# Lecture 18 – 2nd April 2009

**HOMEWORK 07: Out now, due next Tuesday, 7th April, 11:59pm**

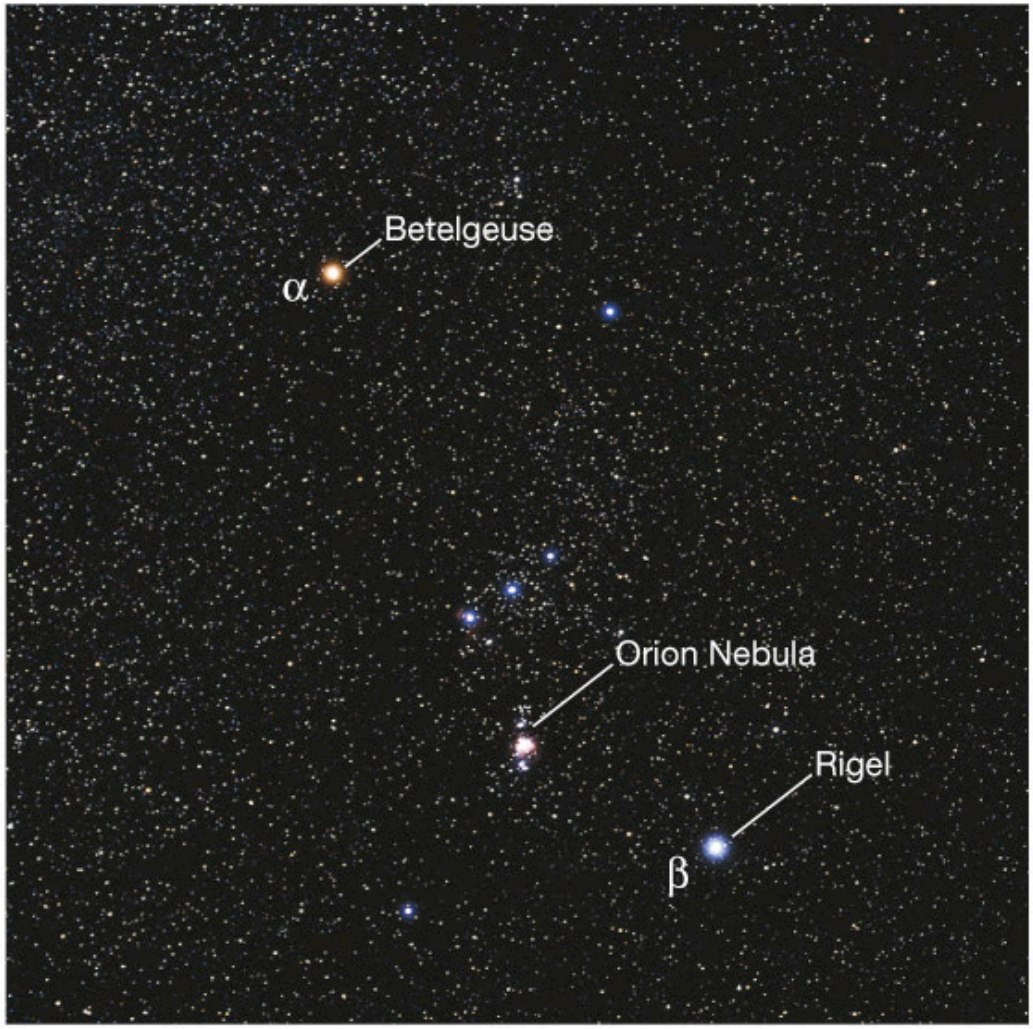
***TEST 03:* Next Thursday, 09th April 2009**

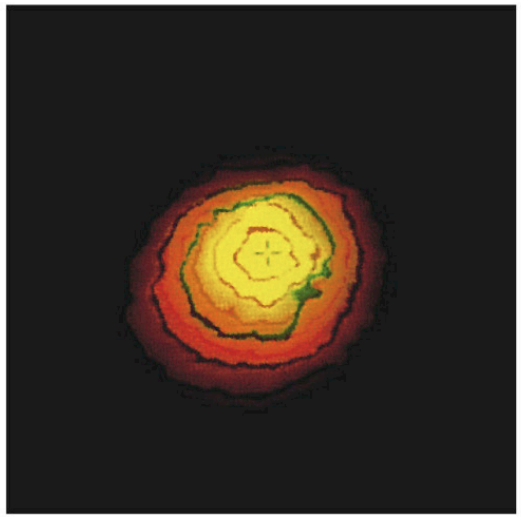
- **SCIENCE TOPICS**:
  Measuring the Stars (cont.)
  The Hertssrpung-Russel Diagram
- **READING**
  Ch 10, sec 10.2 – 10.5
  Beware of excessive detail
- **PRACTICE:**
  Chp. 10 Review: 4, 6, 8, 9, 13, 14
  Chp. 10 Self-test: 1, 3, 4, 10, 11, 14
  Chp. 10 Problems: 3, 4, 10

# Annoucements

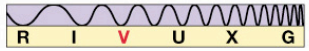
- Test 03
  - next Thursday, 9th April 2009.
  - Lecture 12 (2nd half) to Lecture 19 (1st half)
  - Topics:
    - Inner and Outer Planets Close Up
    - Formation of the Solar System
    - Exoplanets
    - The Sun and how it shines
    - Stars: Properties, Classification and H-R diagram

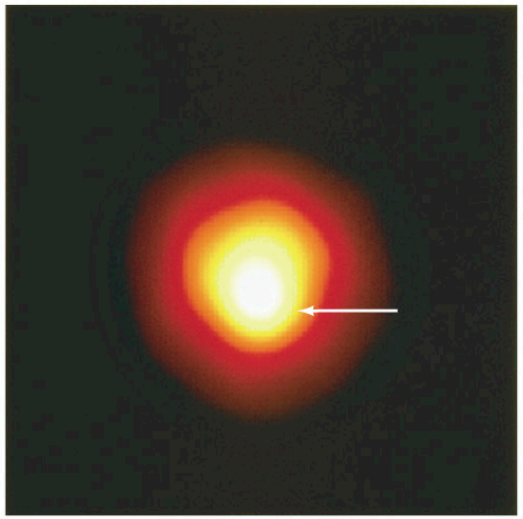
# Measuring the Stars (cont.)



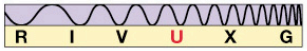
(a)



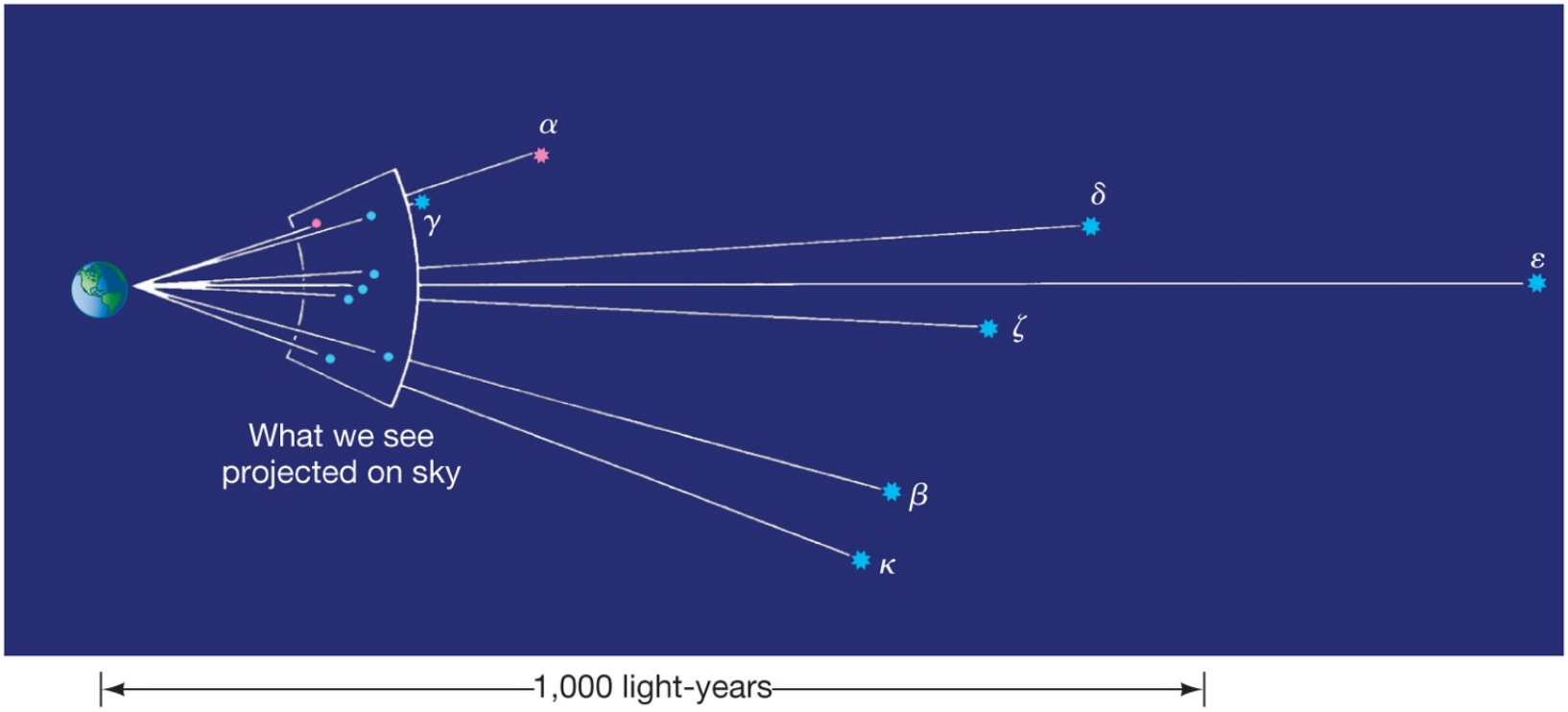



(b)

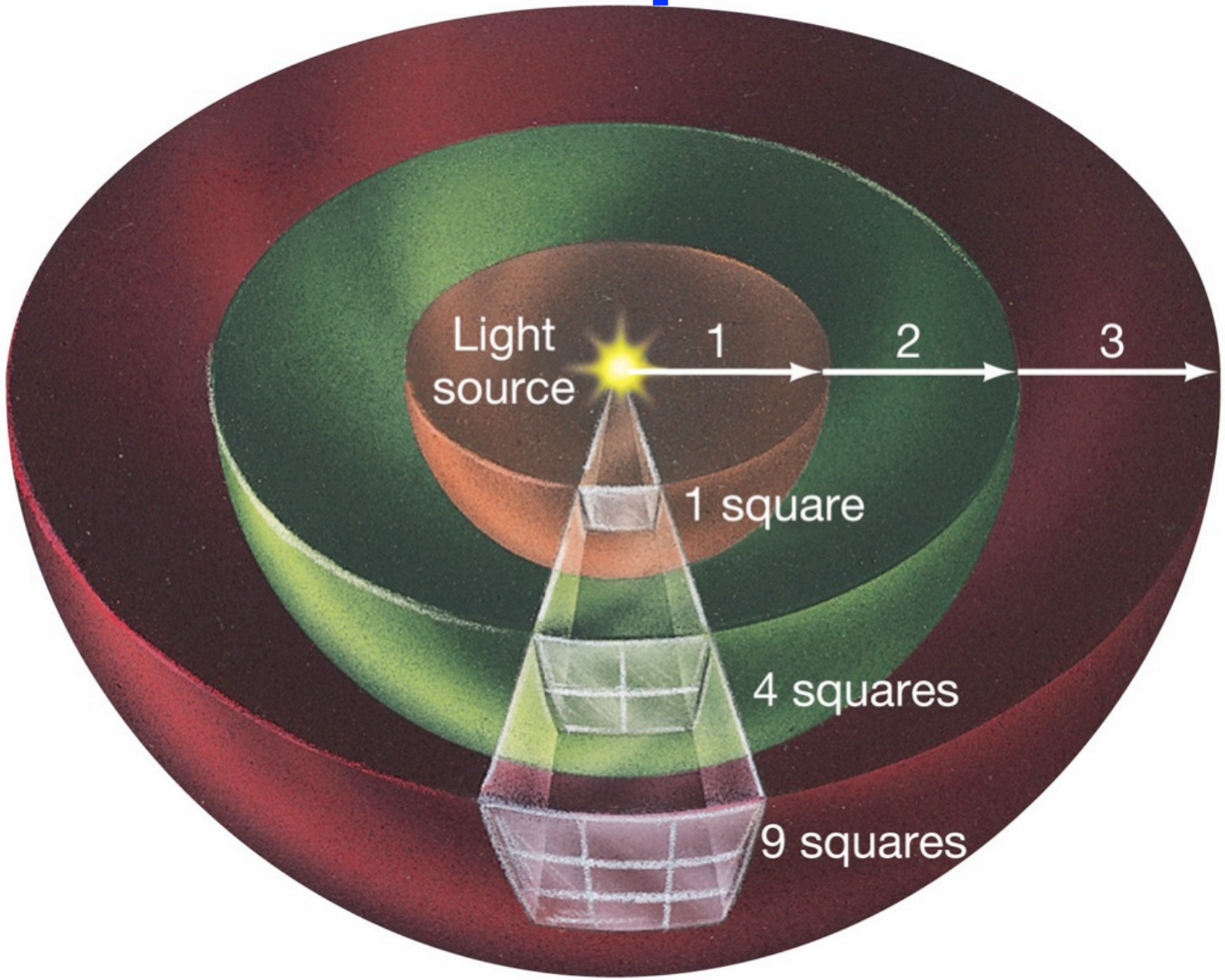
Size of Earth's orbit



# Orion in 3-D



# Inverse square law



100 W

25 W

same distance:
100 W bulb is
4 times brighter

100 W bulb is
twice as far away:

$$B \propto \frac{1}{d^2} = \frac{1}{4}$$

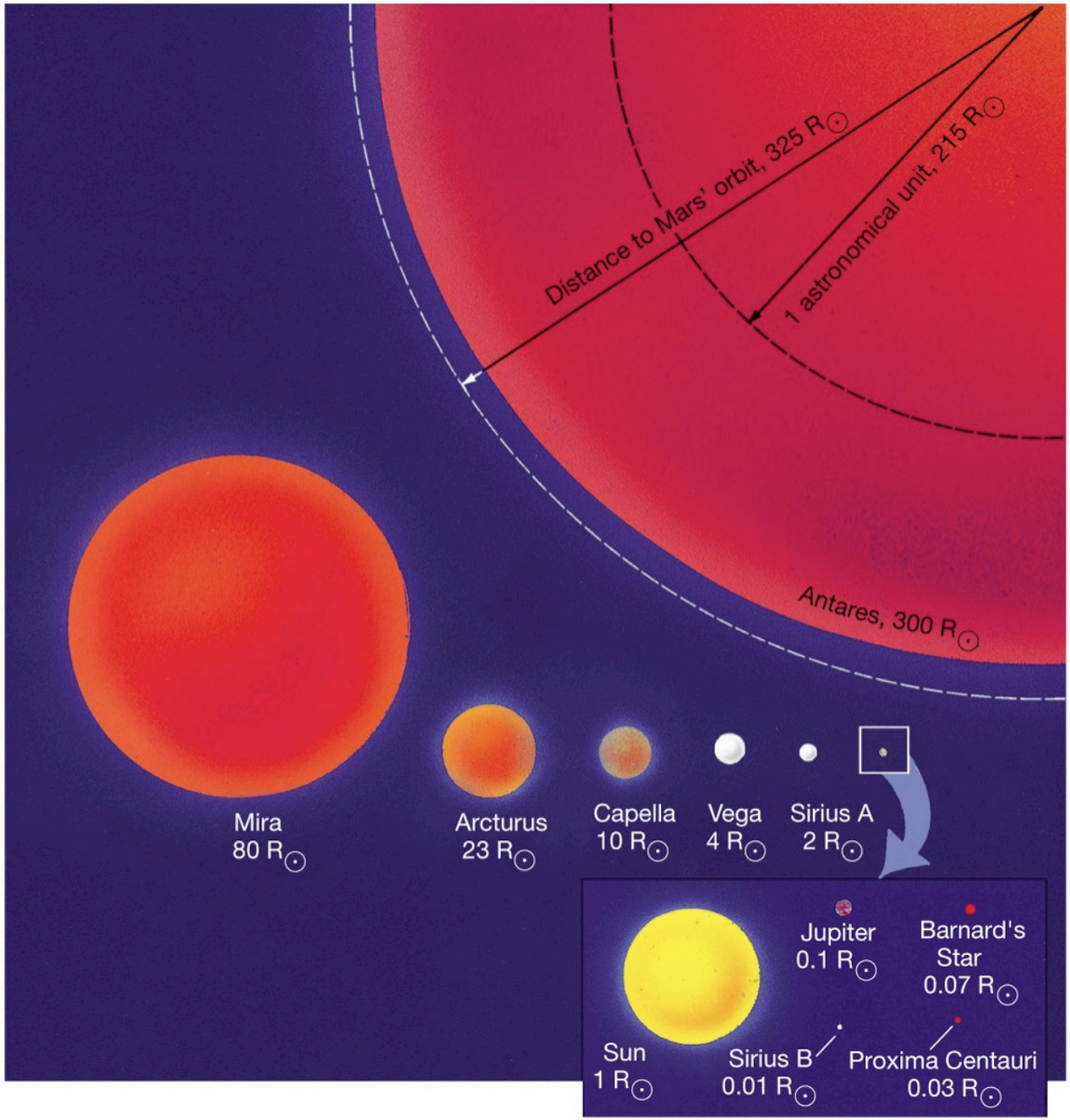
appears the same
brightness as the
25 W bulb

100 W bulb is
4 times as far away:

$$B \propto \frac{1}{d^2} = \frac{1}{16}$$

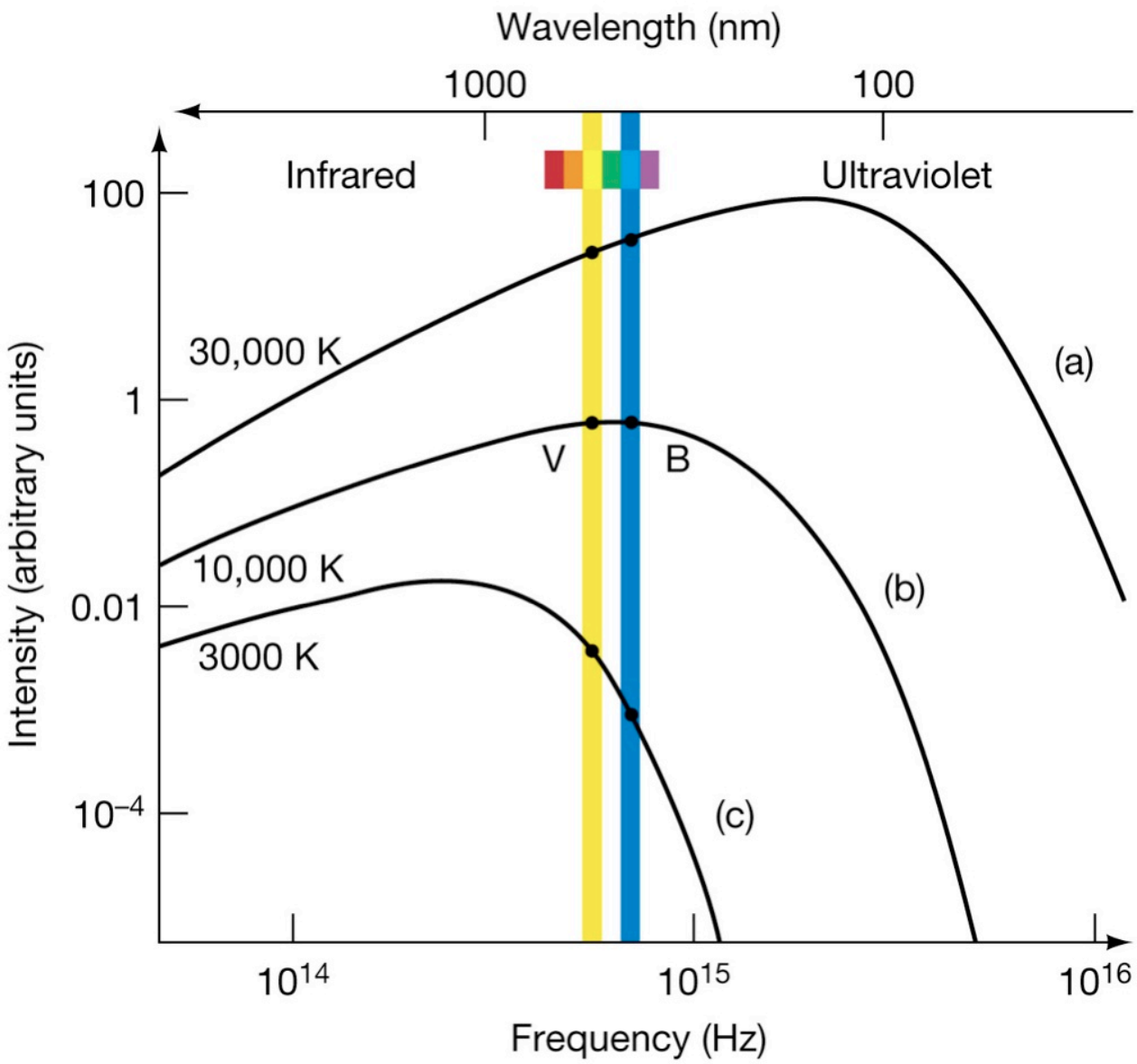
appears 4 times
fainter than the
25 W bulb

# What Determines the Luminosity of a Star?


Distance to Mars' orbit, 325 R⊙
1 astronomical unit, 215 R⊙
Antares, 300 R⊙
Mira
80 R⊙
Arcturus
23 R⊙
Capella
10 R⊙
Vega
4 R⊙
Sirius A
2 R⊙
Jupiter
0.1 R⊙
Barnard's
Star
0.07 R⊙
Sun
1 R⊙
Sirius B
0.01 R⊙
Proxima Centauri
0.03 R⊙

# What Determines the Luminosity of a Star?

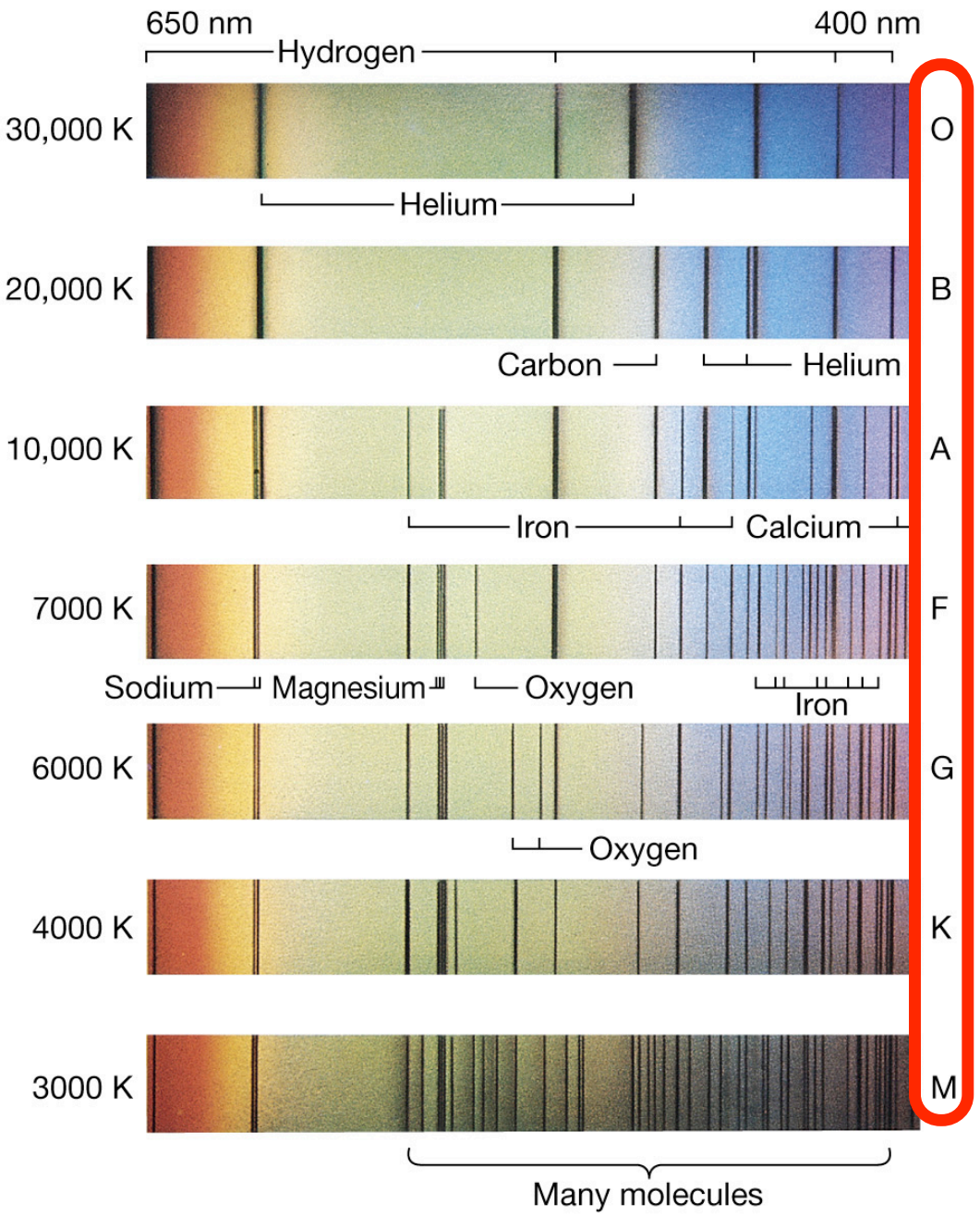
1. Size


Wavelength (nm)
1000
100
Infrared
Ultraviolet
100
1
0.01
$10^{-4}$
Intensity (arbitrary units)
30,000 K
10,000 K
3000 K
V
B
(a)
(b)
(c)
$10^{14}$
$10^{15}$
$10^{16}$
Frequency (Hz)

# What Determines the Luminosity of a Star?

1. Size

2. Temperature




Spectral Class: A Measure of Temperature

# Mnemonics for Spectral Classes

- Oh Be A Fine Girl/Guy, Kiss Me
- Oh Be A Fine Girl/Guy, Kiss My Lips Tenderly
- Oh Be A Fine Girl/Guy, Kiss Me Like This

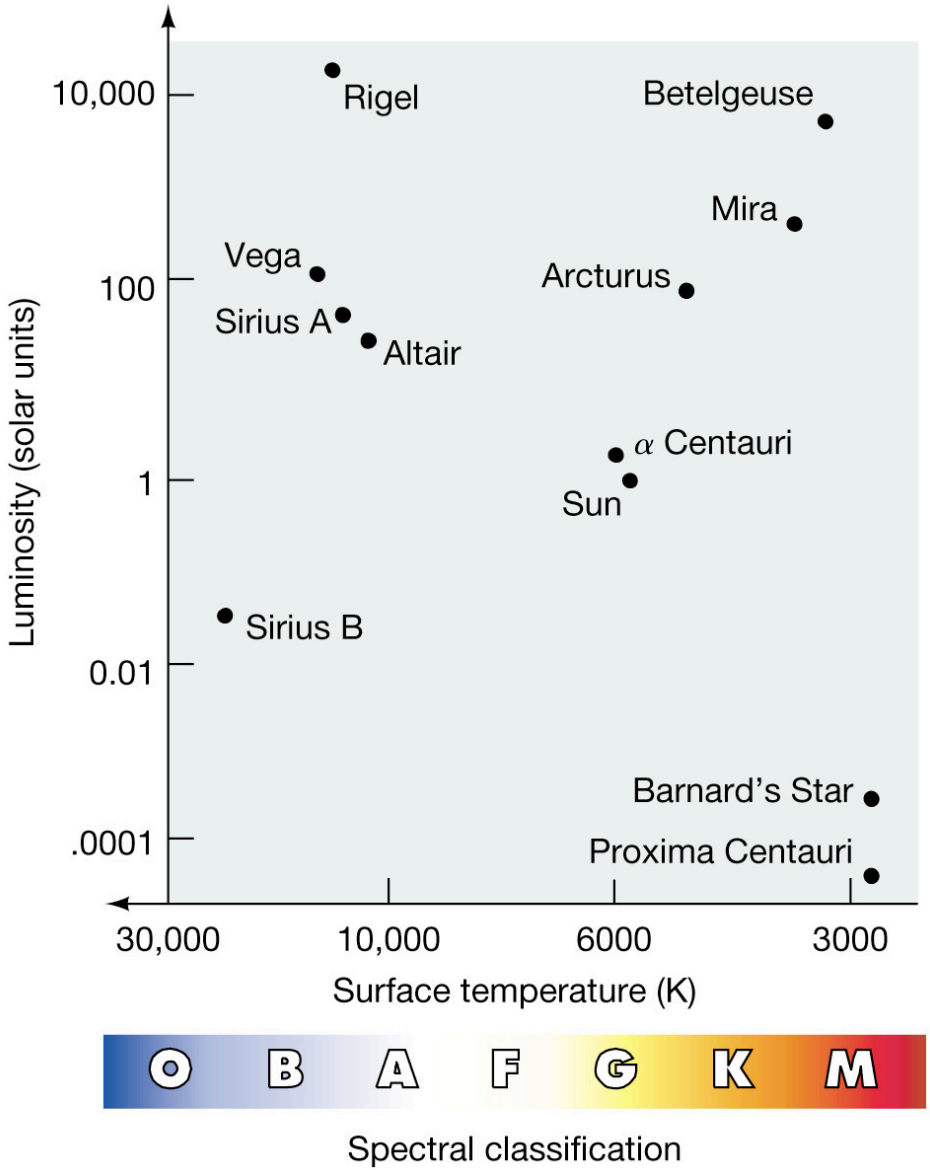
- Our Best Answer For Government, Karl Marx
- Only Brave Adventurers Found Great Kings' Money Last Time.
- Over Broad Amazon Forests, Geologists Know Many Leafless Trees.
- Our Battleship Attacked Galleys For Great Kings' Many Luring Treasures.
- Only Big Animals Find Great King-sized Munchies Like Tomatoes

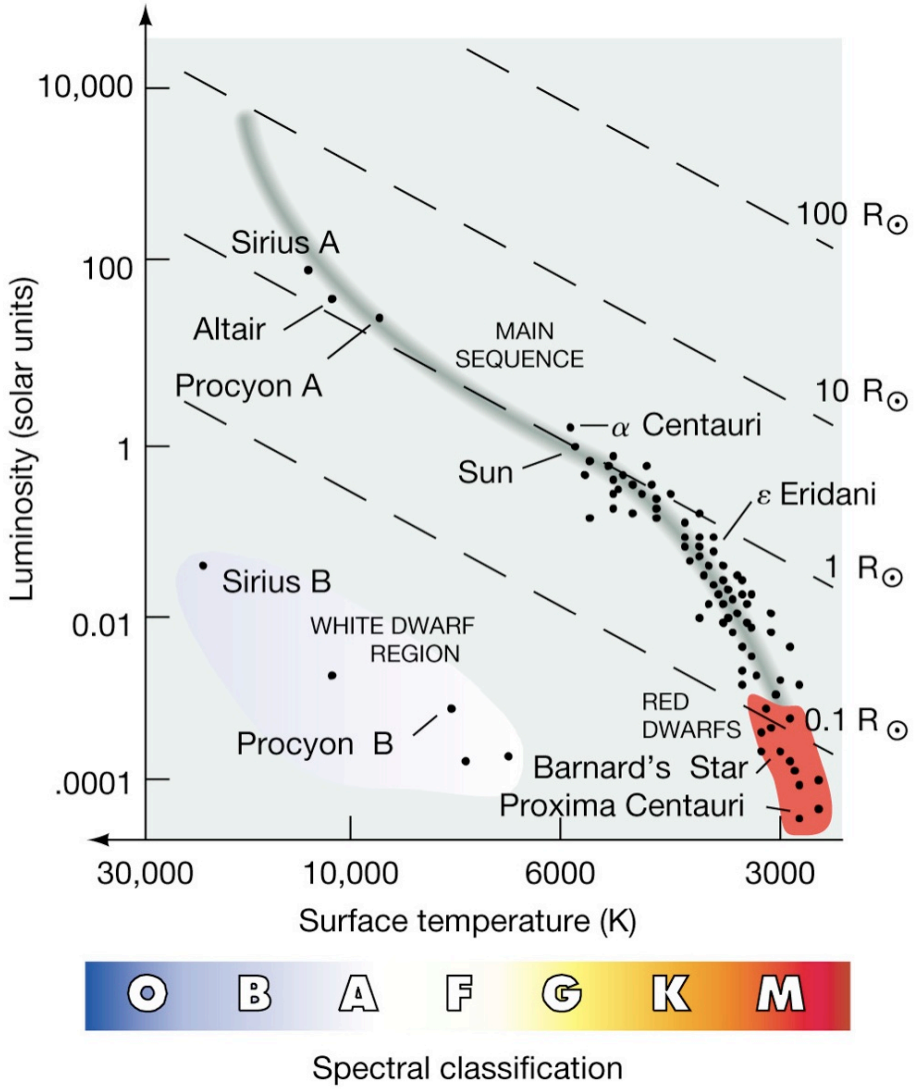
# Measuring the Stars II: The *Hertzsprung-Russell* diagram

# The H-R diagram

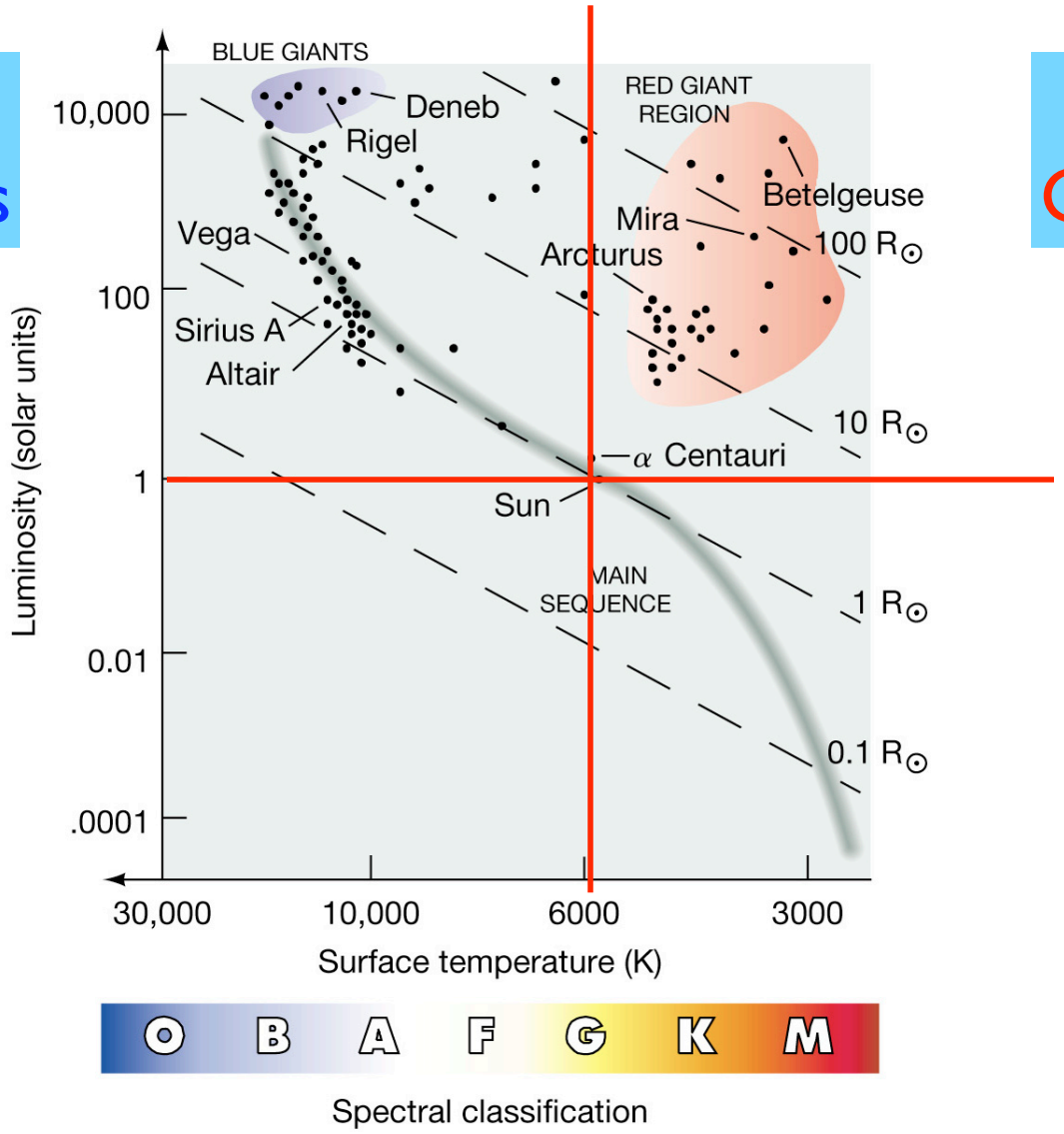
- The Hertzsprung-Russell diagram (H-R) shows the relationship between (intrinsic) luminosity, classification, and effective temperature of stars.
- Ejnar Hertzsprung (Danish) and Henry Norris Russell (American), ~1910s but theory of stellar interiors/evolution much later, ~1950s/1960s)

# The H-R diagram



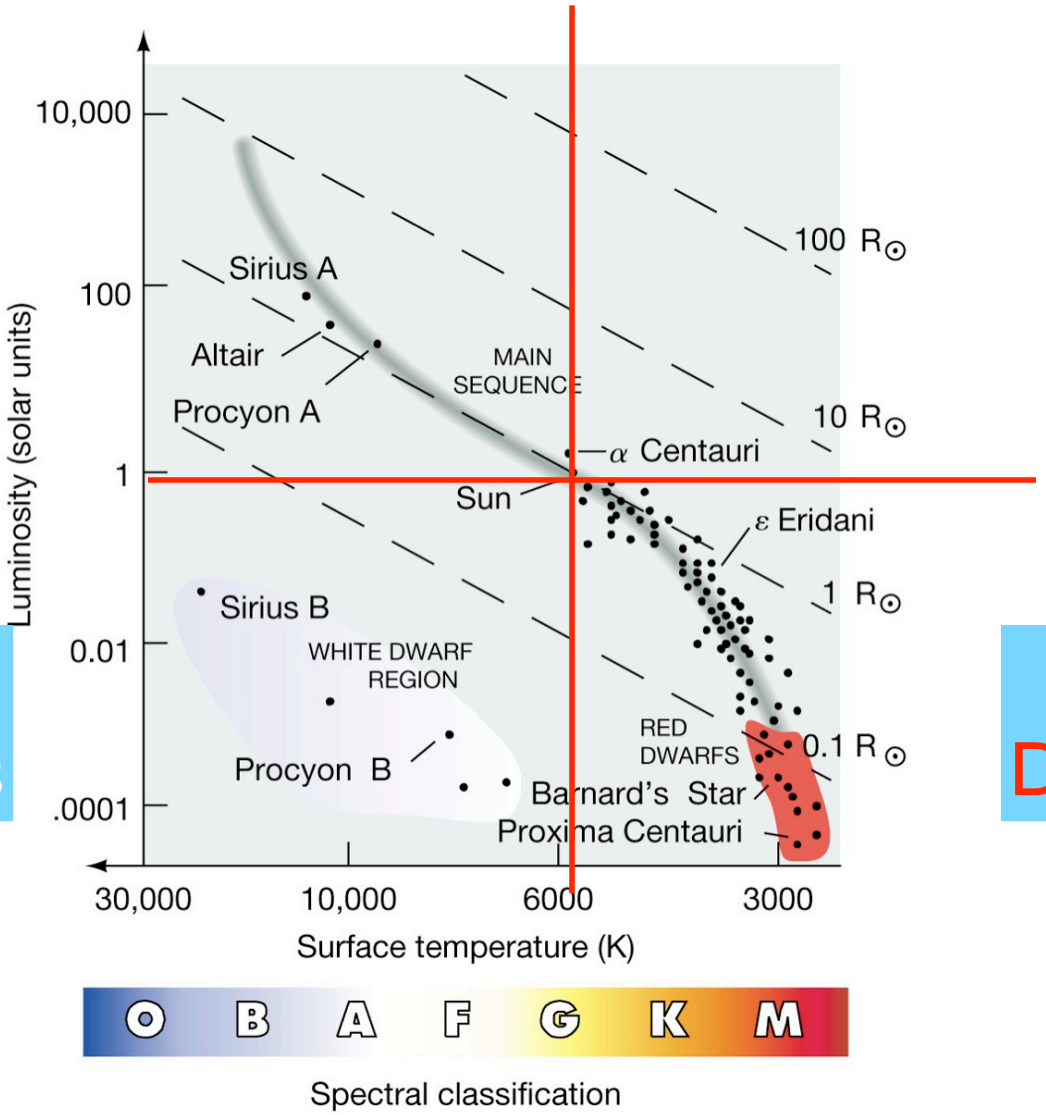

10,000
100
1
0.01
.0001
Luminosity (solar units)
100 R⊙
10 R⊙
1 R⊙
0.1 R⊙
Sirius A
Altair
Procyon A
MAIN SEQUENCE
α Centauri
Sun
ε Eridani
Sirius B
WHITE DWARF REGION
RED DWARFS
Procyon B
Barnard's Star
Proxima Centauri
30,000
10,000
6000
3000
Surface temperature (K)
O
B
A
F
G
K
M
Spectral classification

Blue Giants




Red Giants

White Dwarfs




Red Dwarfs