AST 301
Introduction to Astronomy

John Lacy
RLM 16.332
471-1469
lacy@astro.as.utexas.edu

Myoungwon Jeon
RLM 16.216
471-0445
myjeon@astro.as.utexas.edu

Bohua Li
RLM 16.212
471-8443
bohuali@astro.as.utexas.edu

Watch Venus and Mars move in the sky

For the next week or two you can watch Venus and Mars move relative to Spica.

Find a place you can go at about 8:30 PM where no buildings block your view to the west.

Go there at least 3 times in the next 2 weeks.

Sketch the positions of Venus, Mars, and Spica, as well as some landmarks on the horizon.

Write down the date and time, your location, the weather, and the names of any companions.

This assignment is due Friday, Sep. 10.

How long would it take you to walk to the Sun?

The Sun is about 150,000,000 km from the Earth.

If you can walk 40 km in a day, it would take you 150,000,000 / 40 = 3,750,000 days, or about 10,000 years to walk to the Sun (if someone built a bridge you could walk on to get there).

Let's try running really fast.

What if you could run at the speed of light?

Light travels 300,000 km in a second.

How long would it take to go 150,000,000 km at the speed of light?

What's the formula?

If you drive at 60 mph (miles/hour) for 10 hours you go 600 miles, or 60 mi/hr x 10 hr = 600 mi.

Or if you want to go 300 miles, it will take you 5 hours.

That is 300 mi / 60 mi/hr = 5 hr.

If you want a formula, it is distance = speed x time.

Or time = distance / speed.

Try using it with a distance of 150,000,000 km and a speed of 300,000 km/s.

Compare your answer with your neighbor's.

Distance to the Sun in light-seconds

The answer is 150,000,000 km / 300,000 km/s = 500 sec.

We sometimes give the distance to astronomical objects by the time it takes light to go that distance.

The distance to the Sun is 500 light-seconds.

This is also known as the astronomical unit or AU.

1 AU = 150,000,000 km = 500 light-seconds.

Pluto is about 40 AU from the Sun.

That's about 20,000 light-seconds, or 5.5 light-hours.

When the New Horizons spacecraft gets there the messages it sends back will take 5.5 hours to get to us.

More distant objects

The nearest star to the Sun is about 4 light years away.

That's about 7000 times as far away as Pluto is.

We live in a huge collection of stars called the Milky Way.

It is about 100,000 light-years across.

The size of the Milky Way galaxy is about 30,000 times the distance to the nearest star.

The nearest big galaxy to the Milky Way is another factor of 30 farther away, or 1,000,000 times as far as the nearest star.

How big is the Universe?

I don't know.

We can't see it all.

It might be infinitely large.

The most distant object we can see is about 14,000,000,000 light-years away (or was when the light left it 14,000,000,000 years ago.

That's more than 1,000 times as far away as the Andromeda Galaxy.

We can't see anything more distant because the Universe has only existed for 14,000,000,000 years.

Light from more distant objects couldn't have gotten here yet.

What should you remember?

Don’t memorize all of the numbers.

But do remember roughly how things compare in size and distance from us.

The Sun is roughly 100 times as big as the Earth.

The astronomical unit is roughly 100 times as big as the Sun.

The solar system is roughly 100 AU across.

The nearest star is more than 1000 times that far away.

The Milky Way galaxy is roughly 10,000 times as big as the distance to the nearest star, so it is more than 10,000,000 times bigger than the solar system.

And the Universe is more than 100,000 times bigger than the Milky Way.

Big numbers

Numbers like 1,000,000 are hard to work with.

It is more convenient to use an abbreviation:

$1{,}000{,}000 = 10 \times 10 \times 10 \times 10 \times 10 \times 10 = 10^6$

And we write $2{,}000{,}000$ as 2×10^6

And sometimes we will write $1/10^6$ as 10^{-6}

We can leave numbers written this way while multiplying and dividing. For example:

$2 \times 10^3 \times 3 \times 10^2 = 2 \times 10 \times 10 \times 10 \times 3 \times 10 \times 10$

$= 2 \times 3 \times 10 \times 10 \times 10 \times 10 \times 10 = 6 \times 10^5$

$2 \times 10^3 / 10^2 = 2 \times 10 \times 10 \times 10 / 10 \times 10$

$= 2 \times 10 = 2 \times 10^1 = 20$

The age of the Universe

I gave the age of the Universe as 14,000,000,000 (14×10^9, or 14 billion years, or 14 Gyr).

How did I know that?

We know the age of the Earth quite well because some rocks change as they age by radioactive decay.

The Earth is about 4.5 Gyr old.

There must be stars older than this since the Earth is made of elements that were made inside of stars that lived before the Earth formed.

We can date some stars from how they change as they age, and some are at least 10 Gyr old.

The age of the Universe

The determination of the age of the Universe is more difficult.

Distant galaxies are moving away from us.

From their speeds we can calculate when they were in the same place as we were.

We'll talk more about that during the last week of classes.

The answer comes out to about 14 Gyr.

We think that was the beginning of the Universe, or at least the part of the Universe we can see.

Our motion through space

We aren't standing still.

The Earth is rotating.

An object at the equator moves 24,000 miles (the circumference of the Earth) every 24 hours, or 1000 mph.

That's about 0.5 km/s.

In addition, the Earth is orbiting around the Sun.

Can you figure out how fast it's going?

Use the formula speed = distance / time.

What is the distance around the Earth's orbit?

Hint: the Earth's orbit is nearly a circle with a radius of 1 AU, or 150×10^6 km.

The speed of the Earth

The answer comes out to about 9×10^8 km.

You can do it more accurately on your homework.

We can get the Earth's speed in km/s by dividing the distance it travels in km by the time in seconds.

There are about 3×10^7 seconds in a year, and the Earth travels about 9×10^8 km around the Sun in a year.

Speed = 9×10^8 km / 3×10^7 sec = 30 km/s.

The Sun isn't standing still either.

It is orbiting around the center of the Milky Way at about 200 km/s.

How can the Earth go around the Sun at only 30 km/s while the Sun is moving at 200 km/s? Why doesn't the Earth get left behind?

The speed of the Milky Way

The Milky Way is moving too.

It moves relative to the nearby galaxies at a few 100 km/s.

Is it moving due to the expansion of the Universe?

How can we tell that the distant galaxies are moving away from us rather than us moving away from them?

If they are moving away from us, why are we so special?

We'll talk more about that later.

Assignment for Monday

Read Chapters 1 and 2.

If you haven't yet, find a place where you can see the western horizon and look for Venus, Mars, and Spica.

If it is clear enough to see them, make a sketch and write down the date, time, place, weather, and names of companions.