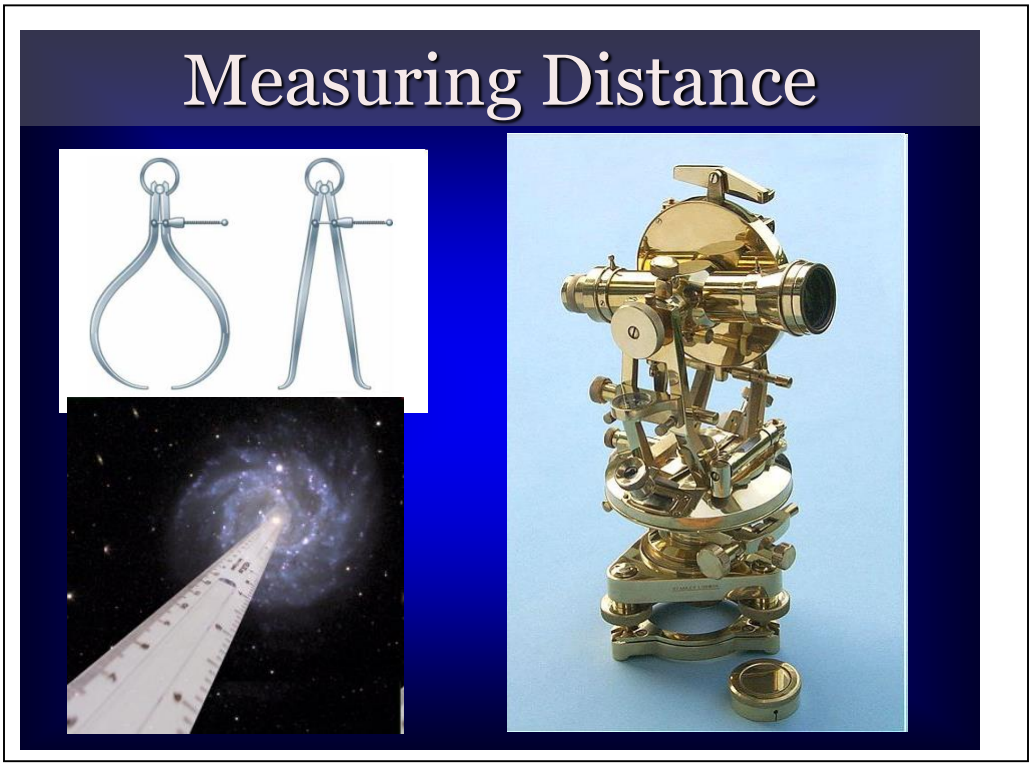
Administrative Stuff

No Lab This Week!

All Other Admin Friday!



Measuring astronomical distances and sizes is one of the most difficult problems in astronomy.

We'll talk many times about the ways that astronomers have devised for measuring distances in space.

Astronomers (and scientists in general) use a lot of different crazy units to measure distances. (miles, feet, light years, parsecs)

Each unit of measure is designed to be suitable for the thing being measured.

Our brains work all right with numbers up to about a million.

Beyond that, the numbers really become senseless because we can't visualize them.

So… We pick a unit that keeps the number small so that we can think about it.

For instance, it makes no sense to measure the distance to Madison in inches.

Units of measure (feet, inches, miles, furlongs, etc.) are defined in a completely arbitrary way.

We generally pick a unit that is matched to the thing that we're measuring.

Starting with a view of the North Campus of UST, we'll define a new unit of measure: The North Campus or the NC

One NC = 0.3 miles.

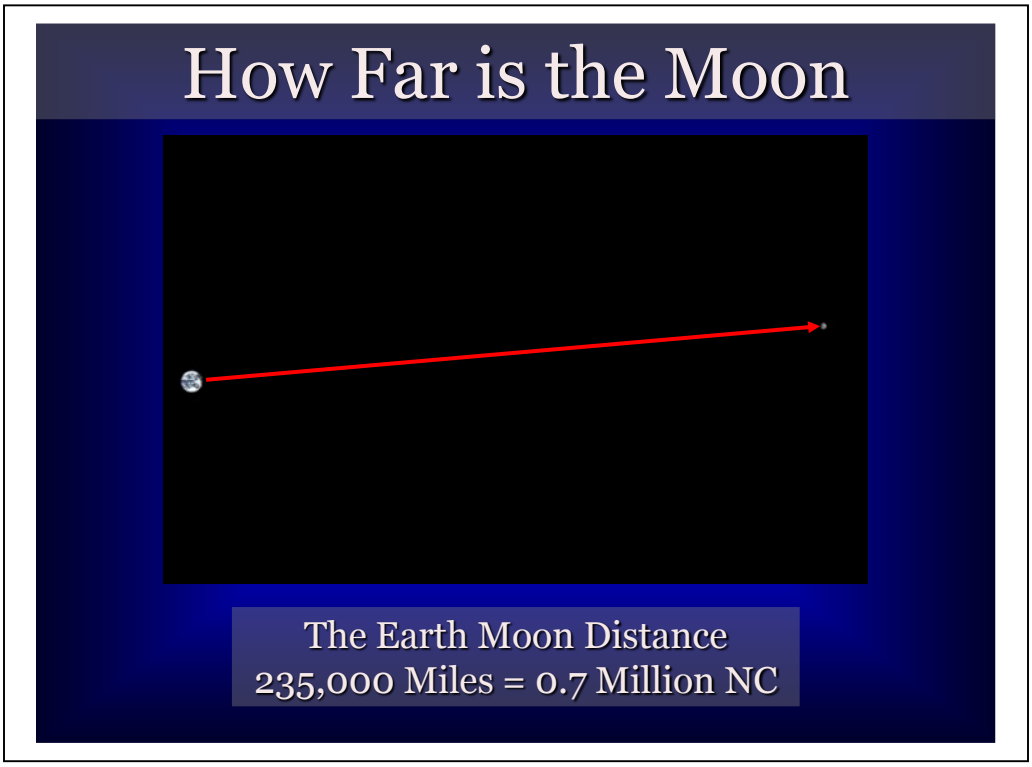
Think about how long it takes you to walk one NC. At 4 mph (13 NCs per hour), it's about 4.5 minutes

The United States is 8,600 NCs across. At 4 mph, you can walk it in 26 days

The Earth is 24,320 NCs around. At 4 mph, you can walk it in 76 days

The Moon is about ¼ of an Earth diameter.

About 30 Earth diameters



You can see why they are rarely drawn to scale.

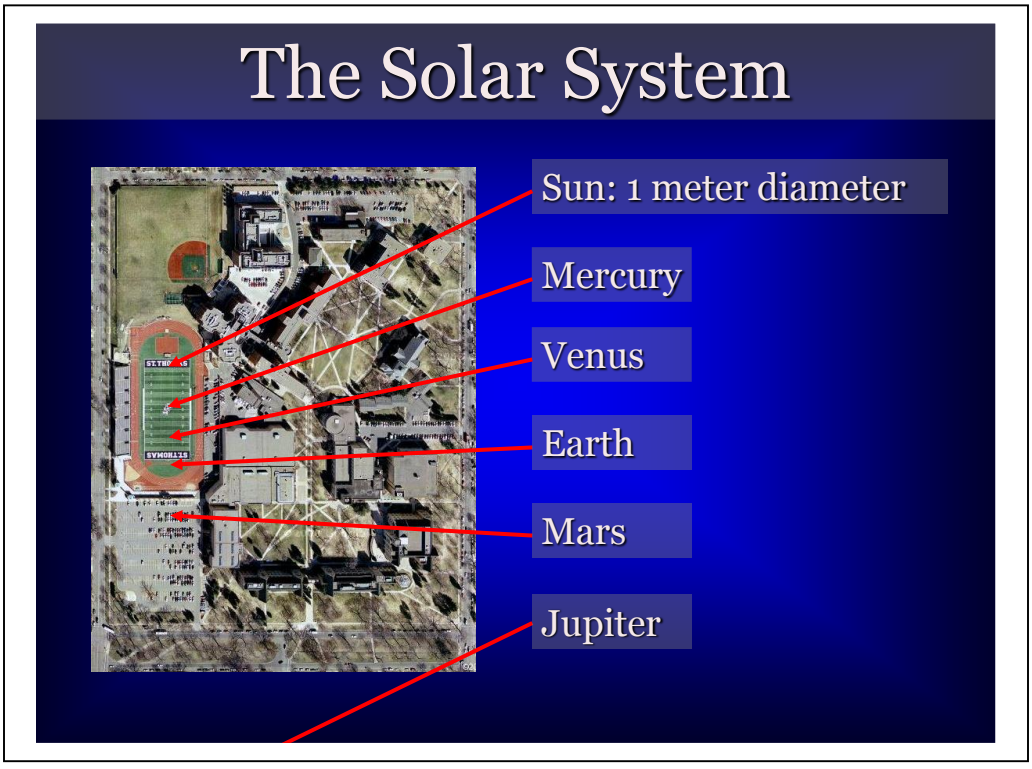
You could walk to the Moon in about 6.7 years at 13 NC/hour
You could imagine a particularly well built car driving 235,000 miles.

Sun Earth Comparison

The Sun is MUCH bigger than the Earth.

It’s about 100 Earth diameters across.

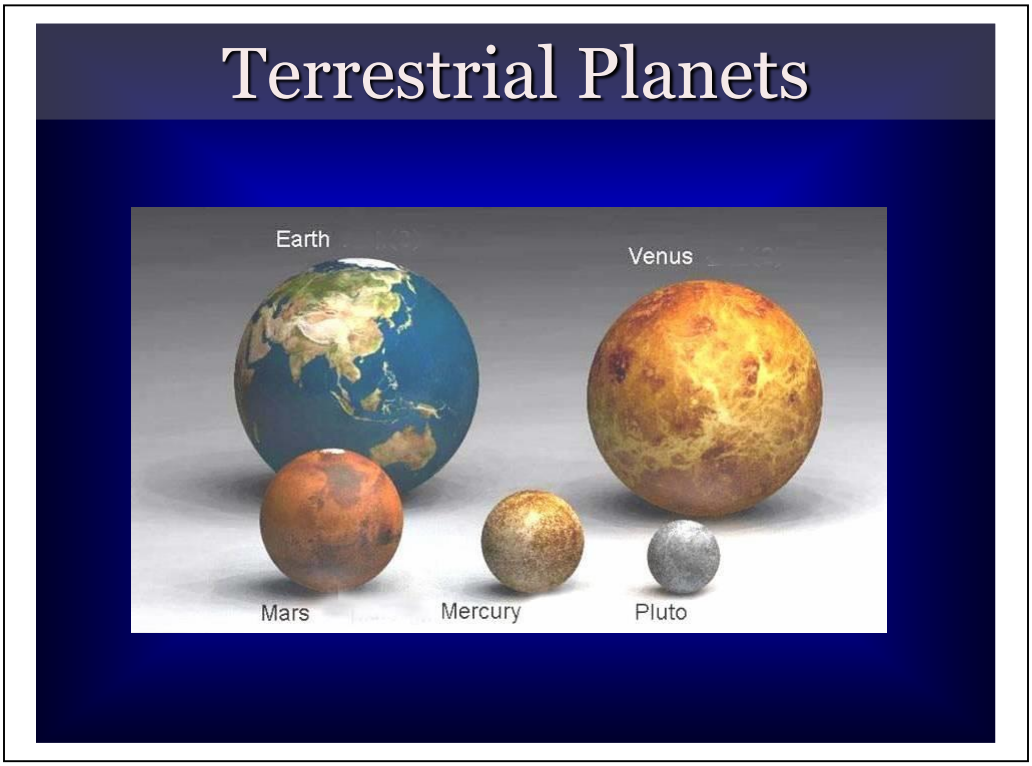
The entire Earth/Moon system fits inside the Sun.



Let the Sun have a diameter of 1 meter and place in the end zone of the UST football field.

Mercury ends up on the 45 yard line.
Venus is about 75 yards away
Earth is just beyond the opposing end zone.
Mars is in the Parking lot
Jupiter is… off the map

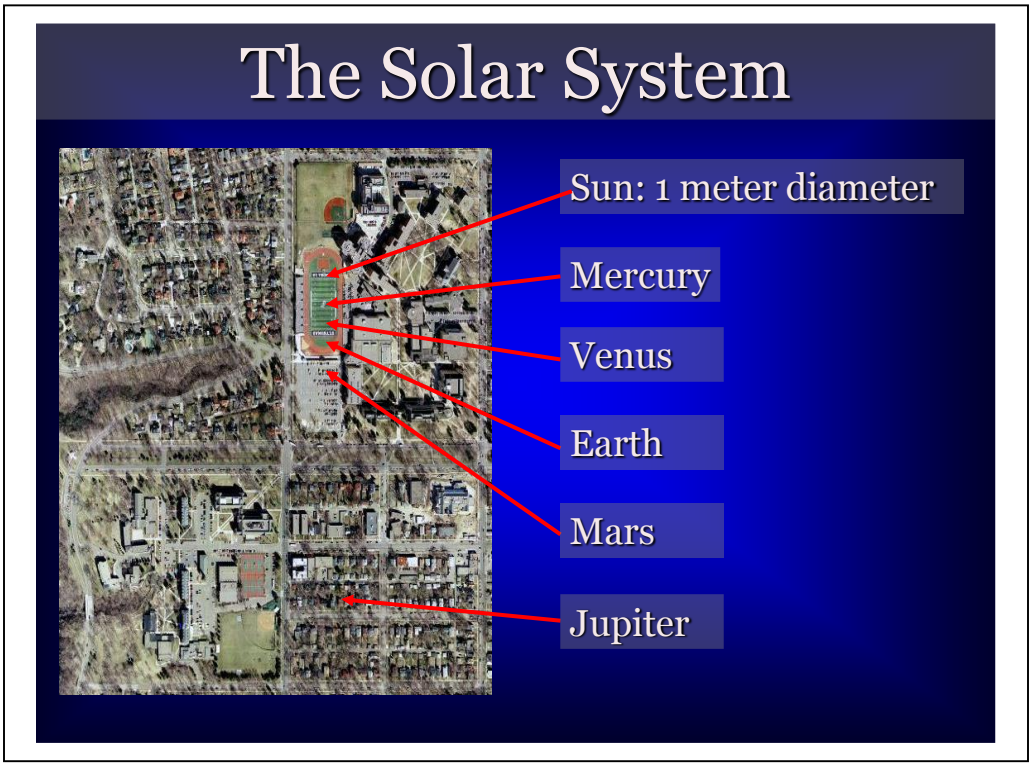
In the solar system, we use a unit of distance called an Astronomical Unit (AU).
It is the average distance between the Earth and the Sun (about 93 million miles)



The Terrestrial Planets.
These are made mostly of rocky stuff.
We'll talk later in the semester about how terrestrial planets form

Earth is the largest by a tiny Fraction. Venus is nearly as large.
The Moon is smaller than Mercury but larger than Pluto.

Pluto is actually not made of rock… it's a rock/ice mixture. It doesn't get to be a planet anymore. So sad.

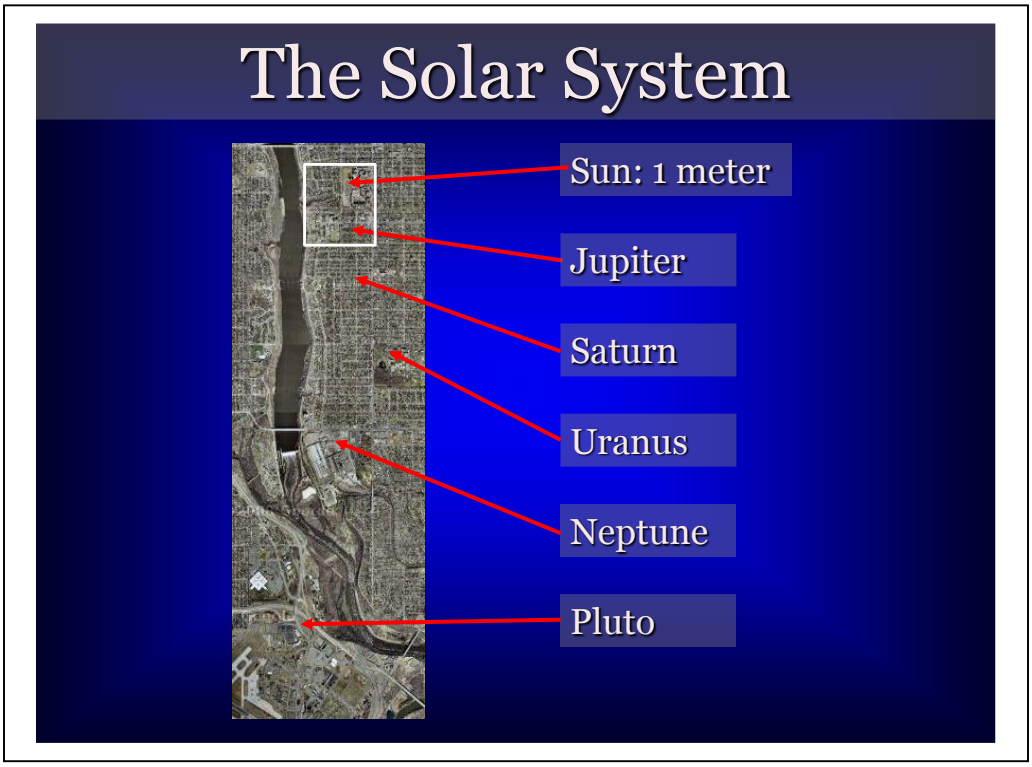


Jupiter is around South Campus.

5 times further away than the Earth is from the Sun.

We say it's 5 AU away.

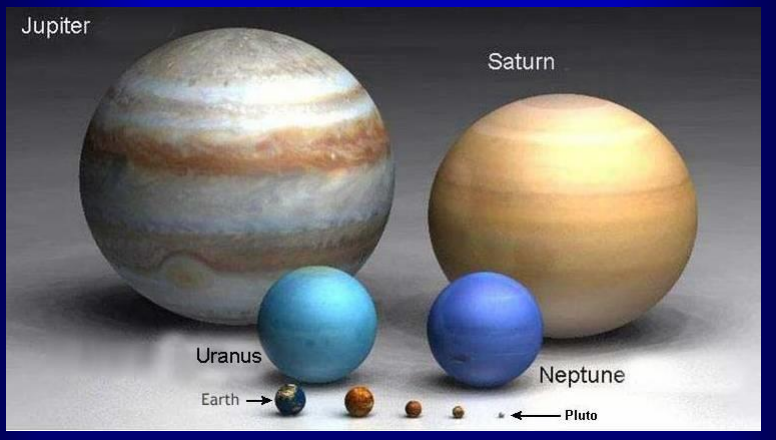
1 AU = the average Earth Sun distance.



The gassy planets are much further away from the Sun than the Earth is.

And they're made of gas (mostly). VERY different than the terrestrial planets.

Gassy Planets



Jupiter is by far the largest planet in the solar system.

It is about 11 Earth diameters.

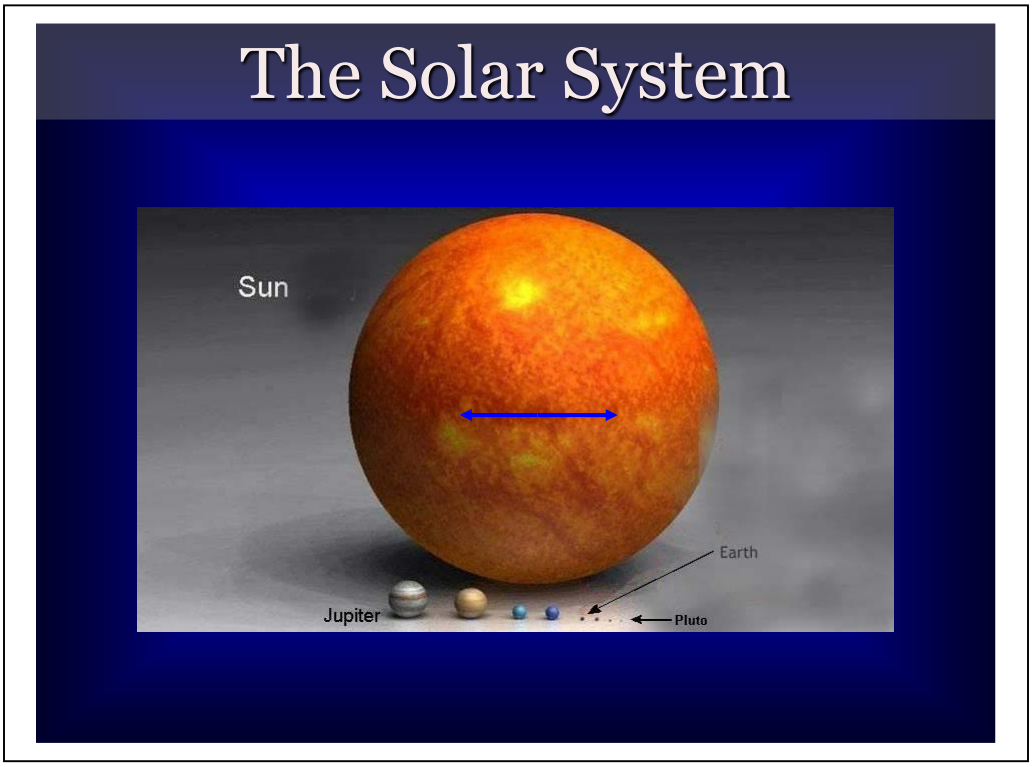
Not counting the Sun, it accounts for 71 percent of the mass in the solar system.

Saturn, the next largest planet, is only 1/3 the mass of Jupiter.

For comparison, the terrestrial planets taken together account for only 0.4 percent of the planetary mass in the solar system.

We'll talk more about Jupiter and the gas giants later in the semester.

Including how to build a giant gas planet.

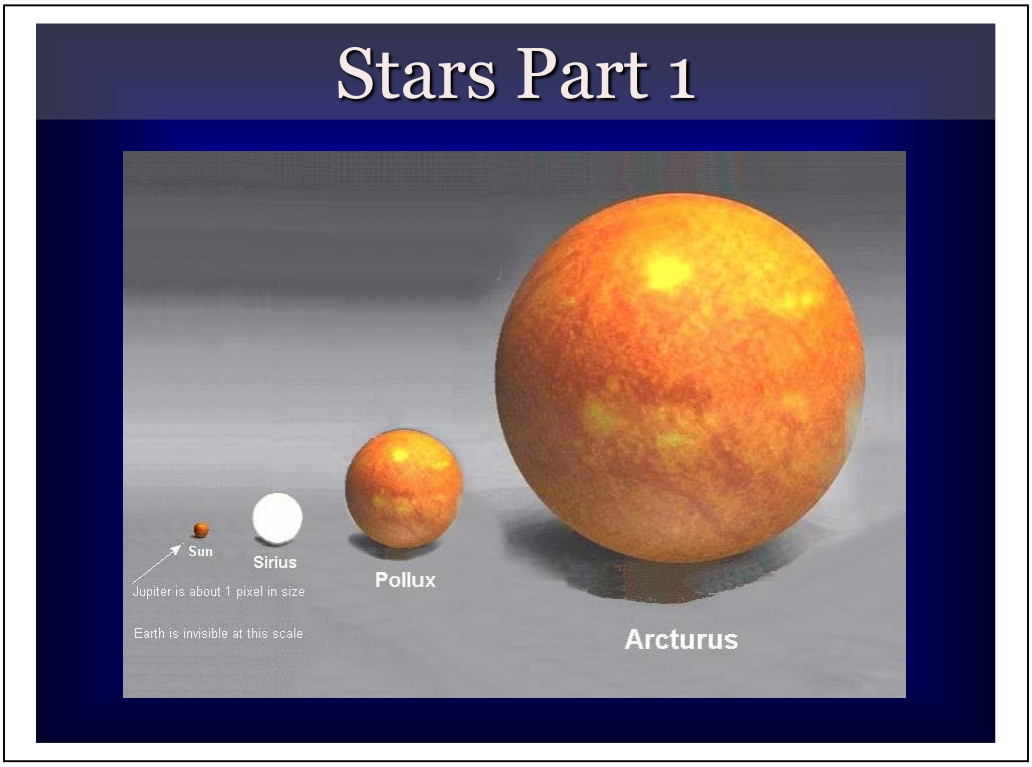


The Sun completely dominates the solar system.

The Earth/Moon system fits easily inside the Sun. Twice
The arrows represent the entire DIAMETER of the Moon's orbit around the Earth.

The Sun has 99.87 percent of the mass of the Solar System.

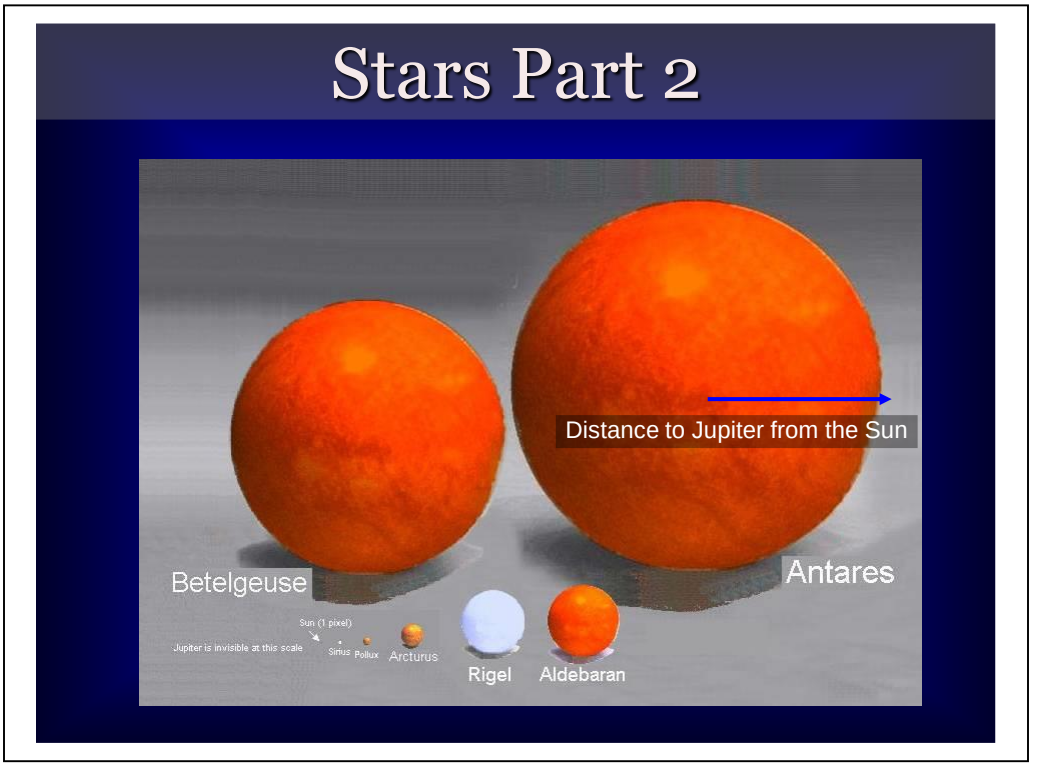
The Sun is a rather small star though…



Sirius is the brightest star in the sky.
Pollux has a planet around it!

Arcturus is a Red Giant star. It is 25 times larger than the Sun.

What is a Red Giant? We'll talk more about Red Giants later…



Even Arcturus is small by star standards.

Rigel is a massive star… 17 times more massive than the Sun. It's REALLY HOT!!!!
11,000 degrees (Kelvin). That's why it looks blue.
The Sun is only 5,800 Kelvin.

Begelgeuse and Antares are nearly 1000 times larger than the Sun.
Antares is 15 times heavier than the Sun.
Both stars are Red Supergiants. Rigel will eventually become a red supergiant.

The Blue line is the distance to Jupiter from the Sun.

We need a new unit to get to the next object – Alpha Centauri.
It's the nearest star to us.

If you're driving 60 mph and you drive for one hour, how far have you gone?
Drive for 2 hours, how far have you gone?
So- with a speedometer and a stopwatch, you can measure distance.

Stars are REALLY far apart- and light is really fast!
Although it LOOKS like light travels from place to place instantly, it doesn't.
It just goes REALLY fast. About 186,000 miles/second.
We'll use the speed of light to measure distances.
If you travel at the speed of light for one year, you have gone one light year!

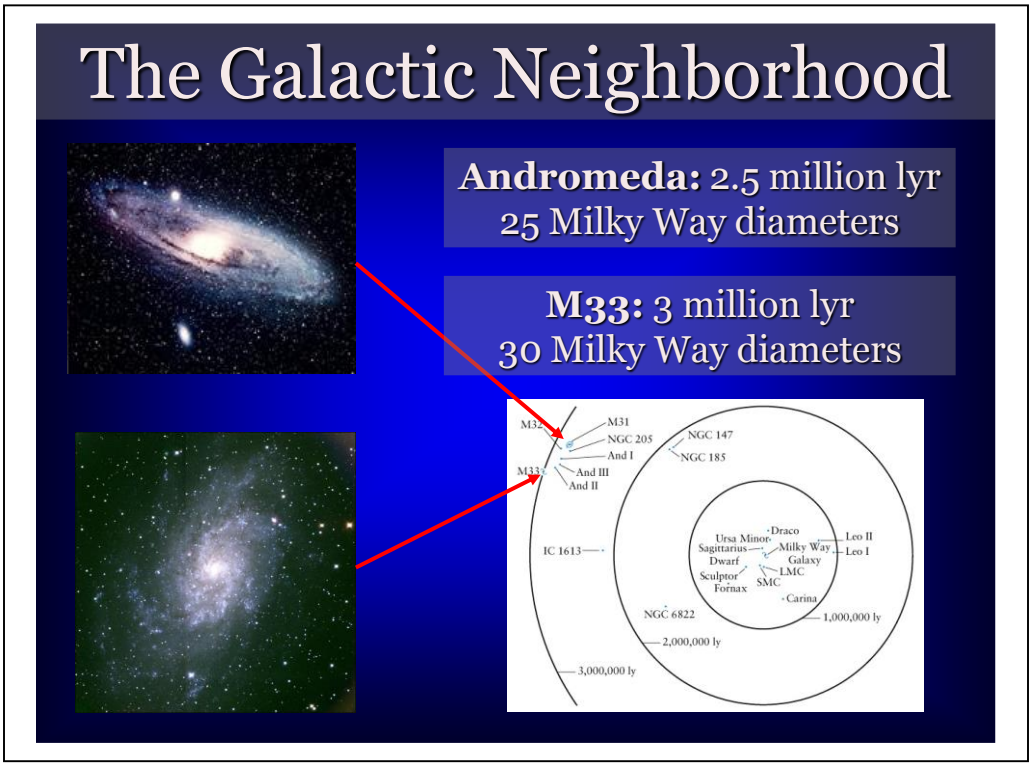
The Sun is about 8 light minutes away
Pluto is nearly 7 light hours away.

The nearest star is 4.4 light years. 6000 solar systems would fit in that space.

On the 1 meter Sun scale, the nearest star is ¾ of the way around the Earth.

Galaxies are HUGE collections of stars. There is one star in the solar system, but many "Solar Systems" in a galaxy.

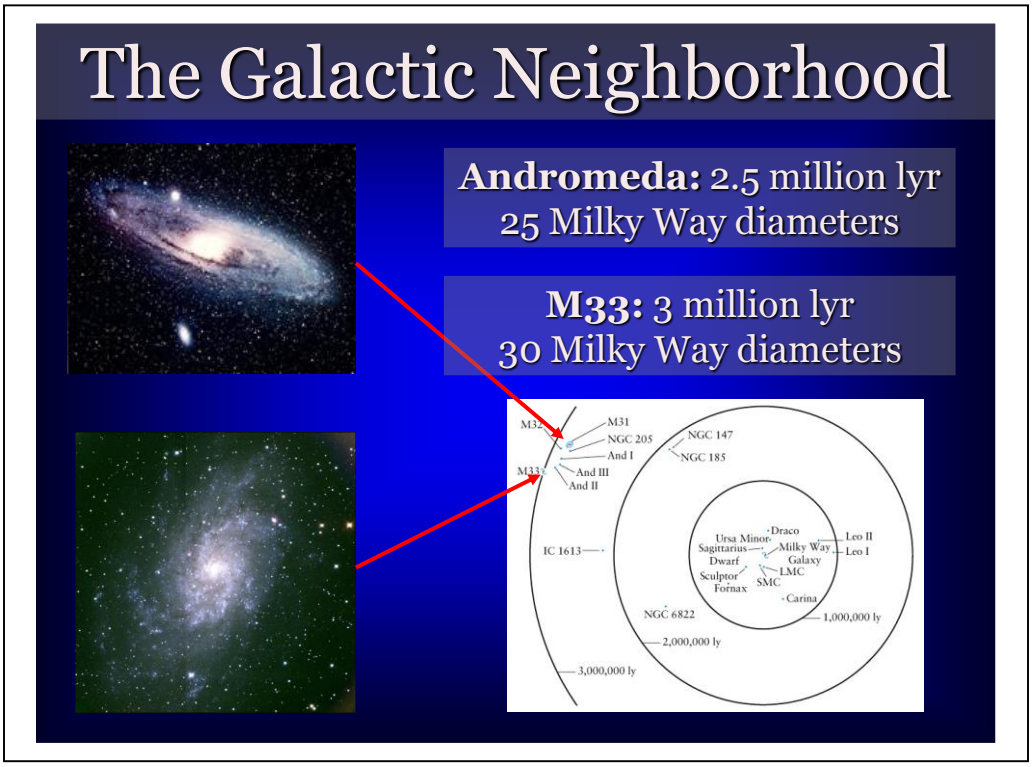
There are about 100 billion stars in the Mily Way Galaxy.
The Milky Way galaxy is 100,000 light years across.
The Sun is about 30,000 light years from the center.



Edwin Hubble found the distance to Andromeda.
It was A LOT further away than anyone thought… 2.5 MILLION light years.
People didn't exists when the light that we see left that galaxy.

There is a lot of space between individual Galaxies.

Our nearest LARGE galactic neighbors are Andromeda and M33 at about 2.5 and 3 million light years respectively.
There are a bunch of other smaller (dwarf) galaxies in the in between space.



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The Universe

This is the Hubble Ultra Deep Field.

It is a very small slice of "empty" sky, the equivalent of looking through an 8 foot long soda straw. It is 1/13 millionth of the total sky.
There are 10,000 galaxies in this image. If the density of galaxies is the same in all directions, that means we would observe 130 billion galaxies.
The most distant galaxies are around 13 billion light years away.

That's about as far as the universe allows us to see, known as the Observable Universe.
Why can we only see 13 billion light years? What's the fundamental limitation? I t's not technology… We'll learn more later!

The Scale of the Universe

6 The Sun
10 The Milky Way Galaxy
3 The Earth
8 The Solar System
1 North Campus
2 The Moon
11 The distance between galaxies
4 Jupiter
12 The Universe
7 The Earth to Sun distance
9 The distance between stars
5 The Earth to Moon Distance