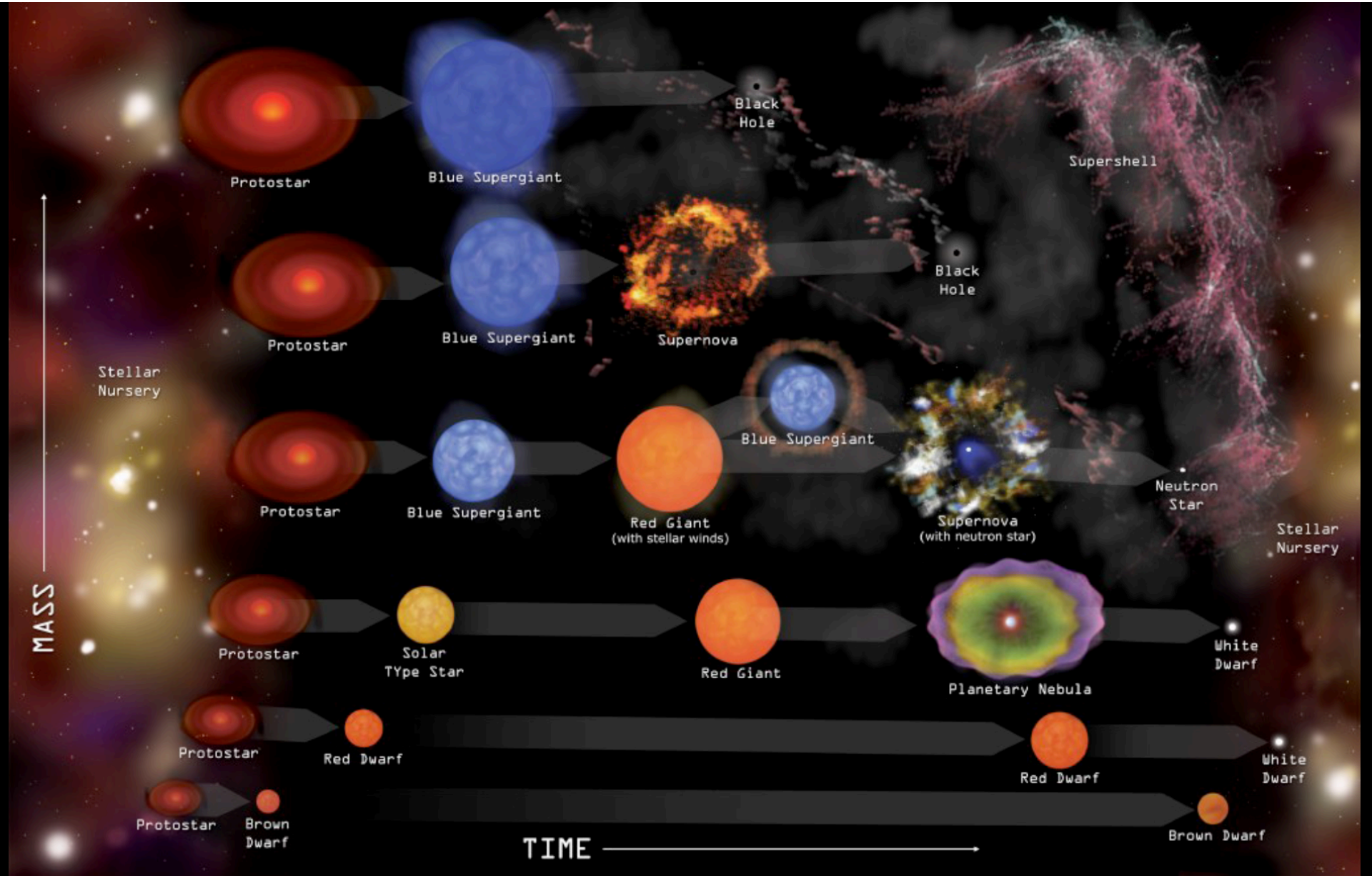
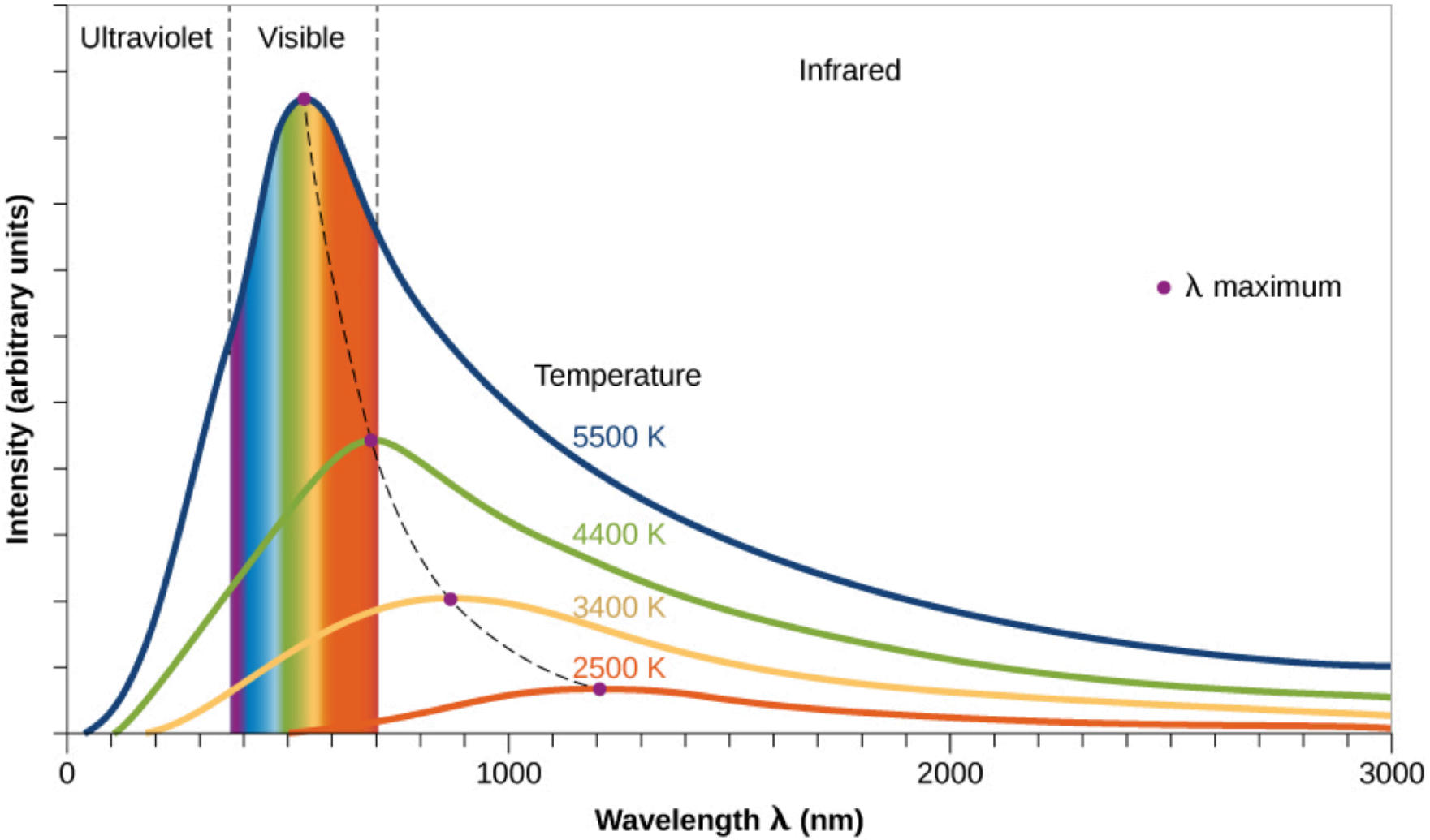

Stars:
Star Formation and the
Stellar Graveyard

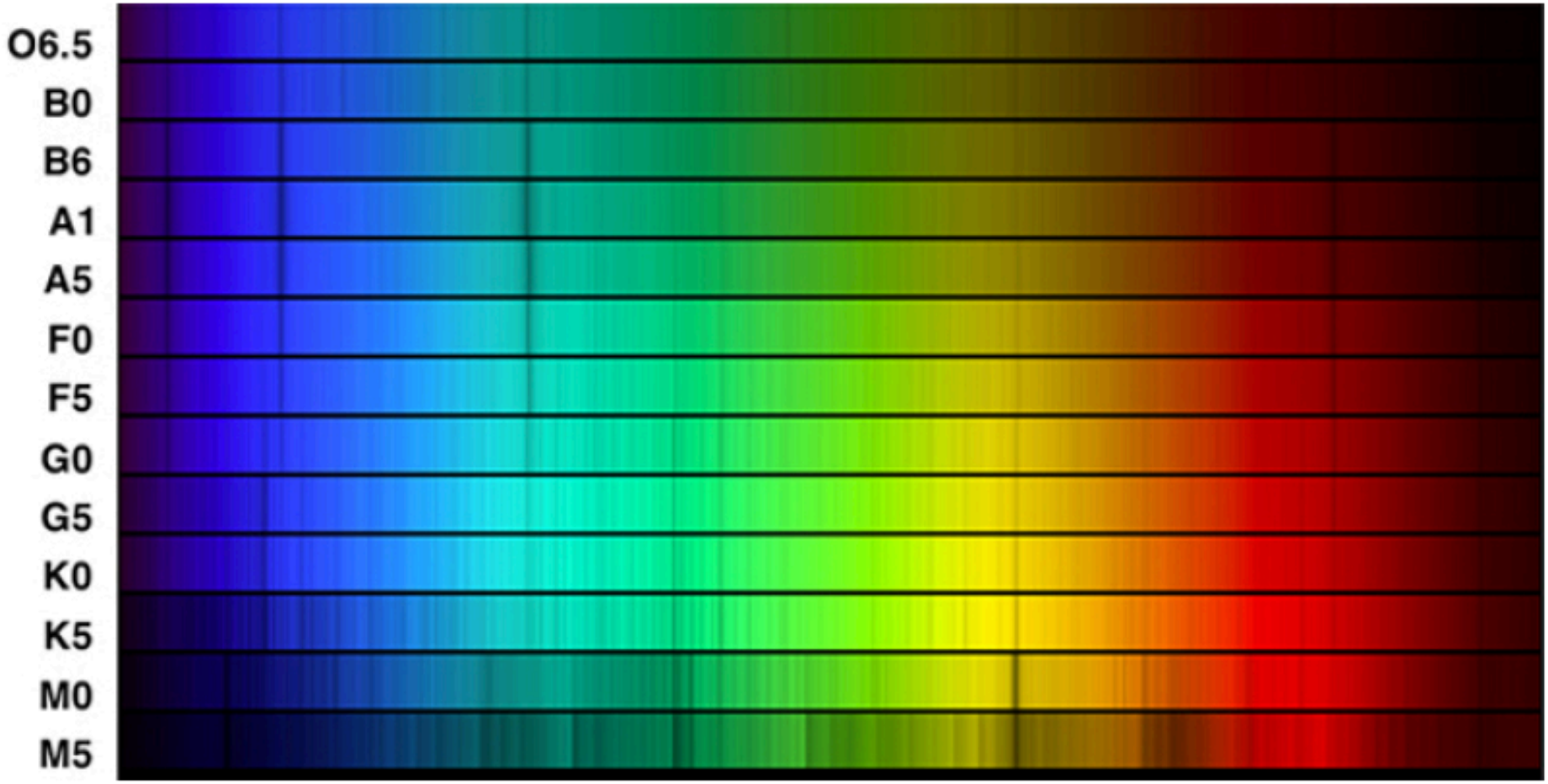

Protostar
Blue Supergiant
Black Hole
Supershell
Protostar
Blue Supergiant
Supernova
Black Hole
Stellar Nursery
Protostar
Blue Supergiant
Blue Supergiant
Red Giant
(with stellar winds)
Supernova
(with neutron star)
Neutron Star
Stellar Nursery
MASS
Protostar
Solar TYpe Star
Red Giant
Planetary Nebula
White Dwarf
Protostar
Red Dwarf
Red Dwarf
White Dwarf
Protostar
Brown Dwarf
Brown Dwarf
TIME

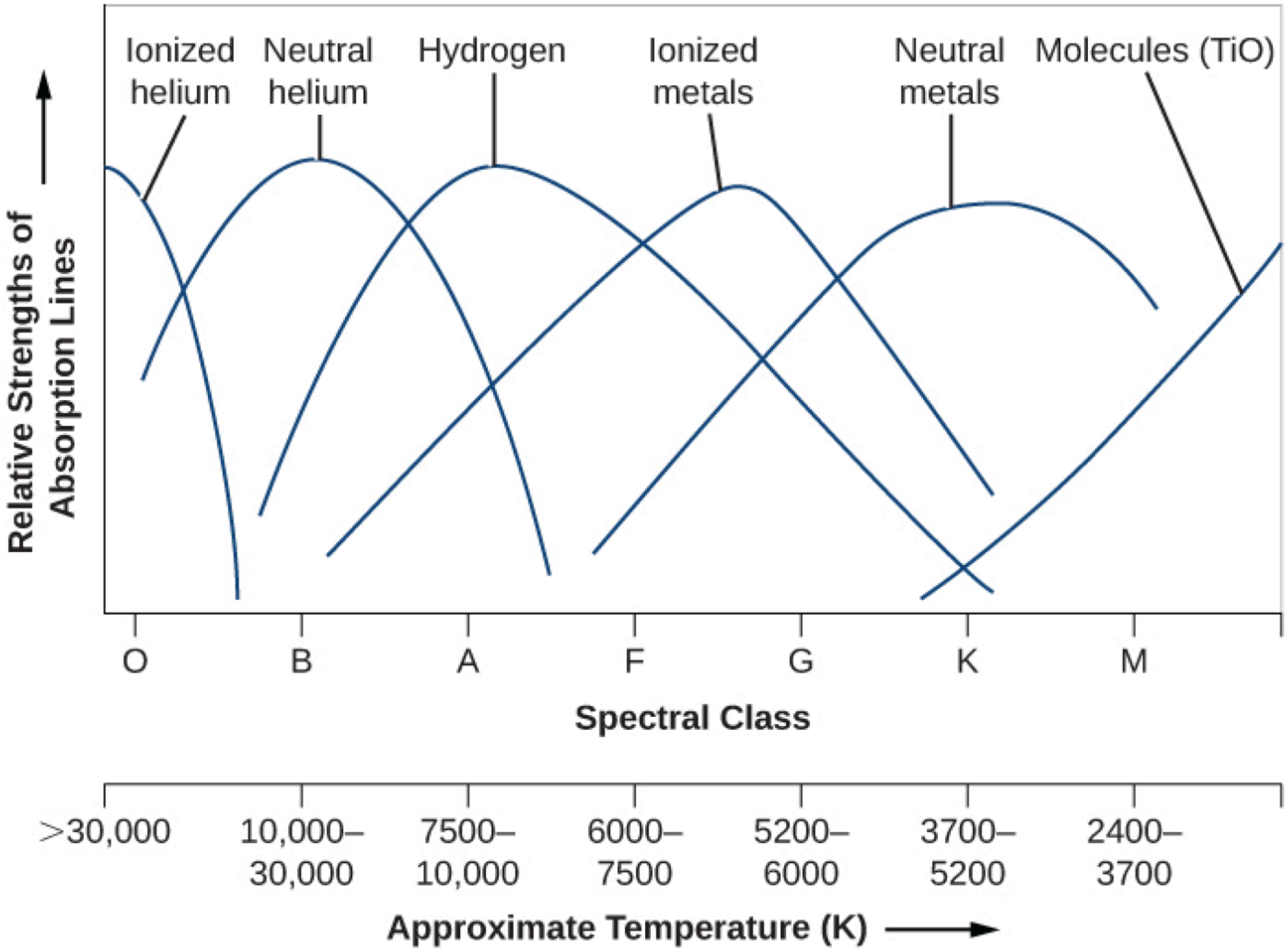
Blackbody emission: hotter things emit at higher energies (=shorter wavelengths)

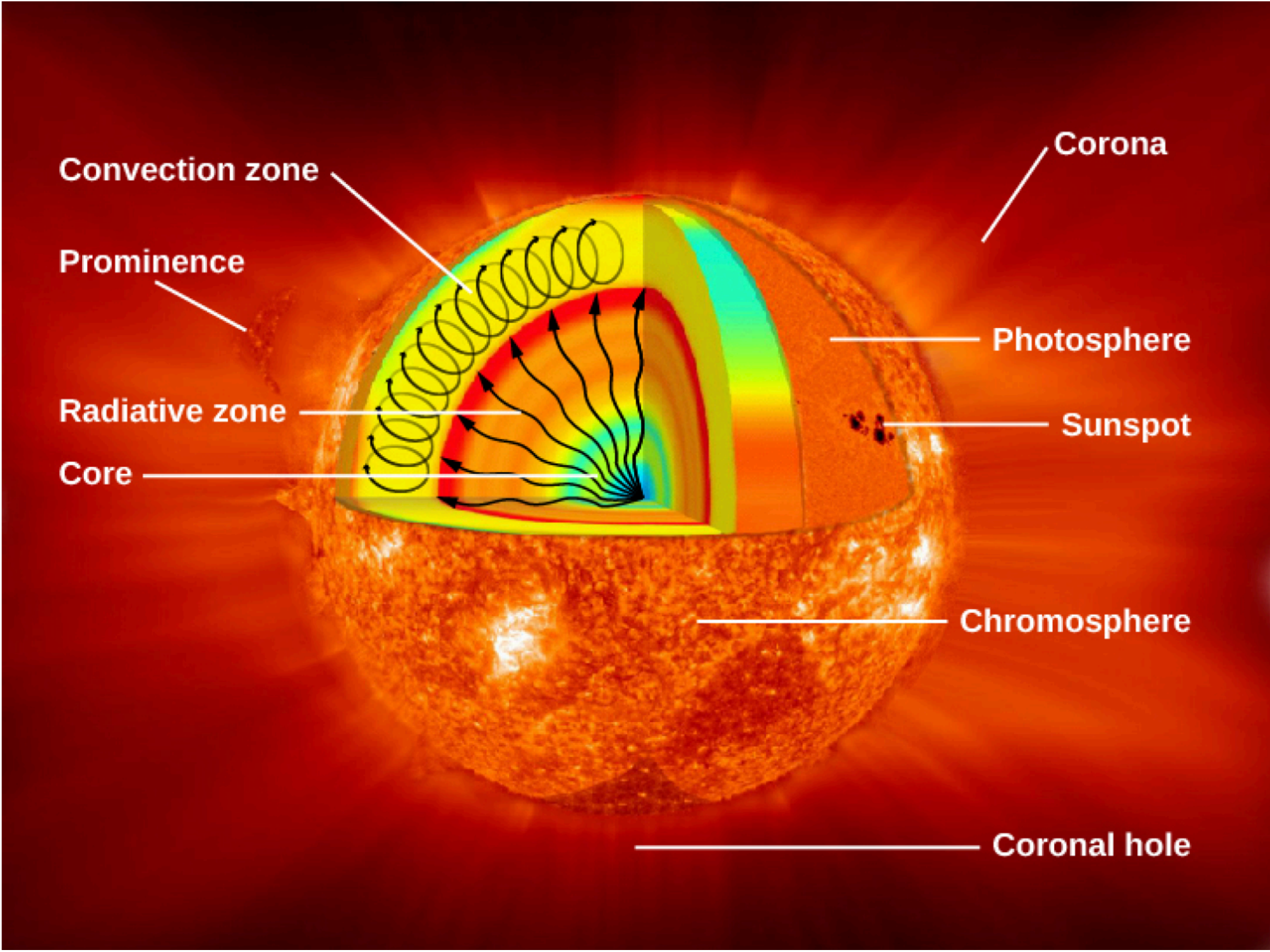
Peak of blackobody: $\lambda_{\max} \cdot T = 0.288\ \mathrm{cm} \cdot \mathrm{K}$



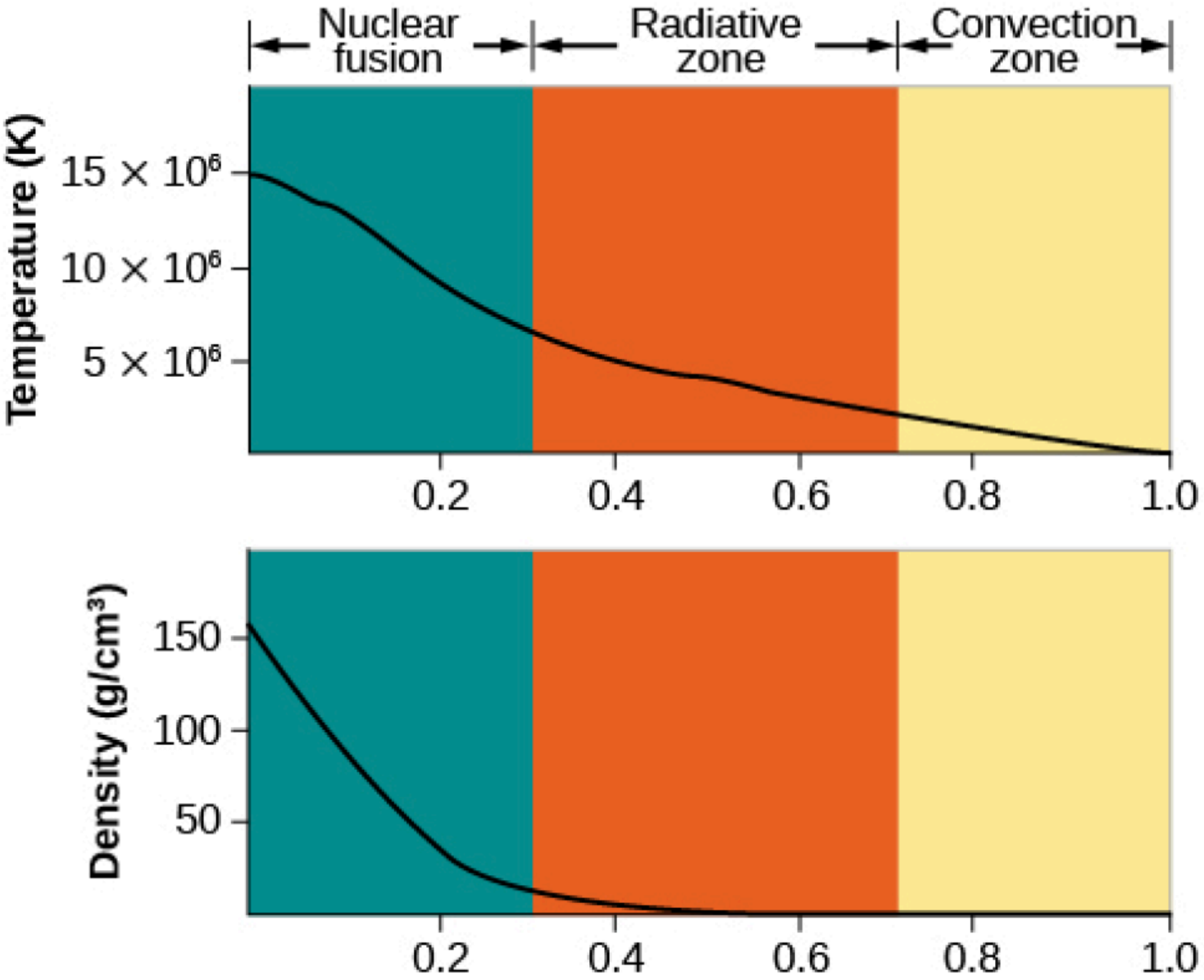
Spectral type = temperature squence



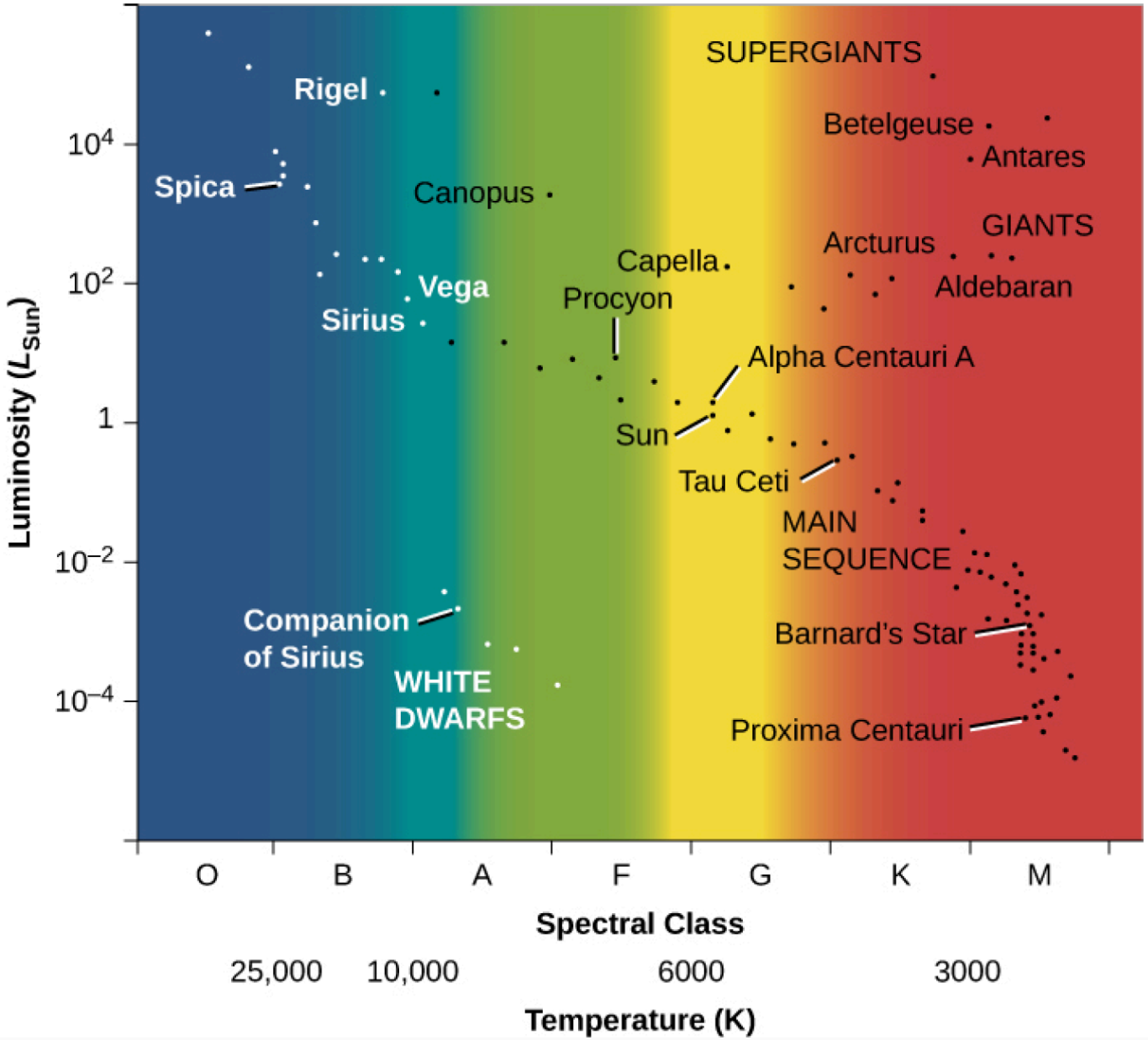

Ionized helium
Neutral helium
Hydrogen
Ionized metals
Neutral metals
Molecules (TiO)
Relative Strengths of Absorption Lines
O
B
A
F
G
K
M
Spectral Class
>30,000
10,000–30,000
7500–10,000
6000–7500
5200–6000
3700–5200
2400–3700
Approximate Temperature (K)


Convection zone
Prominence
Radiative zone
Core
Corona
Photosphere
Sunspot
Chromosphere
Coronal hole

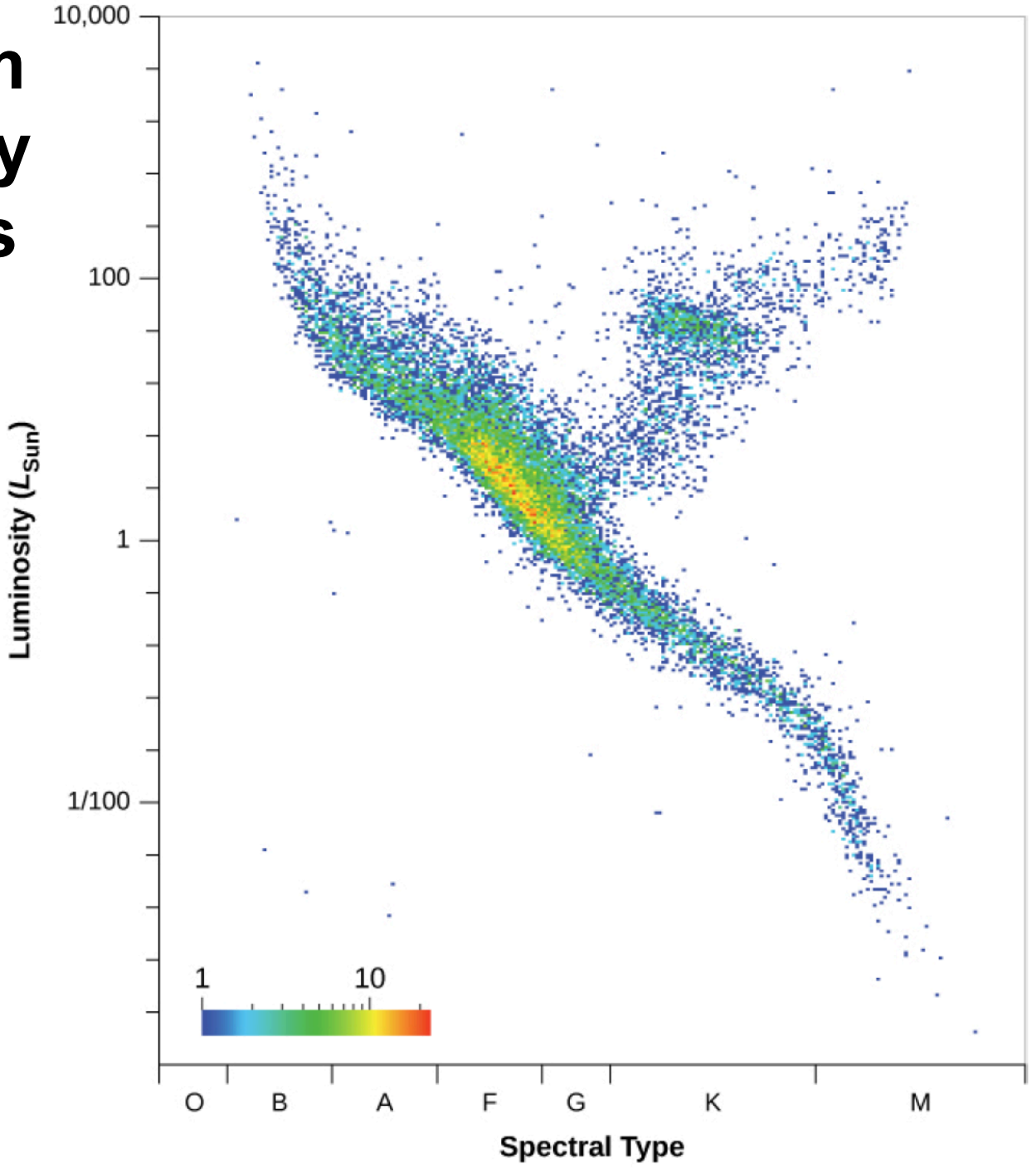
Core of star: very dense, 15 million K



HR Diagram


SUPERGIANTS
Rigel
Betelgeuse
Antares
Spica
Canopus
GIANTS
Arcturus
Capella
Vega
Aldebaran
Procyon
Sirius
Alpha Centauri A
Sun
Tau Ceti
MAIN
SEQUENCE
Companion
of Sirius
Barnard's Star
WHITE
DWARFS
Proxima Centauri
Luminosity (L_{Sun})
10^4
10^2
1
10^{-2}
10^{-4}
O
B
A
F
G
K
M
Spectral Class
25,000
10,000
6000
3000
Temperature (K)

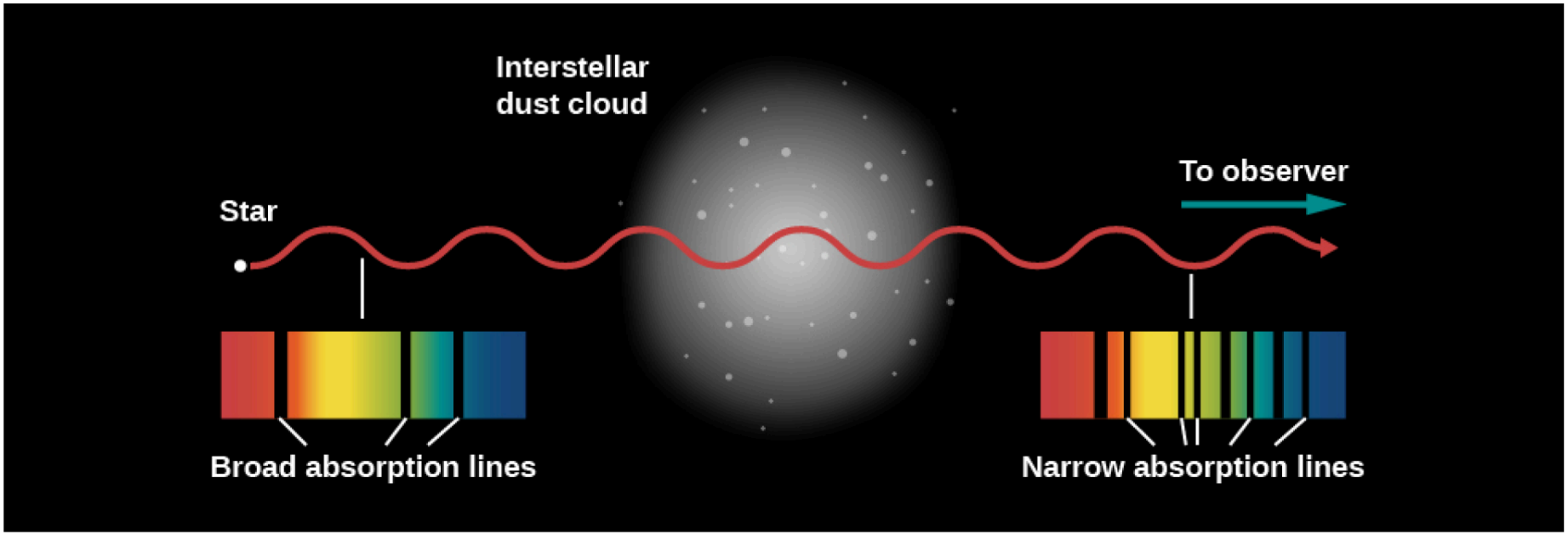
HR Diagram of all nearby bright stars



Interstellar medium

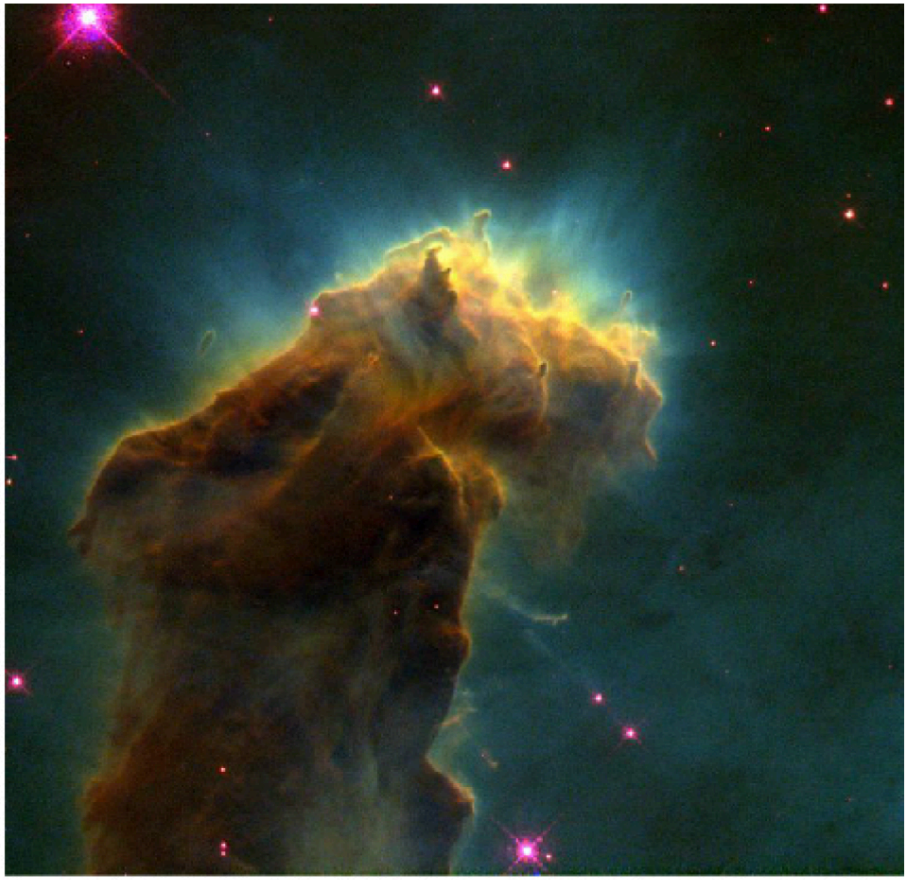
- Space is not quite empty
  - Hot interstellar medium: 10^{-4} ions per cm^3
  - In this room: 10^{19} molecules/cm^3
  - Best vacuum in lab: 10^{10} molecules/cm^3
- Some places are denser and colder
  - Molecular clouds, where stars form
  - Densities of 10^2-10^6 molecules/cm^3

Intestellar medium: how to detect?
Absorption of photons by gas
Emission from gas/dust




Orion Nebula

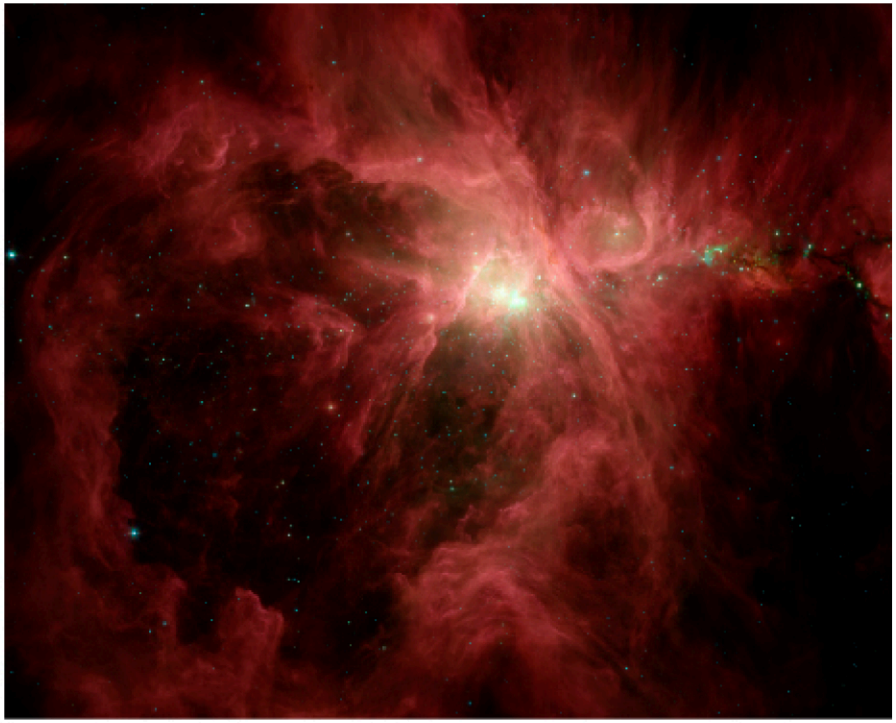

Eta Carina Cluster,
Hubble Space Telescope
Much larger than Orion Nebula
"Mystic Mountain" A Pillar of Gas and Dust in the Carina Nebula
HUBBLESITE.org

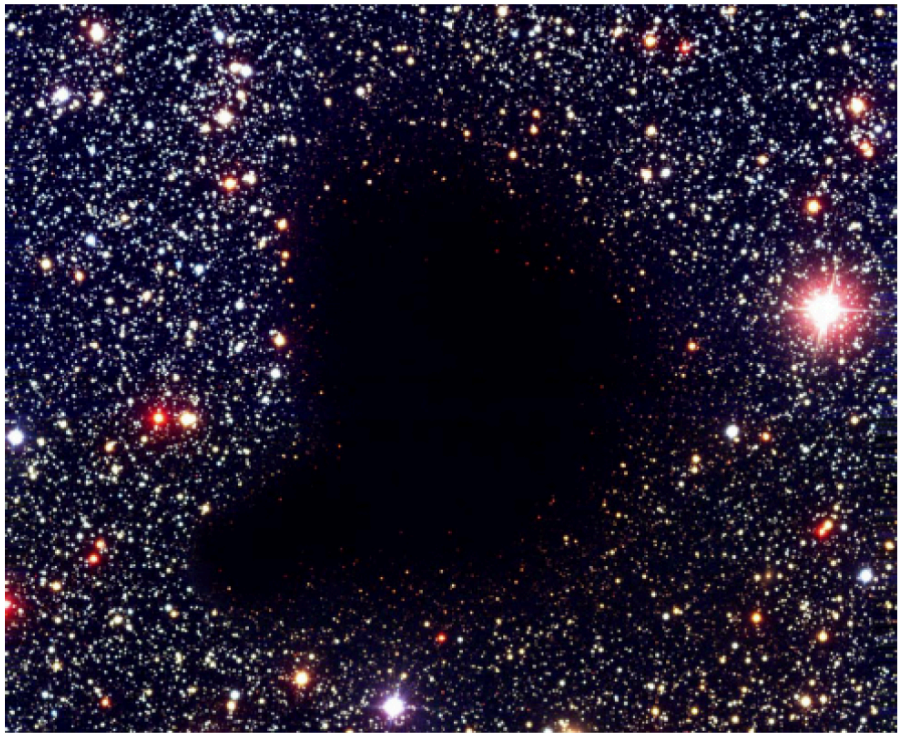


"Pillars" and "Mountains" of Star Formation

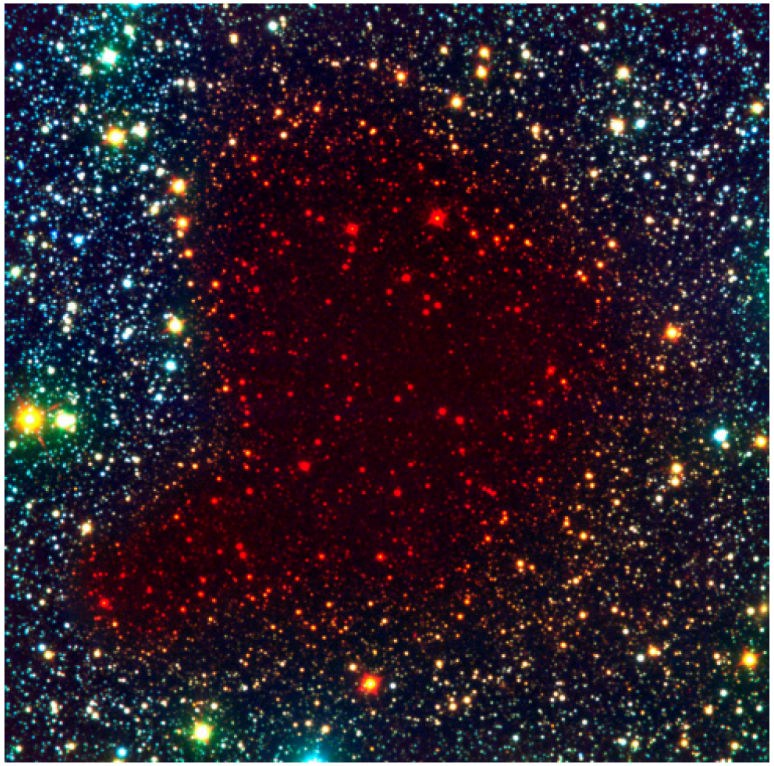
Spitzer Space Telescope • IRAC
Inset: Hubble Space Telescope
ssc2005-23b

NASA / JPL-Caltech / L. Allen (Harvard-Smithsonian CfA)



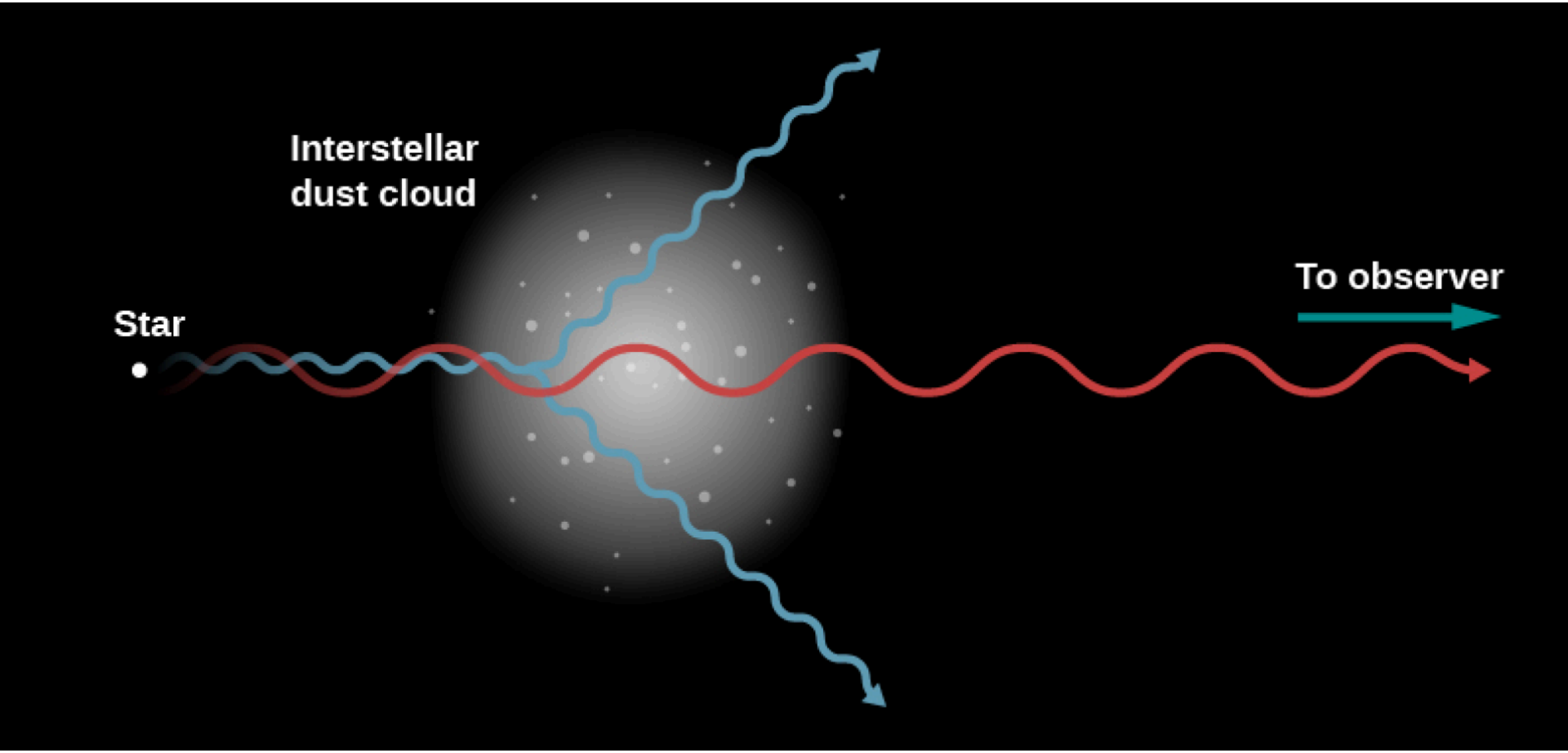


Optical



Near-infrared

Barnard 68: very dusty.
Longer wavelengths look through dust



Blue wavelengths: absorbed/scattered by dust
Red wavelengths: pass through dust


Rosette Nebula
Far-infrared: dust in emission