**Science Reviewer**

**Space and Beyond**

**Introduction:**

* **Star System** – Is a group of planets, meteors, or any other heavenly body that orbits around a large star.
* **Big Bang Theory** best describes the formation of the universe. This theory was proposed by **Georges Lemaître**. The universe came from a single particle that exploded billions of years ago and is continuously expanding up until this day.

**Big Bang Theory:**

* **The Big Bang Theory** – A theory **explains that the universe began around 13.8 billion years ago from an extremely hot, dense point that violently expanded, creating all matter**, energy, space and time.
* This **expansion continues today and observations of galaxies moving away from each othe**r and the presence of cosmic microwave background radiation strongly support the theory.
* As **the universe expanded and cooled**, **elementary particles formed**, which **later combined to create the first atoms**, paving the way for the formation of stars and galaxies.

**Origins of the Solar System:**

* **It is uncertain how the solar system was formed**. Despite coming from the debris of the Big Bang theory, the Solar system is much younger than the universe. The Sun is the center of the solar system.
* **Accretion Hypothesis** – Billions of years after the Big Bang, the **Sun emerged from an interstellar cloud** and was **surrounded by a dusty and gaseous envelope**.
* This hypothesis also explained that **the planets were formed through gravitational attraction of the particles**.
* **Encounter Hypothesis** – It proposes that **around 5 billion years ago**, **a rogue star passed by the Sun**. **Hot gases from the star and the Sun were stripped**.
* These materials then **clumped together eventually formed the planets**.
* This hypothesis **explains why the planets can revolve around the same direction**.
* **Nebular Hypothesis** - It proposes the idea that during the formation of the Solar system, **a cloud of dust started to contract due to the strong gravitational attraction between its particles**.
* As the **dust cloud continuously contracts**, a **flattened into a protoplanetary** **disk**, which eventually became our **Solar system**.
* Also, based on this hypothesis, **the majority of the materials in this spinning nebula are located in the center**.
* **Protoplanet Hypothesis** –It proposes that the **Solar system was formed through an interstellar cloud that is mainly composed of light elements**, that starts to condensed.
* **Most commonly accepted** hypothesis, uses the concepts from the Nebular hypothesis and concepts of matter and fluid mechanics.
* As the central region contracted, it starts to rotate more rapidly, forming planetesimals.
* **Planetesimals** – Are minute heavenly bodies that **can form planets** through accretion.
* **Terrestrial Planets** – Planetesimals **closer** to the developing **Sun** containing **heavier** elements.
* **Jovian Planets** – Planetesimals **father away** than the developing **Sun** containing **lighter**, gaseous elements.
* **Nebular Hypothesis (Immanuel Kant Pierre-Simon Laplace – 18th Century)** – Suggests the solar system formed from a large rotating cloud of gas and dust (**nebula**). Gravity caused the nebula to contract, spin faster and flatten into a disk.
* The Sun formed at the center, while planets condensed from material in the surrounding disk.
* This is the basis of the modern accepted model (the Solar Nebula Theory)
* **Summary: Solar system formed from a large rotating nebula of gas and dus**t, sun formed at the center, planets from the disk.
* **Tidal Hypothesis (James Jeans and Harold Jeffreys – Early 20th Century)** – Suggested that a **near collision between the Sun and another star created huge tidal bulges**. These bulges were torn off and later cooled and condensed into planets.
* **Problem**: The **ejected matter would disperse quickly** instead of condensing.
* **Summary:** A **near-collision between the Sun and another star pulled out tidal matter** that later formed planets.
* **Planetesimal Hypothesis (Thomas Chamberlin and Forest Moulton – Early 20th Century) –** A **passing star pulled matter from the Sun**. The matter **broke into small solid bodies** called planetesimals**. Planets formed by the gradual accumulation of these planetesimals**
* **Issue:** Same as the Tidal Hypothesis – unlikely condensation of ejected materials.
* **Summary:** A **passing star drew out solar matter**, which **broke into planetesimals**; **planets formed** by accretion of these small bodies.
* **Modern Solar Nebula Theory (Viktor Safronov and Later Astronomers – Mid to Late 20th Century)** - An **updated form of the Nebular hypothesis** states that. The **solar system began 4.6 billion years ago from a rotating nebula of hydrogen and helium** plus heavier elements
* Gravity caused the cloud to collapse into a spinning disk.
* The sun formed at the center.
* **Dust and gas in the disk stuck together to form planetesimals** – protoplanets – planets
* **Solar wind cleared away leftover gas**, leaving the present-day solar system.
* **Summary**: Solar system **formed from a collapsing nebula**; Sun at the center, planets from accreting dust and gas in disk; solar wind cleared leftovers.

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| **Hypothesis** | **Proponents** | **Key Ideas** | **Weaknesses** |
| **Nebular Hypothesis (18th century)** | Immanuel Kant, Pierre-Simon Laplace | Solar system formed from a large rotating nebula of gas and dust; Sun formed at the center, planets from the disk. | Could not fully explain the angular momentum distribution (why planets have most of it while the Sun has little). |
| **Planetary Collision Hypothesis** | Georges Buffon | A comet or star passed close to the Sun, pulling out material that condensed into planets. | Hot gas would disperse rather than condense; such close encounters are extremely rare. |
| **Tidal Hypothesis (early 20th century)** | James Jeans, Harold Jeffreys | A near-collision between the Sun and another star pulled out tidal matter that later formed planets. | Same issue as Buffon’s idea—material would dissipate, not condense. |
| **Planetesimal Hypothesis (early 20th century)** | Thomas Chamberlin, Forest Moulton | A passing star drew out solar matter, which broke into planetesimals; planets formed by accretion of these small bodies. | Still relied on rare stellar encounters; matter unlikely to condense effectively. |
| **Protoplanet Hypothesis (mid-20th century)** | Otto Schmidt | Sun formed first; later captured interstellar gas and dust into a disk; planets grew from protoplanets. | Did not fully explain how captured material would settle into stable orbits. |
| **Modern Solar Nebula Theory (20th century – present)** | Viktor Safronov, refined by later astronomers | Solar system (4.6 billion years ago) formed from a collapsing nebula; Sun at center, planets from accreting dust and gas in disk; solar wind cleared leftovers. | Most accepted today, though details about planet migration and early dynamics are still studied. |

**Components of the Solar System**

**Components of the Solar System:**

* **Solar System** – **Composed of different heavenly bodies** formed through the remnants of the interstellar nebula where the Sun was born.
* **Planet** – Large heavenly body that orbits the Sun. There are three conditions for a large heavenly body to comply to be considered as a planet.
* It must **orbit a star**
* It **must be big enough to have enough gravity** to force it into a spherical shape
* It **must be big enough that its gravity clears away** any other objects of a similar size near its orbit around the Sun
* **Terrestrial Planets** – **Planets that have solid surfaces** and are made of **rocky material**. **Mercury, Venus, Earth and Mars** are terrestrial planets.
* **Jovian Planets (Gas Giants)** – **Planets that do not have a solid surface** and is primarily. **made of gases** **Jupiter, Saturn, Uranus and Neptune** are Jovian planets.
* **Dwarf Planet** – **Orbits around a star**. This celestial body is roughly spherical in shape and is relatively smaller than the planets. The five most well-known dwarf planets are Ceres, Pluto, Makemake, Haumea and Eris.

**Comets, Asteroids, Meteoroids, Meteors, and Meteorites:**

* **Comets (Dirty Snowballs)** – Are **heavenly bodies made up of frozen gases, rocks and dust** that were **left from the formation of the Solar system**. **Comets revolve around the sun** in a highly **elliptical orbit**.
* As the comet approaches the sun, the **frozen gases and ice will start to vaporize**, leaving a **jet of dust and gases called** the **coma** and surrounds the solid structure of the comet known as the nucleus. Solar winds cause tails to be produced. These **tails are known as ion tail and dust tail**.
* **Asteroid** – A **piece that is similar to the materials** that **formed** the **planets**. **Asteroids** are located in between the orbits of Mars and Jupiter known as the **asteroid belt**. Asteroids **have varying shapes and sizes**.
* **Ceres** – A **dwarf planet** located in the asteroid belt, is the **largest**.
* **Meteroid (Shooting Stars)** – A **part of the comet’s nucleus that was spread when it was orbiting**. It is a **piece of dust and rock**. However, **most** **meteoroids** that enter Earth’s atmosphere **are** **too** **small** and completely burn down.
* **Meteor** – When a **meteoroid enters Earth’s** atmosphere.
* **Meteorites** – Are **pieces of a meteor that reach the surface** of Earth.
* **Meteor Shower** – There are times when people would see a lot of meteoroids that **enter Earth’s atmosphere and create a spectacular sight**.

**Primary Parts of The Solar System:**

* **Sun** – The **central star of the solar system**. Contains about 99.8% of the total mass. Provides heat, light and energy that sustain life on Earth. Mainly made of hydrogen and helium
* **Planets** – Large celestial bodies that orbit the Sun, which hare divided into two groups:
* **Inner Plants (Terrestrial)** – **Small, rocky, dense with solid surfaces**. Mercury, Venus, Earth, Mars.
* **Outer Planets (Gas Giants and Ice Giants)** – **Much larger, mostly made of gas or ice** with ring systems and many moons. Jupiter, Saturn, Uranus, Neptune.
* **Dwarf Planets** – Smaller than planets but orbit the Sun directly. Not massive enough to clear their orbital paths.
* **Examples**: Pluto, Eris, Haumea, Makemake, Ceres
* **Moons (Natural Satellites)** – **Bodies that orbit planets or dwarf planets**. Earth’s moon is the most studied. Some moons (like Jupiter’s Europa and Saturn’s Enceladus) may have subsurface oceans
* **Asteroids** – **Rocky, metallic objects, mostly found in the Asteroid belt** between Mars and Jupiter. Vary in size from tiny rocks to hundreds of kilometers wide (like Ceres)
* **Comets** – **Made of ice, dust and rock**. **Originate from the Kuiper belt or Oort cloud**. When near the Sun, heat causes them to release gas and dust, forming a glowing coma and tail
* **Meteoroids, Meteors, and Meteorites:**
* **Meteoroids** – Small **rocky** or **metallic** **fragments** in space.
* **Meteors** – Meteoroids that enter Earth’s atmosphere, producing a streak of light (shooting stars).
* **Meteorites** – Remnants that survive and land on Earth’s surface.
* **Asteroid Belt** – **Region between Mars and Jupiter**. **Contains most asteroids**, remnants of early solar system material that never formed into a planet due to Jupiter’s gravity.
* **Oort Cloud** – A **spherical shell of icy objects** **surrounding the solar system**, very far beyond Pluto. Believed to be the **source of long period comets**

**Space Technologies**

**Space Travel and Exploration:**

* **Crewed Space Technology –** Is a type of technology that allows people to be in space while they study space beyond the confinements of Earth. Crewed space technology is a **type of space technology that needs human for it to function**.
* **Astronauts** – The **people who navigate space through crewed space technology**.
* **Spacecraft** – Any **vehicle designed for travel or operation in outer space.** B**road term that includes** satellites, probes, landers, rovers, shuttles, pods and stations. Voyager probes, Hubble Space Telescope, Apollo Lunar Module.
* **Space Station** – Is a **habitable location in space where astronauts and scientists reside** whenever they are in space. They use the space station as laboratories.
* **Space Pods** – Are **vehicles in space that astronauts use whenever** they are traveling short distances from the space station. They also **use this vehicle whenever they are fixing** some damaged areas of the space station.
* **Space Shuttle** - The **Space Shuttle** was a **reusable spacecraft developed by NASA** that looked like an airplane with rocket boosters, carrying **astronauts and cargo to low Earth orbit**. It completed **multiple missions** using orbiters like **Columbia, Challenger, Discovery, Atlantis, and Endeavor**.

**Space Travel and Exploration:**

* **Orbiter** – An **uncrewed spacecraft** designed to **enter and stay in the orbit** of another **heavenly body** in space. As orbiters approach their target, **rockets slow them down** to allow entry into orbit. They can **study a planet or moon for a long time**, using **onboard cameras** to **monitor changes in the atmosphere and surface**.
* **Low Earth Orbit (LEO)** – Located around **200 to 2,000 km** from Earth’s surface. Satellites here travel at a speed of **28,000 km/h** and can fully **orbit Earth in about 90 minutes**.
* **Medium Earth Orbit (MEO)** – Located around **20,000 km above Earth** and completes **one orbit every 12 hours**.
* **Geostationary Orbit (GEO)** – Located **36,000 km above Earth’s surface**, this **artificial orbit keeps satellites fixed over one location** on Earth.
* The common functions of artificial satellites include communication satellites, weather satellites, navigation satellites, Earth observation satellites and astronomical satellites.
* The data gathered by orbiters allow scientists to create detailed maps of planets. They do not reach the surface of the target.
* **Landers** – **Equipment designed to land on the surface** of a **planet, moon, or other body in space**, allowing for **direct study and data collection** from the surface. A lander can carry a rover.
* **Rover** – A **small vehicle** that comes out of a **lander** to **explore the surface** of a **planet or moon**. Both the **lander and rover** are equipped with **mechanical arms** used for **gathering rocks, dust, and soil samples**.