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Types of Planets

There are two types of planets in our solar system: **Terrestrial Planets** and **Gas Giants**.

Terrestrial planets are planets made of rock and metal. Many of them have an inner molten core of metal surrounded on the outside by a rocky mantle and crust. This means that there is a surface to walk around on, like on Earth. In our solar system, these planets reside within the asteroid belt and are closer to the Sun. These planets are smaller in comparison with Gas Giants.

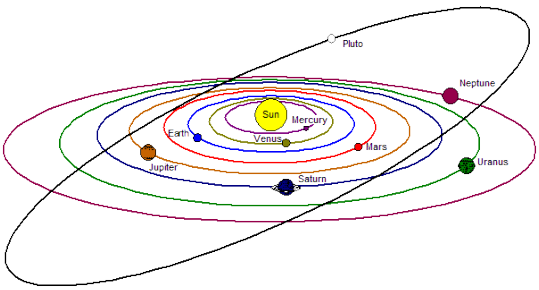
Gas giants, as their name suggests, are planets made almost entirely of gas. New data from satellites suggests that they have an inner core which the gas surrounds. These planets are massive in size since gas isn't very dense and takes up more space than rock.

Main Moons

Most of the planets in the solar system have moons. Some planets, like the gas giants, have many moons. However, most of these moons are too small to be of any major importance. There are only 7 moons large enough to be considered by scientists as a main moon. These main moons are our **Moon**, **Callisto**, **Europa**, **Ganymede, Io, Titan,** and **Triton**.

The Ecliptic

All the objects in our solar system, including the planets, moons, and belts, orbit around the Sun in a roughly equal plane. As you can see in the photo, all the planets are basically in the same field while they orbit the Sun. This is called the Ecliptic.



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Planets of Our Solar System

Mercury

- Closest planet to the Sun, the first terrestrial planet.
- Named after the Roman messenger god, who was also called Hermes in Greek.
- Looks like the Moon, barren, gray, and boring. It is also the smallest planet in the solar system, since Pluto is no longer considered a planet.
- One side of the planet gets blasted by the Sun's rays, the other side receives none of them. This makes one side very hot and the other side bitterly cold.
- **Largest temperature range of any planet** due to the difference between the two sides.
- Mercury has no moons due to it being so close to the Sun. Mercury's gravity is not enough to hold a moon. The Sun's gravity would swallow any moon Mercury has.

Venus

- Second planet from the Sun, second terrestrial planet.
- Named after the Roman goddess of beauty, who was also named Aphrodite in Greek.
- Its atmosphere is super dense, 98% of it is composed of Carbon Dioxide. This atmosphere creates massive pressure as well as trapping lots of heat.
- This makes **Venus the hottest planet in the solar system**, hot enough to vaporize lead.
- Lots of volcanic activity, making it **the most volcanically active planet** in the solar system.
- The vaporized lead in the atmosphere can condense and crystallize at the poles, snowing down as the mineral Galena.
- Like Mercury, Venus has no moons of any kind. Scientists are not sure why.

Earth

- Third planet from the Sun, third Terrestrial planet.
- Is **one of the only planets with liquid water at the surface and the only one within the Goldilocks zone.**
- Because of our liquid water, we are one of the only bodies in the solar system to have a water cycle.
- The only planet in our solar system known to have life.
- The Earth has one moon, simply called “the Moon”.
- **The Sun has much more of a gravitational effect on the Earth than the Moon does**.
- Earth’s atmosphere is composed mostly of Nitrogen, followed by Oxygen. Carbon Dioxide makes up very little of our atmosphere, less than 0.1%.

Mars

- The fourth planet from the Sun, fourth terrestrial planet.
- Named after the Roman god of War, who was also named Ares in Greek.
- Frequently called the Red Planet due to its red hue. The red hue comes from oxidized iron in the sand.
- Seems to have water ice on the planet at the poles. May have water ice under the surface as well.
- **Home of the tallest volcano in the solar system, Olympus Mons**, which is considered an active volcano that may have erupted in the last few decades.
- Also **home to Valles Marineris, the deepest and longest canyon in the solar system**.
- The atmosphere is composed mostly of Carbon Dioxide but it is so thin that it could not retain any heat.
- Mars has two moons, Phobos and Deimos, although neither are large enough to be considered main moons.

Jupiter

- The fifth planet from the Sun, first of the gas giants.
- Named after the king of the Roman gods, who was also called Zeus by the Greeks.
- Jupiter is the largest planet in the solar system, both in size and mass.
- Has a very distinct image due to the alternating bands of light and dark. This gives the planet a marbled appearance.
- Home of the Great Red Spot, a tremendous storm 3 times the size of the entire Earth. It has been going on for over 400 years, with no signs of stopping.
- The atmosphere of Jupiter is composed of 90% Hydrogen and almost 10% Helium.
- The intense pressure formed from all of Jupiter's mass can actually crush the Hydrogen down and turn it into a liquid deep inside the planet.
- Jupiter has 79 moons, only four of which are large enough for scientists to consider as important like our moon. **Those four are Europa, Ganymede, Io, and Callisto**.
- Jupiter may have diamonds that form in its atmosphere due to large Carbon levels. The massive pressure of the planet may crush atmospheric Carbon down into diamonds, which then fall downward like rain.

Saturn

- Sixth planet from the Sun, second gas giant.
- Named after the Roman god of time, who is also known as Kronos, the Titan god of Time in Greek.
- Saturn has a very distinctive appearance due to its large, shiny rings that surround the planet.
- **The rings are made up of billions of pieces of rock debris and are not one solid rocky ring**.
- The rings are 282,000 km across, but only 1 km wide, which means that they are proportionally thinner than a piece of paper or a razor blade.
- Its atmosphere is made up mostly of Hydrogen, 75%, and the rest is Helium, 25%, with some small trace elements. **This means that Saturn would float on water**.
- Like Jupiter, Saturn has many moons. But only one of them is large enough to be considered one of the main moons. **Titan is the only main moon of Saturn.**
- This planet has its own massive storm, which is located directly at its North Pole. This storm is shaped like a hexagon and is very well defined.
- Like on Jupiter, Saturn may have diamond rain due to the large amount of Carbon in the atmosphere and the massive pressure.

Uranus

- The seventh planet from the Sun, third gas giant.
- Named after the Greek god of the sky. The only planet to be named directly after a Greek god instead of a Roman one.
- This planet's color of soft green-blue looks like seafoam.
- The first of the planets in our solar system that are not really visible in the night sky. You'd have to have very good vision or binoculars on a clear, dark night to see it even faintly.
- It is **the first planet to be discovered with a telescope instead of simply seeing it in the night sky**.
- Uranus's atmosphere is made up mostly of Hydrogen and Helium, with some other trace elements like Methane, much like Saturn. However, Uranus would not float on water.
- **The largest moon of Uranus is Miranda**, although it has many other moons such as Oberon and Titania. These moons are named after Shakespeare characters. Miranda is not large enough to be considered a main moon.

Neptune

- The eighth planet from the sun, fourth and last gas giant.
- It is named after the Roman god of the sea, who is called Poseidon in Greek.
- At this time, Neptune is the last planet in the official solar system since Pluto was removed.
- This planet is very similar to Uranus. In fact, Uranus and Neptune have the same chemical composition. **The only difference is that Uranus's atmosphere is made up of 2% Methane while Neptune has 3% Methane**.
- **Scientists think that this 1% difference in Methane concentration leads to the difference in the planet's coloration**. Neptune is a deep blue color, unlike Uranus which is a seafoam green.
- This is **the first planet discovered entirely by math.** When astronomers looked at the orbital path of Uranus, they noticed it was not behaving as it should. They theorized that another large body must be pulling it slightly out of its orbital, which led to the search for and eventual discovery of Neptune.
- The **main moon of Neptune is Triton**, although it has other moons such as Hippocamp and Nereid, all of which are named after sea creatures from mythology.

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Pluto

- The ninth planet from the sun, **now not considered to be a planet**.
- Named after the Roman god of the underworld, who is called Hades in Greek.
- This planet is made mostly of ice and rock, which makes it much more like a comet or a terrestrial planet than like its neighboring gas giants.
- **Pluto is the first dwarf planet, a classification of planets that are too small to clear their path of debris**.
- This classification came about because as we discovered more and more small bodies like Pluto in our solar system, we would have either had to add them to the list of planets or take Pluto off the list. It is easier to take one planet off than it is to add 50 more.
- Surprisingly, Pluto has many moons, which are Charon, Kerberos, Nix, Hydra, and Styx. All of these are named either after things in the underworld or for monsters from Greek mythology.
- **Pluto was discovered in back in 1930 by accident**. Astronomers thought that Neptune, like Uranus, was not following its orbit properly and concluded that there must be yet another planet out there (remember, this is how Neptune was found). They looked for another planet and found Pluto, though it was far away from where they calculated and was much smaller than they expected.
- Since its discovery, Pluto has not made one full trip around the sun.

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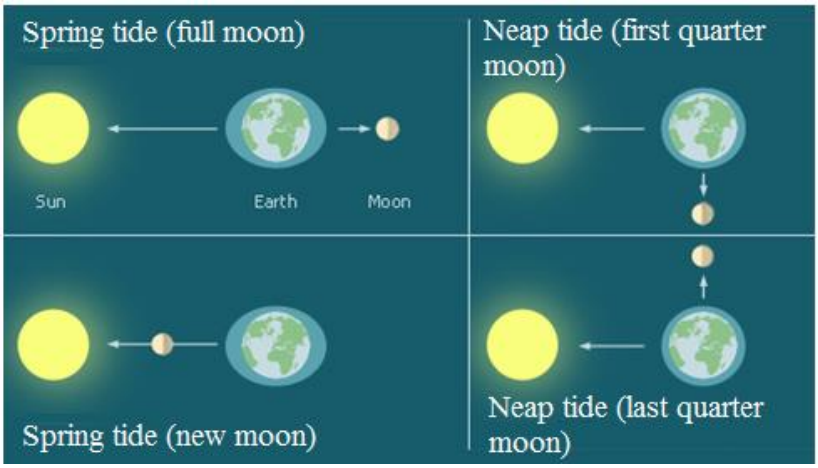
Moons of Our Solar System

Moon

- This is our moon. Contrary to popular belief, it is not called Luna or Lua. Astronomers simply call it “The Moon”.
- Our moon most likely was a part of our planet until another Mars-sized planet, called Theia, collided with the Earth, ejecting a large amount of mantle material into space. This material eventually formed our Moon.
- Our Moon will not be with us forever**. It is slowly drifting away into space at a rate of 3.78 cm a year**, which is about as fast as your fingernails grow.
- **Our Moon is tidally locked**, which means that it is rotating around its axis at the same speed as it revolves around the Earth. This makes it so that the same side of the Moon is always facing the Earth. We never get to look at the back side of the Moon.
- The Moon’s gravity exerts an influence on our tides, giving us both daily high and low tides but also monthly highs and lows that vary depending on time of the month.
- **The Moon and Sun are both responsible for Spring and Neap Tides, which occur bimonthly.**
- Spring tides (named for the “springing forward” of the tides and not the season) are tides created when the Sun and Moon are in alignment. This alignment happens during the full and new moons, when the Moon either sits between the Earth and the Sun (new moon) or when the Earth sits between the Sun and the Moon (full moon).
- Neap Tides (the opposite of Spring tides) are created when the Sun and the Moon form a 90 degree angle with the Earth. This pulls the water in two different directions and creates destructive interference, making lower tides.



Phobos

- The larger of Mars' two moons. Both Phobos and its sister moon Deimos are named after the children of Ares. Phobos is the Greek personification of Fear.
- This moon is doomed due to its inward spiraling progression. Essentially, Phobos is being pulled closer and closer to Mars at a rate of 1.8 cm per year. Eventually it will either be pulled down to the surface and crash land or it will be ripped apart and form rings around Mars.
- The planet already appears to be breaking apart due to gravity. There are many cracks and fractures in its surface.
- Phobos has a massive impact crater, showing that the small moon got hit hard by a meteor. It probably triggered many smaller impacts as well, since small pieces of the moon would have been flung into the air only to fall back down.
- Phobos is not large enough to be considered a main moon.

Deimos

- The smaller of the two moons of Mars. In Greek, Deimos is the personification of Terror.
- Unlike Phobos, Deimos is drifting away from Mars, much like our own Moon.
- It has also suffered many meteor impacts, but its gravity is not strong enough to keep much of the material that is ejected. Consequently it is covered in a lot of fine dust from pulverized rock but has little debris.
- Both Phobos and Deimos have nearly circular orbits, which means that they likely did not come from the nearby asteroid belt, although Deimos is somewhat similar in size to objects found in the belt.
- Deimos is also not large enough to be considered a main moon.

Io

- Of the four Galilean Moons of Jupiter, Io is the closest to the surface of Jupiter.
- The name Io comes from Greek Mythology, as she is one of the many wives of Zeus, who is also called Jupiter in the Roman mythology.
- **This moon is very volcanically active, the only known moon in our solar system to have volcanism**.
- **The volcanism of Io is caused by the tidal pull of Jupiter and the other main moons**. Jupiter's massive gravity pulls Io towards it while the gravity of the other moons pull Io away from Jupiter. The strain cause by this constant pulling in different directions creates friction and heat, causing the volcanism of the moon.
- Due to the volcanism, there is a lot of Sulphur emitted. This combines with oxygen to create Sulphur Dioxide, which freezes and creates snow. This moon can be described as a moon of fire and ice.

Europa

- The smallest of the main Jupiter moons, and the second closest after Io.
- This moon is icy, with the surface being covered in crisscrossed patches of ice. Scientists suspect that there is either liquid water or slushy ice underneath the hard shell.
- Europa has few craters, which indicates that the surface is relatively young. An explanation for the young surface is that if a powerful event, like a meteor impact or a particularly powerful icequake, were to split open the surface of Europa, the liquid water ocean that probably lies beneath the ice could well up and fill in the crack.
- The conditions of the underground ocean are not known, but many scientists suspect that this ocean could potentially support life.
- Europa also seems to have a magnetic field that is powerful enough to disrupt Jupiter's magnetic field, which was detected by the Galileo mission. This can only be explained if Europa has a liquid ocean beneath its surface. This is the best evidence we have that there is liquid water on Europa.

Ganymede

- **The largest of the main moons of Jupiter, and third closest.**
- **Ganymede is the largest moon in the solar system. It is larger than both Pluto and Mercury**.
- **It is the only moon in the solar system with its own magnetic field. This leads scientists to believe that it has its own metallic core at the center.**
- Ganymede had three layers to it: its inner metallic core, a layer of rock surrounding the core, and a layer of ice encasing the rocky layer.
- The outer ice layer seems to be quite thick, up to 800 km.
- **About 40% of the crust is heavily cratered, indicating that it is old. The other 60% is much lighter in color and has fewer craters. This surface has deep grooving in it, leading scientists to speculate that there is a lot of crustal movement that breaks up the surface and creates the grooves. Water could flow out of these grooves and constantly create new surface.**
- There is a thin atmosphere of Oxygen surrounding this moon, but not enough to sustain life.

Callisto

- The final of the main moons of Jupiter.
- It is the second largest of Jupiter's moons, after Ganymede.
- **This moon is the most heavily cratered object in our solar system**.
- Its surface is made of ice. Its has a dark surface scattered with lots of bright specks. Scientists theorize that these bright patches are fresh ice growths, whereas the darker sections are old, worn down ice.
- **If the bright patches are new ice, then it could be that Callisto has a salty liquid ocean underneath the icy surface that wells up creates new patches when a particularly large meteor breaks through the surface.**
- If there is an ocean beneath the ice, there is potential for water to be touching rock below the surface, which could produce life.
- **It has an atmosphere with Carbon Dioxide, Oxygen, and Hydrogen**.

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Titan

- Titan is the only main moon of Saturn, although it is not the only moon of Saturn.
- **Titan is the second largest moon in the solar system after Jupiter's Ganymede**. It is larger than Earth's Moon and larger than mercury.
- Titan has a thick atmosphere which contains primarily Nitrogen and Methane. This is the only other body in the solar system with a liquid cycle, like the Earth's water cycle.
- Titan's liquid cycle is composed of Methane. This Methane forms the lakes, rivers, and streams on Titan's surface. There is also some evidence that there is a liquid Methane ocean beneath the icy surface. There is also evidence that the ocean could be liquid saltwater.
- Titan also seems to be very Earth-like in that it could have "volcanic activity", although not in the same way as Earth. Titan's Icy surface acts like rock and its potential underground ocean works like the magma. It can erupt through cracks in the surface and build up mountains.
- Titan also appears to have deserts, covered in hydrocarbon "sand", which appears very dark in photos. The grains can be described to be "like coffee grounds".
- The hydrocarbons that act like sand actually come from Titan's upper atmosphere, where Nitrogen, Methane, and other trace elements combine and split apart due to the Sun's rays. Sometimes they form hydrocarbons, which then float down to the surface.
- The atmosphere of Titan is quite thick and is hard to see through. This is in part due to the large amount of gaseous Methane in the air.
- The atmospheric Methane is a little bit of a puzzle to scientists. Methane breaks down in the atmosphere due to the Sun's rays, but the concentration levels have not gone down over the years. This leads scientists to theorize that there is something on the surface or under it that produces new Methane that can escape into the atmosphere. This could be considered evidence that there is life on Titan.

Enceladus

- Another moon of Saturn, although much smaller than titan and is not considered to be a main moon.
- Enceladus is yet another icy moon, but Enceladus is confirmed to have a liquid ocean beneath the outer icy shell.
- Enceladus has massive geysers that spew water from its hidden ocean into the atmosphere.
- Most of this water ejected from geysers returns to Enceladus in the form of snow, but some of it makes its way into the E ring of Saturn as frozen droplets. This means that by studying the material in the E ring of Saturn, we can analyze the ocean of Enceladus.
- The water samples that we analyze in Saturn's ring shows the presence of some silicas, which only form when boiling water interacts with rock. This leads scientists to believe that Enceladus has a rocky core that is in contact with the water from the ocean. Moreover, they also conclude that there must be volcanic vents in the rocky crust that heat up the surrounding water, creating the silica that we find in the ice samples from Saturn's ring.
- Because of the presence of liquid water, the presence of silica, and the presence of other minerals found in ice samples, scientists believe that Enceladus could harbor some sea life.
- The surface of Enceladus is quite cold, -330 degrees F. The moon is so cold because it constantly creates snow that falls onto its surface, which creates the brightest and most reflective surface in the solar system. This bright surface reflects most of the sunlight that it receives, which lowers the temperatures even more.

Triton

- Triton is only large moon of Neptune out of the planet's 13 moons.
- Triton is the only moon in the solar system that has a retrograde orbit, which means it orbits around Neptune in a direction opposite to Neptune's rotation. All other moons in the solar system follow their planet's rotation.
- Triton is tidally locked with Neptune, just like our Moon is tidally locked with Earth. That means that the same side of Triton is always facing Neptune.
- The density of Triton is double the density of water, which means that it has a much larger rocky core than that of most of the other satellites in our outer solar system.
- The atmosphere of Triton is mostly made of Nitrogen. Because the moon is so cold, the small amount of Nitrogen frosts onto the planet's surface, creating an icy, reflective surface like that of Enceladus, although not as reflective.

Pluto's Moons

- Pluto's 5 moons are Chiron, Nix, Hydra, Kerberos, and Styx.
- All of Pluto's moons are named after things from the underworld.
- Scientists theorize that Pluto's moons are a result of Pluto's collision with other Kuiper Belt objects. These collisions broke off chunks of debris from both objects and this debris coalesced into the 5 moons that orbit Pluto today.
- Chiron, named after the ferryman of the river of the dead, is about half the size of Pluto. This causes some scientists to refer to Chiron and Pluto as a two-planet system.
- Because Pluto is so small, it is amazing that it is able to hold any moons at all. The orbits of these moons are tight and neat, which is strange given that Pluto's gravity is so small.
- There is very little to say about the rest of the moons of Pluto. They are mostly just like asteroids; they do not even have enough mass to become rounded. Kerberos, Hydra, and Styx have odd, random shapes because they cannot pull themselves in enough due to their lack of gravity.

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Belts in our Solar System

When our solar system formed, it was filled with rocky and icy debris. Eventually, most of this debris either coalesced into our planets or got tossed out of our solar system by the planets. **One of the requirements to be considered a planet as opposed to a dwarf planet is that a planet must clear its orbital path of debris.** (This is one of the reasons that Pluto is not considered a full-fledged planet.) Over time, the planets either assimilated the debris in their path or flung it out into space. But in two areas in our solar system, this did not happen. These two areas are the Asteroid Belt and the Kuiper Belt.

Asteroid Belt

- The Asteroid belt is mainly composed of rocky material, the same rocky materials that make up Mercury, Venus, Earth, and Mars. These are the leftover scraps that never formed into anything.
- **The Asteroid Belt lies between Mars and Jupiter**, kind of like a marker between the Terrestrial Planets and the Gas Giants.
- Unlike movie depictions of asteroid fields, the materials in them are scattered far apart, with wide gaps between the rocks. It would be quite easy to pilot a ship between all of the rocks.
- The total amount of mass in the Asteroid belt is smaller than that of our Moon.
- The debris in the Asteroid field cannot coalesce into any large body because the immense gravity of Jupiter on one side and the gravity of Mars on the other side will rip apart anything that becomes too large.
- The asteroids in the belt are usually composed of rock, but can also contain metals, like nickel and iron, as well as ices. Some of these asteroids are large chunks of solid material, like a large boulder. Others are massive piles of debris held together by gravity, like a landslide of small rocks glued together.

Kuiper Belt

- The Kuiper Belt (pronounced like viper but with a K at the front) is much like the Asteroid Belt, but the objects in in the Kuiper belt are much icier than the objects in the Asteroid Belt. Kuiper belt objects are usually more ice than rock.
- Like the Asteroid belt, the Kuiper Belt could have coalesced into another planet or moon, but the gravity of a neighboring planet, in this case Neptune, stopped its progress. Neptune's gravity is still breaking up any objects that become too large.
- **The Kuiper Belt begins between Neptune and Pluto and stretches beyond both of them**, although scientists didn't realize this for quite some time. Pluto is very likely a Kuiper Belt object that was far enough outside Neptune's orbit to begin to coalesce into a dwarf planet. Astronomers discovered Pluto in 1930, but expected it to be alone, and thus were not looking for its source, which was the Kuiper Belt.
- The Kuiper Belt is one of the sources of comets in our solar system. It occasionally flings comets our way. These comets are Short Period comets, because they come around every couple of years. These comets are usually found near the ecliptic, which is the orbital plane that all of the planets of the solar system revolve in.

The Oort Cloud

- The Oort Cloud is where scientists think that most Long Period comets come from.
- The Oort Cloud has never actually been observed, but it is thought to be a very large field of debris far outside the orbit of Pluto. The Oort Cloud is kind of like a spherical outer shell to our solar system, like a giant balloon with us inside.
- The Long Period comets fly through our solar system in random directions, since they can originate from above or below the ecliptic. Thus, these comets are completely random and are easy to distinguish from comets originating in the Kuiper Belt.
- The Oort cloud has many different zones in it based on how objects in those zones interact with the gravity of our solar system. The inner zones can be directly affected by the gravities of planets like Jupiter, Saturn, and Neptune. The outer zones barely react to the planets at all, and the outer layers can actually escape the Sun's gravity and fly off to other systems.
- Scientists believe that the total mass of the Oort Cloud could be 100 times that of the Earth, which is a lot of mass.

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The Sun

- The Sun lies at the center of our solar system. Its gravity is what holds the system together, pulling all the debris in space towards it. This debris can be as small as dust particles or as large as Jupiter.
- The Sun is a giant burning ball of mostly Hydrogen and Helium. **The Hydrogen in the sun is undergoing nuclear fusion at the core of the Sun, turning from Hydrogen into Helium.**
- **The Sun holds 99.8% of the entire mass of the solar system**. All of the planets combined, all of their moons, and all of the random floating objects make up just 0.2% of the mass in our solar system.
- The Sun is considered to be an average star, although only because it is the first star we could study and is the standard blueprint that we judge all other stars by.
- **The Sun has many layers to it, which are the Core, the Radiative Zone, the Convective Zone, the Photosphere, the Chromosphere, and the Corona.**
- The Sun occasionally develops sunspots on its surface, which are relatively cooler, darker zones on the Sun's surface. These sunspots can have quite an effect on the Earth's climate, often causing cycles of warming and cooling on their own.
- The Sun has a magnetic field that twists and changes in intensity, being anywhere from only 2 times as strong as the Earth's magnetic field to over 3000 times as strong. These changes are due to the Sun's different rotational speed between its equator and the poles. The equator makes a full rotation in less time than the poles do, and this difference can twist and distort the magnetic field.
- The Sun's magnetic field throws off the solar winds, streams of particles and magnetic distortions that fly from the Sun out into the solar system. Our own magnetic field deflects most of the particles, but the few that make it through can get trapped at the poles and become the Auroras that we see.