**THE IMPORTANCE OF THE SUN**
**By**
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On December 2nd, 1995, NASA launched a US-European observatory to study the sun. Ireland has a special interest in this mission. The observatory had an experimental apparatus on-board, designed and built at Maynooth College, that will study solar wind. Well might we humans study our own star, to which we owe our very existence.

All civilisations in early phases of development worship the sun. There is nothing at all surprising about this. Of all the objects in our physical environment, the sun is outstandingly the most important. We owe everything to the sun and without it's heat and light the earth would be a frozen barren rock containing no life of any sort. The sun will not live forever. It is currently half way through its estimated life span. When the sun dies, life will no longer be possible on earth.

The sun is a star, and a fairly ordinary one as stars go. It sits at the centre of our solar system. Nine major planets revolve around the sun, each in a characteristic elliptical orbit of revolution. The closest planet to the sun is Mercury and then in order come Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto. The Earth orbits the sun at an average distance of 93 million miles. The sun is enormous in volume and mass compared to each of the planets. The total mass of the sun is 330,000 times that of the earth and 745 times that of all the planets put together. The diameter of the sun is 109 times greater than the diameter of the earth.

The sun is composed almost entirely of the gases hydrogen (70%) and helium (30%), with only a trace of heavier elements. The core of the sun, extending out to a radius of one quarter of the total radius, is a huge nuclear fusion reactor, where hydrogen atoms are fused together to form helium atoms and enormous amounts of energy are released. The temperature at the centre of the sun is an incredible 15,000,000 degrees centigrade. The energy of the sun is radiated out into space mainly in the form of visible light. When this light reaches planet earth it effectively forms our sole external source of heat and light.

The solar wind is a 'gas' of electrically charged particles that escapes from the sun and spirals into the solar system. Sudden changes in the solar wind can affect the Earth's magnetic field, and this can disrupt navigation and communication systems, damage electric power networks and disrupt satellites. The Irish experiment on-board the recently launched solar observatory will yield valuable information on the effect of solar wind on communication and power networks.

All life on earth is dependent on the energy received from the sun. The sun's light warms the earth to a temperature just right to support life, e.g. over most of the globe the temperature is such that water remains in its liquid state and is neither frozen solid nor boiled off into a gas. Secondly, most of the food used to maintain biological life on earth is ultimately made by harnessing the energy of the sunlight that falls on earth. Also, the fossil fuel stores on earth, i.e. coal, oil, natural gas and peat, are all organic compounds that were originally made with the vital assistance of sunlight.

All biological organisms on earth are grouped into various food chains, where each link feeds on the link below and in turn is eaten by the link above. Man eats animals, animals eat plants. Plants in turn do not build up and sustain themselves by eating simpler forms of life. Rather they are endowed with the remarkable capacity to synthesise their own complex molecules by fusing together two simple compounds, carbon dioxide and water, to form carbohydrate (principally glucose) and oxygen. This process is called photosynthesis and is powered by the energy of sunlight.

Photosynthesis takes place in the green leaves of plants, green in colour because they contain a pigment (chlorophyll) which traps the energy of the sunlight. Organisms capable of satisfying all their requirements relying entirely on the simplest nutrients such as $CO_2$ (carbon dioxide), $NH_3$ (ammonia) and $H_20$ (water) are called autotrophs.

The vital first step in almost all food chains on earth depends on photosynthesis. The glucose produced in photosynthesis is the basic chemical fuel required by most organisms to power their activities. Organisms capable of photosynthesis can make their own glucose from the simple compounds carbon dioxide and water. Most other organisms, including all animals, must have glucose presented to them in a pre-synthesised form. These organisms are called heterotrophs. Note also that photosynthesis releases oxygen to the atmosphere.

Only a small fraction of the total photosynthesis on earth is carried out by the familiar green plant. It has been estimated that some 90% of all photosynthesis is carried out in the seas by various kinds of micro-organisms, including bacteria and algae. If photosynthesis ceased on earth, the essential starting point for food chains would stop and in a short while life on earth would starve to death.

The glucose produced in photosynthesis is used by all organisms in processes called glycolysis and respiration in which energy (in the form of a chemical called ATP) is produced. This energy is used to power all organisms' activities and also to build up the structure of the organism. In respiration glucose is broken down in the presence of oxygen to yield carbon dioxide and water. This process is the opposite to photosynthesis. Carbon dioxide is released back into the atmosphere during respiration. Undisturbed, nature ensures that photosynthesis and respiration are balanced globally and this helps to regulate the gaseous composition of the atmosphere, particularly the concentration of carbon dioxide.

The annual flow of energy through the biological world each year is enormous. The total amount of carbon converted from the gaseous state of carbon dioxide into biological solid structure by all the photosynthetic organisms on the face of the earth each year is about $160 \times 10^9$ tons. $10^9$ is equal to 10 multiplied by itself 9 times. The amount of energy needed to 'fix' this amount of carbon is about $1 \times 10^{18}$ calories per year. To put this figure in context, it is estimated that the amount of energy expended each year by all the man-made machines on the face of the earth is no more than about 4% of the annual flux of biological energy.

Our sun is presently about 4.7 billion years old. It has an estimated life of 10 billion years. When the hydrogen fuel in the sun's core becomes exhausted the sun will expand to become a red giant star, whose outer layers will reach the orbit of the earth or beyond. It will remain a red giant for about half a billion years after which it will contract to a white dwarf star about twice the size of the earth and slowly cool for several billion years. The earth will be destroyed as a home for life during the red giant phase of the sun. Of course, the only way for humankind to survive such a cataclysmic event will be to leave the earth well in advance and to colonise another planet. We have about five billion years to prepare for this.

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