

Solar System Missions - Status Reports to 122nd SSWG

(G. Schwehm, 30th September 2006)

Ulysses:

On 6 October, Ulysses completed its 16th successful year in orbit. The spacecraft continues its climb to high southern latitudes with all subsystems and science instruments in good health. By the middle of November, the spacecraft will have reached 70° south solar latitude, marking the start of the third South Polar Pass.

During the reporting period, science operations have been conducted according to the revised payload power-sharing plan. Largely as a result of the gradually improving thermal situation as Ulysses gets closer to the Sun, several instruments not in the core payload category have been able to acquire data for short periods of time (typically 1 month). These include the gamma-ray burst experiment and the solar wind electron sensor.

Reverse shocks associated with Corotating Interaction Regions (CIR) continue to be observed locally at Ulysses, at much higher latitudes than during the first southern polar pass. The implication is that the spacecraft has yet to fully cross into high-speed solar wind flow from the south polar coronal hole and remains close to the boundary region. This in turn is a consequence of the inclination of the heliospheric current sheet with respect to the Sun's equator being higher than average for the phase of the solar cycle.

From 11-15 September a colloquium took place in Grindelwald, Ch, to celebrate the 80th birthday of Prof. Johannes Geiss. As well as being one of the fathers of the Ulysses mission (and one of its longest-serving PIs), Geiss is a world leader and foremost expert on measurements and interpretation of composition of matter that reveals the history, present state, and future of astronomical objects. At that meeting, George Gloeckler, his Co-PI on the Ulysses Solar Wind Ion Composition instrument (SWICS), noted that Geiss was first to measure the composition of the solar wind noble gases when in the late 1960s he flew his brilliant solar wind collecting foil experiments on the five Apollo missions to the moon. Together with his colleagues on the Ulysses/SWICS team, Geiss has determined the isotopic and elemental composition of the solar wind under all solar wind conditions and at all helio-latitudes.

SOHO:

In response to the NASA Senior Review Panel's recommendation to more rapidly lower the operational cost of SOHO, work has begun on automating SOHO operations. A ground system design review took place on June 16. The aim is to move to unmanned night passes in the summer of 2007. This will also require changes to the on-board software. A CCN to implement the needed on-board software changes has been approved

in July. Saab-Ericsson Space will start the work this month (September 2006) and plans to deliver the final product at the end of this year.

The recent keyhole period has proceeded with only small data losses and the primary objective of obtaining continuous data for the three helioseismology instruments VIRGO, GOLF and MDI (VGM) has been accomplished. Severe competition for Deep Space Network's (DSN) services, a DSN 70-m antenna being out of operation and recurring delays in the STEREO launch have complicated operations planning for this keyhole. The next (Nov-Dec) keyhole will be shorter and the DSN availability is expected to improve, hence the VGM objective of continuous data for the three helioseismology instruments is also expected to be achieved. Impact(s) of the STEREO mission on the next keyhole remain also a question mark.

Science Highlights:

On 7-12 May, the community held a most memorable meeting to celebrate 10 years of successful scientific operations of SOHO (SOHO-17: 10 Years of SOHO and Beyond, Giardini Naxos, Italy). Nearly 300 participants presented and discussed over 250 scientific papers. The papers will be published by ESA's Publications Division as Special Publication SP-617.

SOHO-18 "Beyond the Spherical Sun: a new era in helio- and asteroseismology" was held jointly with the annual meeting of the Global Oscillation Network Group (GONG) from 7 to 11 August at the University of Sheffield, UK. Nearly 130 participants discussed over 150 papers, which will be published by ESA's Publications Division as Special Publication SP-624. A French-Spanish team reported the detection of g modes in the Sun using 10 years of GOLF data. Their results also suggest a solar core rotating significantly faster than the rest of the radiative zone. If confirmed, this could open a new era in the study of the dynamical properties of the central solar interior.

A review in the 14 September issue of *Nature* magazine summarizes our understanding of solar luminosity variations and their effect on the Earth's climate. The authors conclude that brightening of the Sun is unlikely to have had a significant influence on global warming since the seventeenth century, though additional climate forcing by changes in the Sun's output of ultraviolet light, and of magnetized plasmas, cannot be ruled out.

On 9 August a polish amateur astronomer discovered the 1000th SOHO comet in the Kreutz group of sungrazing comets. Being the 1185th comet discovered in data from the SOHO LASCO and SWAN instruments in total, the faint object is officially designated C/2006 P7 (SOHO) by the Minor Planet Center of the IAU. Before the launch of SOHO only some thirty members of the Kreutz group were known.

At the time of writing of this report, 2538 papers based on SOHO observations have been published in the refereed literature since launch. In 2006, 162 papers have appeared in the refereed literature so far. In addition, there have been hundreds of papers in conference proceedings this year, not counting the many presentations at COSPAR, IAU GA, AAS, EGU, and AGU meetings.

Cluster:

Cluster went through its most critical eclipse season of the mission so far with success. C2 and C4, those spacecraft with the best batteries didn't show any problems. C3, went through all eclipses without any problems, although a gas release from a not yet fully identified source was experienced during charging. It had no adverse effect on the spacecraft or instruments.

C1 went through the first two eclipses in decoder only mode (all systems switched off including onboard computer) with success and could be restarted without problems at the exit of eclipse. Data return from C2, C3 and C4 was nominal as usual outside the eclipses period, only on C1 the instruments had to be switched off during the eclipse season that lasted about one week.

Science operations are nominal. Software changes have been identified to go through the 1000 orbit that will occur in December 2006. A test will be conducted with the PIs in October.

Cluster Active Archive is operating nominally. User access is growing every month and a total of 256 users are registered at the end of August. The CAA data download was 61 GBytes during August 2006 (increased by more than 125% as compared to July 2006). The data products from the instrument teams to the CAA keep flowing according to the delivery plans. The biggest problem at the moment exists on the CAA side where the data validation and ingestion processes take too long time. Since April 2006, the amount of data products delivered to the CAA has kept increasing at a significant rate, producing a backlog of data products that are waiting for validation and ingestion. The team is currently investigating various methods how the validation and ingestion procedure could be sped up.

In September the CAA has opened a feedback forum where the users can report on problems and present ideas how the CAA could be improved in order to aid the science activities of the users. Currently the CAA seeks for suggestions of what kind of quick-look plots and on-demand graphical products users wish to see on the CAA.

A new paper by G. Marklund, accepted in J. Geophys. Res., showed a dramatic change in the aurora as the electric potential structure changed. Between C1 and C2 spacecraft crossings of the aurora, the potential changed from a symmetric U shape to an asymmetric S shape, and at the same time the plasma conditions were changing in the polar cap region. Such studies are helping us to understand the origin and dynamics of the aurora.

The Cluster SWT and 12th Cluster workshop was held in Saariselka, Lapland, Finland. 70 scientists from Europe and USA participated. The meeting was organised in two parallel sessions covering the bow shock, magnetopause, cusp, inner magnetosphere and magnetotail.

Mars Express:

Early June saw the celebration of 3 years in space for Mars-Express. Most of the activities in the reporting period were devoted to the preparation of the with regard to power very challenging eclipse/aphelion season. The specially designed Survival Mode (SUMO) was tested and so far successfully used to safely sail through the longest eclipses.

Some problems have been identified in operating the SPICAM instrument. These problems are currently not understood, but despite the problems the instrument still delivers excellent science data.

As the spacecraft has been configured for the low-power/aphelion season, payload operations had to be suspended 10 weeks.

Early next year (Feb-Mar 2007) the default Mars Express groundstation (New Norcia) will be used by Rosetta – for which it is as well the designated prime ground station -for the preparation and execution of its mars flyby. With Cebreros being used by Venus Express and DSN availability uncertain, this will probably mean two months with almost zero science return for Mars Express.

A Mars-Express science working team and science operations working group meeting was held at ESOC 28-30 June 2006. At this meeting the OMEGA PI, once again, announced that he would discontinue delivering data to the archive. The OMEGA data (and that of some other instruments) is now well overdue for delivery into the archive.

The latest major Mars Express discovery was made by the SPICAM team concerning the existence of very high-altitude CO₂ clouds in the Martian atmosphere (see web release):

http://www.esa.int/esaSC/SEMC4JZ7QQE_index_0.html

A spectacular set of images covering the Cydonia region, and including the famous “face on Mars” and its current appearance following years of geological processing was released on the web in the last week of September.

Rosetta:

The Rosetta spacecraft and its payload are in excellent health and everything is set to prepare the Mars flyby on 25 February 2007.

Until 26 July the Rosetta spacecraft had been for two month Near Sun Hibernation Mode (NSHM). It was then reconfigured to Active Cruise Mode. Before entering the NSHM the Solar Conjunction activities were completed on 18 May 2006, though TM/TC link was actually never permanently lost. This phase included the RSI solar corona sounding campaign from 15 March until 18 May. During NSHM RPC, the Rosetta Plasma

Consortium carried out a measurement campaign in the (far) downstream tail region of comet Honda between 4 and 9 July 2006. Preliminary analysis of the data, which was presented by the team during the 21st Rosetta SWTM at ESOC, 14/15 September, indicates that the Magnetometer detected the tail. The observations are so promising that similar campaigns have been requested for future potential comet tail crossings. As usual, the Standard Radiation Monitor (SREM) has been the only payload element operated continuously and is active in background mode with accumulation parameters configured for active cruise. The first summary results from the SREM covering the first two years of the mission were presented at the last SWTM.

The next big event for Rosetta will be the Mars flyby on 25 February 2007 with the closest approach at 01:53 UTC. In preparation for this crucial mission milestone the DSN/ESA Tracking Campaign already started on 28 August. Before that two DSN delta-DOR tracks of 1-hour each were performed (DSS 24/45 and DSS 55/25) beginning of August. This was the first time that delta-DOR measurements were taken with Rosetta. The data processing performed by Flight Dynamics that the reduced delta-DOR data were of excellent quality.

Before the actual Mars flyby, OSIRIS will observe Lutetia, the mission's second asteroid target in January; and in April Rosetta will support a joint Jupiter observation campaign in support of NASA's New Horizon mission to Pluto.

Cassini/Huygens

The International Academy of Astronautics (IAA) has selected the Cassini-Huygens team for the 2006 Laurels for Team Achievement. A special Cassini-Huygens session was organized on 1 October at the IAC in Valencia, Spain. Jean-Pierre Lebreton, Daniel Gautier and Tobias Owen have been awarded the Grand Prix Marcel Dassault de L'Academie de Science for their work on Cassini-Huygens. The award ceremony will take place on 28 November in Paris.

The Cassini orbiter continued its exciting journey through the Saturn system and delivers excellent science. Extended Cassini Orbiter mission scenarios will be discussed at the Cassini-Huygens PSG in Pasadena in October. Titan and Enceladus are the two primary targets for the extended mission. The final tour selection for the extended is foreseen in January 2007.

Five out of the eight Huygens scientific data sets (ACP, GCMS, HASI, DWE, engineering data set) were delivered to the ESA Planetary Science Archive (PSA) in early August. The data set is also mirrored in the NASA PDS atmospheric node. The remaining three data sets (SSP, DISR, DTWG) are still in the review process that needs to be fully completed before the data are being released. The Huygens VLBI data products will be added later.

Recent scientific highlights of the mission include, 'Methane drizzle on Titan' by Tokano et al., Nature 442, 432-435 (27 July 2006) and 'Evidence for a Polar Ethane Cloud on Titan', by Caitlin Griffith, published in the 15 September issue of Science.

A multi-lingual version of the Huygens movie was made available to the wide public during the summer through collaboration between Europlanet and the Communication Support Office of the Directorate. A copy of the CD-ROM will be included in the October issue of Ciel&Espace.

Double Star:

A status report will be given at the meeting as part of the presentation of the proposal to endorse the mission for an additional ten month.

Venus Express:

RSSD took over the management of the mission from the Project Team after the successful completion of the VEX Commissioning Results Review held 4 July at ESOC. Payload and spacecraft operations have been running smoothly despite the fact, that the spacecraft entered four safe modes since end of August. However, operations were recovered very fast and the spacecraft was back within hours in nominal science mode. First results from the mission were presented at the Europlanet Science Conference in Berlin, 17-22 September.

A special presentation on the status of Venus Express and the first results will be given by the VEX Project Scientist at the meeting.

SMART-1:

The operational mission of SMART-1 ended on 3 September, at 07:42:22 CEST (05:42:22 UT), when the New Norcia ground station in Australia suddenly lost radio contact with the spacecraft. SMART-1 ended its journey in the Lake of Excellence, at latitude 34.4° South and longitude 46.2° West.

The impact took place on the nearside of the Moon, in a dark area just near the terminator at a 'grazing' angle of between 5 and 10 degrees and a speed of about 2 kilometres per second. The impact time and location was planned to favour observations of the impact event from ground-based telescopes. This was achieved by a series of orbit manoeuvres and orbit corrections performed during the course of summer 2006, using very ingenious combinations of wheel off – loadings and thruster firings to reach an optimum orbit. The last of these manoeuvres was performed on 1 September. A final orbit adjustment had to be implemented as a reanalysis of available lunar data performed at the University of Nottingham suggested that, in the absence of any further manoeuvres, impact would very likely occur one orbit earlier, at 02:38 CEST (00:38 UT) during orbit 2889, if SMART-1 clipped the rim of Clausius crater.

The planned impact concluded a very successful mission that, in addition to testing innovative space technology, had been conducting a thorough scientific exploration of the Moon for about a year and a half. For the last 16 months and until its final orbits, SMART-1 had been studying the Moon, gathering data about the morphology and mineralogical composition of the surface in visible, infrared and X-ray wavelength ranges.

Professional and amateur observers – from South Africa to the Canary Islands, South America, the continental USA, Hawaii and many other locations – participated in the ground based campaign to observe the impact. The most impressive observation was the impact flash in the Infrared as observed by the Canada-France-Hawaii telescope (CFHT). JIVE, the Joint Institute for Very long Baseline Interferometry in Europe coordinated a very successful joint SMART-1 observation campaign that included five radio telescopes. Besides its mission proper, SMART-1 served as a test bed to test and calibrate parts of the ground segment to be implemented by the Chinese and Indian Space Agencies in preparation of their future lunar missions Chang'e 1 and Chandrayaan.

BepiColombo:

A brief status report will be given at the meeting by the BepiColombo Project Manager.

* * *