Introduction to Astronomy

ASTRO 010

Lecture 02 15 Jan 2009

- The Scale of Things
- Some *very* basic algebra
- Astronomical Lengths

Orders of Magnitude

Astronomy has some *BIG* numbers...

Radius of the Earth:

6 400 000 m = 6 400 km

Distance to the Sun:

150 billion m =150 000 000 km = 150 million km

Radius of the Solar System:

6 000 000 000 km = 6 billion km

Distance to a Nearby Star:

40 000 000 000 000 km = 40 thousand billion km

Diameter of the Milky Way:

900 000 000 000 000 000 km = 9 hundred million billion km

Distance to Nearest galaxy to our own:

3 000 000 000 000 000 000 000 km = 3 thousand billion billion km

I
10

$$1$$

$$10$$

$$100 = 10 \times 10 = 10^2$$

$$1\,000 = 10 \times 10 \times 10 = 10^3$$

$$10\,000 = 10^4$$

$$100\,000 = 10^5$$

$$1\,000\,000 = 10^6$$

Prefix	Symbol	Factor
kilo	k	10^3
Mega	M	10^6
Giga	G	10^9
Tera	T	10^{12}
Peta	P	10^{15}
Exa	E	10^{18}

$$1 = 10^{0}$$

$$0.1 = 10^{-1}$$

$$0.01 = 10^{-2}$$

$$0.001 = 10^{-3}$$

$$0.000\ 1 = 10^{-4}$$

$$0.000\ 01 = 10^{-5}$$

$$0.000\ 001 = 10^{-6}$$

Prefix	Symbol	Factor
milli	m	10^{-3}
micro	μ	10^{-6}
nano	n	10^{-9}
pico	p	10^{-12}
femto	f	10^{-15}
atto	a	10^{-18}

The speed of light (SoL) is:

300 000 km/s

or

300 000 000 m/s

The speed of light (SoL) is:

300 000 km/s

or

300 000 000 m/s

or

3 x 100 000 000 m/s

or

3×10^8 m/s

$$10^a \times 10^b = 10^{(a+b)}$$

$$10^a \div 10^b = 10^{(a-b)}$$

$$10^a \times 10^b = 10^{(a+b)}$$

$$10^a \div 10^b = 10^{(a-b)}$$

e.g.

$$10^3 \times 10^6 = 10^9$$

$$10^3 \div 10^6 = 10^{-3} = 0.001$$

Radius of the Earth: 6×10^3 km

Distance to the Sun: 1.5×10^8 km

Radius of the Solar System: 6×10^9 km

Radius of the Earth: 6.4×10^3 km

Distance to the Sun: 1.5×10^8 km

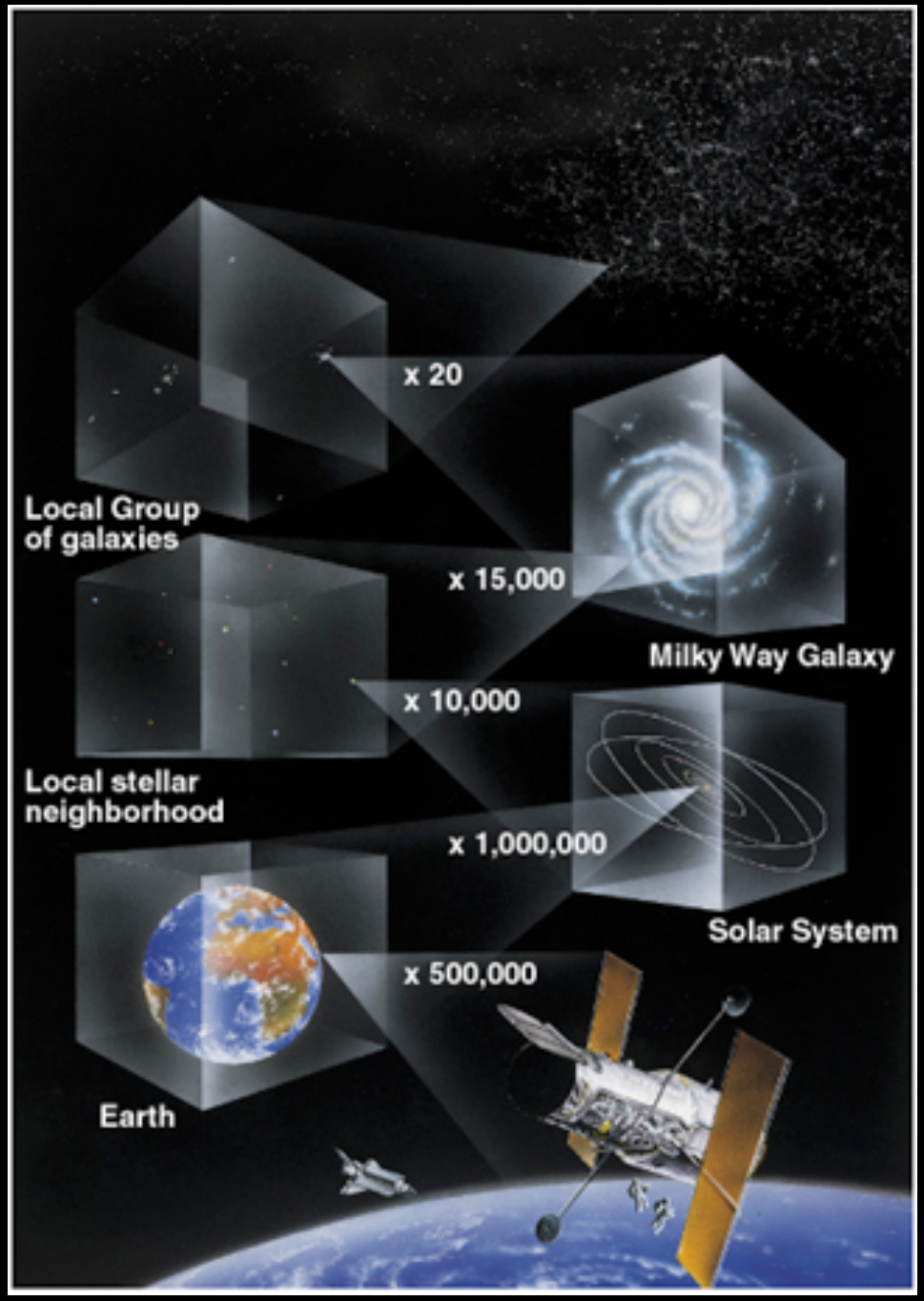
Radius of the Solar System: 6×10^9 km

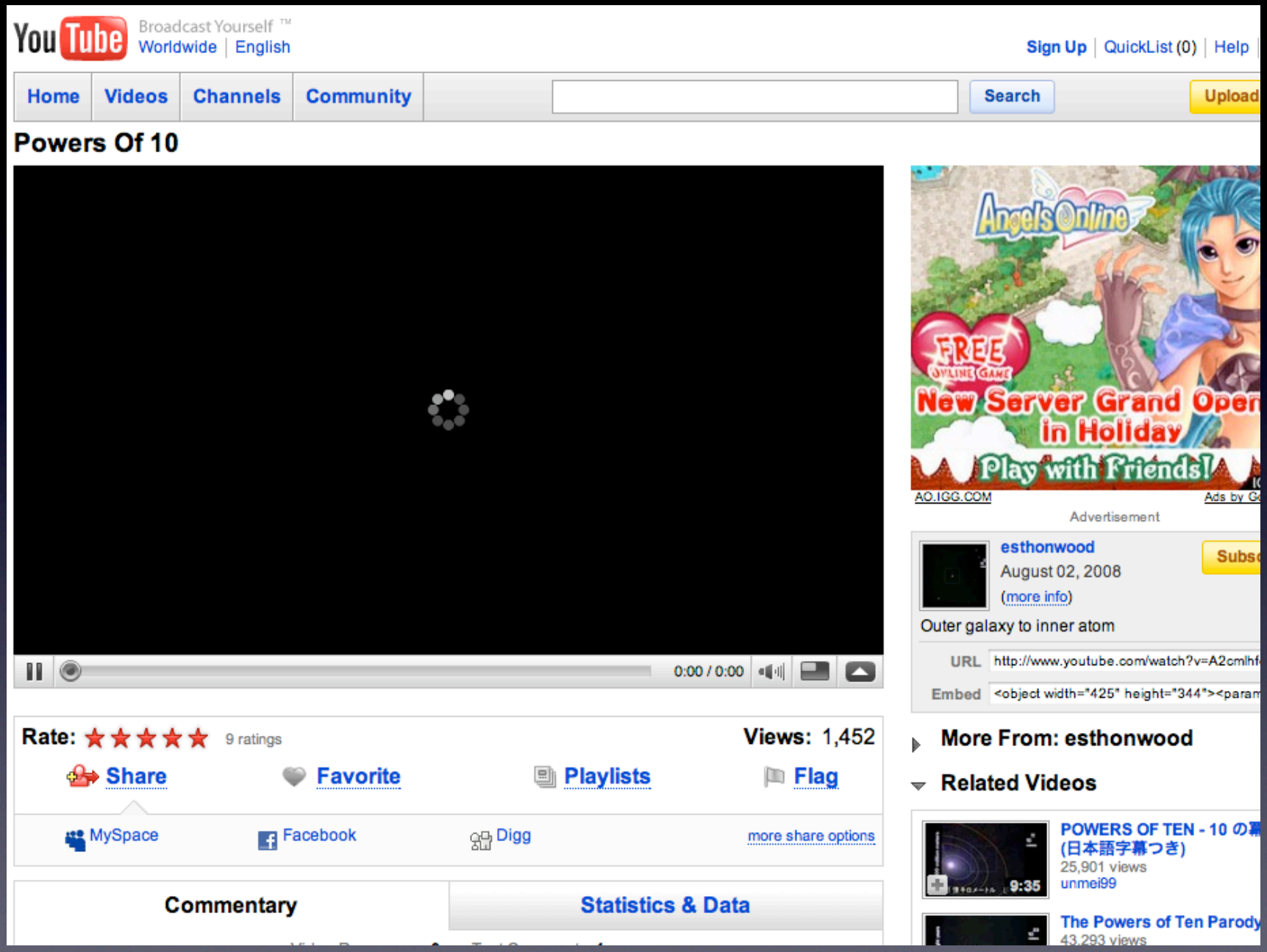
Distance to a Nearby Star: 4×10^{13} km

Diameter of Our Galaxy: 9×10^{17} km

Distance to Nearest galaxy: 3×10^{21} km

How much larger is the Solar System than the Earth?


x 20
Local Group
of galaxies
x 15,000
Milky Way Galaxy
x 10,000
Local stellar
neighborhood
x 1,000,000
Solar System
x 500,000
Earth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Length Scales (1)

The Astronomical Unit (AU):
This is the distance between the Sun and the Earth =

1.5×10^8 km

(also 8 "light minutes")

Length Scales (2)

A light year (ly)

The distance light travels (at 3×10^8 m/s) in one year (3.1×10^7 s) =

9.5×10^{12} km.

Length Scales (3)

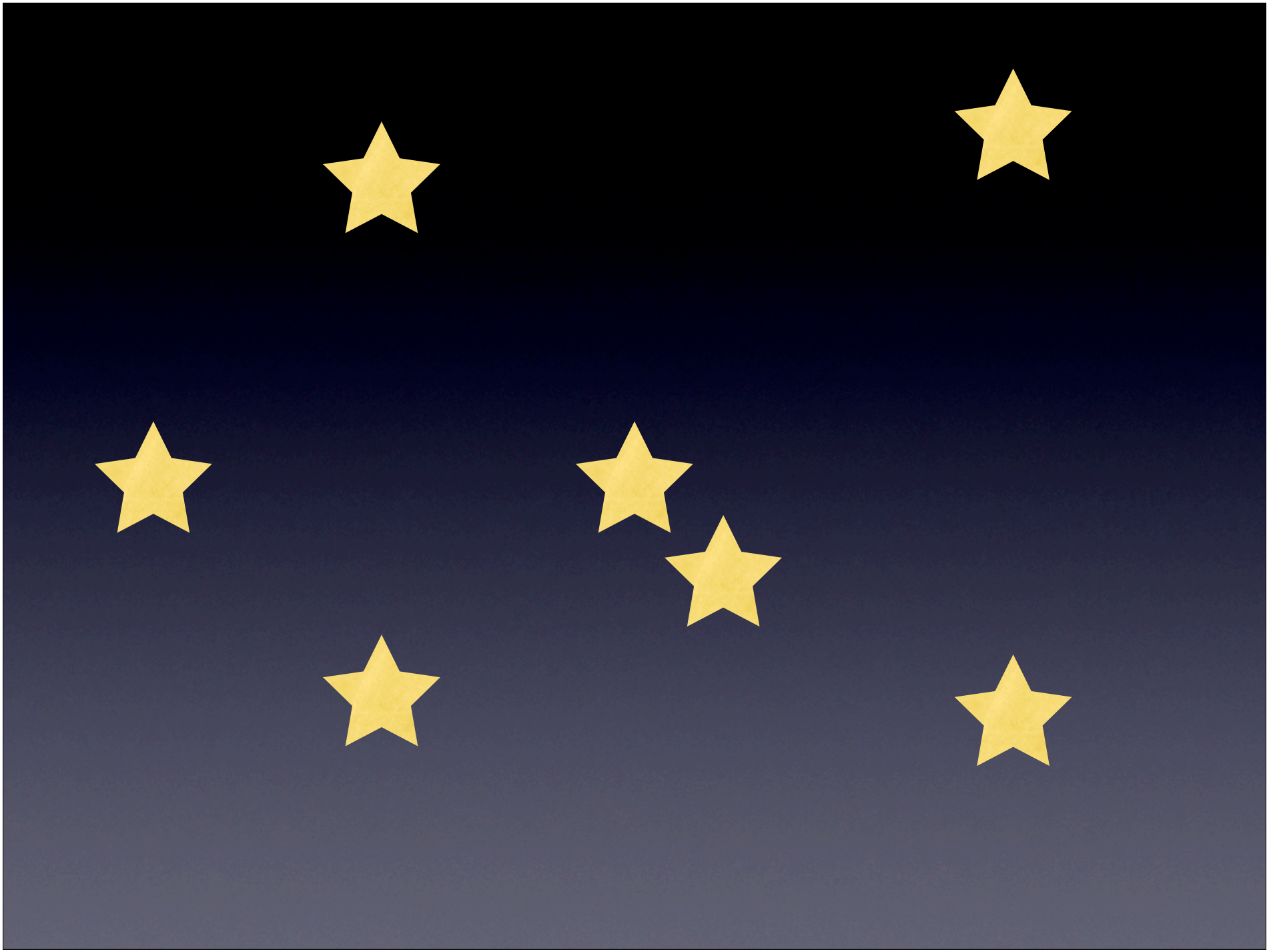
A parsec (pc)

The distance of a star that produces a parallax of 1 arcsecond with a baseline of 1 AU =

3.09×10^{13} km

= 206265 AU = 3.26 ly

Parallax



$$\text{Distance (pc)} = \frac{\text{baseline (AU)}}{\text{parallax (arcsec)}}$$

$$\text{Distance (pc)} = \frac{1 \text{ (AU)}}{\text{parallax (arcsec)}}$$

$$\text{Distance (AU)} = \frac{\text{baseline (AU)}}{\text{parallax (radians)}}$$

Time Scales (1)

Light travel time from the Sun to the Earth:

8 minutes

Time Scales (2)

Age of the Sun:

5 billion years

Length Scales (3)

Age of the Universe:

13.7 billion years

Today's "take-home":

- Astronomers use "Powers of Ten"
- The *AU*, *light year* and *parsec* are all (different) astronomical lengths

Next time on Astro 10:

- The Seasons
- Equinoxes and Eclipses

Tuesday, 20th January 2009, 108 Forum, 11:15am

Existential Questions

- Why do we see day and night?
- What causes the seasons? What makes the days longer in the summer than in the winter?
- Why do we see different stars in the summer and in the winter?
- What causes the phases of the moon?