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Tapping, Ken

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THE SOLAR SYSTEM

Ken Tapping, 7th November, 2017

The Solar System contains one star – the Sun, eight planets – Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune, and their satellites. There are very many asteroids, mostly orbiting the Sun between Mars and Jupiter. Beyond Neptune is a doughnut-shaped belt of icy objects ranging from too small to see to bodies like Pluto and Eris. This is known as the Kuiper Belt, and its members as "Kuiper Belt Objects". Then, even further away, where the Sun just looks like a bright star, and it is very cold, lies the Solar System's "deep freeze". It contains millions of frozen fragments of construction material left over after the Sun, planets and other bodies formed. On occasion, a collision sends one of these fragments onto a new course, taking it into the inner parts of the Solar System, where the Sun evaporates its material, forming a comet.

Over the last couple of decades, and especially over the last few years, our knowledge of the Solar System has grown enormously. The huge amount of new information we have about the planet Mars is an example; then we have the flyby of Pluto and space probes exploring the neighbourhoods of Jupiter and Saturn. All this fits with new, complementary information about the Solar System as a whole, producing a more complete picture of the piece of the cosmos we live in. In the next few articles we'll summarize that picture. We'll start in the centre, with the Sun.

The Sun is a fairly average yellow dwarf star. It is a big ball of mainly hydrogen. It produces energy by nuclear fusion reactions in its core, where hydrogen is converted into helium and eventually into heavy elements. Flows of material in its interior generate strong magnetic fields. These change the Sun's appearance from what would otherwise be a "fuzzy blob of hot gas" into what we see in the sky: a hard-outlined, bright, yellow disc. Its diameter is about 1.5 million kilometres and it lies roughly 150 million kilometres away.

A square metre of black card facing the Sun here at the Earth will capture about 1400 Watts, which is why black things in the sunlight get so hot. Since we know our distance from the Sun and that the Sun sends out its energy equally in all directions, we can calculate that the Sun's total energy output is about 4E26 W (4 followed by twenty six zeros). It is sobering to think that there are stars hundreds of thousands of times brighter than the Sun. The Sun will be able to sustain this output over a lifetime of about 10 billion years. It is now about 4.5 billion years old. It is brightening slowly, so that in a few billion years the Earth will become too hot for us and all the other living things sharing it.

The magnetic fields in the Sun act rather like huge lumps of elastic. As these magnetic fields are twisted and stretched by movements of material inside the Sun, enormous amounts of energy get stored in them. Then, when the stresses become too large, the magnetic fields snap and rearrange, releasing all that energy. This is what drives solar flares and coronal mass ejections (also known as "solar storms"), and causes power outages, communication blackouts and damaged satellites.

One thing the Sun does not cause is the rhythm of seasons. The Earth's axis is tilted by about 23 degrees, so that it always points close to the North (or Pole) Star. There is a point in the Earth's orbit when the Northern Hemisphere is leaning directly towards the Sun, and consequently the Southern Hemisphere is leaning away. This gives us summer in the Northern Hemisphere and winter "down under". Then, six months later, when we are on the opposite side of the Earth's orbit, the situation is reversed.

Saturn lies low in the southwest, getting lost in the twilight. Mars lies in the dawn glow, with brilliant Venus below, and Jupiter below Venus. The Moon will reach Last Quarter on the 10th.

Ken Tapping is an astronomer with the NRC's Dominion Radio Astrophysical Observatory, Penticton, BC, V2A 6J9.

Tel (250) 497-2300, Fax (250) 497-2355

E-mail: ken.tapping@nrc-cnrc.gc.ca