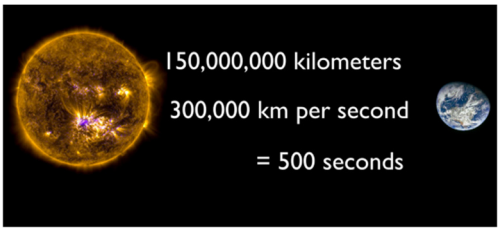
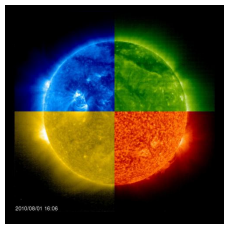
Sun series Parts 1 – 10

Part 1 The Sun - some facts



Time for sunlight to reach Earth



Sun through filters

Our star

Our nearest star is central to the existence and continuation of life on Earth and it permeates many aspects of human culture eg religion, language, calendars, lifestyle. Astronomically, it also totally dominates the solar system.

Vital statistics

Age Around 4.6 billion years. It is roughly middle-aged, with a remaining life of around 5 billion years.

Spectral class The Sun is a G2V star ie a yellow-white star in the main sequence (it generates its energy by converting hydrogen to helium), with a surface temperature around 5,000 K.

Colour When viewed from space or when high in the sky it appears almost white. Its yellow, red or orange colours are a result of atmospheric scattering.

Distance from Earth This varies ,because Earth's orbit is slightly elliptical. The mean distance is about 150,000,000 km – 1 astronomical unit (AU).

Time for light from the Sun to reach Earth About 8 minutes 19 seconds.

Absolute magnitude +4.83. Absolute magnitude is the brightness a star would have in perfectly clear space around 30 light years away from Earth. + values mean less bright. So, the Sun is a relatively pale star.

Apparent (observed) magnitude -26.74 . For an observer on Earth, the Sun is easily the brightest celestial object visible from Earth (signified by the large negative value). For comparison, that of Sirius, the brightest distant star, is -1.44.

Shape Made of hot plasma, it is almost a perfect sphere, polar and equatorial diameters differing by only 10 km. Planetary tidal effects are almost non-existent.

Diameter 1,392,530 km (about 109 times Earth). For practical purposes, the Sun's radius is considered to be the distance from the centre to edge of photosphere, the apparent visible surface of the Sun.

Mass The Sun contains about 99.86% of the total mass of the solar system - 1.989 x 10^{30} kg. Its mass is approximately 330,000x times that of Earth.

Mean density The gaseous Sun has a density of 1.41 g/cm^3 (that of rocky Earth is 5.52 g/cm$^{3)}$). It has no definite boundary, the density in its atmosphere decreasing exponentially with increasing distance.

Temperature At the surface: this is around 5,595°C (5,778 K). Initially, this falls with altitude, but then there is a marked increase with increasing distance from the surface. Temperatures at the core are around 15.6 million K.

Rotation This occurs faster at the equator than the poles, the differential rotation caused by convective motion due to heat transport and the Coriolis force caused by the rotation itself.

Rotational period About 25.6 days at the equator and 33.5 days at the poles. Viewed from Earth, solar equatorial rotation appears to be about 28 days.

History A Population 1 (heavy element rich) type, it formed from the gravitational collapse of matter within part of a giant molecular cloud. This cloud would have contained the remnants of older Population II and III stars. Its formation was possibly triggered by shockwaves from a nearby supernova – evidence given by the high abundance of heavy elements in the solar system eg gold, uranium relative to their abundance in Population ll, heavy-element poor stars. As one fragment of the cloud collapsed, it began to rotate because of conservation of angular momentum, and heat up with the increasing pressure. Gravity and pressure at the centre caused the mass to become increasingly hot, eventually initiating nuclear fusion.

Composition This was inherited from the interstellar medium from which it formed. About ¾ of its mass is hydrogen (+/- 73%)**.** The rest is mostly helium (23.8%), plus tiny quantities of heavier elements including oxygen (1%), neon (0.2%), iron (0.2%) and carbon (0.3%). The hydrogen and helium were formed during the Bing Bang and the heavier elements form stellar nucleosynthesis by earlier generation stars. In the inner areas, nuclear fusion has converted hydrogen to helium, so the innermost parts are now about 60% helium.

Energy production Every second, more than 4 million tonnes of matter are converted into energy within the core, producing solar radiation and neutrinos. So far, the Sun has converted around 100 times Earth's mass into energy, about 0.03% of its own total mass**.** It is gradually becoming hotter because the helium atoms in the core occupy less volume than the original hydrogen atoms which were fused. The Sun's brightness increases by about 1% every 100 million years.

Magnetism Motion inside the Sun generates a magnetic field via a dynamo process. The field varies across the surface, and over a wide range of timescales, the 11-year solar cycle being the most prominent. The field is the source of active solar events including solar flares and coronal mass ejections. The solar magnetic field extends well beyond the Sun, the solar wind carrying plasma into space, forming the interplanetary magnetic field.

Sources: Ridpath, I (Ed) (2012) Oxford dictionary of astronomy 2nd ed rev, Ridpath, I (Ed) Astronomy (2006) Dorling Kindersley – Eyewitness companions, www.en.wikipedia.org