6.1 Solar Orbiter

Introduction

The Sun's atmosphere and the heliosphere are uniquely accessible domains of space, where fundamental physical processes common to solar, astrophysical and laboratory plasmas can be studied in detail and under conditions impossible to reproduce on Earth or to study from astronomical distances.

The results from missions such as Helios, Ulysses, Yohkoh, SOHO, TRACE and RHESSI have significantly advanced our understanding of the solar corona, the associated solar wind and the 3-D heliosphere. Further progress is to be expected with the launches of STEREO, Solar-B and the first of NASA's Living With a Star (LWS) missions, the Solar Dynamics Observatory (SDO). Each mission has a specific focus, being part of an overall strategy of coordinated solar and heliospheric research. An important element of this strategy, however, has yet to be implemented. We have reached the point where further *in situ* measurements, now much closer to the Sun, together with high-resolution imaging and spectroscopy from a near-Sun and out-of-ecliptic perspective, promise to bring about major breakthroughs in solar and heliospheric physics. Solar Orbiter will, through a novel orbital design and an advanced suite of instruments, provide the required observations. The unique mission profile of Solar Orbiter will, for the first time, make it possible to:

- explore the uncharted innermost regions of the Solar System;
- study the Sun from close by (45 solar radii, or 0.21 AU);
- swing by the Sun, tuned to its rotation, and examine the solar surface and the space above from a quasi-heliosynchronous vantage point;
- to provide images of the Sun's polar regions from heliographic latitudes up to 38°.

Science goals

Within the framework of the global strategy outlined above, the top-level scientific goals of the Solar Orbiter mission are to:

- determine the properties, dynamics and interactions of plasma, fields and particles in the near-Sun heliosphere;
- investigate the links between the solar surface, corona and inner heliosphere;
- explore, at all latitudes, the energetics, dynamics and fine-scale structure of the Sun's magnetised atmosphere;
- probe the solar dynamo by observing the Sun's high-latitude field, flows and seismic waves.

The near-Sun interplanetary measurements together with simultaneous remote-sensing observations of the Sun will permit us to disentangle spatial and temporal variations during the co-rotational phases. They will allow us to understand the characteristics of the solar wind and energetic particles in close linkage with the plasma conditions in their source regions on the Sun. By approaching as close as 45 solar radii, Solar Orbiter will view the solar atmosphere with unprecedented spatial resolution (goal: 35 km pixel size, equivalent to 0.05 arcsec from Earth). Over extended periods, Solar Orbiter will deliver images and data of the polar regions and the side of the Sun not visible from Earth. This latter aspect is a key factor in Solar Orbiter's role as a Solar Sentinel within the framework of the International Living With a Star (ILWS) initiative.

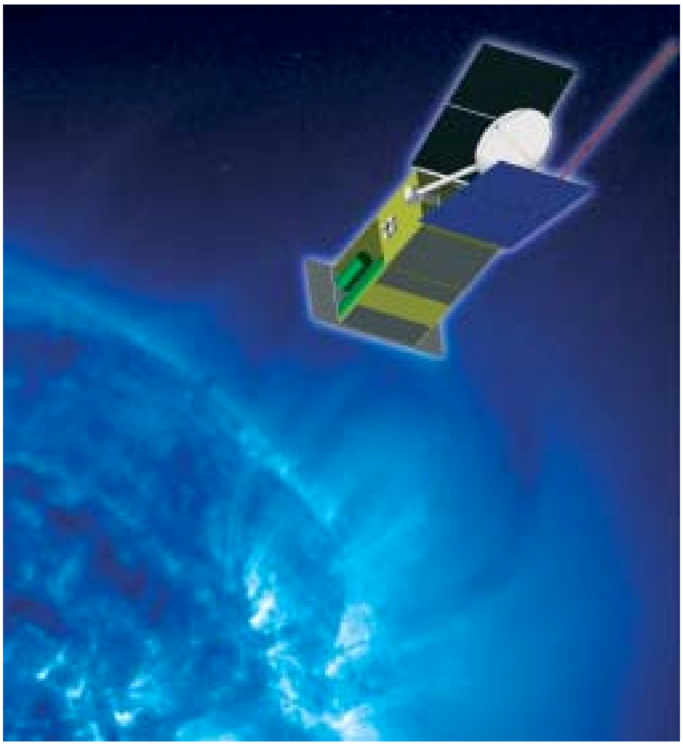

Fig. 6.1.1. Artist's impression of the Solar Orbiter spacecraft near perihelion.

For further information, see http://sci.esa.int/solarorbiter

Status

Solar Orbiter was selected as an ESA Flexi-mission in 2000, and reconfirmed in 2002 to be implemented as a common development with the BepiColombo mission to Mercury. In order to arrive at a detailed definition of the model payload, and to identify necessary payload technology developments, two Solar Orbiter Payload Working Groups (one for *in situ* instruments, and one for remote-sensing instruments) were established in 2002. In 2003, a Solar Orbiter Science Definition Team (SDT) was given the task of reviewing the scientific goals of the mission as presently understood, refining these goals where needed, and prioritising them in order to achieve a well-balanced, and highly focused scientific mission. The SDT was also given the task of defining the sets of measurements needed to achieve the mission's scientific goals, taking into account, where appropriate, the output of the Payload Working Group activity. The principal output of the SDT was the Solar Orbiter Science Requirements Document (Sci-RD), issued in December 2003. Taking into account these science requirements, the SDT defined a baseline model payload that would meet the solar and heliospheric science objectives. This model payload includes the following instrument packages:

- *heliospheric in-situ instruments:* plasma package (solar wind analyser); fields package (radio and plasma wave analyser, magnetometer, coronal sounding); particles package (energetic particle detectors, interplanetary dust detector, neutral particle detector, solar gamma-ray and neutron detector);
- *solar remote sensing instruments:* visible-light imager and magnetograph; EUV full-Sun and high-resolution imager; EUV spectrometer; X-ray spectrometer/telescope; coronagraph.

Following the SDT activities in 2003, Solar Orbiter is now undergoing re-assessment in ESA and industry. Specific activities include:

- Payload Integration Study performed in industry (January-June 2004);
- ESTEC Concurrent Design Facility (CDF) Study, which is an update to the CDF study performed in 1999 (four sessions, March 2004);
- two parallel System-level Assessment Studies performed in industry (April-December 2004).

Solar Orbiter is currently foreseen to be launched no earlier than October 2013.