

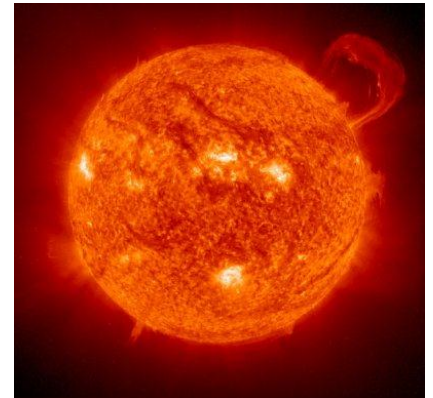
SKY SCIENCE

STUDY NOTES

Also use your class notes and tests.

I CAN observe, describe and interpret the movement of objects in the sky; and explain pattern and order in these movements.

- Stars are like non-stop nuclear explosions. They emit (send out) their own light. Almost everything else we see in space REFLECTS light.
- The Sun is the closest star to our planet. It is an average size star. It makes light, heat and energy for our planet. Without it there would be no life on our planet. :-)
- Light that leaves the Sun takes 8 minutes to reach the Earth.
- Never look at the Sun directly or through a telescope or binoculars. Your eye has a lens and the Sun's light energy will focus on the sensitive nerves at the back of your eye and burn them, causing blindness. This is like burning wood with sunlight through a magnifying glass.



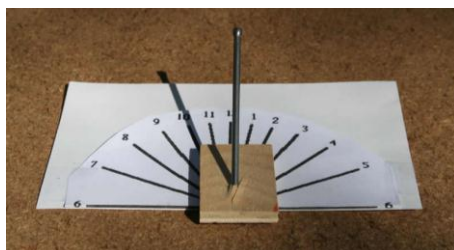
Scientists use special equipment and filters to study the Sun.



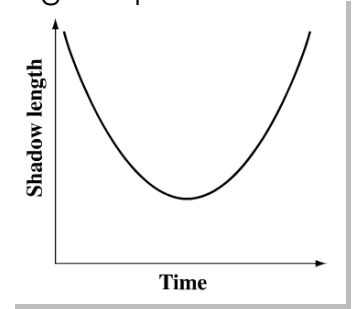
- The Earth rotates on its axis
- It takes 24 hours (one Earth day) to make a full rotation.
- The Earth's rotation makes it **seem** like the Sun rises in the east, moves through the southern part of the sky (if you are in the northern part of the planet) and sets in the west. The Sun isn't really moving like that.
- This path creates shadows that are long early in the morning, short in the middle of the day and long at sunset (and each length in between).
- You can judge the time of day based on the length of a shadow. This is how a sundial works.

The part of the sundial that makes the shadow is called the 'gnomon'.

To work best, a sundial must be designed for a specific place on the planet and adjusted for the time of year.



- The shortest shadow will always happen when the Sun is at its highest position in the sky. This is called 'solar noon' (may or may not be 12:00).
- If you graph the length of a shadow over a day, the graph will be shaped like a 'U'.
- The Earth rotates around an imaginary line called its axis.
- The Earth's rotation also makes it seem like the stars move through the night sky.



This picture is taken with the camera shutter left open all night.

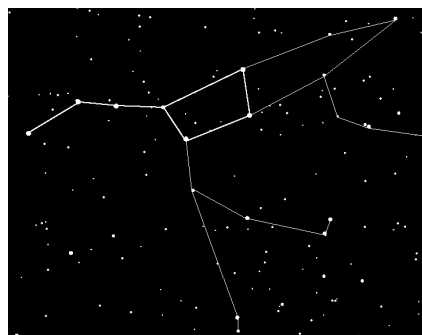
In the middle is the star Polaris (also called 'the North Star'). It is in the middle and doesn't seem to rotate much because the Earth's axis from the northern hemisphere happens to point towards it. Polaris is directly above the Earth's North Pole so it is always in the north part of the sky. If you can find it you can judge direction by it.



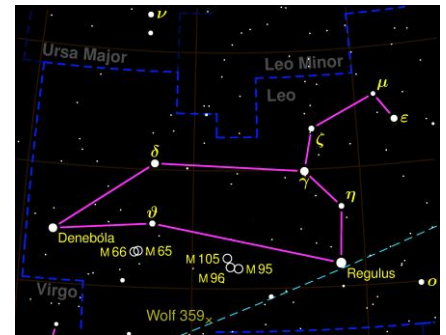
- Imagined pictures on groups of stars are called constellations. There are many stories and myths about them.



Orion - The Hunter



Ursa Major (The Great Bear)



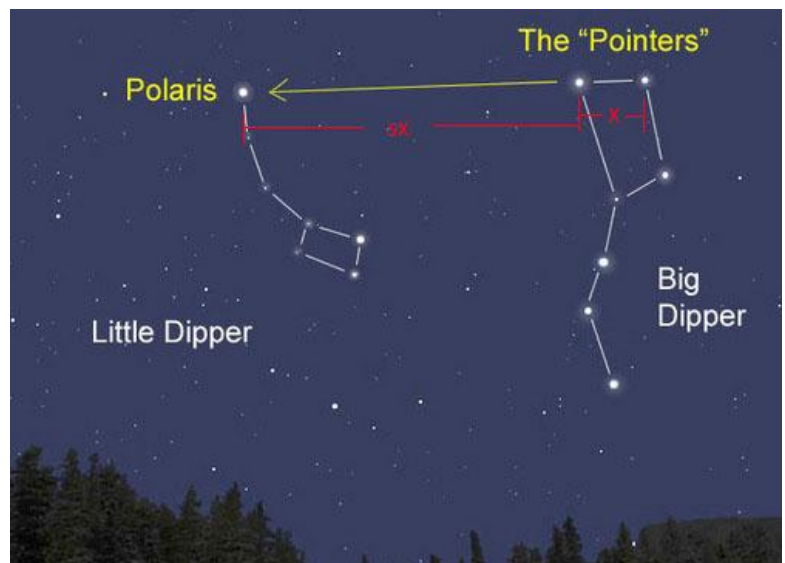
Leo (The Lion)

Several constellations are the basis of 'astrology' but that is NOT a science.

Astronomy is the branch of science that deals with celestial objects and space and the universe.

The 'Big Dipper' is part of Ursa Major. The stars that make the edge of the Big Dipper can be used as pointer stars. The line they make points towards Polaris (The North Star). Polaris happens to be part of the constellation Ursa Minor (The Little Bear).

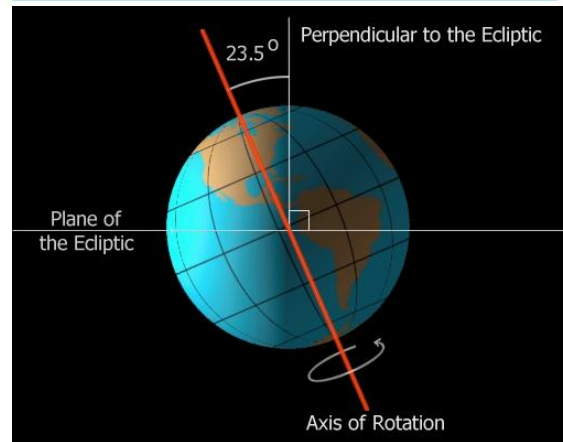
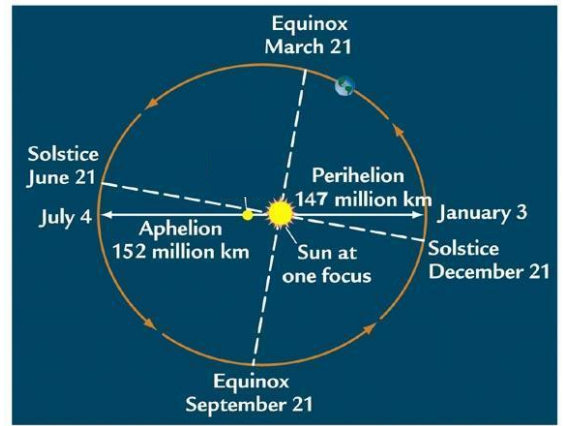
Constellations also seem to change position in the sky over different times of year.



THE REASON FOR THE SEASONS

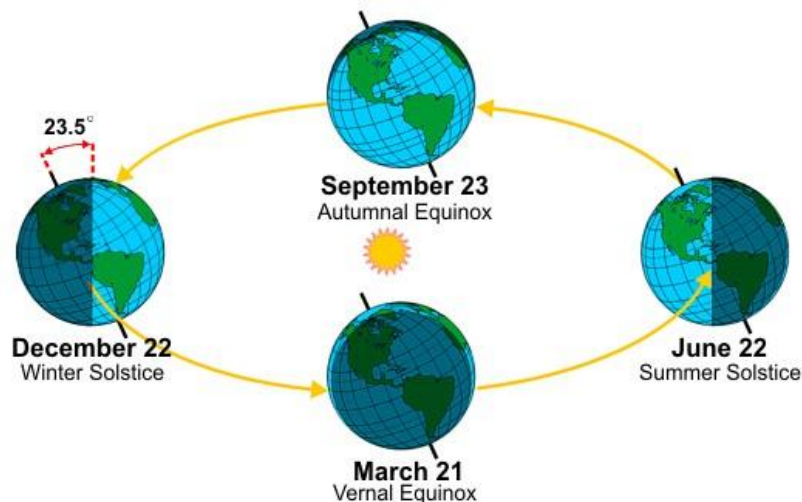
The distance between the Earth and the Sun DOES NOT cause the seasons. In fact, for the northern hemisphere, Earth is **closer** to the Sun in the winter.

- The Earth revolves (orbits) around the Sun.
- It takes 365.25 days (one Earth year) to complete an orbit. The extra 0.25 ($\frac{25}{100}$ or one-fourth) of a day adds up every four years to make an extra day. To keep the calendar accurate, we adjust by putting the extra day at the end of February and call it a 'leap year'.
- The Earth's axis is tilted 23.5° off the perpendicular to the plane it travels in around the Sun. This plane is called the 'Plane of the Ecliptic'.
- The revolution and the tilt of the Earth tips different parts of the planet towards and away from the Sun. This creates seasons.



Season	Canada is tilted	Sun in the sky	Sun up for	Temperatures
Summer	Towards the Sun	high	Long time	Hot
Winter	Away from the Sun	low	Short time	Cold

Seasons are also affected by the complicated processes of weather.



This diagram is for the northern hemisphere. Season are opposite in Southern hemisphere (Australia for example). Countries around the equator don't have much difference of seasons.

Winter Solstice: The Sun is lowest in the sky. Least amount of sunlight. Shortest day of year.

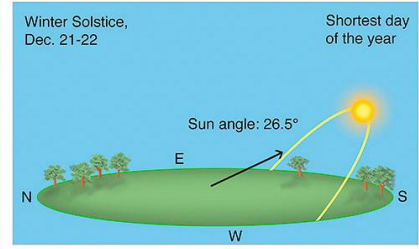
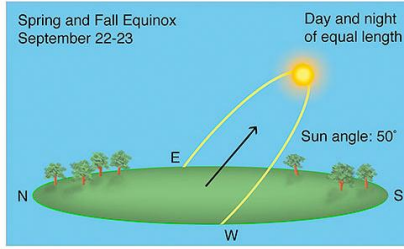
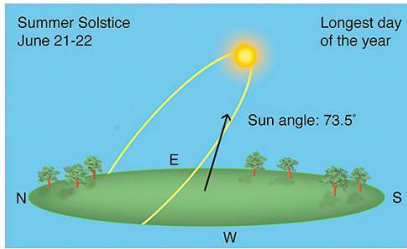
Summer Solstice: The Sun is highest in the sky. Most amount of sunlight. Longest day of year.

"Sol - Stice" means "Sun stands still"

Autumnal and Vernal (Spring) Equinox: Day and night are the same length of time.

"Equi-Nox" means "Equal night"

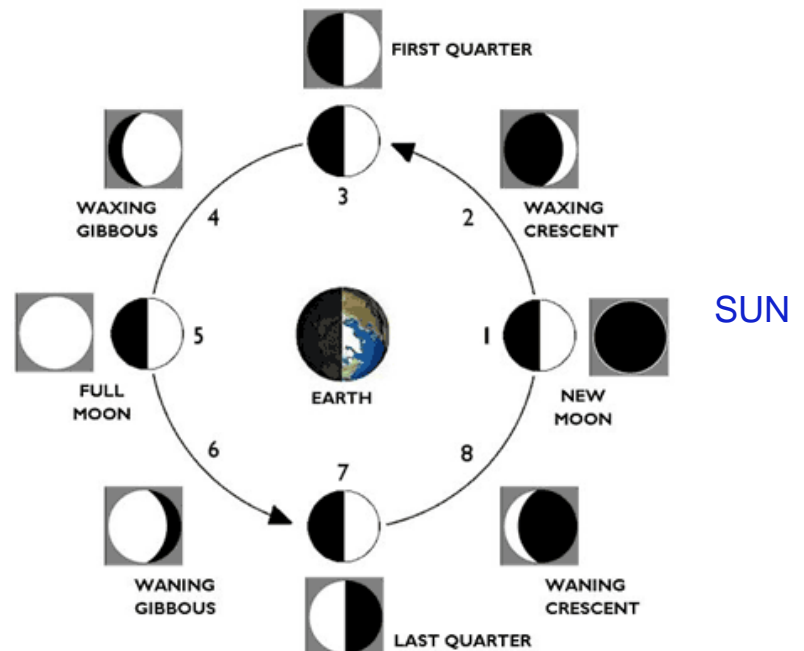
- In the Northern hemisphere, during the winter, the Sun seems to travel across the sky very low. During the summer, the Sun seems to travel across the sky very high.
- Solar noon on the Summer Solstice is the **highest** the Sun ever seems to get in the sky.
- Solar noon on the Winter Solstice is the **lowest** the Sun ever seems to get in the sky.



- The Earth's natural satellite is called the Moon.
- The Moon revolves (orbits) the Earth.
- It takes the Moon 28 Earth days (about a month) to orbit the Earth once.
- The Moon rotates (spins) at the same rate that it orbits the Earth. This causes one side of the Moon to always face towards Earth. This is called the Near Side. We can't see the Far Side from Earth.



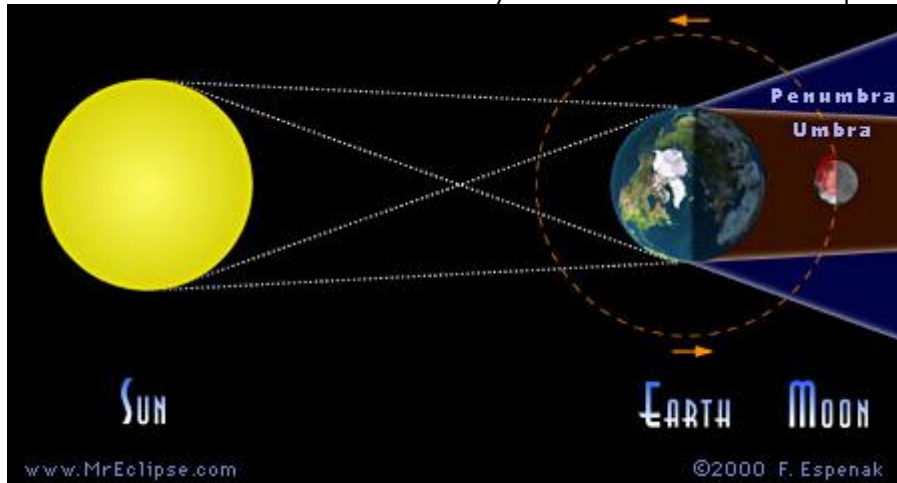
- The Moon reflects the Sun's light. It doesn't make its own light.
- Depending on where the Moon and the Sun are, shadows on the Moon make it look different. These are called the phases of the Moon.



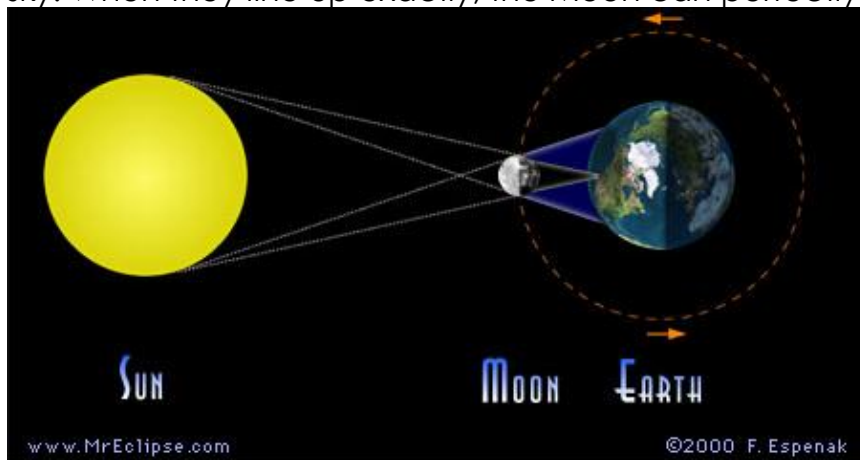
Waxing means getting brighter.
Waning means losing energy or getting dimmer.

When the Sun, the Earth and the Moon are in special positions there can be an eclipse. These are special occasions that only happen a certain times and can only be seen from certain places on Earth.

A **lunar eclipse** happens in the order Sun – Earth – Moon when the Earth's shadow blocks the Moon. Sunlight passing through the Earth's atmosphere causes a reddish colour on a Full moon. Not every Full Moon is lunar eclipse. They must line up just right.



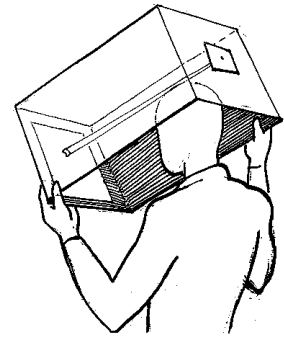
A **solar eclipse** happens in the order Sun – Moon – Earth when the *disc* of the Moon blocks the *disk* of the Sun. There can be a partial solar eclipse or a total solar eclipse. These do not happen everywhere in the universe. It is an amazing coincidence that the circular face of our Sun is about 400 times larger than the circular face of our moon **and** the Sun is about 400 times further from the Earth than the Moon is. The result is, from Earth, the Sun and the Moon appear to be the same size circle in the sky. When they line up exactly, the Moon can perfectly cover the Sun.



<p>Solar eclipse beginning</p>	<p>Almost fully covered. This is called the 'Diamond Ring'</p>	<p>Total solar eclipse. The Moon perfectly covers the Sun. The Sun's corona is visible.</p>	<p>The Moon's shadow on the Earth during a solar eclipse. People in the middle of the shadow could experience a total solar eclipse.</p>

Never look directly at a solar eclipse. Although it seems dark, there is still light energy from the Sun's corona that can damage eyes.

A pinhole camera can safely show the process.



- There are eight planets in our solar system.
- In order from the Sun they are:

SUN	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune
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A way to remember it is with the first letter of

“My Very Easy Method Just Simplified Us Naming planets”

(Pluto used to be considered a planet)

Each planet is very unique.

- The four inner planets are rocky planet. The four outer planets are called ‘gas giants’.
- All the gas giant planets have rings made of ice and dust. Saturn has the largest rings.
- The distance from the Sun (larger orbits) causes longer years on each planet. For instance, one year on Mars is the same as 687 Earth days or 1.88 Earth years.
- The length of day/night (rotation) is different on each planet.
- Planets have different amounts of moons (natural satellites).
- Mercury and Venus don't have any moons. Jupiter has around 63 moons.
- The planets from smallest to largest (not counting rings) are:

Mercury	Mars	Venus	Earth	Neptune	Uranus	Saturn	Jupiter
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The force of gravity is linked to the mass of an object. Each planet (and moon) has it's own gravitational pull. You would weigh different amounts depending on where you were.

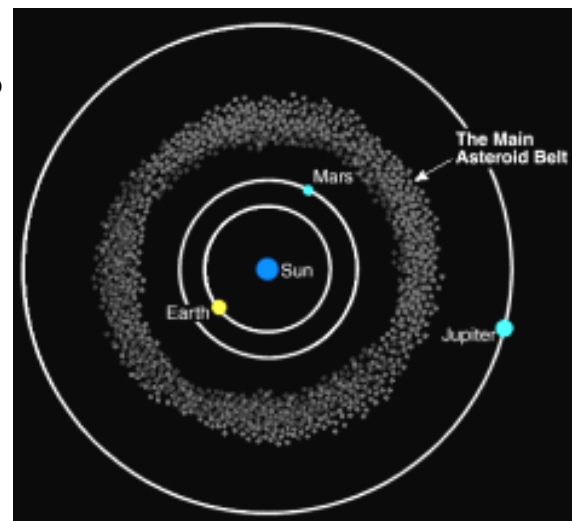
Pluto is a ‘dwarf planet’. Dwarf planets act a little differently than the other planets. Other dwarf planets include: Ceres (between Mars and Jupiter), Eris and Makemake (further out than Pluto).

- There is an asteroid belt of rocks between Mars and Jupiter that orbits the Sun.
- Meteoroids are space rocks outside of the asteroid belt that orbit the Sun.



- Meteors are meteoroids that enter the Earth's atmosphere and burn up from the heat of friction (going from the vacuum of space to the gases of an atmosphere). They get a long flaming tail and are also called ‘shooting stars’.

- The Earth's atmosphere is like a shield.



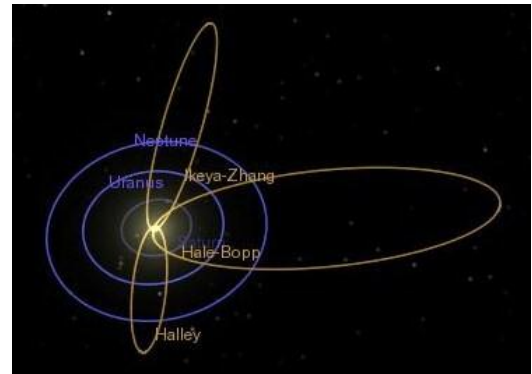
- Meteorites are meteors that don't totally burn up in our atmosphere and hit the ground (make a crater).



Comets travel through space in long elliptical orbits around the Sun. We can only see them from Earth after long periods of time.



Comets are mostly made of ice. They are like dirty snowballs. When they get close to the Sun, waves of heat and radiation melt the ice and send a long tail away from the Sun.



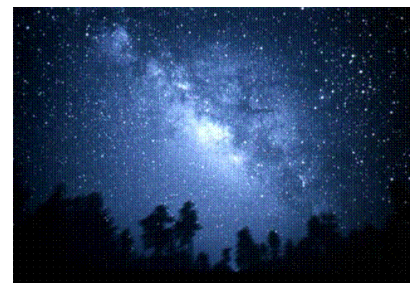
Halley's Comet is a famous comet (its return was predicted by astronomer Edmond Halley in 1705). It returns every 75 years.

Halley's Comet last appeared in the inner Solar System in 1986 and will next appear in mid-2061.

A galaxy is a large system of stars and solar systems held together by gravity and isolated from similar systems by vast regions of space. They can be spiral, elliptical or irregular in shape.



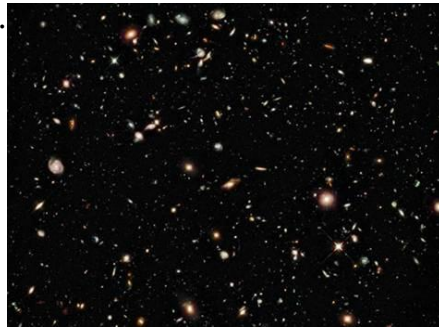
We are part of the Milky Way galaxy. The name is because we can see part of it in the night sky as a lighter band of stars (like spilled milk).



We can't take a picture of our entire galaxy but can figure out it is a spiral galaxy because of the way it behaves.

Our solar system is in an outer arm of the spiral.

The Hubble Space Telescope took a picture of one spot of deep space that shows thousands of galaxies.



There are lots of ways to learn about space

- **Telescopes** – lenses to make things look bigger. Different filters can show different things. The higher and further from the city the better one can see. They are often up on mountains.
- **Space Telescopes** – Mr. Hubble had the idea to put a big telescope in space orbiting the Earth. It avoids the distortion of looking through an atmosphere. It can see things very far away.
- **Radio Telescopes** – receive radio frequencies from space – give information.
- **Space shuttles** – get humans up into space for experiments
- **Space stations** – orbiting laboratories for people to live and work in zero gravity.
- **Satellites** – machines that orbit the Earth to gather and send information
- **Space Probes** – robots that fly to far parts of space to gather photos and information and send it back to Earth. Some land on other planets.

Space is really, really, really big. No even bigger than that! In fact, it's expanding and getting bigger even as you are reading this.

In our solar system distances are measured in Astronomical Units (AU) – One AU is the average distance from the Earth to the Sun. (about 150 000 000 kilometers).

Further distances are measured in light years – the distance light travels in one earth year.

The speed of light is about 300 000 km in one second.

So in one earth year, light will have travelled almost 10 trillion kilometers (10 000 000 000 000 km).

For example:

- the second closest star to Earth (the Sun is the closest) is Proxima Centauri. It is 4.2 light years away.
- the diameter of the Milky Way galaxy is estimated as 100 000 light years.
- Many stars you see in the night sky are often hundreds of light years away. What you see is how they looked hundreds of year ago. The night sky is like a time machine – looking back into the past.

The universe is full of many mysteries waiting to be discovered and explained by science.