**Cosmology/Astrophysics**

Session 4: **The Solar System part 1**

This is a gravitationally-bound system, consisting of the Sun and objects that orbit it.

It is part of the Milky Way galaxy.

The Solar System was formed 4.5 billion years ago. Clues about its formation come from meteorites, its structure and from planet-forming systems around young stars. It would have formed from a cloud of dust and gas which collapsed to form a solar nebula (a spinning cloud of material), gradually pulled together by gravity to form a star in the centre, surrounded by a disc of material from which the planets and their moons formed. Left-over remnants are asteroids, comets etc.

Nearest to the sun are the 4 rocky planets, which could withstand the heat of the sun. Next are 2 gas giants and, further out, 2 ice giants.

**The Milky Way** is a spiral galaxy. Our sun and solar system are located in the Orion Arm (or Orion Spur)

At the centre of the solar system is **the Sun**, a 4.5 billion year-old star, a **yellow dwarf**, a medium-sized star. Its gravity holds the solar system together. It is about half way through its lifetime.

It is a hot, glowing ball of hydrogen and helium. Nuclear fusion reactions in its interior produce energy, including heat and light, which we depend on for our existence.

15 million °C at its core

5,500 °C at its surface (the photosphere)

One of the biggest mysteries about the Sun is that its outer atmosphere, the corona, gets hotter the further it is from the sun’s surface... up to 2 million °C.

It orbits the centre of the Milky Way, taking about 230 million years for one orbit. It also spins on its axis. It is 93 million miles from Earth = 1 AU (1 astronomical unit)

**The Magnetosphere**: Sun generates magnetic fields which pervades the solar system.

**Sunspots** are huge, dark, irregularly shaped, temporary areas of intense magnetism on the sun that expand and contract as they move. They are cooler than their surroundings, which is why they appear dark.

**The Sun’s Atmosphere**:The photosphere, sometimes referred to as the surface of the Sun, is not a solid surface, but is the lower part of the Sun’s atmosphere. Above that is the chromosphere, then the corona, which is where we see features such as solar prominences, flares, and coronal mass ejections. The latter two are giant explosions of energy and particles that can reach Earth.

High solar activity can cause disruption on Earth, affecting satellites, GPS, radio communications... The strongest storm on record happened 1st Sep 1859 (called the Carrington Event).Telegraph systems worldwide went haywire: spark discharges shocked operators and set light to their telegraph paper. The skies worldwide experienced green, red and purple auroras... The result of energy and particles from the sun interacting with the Earth’s atmosphere.

Next predicted period of maximum activity is July 2025.

**Asteroids:** The orbits of planets, asteroids and comets are ellipses, some more elongated than others.

The main Asteroid belt lies between Mars and Jupiter. It contains millions of rocky remnants left over from the formation of the Solar System. They orbit the Sun and range from 10m across, to 530 km.

*Trojan* asteroids share an orbit with a larger planet (most of them in Jupiter’s orbit). They remain in a stable orbit, in gravitational equilibrium with the large planet and the sun. There are also Mars and Neptune trojans, and NASA announced the discovery of an Earth trojan in 2011.

**The Kuiper belt** is a doughnut-shaped region of what are believed to be leftover remnants from the formation of the solar system. It is located beyond the orbit of Neptune. It contains millions of small icy bodies, some over 600 miles in diameter (including Pluto) and hundreds of thousands larger than 60 miles wide. The bodies (Kuiper Belt Objects or KBOs) consist of rock, water ice and other frozen compounds such as ammonia and methane.

A fairly large number of KBOs either have moons or are binary objects. Binaries are pairs of objects that are relatively similar in size or mass that orbit around a point that lies between them. Some binaries, like Arrokoth, actually touch, creating a sort of peanut shape, creating what's known as a contact binary.

This information, and much more can be found on the NASA web-site:

<https://solarsystem.nasa.gov/solar-system/our-solar-system/overview/>