Lecture 7

Stars and Galaxies and Nebula, (Oh My!)

Feb 18 2003
8:00 PM
BMPS 1420

This week's topics

- Objects in the night sky
  - Stars
    - HR Diagram
  - Galaxies
    - Morphology and Classification
  - Nebulae
    - Planetary
    - Globular Clusters
    - Other

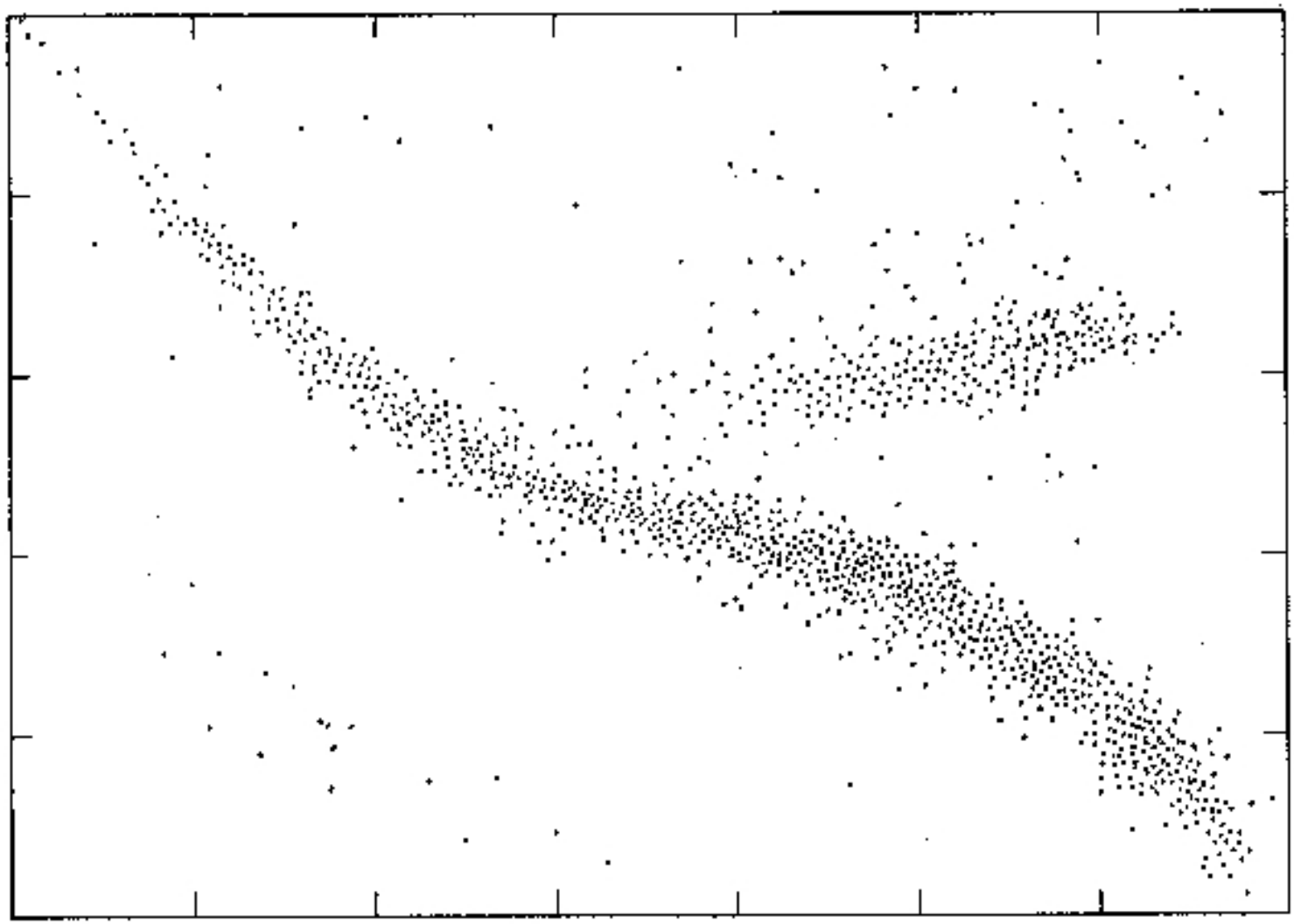
Stars

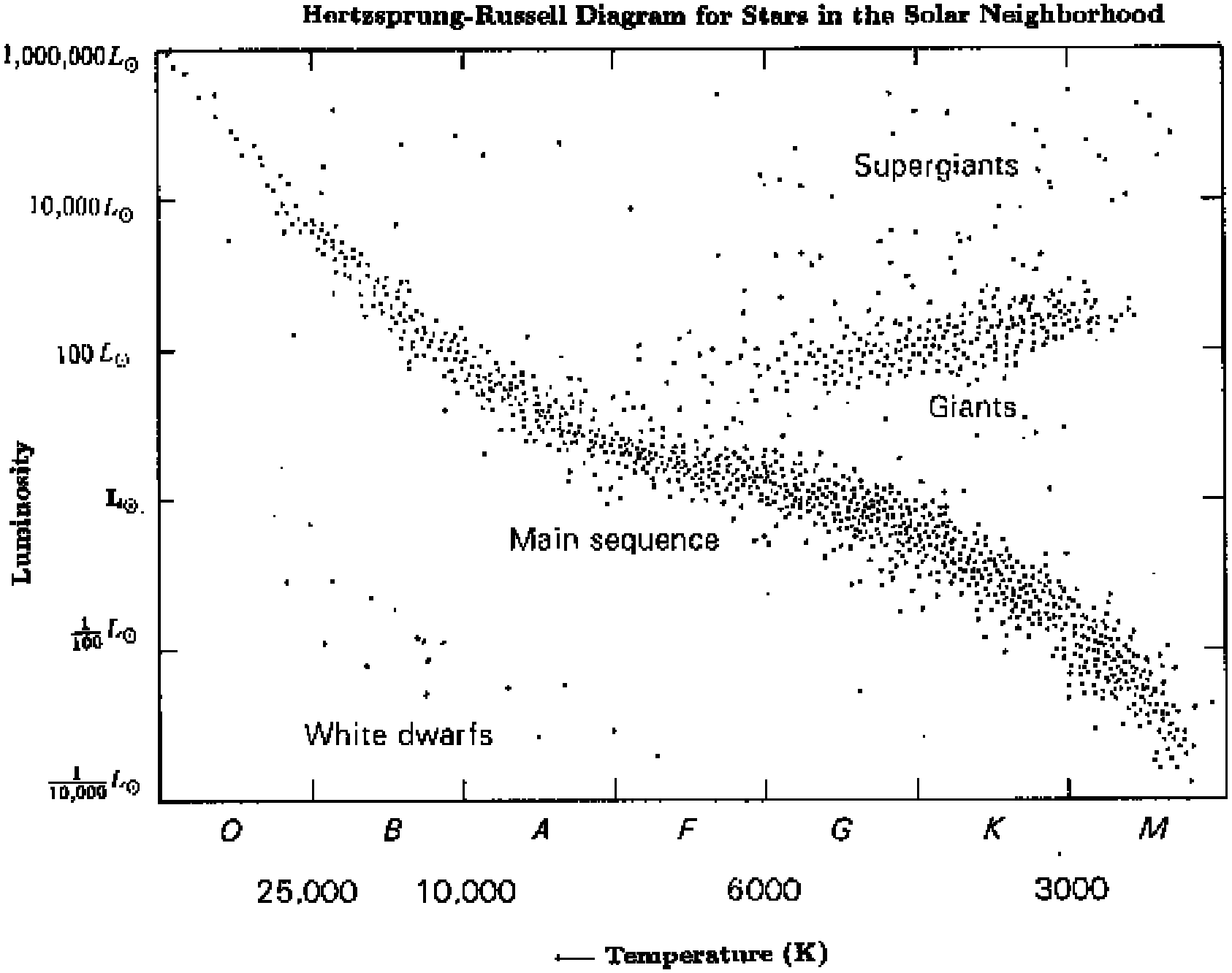
- Things we would like to know about stars
  - Luminosity
  - Temperature
  - Mass
  - Composition
  - Distance

The HR Diagram

- Developed in early 1900's
  - Independently worked out by two different individuals
    - Ejnar Hertzsprung (Denmark) [L vs Color]
    - Henry Norris Russell (USA) [L vs Spectral Type]

Hertzsprung-Russell Diagram for Stars in the Solar Neighborhood




Hertzsprung-Russell Diagram for Stars in the Solar Neighborhood
1,000,000 $L_\odot$
10,000 $L_\odot$
100 $L_\odot$
$L_\odot$
$\frac{1}{100}$ $L_\odot$
$\frac{1}{10,000}$ $L_\odot$
Luminosity
Supergiants
Giants
Main sequence
White dwarfs
O
B
A
F
G
K
M
25,000
10,000
6000
3000
Temperature (K)

Notice the stellar classification:

O	B	A	F	G	K	M
higher temp						lower temp
higher mass						lower mass

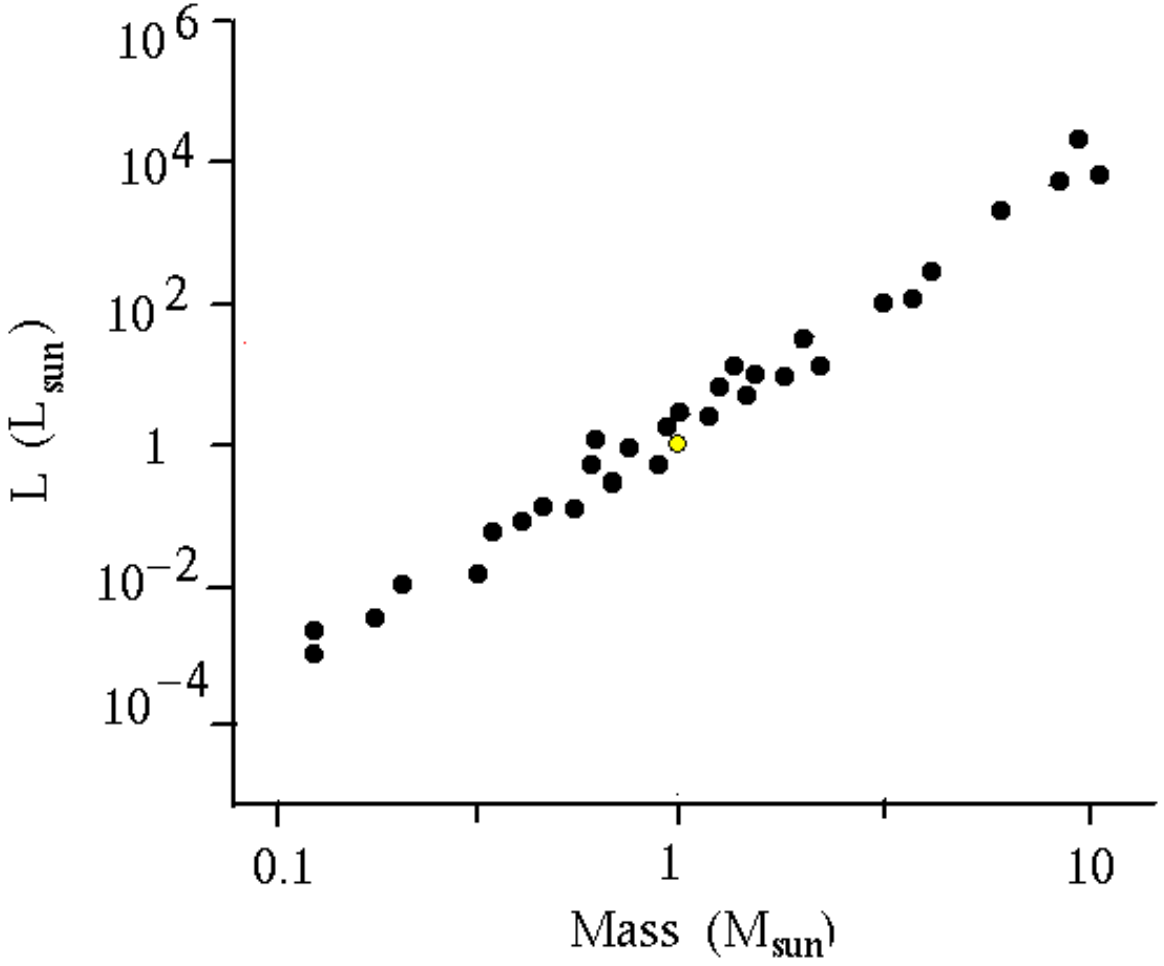
Turns out that luminosity (L) can be related to the surface area and temperature of the star:

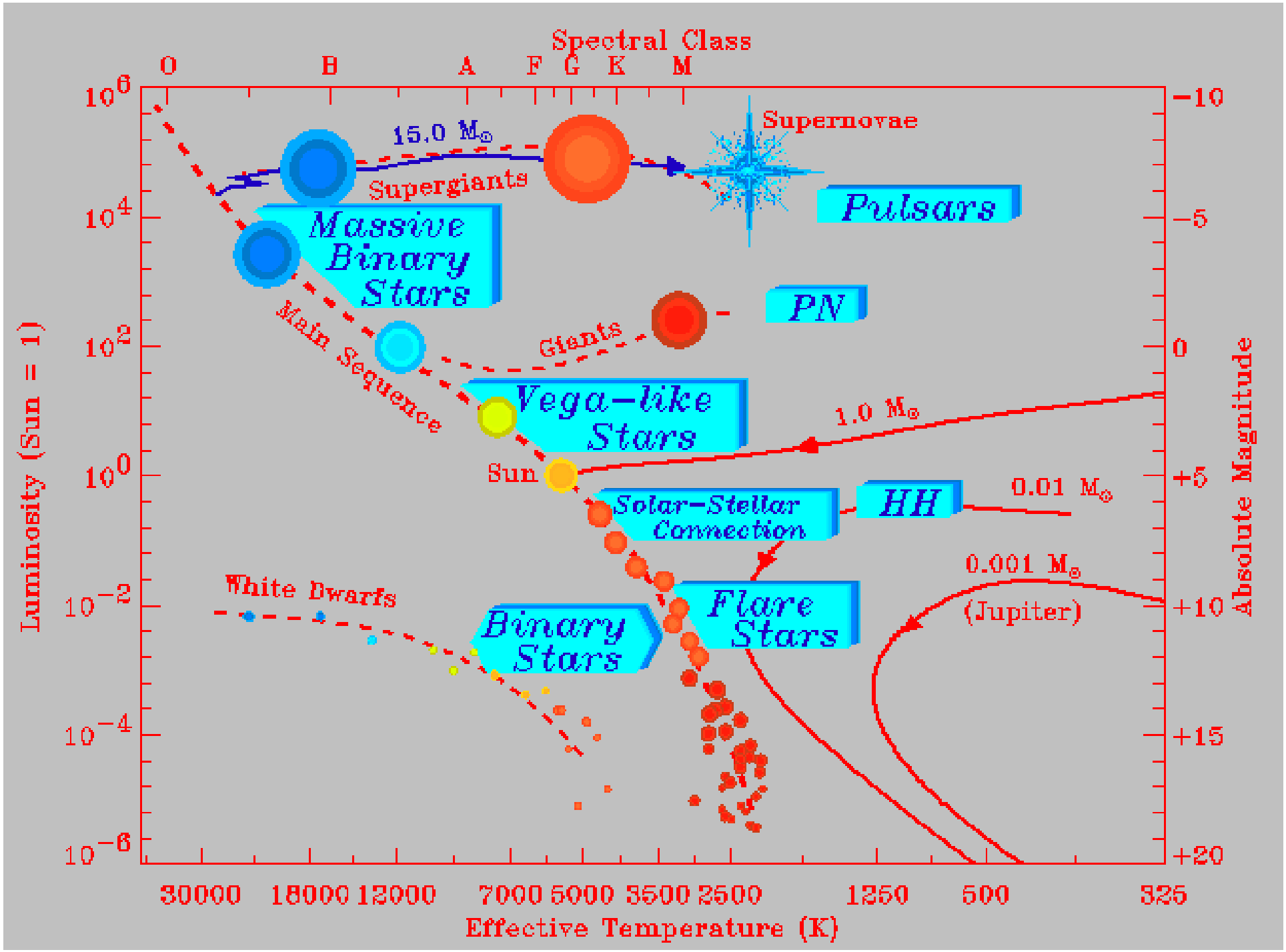
$$L = 4 \pi R^2 \sigma T^4$$

So it turns out that if we know the luminosity (since we measured it) and we know the temperature (since color can be thought of as temperature) we can figure out the size of the star.

There is also a Mass / Luminosity relationship for stars on the Main Sequence (MS)

Mass / Luminosity Relation




Spectral Class
O
B
A
F
G
K
M
Luminosity (Sun = 1)
Absolute Magnitude
Effective Temperature (K)
30000
18000
12000
7000
5000
3500
2500
1250
500
325
15.0 M⊙
Supergiants
Supernovae
Pulsars
Massive Binary Stars
PN
Giants
Main Sequence
Vega-like Stars
Sun
1.0 M⊙
Solar-Stellar Connection
HH
0.01 M⊙
0.001 M⊙
(Jupiter)
White Dwarfs
Binary Stars
Flare Stars

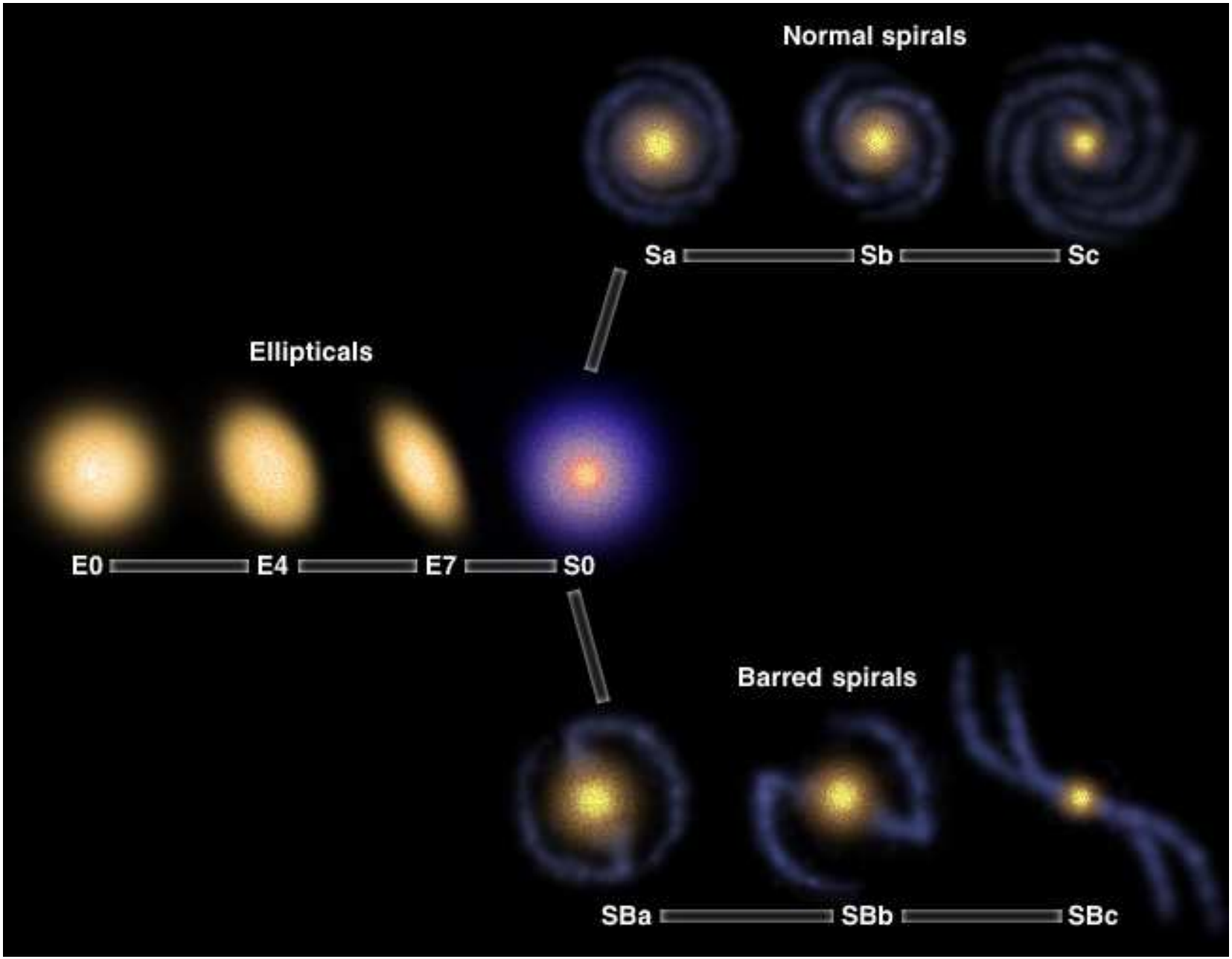
Stars

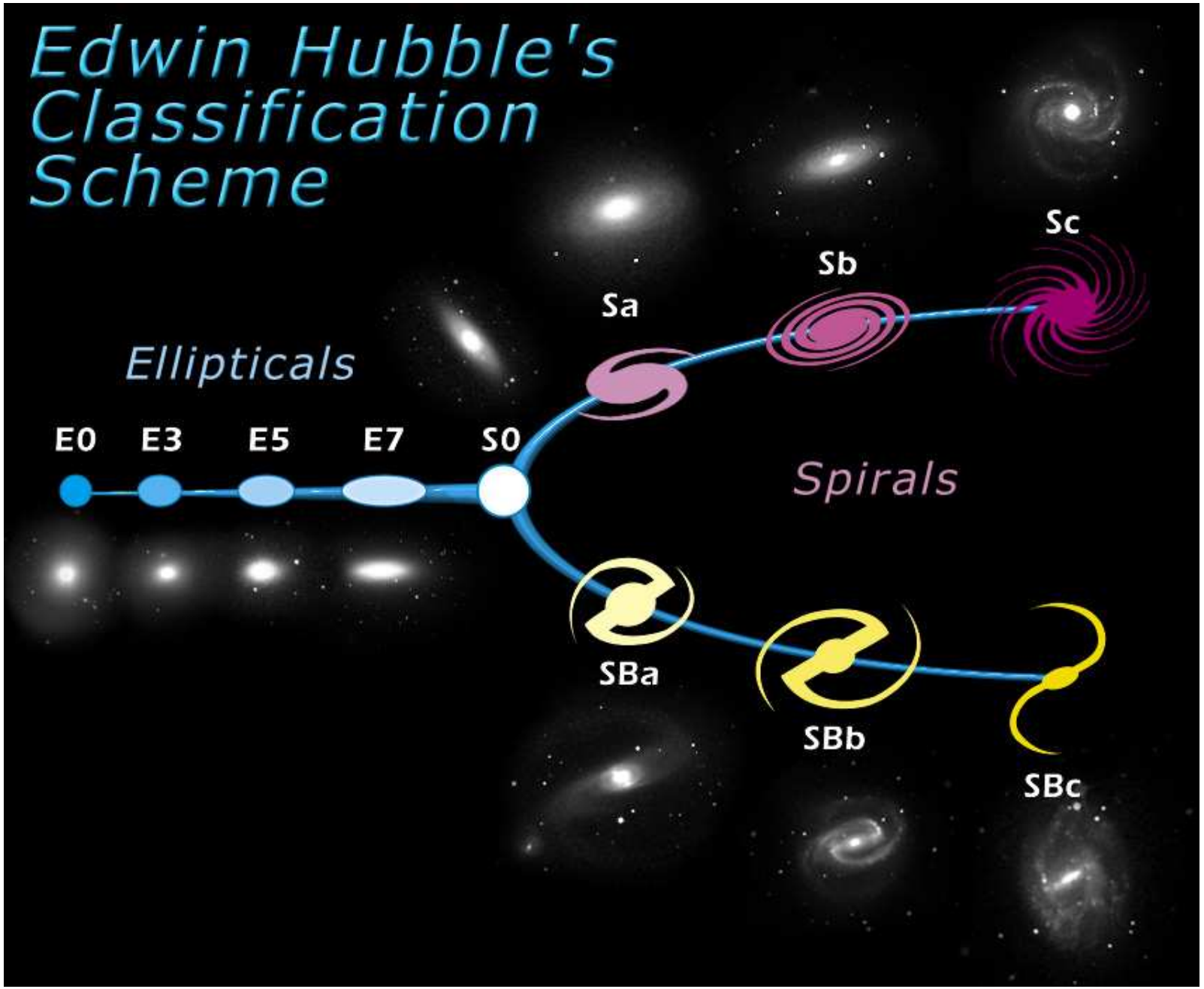
- Things we would like to know about stars
  - Luminosity MEASURED
  - Temperature FROM COLOR
  - Mass FROM MASS/LUMINOSITY RELATION
  - Composition FROM SPECTRA
  - Distance NEXT CLASS

Galaxies

It is clear that the two galaxies at the top are quite different from the two galaxies at the bottom.

We need a system to classify different types of galaxies based on their appearance.


Normal spirals
Sa
Sb
Sc
Ellipticals
E0
E4
E7
S0
Barred spirals
SBa
SBb
SBc


Edwin Hubble's Classification Scheme
Ellipticals
E0
E3
E5
E7
S0
Sa
Sb
Sc
Spirals
SBa
SBb
SBc

Nebulae

- Galaxies
- Globular Clusters
- Open Clusters
- Emission Nebulae
- Reflection Nebulae
- Dark Nebulae
- Planetary Nebulae
- Supernova Remnants

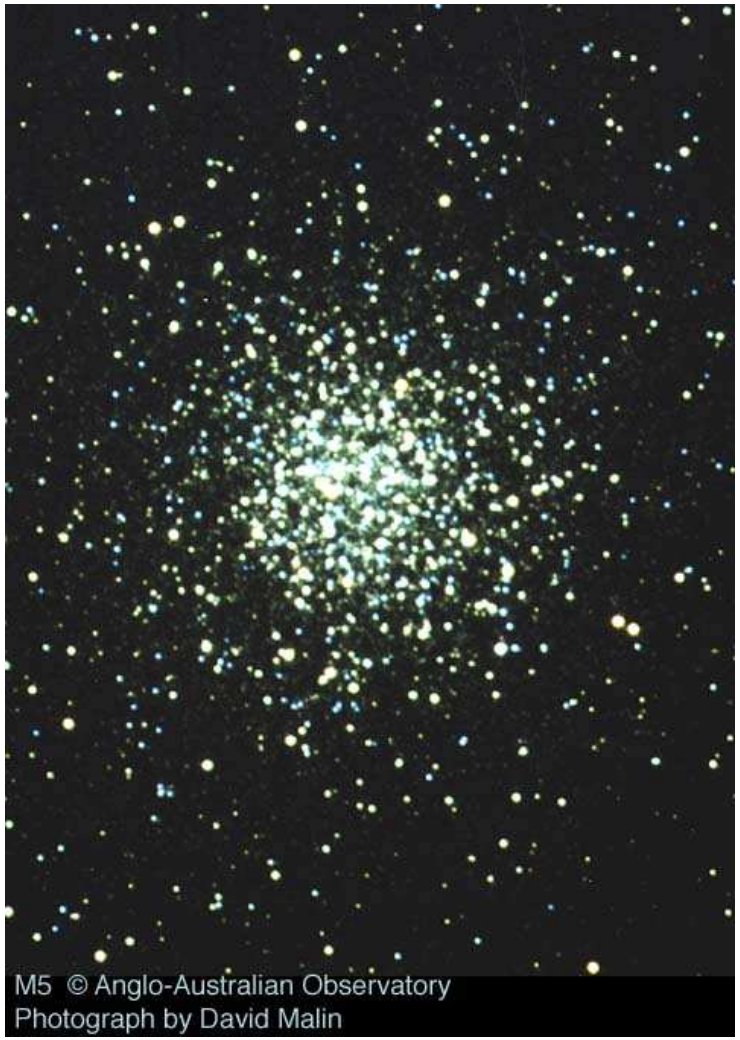
Globular Clusters

Clumps of old stars, about the same age and distance away.

Found in the halo of our own galaxy (as well as the halo of other galaxies, but I digress).

Very old stars. (low abundance of heavy metals)

M 5



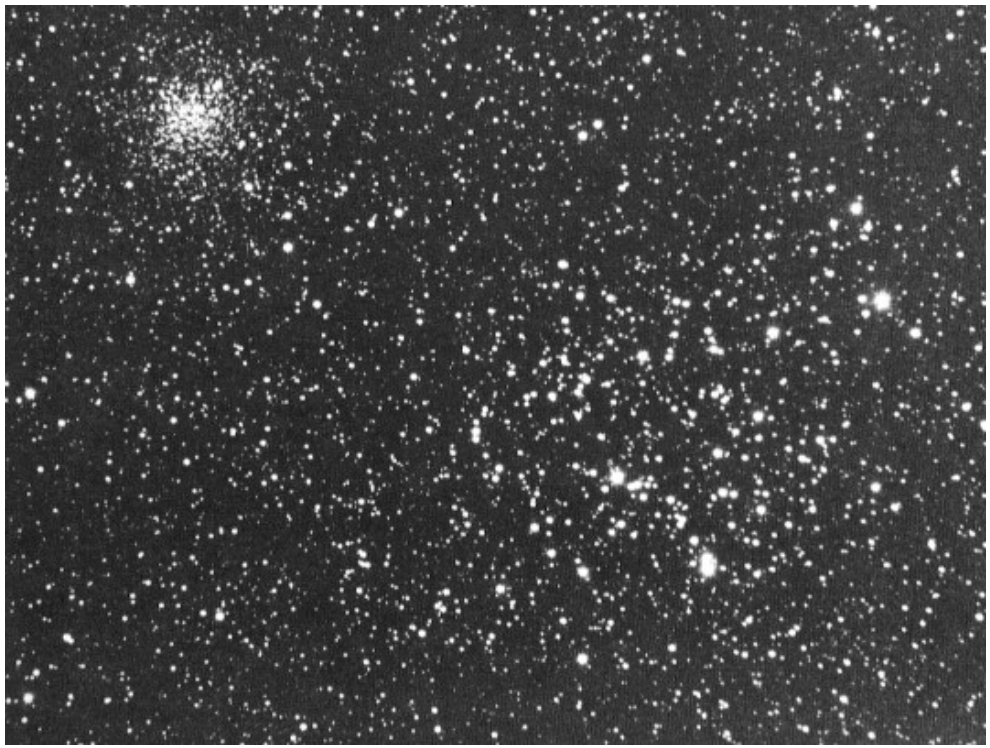
Open Clusters

Loose grouping of stars, held together by mutual gravitational attraction.

They orbit in the disk of our galaxy and don't last very long, members escape the group over time.

All about the same age and composition so it is likely that they formed around the same time.

M 35



Emission Nebulae

The light is emission from the nebula itself. It is energized by UV radiation from a nearby star.

These are the neon lights of the universe.

North America Nebula
(near Deneb in Cygnus)

Reflection Nebulae

Witch Head Nebula
(Near Rigel in Orion)

Fine dust reflecting the light of a nearby star.

Typically blue in color because the dust is more efficient at reflecting the blue light.

Dark Nebulae

Horse Head Nebula (in Orion)

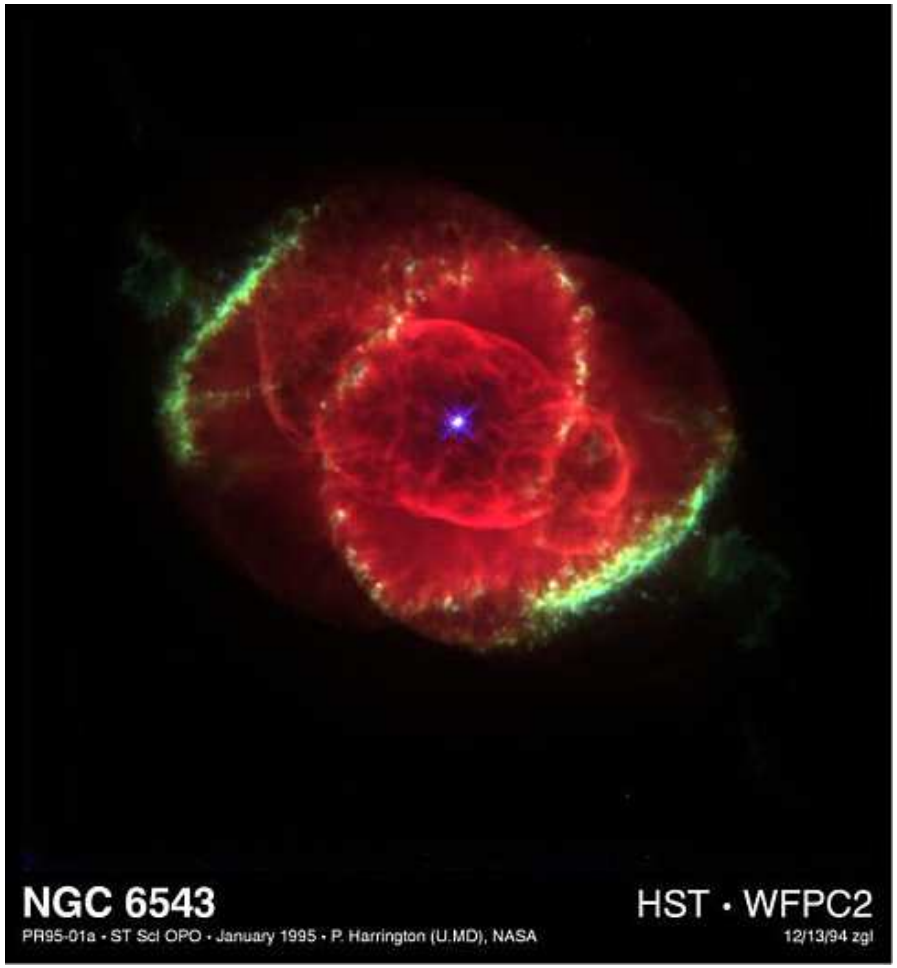
Clouds of dust, obscuring the objects behind it by absorbing the light. Also called absorption nebulae.

Planetary Nebula

Dying days of a low to mid mass star.

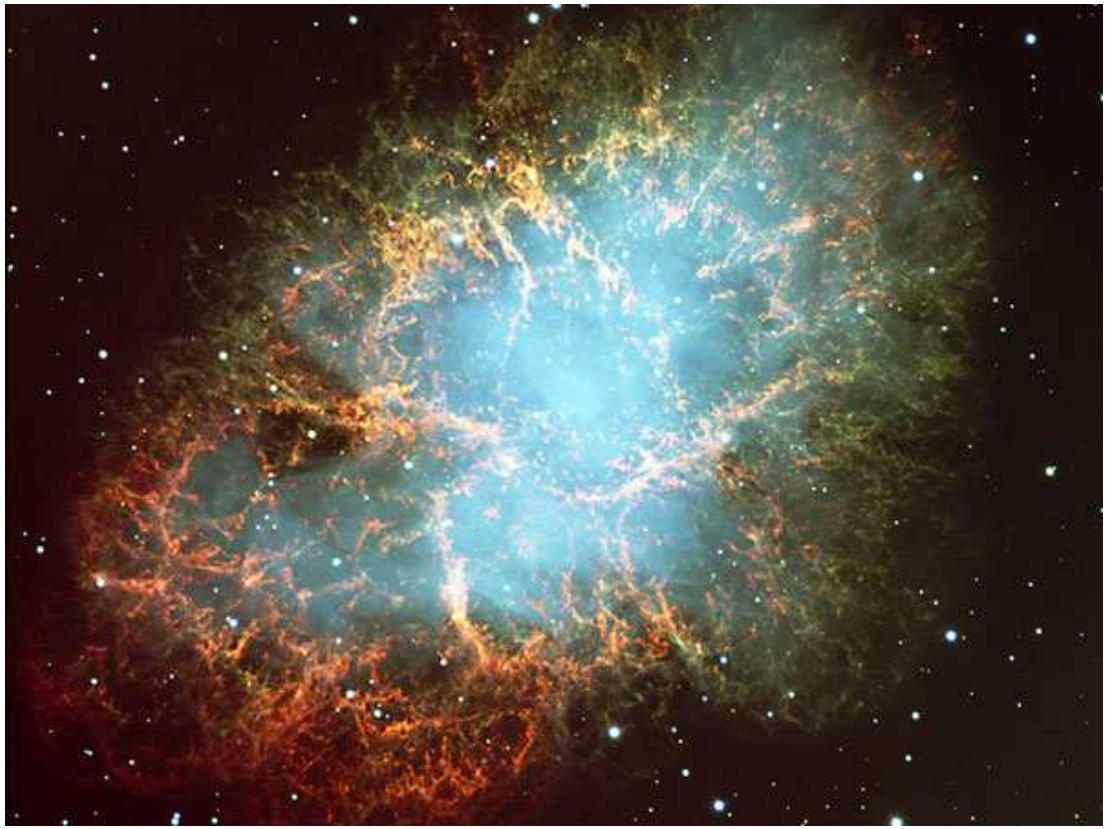
Outer layers of gas are blown off from the core of a star. The core often goes on to become a white dwarf. The eject gas is illuminated by the remaining star. This is the fate of most stars, including our own Sun.

Cat's Eye Nebula (NGC 6543



Supernova Remants

SN in 1054 (recorded by Chinese and native American astronomers) 6000 light years away. In the constellation Taurus.

The Crab nebula is the result of the explosive death of a massive star.

The Crab Nebula