Solar System Essay, Research Paper

The Sun is an ordinary G2 star, one of more than 100 billion stars in our galaxy.

diameter: 1,390,000 km.

mass: 1.989e30 kg

temperature: 5800 K (surface)

15,600,000 K (core)

The Sun is by far the largest object in the solar system. It contains more than 99.8% of the total

mass of the Solar System (Jupiter contains most of the rest).

The Sun is personified in many mythologies: the Greeks called it Helios and the Romans called it

Sol.

The Sun is, at present, about 75% hydrogen and 25% helium by mass (92.1% hydrogen and

7.8% helium by number of atoms); everything else (”metals”) amounts to only 0.1%. This changes

slowly over time as the Sun converts hydrogen to helium in its core.

The outer layers of the Sun exhibit differential rotation: at the equator the surface rotates once

every 25.4 days; near the poles it’s as much as 36 days. This odd behavior is due to the fact that the

Sun is not a solid body like the Earth. Similar effects are seen in the gas planets. The differential

rotation extends considerably down into the interior of the Sun but core of the Sun rotates as a solid

body.

Conditions at the Sun’s core are extreme. The temperature is 15.6 million Kelvin and the pressure

is 250 billion atmospheres. The core’s gases are compressed to a density 150 times that of water.

The Sun’s energy output (3.86e33 ergs/second or 386 billion billion megawatts) is produced by

nuclear fusion reactions. Each second about 700,000,000 tons of hydrogen are converted to about

695,000,000 tons of helium and 5,000,000 tons (=3.86e33 ergs) of energy in the form of gamma

rays. As it travels out toward the surface, the energy is continuously absorbed and re-emitted at

lower and lower temperatures so that by the time it reaches the surface, it is primarily visible light.

For the last 20% of the way to the surface the energy is carried more by convection than by

radiation.

The surface of the Sun, called the photosphere, is at a temperature of

about 5800 K. Sunspots are “cool” regions, only 3800 K (they look dark

only by comparison with the surrounding regions). Sunspots can be very

large, as much as 50,000 km in diameter. Sunspots are caused by

complicated and not very well understood interactions with the Sun’s

magnetic field.

A small region known as the chromosphere lies above the photosphere.

The highly rarified region above the chromosphere, called the corona,

extends millions of kilometers into space but is visible only during eclipses

(left). Temperatures in the corona are over 1,000,000 K.

The Sun’s magnetic field is very strong (by terrestrial standards) and

very complicated. Its magnetosphere (also known as the heliosphere

extends well beyond Pluto.

In addition to heat and light, the Sun also emits a low density stream of charged

particles (mostly electrons and protons) known as the solar wind which

propagates throughout the solar system at about 450 km/sec. The solar wind and

the much higher energy particles ejected by solar flares can have dramatic effects

on the Earth ranging from power line surges to radio interference to the beautiful

aurora borealis.

Recent data from the spacecraft Ulysses show that the solar wind emanating from the polar

regions flows at nearly double the rate, 750 kilometers per second, that it does at lower latitudes.

The composition of the solar wind also appears to differ in the polar regions. And the Sun’s magnetic

field seems to be surprisingly uniform.

Further study of the solar wind will be done by the recently launched Wind, ACE and SOHO

spacecraft from the dynamically stable vantage point directly between the Earth and the Sun about

1.6 million km from Earth.

The solar wind has large effects on the tails of comets and even has measurable effects on the

trajectories of spacecraft.

Spectacular loops and prominences are often visible on the Sun’s limb (left).

The Sun’s output is not entirely constant. Nor is the amount of sunspot activity.

There was a period of very low sunspot activity in the latter half of the 17th century called the

Maunder Minimum. It coincides with an abnormally cold period in northern Europe sometimes

known as the Little Ice Age. Since the formation of the solar system the Sun’s output has increased

by about 40%.

The Sun is about 4.5 billion years old. Since its birth it has used up about half of

the hydrogen in its core. It will continue to radiate “peacefully” for another 5 billion

years or so (although its luminosity will approximately double in that time). But

eventually it will run out of hydrogen fuel. It will then be forced into radical changes

which, though commonplace by stellar standards, will result in the total destruction

of the Earth (and probably the creation of a planetary nebula).

The Sun’s satellites

There are nine planets and a large number of smaller objects orbiting the Sun. (Exactly which

bodies should be classified as planets and which as “smaller objects” has been the source of some

controversy, but in the end it is really only a matter of definition.)

Distance Radius Mass

Planet (000 km) (km) (kg) Discoverer Date

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Mercury 57,910 2439 3.30e23

Venus 108,200 6052 4.87e24

Earth 149,600 6378 5.98e24

Mars 227,940 3397 6.42e23

Jupiter 778,330 71492 1.90e27

Saturn 1,426,940 60268 5.69e26

Uranus 2,870,990 25559 8.69e25 Herschel 1781

Neptune 4,497,070 24764 1.02e26 Galle 1846

Pluto 5,913,520 1160 1.31e22 Tombaugh 1930