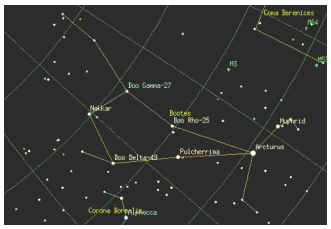
The Stars

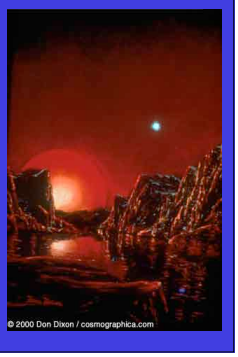
"e quindi uscimmo a riveder le stelle"
Last words of Dante's *Inferno*



The Stars are other Suns

"L'amor che muove il Sole
E le altre stelle"… Dante, end
Of Paradiso

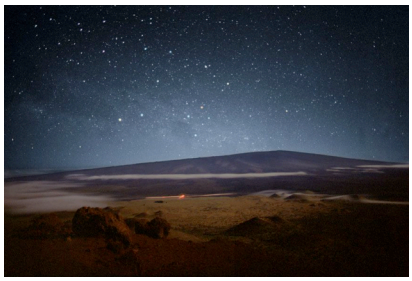
Or…the Sun is the closest star



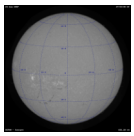
Basic Questions about Stars

- How far away are they?
- How hot are they?
- How massive are they?
- What are they made of?
- Why do they shine?
- What is their "life cycle"?
- Do they have planets too?

How far away are they to be glowing points in the night sky rather than the blazing Sun?



Return to an idea from last time…distance expressed in terms of travel time



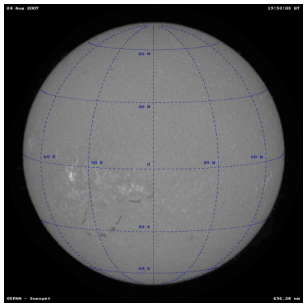
Distance to Sun in terms of light travel time
d=vt (like driving to Des Moines)
t=d/v

The fastest *anything* can travel is speed of light = c = 2.9979E+08 meters/sec

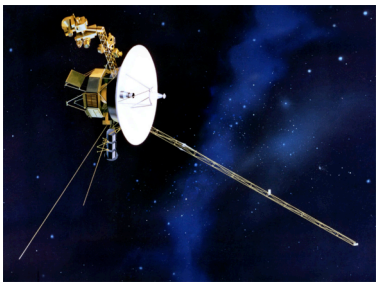
Distance to Sun = 1 au = 1.496E+11 meters (see Appendix 1), so light travel time from Sun is
t=d/c =1.496E+11/2.9979E+08 =
t=499.02 sec

A little over 8 minutes

The Sun could have exploded 7 minutes ago, and we would not have gotten the news yet!

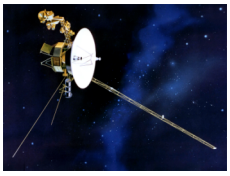


Let's repeat the calculation with the Voyager 1 spacecraft, 114.2 au from Sun



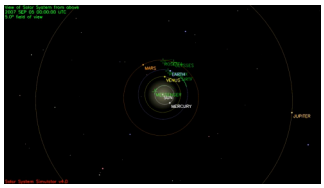
Voyager is a long ways out there

- Light takes 15.9 hours to reach Voyager 2 from Earth.
- Round-trip time is well over a day!



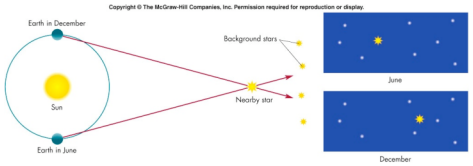
Summary: an alternative description of the size of the solar system

- Inner solar system is light minutes in extent
- Outer solar system is light hours to a light day across



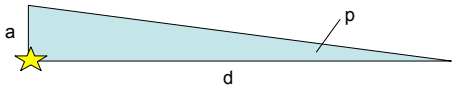
Most Basic Method of Stellar Distance Determination

Trigonometric parallax: an ordinary surveying technique



DEMO

Some equations about parallax



Tan(p) = a/d

If p is small, and expressed in radians,

Tan(p) = p, so

We have p=a/d, or d=a/p

First point: parallaxes are small (noted by Aristotle). Need a smaller angular unit than degrees

- 1 degree = 1/90 of a right angle
- 1 arcminute (') is 1/60 of a degree
- 1 arcsecond (") is 1/60 of an arcminute

1 arcsecond is the angle subtended by a penny at a distance of 4.1 km (2.5 miles)

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+18 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:

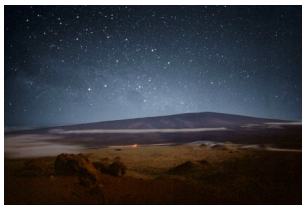
- 9.460E+15 meters
- 3.26 light years = 1 parsec

So what are the distances to the stars?

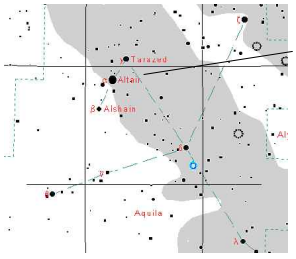
- First measurements made in 1838 (Friedrich Bessel)
- Closest star is Alpha Centauri, p=0.75 arcseconds, d=1.33 parsecs= 4.35 light years
- Nearest stars are a few to many parsecs, 5 - 20 light years

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



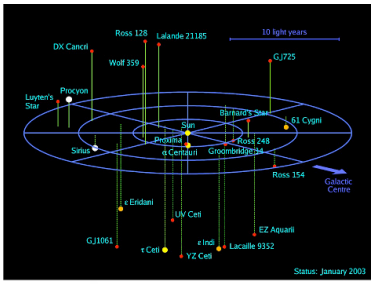
When we look at the night sky, which are the nearest stars?



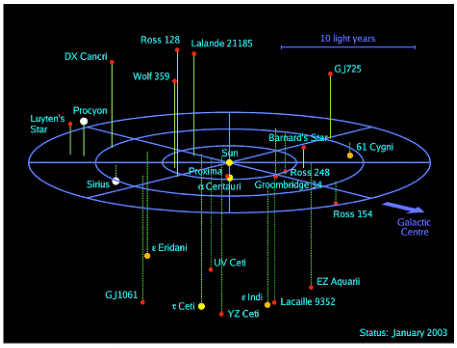
Altair… 5.14 parsecs = 16.8 light years

Look at Appendix 12 of the book

So, who are our neighbors in space?



3D Map of Known Stellar Systems in the Solar Neighbourhood

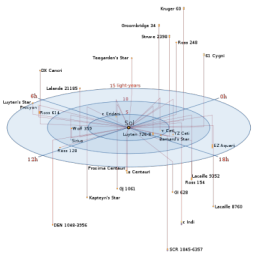


3D Map of Known Stellar Systems in the Solar Neighbourhood

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")