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SCIENCE AND ENGINEERING RESEARCH COUNCIL

THE SOLAR HELIOSPHERIC OBSERVATORY –'SOHO'

The SOHO spacecraft will be launched in 1995 into a position in space some 1.5 million kilometres away from the Earth. From there it will be able to study the Sun continuously, and not be affected by the day/night cycle. Also it will be able to sample directly the chemical composition of the material ejected by the Sun, which is known as the *solar wind.*

Our Sun, at a distance of 93 million miles, is the nearest star, and consequently we are able to observe it in considerably greater detail than the others we see in the night sky. The Sun is responsible for providing us with the energy necessary for life to exist on Earth. This energy is being continuously created at the core of the sun, where at temperature of several million degrees, the element Hydrogen is steadily being turned into Helium. During the course of the nuclear reaction, a quantity of 'waste' energy is created. This energy, in the form of photons of light, gradually makes its way to the surface of the Sun (suffering many collisions with atoms on the way). The solar 'surface', as we see it, is where the gas forming the sun is sufficiently tenuous that most of these photons can escape into space. By this point the gas has cooled to a mere 6000 degrees, and we see it as a white-hot disc in the sky.

While the Sun provides energy necessary for life, it also emits damaging radiation at the short ultra-violet and X-ray wavelengths. For protection against these rays we are dependent upon the Earth's atmosphere and upon the particular mixture of gases within this atmosphere. Fortunately, this protection is generally extremely effective, and the majority of the radiation is stopped many miles above the Earth's surface. However it is noticeable how climbing a relatively modest mountain can dramatically effect the sunburn caused by the UV radiation. Also the much publicised ozone-hole appears to have substantially decreased the effectiveness of the atmospheric absorption.

Fig. 1 - A soft X-ray image of the solar disc upon which has been superimposed a white-light image of the corona taken at total eclipse.

The source of these short wavelengths occurs in a very tenuous layer in the Sun's atmosphere which lies above the visible surface. This region is known as the Corona, and is clearly visible from Earth only at times of total solar eclipse, when the intense light from the disc is hidden by the moon (nb. the next total eclipse visible from the UK occurs in 1999). At ultra-violet and X-ray wavelengths however, the situation is reversed, and it is the corona which dominates. In high resolution photographs we can see that the light is emitted particularly strongly from areas surrounding sunspots, areas which are known as *active regions.* The interesting thing is that sunspots are associated with very high magnetic fields, and the fine structure in the active regions shows a structure very reminiscent of the magnetic field lines around a bar magnet. And this is exactly what we are seeing, for the very thin atmosphere of the corona is heated to a temperature of greater than 1,000,000 degrees and the atoms of the gas are stripped of their outer electrons (a process called ionization). The positions of the now charged ions are controlled by the magnetic forces emerging from the sunspot, and in the corona we can often see the most beautiful magnetic arches and streamers.

The corona also has other surprises, and one of particular interest to the SOHO instruments will be the solar wind. The sun, in common with many other stars, emits large amounts of gas, and this streams away into space with velocities of up to 1000km/sec. Some of this material reaches the Earth, but is largely deflected by the Earth's magnetic field, and the only visible evidence of this is the aurorae seen at high latitudes. In space however the effects of this bombardment can be very harmful to instruments, in particular their electronic components. It can also be extremely hazardous to the crew of any spacecraft, and the effects of the solar wind are being extensively studied by the scientists planning the future missions to Mars. SOHO will be able to measure the composition and the energy of the solar wind, and furthermore will be able to investigate those regions in the corona which are thought to be its source.

The Rutherford Appleton Laboratory is leading an international team of scientists and engineers who are together building the Coronal Diagnostic Spectrometer (CDS) for SOHO which will investigate the sun in the extreme ultra violet. By measuring the emissions at these wavelengths it will be possible to determine with some precision the temperature and densities within the coronal structures. At the moment we have completed the initial design work on the instrument, and are starting to build up the prototype hardware.

The launch of SOHO will occur in 1995 from the Kennedy Space Centre in Florida, using an Atlas II rocket. By this time we will have spent approximately 10 years on design and construction of the CDS. But this is really only the start, with luck we can hope for ten further years of first class scientific data, and a few answers to the many scientific puzzles provided by our Sun.

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