SOLAR SYSTEM MISSIONS - Status Reports to 123rd SSWG

(Hermann Opgenoorth, RSSD, Solar System Missions Division, 17/12/2006)

Ulysses

On 17 November the Ulysses spacecraft arrived at 70º south solar latitude, marking the start of the third South Polar Pass. The maximum southern latitude (79.7º S) will be reached on 7 February. All spacecraft subsystems and science instruments remain in good health, with no anomalies during the reporting period. Preparations for the next nutation season, which will start in February and last approximately 12 months, are under way. A Nutation Readiness Review will be held in JPL on 24 January.

Ground segment performance has been excellent, leading to an overall data return for the period of better than 98%.

On the science front, the Ulysses teams participated in a very successful Heliospheric Network Workshop held in Oxnard, CA, from 6 to 10 November. The Heliospheric Network is the collective name for the international fleet of spacecraft studying the Sun and heliosphere. Ulysses is a key member of this network, together with SOHO, NASA's ACE, Voyager and Wind spacecraft and now also the recently launched twin STEREO satellites. The four themes of the Workshop were The Outer Heliosphere and Interstellar Connection, Solar Wind Transients, Energetic Particles, and Solar Cycle Variations. With its comprehensive data set, already covering almost a full 22-year magnetic cycle of the Sun, Ulysses plays a central role in all of these areas. Measurements from Ulysses are being used to study physical processes in the heliosphere ranging in distance from the solar surface to the local interstellar cloud, and in time from the present to the earliest moments of the universe.

SOHO

The spacecraft status is nominal and science operations are progressing smoothly. Automatisation efforts for future low manpower mission operation proceed on schedule. The delivery of the Central On-Board Software (COBS) patch is expected for mid January 2007. The overall aim is to move operation to unmanned night passes as of the summer of 2007.

The SUMER A-Detector has reached its end of life. Engineering tests performed in mid November revealed that the deterioration of the ADC has progressed to a point where the detector has become unusable. All lines (spatial positions) are now affected and several columns (spectral dimension) are missing now as well, indicating a similar problem with the second ADC of the A-Detector. Subsequent tests of the fully redundant Sumer B-Detector showed that this detector is still in good health and will be used instead.

A first SOHO/Hinode (SUMER/EIS) mini-campaign was successfully run from 9 to 17 November. A wider SOHO/Hinode/TRACE campaign is planned for a period of 4 to 6 weeks from Mid March up to the end of April 2007.

MDI, EIT, and CDS successfully observed the Mercury transit on 8 November. There was considerable public interest in this event, with over 2.4 million requests to our SOHO web server and a total download volume of over 215 GByte on that day.

HINODE (formely known as Solar-B)

After a successful launch on September 23, Solar-B has, following Japanese tradition, been renamed to "***Hinode***" meaning "Sunrise". After a successful commissioning phase all three instruments have begun to deliver excellent quality data of unprecedented resolution in both space and time (first movies showing incredible details of fast developments will be shown at the SSWG meeting). In particular, *Hinode* took excellent images of the Mercury transit.
In October a team from ESTEC visited the Hinode Data Center in Oslo, and also the sateelite receiver facilties of KSAT in Tromsö and on Svalbard for a formal readiness review of the ESA ground-station support. All data reception is presently functioning without problems and the Hinode datacenter has successfully demonstrated their readiness for the expected huge amounts of high quality data.
In the middle of this initial Hinode success story we have, however, received very sad news that the mental father of the mission, Prof. T. Kosugi, died from a severe cerebral infarct on the weekend before the first major Hinode press release in Japan. We all will miss him as a reliable friend, and successful and outstanding mentor of international collaboration in Solar Physics.
The intended AO for 2 European members of the Hinode SWT had just been rewritten, following some of his remarks, and was ready for re-submission to JAXA for final comments, when the message of his death reached us. We will now take up the issue with his successor Prof. Nakatani, and issue the AO soon in the New Year, for speedy *per capsulam* treatment by SSWG. Anyway, the first after-launch meeting of the full Hinode SWT has presently been delayed until further notice.

CLUSTER

The four spacecraft and instruments are operating nominally again, after the somewhat limited and stressful eclipse operations of last autumn. The constellation manoeuvres have been successfully executed to change the spacecraft configuration from a 10000 km tetrahedron in the tail to a "flat triangle" of 500-10000 km parallel to the bow shock and magnetopause (a first test of the so—called "multi-scale" operation scheme).

JSOC and ESOC operations are continuing nominally. The data return from September 2006 to November 2006 was on average 99.4 %.

Cluster Active Archive is operating nominally. User access is growing every month and a total of 328 users are registered at the end of October (around 30% increase from last report). The system was optimised to increase the efficiency of the ingestion process and (while there still occur occasional delays of PI data delivery to the CAA) all data delivered are presently online.

As of early December 551 papers have been published in the refereed literature using Cluster and Double star data. N. Nykyri from Imperial College published the most recent paper in Annales Geophysicae using Cluster data. The study showed that, surprisingly, reconnection can take place within giant vortices produced by Kelvin-Helmlotz instabilities. Previous studies and theoretical consider were either the occurrence of KH instability or reconnection, depending on the interplanetary magnetic field, but not both at

the same time. It was shown in this study that when the vortices started to roll-up they could trigger reconnection.

Double Star

The two spacecraft and the instruments are operating nominally. TC-1 has successfully passed the long eclipse season in November.
The European Payload Operation System (EPOS) co-ordinates the operations for the seven European instruments on TC-1 and TC-2 and all operations are running smoothly. Data are acquired using the VILSPA 2 ground station and the possible data rate has decreased to 2-2.5 h per day since the TC-2 apogee is now in the Southern hemisphere.
As of early December 551 papers have been published in the refereed literature using Cluster and Double star data. A study on substorm generation mechanism was published in Geophysical Research Letters by Takada et al., from IWF (Austria), using Double Star and Cluster data. This study examined Bursty Bulk Flow (BBF) events observed at Cluster and consecituve magnetic dipolarisation observed at Double Star. It showed that 33% of dipolarisations are associated with BBFs. This result suggests that BBFs dissipates over a limited range, around 4-8 earth radii, and that the magnetotail topology is a key element in the dissipation.

Cassini-Huygens

The Cassini Orbiter mission is progressing very well. The nominal 4-year Cassini-Huygens mission ends in June 2008. A 2-year extension of the orbiter mission is presently being contemplated. New mission scenarios were extensively discussed at the Cassini-Huygens PSG held in Pasadena on October 16-20. It is predicted that sufficient fuel for nearly 300 m/s of Delta-V will remain at the end of the nominal mission in July 2008. Also RTG power output is very nominal, and the RTG could principally provide power to Cassini for more than 10 additional years. Various tours options, which are being designed for a 2-year extension, would consume up to about 180-200 m/s. Titan and Enceladus are the two main targets of the extended mission, which will mostly address discoveries made and surprises encountered during the nominal mission (at Saturn, its rings, its magnetosphere and its moons). It will also extend the coverage of Titan's surface observations and allow for the study of seasonal effects at Saturn and Titan. All study work is well on schedule for a final selection of the 2-year extension trajectory in January 2007 at the next PSG meeting. In the end the Cassini Orbiter Mission extension will have to be decided by NASA in early 2007.
The coordinated Huygens data analysis is also progressing very well. The 4th Data analysis workshop was help at LPL, Univ. of Arizona on November 6-7. Convergence has been obtained on the reconstruction of the entry and descent trajectory, which has been worked on by various groups, utilizing different approaches (including NASA/LaRC through a collaboration effort with the Huygens team). Scientific papers on Huygens results are regularly appearing in the literature. The GCMS team is carrying out an extensive calibration programme using the flight spare model and a major ACP/GCMS calibration is planned for winter/early fall of 2007. Two further Huygens coordinated data analysis workshops are planned in 2007, the next one possibly at NASA/GSFC in the May-July timeframe.

More than 150 papers related to Cassini-Huygens were presented at the fall AGU meeting. In many respects, Titan is more Earth-like than any other body in the Solar System. More than 500 papers on Cassini-Huygens have appeared in the referred literature. Web stories on Cassini-Huygens results are appearing almost at a daily rate on JPL's site at http://saturn.jpl.nasa.gov. An average of 2 to 4 stories per months are published on ESA's site at http://saturn.esa.int.

Rosetta

After a rather long time of low activity with regard to spacecraft and science operations the "Mars Swing-By Phase" for Rosetta formally started on 28th July, to prepare the spacecraft and the payload for this mission critical event. The actual swing-by will take place on 25th February 2007 at 01:57 UTC.
The 2nd Deep Space Maneuver, which was performed on 29 September, and a subsequent minor touch-up maneuver changed the peri-centre distance for the Mars flyby from about 450000 km to 285 km from the surface of Mars. Four additional maneuver slots are foreseen in the future mission timeline to fine tune this distance to the nominal 250 km.
The first payload Active Checkout started on 22nd November with the execution of the RSI Passive Checkout sequence. The operations for all other instruments started on 23rd November with a joint non-interactive set of operations involving all instruments except ROSINA and OSIRIS. These two instruments had their individual check-out passes somewhat later, as they included onboard S/W upgrades. In addition the two Navigation Cameras were operated as part of this first activity. The checkout sequence was executed outside ground station coverage, but the data which were dumped to ground on 27 November showed that most of the operations executed very smoothly, with the exception of some problems with the plasma instruments. Those have, however, been resolved during some of the follow-on passes.
From 28th November until 1st December the main emphasis was on the Philae Lander check-out, during which the Lander for the first time ran on its own batteries, decoupled from the power of the orbiter. This mode will probably also be used during the eclipse phase of the Mars swing-by, allowing the Lander payload to take measurements while the orbiter will be shut down.
The Payload Check-out will finish on 22 December. OSIRIS will observe Lutetia, Rosetta's second asteroid fly-by target between 2nd and 4th January, followed by a test of the pre-eclipse Mars observation attitude on 7 January.
A verbal update on the results of the active payload Check-out will be given at the meeting, as at the time of preparing this report the check-out activities have not been completed.
As of late November 2006, Dr. Rita Schulz (formerly Project Scientist of BepiColombo) has been assigned to be Project Scientist of the Rosetta mission.

Smart-1

The satellite is now firmly placed on the Lunar surface, probably suffering considerable disintegration at impact. The data-analysis is, however, continuing with somewhat increasing support from ESA and further decreasing support from the PI funding institutions. Smart-1 mission data is presently also being made available to China, in preparation of their first Lunar mission, Chang-e 1.

Mars Express and **Venus Express**

For both missions extended paperwork will be distributed to SSWG, in order to demonstrate the science case for extensions of both missions (to be discussed at the SSWG meeting). Therefore the normal report is omitted here.

BepiColombo

On 29-30 November the 4th MPO SWG was held at ESTEC. This was the first meeting were all parties involved in the mission development presented their concepts to the PI teams. Presentations started with the Project Team, followed by industry (ASTRIUM-Germany), ESOC and the Science Ground Segment. The information was very much appreciated the teams.
Following the negotiations for the Multi-Lateral Agreement (MLA) between ESA and the participating member states in September 2007, funding seems now to be secured for all instruments although some final contracts are lacking due to the outstanding approval of SPC (e.g. Switzerland) or for internal reasons (e.g. Italy).
The apparent non-selection of proposals to NASA in the framework of the discovery program (STROFIO, part of the SERENA Suite, and ground station support for MORE) appear not to be serious at this moment and discussions on these matters have been initiated between NASA and the ESA coordination office (Marcello Coradini and Hermann Opgenoorth). In the meantime SwRI will provide preliminary study funding for STROFIO, and ground station support for More can come into the program at a later stage. However, the PIs of SERENA and MORE have been asked to provide analysis of the science impact, just in case of final confirmation of such funding shortfalls.
As of November 2006 Dr. Rita Schulz has been reassigned to be Project Scientist of Rosetta, see above. Until a new project scientist can be installed for the BepiColombo mission, Hermann Opgenoorth will be acting PS for B/C with strong support from the present deputy PS, Dr. Johannes Benkhoff, and the coordinator for MMO science matters, Dr. Harri Laakso.

Solar Orbiter

Progress in being made on a number of fronts. Following discussions at the 2nd Solar Orbiter Workshop held in Athens in October concerning the possibility of joining Solar Orbiter and NASA's Sentinels into a single collaborative programme, preliminary mission analysis and engineering studies have been carried out. Focusing on a combined launch of Solar Orbiter and 3 Inner Heliospheric Sentinel satellites, studies by the NASA and ESA project teams have produced several interesting orbit options which would meet the core requirements of both missions.
A meeting at which the scientific merits of these options were once more discussed by the joint core Science Definition Teams of the Solar Orbiter and the Solar Sentinels (the so-called "SOS team") took place on 10 December in San Francisco, just prior to the Fall AGU. In general the presentations and discussions at this meeting were so promising, and in favour of a merging of both missions, that it was decided to dissolve the SOS-team at

this point. The ESA and NASA official present at the meeting agreed to nominate and call a new (interim) Joint Science and Technology Definition team (JSTDT) by mid January, and work to wards the signature of a Letter of Agreement, LoA, for further study of a joint mission before March of 2007. This new JSTDT will be charged to provide, within less that one year's time, a viable optimized science and technology case for the combined mission, and also to deliver an updated view on the strawman payload, in response to such optimized or even emerging new science requirements (more details and further updates on the discussed orbit options will orally be given at the SSWG meeting).
In addition to these joint ESA-NASA activities, two parallel industrial studies involving Alcatel and Astrium are being conducted that are aimed at consolidation of the Solar Orbiter Heat Shield design and related system-level aspects, in particular instrument accommodation. With regard to the latter, information exchanges with those teams which submitted Letters of Intent, in response to the Call that was issued in July, have been initiated with a view to arriving at a better definition of the key interfaces.

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