INTRODUCTION TO ASTROPHYSICS

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(2-CHA)

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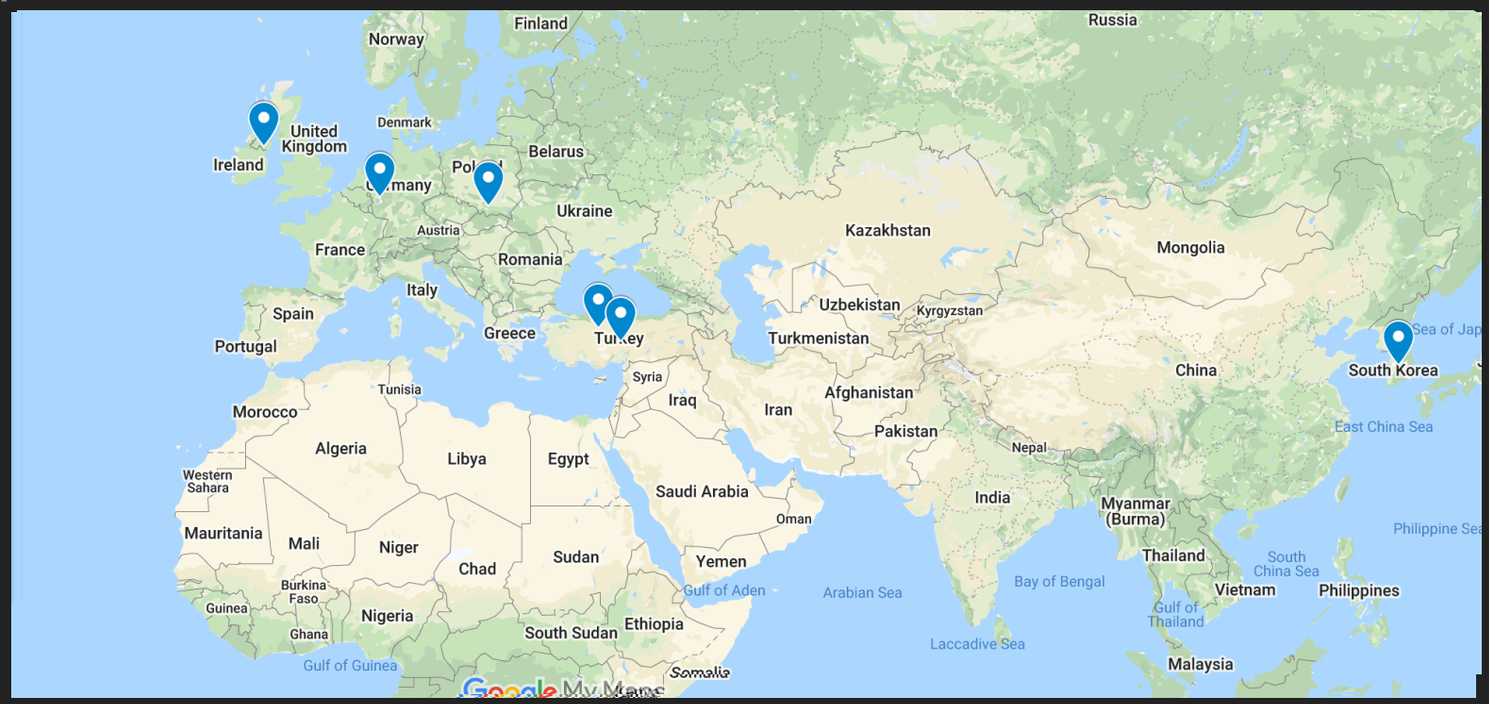
- BSc: Ankara University, Astronomy and Space Sci.
  - Binary stars
- MSc: Erciyes University, Astronomy and Space Sci.
  - Cool stars
  - University of Bonn, Max Planck Inst., Radio Astronomy
- PhD: Queen's University of Belfast, Astrophysics
  - Hot subdwarf stars
- Post-doc: Korea Astronomy and Space Science Institute (KASI)
  - GMT - Science Team
  - Dwarf stars

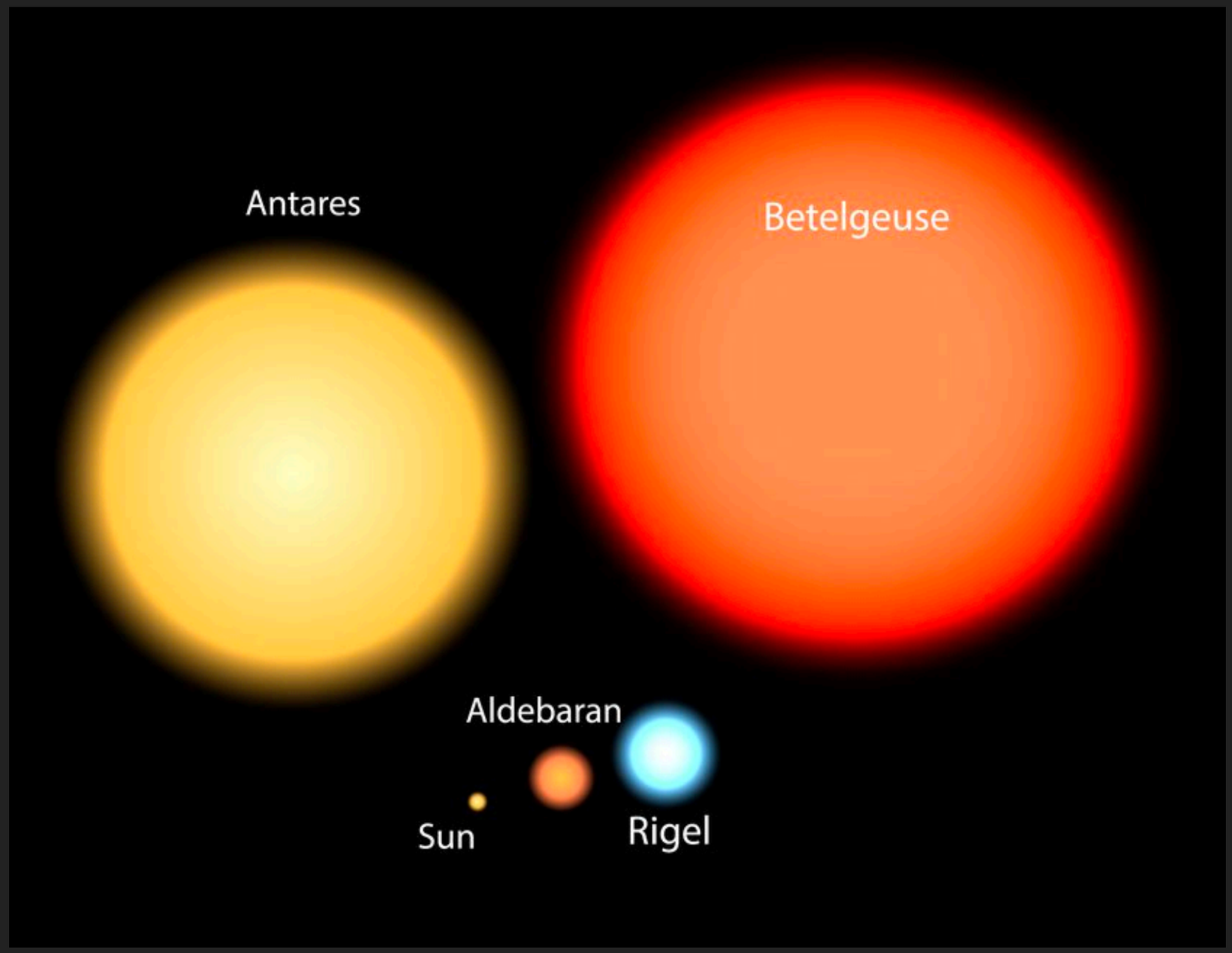


PREVIOUSLY

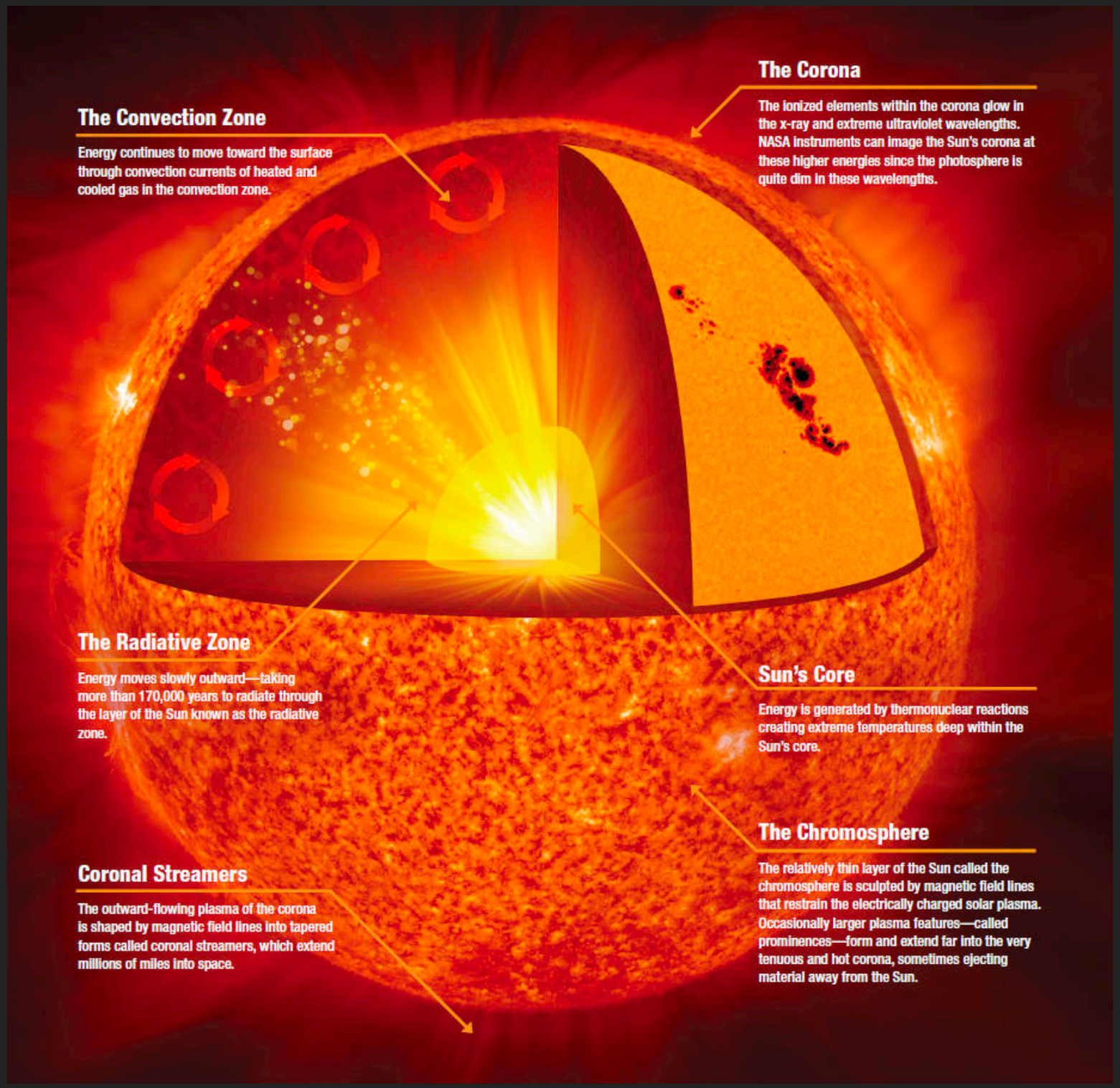
- What is a star?
- Distance scales and units in astronomy
- Night sky, constellations and magnitudes
- Earth’s orbit
- Kepler’s Laws
- Solar System

1. THE SUN

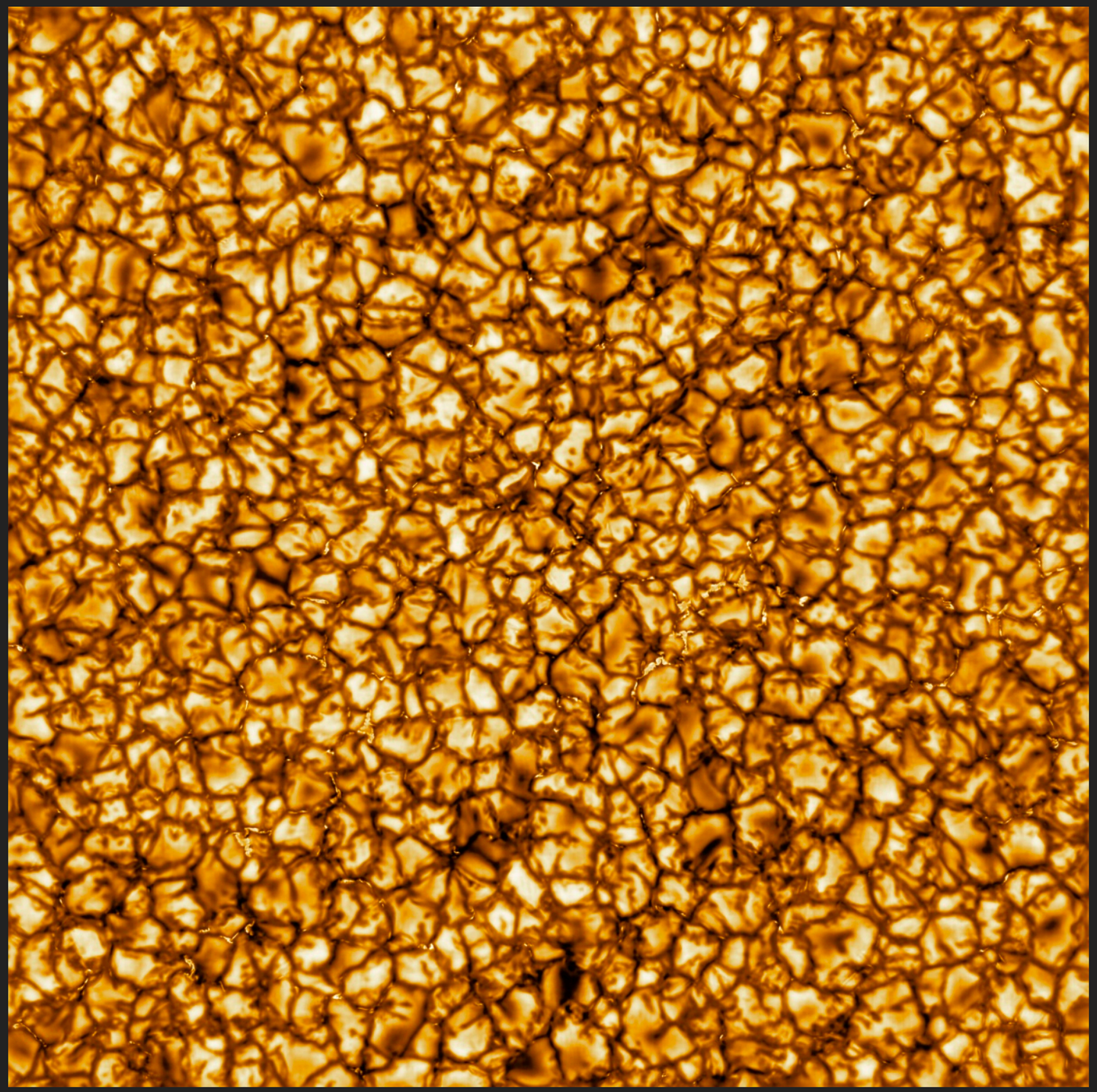
- What is the importance of Sun?



- Structure - internal structure



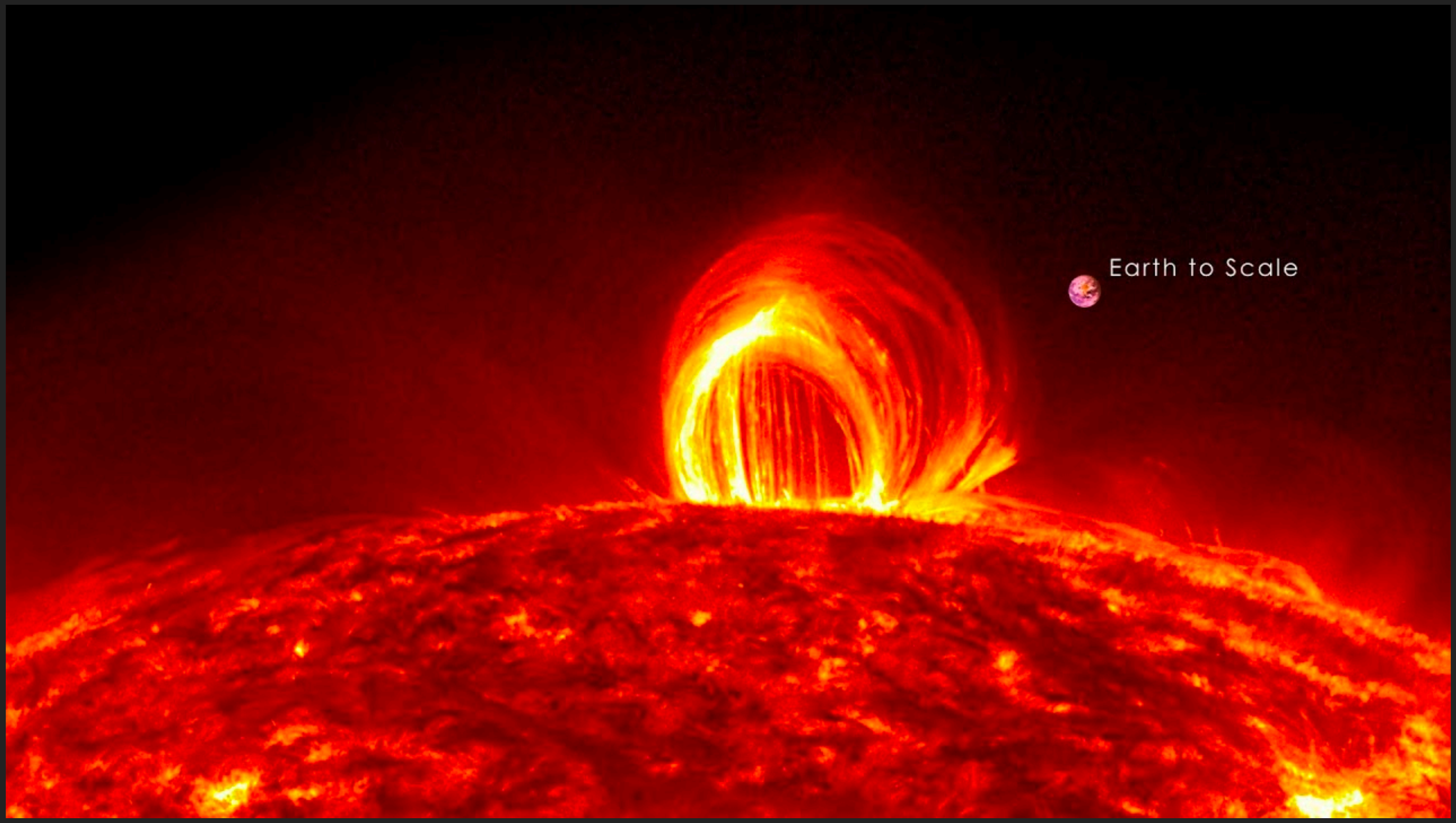
- Surface structure



~30 km

Inouye Solar Telescope @ Haleakala, Maui, Hawai'i - Jan.2020

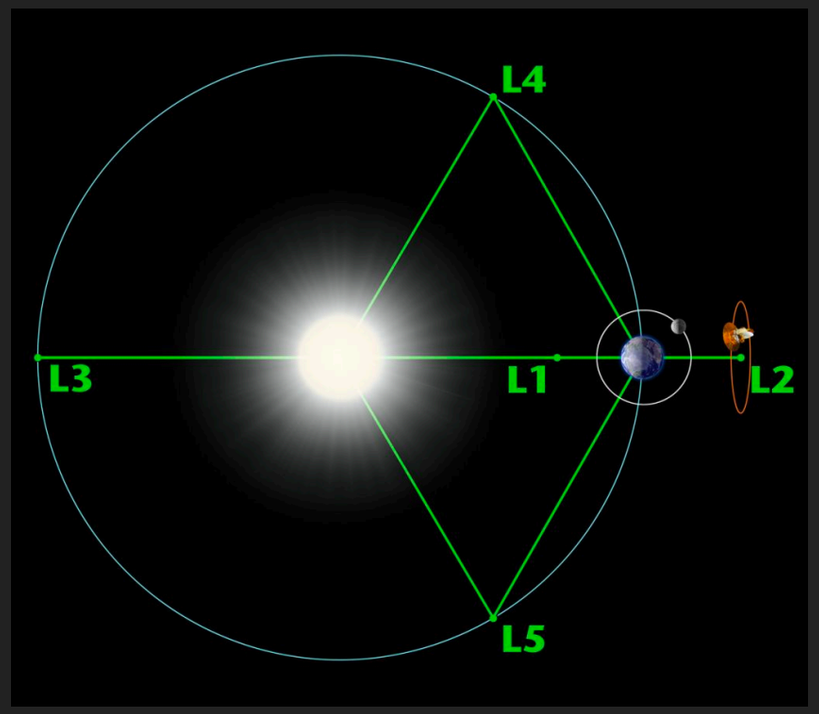
- Atmospheric properties, atmospheric activities and Effects on Earth

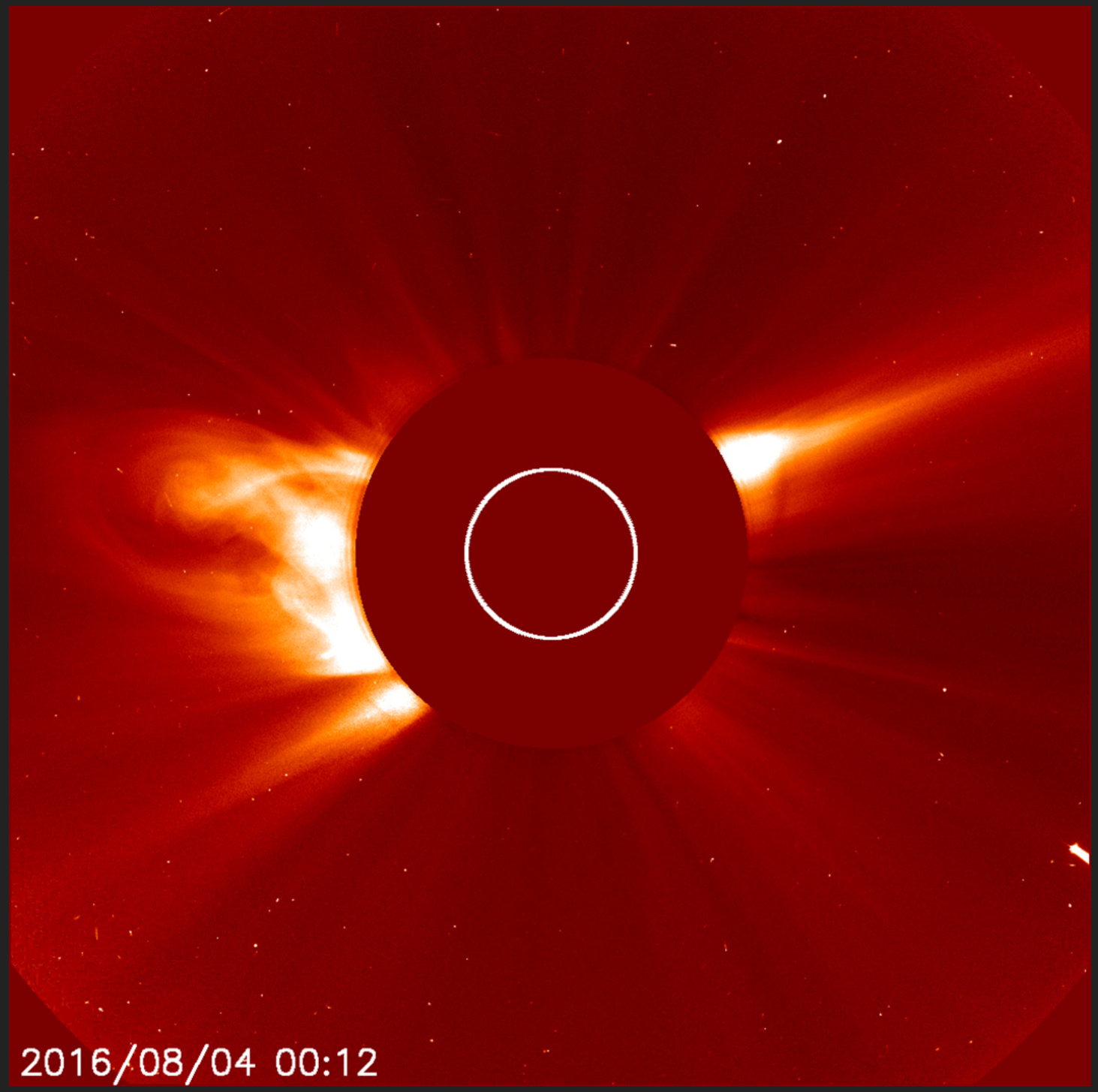


- How do we observe Sun

Projecting an image of the Sun with a small refractor.

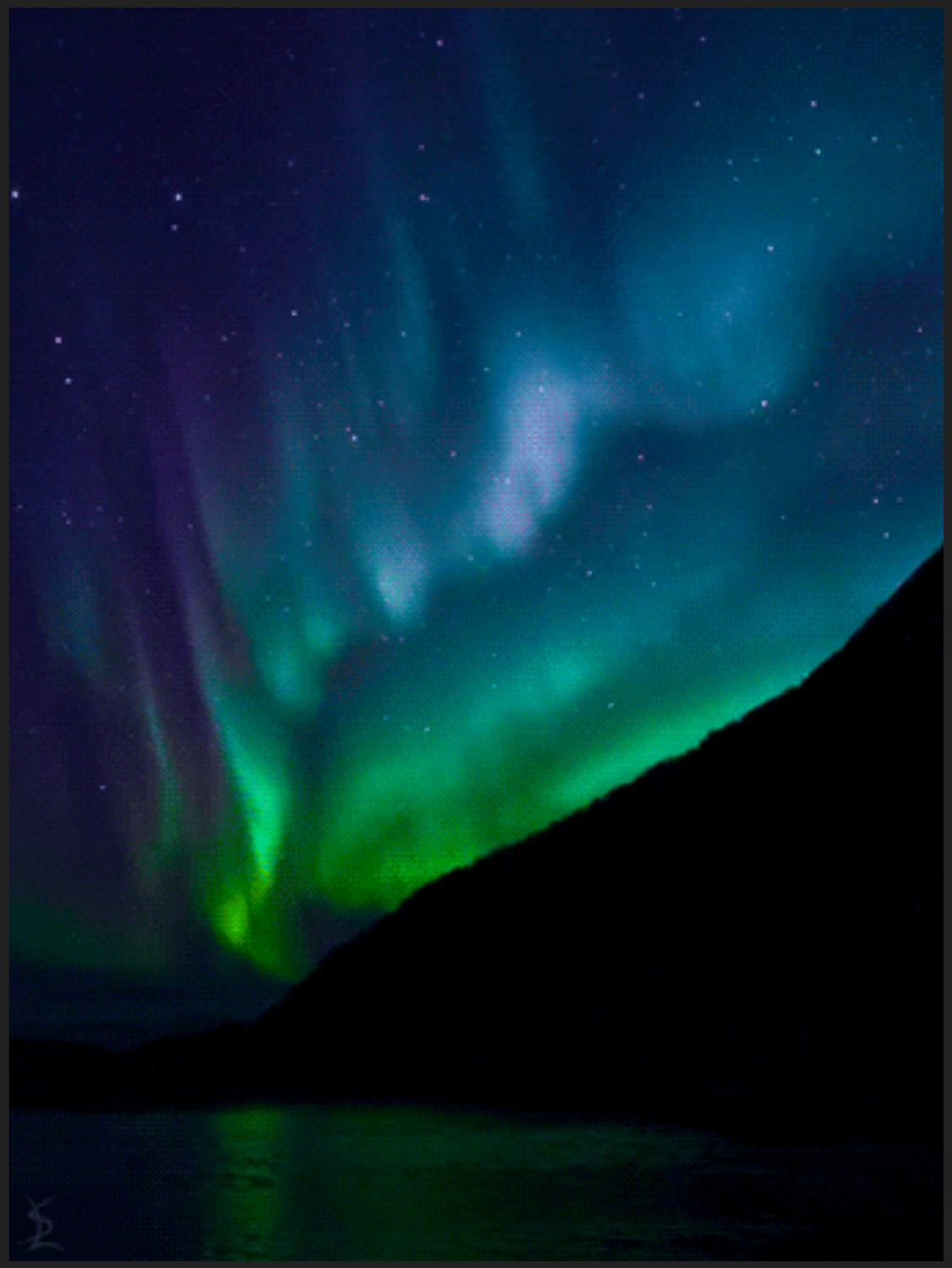
- How do we observe Sun



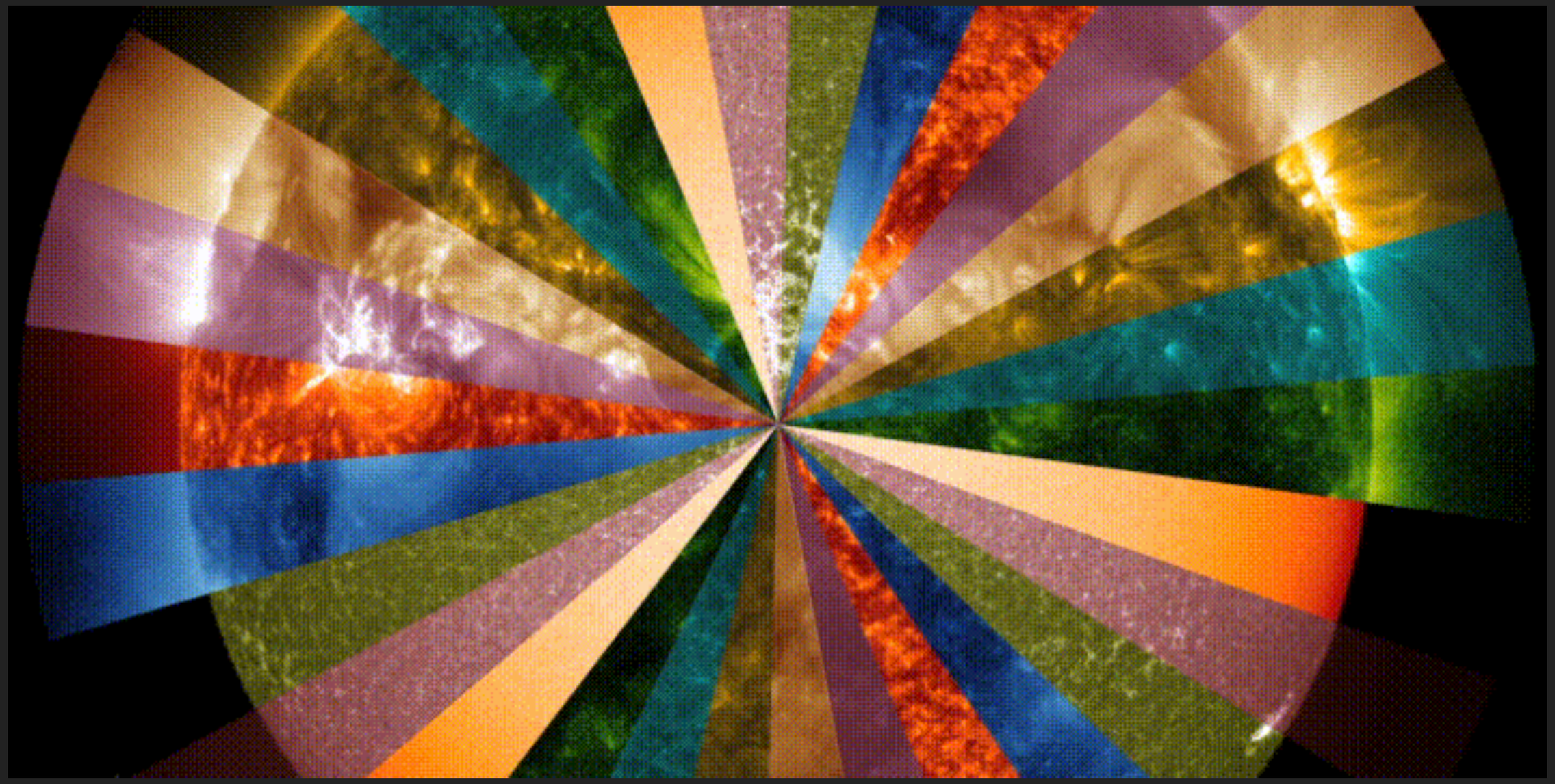


SOHO saw a bright comet plunge toward the sun on Aug. 3-4, 2016, at nearly 1.3 million mph.

- Interaction with other objects - swallowing comets, Solar system planets



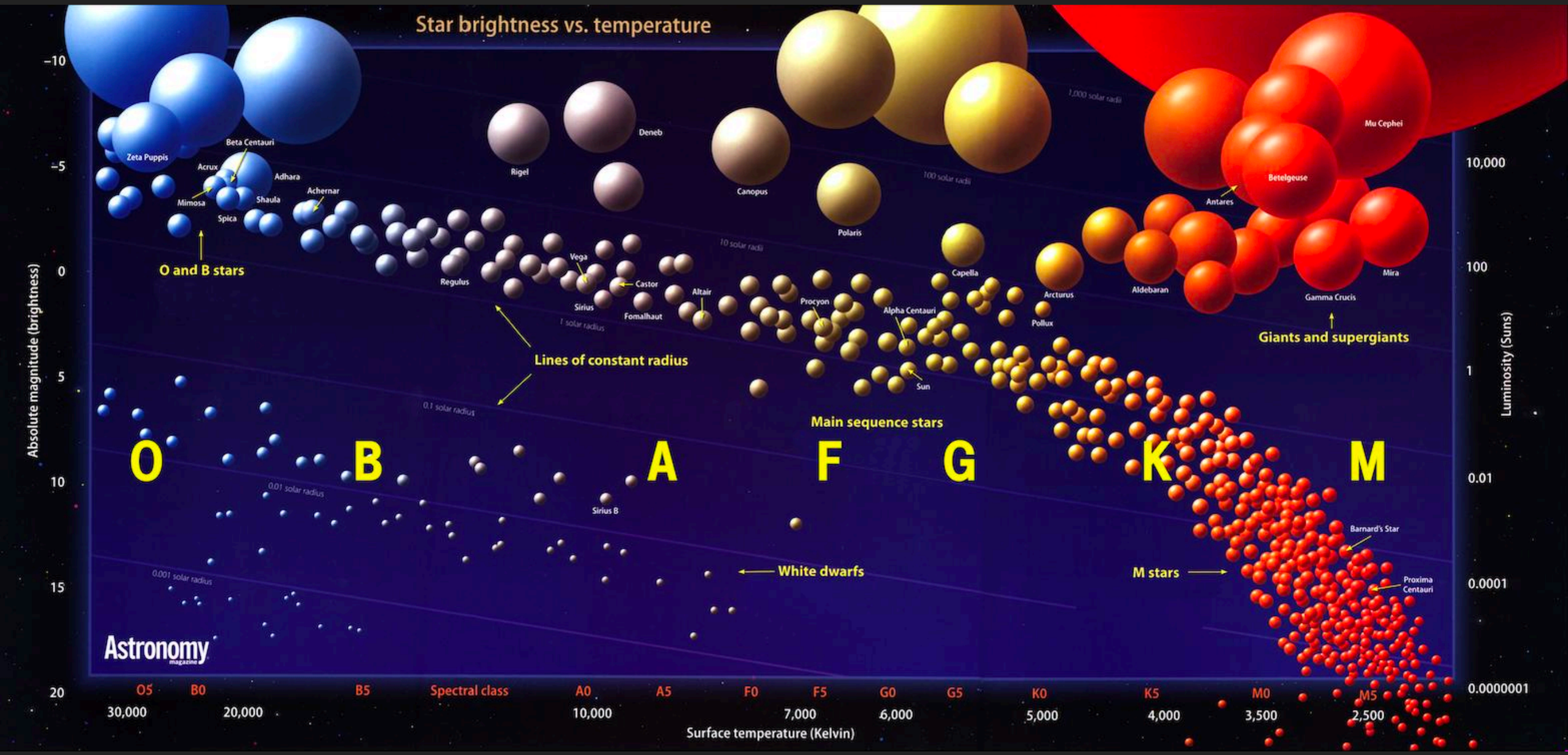
THE SUN



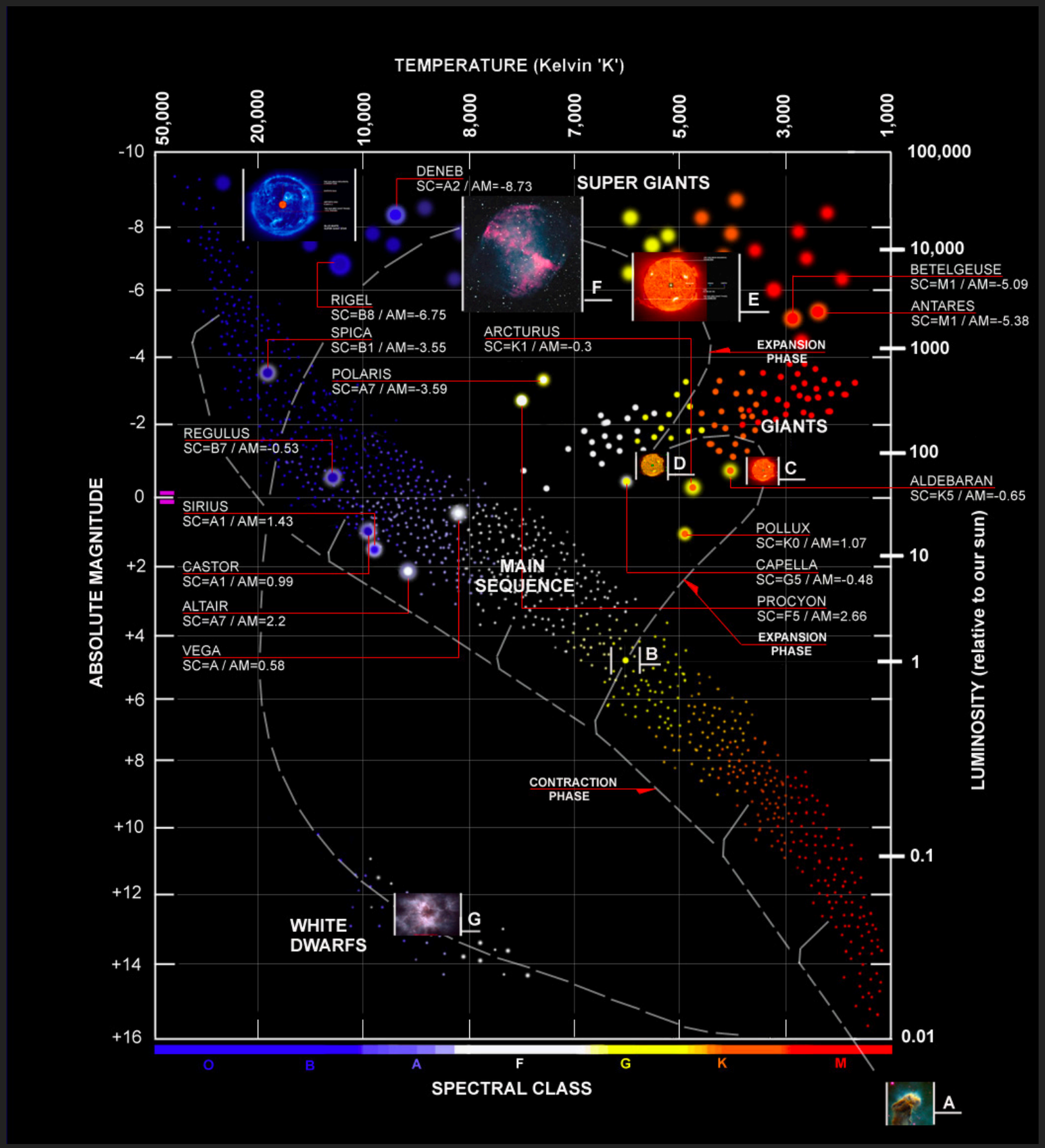
2. PHYSICAL PARAMETERS OF STARS

- Absolute parameters stars
  - Mass
  - Radius
  - Temperature
  - Luminosity (log L)
  - log g
  - M_{bol}
  - Distance

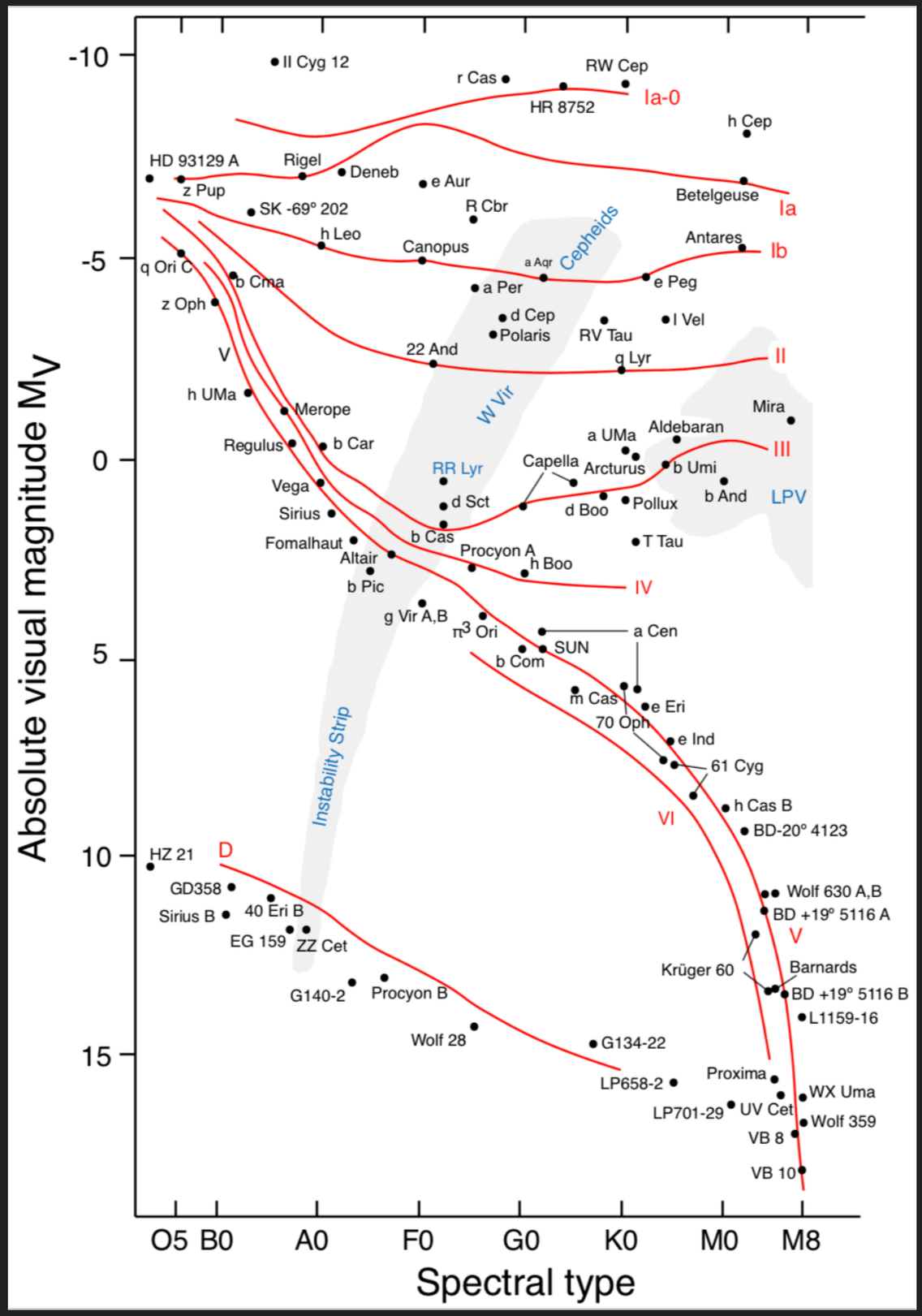
3. HERTZSPRUNG–RUSSELL DIAGRAM



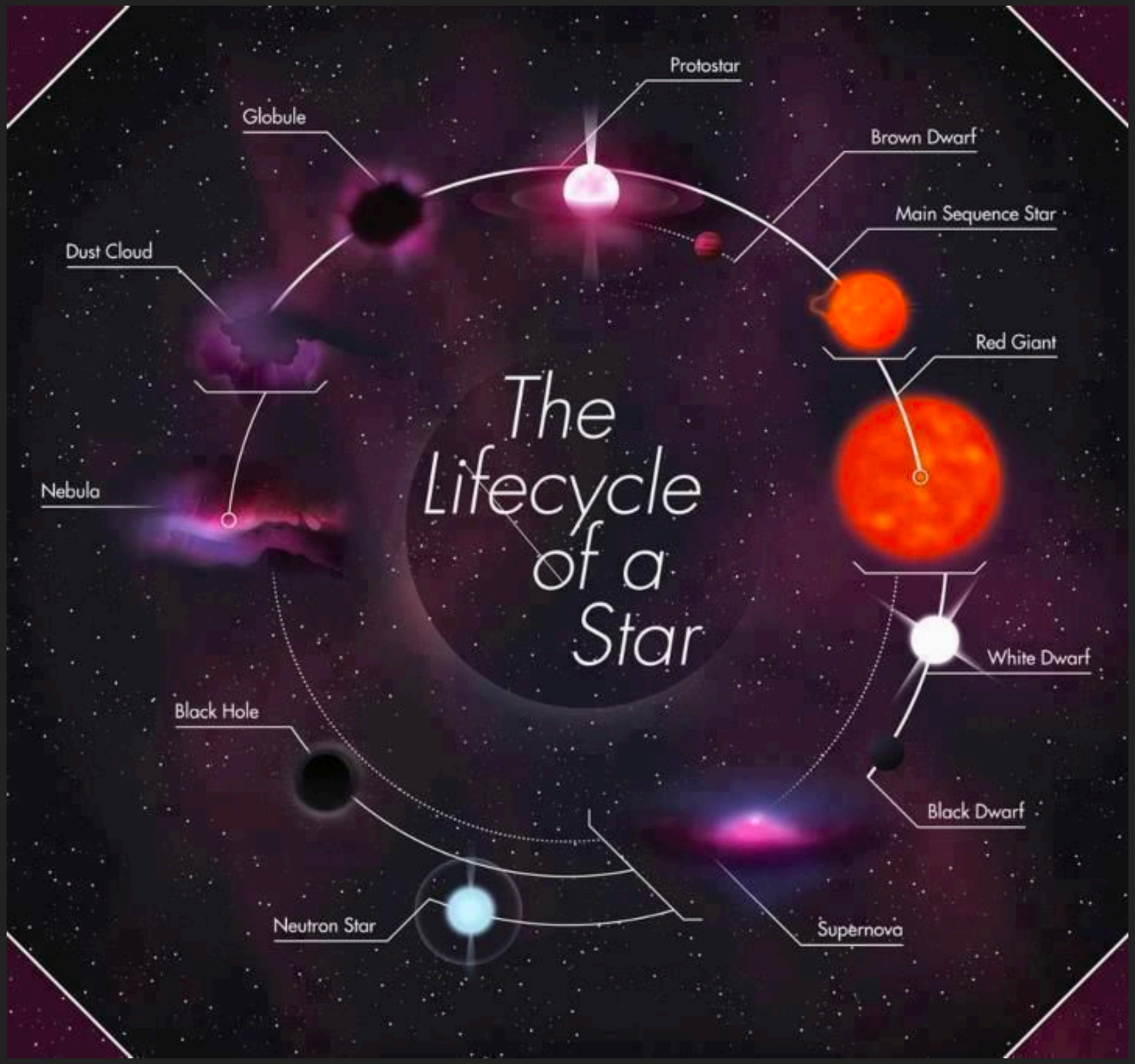
HR DIAGRAM


TEMPERATURE (Kelvin 'K')
50,000
20,000
10,000
8,000
7,000
5,000
3,000
1,000
ABSOLUTE MAGNITUDE
-10
-8
-6
-4
-2
0
+2
+4
+6
+8
+10
+12
+14
+16
LUMINOSITY (relative to our sun)
100,000
10,000
1000
100
10
1
0.1
0.01
SUPER GIANTS
DENEB
SC=A2 / AM=-8.73
RIGEL
SC=B8 / AM=-6.75
SPICA
SC=B1 / AM=-3.55
POLARIS
SC=A7 / AM=-3.59
REGULUS
SC=B7 / AM=-0.53
SIRIUS
SC=A1 / AM=1.43
CASTOR
SC=A1 / AM=0.99
ALTAIR
SC=A7 / AM=2.2
VEGA
SC=A / AM=0.58
ARCTURUS
SC=K1 / AM=-0.3
EXPANSION PHASE
GIANTS
BETELGEUSE
SC=M1 / AM=-5.09
ANTARES
SC=M1 / AM=-5.38
ALDEBARAN
SC=K5 / AM=-0.65
POLLUX
SC=K0 / AM=1.07
CAPELLA
SC=G5 / AM=-0.48
PROCYON
SC=F5 / AM=2.66
EXPANSION PHASE
MAIN SEQUENCE
CONTRACTION PHASE
WHITE DWARFS
A
B
C
D
E
F
G
O
B
A
F
G
K
M
SPECTRAL CLASS

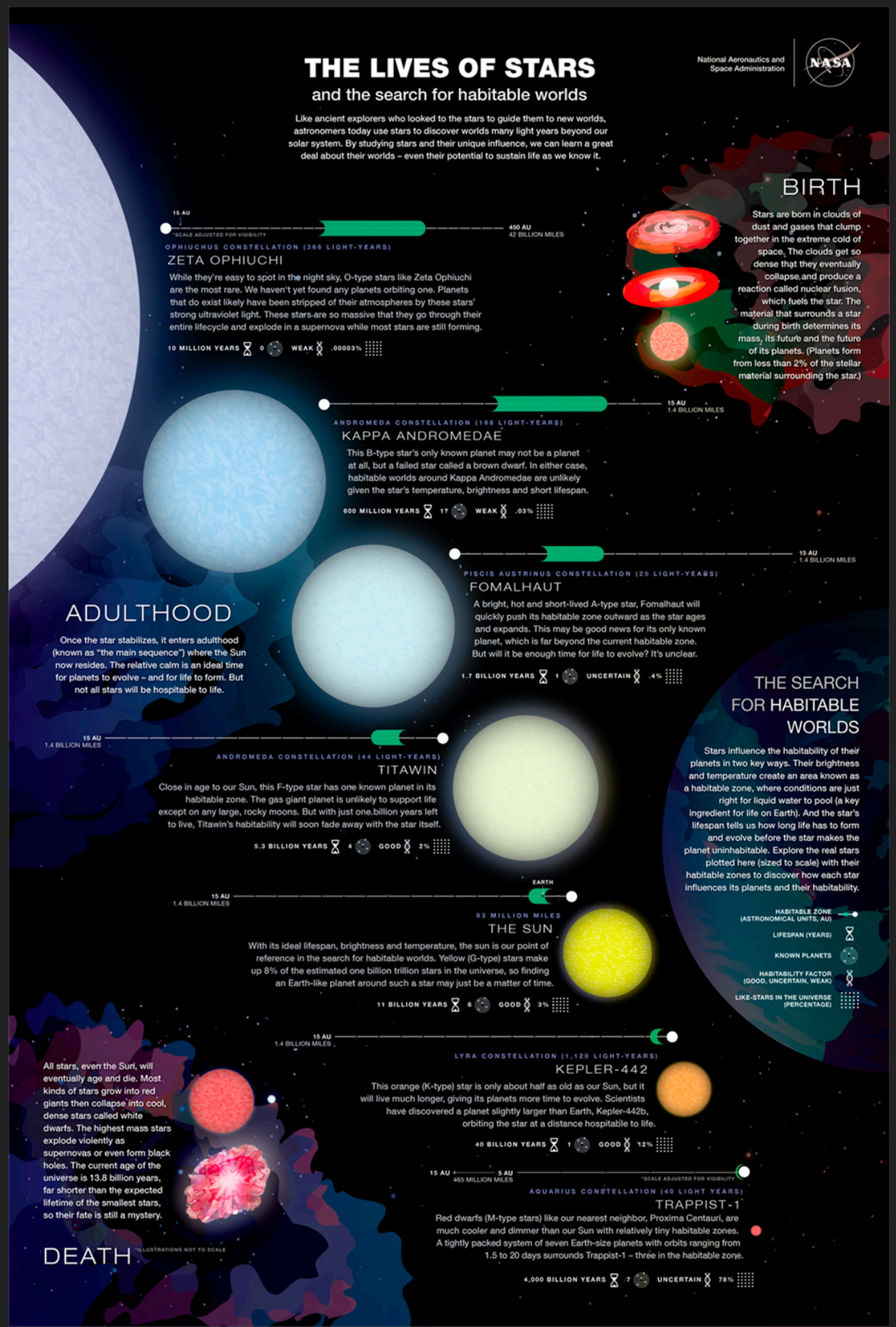
HR DIAGRAM


Absolute visual magnitude M_V
-10
-5
0
5
10
15
O5 B0 A0 F0 G0 K0 M0 M8
Spectral type
II Cyg 12
r Cas
RW Cep
HR 8752
Ia-0
h Cep
HD 93129 A
Rigel
Deneb
e Aur
z Pup
Betelgeuse
Ia
SK -69° 202
R Cbr
h Leo
Canopus
Antares
Ib
q Ori C
b Cma
a Aqr
Cepheids
a Per
e Peg
z Oph
d Cep
Polaris
RV Tau
l Vel
V
22 And
q Lyr
II
h UMa
Merope
W Vir
Mira
a UMa
Aldebaran
Regulus
b Car
III
RR Lyr
Capella
Arcturus
b Umi
Vega
d Sct
d Boo
Pollux
b And
LPV
Sirius
Fomalhaut
b Cas
T Tau
Procyon A
h Boo
Altair
IV
b Pic
g Vir A,B
π3 Ori
a Cen
SUN
b Com
m Cas
e Eri
70 Oph
e Ind
61 Cyg
Instability Strip
h Cas B
VI
BD-20° 4123
HZ 21
D
GD358
Wolf 630 A,B
Sirius B
40 Eri B
BD +19° 5116 A
EG 159
ZZ Cet
V
Krüger 60
Barnards
G140-2
Procyon B
BD +19° 5116 B
L1159-16
Wolf 28
G134-22
LP658-2
Proxima
WX Uma
LP701-29
UV Cet
Wolf 359
VB 8
VB 10

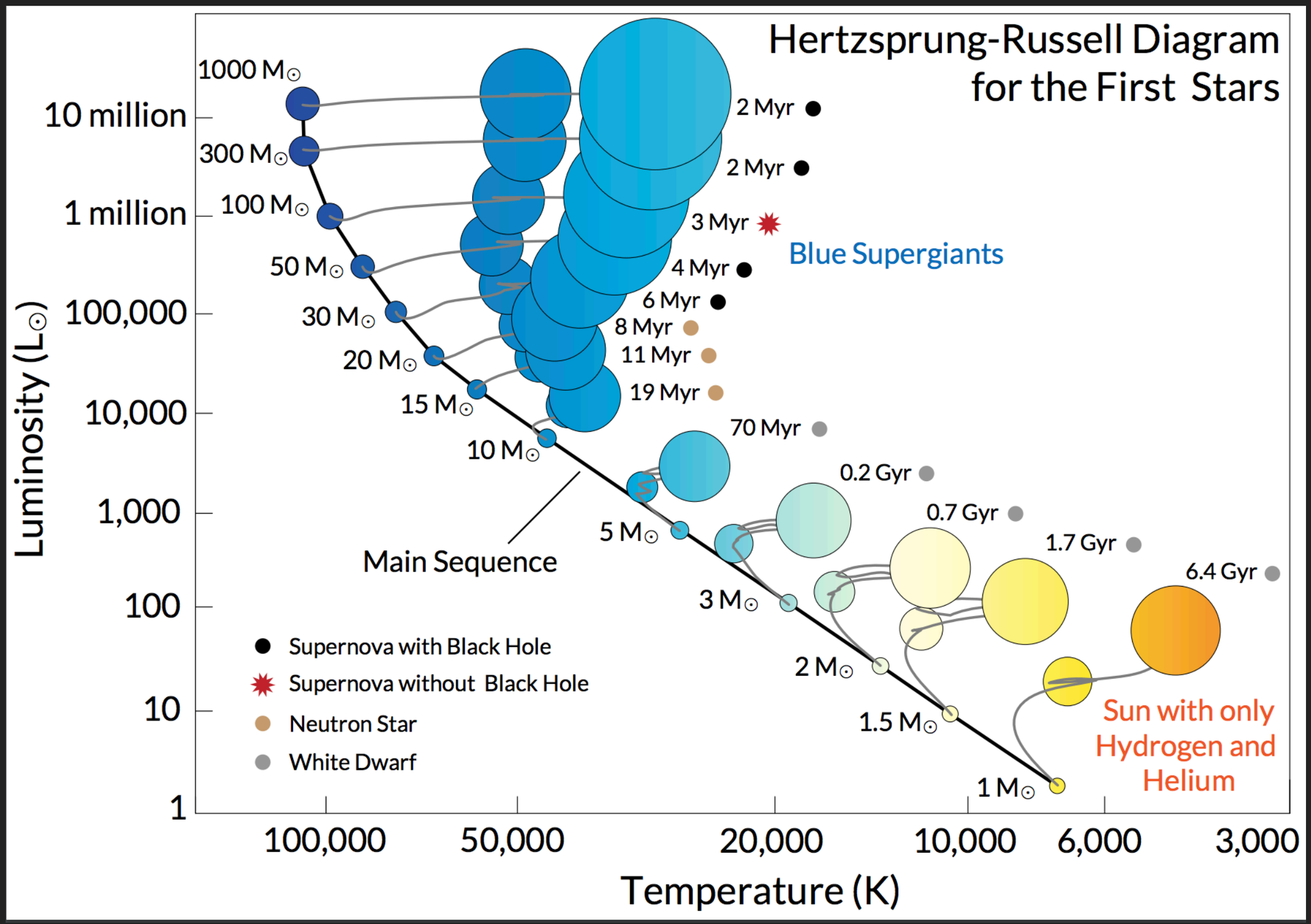
4. EVOLUTION OF STARS



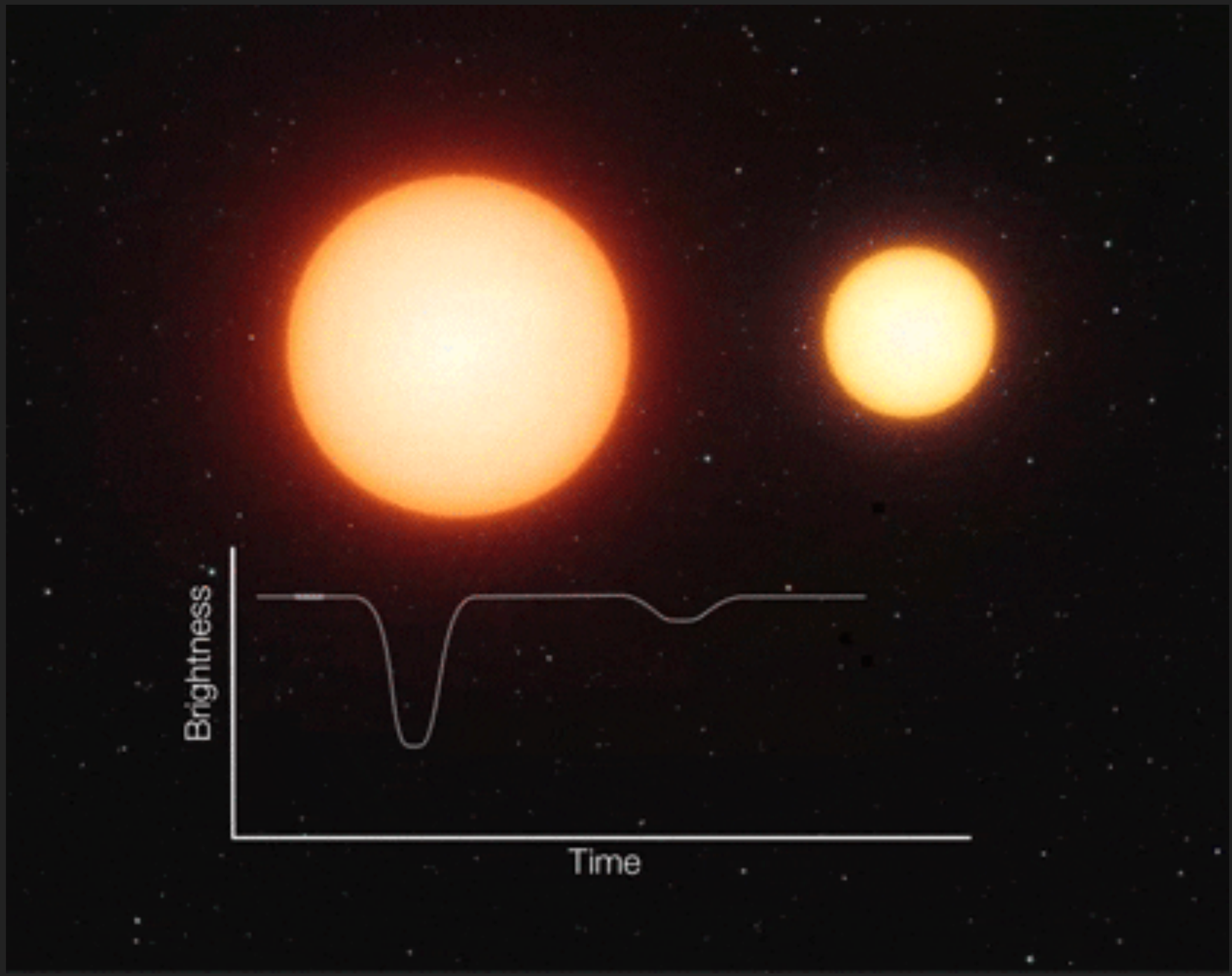
EVOLUTION OF STARS



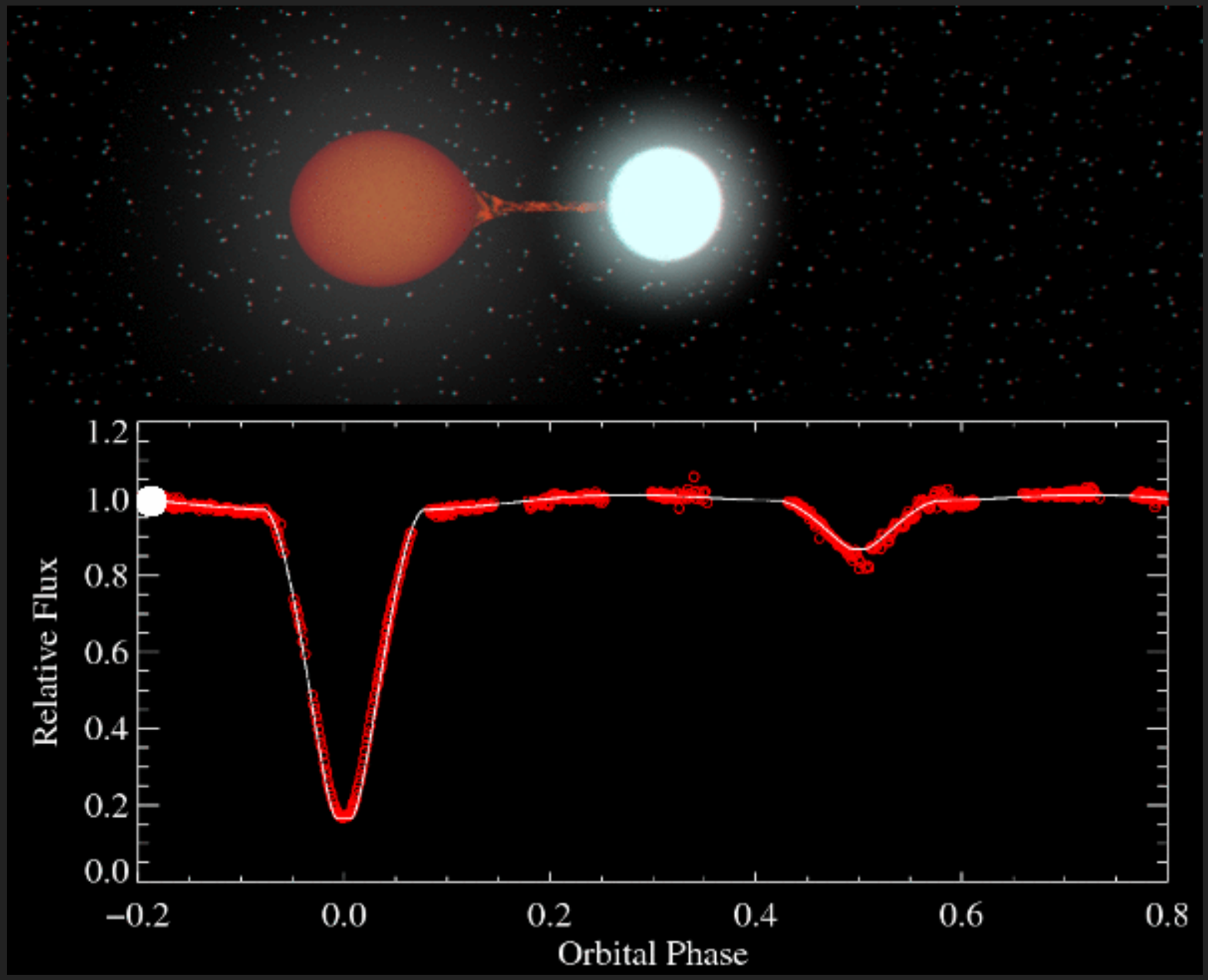
EVOLUTION OF STARS



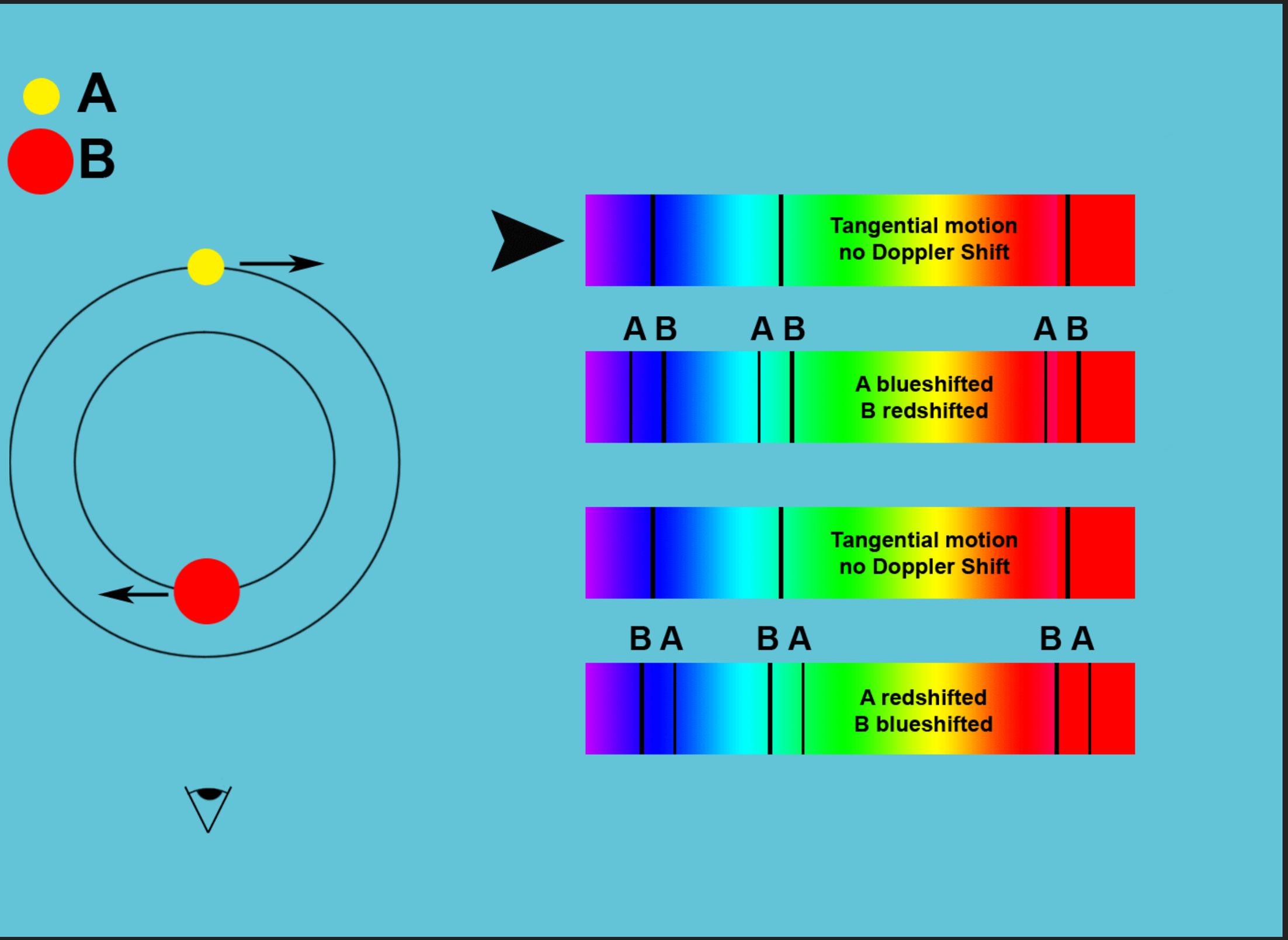
5. BINARY SYSTEMS



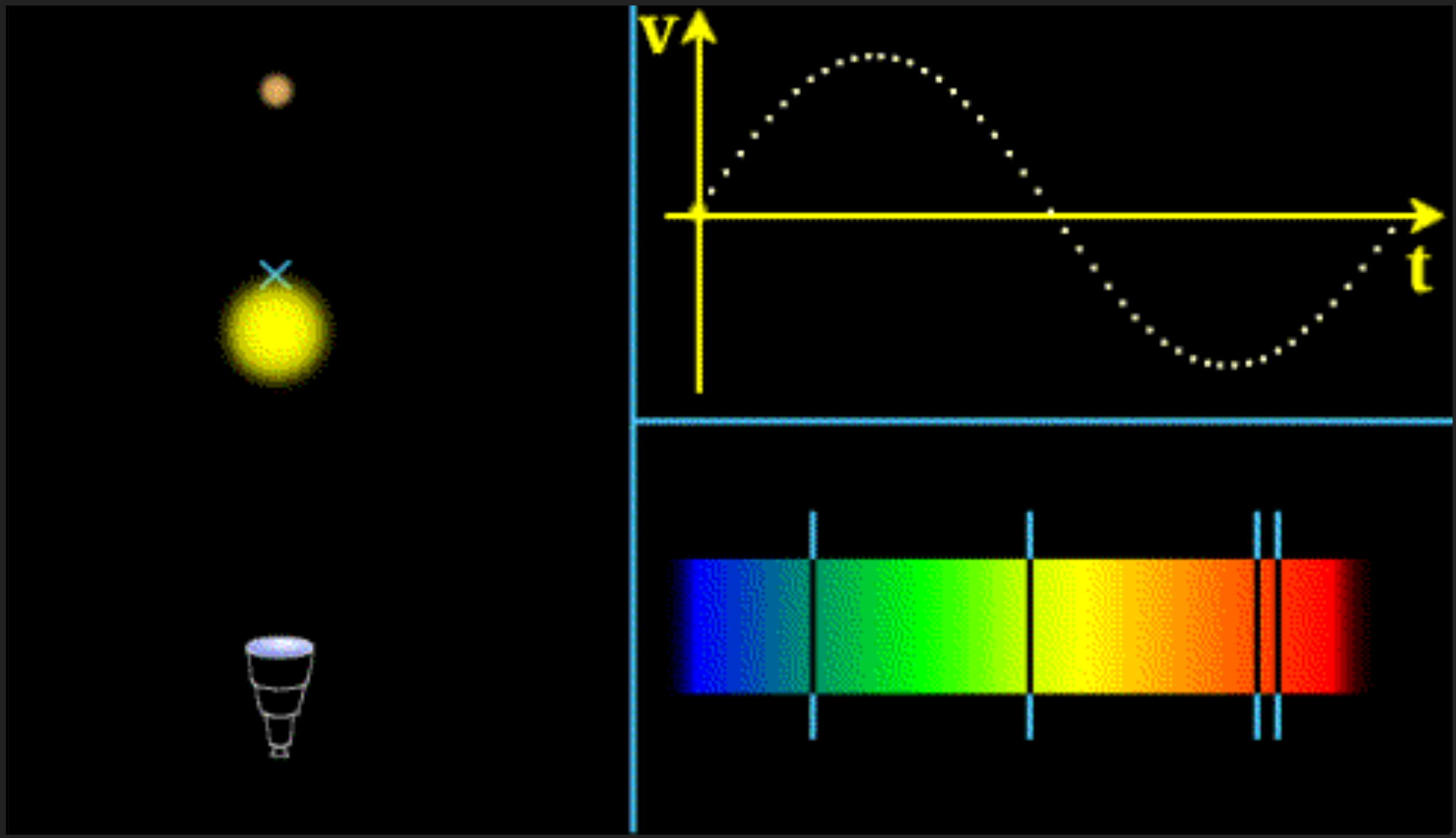
BINARY SYSTEMS



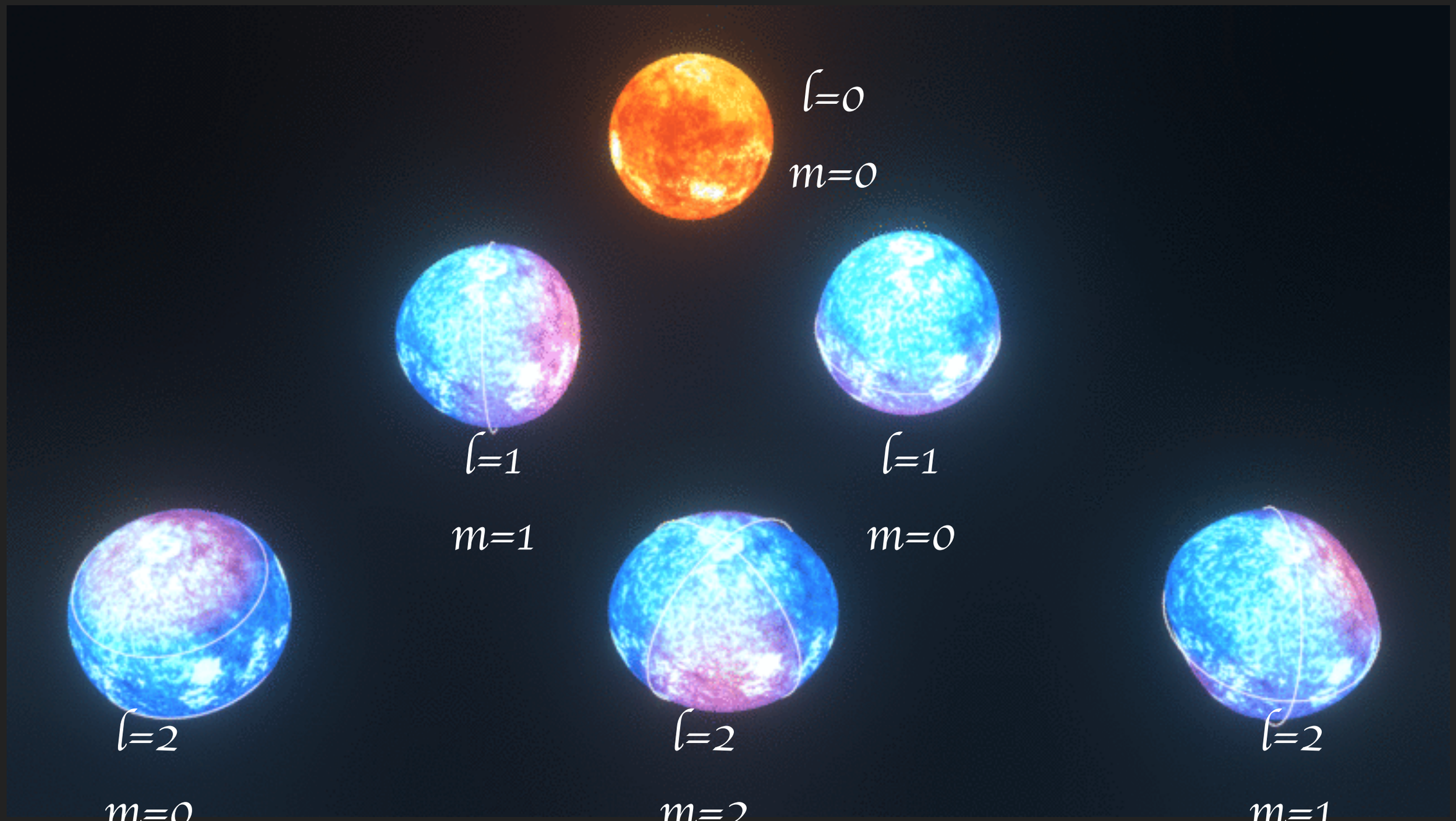
BINARY SYSTEMS



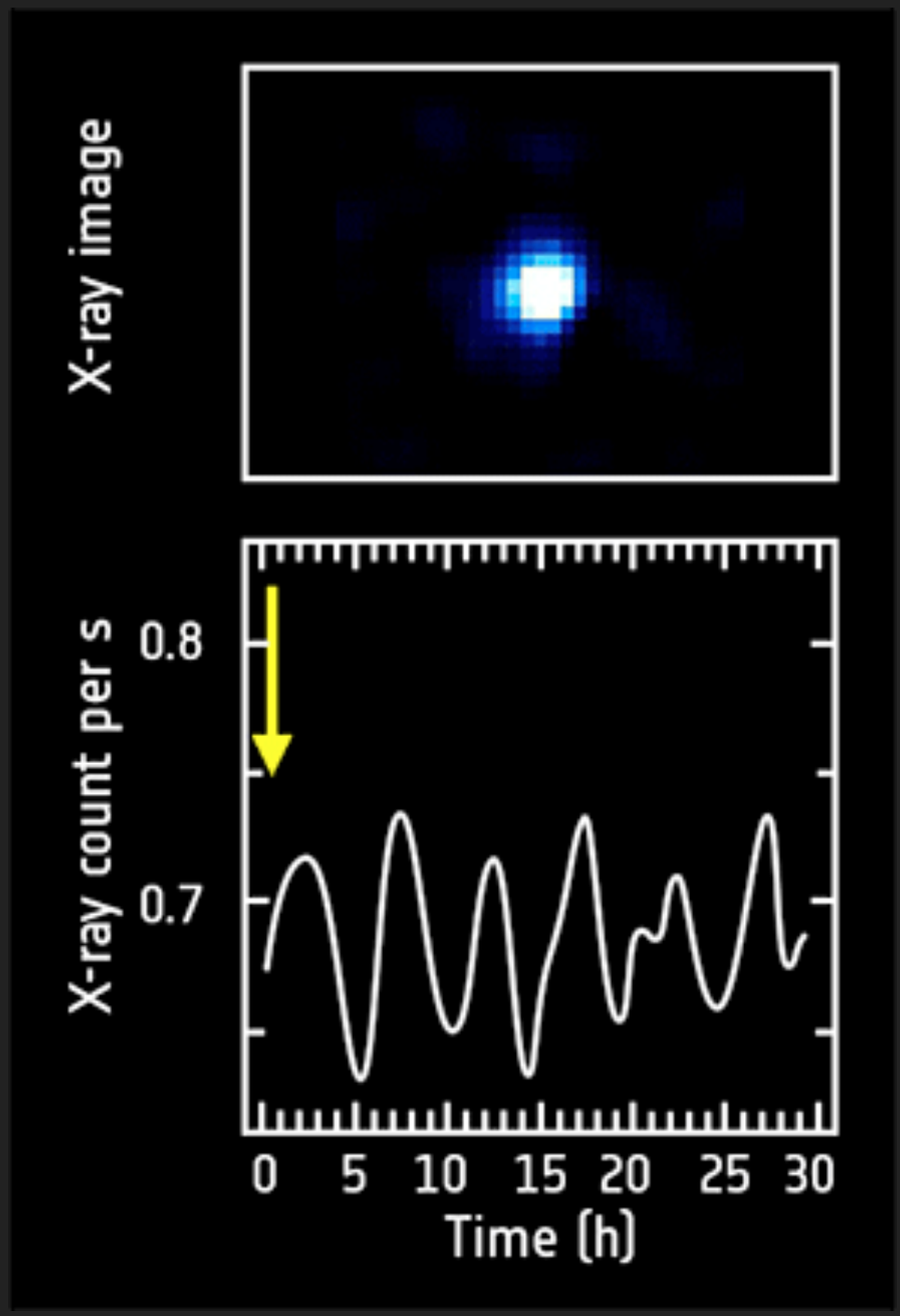
BINARY SYSTEMS - EXOPLANETS



6. PULSATING STARS



PULSATING STARS

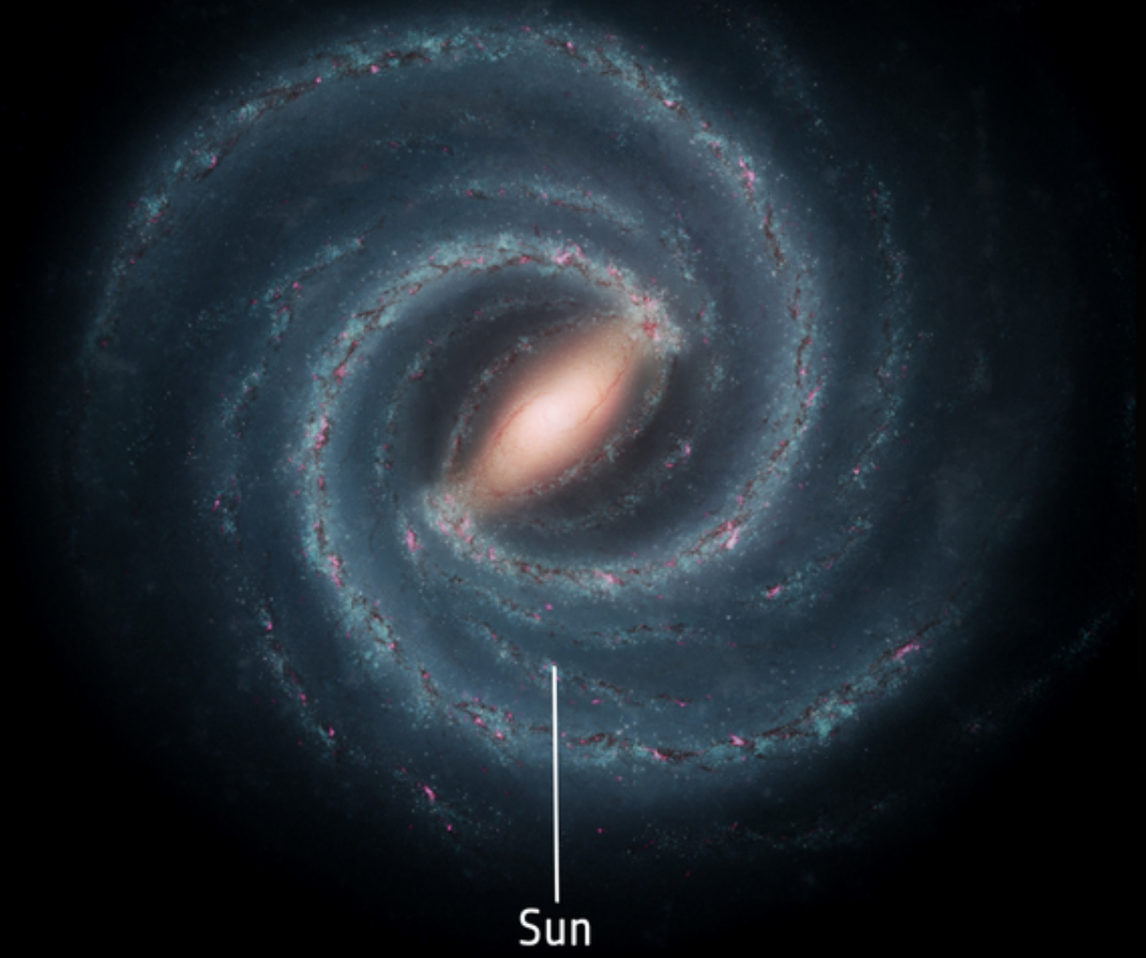


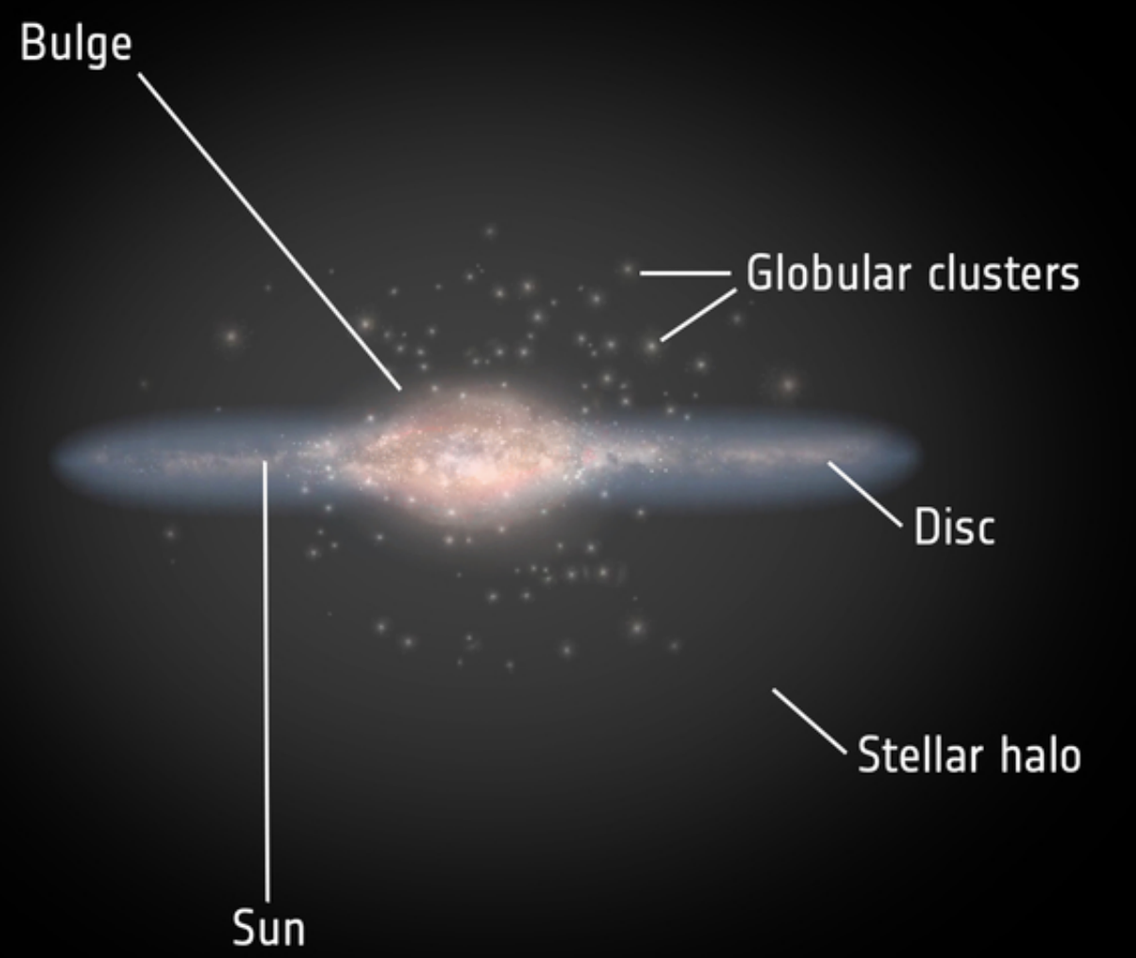
PULSATING STARS

7. THE MILKY WAY AND GALAXIES

→ ANATOMY OF THE MILKY WAY

esa





www.esa.int

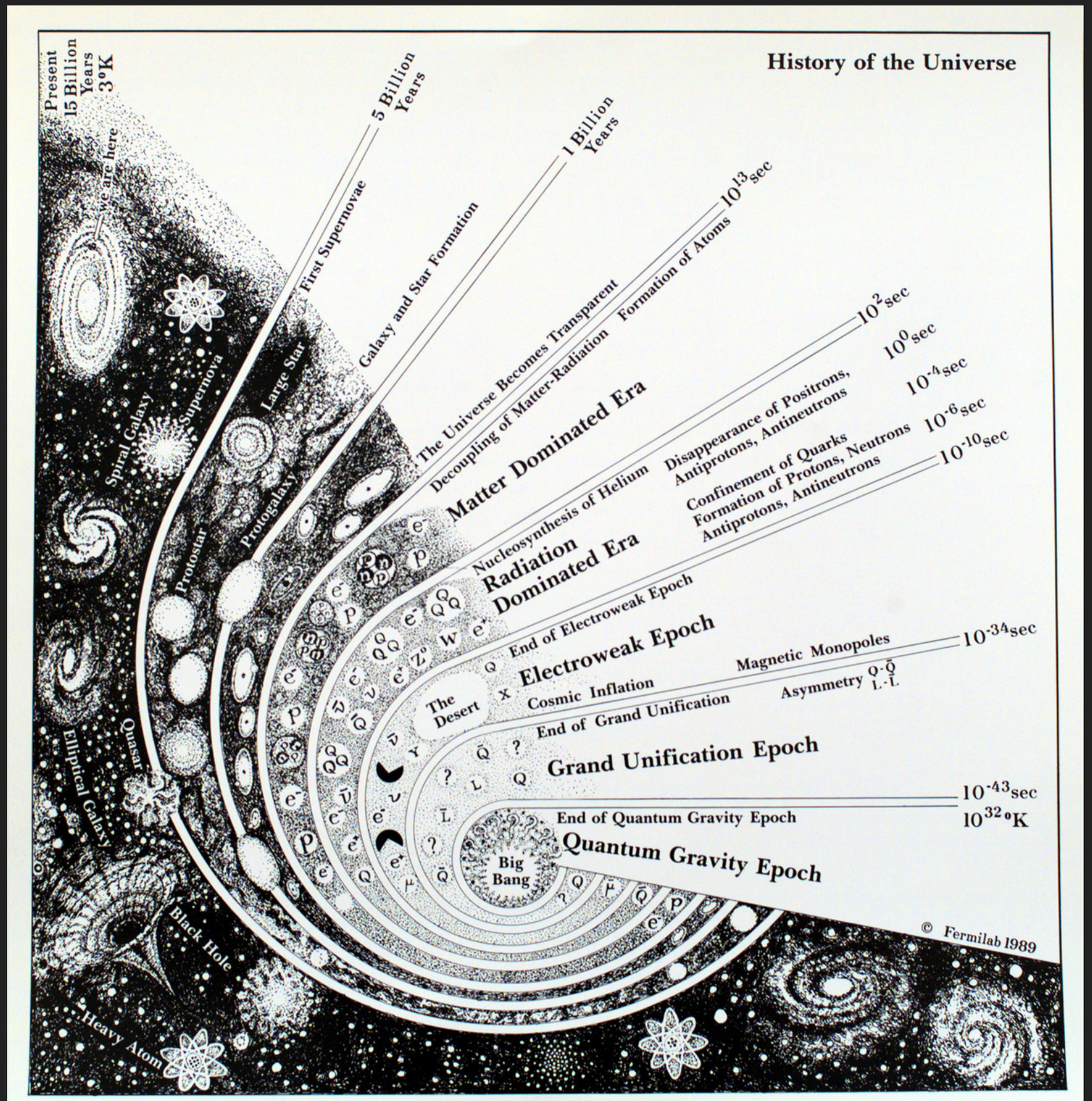
European Space Agency

8. DARK MATTER

the Universe is mostly dark: about 96 percent consists of dark energy (about 73%) and dark matter (about 22%).

Only about 4.6 percent of the Universe—including the stars, planets and us—is made of familiar atomic matter.

9. THE EVOLUTION OF THE UNIVERSE



10. THE SEARCH FOR LIFE IN THE UNIVERSE