Solar Orbiter: Unlocking the Secrets of our Star

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Credit: ESA

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Credit: ESA
Solar Orbiter ‘nominal’ mission phase begins with the Earth swingby at end of this month.
The Wider View – Heliospheric Imaging

Image composite of NASA/Stereo images
The Solar Wind

• Extension of solar corona, and the activity / variability, into interplanetary space;

• Note the major variability occurs near the ecliptic plane – thus the Earth is immersed in this fluctuating environment;

• The goal of Solar Orbiter is to understand the origins and drivers of this variability.
### Instruments and Measurements

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<td>Coronagraph (METIS/COR)</td>
<td>Visible, UV and EUV imaging of the solar corona</td>
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<td>Heliospheric Imager (SoIOHI)</td>
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- The science goals can only be achieved with both in situ measurements of the plasma conditions local to the spacecraft together with relevant remote observations of the source(s) of that plasma in near-Sun environment.
- Thus a key challenge is to be able to make the connection between the 2 sets of observations.
Solar Orbiter - Solar Wind Analysers (SWA)

Electron Analyser System (EAS):
- Electrons
- \(< 5\ \text{keV}\)
- quasi- \(4\pi\ \text{sr FoV}\);
- Build led by UCL/MSSL, UK

Proton-Alpha Sensor (PAS):
- Protons/Alphas,
- \(0.2 - 20\ \text{keV/q}\),
- \(60^\circ \times 40^\circ\ \text{FoV around SW flow direction};
- Build led by IRAP, Toulouse, Fr

Heavy Ion Sensor (HIS):
- He – Fe,
- \(< 0.5 - 100\ \text{keV/q}\),
- \(96^\circ \times 34^\circ\ \text{FoV centred on SW flow};
- Build led by SWRI (US) and IRAP (Fr)
Extreme Ultraviolet Imager (EUI)

- PI group is Royal Observatory Brussels (Belgium) and UCL/MSSL designed and built the Central Electronics Box;

- 2 instruments, 3 telescopes:
  - Full Sun Imager (FSI):
    - 17.4 & 30.4nm, 3072 x 3072 pixels
    - FoV: 2 $R_{\text{sun}}$ at perihelion
  - High Resolution Imager (HRI); 2 telescopes:
    - 17.4nm & Lyman-alpha, 2048 x 2048 pixels
    - FoV: 1000 arcsec$^2$
Solar Orbiter Payload Accommodation

- Spacecraft prime contractor: Airbus D&S, Stevenage, UK

Credit: ESA
The Thermal Challenge

The majority of the spacecraft and subsystems reside behind a bespoke heat shield:

- SolarBlack coating
- 40 cm thick (high-temperature MLI, star brackets, low-temperature MLI)
- surface temperature between -200°C and +520°C
Mission Profile

- Spacecraft makes multiple Earth and Venus gravity assist manoeuvres;
- Mission duration >10 years, reaching minimum perihelion distance: ~60 solar radii (0.28 AU) and maximum solar latitude ~35°.
**EUI Early Observations from the Cruise (check-out) Phase**

- Full Sun Imager (FSI), tuned to access:
  - Low corona (17.4 nm)
  - Transition region (30.4 nm)

- High Resolution Imagers:
  - EUI (17.4 nm)
  - Lyman-α (121.6 nm)
  - Co-aligned with high resolution imagers of the other remote sensing instruments to support science goals;
EUV Quiet Sun from 0.56 au
CME observed by SWA on 18/19 July 2021

SOHO/LASCO showed a CME on 17th July 2021 at 0540 UT. PAS and EAS show shock arrival 36 hours later and denser, faster plasma arrived ~50 hours after the CME was observed.

CME directed towards Solar Orbiter – such an event occurring at SO perihelion and during an observing window has potential to provide new information on CME creation and release.
Summary

• Hopefully I have managed to convey some of the motivations for building and launching the Solar Orbiter mission;

• We are nearing the end of the cruise phase, at which point the full payload complement will start regularly coordinating observations by which to address the mission science goals of understanding the dynamic outer atmosphere of a star and the physical processes that control of our local space environment;

• Even so, data from the cruise/check-out operations have already yielded discoveries, interesting new viewpoints and new science results, so there is promise for lots more once the nominal mission starts at the end of the month;

• [Even more so when Solar Orbiter observations are considered in context of other assets (e.g. Parker Solar Probe, Hinode, Solar Dynamics Observatory) which for time reasons I have barely touched on in passing];

• Stay tuned……