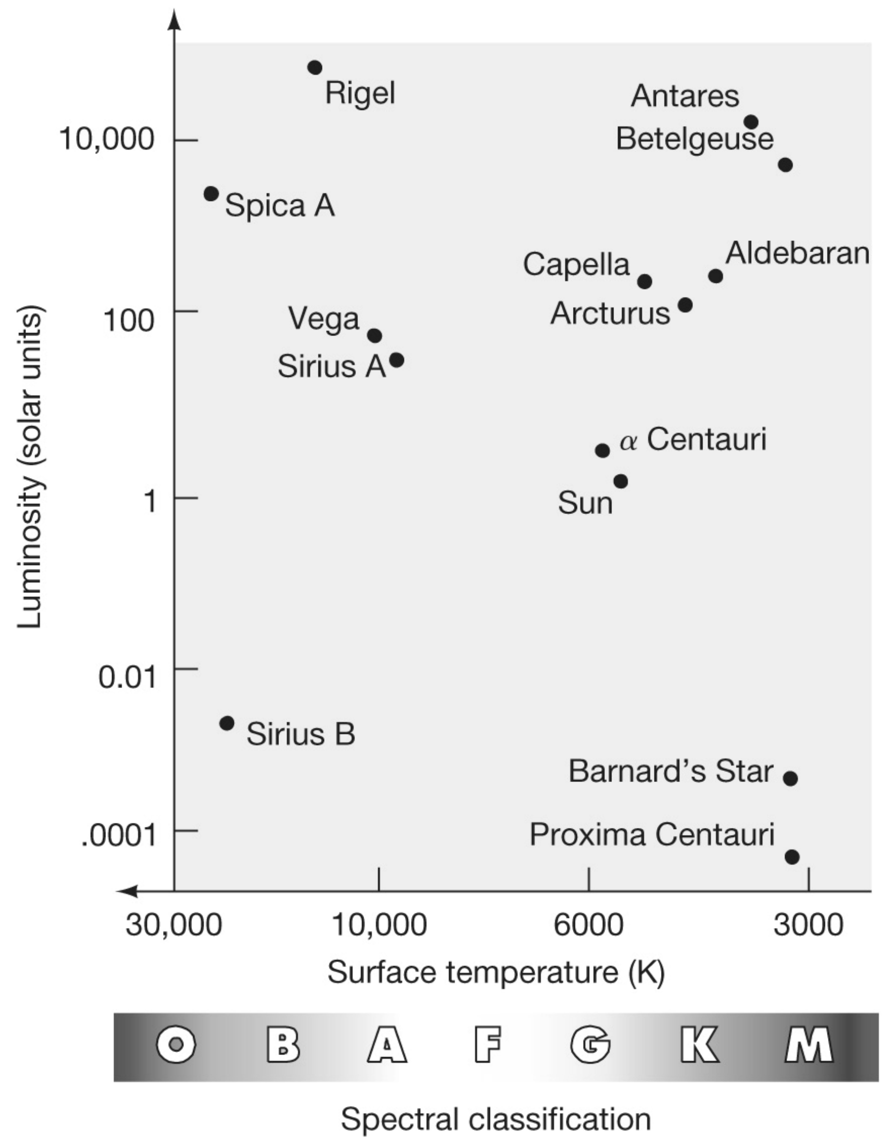
10.5 The Hertzsprung-Russell Diagram

The H-R diagram plots stellar luminosity against surface temperature.

This is an H-R diagram of a few prominent stars:



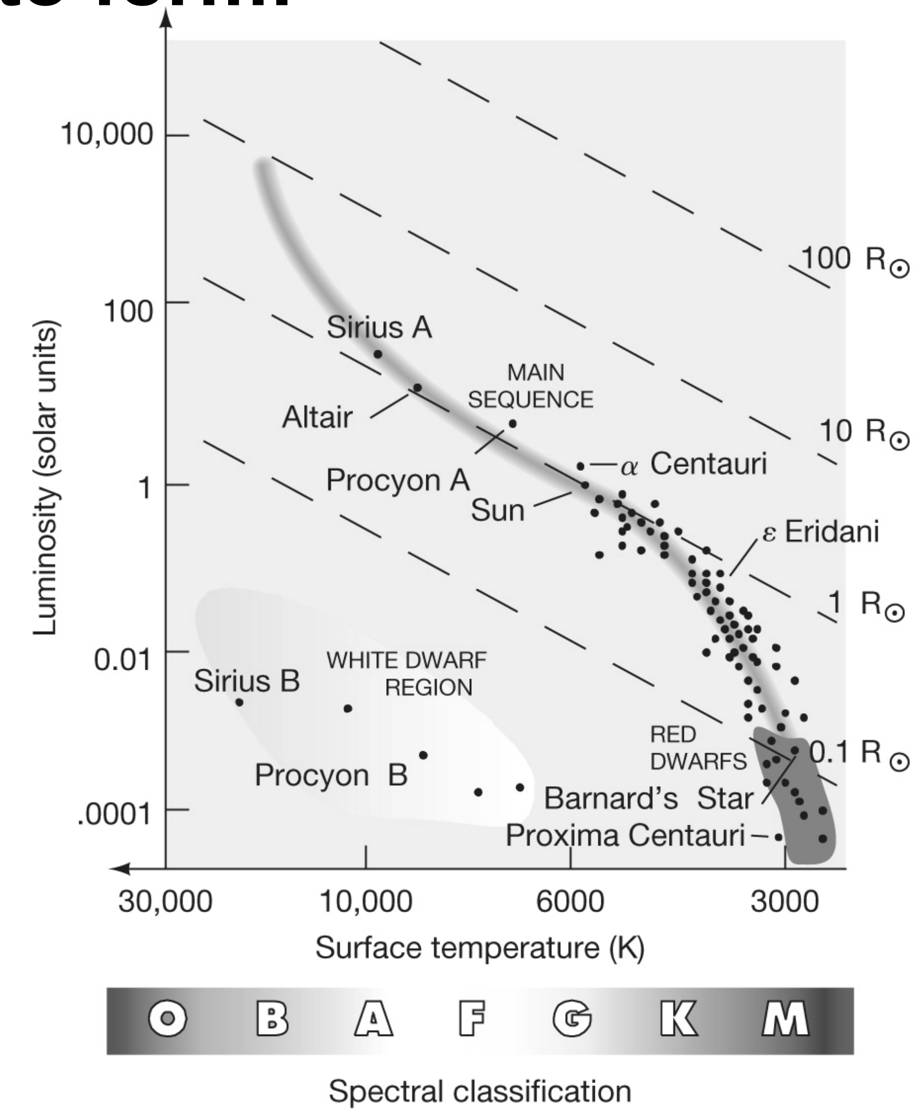
10.5 The Hertzsprung-Russell Diagram

Once many stars are plotted on an H-R diagram, a pattern begins to form:

These are the 80 closest stars to us; note the dashed lines of constant radius.

The darkened curve is called the Main Sequence, as this is where most stars are.

Also indicated is the white dwarf region; these stars are hot but not very luminous, as they are quite small.

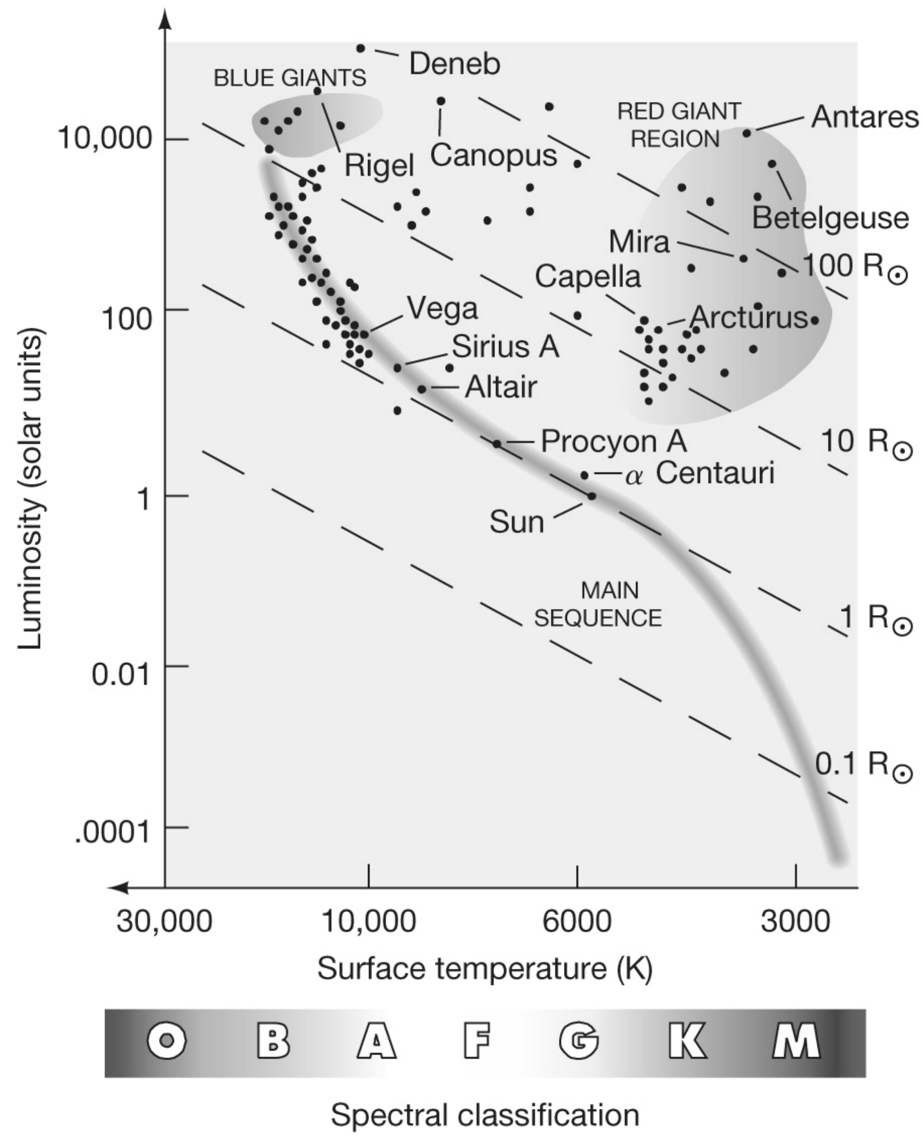


10.5 The Hertzsprung-Russell Diagram

An H-R diagram of the 100 brightest stars looks quite different:

These stars are all more luminous than the Sun. Two new categories appear here – the red giants and the blue giants.

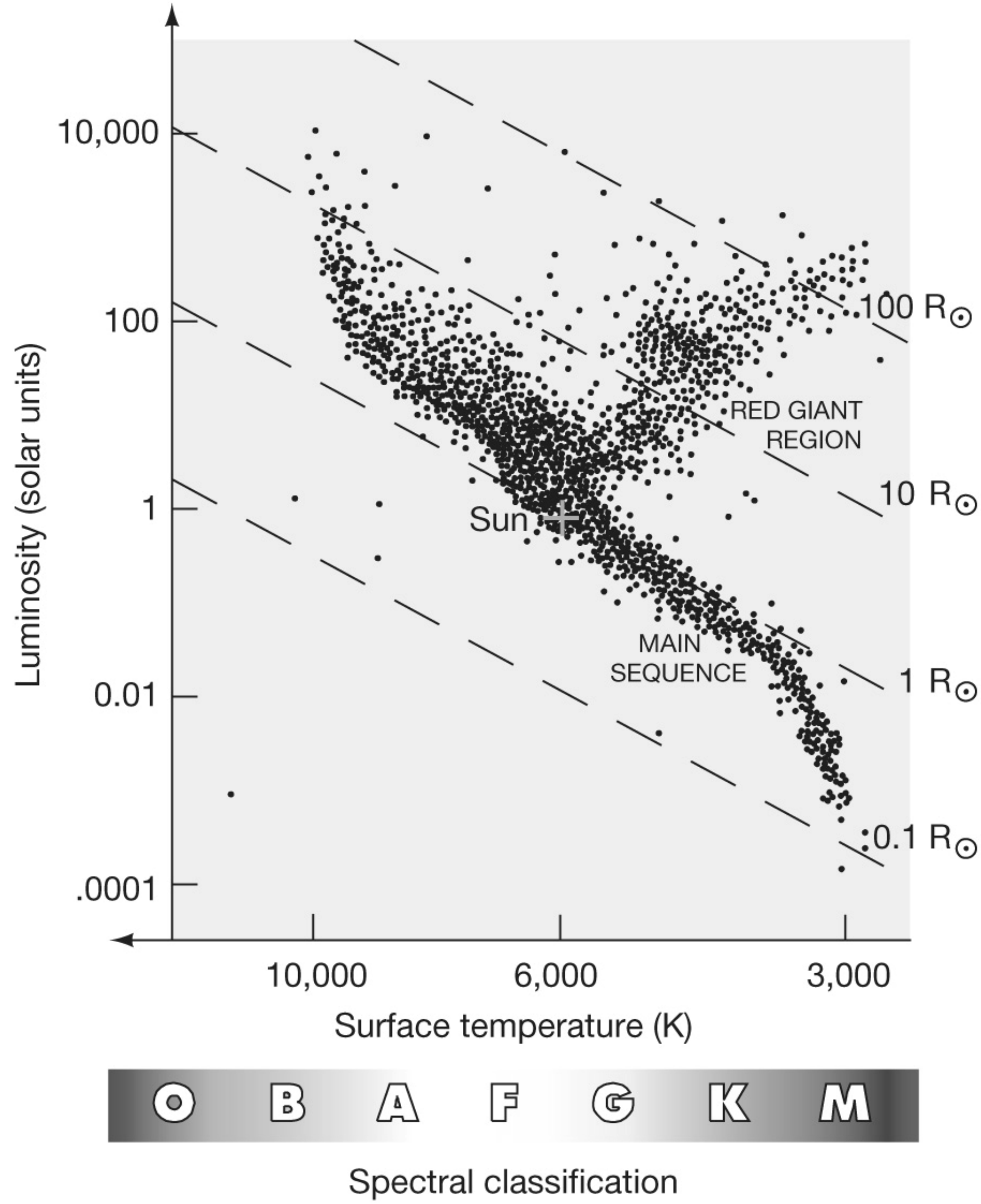
Clearly, the brightest stars in the sky appear bright because of their enormous luminosities, not their proximity.



10.5 The Hertzsprung-Russell Diagram

This is an H-R plot of about 20,000 stars. The main sequence is clear, as is the red giant region.

About 90% of stars lie on the main sequence; 9% are red giants and 1% are white dwarfs.



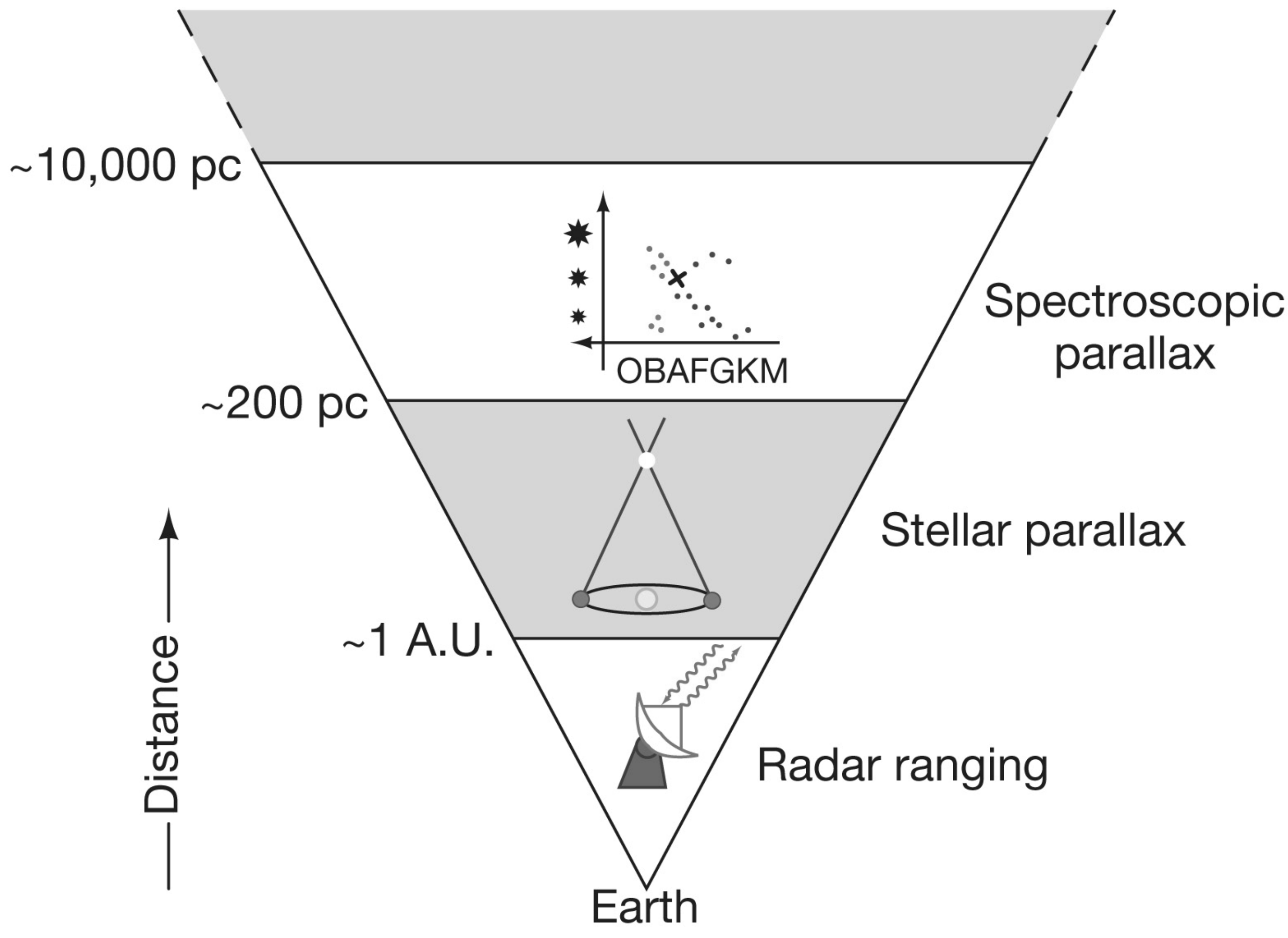
10.6 Extending the Cosmic Distance Scale

Spectroscopic parallax: has nothing to do with parallax, but does use spectroscopy in finding the distance to a star.

1. **Measure the star's apparent magnitude and spectral class**
2. **Use spectral class to estimate luminosity**
3. **Apply inverse-square law to find distance.**

10.6 Extending the Cosmic Distance Scale

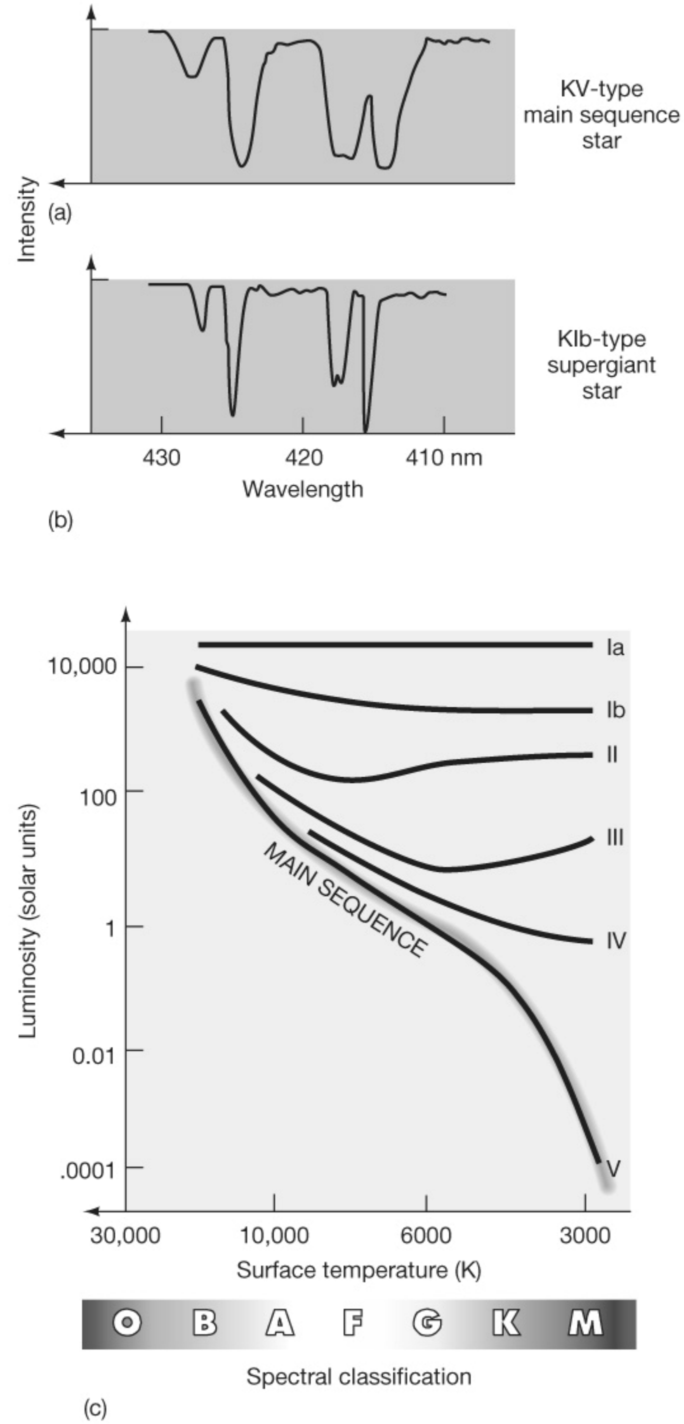
Spectroscopic parallax can extend the cosmic distance scale to several thousand parsecs:



10.6 Extending the Cosmic Distance Scale

The spectroscopic parallax calculation can be misleading if the star is not on the main sequence. The width of spectral lines can be used to define luminosity classes:

TABLE 10.3 Stellar Luminosity Classes	
CLASS	DESCRIPTION
Ia	Bright supergiants
Ib	Supergiants
II	Bright giants
III	Giants
IV	Subgiants
V	Main-sequence stars/dwarfs



10.6 Extending the Cosmic Distance Scale

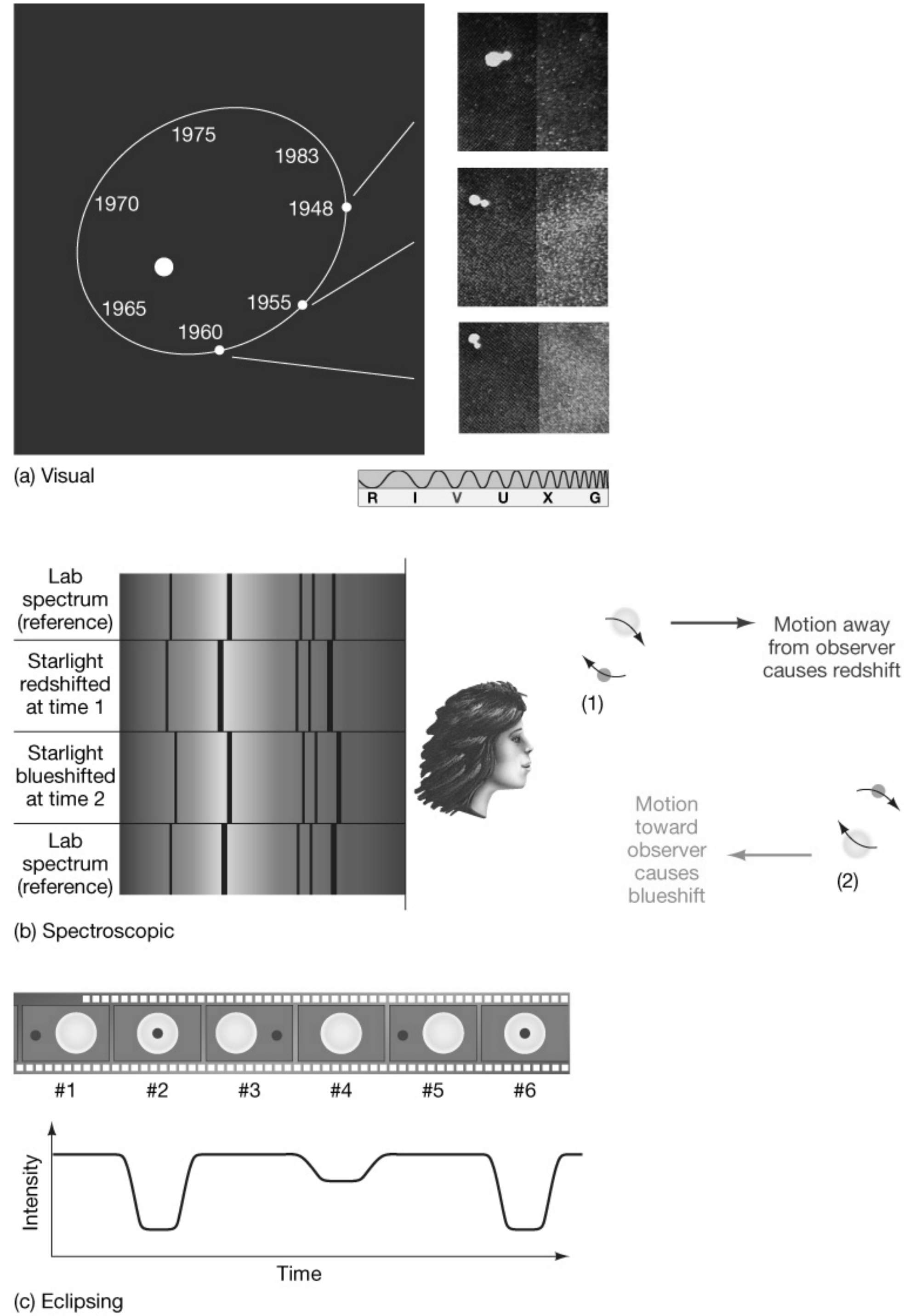
In this way, giants and supergiants can be distinguished from main sequence stars.

TABLE 10.4 Variation in Stellar Properties within a Spectral Class

SURFACE TEMPERATURE (K)	LUMINOSITY (solar luminosities)	RADIUS (solar radii)	OBJECT	EXAMPLE
4900	0.3	0.8	K2V main-sequence star	ε Eridani
4500	110	21	K2III red giant	Arcturus
4300	4000	140	K2Ib red supergiant	ε Pegasi

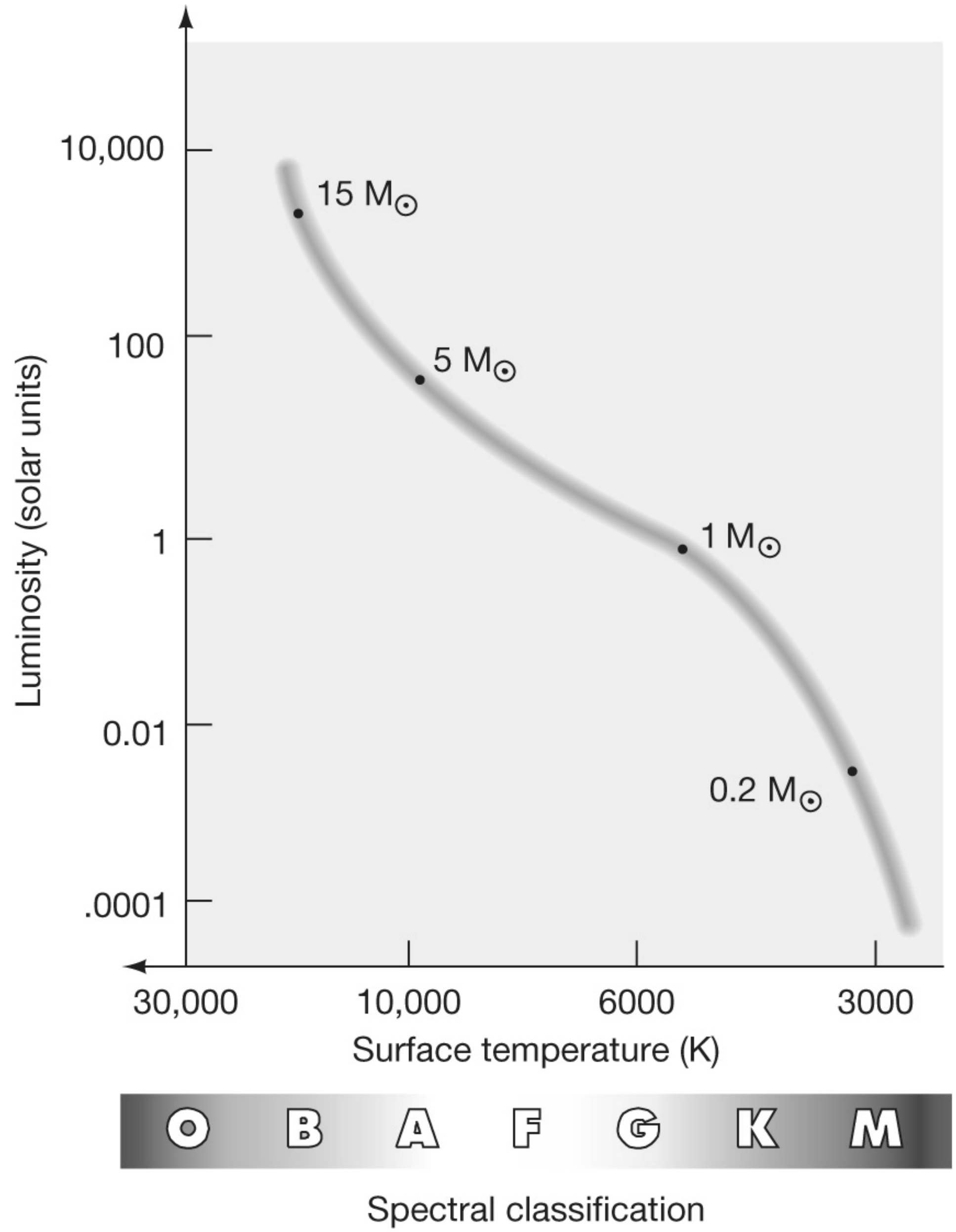
10.7 Stellar Masses

Many stars are in binary pairs; measurement of their orbital motion allows determination of the masses of the stars. Orbits of visual binaries can be observed directly; Doppler shifts in spectroscopic binaries allow measurement of motion; and the period of eclipsing binaries can be measured using intensity variations.

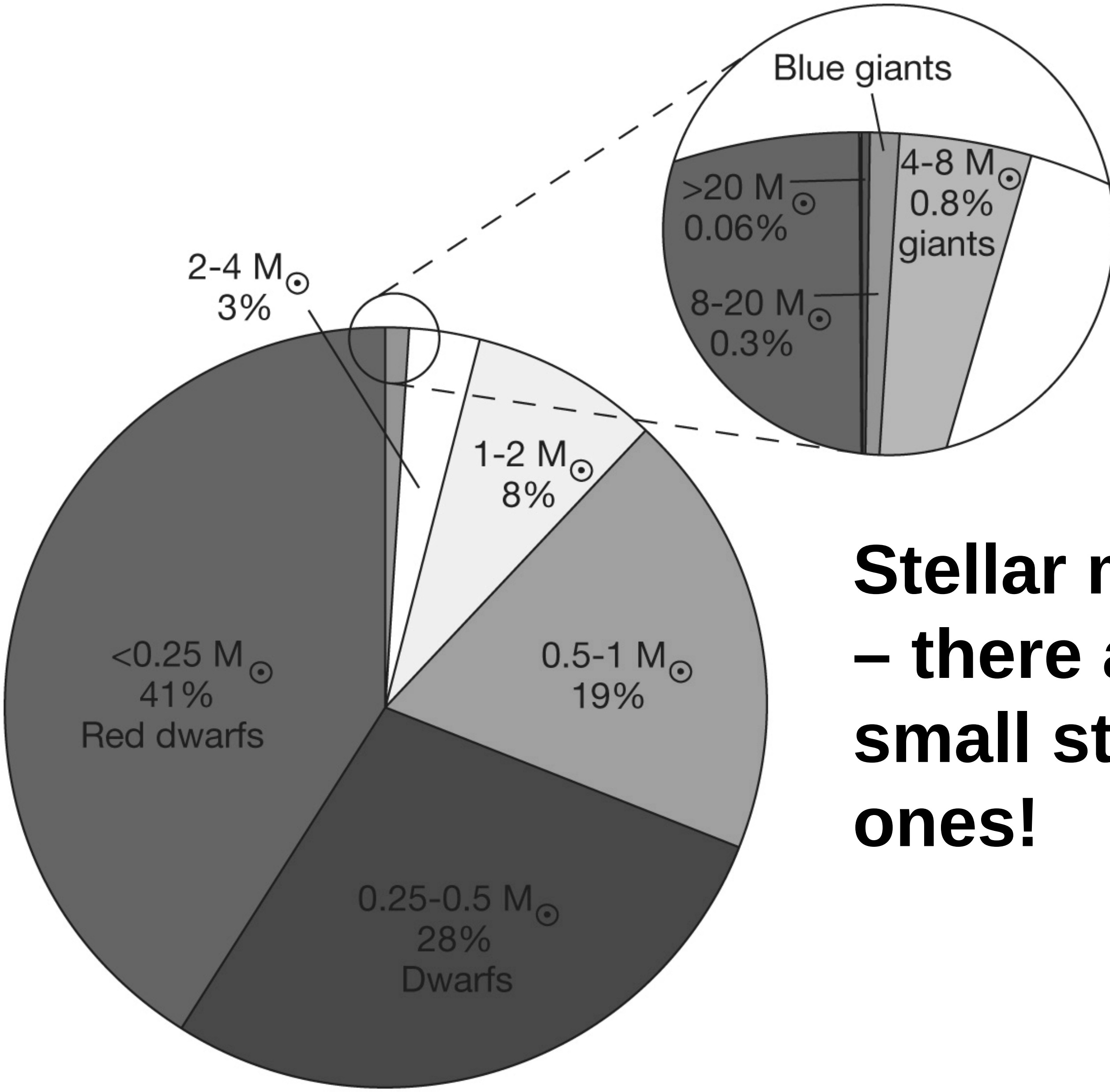


10.7 Stellar Masses

Mass is the main determinant of where a star will be on the Main Sequence:



10.7 Stellar Masses



Stellar mass distributions – there are many more small stars than large ones!

Summary of Chapter 10

- **Distance to nearest stars can be measured by parallax**
- **Apparent brightness is as observed from Earth; depends on distance and absolute luminosity**
- **Spectral classes correspond to different surface temperatures**
- **Stellar size is related to luminosity and temperature**

Summary of Chapter 10

- **H-R diagram is plot of luminosity vs. temperature; most stars lie on main sequence**
- **Distance ladder can be extended using spectroscopic parallax**
- **Masses of stars in binary systems can be measured**
- **Mass determines where star lies on main sequence**