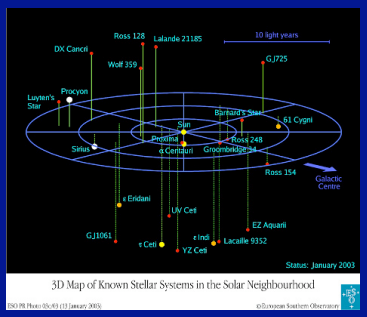
How far away are the nearest stars?



Which stars are they?

Last time:

- Distances to stars can be measured via measurement of parallax (trigonometric parallax, stellar parallax)
- Defined two units to be used in describing stellar distances (parsec and light year)

A new unit of distance: the **parsec**

A parsec is the distance of a star whose parallax is 1 arcsecond.

A star with a parallax of 1/2 arcsecond is at a distance of 2 parsecs.

What is the parsec?

- 3.086 E+16 meters
- 206,265 astronomical units

Another unit of distance (I like this one better): **light year**

A light year is the distance a light ray travels in one year

A light year is:

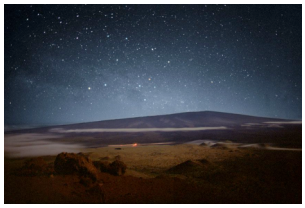
- 9.460E+15 meters
- 3.26 light years = 1 parsec

So what are the distances to the stars?

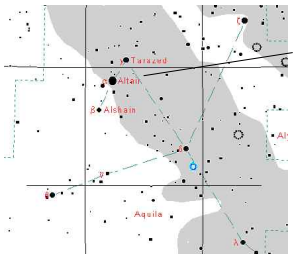
- First measurements made in 1838 (Friedrich Bessel)
- Closest star is Alpha Centauri, p=0.75 arcseconds, d=1.33 parsecs= 4.35 light years
- Nearest stars are a few to many parsecs, 5 - 20 light years

The distances to the stars are truly enormous

- If the distance between the Earth and Sun were shrunk to 1 cm (0.4 inches), Alpha Centauri would be 2.75 km (1.7 miles) away



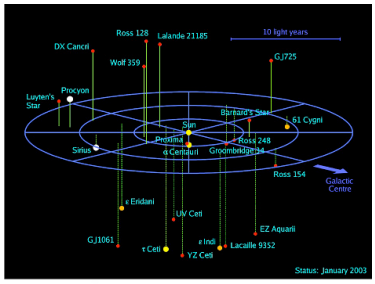
When we look at the night sky, which are the nearest stars?



Altair… 5.14 parsecs = 16.8 light years

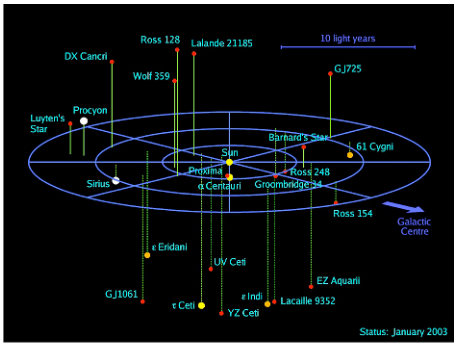
Look at Appendix 12 of the book (stars nearer than 4 parsecs or 13 light years)

So, who are our neighbors in space?



3D Map of Known Stellar Systems in the Solar Neighbourhood

ESO PR Photo 03c/03 (13 January 2003) ©European Southern Observatory

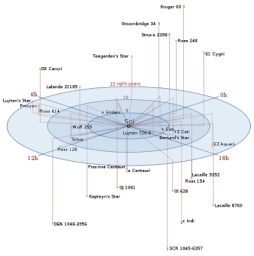


3D Map of Known Stellar Systems in the Solar Neighbourhood

ESO PR Photo 03c/03 (13 January 2003) ©European Southern Observatory

The nearest stars

- 34 stars within 13 light years of the Sun
- The 34 stars are contained in 25 star systems
- Those visible to the naked eye are Alpha Centauri (A & B), Sirius, Epsilon Eridani, Epsilon Indi, Tau Ceti, and Procyon
- We won't see any of them tonight!



Stars we can see with our eyes that are relatively close to the Sun

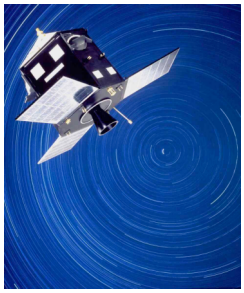
- Arcturus … 36 light years
- Vega … 26 light years
- Altair … 17 light years
- Beta Canum Venaticorum .. 27 light years (a star like the Sun)
- Lambda Serpentis … 38 light years (***)
- 72 Herculis … 47 light years (***)
- 18 Scorpii … 46 light years (the "Solar Twin")

A history of progress in measuring stellar distances

- Parallaxes for even close stars are tiny and hard to measure
- From Abell "Exploration of the Universe", 1966: "For only about 700 stars, however, are the parallaxes large enough to be measured with a precision of 10 percent or better".
- 1 percent parallaxes for only few dozen stars (p377 of book)

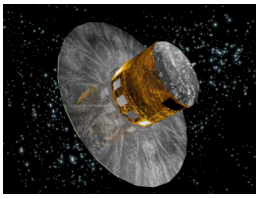
The Hipparchos spacecraft (1989-1993)

- 1 % distances for over 400 stars
- 5 % distances for 10,000 stars
- We have better knowledge of our neighbors, and their properties



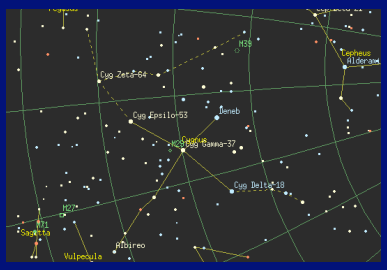
In the future…GAIA

- Will measure parallaxes of a billion stars
- Will have angular precision of about 1:100000 arcsec
- Roughly 10% distances 10,000 parsecs away
- Launch in 2012
- Will produce important advances in astronomy



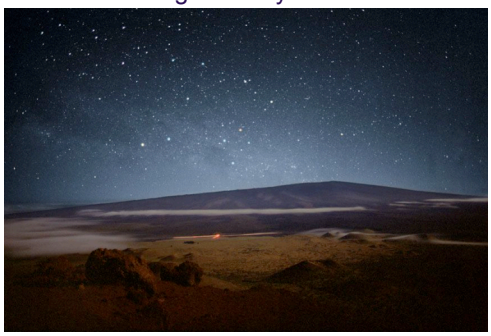
The distances to stars are interesting enough by themselves, but what do stellar distances tell us about the stars?

What are the distances to the stars in Cygnus?



Distances to the Stars of Cygnus

Bright Stars and Faint Stars: the stellar magnitude system



How do we describe the differences in brightness of stars (strikingly obvious when you look at the night sky)?

Modern scientific method: units of power/area

⇨ Demo

the right way to express it

What are units of power in physics?

Brightnesses of Stars: The Magnitude System

The traditional way to describe the brightness of stars…using the human eye as a light detector

Magnitudes, Apparent and Absolute

- Apparent magnitude is the brightness of an object *as it appears to you*
- System due to Hipparchos (2nd century BC)
- Nowadays system made more precise
- Magnitude changes are "logarithmic", each magnitude means factor of 2.512 in brightness
- See Table 16.2 (p382)

Table 16.2…Magnitude differences and brightness ratios

Magnitude Diff.	Brightness ratio
0.0	1.0
1.0	2.5
2.0	6.3
5.0	100.0

Pick a bright (first magnitude) star as m=0, and assign magnitudes to all astronomical objects. Table 16.1

Object	Apparent magnitude
Arcturus	-0.06
Vega	0.04
Altair	0.77
Deneb	1.26
Zeta UMa	2.27
Theta Capricorni	4.07

Limit of naked eye visibility: 5.0 - 6.0