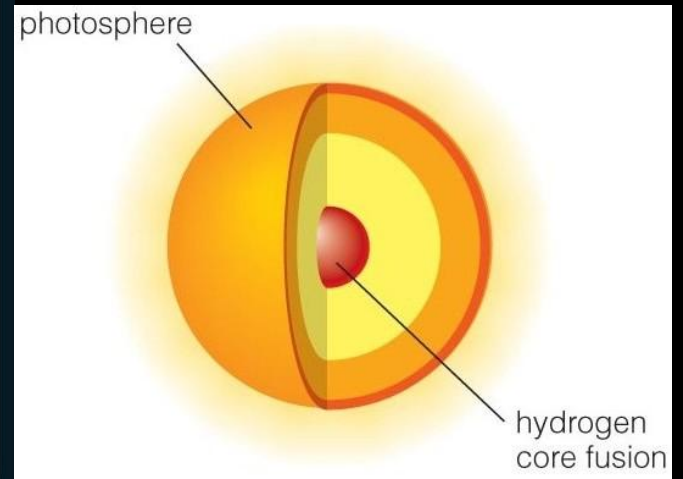
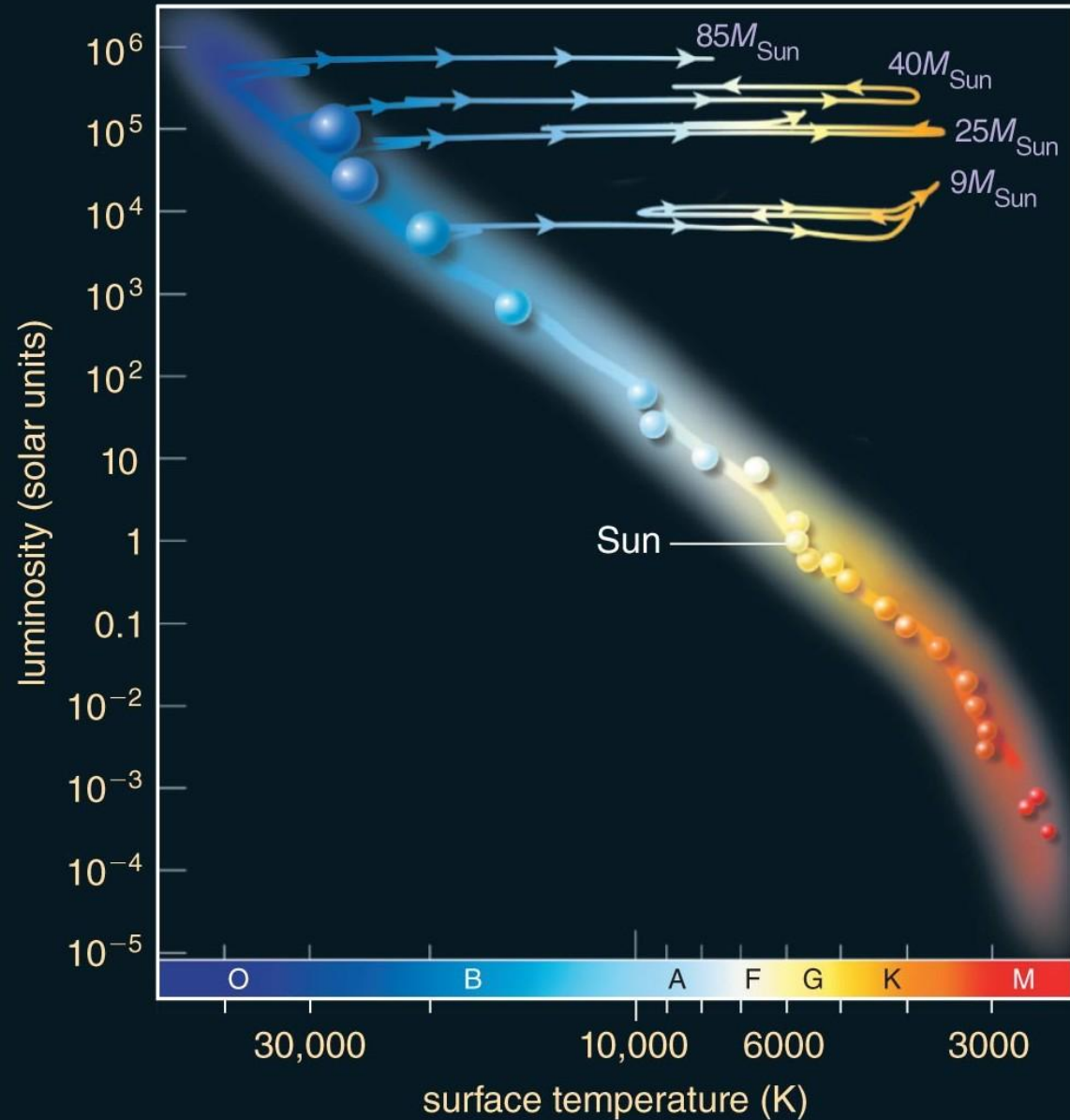
NGC602



The Hertzsprung-Russell Diagram

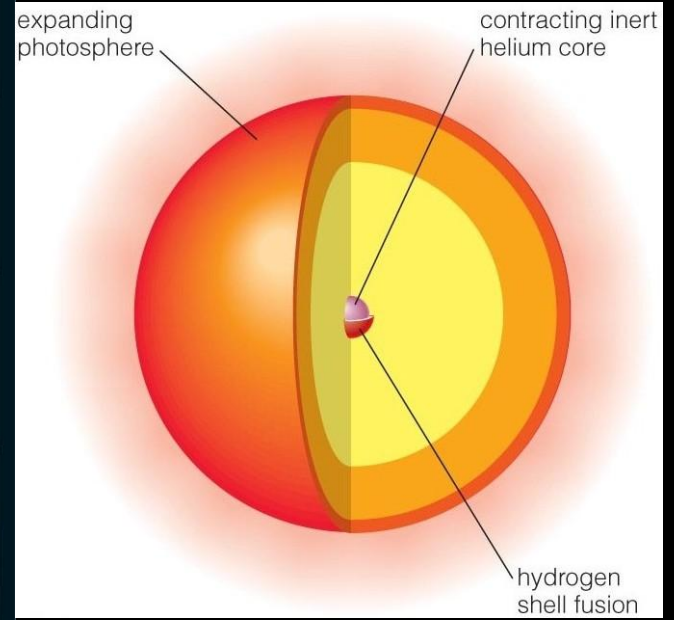
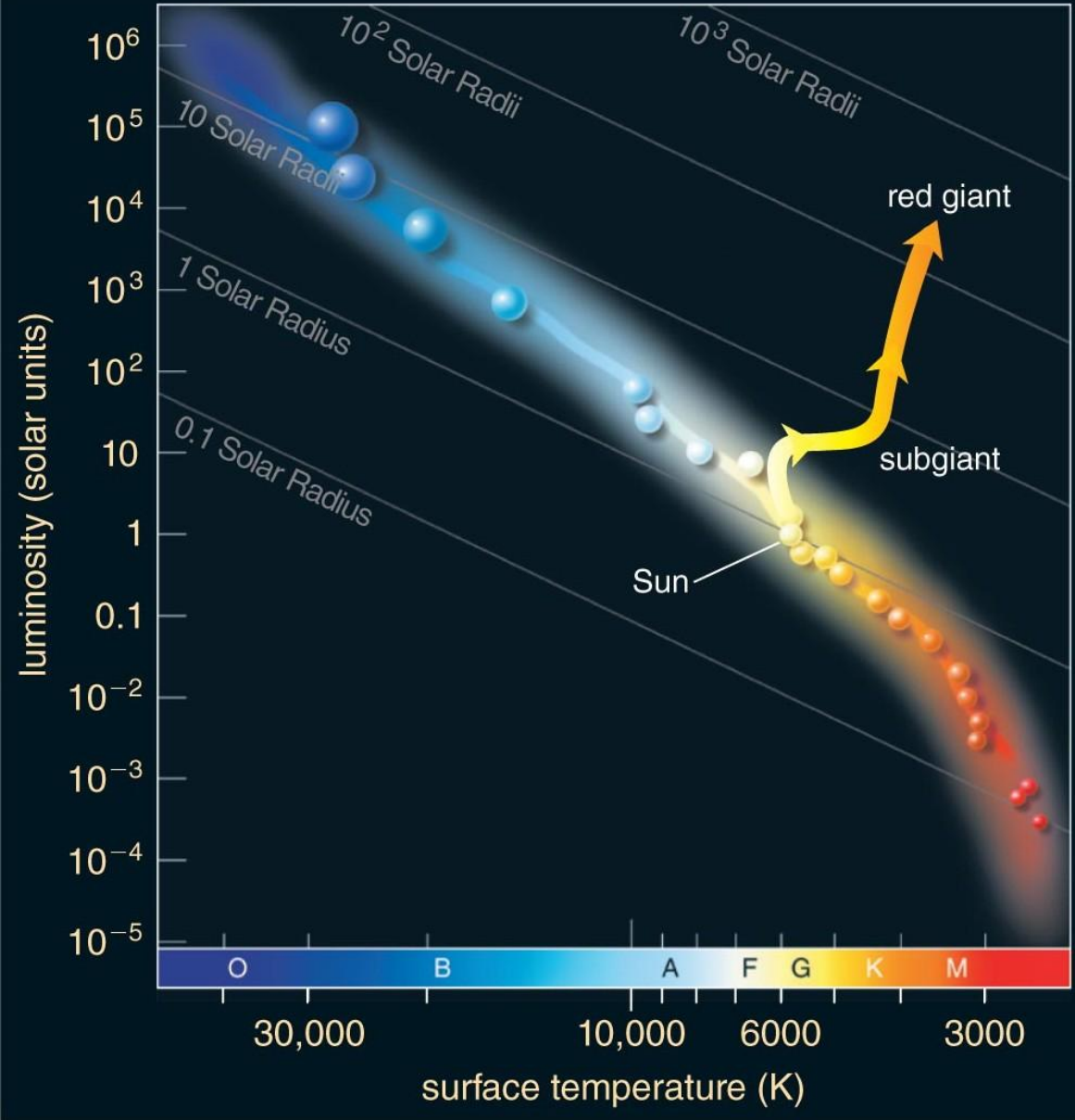


Main sequence

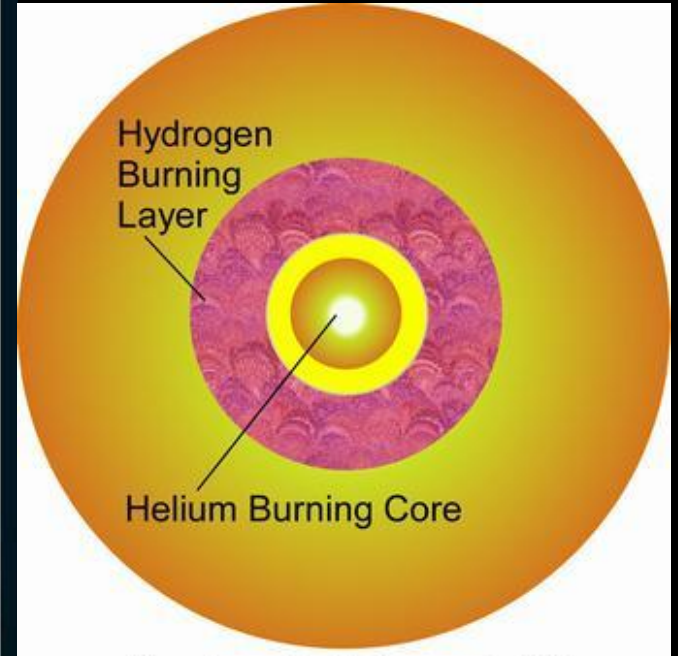
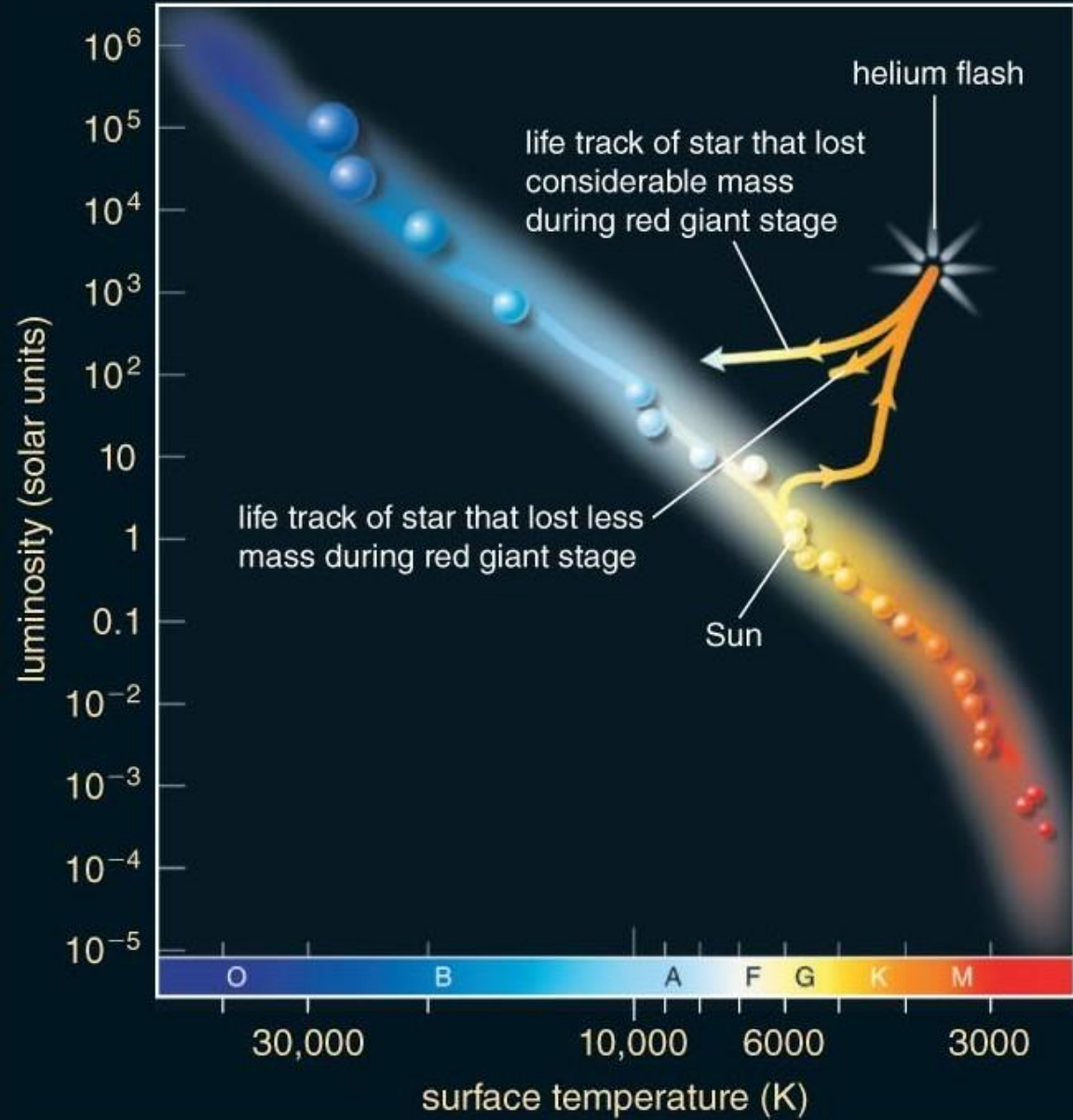


Red giant

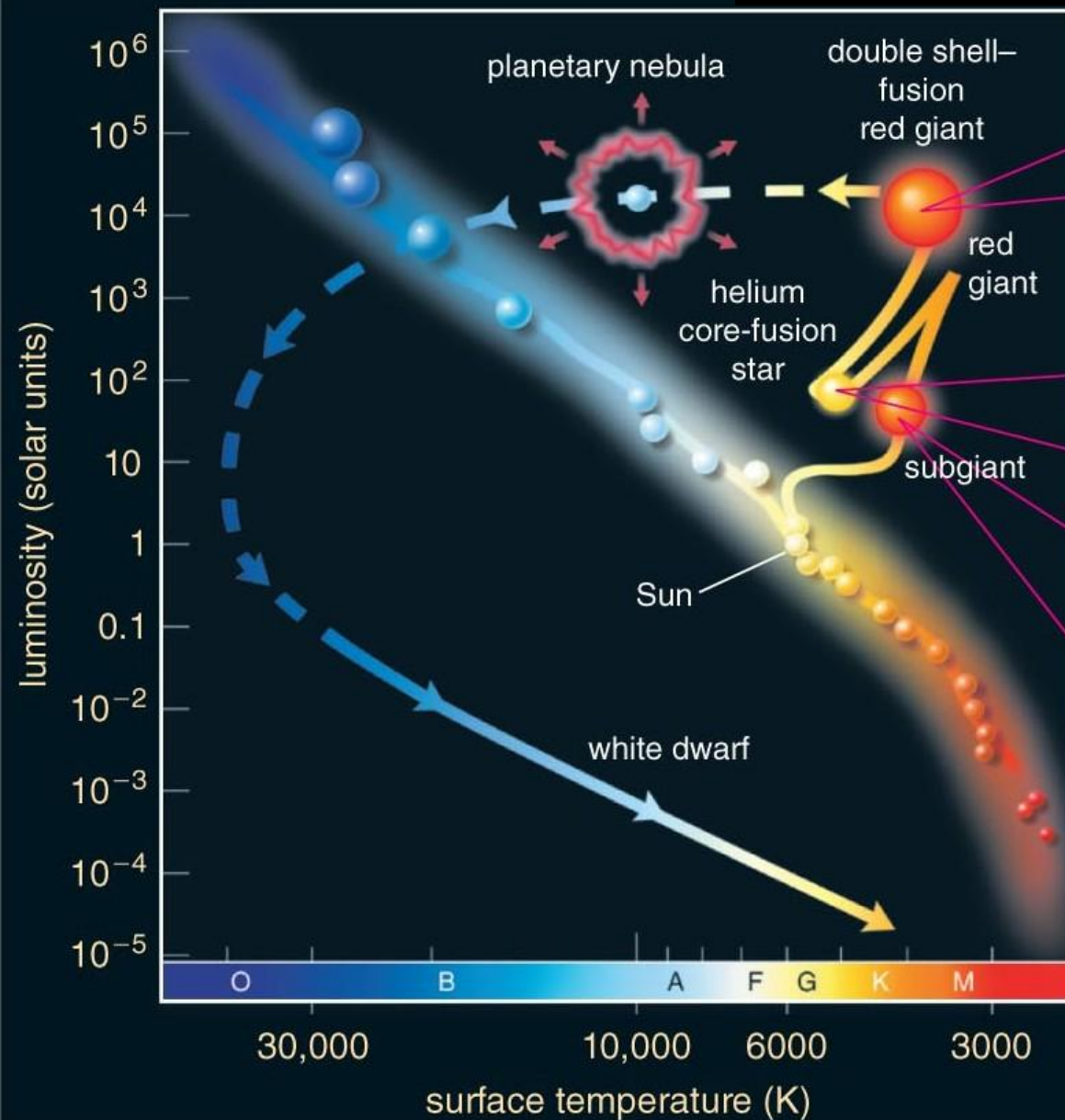
E.g. Arcturus and Aldebaran

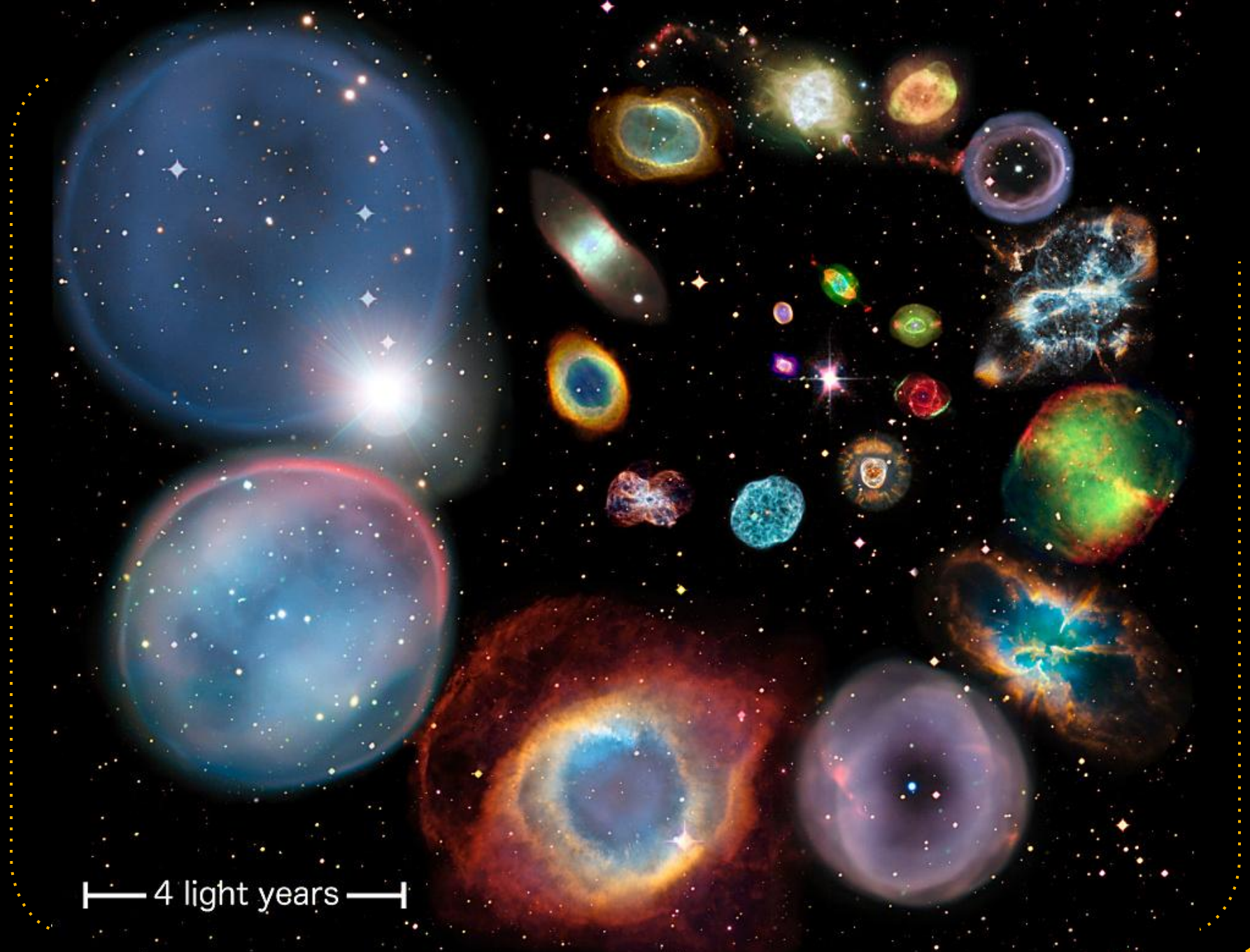


Helium burning



Planetary nebula





— 4 light years —

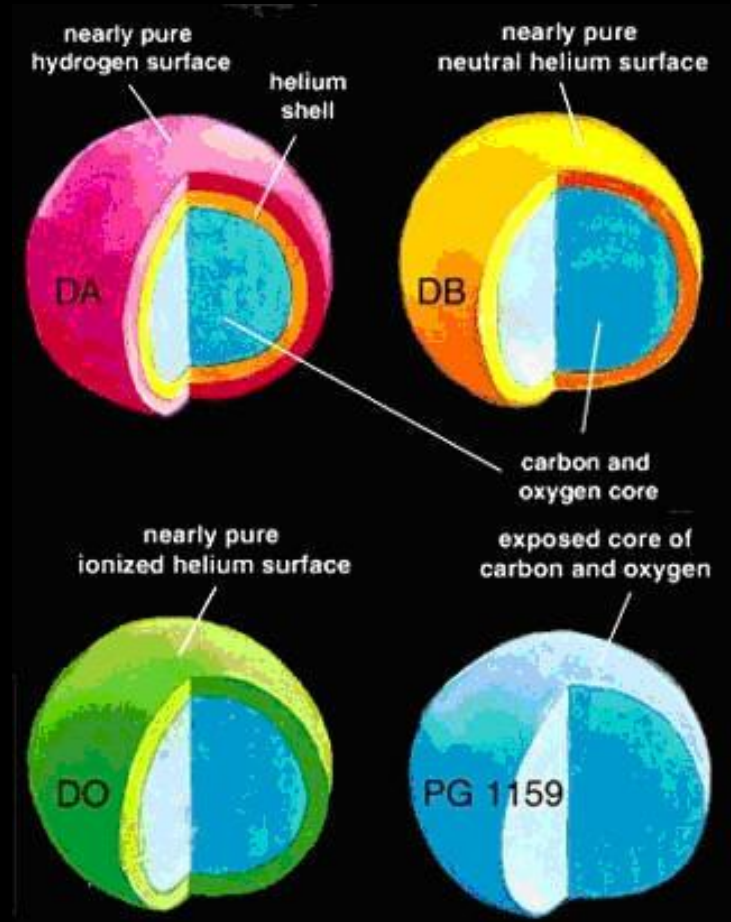
White dwarfs



Sirius B



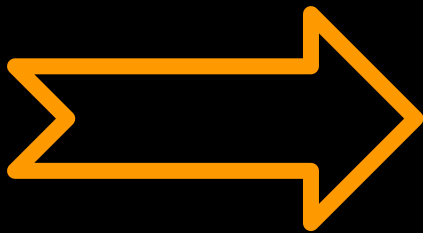
Sirius A



Gabriela and Fabio Carvalho - Observatório OTUS

White dwarfs are faint, but

- **Simple** (compared to other evolutionary stages)
- **Abundant** (final state of over 95% of stars)
- **Old**



**Excellent
laboratories for
astronomy and
physics!**

Mining for White Dwarfs

Most efficient way: make use of public large surveys



2.5 m telescope

Imaged $\frac{1}{3}$ of the sky



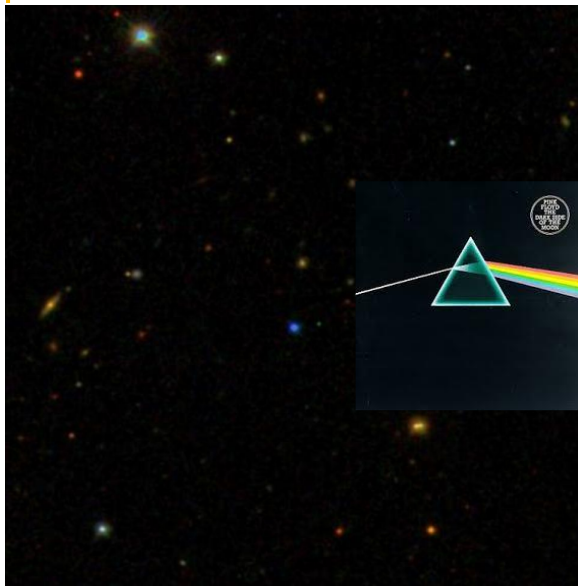
Brightness, colour, position and distance for over a billion stars

(All sky)

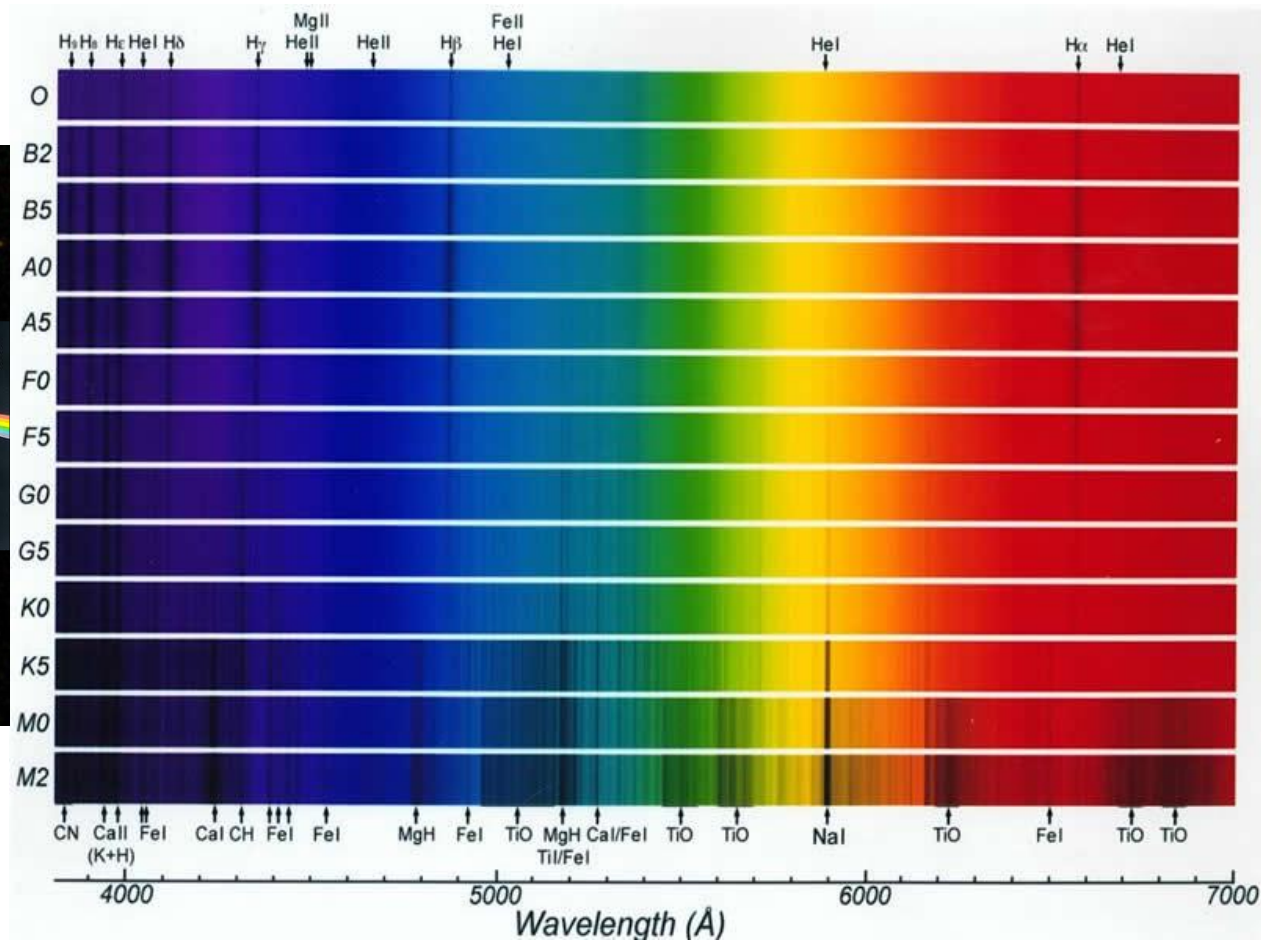
Sloan Digital Sky Survey



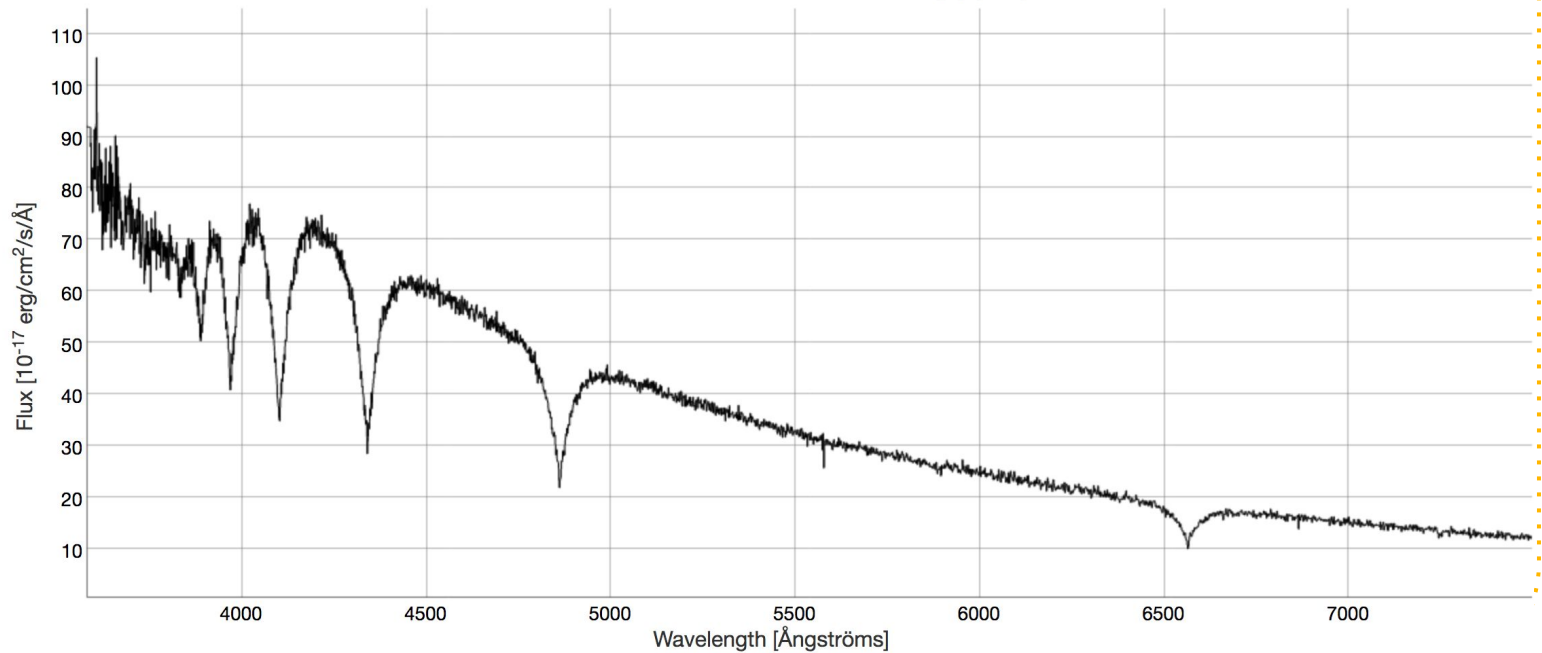
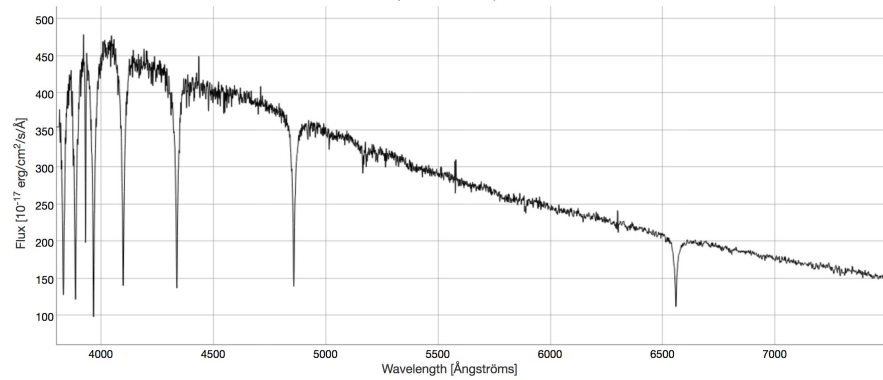
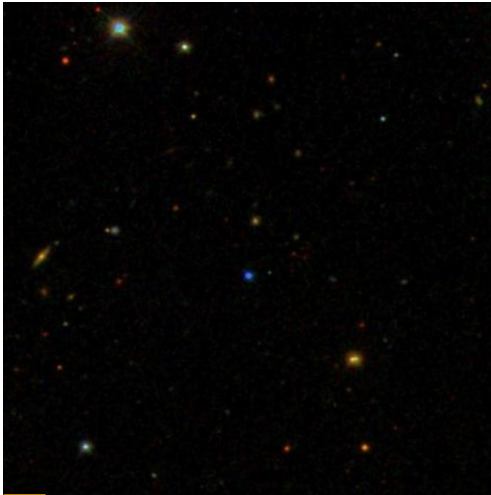
Sloan Digital Sky Survey



Each chemical element has its own fingerprint.

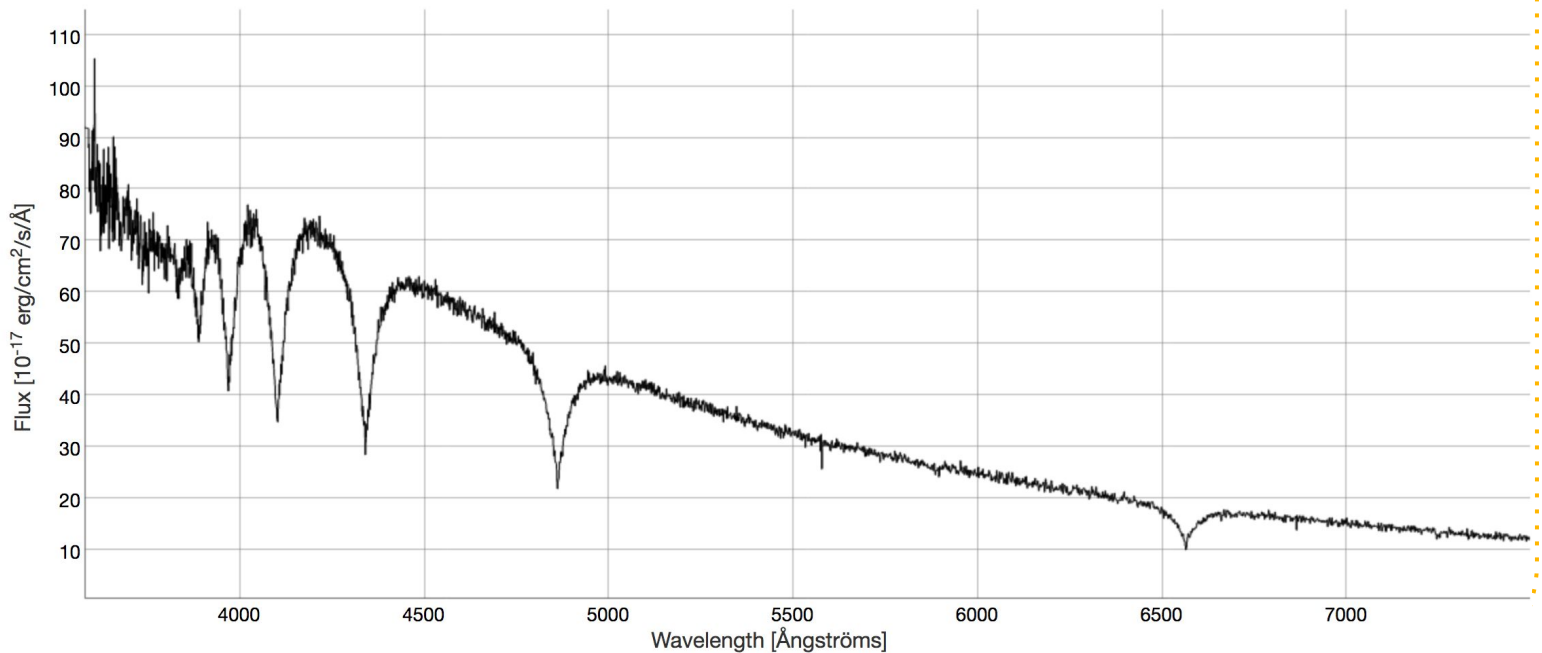
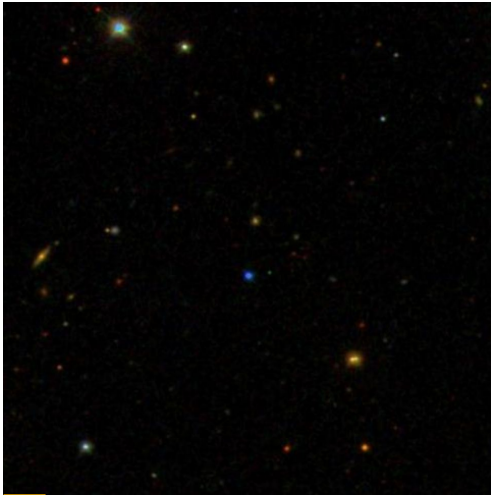


Sloan Digital Sky Survey

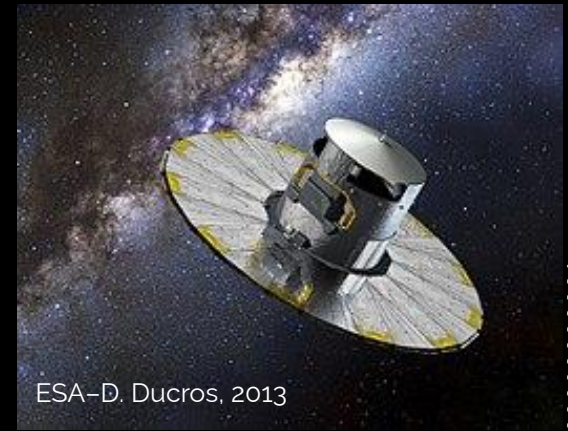


Sloan Digital Sky Survey

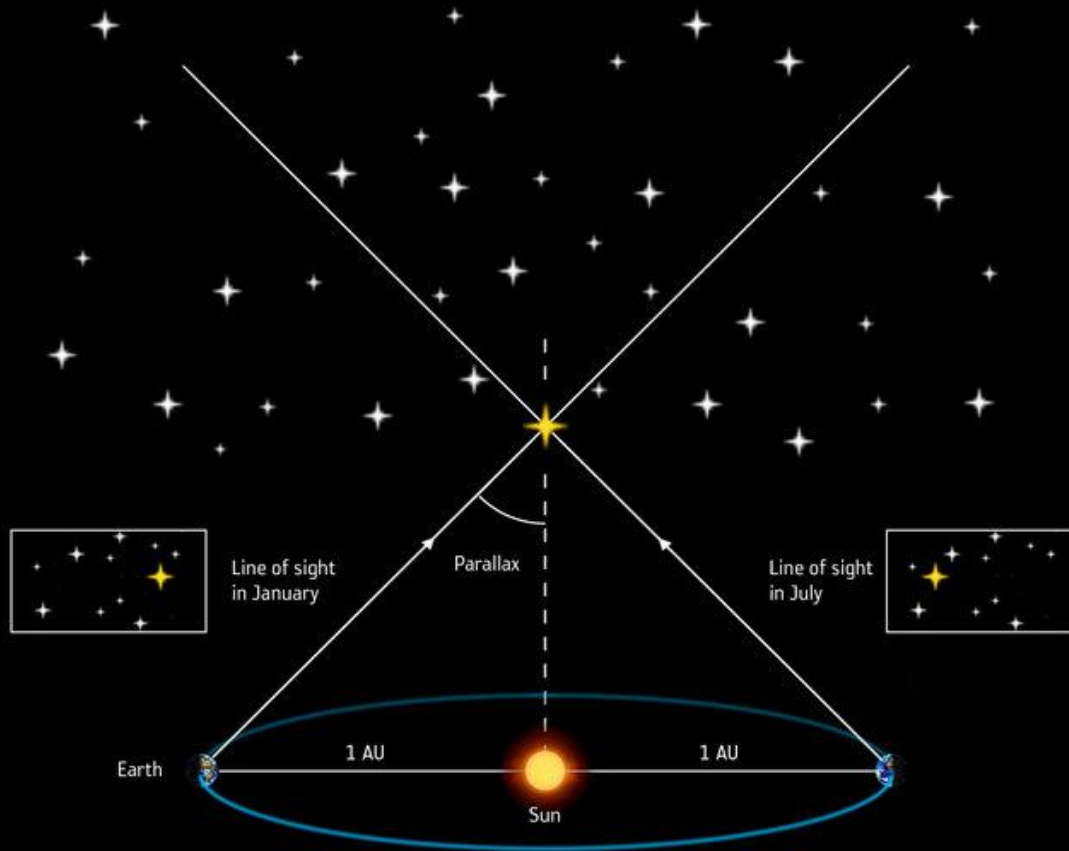
From 5,000 to over 30,000!
6-fold increase!



Gaia



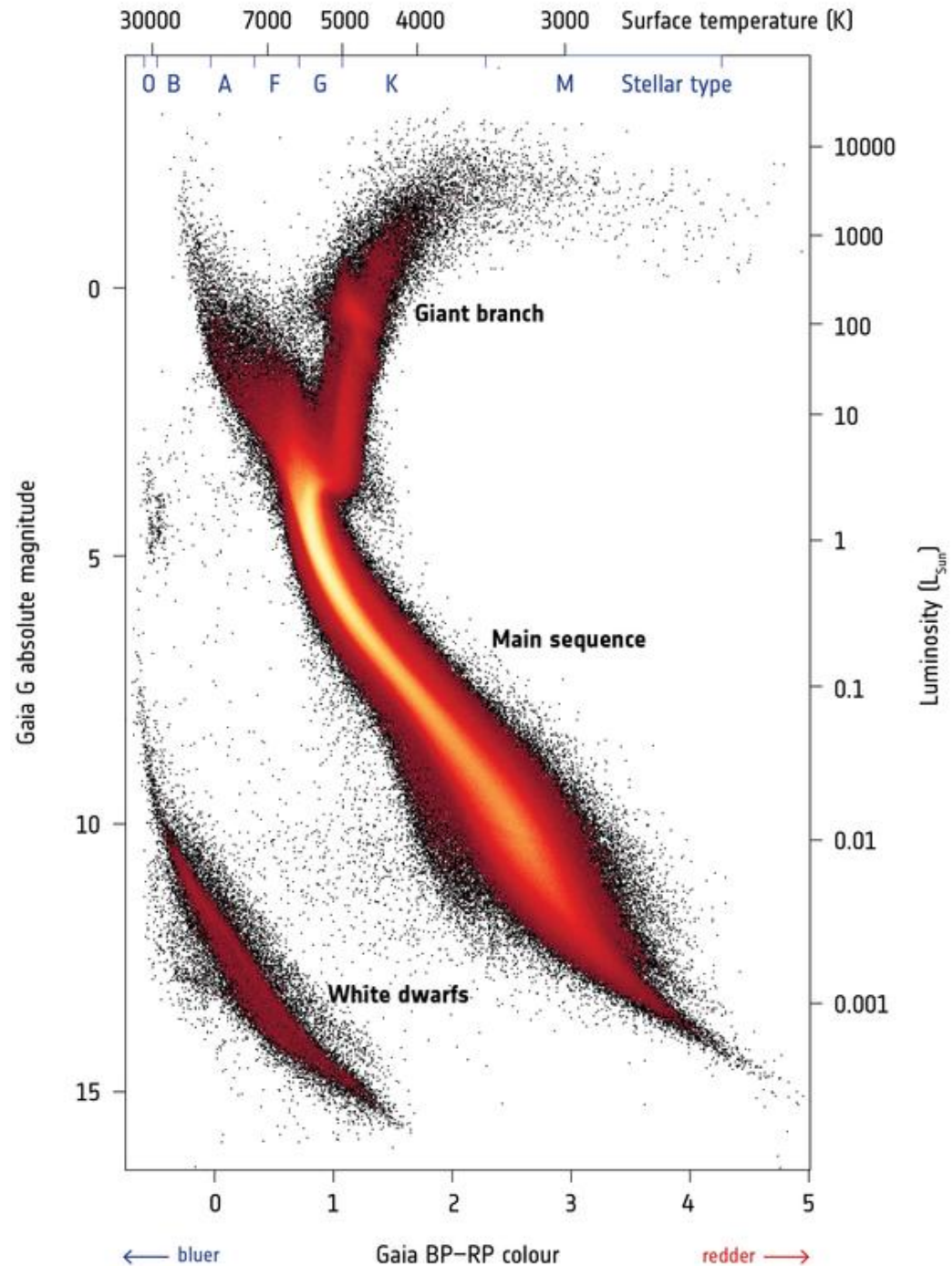
Measures
apparent
magnitude,
colour, and
parallax



ESA/ATG medialab

Gaia

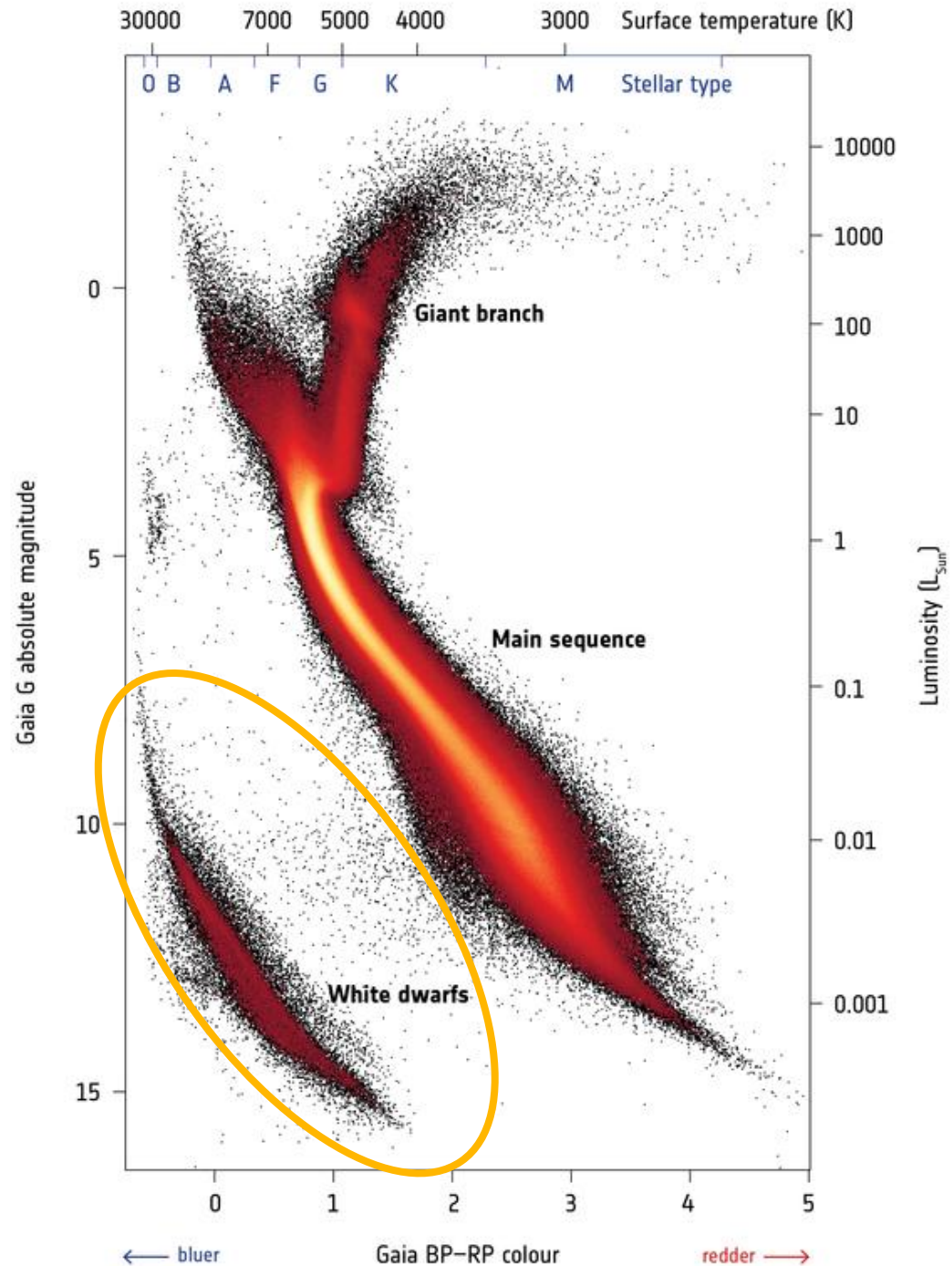
We can now simply pick white dwarfs!



Gaia

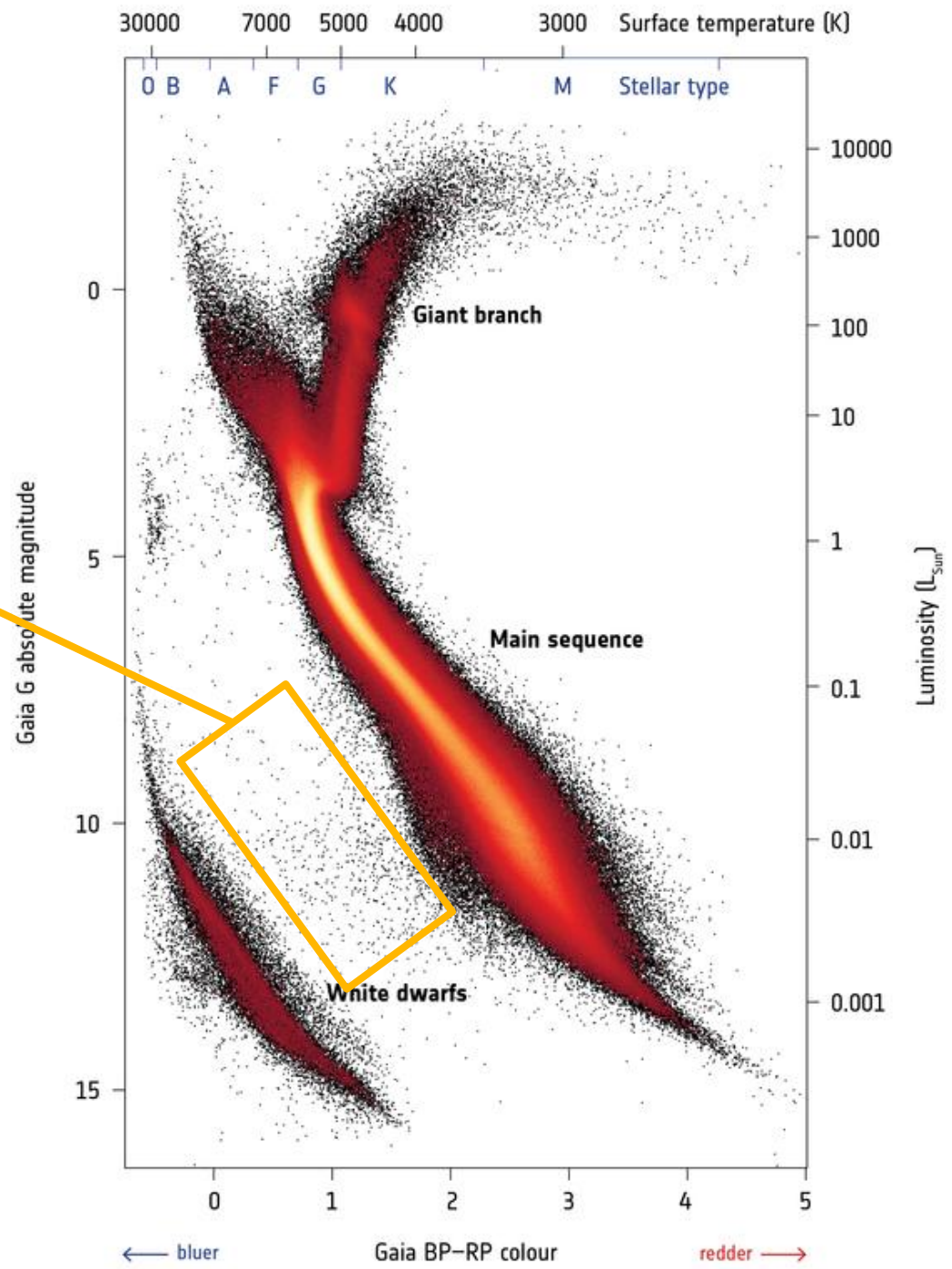
We can now simply pick white dwarfs!

About **260,000**
new ones (!!!)



Gaia

"Outliers"

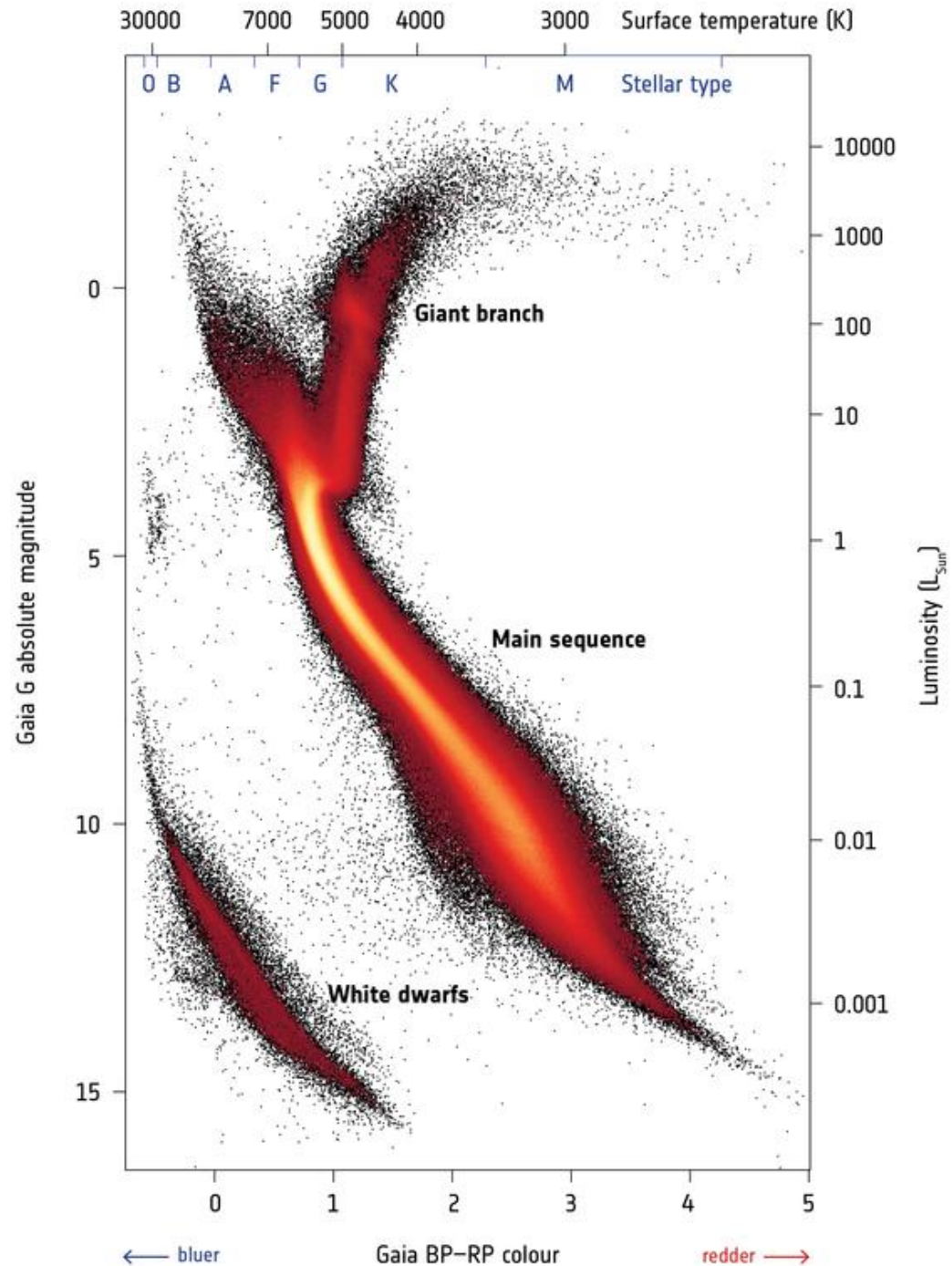


Gaia

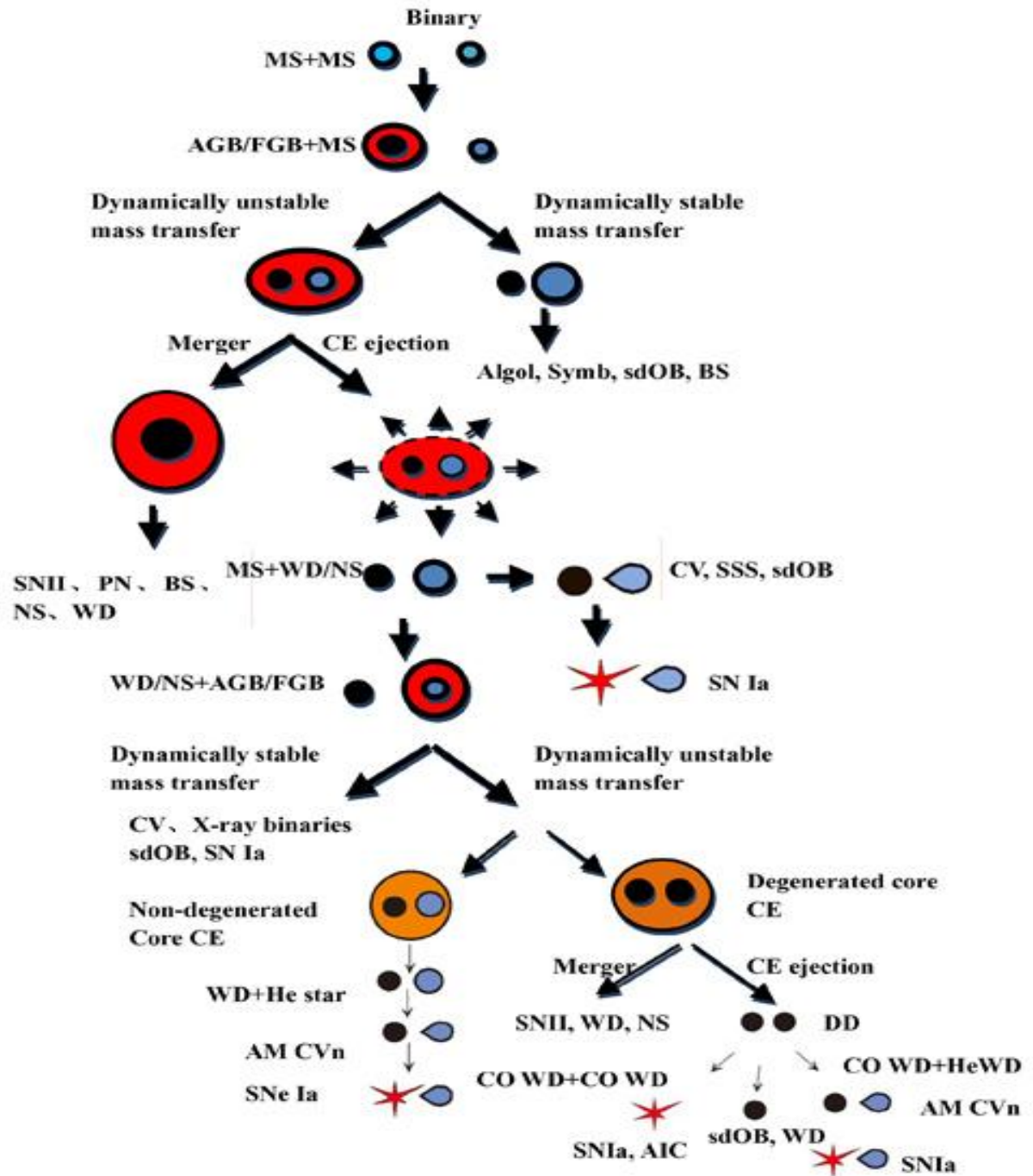
"Outliers"



Binaries!

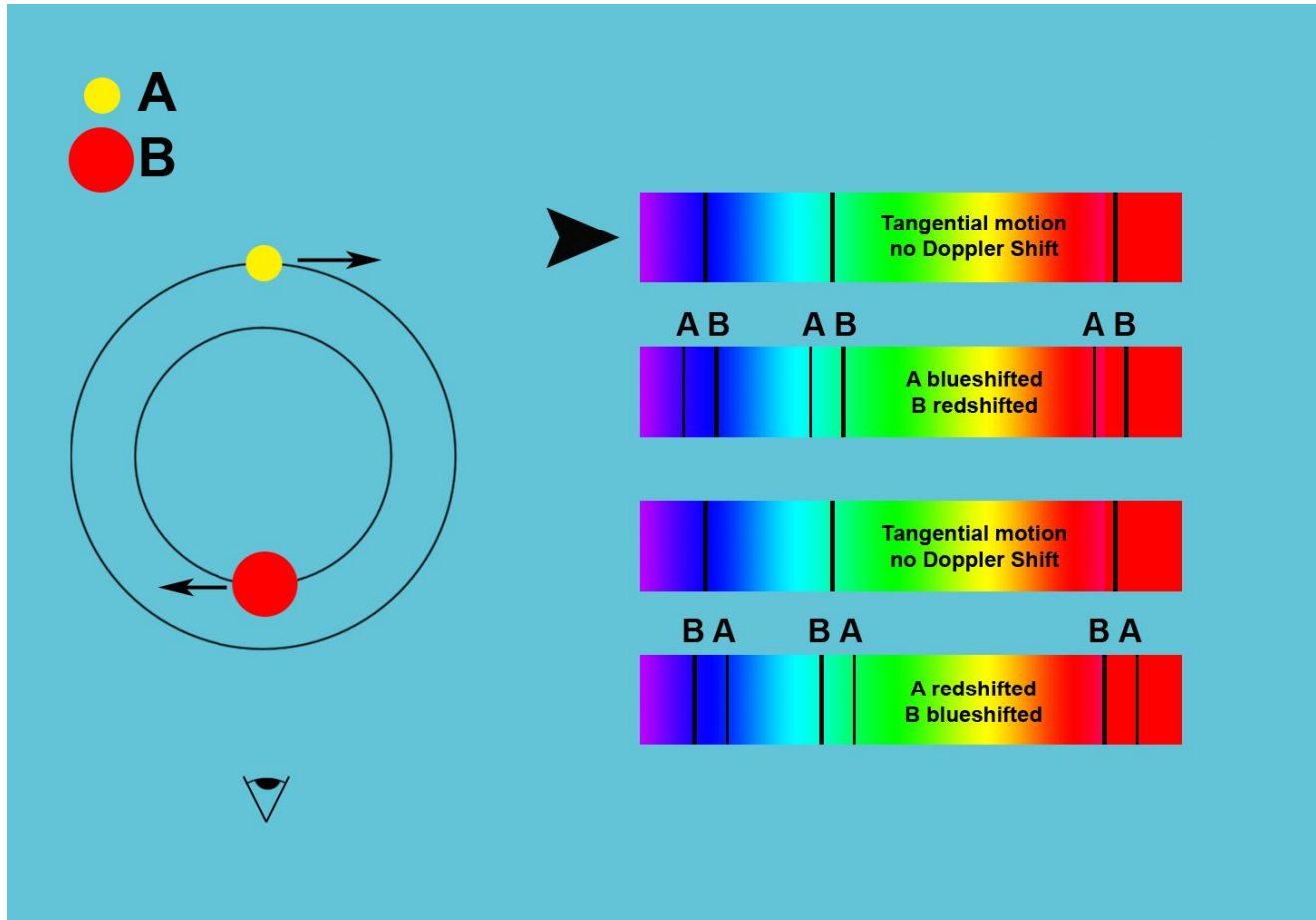


Binary evolution



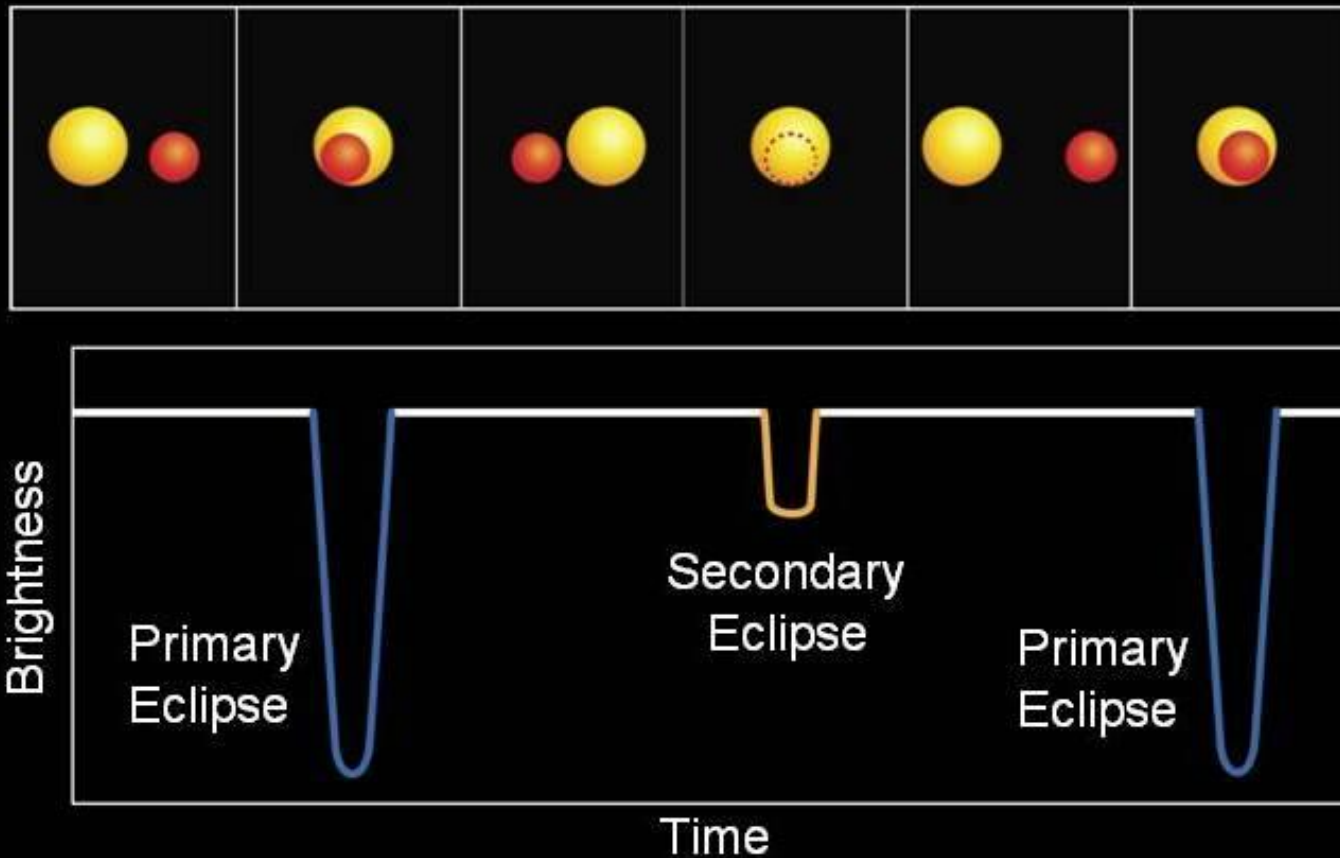
How to find binaries?

1. Radial Velocity shifts

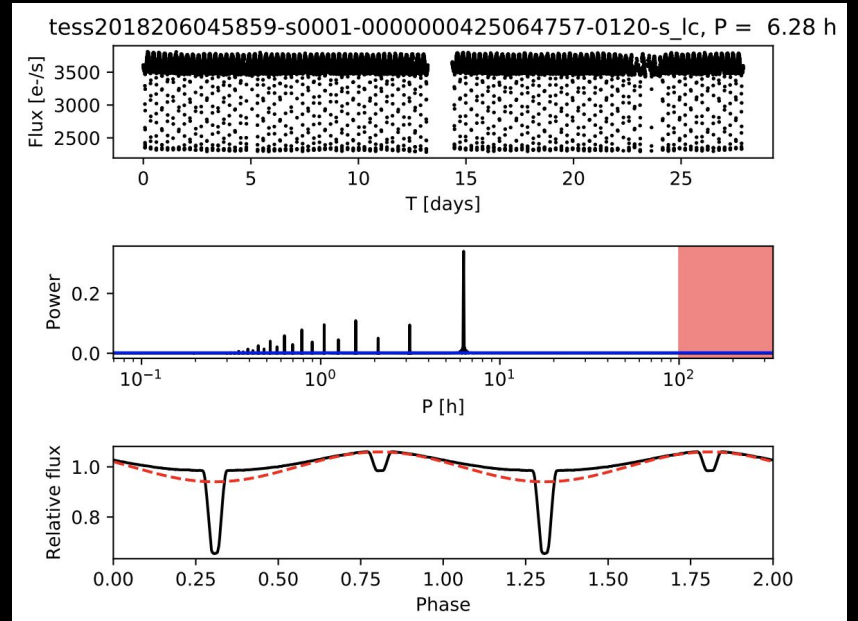
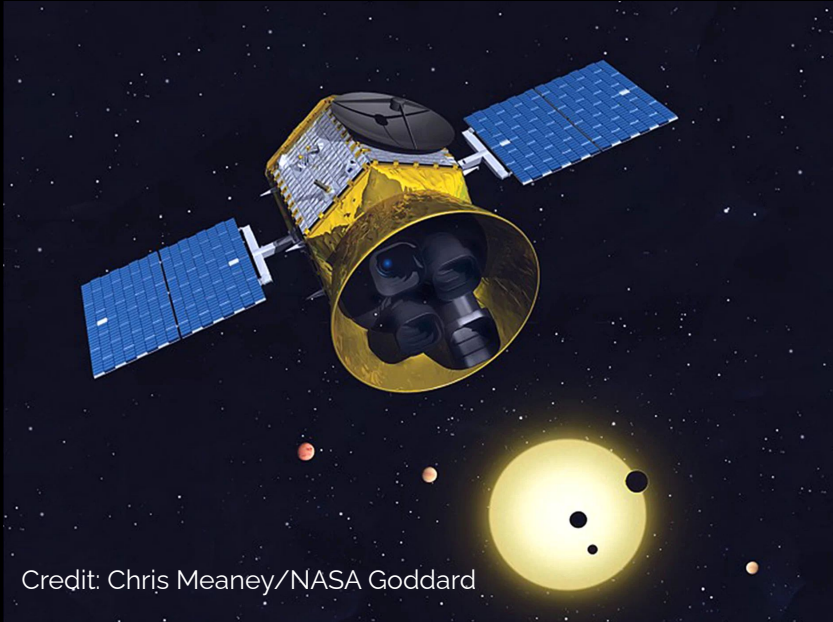


How to find binaries?

2. Light curve variations



TESS





Thanks!

Any questions?

You can also read about astrophysics at [@astrobites](#) (English)

[@astrobitos](#) (Spanish)

[@astropontos](#) (Portuguese)