Date: Mon, 5 Jan 1998 16:43:55 -0700
Subject: launch scrubbed 1/5/98

The launch was scrubbed today at L-1 hr due to a radar system required by range safety being red. Looks like we're recycling for tomorrow. The launch window tomorrow is 4 minutes long and opens at 02:28:43 GMT, or 06:28:43 PM PST.
- Marcie

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Date: Wed, 7 Jan 1998 04:49:53 -0700
Subject: Lunar Prospector Status Report - inputs to PAO reports #1 & #2

At 1230 GMT, the spacecraft is performing very well and we are continuing through the first day timeline. The science booms have been deployed and all instruments have been turned on. The spacecraft is spinning at 11.2 rpm at the nominal cruise attitude. The first trajectory correction maneuver (TCM#1) was performed with preliminary results looking very good.
All times are GMT on January 7.

02:28:43 Launch!
03:25 Nominal s/c turn-on
03:25 TRDS saw the signal but could not lock up on telemetry. Reason unknown at this time.
03:45 Goldstone (DSS 16 and 24) start of pass
03:46 Receiver locked on signal
03:49 Lock on telemetry 300 bps - telemetry was very noisy and glitched in and out of lock (see below). Verified spacecraft operation - transmitter on, 51 rpm, nominal attitude, science off, all nominal.
04:32 began commanding - sent a test command
04:46 began the first steps in the timeline
05:52 began the first reorientation maneuver, a 90 deg turn. The data quality improved somewhat after the maneuver.
06:14 changed to the science data rate of 3600 bps. Solid lock on the telemetry was established from this point on.
06:33 spun down from 51 rpm to 31 rpm in preparation for boom deployment
06:35 turned on the MAG instrument to monitor boom deployment
06:39 deployed the magnetometer instrument boom
07:09 began science boom deployment (which reduced the spin rate to 6.8 rpm)
07:27 confirmed all three science booms completely deployed
07:46 spun up to 11.2 rpm
08:06 ER on
08:10 Spectrometer Electronics on
08:23 NS on
08:26 GRS on
08:29 APS on
Spectrometers configured
09:23 Reorientation to nominal cruise attitude (22 deg turn)
09:45 ER Cover removed

10:10 ER configured
12:55-12:28 TCM#1 fired 61.5 m/s

It was expected that the data might be poor at initial acquisition because of the geometry of the link. The ground station was looking at the back end of the spacecraft, and the antenna, although it is omnidirectional, was on the top of the spacecraft, so the signal was blocked by the spacecraft structure. We had hoped we could start the reorientation maneuver to bring the spacecraft around before the data got poor. But the data was noisy enough that it was felt to be too risky to command the maneuver until the data got better, which took over an hour.

When it was realized that the boom deployment sequence would occur later than expected, the original reorientation was modified to put the spacecraft in a slightly more favorable thermal condition for boom deployment. The spacecraft was oriented to the nominal cruise attitude after the science configuration.

Tomorrow we will turn the science instruments to high voltage and perform TCM#2 if required and we should be back on the timeline.

Thanks to everyone on the team! Congratulations!

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Date: Thu, 8 Jan 1998 01:46:14 -0700
Subject: Lunar Prospector Status - input to PAO report #3

At 0900 GMT January 8 (1 am PST), we have completed day 2's activities. We have had excellent support from the DSN and have had no significant outages in telemetry or command uplink. The major activity throughout the day was monitoring engineering and science data for the first full day of spacecraft operation. All systems look normal. One configuration command was sent to the APS instrument to collect better statistics. Command activity began tonight at about 10 p.m., when the Electron Reflectometer, Neutron Spectrometer, and Gamma Ray Spectrometer instruments were commanded to high voltage. There were no anomalies and all instruments are providing good data. The focus for the instruments now is to collect calibration data enroute to the moon.

The second trajectory correction maneuver was performed tonight. It was fairly small, 8.4 m/s, and the navigation team will take overnight to verify the results. A third TCM has been scheduled for Friday night/Saturday morning, to trim out any final errors.

It had been scheduled that the spacecraft would be placed into its attitude for LOI burn after the TCM tonight, but that has been postponed until tomorrow afternoon. This will allow the dynamics engineer to get an update on the initial attitude, which changed slightly due to the TCM.

Timeline from today:

Jan 7 @ 19:46 GMT, configuration change to APS instrument

Jan 8
06:09 - 06:54 ER to high voltage
07:04 - 07:25 NS to high voltage
07:35 - 07:44 GRS to high voltage
08:25 - 08:40 TCM#2 8.4 m/s

Current configuration: spinning at 12.685 rpm, cruise attitude, all instruments on. Transmitting at 3600 bps (science format) on the omni antenna.

Tomorrow there will be a command session beginning about 5 p.m. local PST (0100 GMT 1/9/98) to command two of the instruments which may need gain changes, and to reorient the spacecraft to the LOI attitude.

==========
Date: Thu, 8 Jan 1998 23:51:15 -0700
Subject: Lunar Prospector Status 1/9/98 0800 GMT - input to PAO report #4

At 1/9 0800 GMT (Thursday night midnight PST), the spacecraft continues to perform beautifully. Today's activities focussed on some calibration sequences for the science instruments and analysis of the results of the 2nd trajectory correction maneuver executed last night. Results were terrific; we are now very close to being on target - if we do execute a third TCM tomorrow night, it will be only a 1 or 2 second burn.

Station 24 at Goldstone had trouble locking up on the telemetry at the start of its pass today. For about 1.5 hours, the data was noisy and glitching in and out of lock. After they adjusted the subcarrier frequency a bit, they locked up and stayed in solid lock. A telecon will be set up tomorrow with the DSN engineer to work out procedures to prevent this problem in the future. Due to the rolling storage of data, 53 minutes of this data will be corrected by data processing.

Commanding today consisted of science configuration and calibration commanding and the execution of the reorientation maneuver placing the spacecraft into its attitude for Lunar Orbit Insertion (LOI).

Commanding (GMT times)
03:15-04:50 MAG/ER configuration commanding
05:00-05:12 Spectrometer commanding
06:30 Reorientation maneuver (31 deg)

The spacecraft is essentially ready for LOI - at the right attitude and spin period, and on course. A very small velocity trim may be executed tomorrow night. The spacecraft has all 5 instruments on collecting good data. To date, 250 commands have been sent to the spacecraft and all have executed normally.

==========

Date: Sat, 10 Jan 1998 10:08:26 -0700
Subject: Lunar Prospector Status report 01/10/98 - input to PAO #5

The spacecraft continues to perform well. Yesterday only a few (8) science configuration commands were sent. The third trajectory correction maneuver was cancelled. We are now expected to reach closest approach to the moon within 4 seconds of our planned time, and fly by at an altitude within 3 km of the target. The attitude of the spacecraft is also correct for the lunar orbit insertion firing and so a reorientation trim maneuver was cancelled last night also. The LOI burn is scheduled for 1/11 at 1145 GMT
(3:45 am tomorrow morning PST).

A brief summary of yesterday's events includes:

1/9 23:31 GMT Science instrument gain commands sent
23:47-00:13 Telemetry outage (pre-scheduled) for some ground equipment at the DSN to be rebooted. Data was replayed from the station later.
1/10 02:53 GMT Science instrument gain commands sent

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Date: Sun, 11 Jan 1998 06:17:09 -0700
Subject: Lunar Prospector Status - in orbit! - input to PAO report #6

The Lunar Prospector spacecraft has successfully entered orbit about the moon! Preliminary analysis of the tracking data shows that the s/c is in an 11.8 hour period orbit, very close to the target 12 hour orbit. The insertion into lunar orbit today was the most critical event for the spacecraft - if the engines could not be commanded to fire within about 2 hours of the time of closest approach, the mission would end in a flyby of the moon. Now, the s/c is safely in a stable orbit and although the second and third LOI burns are scheduled for tomorrow and Tuesday, they are not
time critical.

Today's events are summarized below
Jan 10 23:27 to Jan 11 00:49 (GMT) 18 science configuration commands sent
Jan 11 01:00 to 02:40 telemetry lost due to problems in getting trajectory predictions to the station
Jan 11 06:45 GMT the threshold of the Earth-Moon Limb sensor was set in preparation for lunar orbit
Jan 11 10:34 GMT thruster heaters turned on in preparation for the orbit insertion burn (this is done for every maneuver, I just haven't reported it before)
Jan 11 10:45 GMT the maneuver command was loaded into the s/c register and began timing down
Jan 11 11:45 to 12:17 Lunar Orbit Insertion (LOI)#1 fired
the two thrusters on the bottom of the spacecraft fired for 32.2 minutes continuously to slow the spacecraft down and enter lunar orbit.

Jan 11 12:20 GMT spacecraft engine configuration safed for end of maneuver

The latest pre-LOI trajectory showed that we flew by the moon at an altitude of 71 km, about 11 km below the original target. The inclination of the orbit should be about 89.7 deg, just below the 89.9 deg target. The time of closest approach was estimated to be 33 seconds earlier than the original target. The spacecraft is spinning at 13.2 rpm; all science instruments are on and working - the spectrometer scientist was thrilled to see his first lunar data during the closest approach. The initial estimate of the orbit period is 11.8 hr; this would mean the orbit would reach an altitude of just over 8,500 km at its furthest distance from the moon just under six hours after the burn. A contingency spin trim maneuver scheduled for after the LOI burn was cancelled, as there was very little change in the spin rate during the maneuver and it was not necessary.

The spacecraft performed perfectly throughout the maneuver, even though there were outages in the data. The DSN stations lost lock on the uplink and downlink signal from the spacecraft during the burn due to problems in getting the trajectory predicts to the station before the maneuver. About 5 minutes of data was lost. The prediction problem is now understood and there should not be similar outages during LOI#2 and LOI#3.

There is a capture orbit correction maneuver scheduled for 1/11 17:40 GMT (9:40 AM PST) if necessary. This will allow correction of the inclination if it was perturbed enough during the LOI burn. The next activity will occur at about 11:15 GMT (3:15 am Monday morning PST), when another 30 minute burn fires to reduce the orbit period to only 3.5 hours at LOI#2.

==========
Date: Sun, 11 Jan 1998 09:04:08 -0800
Subject: Capture Orbit Correction

The Capture Orbit Correction maneuver is not necessary so it has been cancelled.

As soon as we know the time for the next maneuver you will be notified.

==========
Date: Mon, 12 Jan 1998 04:53:29 -0700
Subject: Lunar Prospector Status 1/12/98 - input to PAO report #7

Lunar Prospector is now 2/3 of the way into its mapping orbit configuration. Lunar Orbit Insertion Burn #2 was successfully completed this morning, placing the spacecraft into a 3.5 hour period orbit. The spacecraft continues to perform perfectly.

The LOI#2 periselene (closest approach) altitude was 83 km, and the aposelene altitude (furthest distance) is expected to be about 1870 km. Closest approach during the LOI#2 burn occurred at 11:12 GMT. Periapsis is about 30 degrees north and the orbit plane is currently just about perpendicular to the earth-moon

line. If you were looking at the moon (behind the clouds here at Ames), you would see the entire orbit, with periapsis to the upper right and the aposelene about half a lunar diameter away from the moon to the lower left. This means the spacecraft never gets behind the moon as seen from earth and we have continuous communications with it. After LOI#3 tomorrow morning, we start having 20 minute occultations each 2 hour orbit, which increase to 47 minutes within a week. The orbit plane is also perpendicular to the moon-sun line, so that the spacecraft does not go behind the moon into shadow. The first eclipses start about 9 days after LOI#3.

The current spacecraft configuration is all science instruments on, 3600 bps on the omni antenna, spinning at 12.15 rpm with the spin axis in the LOI burn attitude. To date, the spacecraft has burned 68% of its initial fuel load of 138 kg. Tomorrow's LOI burn will use another 17%, leaving 34 kg for maintaining the mapping orbit.

Commanding activities today were centered on the LOI burn:
All commanding took place on Jan 12 GMT:
10:32 turned thruster heaters on
10:43 loaded maneuver commands into spacecraft command register
10:58-11:25 LOI#2 burn (27.1 minute burn)
11:28 maneuver safing
11:38 spin thruster heater on
12:03 executed 5 sec burn to drop spin rate from 13.9 to 12.1 rpm

==========
Date: Tue, 13 Jan 1998 05:34:45 -0700
Subject: Lunar Prospector in mapping orbit -input to PAO report #8

The Lunar Prospector spacecraft was successfully placed in its mapping orbit this morning, when the third Lunar Orbit Insertion burn was completed. Firing the two aft axial thrusters for 27 minutes, the orbit was nearly circularized at about 100 km altitude. All science instruments are collected good data, and the spacecraft is working perfectly.

The LOI#3 flyby altitude was 89 km, at an inclination of 89.93 deg. Initial estimates from the navigation team are that the burn was about 4% low, and the orbit is about 92x160 km. The burn lasted 27 minutes and used about 23.5 kg of propellant. The spacecraft now has 34 kg of propellant for maintaining the mapping orbit during the one year nominal mission.

After the burn, the spin rate was trimmed back to 12 rpm for science requirements. Tomorrow the science instrument gains will be tweaked to match the data seen in the mapping orbit. Thursday the orbit will be circularized, the attitude oriented to the nominal attitude (spin axis perpendicular to the ecliptic plane) and the antenna switched to the medium gain antenna.

Lunar occultations, where the spacecraft passes behind the moon as seen from the earth ground stations, will start later today.

The timeline of activities is given below:
013/10:27 GMT thruster heaters turned on
10:38 GMT command sent to start the maneuver with 1 hour time delay
11:38 - 12:05 LOI burn: 27.0 minutes, 23.5 kg of propellant
12:07 GMT engines safed
12:18 GMT spin thruster heater turned on
12:54-13:01 - expected occultation did not occur because of underburn
13:11 GMT spin trim: 2.0 second burn; spin rate 13.1 to 12.01 rpm

The navigation team will know the final orbit in about a couple of hours.

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Date: Wed, 14 Jan 1998 10:24:47 -0700
Subject: Lunar Prospector Status 1/14/98 - input to PAO report #9

The spacecraft continues to operate nominally. No command activities were scheduled for the last 24 hours as the operations team began a shift to normal hours. Once an orbit spacecraft occultations began occurring at 1854 GMT yesterday. The first one lasted about 7 minutes, and already they have increased in length to 33.5 minutes. As the moon goes around the sun, occultations will repeat with a 14 day cycle - 11 days with occultations and 3 days without. Solar eclipses begin in about 8 days, and as they are related to the position of the sun, they repeat in half-year cycles, so that we will have eclipses every orbit for 147 days, then 40 days without eclipses before repeating.

The final orbit determination shows the spacecraft in a 92 x 153 km orbit. The inclination is 90.1 and the orbit period 2 hours. This will be trimmed on Thursday to be within the desired 100±20 km orbit. This morning, we plan to do some science configuration commanding.

==========
Date: Thu, 15 Jan 1998 10:45:07 -0700
Subject: Lunar Prospector Status 1/15/98 - input to PAO report #10

The spacecraft continues to operate nominally in its 2 hour period orbit. Now that the spacecraft is in low lunar orbit, radio science data has begun to be collected at the Deep Space Network. These data will be used by the Gravity Experiment scientist, Alex Konopliv at JPL, to get a much more detailed gravity map of the moon. We are currently in orbit 37, with the spacecraft in its Lunar Orbit Insertion attitude, spinning at 12 rpm. All science instruments are on and collecting good data. The spacecraft experiences occultations once each orbit, when it goes behind the moon and communications are lost. Data is continually saved in a 53 minute rolling storage unit on the spacecraft C&DH. Currently, occultations are 41 minutes long, approaching the maximum of 47 minutes.

Yesterday at 19:34 GMT, 10 science configuration commands were sent to set the gains on the spectrometer instruments.

Later today, the orbit will be trimmed to circularize it to the 100 km ± 20 km mapping orbit. After the orbit trim, the spacecraft will be precessed to its nominal mapping orbit attitude, with the spin axis perpendicular to the ecliptic plane.

Status at 1800 GMT, 1/15/98:
Orbit: 37
Orbit Altitude: 92 x 153 km
Period: 2 hrs 0 min
Attitude: LON: 197 deg; LAT 59 deg
Spin Rate: 12.0 rpm
Comm: 3600 bps; OMNI antenna
Occultations: 41 minutes each orbit
Eclipses: none

==========

Date: Thu, 15 Jan 1998 16:49:55 -0700
Subject: Lunar Prospector status 1/16/98 GMT - input to PAO report #11

The Lunar Prospector orbit trim maneuvers and spacecraft attitude reorientation were successfully completed this afternoon. Final determination of the orbit will not be available for several hours, as the navigation team must collect data for an orbit or two. The spacecraft performed nominally and it is expected that the orbit is now within the 100 ± 20 km altitude orbit desired for mapping. The attitude is also expected to be within a degree of the desired mapping attitude, with the spin axis near normal to the ecliptic plane.

The timeline of events are as follows:
015/20:31 GMT - thruster heaters on
015/21:44 GMT - thruster firing to lower aposelene from 153 km to 100 km
76.6 sec burn to reduce speed by 12.1 m/s
015/22:06 GMT - thruster heaters on
015/22:32 GMT - thruster firing to raise periselene from 92 km to 99 km
16.4 sec burn to reduce speed by 2.6 m/s
015/23:32 GMT - thruster heaters on
015/23:57 GMT - pulsed thruster firing to reorient attitude to mapping attitude
139 pulses fired to precess spin axis 31.5 degrees
target attitude: latitude: 89 deg; longitude 296 deg

The science instruments are all on and collecting good data. In tomorrow's report I will include more accurate results of today's maneuvers.

==========

Date: Fri, 16 Jan 1998 08:32:07 -0700
Subject: Lunar Prospector Status 1/16/98 - input to PAO report #12

The Lunar Prospector spacecraft has successfully reached its mapping orbit. Yesterday's trim maneuvers placed the spacecraft into a 99 km x 100 km altitude

orbit with an inclination of 90° and a period of 118 minutes. This orbit will change over time as the gravity anomalies of the moon pull on the orbit, but it is expected that it will remain within the mapping orbit limits for a couple of weeks. As one of the experiments is to learn more about the gravity model of the moon, the time between maneuvers is somewhat uncertain.

The initial estimate of the spin axis pointing after yesterday's reorientation shows it about 2.7 degrees from the target but within acceptable limits.

The current state of the spacecraft as of 1600 GMT 1/16:

Orbit number: 48
Science: all instruments on
Downlink: 3600 bps, omni antenna
Spin Rate: 12.09 rpm
Spin Axis Attitude:
Latitude: 87.1
Longitude: 218
Orbit: Periselene: 99 km
Aposelene: 100 km
Period: 118 min

Earth Occultations: 44 min
Solar Eclipses: none

Merge files have been delivered through day of year 013.

==========
Date: Wed, 21 Jan 1998 16:33:22 -0700
Subject: Lunar Prospector status 1/22 GMT - input to PAO report #13

Status of Lunar Prospector as of 1/22/98 00:00 GMT

Orbit: 113
Downlink: 3600 bps
Spin Rate: 12.08 rpm
Spin Axis Attitude:
Latitude: 88.8 deg
Longitude: 233 deg
Trajectory:
Periselene: 80 km
Aposelene: 120 km
Period: 118 minutes
Occultations: 45 minutes
Eclipses: 3 minutes (penumbra only)
Upcoming events:
Monitoring of spacecraft power parameters as eclipses become longer.
Configuration commanding of MAG/ER scheduled for Thursday afternoon.

==========
Date: Fri, 23 Jan 1998 16:51:33 -0700
Subject: Lunar Prospector Status 1/23/98 - input to PAO report #14

The Lunar Prospector spacecraft continues to operate well. The current state (as of 0000 GMT 1/24/98) is:

Orbit: 137
Downlink: 3600 bps
Spin Rate: 12.09 rpm
Spin Axis Attitude:
  Latitude: 87.9 deg
  Longitude: 224 deg
Trajectory:
  Periselene: 90 km
  Aposelene: 110 km
  Period: 118 minutes
Occultations: 35 minutes
Eclipses: 15 minutes

72 commands were sent yesterday to set gains for the MAG/ER instruments and to put the downlink to the Medium Gain Antenna. This increased the signal level by about 7 dB, improving the data return at the 26 m stations.

Upcoming events:
On Monday, a small spin axis attitude reorientation maneuver will be executed, followed by a spin trim.

==========
Date: Mon, 26 Jan 1998 17:55:04 -0700
Subject Lunar Prospector Status 1/26/98 - input to PAO report #15

The Lunar Prospector spacecraft continues to operate well. The current state (as of 0000 GMT 1/27) is:

Orbit: 174
Downlink: 3600 bps
Spin Rate: 11.94 rpm
Spin Axis Attitude (maneuver target):
  Latitude: 89.3 deg
  Longitude: 352 deg
Trajectory:
  Periselene: 88 km
  Aposelene: 112 km
  Period: 118 minutes
Occultations: none
Eclipses: 25 minutes

24 commands were sent today to reorient the spin axis and trim the spin rate. The spin axis is approximately aligned with the ecliptic North Pole, but it is tilted about 1 deg or so towards the sun for thermal reasons and to reduce boom shadowing on the solar arrays. As the earth moves around the sun, the spin axis must be tweaked a bit to maintain this configuration. The spin rate will be kept to 12.0 ± 0.1 rpm during the gravity mapping period - the first two months of the mission. The timeline of events is given below:

1652 Thruster heaters commanded on
1718 Reorientation maneuver - 12 pulses to precess the spin axis 2.4 deg.
1720 Reset Thrusters
1728 Thruster heater commanded on
1754 Spin trim 12.098 rpm -> 11.936 rpm (0.61 sec burn)
1754 Reset Thrusters

Upcoming events:
None scheduled

==========
Date: Thu, 29 Jan 1998 17:16:46 -0700
Subject: Lunar Prospector Status 1/29/98 - input to PAO report #16

On Wednesday (1/28 at 23:48 GMT), 5 configuration commands were sent to the Magnetometer/Electron Reflectometer instrument box.
The Lunar Prospector spacecraft continues to operate well. The current state (as of 00:00 GMT 1/30) is:

Orbit: 211
Downlink: 3600 bps
Spin Rate: 11.94 rpm
Spin Axis Attitude:
Latitude: 89.5 deg
Longitude: 331.2 deg
Trajectory:
Periselene: 86 km
Aposelene: 114 km
Period: 118 minutes
Occultations: 43 minutes
Eclipses: 30 minutes

Lunar Prospector is into its second week of mapping orbit operations and has transitioned into a production mode, whereby telemetry and orbit ephemeris products are routinely generated in support of science data processing. While Lunar Prospector has no onboard tape recorders, it does store up to 53 minutes of data in solid state memory and continuously replays that delayed stream along with the real-time stream. This feature provides access to data collected during ground station occultations --- when the spacecraft passes behind the moon as viewed from Earth.

LP telemetry contains measurements made by each science instrument at regular intervals. Knowing the time of the measurements and having an orbit ephemeris indicating where the spacecraft was at those times, scientists can compile a history of measurements over each region of the moon. A very large number of measurements are required since the various data signals being measured by each instrument are low in power and high in noise level. It is only by taking a large number of such measurements that the noise on the signal can be "averaged out" (since typically such noise is random in nature), leaving only the true measurement behind. Having successfully placed Lunar Prospector in the required mapping orbit and checked out the spacecraft, scientists and engineers are currently focused on the important task of science data collection and processing.

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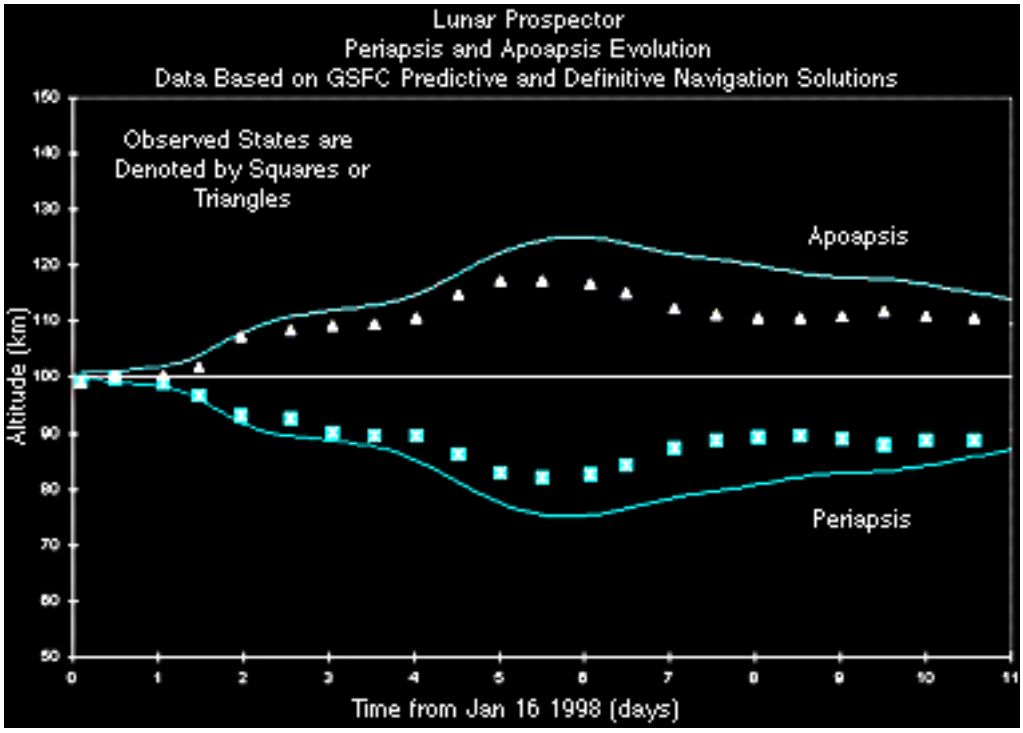
Lunar Prospector Mission Status Report #17

February 06, 1998 - 6:00 p.m. EST (3:00 a.m. PST)



As discussed in previous status reports, Lunar Prospector scientists require orbit ephemeris data that describe the position of the spacecraft over the moon in order to accurately map data collected by their instruments onto the lunar surface. An accurate history of the Lunar Prospector trajectory over the moon is referred to as a "definitive" orbit ephemeris. A prediction of the future path of the spacecraft is referred to as a "predicted" orbit ephemeris. For Lunar Prospector, engineers at NASA's Goddard Space Flight Center use Doppler data collected by tracking stations from the Jet Propulsion Laboratory's (JPL) Deep Space Network to compute a definitive orbit ephemeris. Predicted orbit ephemeredes are also generated for several weeks into the future in order to

enable mission controllers to schedule station tracks, anticipate shadow events and plan orbit maneuvers as necessary. Long-term predictions of the path of low altitude lunar orbiting missions is made difficult by the moon's non-uniform gravity field that results from an uneven distribution of the moon's mass. The non-uniform mass distribution of the moon makes it necessary to construct complicated models of the lunar gravity in order to accurately predict the evolution of the LP orbit over time. The figure above shows predictions made shortly after entering
the mapping orbit of the periapsis (lowest) and apoapsis (highest) altitude of Lunar Prospector compared with actual values computed from a definitive orbit. Such figures are used to assess the accuracy of candidate lunar gravity models. The Doppler Gravity Experiment (see description under the "Instrument" heading of the LP Web site's Science section) conducted by Dr. Alexander Konopliv of JPL, will among other things, help construct an improved gravity model of the moon which can be used by this and future missions to compute accurate long-term orbit predictions. Until now, very few missions have orbited the moon close enough and long enough to allow a highly accurate lunar gravity model to be constructed. Lunar Prospector is unique, in that it will orbit the moon in a low polar orbit (dropping as low as 10 km during the extended mission) that will provide gravity data over the entire lunar surface every two weeks. Already, preliminary gravity models from the Doppler Gravity Experiment are being generated which appear to be tracking definitive solutions much more closely than the sample pre-launch model shown in the figure above.

==========
Date: Mon, 2 Feb 1998 12:51:21 -0700
Subject: Lunar Prospector status 2/1/98

Lunar Prospector Status Report - input for PAO report #18

Over the weekend, there was an anomaly with the Spectrometer Instrument electronics that has been corrected. At 14:18 GMT on 1/31/98, the instrument seemed to have inexplicably frozen up - a fixed hex pattern was coming from the instrument with no valid data. After many discussions with the mission director and instrument PI, it was decided to power the instrument off and then on again to correct the problem. Commands were sent that evening and the instrument was operating and properly configured again by 04:21 on 2/1. The cause of the anomaly is not known at this time.

The timeline of recovery activities (2/1 GMT):
01:47-01:55 - 3 cmds sent to the spectrometer electronics. These did not execute.

01:58-02:06 - Spectrometer electronics powered off and then on again. Appeared immediately to be sending valid data again.

02:17 - 04:21 Instruments reconfigured and hi voltages turned on. These commands are all through the spectrometer electronics and validated that the instrument commands were executing properly again and that the telemetry data was valid again.

A total of 38 commands were sent.

Current spacecraft state (18:00 GMT 2/2/98, DOY 033):

Orbit: 256
Downlink: 3600 bps
Spin Rate: 11.94 rpm
Spin Axis Attitude:
  Latitude: 89.2 deg
  Longitude: 13.54 deg
Trajectory:
  Periselene: 96 km
  Aposelene: 104 km
  Period: 118 minutes
Occultations: 46 minutes
Eclipses: 32 minutes

==========
Date: Mon, 9 Feb 1998 15:07:21 -0700

Subject: Lunar Prospector Status 2/9/98 - input to report #19

Lunar Prospector Status Report

The spacecraft continues to perform very well. There were no anomalies or commanding activities this week. A small reorientation maneuver is planned for tomorrow afternoon to keep the orientation of the spin axis so that the sun angle is pointing slightly to the top of the spacecraft for thermal reasons.

Current spacecraft state (00:00 GMT 2/10/98, DOY 041):

Orbit: 345
Downlink: 3600 bps
Spin Rate: 11.94 rpm
Spin Axis Attitude:
  Latitude: 89.3 deg
  Longitude: 24.8 deg
Trajectory:
  Periselene: 92 km
  Aposelene: 109 km
  Period: 118 minutes
  Inclination: 90.3 deg
Occultations: none
Eclipses: 39 minutes

==========
Date: Thu, 19 Feb 1998 09:24:45 -0700
Subject: Lunar Prospector Status 2/19 - input to report #20

The spacecraft continues to perform very well and all instruments continue to collect good data. A small reorientation maneuver was performed last week to keep the orientation of the spin axis so that the sun shines slightly on the top of the spacecraft for thermal reasons.

The reorientation maneuver was executed on DOY 041 (Day of Year 41 or Feb 10) with the following timeline (times are GMT):
2229 Thruster Heaters on
2255 Fire 12 0.2-sec pulses with the A1/A4 thrusters
2257 Safe thrusters

The reorientation maneuver was expected to precess the spin axis by 1.7 deg; expecting to put the sun equatorial angle at 1.0 deg (sun shining just slightly from the top). Actual performance was a bit higher than expecting, precessing about 1.84 degrees, and putting the SEA at 1.25 deg. 13 commands were sent.

Current spacecraft state (00:00 2/19/98 GMT, DOY 050):

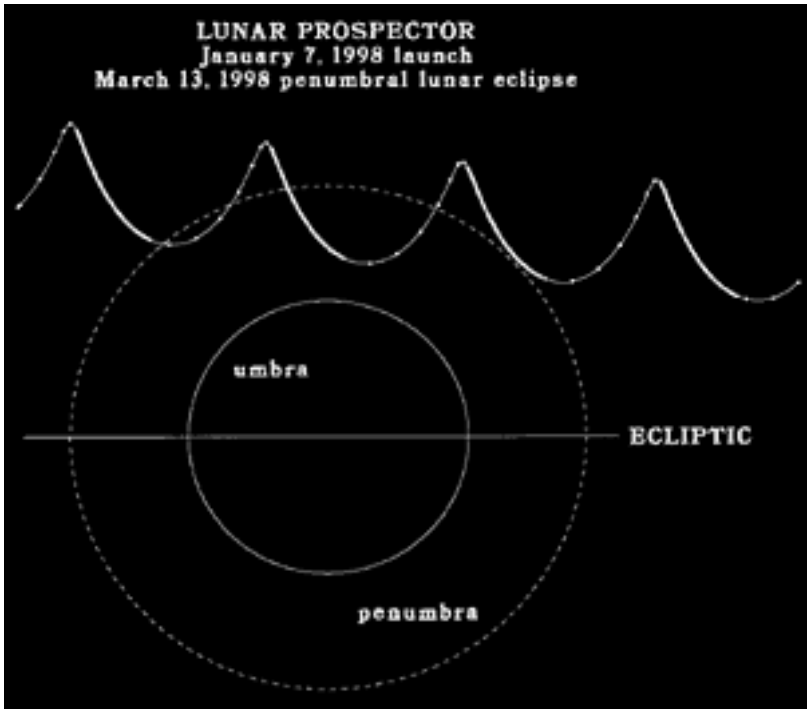
Orbit: 455
Downlink: 3600 bps
Spin Rate: 11.94 rpm
Spin Axis Attitude:
  Latitude: 88.1 deg
  Longitude: 18.22 deg
Trajectory:
  Periselene: 85 km
  Aposelene: 115 km
  Period: 118 minutes
  Inclination: 90.3 deg
Occultations: 43 minutes
Eclipses: 42 minutes

==========
Date: Thu, 26 Feb 1998 17:15:54 -0700
Subject: Lunar Prospector Status 2/27/98 - input to report #21

The spacecraft continues to perform very well and all instruments continue to collect good data. Only 2 commands were sent this past week. On Feb 21, commands were sent to tweak the gain setting on the Gamma Ray Spectrometer.

Because LP is no longer in the initial verification period after launch (nominally one month), we no longer get 24 hr/day coverage support from the DSN. This past week we were impacted by several launch events, all which also use the 26-m antenna network at the DSN for support. Coverage this past week totaled about 76 %.

The project is currently working on plans for the first orbit trim maneuver, where the s/c velocity will be changed at specific times to recircularize the orbit to the nominal 100 ± 20 km orbit. This is expected to be executed some time next week.



Also, we are planning for the March 13 partial eclipse of the moon. On March 13, from 0214-0626 GMT [the evening of March 12 local time], the moon will have the Sun partially blocked by the earth. The spacecraft orbiting the moon will enter and exit the penumbral shadow twice as it circles the moon during this period. The partial blockage of the sun will mean that the solar cells will not be generating full power during this time, and as the spacecraft will be having 46 minute long eclipses each orbit just from passing behind the moon. The reduced energy from the sun will slow the recharging of the spacecraft battery. We don't expect any problems but procedures are being written to allow us to safely monitor the spacecraft during this event.

Another item of astronomical interest, during the solar eclipse this morning, we lost about 9 minutes of data as the moon passed in front of the sun. This is not because of the eclipse itself, but the ground radio telescopes pointing at the spacecraft are also pointing almost right at the sun. This causes the ground receivers to pick up radio noise from the sun, making it hard to recognize the data.

Current spacecraft state (00:00 GMT 2/27/98, DOY 058):

Orbit: 565
Downlink: 3600 bps
Spin Rate: 11.94 rpm

Spin Axis Attitude:
  Latitude: 88.8 deg
  Longitude: 329 deg
Trajectory:
  Periselene: 78 km
  Aposelene: 123 km
  Period: 118 minutes
  Inclination 90.9 deg
Occultations: 47 minutes
Eclipses: 44 minutes

There will be an LP press conference next Thursday, March 5, at 10 am PST; televised on NASA TV to discuss some of the preliminary science results.

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Lunar Prospector Status Report #22

March 5, 1998 - 3:00 p.m. EST (12:00 noon PST)

Douglas Isbell
Headquarters, Washington, DC
March 5, 1998
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David Morse
Ames Research Center, Moffett Field, CA
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RELEASE: 98-38

LUNAR PROSPECTOR FINDS EVIDENCE OF ICE AT MOON'S POLES

There is a high probability that water ice exists at both the north and south poles of the Moon, according to initial scientific data returned by NASA's Lunar Prospector.

The Discovery Program mission also has produced the first operational gravity map of the entire lunar surface, which should serve as a fundamental reference

for all future lunar exploration missions, project scientists announced today at NASA's Ames Research Center, Moffett Field, CA.

Just two months after the launch of the cylindrical spacecraft, mission scientists have solid evidence of the existence of lunar water ice, including estimates of its volume, location and distribution. "We are elated at the performance of the space craft and its scientific payload, as well as the resulting quality and magnitude of information about the Moon that we already have been able to extract," said Dr. Alan Binder, Lunar Prospector Principal Investigator from the Lunar Research Institute, Gilroy, CA.

The presence of water ice at both lunar poles is strongly indicated by data from the spacecraft's neutron spectrometer instrument, according to mission scientists. Graphs of data ratios from the neutron spectrometer "reveal distinctive 3.4 percent and 2.2 percent dips in the relevant curves over the northern and southern polar regions, respectively," Binder said. "This is the kind of data 'signature' one would expect to find if water ice is present."

However, the Moon's water ice is not concentrated in polar ice sheets, mission scientists cautioned. "While the evidence of water ice is quite strong, the water 'signal' itself is relatively weak," said Dr. William Feldman, co-investigator and spectrometer specialist at the Department of Energy's Los Alamos National Laboratory, NM. "Our data are consistent with the presence of water ice in very low concentrations across a significant number of craters." Using models based on other Lunar Prospector data, Binder and Feldman predict that water ice is confined to the polar regions and exists at only a 0.3 percent to 1 percent mixing ratio in combination with the Moon's rocky soil, or regolith.

How much lunar water ice has been detected? Assuming a water ice depth of about a foot and a half (.5 meters) -- the depth to which the neutron spectrometer's signal can
penetrate -- Binder and Feldman estimate that the data are equivalent to an overall range of 11 million to 330 million tons (10-300 million metric tons) of lunar water ice, depending upon the assumptions of the model used. This quantity is dispersed over 3,600 to 18,000 square miles (10,000-50,000 square kilometers) of water ice- bearing deposits across the northern pole, and an additional 1,800 to 7,200 square miles (5,000-20,000 square kilometers) across the southern polar region. Furthermore, twice as much of the water ice mixture was detected by Lunar Prospector at the Moon's north pole as at the south.

Dr. Jim Arnold of the University of California at San Diego previously has estimated that the most water ice that could conceivably be present on the Moon as a result of meteoritic and cometary impacts and other processes is 11 billion to 110 billion tons.

The amount of lunar regolith that could have been "gardened" by all impacts in the past 2 billion years extends to a depth of about 6.5 feet (2 meters), he found. On that basis, Lunar Prospector's estimate of water ice would have to be increased by a factor of up to four, to the range of 44 million to 1.3 billion tons

(40 million to 1.2 billion metric tons). In actuality, Binder and Feldman caution that, due to the inadequacy of existing lunar models, their current estimates "could be off by a factor of ten in either direction."

The earlier joint Defense Department-NASA Clementine mission to the Moon used a radar-based technique that detected ice deposits in permanently shadowed regions of the lunar south pole. It is not possible to directly compare the results from Lunar Prospector to Clementine because of their fundamentally different sensors, measurement "footprints," and analysis techniques. However, members of the Clementine science team concluded that its radar signal detected from 110 million to 1.1 billion tons (100 million to 1 billion metric tons) of water ice, over an upper area limit of 5,500 square miles (15,500 square kilometers) of south pole terrain.

There are various ways to estimate the economic potential of the detected lunar water ice as a supporting resource for future human exploration of the Moon. One way is to estimate the cost of transporting that same volume of water ice from Earth to orbit.

Currently, it costs about $10,000 to put one pound of material into orbit. NASA is conducting technology research with the goal of reducing that figure by a factor of 10, to only $1,000 per pound. Using an estimate of 33 million tons from the lower range detected by Lunar Prospector, it would cost $60 trillion to transport this volume of water to space at that rate, with unknown additional cost of transport to the Moon's surface.

From another perspective, a typical person consumes an estimated 100 gallons of water per day for drinking, food preparation, bathing and washing. At that rate, the same estimate of 33 million tons of water (7.2 billion gallons) could support a community of 1,000 two-person households for well over a century on the lunar surface, without recycling.

"This finding by Lunar Prospector is primarily of scientific interest at this time, with implications for the rate and importance of cometary impacts in the history and evolution of the Solar System," said Dr. Wesley Huntress, NASA Associate Administrator for Space Science. "A cost-effective method to mine the water crystals from within this large volume of soil would have to be developed if it were to become a real resource for drinking water or as the basic components of rocket fuel to support any future human explorers."

Before the Lunar Prospector mission, historical tracking data from various NASA Lunar Orbiter and Apollo missions had provided evidence that the lunar gravity field is not uniform. Mass concentrations caused by lava which filled the Moon's huge craters are known to be the cause of the anomalies. However, precise maps of lunar mass concentrations covering the moon's equatorial nearside region were the only ones available.

Lunar Prospector has dramatically improved this situation, according to

co-investigator Dr. Alex Konopliv of NASA's Jet Propulsion Laboratory, Pasadena, CA. Telemetry data from Lunar Prospector has been analyzed to produce a full gravity map of both the near and far side of the moon. Konopliv also has identified two new mass concentrations on the Moon's nearside that will be used to enhance geophysical modeling of the lunar interior. This work has produced the first-ever complete engineering-quality gravity map of the moon, a key to the operational safety and fuel-efficiency of future lunar missions.

"This spacecraft has performed beyond all reasonable expectations," said NASA's Lunar Prospector mission manager Scott Hubbard of Ames. "The findings announced today are just the tip of the iceberg compared to the wealth of information forthcoming in the months and years ahead."

Lunar Prospector is scheduled to continue its current primary data gathering mission at an altitude of 62 miles (100 kilometers) for a period of ten more months. At that time, the spacecraft will be put into an orbit as low as six miles (10 kilometers) so that its suite of science instruments can collect data at much finer resolution in support of more detailed scientific studies. In addition, surface composition and structure information developed from data returned by the spacecraft's Gamma Ray Spectrometer instrument will be a crucial aspect of additional analysis of the polar water ice finding over the coming months.

The third launch in NASA's Discovery Program of lower cost, highly focused planetary science missions, Lunar Prospector is being implemented for NASA by Lockheed Martin, Sunnyvale, CA, with mission management by NASA Ames. The total cost to NASA of the mission is $63 million.

Read more in Ice on the Moon?

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Date: Fri, 6 Mar 1998 09:45:11 -0700
Subject: Lunar Prospector Status 3/6/98 - input to report #23

The spacecraft continues to perform very well and all instruments continue to collect good data. No commands were sent this past week.

After a 15-hour tracking gap last Friday, tracking allocations were better this week, with only a handful of short outages scheduled.

The first orbit trim maneuver is scheduled for this Saturday. Two axial burns are scheduled, one to raise periselene and the other to lower aposelene. The target orbit will not be exactly 100 km circular, but will be biased to allow the perturbations to keep the orbit within the desired 100 ± 20 km orbit for a longer time. The target orbit is 87 x 113 km.

Current spacecraft state (00:00 GMT 3/6/98, DOY 065):

Orbit: 650
Downlink: 3600 bps

Spin Rate: 11.94 rpm
Spin Axis Attitude:
  Latitude: 88.8 deg
  Longitude: 31.69 deg
Trajectory:
  Periselene: 82 km
  Aposelene: 117 km
  Period: 118 minutes
  Inclination: 90.0 deg
Occultations: none
Eclipses: 45 minutes

==========
Date: Wed, 11 Mar 1998 17:04:16 -0700
Subject: Lunar Prospector Status 3/12/98 report #24

The spacecraft continues to perform very well and all instruments continue to collect good data. On March 7 (PST), commands were sent to fire the thruster and correct for the long term changes to correct the orbit. Also, two commands were sent to tweak the GRS HV gain on March 10.

The first orbit trim maneuver was executed last Saturday. Two axial burns are fired, one to raise periselene, and the other to lower aposelene. The target orbit was 87x113 km, not circular, but biased to allow the perturbations to keep the orbit within the desired 100 ± 20 km orbit for a longer time. The actual maneuver results were very close, resulting in an orbit 87.7x112.3 km. The command timeline for the past week is given below (all times are GMT):

067/0326 Thruster heaters on
067/0349 Thrusters A3 and A4 fired for 46.5 seconds.
067/0350 Thruster safed
067/0432 Thruster heaters on
067/0453 Thrusters A3 and A4 fired for 50.9 seconds.
067/0454 Thrusters safed
069/1500 GRS gain command sent

Current spacecraft state (00:00 GMT 3/12/98, DOY 071):

Orbit: 711
Downlink: 3600 bps
Spin Rate: 12.18 rpm
Spin Axis Attitude:
  Latitude: 88.5 deg
  Longitude: 47.52 deg
Trajectory:
  Periselene: 94 km
  Aposelene: 106 km
  Period: 118 minutes
  Inclination 90.7 deg

Occultations: 44 minutes
Eclipses: 45 minutes

Early on March 13 (GMT), the moon will see the sun partially blocked by the earth. This will be carefully monitored by the project to ensure full battery recharging after normal once-per-orbit passages over the nightside of the moon. Also on March 13, the project plans to execute small attitude and spin trim maneuvers.

==========
Date: Wed, 18 Mar 1998 17:02:15 -0700
Subject: Lunar Prospector Status 3/19/98 report #25

The Lunar Prospector spacecraft continues to perform very well and all instruments continue to collect good data. On March 13 GMT (Thursday evening local), the spacecraft experienced penumbral eclipse as the moon (and the spacecraft orbiting it), saw the earth partially block the sun. No power or thermal problems occurred during the event. Also on March 13 (Friday afternoon local), attitude and spin trim maneuvers were performed.

During the penumbral eclipse, there was a visible drop in solar array current and the battery showed a slight discharge before entering its normal 46 minute eclipse as it passed over the night side of the moon. Recharge after that eclipse was nominal.

On DOY 072 (last Friday), the spin axis was precessed about 2 degrees to keep the sun just above the spacecraft equator for thermal reasons. Also, the spin rate was trimmed to correct for small changes to the spin rate which occurred during last week's orbit trim maneuver.

Commands were sent as shown below (all times GMT on DOY 072):
2100 Thruster heaters commanded on
2104 Loaded maneuver parameters
2126 Fire A1/A4 thrusters (13 pulses) to precess spin axis 1.7 deg
2131 Thruster heater commanded on
2140 Loaded maneuver parameters
2150 Fire T1 thruster for 0.81 sec
2151 Safe thrusters

The results of the spin axis reorientation are still under investigation as the engineering team is reviewing the attitude data (both pre- and post-maneuver) to account for natural precession of the spin axis. The spin trim was exactly on target, changing the spin rate from 12.17 rpm to 11.95 rpm.

Current spacecraft state (00:00 GMT 3/19/98, DOY 078):

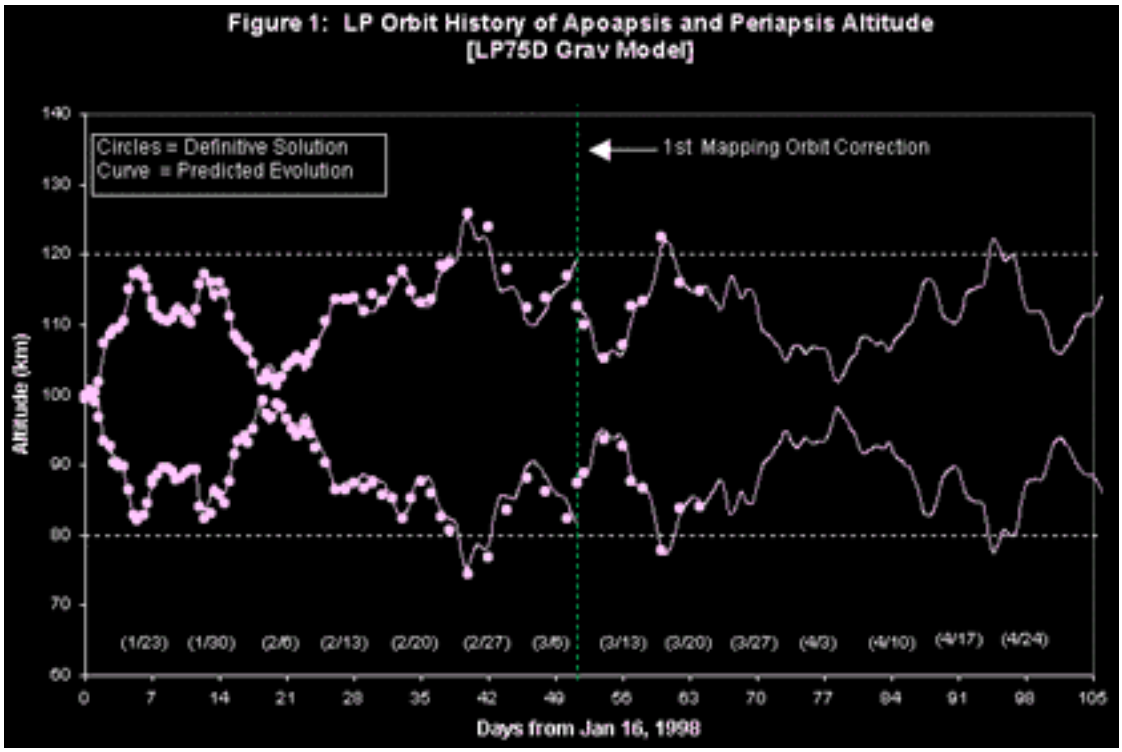
Orbit: 797
Downlink: 3600 bps
Spin Rate: 11.95 rpm

Trajectory:
  Periselene: 84 km
  Aposelene: 115 km
  Period: 118 minutes
  Inclination 90.4 deg
Occultations: 40 minutes
Eclipses: 46 minutes

==========

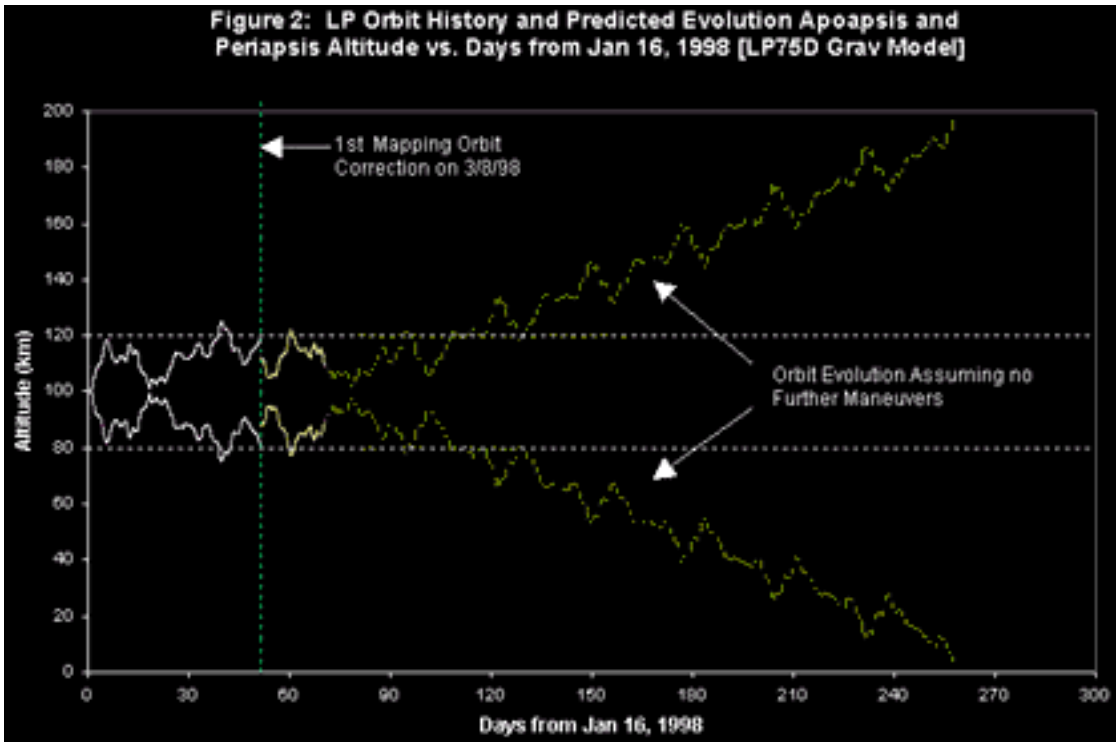
Date: Thu, 26 Mar 1998 15:11:14 -0800
Subject: Lunar Prospector Status 3/26/98 report #26

The spacecraft continues to perform very well and all instruments continue to collect good data. The LP orbit is evolving consistently with predictions from the latest gravity model (LP75D) supplied by Dr. Konopliv/JPL, which has been in use since March 3, 1998 for LP orbit determination product generation. The accuracy of orbit determination solutions have improved dramatically over pre-launch models. As planned before launch, definitive orbit solutions for the time span prior to March 3 are being re-computed by Goddard Space Flight Center using the updated gravity model and will be made available by mid-April.



A plan for conducting Lunar Prospector orbit maneuver has been implemented which calls for maneuvers approximately every two months. These maneuvers are timed to coincide with periods when the orientation of LP orbit plane is such that continuous ground station coverage is available (when orbit normal is aligned with the Earth-moon line every 14 days). This guarantees coverage of the maneuvers, which consist of two burns spaced close to 180 degrees apart to

adjust orbit eccentricity and the location of periapsis. The next orbit maneuver is tentatively planned on or about May 1st. Next week, a small attitude re-orientation will likely be scheduled to trim out the attitude.



Current spacecraft state (00:00 3/27/98 GMT):

Orbit: 895
Downlink: 3600 bps
Spin Rate: 11.96 rpm
Spin Axis Attitude:
  Latitude: 87.9 deg
  Longitude: 91.79 deg
Trajectory:
  Periselene Alt: 89 km
  Aposelene Alt: 109 km
  Period: 118 minutes
  Inclination: 91 deg
Occultations: 45 minutes
Eclipses: 47 minutes

==========
Date: Thu, 2 Apr 1998 11:36:28 -0700
Subject: Lunar Prospector Status 4/2/98 report #27

The Lunar Prospector spacecraft continues to perform well and all instruments continue to collect good data. On March 31 GMT, an attitude reorientation trim maneuver was executed.

On DOY 090 (this past Tuesday), the spin axis was precessed about 5 degrees to keep the sun just above the spacecraft equator for thermal reasons. 23 pulses were fired.

Commands were sent as shown below (all times GMT on DOY 090):
22:32 Thruster heaters commanded on
22:37 Loaded maneuver parameters
22:58 Fire A1/A4 thrusters (23 pulses) to precess spin axis 4.7 deg
23:01 Safe thrusters

The results of the spin axis reorientation are under continuing investigation as the engineering team is reviewing the attitude data (both pre- and post-maneuver) to account for natural precession of the spin axis. The calibration data for the Earth-Moon Limb Crossing Sensor needs updating based on flight data. Until this recalibration is done, the exact attitude and performance of the maneuvers cannot be analyzed.

Current spacecraft state (00:00 GMT 4/2/98, DOY 092):

Orbit: 968
Downlink: 3600 bps
Spin Rate: 11.96 rpm
Trajectory:
    Periselene Alt: 93.4 km
    Aposelene Alt: 105.9 km
    Period: 118 minutes
    Inclination: 90.2 deg
Occultations: 25 minutes
Eclipses: 47 minutes (maximum)

The spacecraft orbit is currently aligned with the moon-sun line. This means the spacecraft passes directly over the local noon and midnight points on the moon, experiencing the hottest temperatures and longest eclipses of the mission. In about 3 months, when the moon (and the Earth) has continued around the sun, the orbit will be perpendicular to the moon-sun line and we will have a period of a few weeks with no eclipses before rotating around through another eclipse season.

==========
Date: Thu, 16 Apr 1998 09:18:02 -0700
Subject: Lunar Prospector Status 4/16/98 report #28

NOTE: There was no status report last week.

The Lunar Prospector spacecraft continues to perform well and all instruments continue to collect good data.

The attitude data has been reprocessed, verifying that the last two maneuvers have executed as planned. The reason for the conflicting attitude data was that the effects of gravity gradient on the attitude had not been accounted for. The attitude model is being updated to include that effect. The next attitude reorientation is scheduled for 4/27.

Current spacecraft state (00:00 GMT 4/16/98, DOY 106):

Orbit: 1139
Downlink: 3600 bps
Spin Rate: 11.96 rpm
Spin Axis Attitude:
  Latitude: 82 deg
  Longitude: 124 deg
Trajectory:
  Periselene Alt: 87.6 km
  Aposelene Alt: 110.9 km
  Period: 118 minutes
  Inclination: 90.0 deg
Occultations: 35 minutes
Eclipses: 46 minutes

==========
Date: Thu, 23 Apr 1998 10:46:56 -0700
Subject: Lunar Prospector Status 4/27/98 report #29

The Lunar Prospector spacecraft continues to perform very well.

The Alpha Particle Spectrometer (APS) has seen an increase in particle counts over the last couple of weeks which has been associated with an increase in solar activity.

Current spacecraft state (00:00 GMT 4/23/98, DOY 113):

Orbit: 1225
Downlink: 3600 bps
Spin Rate: 11.96 rpm
Spin Axis Attitude (ecliptic):
  Latitude: 82.7 deg
  Longitude: 138 deg
Trajectory:
  Periselene Alt: 81.8 km
  Aposelene Alt: 118 km
  Period: 118 minutes
Occultations: 46 minutes
Eclipses: 46 minutes

An attitude reorientation maneuver is scheduled for Monday, 4/27, with a maneuver test pulse firing scheduled for Friday, 4/24.

==========
Date: Fri, 1 May 1998 11:15:00 -0700
Subject: Lunar Prospector Status 5/1/98 report #30

The Lunar Prospector spacecraft continues to perform very well and instruments are collecting good data.

Several maneuvers were performed in the last week: a test pulse firing, a reorientation of the spin axis, a circularization set of burns and a spin trim.

ON DOY 113, commands were sent to set the telemetry to read out thruster temperatures at a high rate for the test on DOY 114.

Lunar Prospector executed a 2-pulse reorientation maneuver at GMT 114/1531. Engines used were A1 and A4, each executed one 0.2 second pulse, for a total reorientation of approximately 0.15 degrees.

On DOY 117, the spin axis was precessed by 8.5 deg by firing 40 0.2-sec pulses. Engines A1 and A4 were fired at 117/1508.

A set of circularization burns were fired DOY 121. At 15:50 GMT, thrusters A3 and A4 were fired for 38.8 seconds to increase the s/c velocity by 6.0 m/s, raising periapsis from 85 km to 112 km. At 16:54, thrusters A3 and A4 were fired for 37.1 seconds at the ascending node to make a new periapsis with altitude 88 km by slowing the spacecraft down by 5.74 m/s. The target orbit is now 88 x 112 km but with apoapsis and periapsis flipped. The spin rate was trimmed with a spin down maneuver at 17:35 GMT. Thruster T1 was fired for 0.7 seconds to reduce the spin rate from 12.15 to 11.95 rpm.

After the maneuver burns, the high-level voltage on the GRS instrument was increased by one count with a GHV1LEV command.

Current spacecraft state (1600 GMT 5/1/98, DOY 121) [before all burns today]:

Orbit: 1330
Downlink: 3600 bps
Spin Rate: 11.96 rpm
Spin Axis Attitude (ecliptic):
  Latitude: 88.7 deg
  Longitude: 103.3 deg
Trajectory:
  Periselene Alt: 85 km
  Aposelene Alt: 114 km
  Period: 118 minutes
Occultations: none
Eclipses: 45 minutes

The navigation team will need several hours to confirm the orbit burns, but preliminary data shows that everything went nominally.

==========
Date: Thu, 7 May 1998 13:21:13 -0700
Subject: Lunar Prospector Status 5/7/98 report #31

The Lunar Prospector spacecraft continues to perform very well and instruments are collecting good data.

No commanding has been done in the last week. Results of the orbit trim performed last week show that the final orbit was reached as targeted, 88 km x 112 km.

Current spacecraft state (0000 GMT 5/7/98, DOY 127):

Orbit: 1396
Downlink: 3600 bps
Spin Rate: 11.96 rpm
Spin Axis Attitude (ecliptic):
  Latitude: 88.1 deg
  Longitude: 123.2 deg
Trajectory:
  Periselene Alt: 88 km
  Aposelene Alt: 112 km
  Inclination: 90.9 deg
  Period: 118 minutes
Fuel Remaining: 30.7 kg; (22%)
Occultations: 46
Eclipses: 43 minutes

==========
Date: Fri, 15 May 1998 13:04:31 -0700
Subject: Lunar Prospector Status 5/15 report #32

The Lunar Prospector spacecraft continues to perform very well and instruments are collecting good data.

The MAG/ER instrument was reconfigured yesterday to optimize performance and simplify data analysis. The instrument now does automatic gain changes, has a new default status, and a new telemetry format. A total of 292 commands were sent yesterday to implement these changes.

Current spacecraft state (0000 GMT 5/15/98, DOY 135):

Orbit: 1494
Downlink: 3600 bps
Spin Rate: 11.96 rpm
Spin Axis Attitude (ecliptic):

Latitude: 88.3 deg
Longitude: 136.7 deg
Trajectory:
Periselene Alt: 86 km
Aposelene Alt: 114 km
Period: 118 minutes
Fuel Remaining: 30.7 kg; (22%)
Occultations: none
Eclipses: 42 minutes

==========
Date: Thu, 21 May 1998 09:24:01 -0700
Subject: Lunar Prospector Status 5/21/98 report #33

The Lunar Prospector spacecraft continues to perform very well.

Yesterday, May 20 (DOY 140), a spin axis reorientation was commanded, to maintain a positive sun angle. 5 0.2-second pulses were fired using the A1/A4 thrusters to precess the spin axis 0.8° toward the sun. Initial estimates are that the maneuver went as commanded. Such maneuvers ensure optimal performance from the solar arrays and good battery performance.

After the reorientation the maneuver, the #3 face of the APS instrument was commanded off. For the last few days due to solar flares, it had been seeing enough noise to saturate the entire instrument. Shutting off the detectors when they are saturated and incapable of sending useable data will increase the likelihood of preserving detector functionality for the future when solar activity has returned to normal.

Current spacecraft state (0000 GMT 5/21/98, DOY 141):

Orbit: 1567
Downlink: 3600 bps
Spin Rate: 11.94 rpm
Spin Axis Attitude (ecliptic) [maneuver target]:
Latitude: 88.2 deg
Longitude: 121 deg
Trajectory:
Periselene Alt: 92 km
Aposelene Alt: 106 km
Inclination: 91 deg
Period: 118 minutes
Occultations: 46 minutes
Eclipses: 40 minutes

==========
Date: Thu, 28 May 1998 15:25:18 -0700
Subject: Lunar Prospector Status 5/29/98 report #34

The Lunar Prospector spacecraft continues to perform very well.

Current spacecraft state (0000 GMT 5/29/98, DOY 149):

Orbit: 1666
Downlink: 3600 bps
Spin Rate: 11.96 rpm
Spin Axis Attitude (ecliptic):
  Latitude: 88.2 deg
  Longitude: 133.8 deg
Trajectory:
  Periselene Alt: 98 km
  Aposelene Alt: 102 km
  Inclination: 90 deg
  Period: 118 minutes
Occultations: none
Eclipses: 36 minutes

==========
Date: Thu, 4 Jun 1998 17:39:19 -0700
Subject: Lunar Prospector Status 6/5/98 report #35

The Lunar Prospector spacecraft continues to perform very well.

Current spacecraft state (0000 GMT 6/5/98, DOY 156):

Orbit: 1751
Downlink: 3600 bps
Spin Rate: 11.96 rpm
Spin Axis Attitude (ecliptic):
  Latitude: 87.7 deg
  Longitude: 147.1 deg
Trajectory:
  Periapsis Alt: 90.0 km
  Apoapsis Alt: 108.2 km
  Inclination: 90.8 deg
  Period: 118 min
Occultations: 47 minutes
Eclipses: 31 minutes

On DOY 145 (5/25), Face #5 of the APS began intermittently showing problems with noise saturating the instrument (as was seen on Face #3 about a week before that). On DOY 153 (6/2), commands were sent to investigate whether there was noise leakage between these two faces. Nothing definitive was found and the current configuration is that both Face #3 and Face #5 are commanded off. A total of 8 commands were transmitted.

==========
Date: Fri, 12 Jun 1998 15:54:31 -0700

Subject: Lunar Prospector Status 6/12/98 report #36

The Lunar Prospector spacecraft continues to perform very well.

Current spacecraft state (0000 GMT 6/12/98, DOY 163):

Orbit: 1837
Downlink: 3600 bps
Spin Rate: 11.96 rpm
Spin Axis Attitude (ecliptic):
Latitude: 86.6 deg
Longitude: 158.7 deg
Trajectory:
Periapsis Alt: 84.7 km
Apoapsis Alt: 114.7 km
Inclination: 89.9 deg
Period: 118 min
Occultations: none
Eclipses: 21 minutes

On DOYs 159-162 (6/8-11), several commands were sent to examine the cause of the noise on the APS. Preliminary results show that the light leak on Face #5 somehow affects Face #3 (with occasional impact on Face #4 as well). The anomaly is still under investigation and the current APS configuration is Faces #1, 2 & 4 are on, Faces #3 & 5 are off. A total of 22 commands were sent.

==========
Date: Thu, 18 Jun 1998 15:57:27 -0700
Subject: Lunar Prospector Status 6/19/98 report #37

The Lunar Prospector spacecraft continues to perform very well.

Current spacecraft state (0000 GMT 6/19/98, DOY 170):

Orbit: 1922
Downlink: 3600 bps
Spin Rate: 12.00 rpm
Spin Axis Attitude (ecliptic):
Latitude: 86.2 deg
Longitude: 163.4 deg
Trajectory:
Periapsis Alt: 90.2 km
Apoapsis Alt: 108 km
Inclination: 89.9 deg
Period: 118 min
Occultations: none
Eclipses: none

No commands were sent this week. The earth-moon system has rotated around such that for the first time since January 20, the spacecraft is experiencing no solar eclipses each orbit. The spacecraft will remain in continual sunlight until July 24.

==========

Date: Fri, 26 Jun 1998 10:23:59 -0700
Subject: Lunar Prospector Status 6/26/98 report #38

The Lunar Prospector spacecraft continues to perform very well.

Current spacecraft state (0000 GMT 6/26/98, DOY 177):

Orbit: 2008
Downlink: 3600 bps
Spin Rate: 12.01 rpm
Spin Axis Attitude (ecliptic):
  Latitude: 86.3 deg
  Longitude: 164.9 deg
Trajectory:
  Periapsis Alt: 90 km
  Apoapsis Alt: 110 km
  Inclination: 89.8 deg
  Period: 118 min
Occultations: none
Eclipses: none

A Mapping Orbit Correction (MOC) was performed yesterday to maintain the mapping orbit. On DOY 176, at 2142 GMT, the orbit periapsis altitude was raised from 83 km to 109 km using a 39.2 second burn of the A3/A4 thrusters. At 2246 GMT, the A3/A4 thrusters were fired again for 38.5 seconds to lower apoapsis altitude from 118 km to 90 km. At 2323 GMT, thruster T2 was fired for 0.48 seconds to reduce the spin rate from 12.128 rpm to 12.01 rpm. Analysis from the orbit determination team shows that the maneuvers went very well. The next MOC burn is expected to occur in about 2 months. A total of 37 commands were sent to execute these maneuvers.

==========

Date: Wed, 1 Jul 1998 13:18:48 -0700
Subject: Lunar Prospector Status 7/1 report #39

The Lunar Prospector spacecraft continues to perform very well.

Current spacecraft state (0000 GMT 7/1/98, DOY 182):

Orbit: 2069
Downlink: 3600 bps
Spin Rate: 12.01 rpm
Spin Axis Attitude (ecliptic):

Latitude: 85.9 deg
Longitude: 167.3 deg
Trajectory:
Periapsis Alt: 90.6 km
Apoapsis Alt: 109.3 km
Inclination: 91 deg
Period: 118 min
Occultations: 47 minutes
Eclipses: none

No commanding was done this week. Although there were many changes to the tracking schedule due to the recovery efforts for the SOHO spacecraft, LP tracking was still very good and we had only a few short (~1 hour) outages throughout the week.

==========
Date: Fri, 10 Jul 1998 10:55:17 -0700
Subject: Lunar Prospector Status 7/10/98 report #40

The Lunar Prospector spacecraft continues to perform very well.

Current spacecraft state (0000 GMT 7/10/98, DOY 191):

Orbit: 2179
Downlink: 3600 bps
Spin Rate: 12.00 rpm
Spin Axis Attitude (ecliptic):
Latitude: 85.6 deg
Longitude: 169 deg
Trajectory:
Periapsis Alt: 90.2 km
Apoapsis Alt: 108.6 km
Inclination: 89.9 deg
Period: 118 min
Occultations: none
Eclipses: none

No commanding was done this week. No occultations and no eclipses mean that if you look at the moon right now you would see a full moon (in full sunlight). The spacecraft is going around it counter-clockwise and is never behind the moon (always in communications with earth) and always in sunlight. This condition only lasts a couple of days before the moon rotates around the earth enough to block part of the orbit as seen from Earth; the next occultation is scheduled for later today (11 am).

==========
Date: Thu, 16 Jul 1998 13:36:22 -0700
Subject: Lunar Prospector Status 7/16/98 report #41

The Lunar Prospector spacecraft continues to perform very well.

Current spacecraft state (0000 GMT 7/16/98, DOY 197):

Orbit: 2252
Downlink: 3600 bps
Spin Rate: 12.00 rpm
Spin Axis Attitude (ecliptic):
Latitude: 84.7 deg
Longitude: 173.5 deg
Trajectory:
Periapsis Alt: 95.8 km
Apoapsis Alt: 104.9 km
Inclination: 90.8 deg
Period: 118 min
Occultations: 46 minutes
Eclipses: none

No commanding was done this week.

==========
Date: Thu, 23 Jul 1998 15:37:14 -0700
Subject: Lunar Prospector Status 7/24/98 report #42

The Lunar Prospector spacecraft continues to perform very well.

Current spacecraft state (0000 GMT 7/24/98, DOY 205):

Orbit: 2350
Downlink: 3600 bps
Spin Rate: 12.00 rpm
Spin Axis Attitude (ecliptic):
Latitude: 84.0 deg
Longitude: 176.4 deg
Trajectory:
Periapsis Alt: 93.8 km
Apoapsis Alt: 106.8 km
Inclination: 89.9 deg
Period: 118 min
Occultations: none
Eclipses: none

No commanding was done this week.

==========
Date: Tue, 28 Jul 1998 11:24:34 -0700
Subject: Lunar Prospector Status 7/28/98 report #43

A reorientation maneuver was executed yesterday to precess the spin axis back towards the north ecliptic pole. 27 pulses were fired using jets A1 and A4, precessing the spin axis about 5.5 degrees. 15 commands were sent.

The Lunar Prospector spacecraft continues to perform very well.

Current spacecraft state (0000 GMT 7/28/98, DOY 209):

Orbit: 2399
Downlink: 3600 bps
Spin Rate: 12.01 rpm
Spin Axis Attitude (ecliptic):
    Latitude: 89.3 deg
    Longitude: 157 deg
Trajectory:
    Periapsis Alt: 92.2 km
    Apoapsis Alt: 107.8 km
    Period: 118 min
Occultations: 47 minutes
Eclipses: 15 minutes

==========
Date: Fri, 14 Aug 1998 09:05:17 -0700
Subject: Lunar Prospector Status 8/14/98 report #44

The Lunar Prospector spacecraft continues to perform very well. There has been very little commanding activity during the past two weeks.

Yesterday, 10 commands were sent to examine the status of the Alpha Particle Spectrometer instrument. Noise has been seen in 2 of the 5 faces of the instrument and these faces have been turned off for the last few months to prevent total saturation of the instrument. Results of the test yesterday showed no change in the status. These two faces were commanded off again and the instrument continues to get good data from the remaining 3 faces.

Last Friday evening, the moon saw a partial eclipse of the sun by the earth. It was a very shallow eclipse, and as expected, there was no effect seen on the spacecraft in either the thermal or the power subsystems.

Current spacecraft state (0000 GMT 8/14/98, DOY 226):

Orbit: 2606
Downlink: 3600 bps
Spin Rate: 12.01 rpm
Spin Axis Attitude (ecliptic):
    Latitude: 88.7 deg
    Longitude: 169.8 deg
Trajectory:
    Periapsis Alt: 90.7 km

Apoapsis Alt: 109.9 km
Inclination: 90.0 deg
Period: 118 min
Occultations: 45 minutes
Eclipses: 37 minutes

==========
Date: Thu, 20 Aug 1998 14:49:22 -0700
Subject: Lunar Prospector Status 8/21/98 report #45

The Lunar Prospector spacecraft continues to perform very well.

Thrusters were fired last week to recircularize the spacecraft's orbit. Analysis by the navigation team at GSFC indicates that the maneuver went very well. The timeline was as follows (all activities were on 8/17, Day of Year 229; times are GMT):

1604 thruster heaters on
1634 fire A3/A4 thrusters for 42.3 seconds to increase the velocity by 6.42 m/s
1715 thruster heaters on
1741 fire A3/A4 thrusters for 45.0 seconds to decrease the velocity by 6.83 m/s
1756 thruster heater on
1801 fire T1 thruster for 0.75 seconds to return spin rate to 12 rpm

The maneuver was estimated to use 1.2 kg of propellant, leaving 27.75 kg remaining (20%).

Just before the maneuver, commands were sent to turn on all faces of the APS instrument. Two of the five faces of the instrument see enough noise from stray light when the spacecraft is over the bright northern hemisphere to saturate the entire instrument. However, it was decided that it was better to get data from all 5 faces during the remaining 3/4 of the orbit,
than to only get data from 3 of 5 faces during the entire orbit. So at the present time, all five faces are turned on.

Current spacecraft state (0000 GMT 8/21/98, DOY 233):

Orbit: 2692
Downlink: 3600 bps
Spin Rate: 12.00 rpm
Spin Axis Attitude (ecliptic):
Latitude: 88.5 deg
Longitude: 161.8 deg
Trajectory:
Periapsis Alt: 90.6 km
Apoapsis Alt: 105.7 km
Inclination: 90.1 deg
Period: 118 min
Occultations: 34 minutes

Eclipses: 41 minutes

==========
Date: Fri, 28 Aug 1998 14:27:39 -0700
Subject: Lunar Prospector Status 8/28/98 report #46

The Lunar Prospector spacecraft continues to perform very well.

There was no commanding activity in the last week.

Current spacecraft state (0000 GMT 8/28/98, DOY 240):

Orbit: 2778
Downlink: 3600 bps
Spin Rate: 12.00 rpm
Spin Axis Attitude (ecliptic):
  Latitude: 87.9 deg
  Longitude: 117.1 deg
Trajectory:
  Periapsis Alt: 78.2 km
  Apoapsis Alt: 118.8 km
  Period: 118 min
Occultations: 46 minutes
Eclipses: 43 minutes

Plans are underway to review the power balance during the upcoming penumbral eclipse. On September 6 at ~11:00 GMT, the Earth will block up to 83% of the light from the Sun. As the spacecraft will be in 45 minute long eclipses each orbit (as the spacecraft orbit crosses the dark side of the moon), power sharing may be required to ensure the battery is not depleted.

==========
Date: Fri, 4 Sep 1998 10:27:17 -0700
Subject: Lunar Prospector Status 9/4/98 report #47

The Lunar Prospector spacecraft continues to perform very well.

There were two commands sent this past week (8/31) to adjust the gain of the GRS instrument.

Current spacecraft state (0000 GMT 9/4/98, DOY 247):

Orbit: 2863
Downlink: 3600 bps
Spin Rate: 12.00 rpm
Spin Axis Attitude (ecliptic):
  Latitude: 87.7 deg
  Longitude: 191.4 deg
Trajectory:

Periapsis Alt: 85.4 km
Apoapsis Alt: 111.6 km
Period: 118 min
Occultations: 28 minutes
Eclipses: 44 minutes

Plans are underway to for the upcoming penumbral eclipse. On September 6 at ~11:00 GMT, the Earth will block up to 83% of the light from the Sun. As the spacecraft will be in 45 minute long eclipses each orbit (as the spacecraft orbit crosses the dark side of the moon), this will cause a measurable impact on the s/c battery. Plans are to turn off the Earth-Moon Limb Sensor and the Pressure Transducer, and the flight team will be prepared to turn off the primary heater circuit if necessary.

==========
Date: Thu, 10 Sep 1998 11:39:19 -0700
Subject: Lunar Prospector Status 9/11/98 report #48

The Lunar Prospector spacecraft continues to perform very well.

There were two commands sent this past week (9/6) to adjust the gain of the GRS instrument.

The spacecraft successfully survived the penumbral eclipse which occurred at 1100 GMT on 9/6/98. Due to the geometry of the orbit around the moon, as the moon pass through the Earth's penumbra, the spacecraft saw the sun blocked twice - the first time up to 83% of the sun was blocked; the second time, only 15% of the sun was blocked. Estimates are that there was an extra 8% Depth of Discharge (DOD) on the battery due to the first event. Since the spacecraft was also passing through 45 minute lunar night passes, the total discharge on the battery was about 50%, well within normal operations. There had been some concern that the propellant tank heaters might come on during this event, causing a much larger discharge, but this did not happen until after both penumbral events. No battery discharge was seen during the second penumbral event. Events were as follows (249 is the Day of Year):

249/0752 Commanded GRS gain change
249/0755 Commanded Pressure transducer off
249/0756 Commanded Earth-Moon limb sensor off
249/0903 Enter Lunar night pass and Earth occultation (loss of signal [LOS])
249/0948 Exit Lunar night pass
249/0949 Exit Earth occultation (acquisition of signal [AOS])
249/1023 Enter Earth penumbral shadow
249/1040 Began battery discharge
249/1057 Max penumbra (83% sunlight blocked)
249/1100 Enter Lunar night pass with DOD 8%
249/1101 Enter Earth occultation (LOS)
249/1131 Exit Earth penumbral shadow
249/1145 Exit Lunar night pass

249/1146 Exit Earth occultation (AOS) battery recharging nicely
249/1218 Enter Earth penumbral shadow
249/1235 Max penumbra (15% sunlight blocked)
249/1250 Commanded Pressure transducer on
249/1251 Commanded Earth-Moon Limb sensor on
249/1253 Exit Earth penumbral shadow - saw no battery discharge; battery fully charged
249/1258 Enter Lunar night pass and Earth occultation (LOS)
249/1335 Tank heaters on
249/1353 Exit Lunar night pass and Earth occultation (AOS)

Current spacecraft state (0000 GMT 9/10/98 DOY 253):

Orbit: 2937
Downlink: 3600 bps
Spin Rate: 12.00 rpm
Spin Axis Attitude (ecliptic):
Latitude: 87.65 deg
Longitude: 188.67 deg
Trajectory:
Periapsis Alt: 91.1 km
Apoapsis Alt: 105.9 km
Period: 118 min
Occultations: 45 minutes
Eclipses: 45 minutes

==========
Date: Fri, 18 Sep 1998 14:14:34 -0700
Subject: Lunar Prospector Status 9/18/98 report #49

The Lunar Prospector spacecraft continues to perform very well.

This week, as the eclipses approach maximum, the propellant tank pressure transducer was turned off and we began cycling the transmitter off during occultations when the propellant tank heater is on. The tank heater is the largest load on the spacecraft, and it comes on for about 3 hours about once each day. With this load on, the battery cannot completely recharge between eclipses. To reduce the total discharge during heater events, the transmitter is powered off for 50 minutes surrounding occultations (when the spacecraft is behind the moon, as seen from Earth, we get no downlink from the spacecraft then anyway). The cycling data storage covers these outages and so no data is lost.

Commanding activity:
254/0426 Pressure Transducer Off
259/1713 Transmitter Off
259/1753 Transmitter On
259/1910 Transmitter Off
259/2000 Transmitter On
260/1642 Transmitter Off

260/1732 Transmitter On
261/1415 Transmitter Off
261/1512 Transmitter On (command delayed due to station problems)
261/1604 Transmitter Off
261/1702 Transmitter On

As this will be an ongoing activity until eclipses become significantly shorter, I will not report these times in future detail unless commands are delayed for any reason causing outages, or this procedure changes.

Current spacecraft state (2000 GMT 9/18/98, DOY 261):

Orbit: 3045
Downlink: 3600 bps
Spin Rate: 12.00 rpm
Spin Axis Attitude (ecliptic):
  Latitude: 87.3 deg
  Longitude: 190.22 deg
Trajectory:
  Periapsis Alt: 89.6 km
  Apoapsis Alt: 107.4 km
  Period: 118 min
Occultations: 40 minutes
Eclipses: 46 minutes
Propellant
 remaining: 27.8 kg

==========
Date: Fri, 25 Sep 1998 12:06:10 -0700
Subject: Lunar Prospector Status 9/25/98 report #50

The Lunar Prospector spacecraft continues to perform very well.

The procedure to turn the transmitter off during occultations with the propellant tank heater on is working well. There have been a few times where we have had slight delays in the turn on, 1 time due to operator error and 4 times due to station configuration delays. Of these events, 2 have caused the transmitter to be off for more than the storage loop on the spacecraft causing short outages of 4 minutes each (DOY 261 and 268). The lowest battery voltage seen since implementing the procedure on 9/16 is 25.06V, well above the 24.5V yellow limit.

No other commanding was done this week.

Current spacecraft state (0000 GMT 9/25/98, DOY 268):

Orbit: 3120
Downlink: 3600 bps
Spin Rate: 12.00 rpm

Spin Axis Attitude (ecliptic):
    Latitude: 87.24 deg
    Longitude: 181.54 deg
Trajectory:
    Periapsis Alt: 86.2 km
    Apoapsis Alt: 110.8 km
    Period: 118 min
Occultations: 46 minutes
Eclipses: 46 minutes
Propellant
 remaining: 27.8 kg

Plans are getting finalized for flipping the spacecraft 180°. On Oct 5, the spacecraft spin axis will be reoriented from the north ecliptic pole to the orbit normal. This will provide good calibration data for the GRS instrument. On Oct 7, the spacecraft will be turned the other 90°, putting the spin axis at the south ecliptic pole. This flip will allow the APS instrument to collect data it has missed due to the anomaly on one of its faces. Except for small drifts and special procedures, the spacecraft attitude will remain in this orientation for the rest of the mission.

==========
Date: Thu, 1 Oct 1998 14:56:05 -0700
Subject: Lunar Prospector Status 10/1/98 report #51

The Lunar Prospector spacecraft continues to perform very well.

There was one instance this week where the transmitter on command was delayed, causing 17 minutes of data to be lost (DOY 270). This was due to a DSN configuration problem caused by miscommunication between the LP and the DSN controllers. A notice to the stations has been released to prevent future problems.

No other commanding was done this week.

Current spacecraft state (0000 GMT 10/1/98, DOY 274):

Orbit: 3194
Downlink: 3600 bps
Spin Rate: 12.00 rpm
Spin Axis Attitude (ecliptic):
    Latitude: 86.91 deg
    Longitude: 184 deg
Trajectory:
    Periapsis Alt: 79.1 km
    Apoapsis Alt: 117.9 km
    Period: 118 min
Occultations: 7 minutes
Eclipses: 46 minutes

Propellant
remaining: 27.8 kg

Plans are getting finalized for flipping the spacecraft 180°. On Oct 5, the spacecraft spin axis will be reoriented from the north ecliptic pole to the orbit normal (lat: 0, lon: 282). This will provide good calibration data for the GRS instrument. On Oct 7, the spacecraft will be turned the other 90°, putting the spin axis at the south ecliptic pole. This flip will allow the APS instrument to collect data it has missed due to the anomaly on one of its faces. Except for small drifts and special procedures, the spacecraft attitude will remain in this orientation for the rest of the mission.

The reason for doing the flip and GRS calibration this week is due to the alignment of the LP orbit, the Earth, Sun and Moon. On Oct 6, the orbit will cross over the noon/midnight longitude of the moon. As this is also full moon, this means that the Sun, Earth, Moon, and LP's orbit are all in a line. Turning the spin axis 90 deg around that line will keep the sun perpendicular to the solar arrays as well as keep the Earth near 90 deg for good communications. With the spin axis perpendicular to the orbit plane, the geometry of the GRS detector no longer changes with latitude and any asymmetries in the instrument response can be measured and corrected for.

==========
Date: Fri, 9 Oct 1998 10:41:52 -0700
Subject: Lunar Prospector Status 10/9/98 report #52

The Lunar Prospector spacecraft continues to perform very well.

The spacecraft was flipped over this week in two major maneuver intervals. The spacecraft is now flying with its spin axis pointed toward the south ecliptic pole, rather than the north ecliptic pole.

On Oct 5, the spacecraft was reoriented 90 deg to lay in the ecliptic plane, normal to the orbit plane. The attitude was within 0.9 deg of the target attitude and so trim maneuvers were cancelled.

On Oct 7, the spacecraft was reoriented the remaining 90 deg to point towards ecliptic south. The final attitude is within 0.6 deg of the target and again trim maneuvers were cancelled.

Major commanding events are given below.

278/14:11 Pressure Transducer ON
278/14:12 Downlink to OMNI antenna
278/16:05 Start part A of first reor sequence: 255 0.2 sec pulses, A1/A4 jets, precess 54 deg
278/16:44 Start part B of first reor sequence: 174 0.2 sec pulses, A1/A4 jets, precess 37 deg
Target attitude lat: 0, lon: 282, Actual attd lat: 0.7, lon: 281.5

280/15:17 Start part A of 2nd reor sequence: 255 0.2 sec pulses, A1/A4 jets, precess 53 deg
280/15:49 Start part B of 2nd reor sequence: 179 0.2 sec pulses, A1/A4 jets, precess 37 deg
Target attitude lat: -89.5, lon: 193, Actual lat: -89.1, lon: 156.2
281/15:23 Switch downlink back to Medium Gain Antenna (MGA)

2.5 kg of propellant were used during these maneuvers.

The transmitter continues to be cycled during occultations when the propellant tank heater is on. There were no commanding anomalies that caused any data losses during the past week. There was one instance (DOY 278), when the transmitter could not be commanded off due to a problem at DSS 61, but it did not have an adverse effect on the battery.

On Oct 3, 2 commands were sent to tweak the GRS gain.

Current spacecraft state (0000 GMT 10/9/98, DOY 282):

Orbit: 3292
Downlink: 3600 bps
Spin Rate: 12.08 rpm
Spin Axis Attitude (ecliptic):
Latitude: -89.1 deg
Longitude: 158.34 deg
Trajectory:
Periapsis Alt: 88.7 km
Apoapsis Alt: 108.3 km
Period: 118 min
Occultations: 41 minutes
Eclipses: 47 minutes
Propellant
remaining: 25.2 kg

On Oct 12, there will be a recircularization maneuver sequence to maintain the 100 ± 20 km altitude orbit.

==========
Date: Fri, 16 Oct 1998 10:56:59 -0700
Subject: Lunar Prospector Status 10/16/98 report #53

The Lunar Prospector spacecraft continues to perform very well.

A Mapping Orbit Correction maneuver sequence was fired Oct 12 with excellent results. The timeline for that activity is given below. There was no other commanding this week.

285/17:41 A1/A2 thruster heaters ON
285/17:47 load maneuver parameters

285/18:12 fire A1/A2 for 45.5 sec (7.22 m/s velocity increase)
285/18:40 A1/A2 thruster heaters ON
285/18:42 load maneuver parameters
285/19:11 fire A1/A2 for 40.9 sec (6.50 m/s velocity decrease)
285/19:17 T1 thruster heater ON
285/19:30 load maneuver parameters
285/19:34 fire T1 for 0.55 sec (despin 12.14 rpm to 12.00 rpm)

1.2 kg of propellant was used during these maneuvers.

The transmitter continues to be cycled during occultations when the propellant tank heater is on. There were no commanding anomalies that caused any data losses during the past week. There was one instance (DOY 284) when the off commands were delayed due to MCC operator error, but no data was lost. There was one instance (DOY 287), when the transmitter could not be commanded off due to a problem at DSS 54, but it did not have an adverse effect on the battery.

Current spacecraft state (0000 GMT 10/16/98, DOY 289):

Orbit: 3377
Downlink: 3600 bps
Spin Rate: 12.00 rpm
Spin Axis Attitude (ecliptic):
    Latitude: -88.98 deg
    Longitude: 165.52 deg
Trajectory:
    Periapsis Alt: 90.6 km
    Apoapsis Alt: 109.4 km
    Period: 118 min
Occultations: 43 minutes
Eclipses: 46 minutes
Propellant
 remaining: 24.1 kg

This orbit correction maneuver was the last one of the nominal mission. The next orbit maneuver will be December 19, when the orbit will be lowered to an average altitude of 40 km as a transition to the extended mission orbit.

==========
Date: Fri, 23 Oct 1998 10:27:29 -0700
Subject: Lunar Prospector Status 10/23/98 report #54

The Lunar Prospector spacecraft continues to perform very well.

The transmitter continues to be cycled during occultations when the propellant tank heater is on. There were three commanding anomalies (twice on DOY 291 and once on 292) that caused a total of 43 minutes of data loss during the past week, all due to misconfigurations at the station. Communications procedures

have been reviewed to reduce this problem in the future. There were two instances (DOY 290 and 292) when the off commands were not transmitted due to operator error, but there was no impact on the battery at either event. Transmitter commands were the only commanding activity this week.

Current spacecraft state (0000 GMT 10/23/98, DOY 296):

Orbit: 3463
Downlink: 3600 bps
Spin Rate: 12.00 rpm
Spin Axis Attitude (ecliptic):
Latitude: -89.02 deg
Longitude: 166.15 deg
Trajectory:
Periapsis Alt: 81.4 km
Apoapsis Alt: 118.6 km
Period: 118 min
Occultations: 42 minutes
Eclipses: 45 minutes
Propellant
remaining: 24.1 kg

==========
Date: Thu, 29 Oct 1998 08:51:08 -0700
Subject: Lunar Prospector Status 10/29/98 report #55

The Lunar Prospector spacecraft continues to perform very well.

The transmitter continues to be cycled during occultations when the propellant tank heater is on. There was one commanding problem at the station, which caused a 28 minute delay in transmission of the transmitter off/on commands on DOY 300. Because we were in a period of operations without occultations, there was no loss of data.

On DOY 300, at 1757 GMT, some of the data from the spectrometer instruments became garbled. Analysis by the science team at LANL suggested a software error in the spectrometer electronics. 35 commands were sent to reset the electronics power and reconfigure the instruments. They were all reconfigured and producing good data at 302/0034. On 302 at 1615 GMT, 2 commands were sent to tweak the gain of the NS instrument.

Current spacecraft state (0000 GMT 10/29/98, DOY 302):

Orbit: 3536
Downlink: 3600 bps
Spin Rate: 12.00 rpm
Spin Axis Attitude (ecliptic):
Latitude: -88.84 deg
Longitude: 166.15 deg

Trajectory:
    Periapsis Alt: 87.1 km
    Apoapsis Alt: 112.9 km
    Period: 118 min
Occultations: 32 minutes
Eclipses: 45 minutes
Propellant
  remaining: 24.1 kg

==========
Date: Thu, 5 Nov 1998 16:41:29 -0700
Subject: Lunar Prospector Status 11/6/98 report #56

The Lunar Prospector spacecraft continues to perform very well.

Beginning Nov 2 (DOY 306), the DSN began collecting occultation timing data for the radio science team. This campaign will continue through Nov 14.

The transmitter continues to be cycled during occultations when the propellant tank heater is on. On DOY 306 a station configuration problem caused the transmitter on commands to be delayed, causing a 24 minute data loss. A similar problem occurred on DOY 308 (4 minute loss) and DOY 309 (8 minute loss). These problems have occurred due to configuration changes at the station due to the radio science campaign.

Current spacecraft state (0000 GMT 11/6/98, DOY 310):

Orbit: 3634
Downlink: 3600 bps
Spin Rate: 12.00 rpm
Spin Axis Attitude (ecliptic):
    Latitude: -88.94 deg
    Longitude: 170.16 deg
Trajectory:
    Periapsis Alt: 90.0 km
    Apoapsis Alt: 110.0 km
    Period: 118 min
Occultations: 37 minutes
Eclipses: 44 minutes
Propellant
  remaining: 24.1 kg

The project is finalizing the timelines to turn the spacecraft 80° in preparation for the Leonids Shower event. On Nov 17, the Earth passes through the orbit of the comet Tempel-Tuttle. Although the comet itself is further ahead in its orbit, it is close enough to the Earth that there will be a lot of dust. The dust will cause spectacular meteor showers as seen from the surface of the Earth, as well as cause potential damage to spacecraft in the Earth-Moon system. This year, as the comet recently came through this area, the storm is expected to be the worst it

has been in 33 years. As the relative speed of the dust particles can be as high as 72 km/sec, even the very small dust particles can cause damage to the spacecraft.

Lunar Prospector will be turned so that the dust approaches the bottom of the spacecraft. This attitude was chosen because of the desire to minimize impacts on the solar panels and the fact that the propellant system at the bottom of the spacecraft is much less sensitive to this kind of potential damage than the top of the spacecraft, with its antenna and electronics. The spacecraft will be turned Nov 15 and maintained at that attitude until Nov 19.

==========

Date: Fri, 13 Nov 1998 11:13:45 -0700
Subject: Lunar Prospector Status 11/13/98 report #57

The Lunar Prospector spacecraft continues to perform very well.

Beginning Nov 2 (DOY 306), the DSN began collecting occultation timing data for the radio science team. This campaign will continue through Nov 14.

The transmitter continues to be cycled during occultations when the propellant tank heater is on. On DOY 316, a command system configuration problem at the station caused a 14 minute data loss when the command to power the transmitter on was delayed.

Current spacecraft state (0000 GMT 11/13/98, DOY 317):

Orbit: 3719
Downlink: 3600 bps
Spin Rate: 12.00 rpm
Spin Axis Attitude (ecliptic):
  Latitude: -88.92 deg
  Longitude: 178.81 deg
Trajectory:
  Periapsis Alt: 93.2 km
  Apoapsis Alt: 106.8 km
  Period: 118 min
Occultations: 45 minutes
Eclipses: 43 minutes
Propellant
 remaining: 24.1 kg

An independent board reviewed the plans for the extended mission last week, and a report is expected by the end of next week.

Plans have been finalized for the attitude reorientation maneuvers scheduled for next week to turn the spacecraft to the safest attitude for the Leonids shower next week. Peak shower activity is expected to occur on Nov 17.

==========

Date: Fri, 20 Nov 1998 08:39:14 -0700
Subject: Lunar Prospector Status 11/20/98 report #58

The Lunar Prospector spacecraft is operating well and saw no anomalies or status changes due to the Leonids shower this week. Science instruments continued to collect good data throughout the week.

The spacecraft was turned 80 deg on 11/15 to minimize the cross sectional area of the solar arrays in the direction of the shower. A trim maneuver was executed 11/16. On 11/19, the spacecraft was turned back to the nominal attitude with the spin axis nearly aligned with the ecliptic south pole.

A summary of events is given below. All maneuvers involved pulse firing jets A1&A4 for 0.2 seconds each pulse. These large maneuvers were broken up into segments because they had to be done during the 10-15 minutes twice each orbit that the spacecraft was between occultation (where the signal to earth is blocked by the moon), and eclipse (where the sun is blocked by the moon). The sun is the reference on the spacecraft for timing the pulses and so all pulsed maneuvers are only executed in sunlight. Attitudes are in ecliptic coordinates, latitude/longitude.

11/15 80 deg reor (executed in 7 segments):
319/15:00 Switch downlink to OMNI antenna
319/15:41 Fire 55 pulses; slew 11.3 deg starting attd: -88.9/166
319/16:44 Fire 55 pulses
319/17:39 Fire 55 pulses
319/18:45 Fire 55 pulses
319/19:37 Fire 55 pulses
319/20:41 Fire 55 pulses
319/21:35 Fire 49 pulses; slew 10 deg target attd: -12.1/327.4
measured attd: -20.7/327.3
Total reorientation used 1.11 kg of propellant

11/16 8 deg attitude trim
321/0006 Fire 40 pulses; slew 8.0 deg; used 0.11 kg of propellant
starting attd: -20.7/327.3; target attd: -12.7/327.7
measured attd: -11.5/327.4

11/19 80 deg reor
323/17:55 Fire 110 pulses; slew 22.5 deg starting attd:
-14.0/326.9
323/18:56 Fire 110 pulses
323/19:53 Fire 110 pulses
323/20:56 Fire 40 pulses; slew 3.1 deg target attd:
-89.4/270.0
measured attd: -89.1/289
Total reorientation used 1.07 kg of propellant

The transmitter continues to be cycled during occultations when the propellant tank heater is on, although as eclipses get shorter, it has not been cycled as regularly. There was one instance (DOY 321) where the planned transmitter cycling commands could not be transmitted due to a combination of station and MCC problems but it had no impact on the battery.

Current spacecraft state (0000 GMT 11/20/98, DOY 324):

Orbit: 3805
Downlink: 3600 bps
Spin Rate: 12.07 rpm
Spin Axis Attitude (ecliptic):
  Latitude: -88.46 deg
  Longitude: 306.09 deg
Trajectory:
  Periapsis Alt: 93.0 km
  Apoapsis Alt: 107.0 km
  Period: 118 min
Occultations: 38 minutes
Eclipses: 41 minutes
Propellant
 remaining: 21.8 kg

A trim maneuver tentatively scheduled for this afternoon has been cancelled as the attitude is so close to the target.

==========
Date: Fri, 4 Dec 1998 10:31:16 -0700
Subject: Lunar Prospector Status 12/4/98 report #59

The Lunar Prospector spacecraft is operating well and all instruments continue to collect good data.

Transmitter cycling during propellant tank heater events was cancelled beginning 11/24 as eclipse durations have dropped below 40 minutes. If required, cycling will begin again sometime next year when the next eclipse season starts up.

On 12/2, 2 commands were sent to collect a high data rate MAG/ER snapshot.

On 12/4, a series of thruster burns were fired to dump 1.8 kg of propellant. Reducing the amount of propellant in the tanks will reduce the time the propellant tank heater is on, reducing the need for cycling the transmitter during the extended mission. Both spin thrusters were fired for an integer number of rotations in a series of four burns.

Current spacecraft state (1800 GMT 12/4/98, DOY 338):

Orbit: 3976

Downlink: 3600 bps
Spin Rate: 11.99 rpm
Spin Axis Attitude (ecliptic):
Latitude: -88.39 deg
Longitude: 279.52 deg
Trajectory:
Periapsis Alt: 91.1 km
Apoapsis Alt: 108.9 km
Period: 118 min
Occultations: none
Eclipses: 32 minutes
Propellant
remaining: 20.0 kg

On December 19, the orbit will be lowered from the nominal 100 km altitude mapping orbit to a 40 km altitude orbit. This will allow collection of data which can improve the gravity model in preparation for the extended mission. On January 16 the extended mission will begin, when the spacecraft will be lowered into a 25-30 km altitude orbit for six months.

==========
Date: Fri, 11 Dec 1998 09:40:51 -0700
Subject: Lunar Prospector Status 12/11/98 report #60

The Lunar Prospector spacecraft is operating well and all instruments continue to collect good data.

There was no commanding this week.

Current spacecraft state (0000 GMT 12/11/98, DOY 345):

Orbit: 4062
Downlink: 3600 bps
Spin Rate: 11.99 rpm
Spin Axis Attitude (ecliptic):
Latitude: -88.24 deg
Longitude: 260.77 deg
Trajectory:
Periapsis Alt: 80.4 km
Apoapsis Alt: 119.6 km
Period: 118 min
Occultations: 45 minutes
Eclipses: 20 minutes
Propellant
remaining: 20.0 kg

==========
Date: Fri, 18 Dec 1998 09:37:09 -0700
Subject: Lunar Prospector Status 12/18/98 report #61

The Lunar Prospector spacecraft is operating well and all instruments continue to collect good data.

Two commands were sent to tweak the GRS gain on DOY 349.

Current spacecraft state (0000 GMT 12/18/98, DOY 352):

Orbit: 4147
Downlink: 3600 bps
Spin Rate: 11.99 rpm
Spin Axis Attitude (ecliptic):
  Latitude: -87.98 deg
  Longitude: 244.15 deg
Trajectory:
  Periapsis Alt: 83.4 km
  Apoapsis Alt: 116.6 km
  Period: 118 min
Occultations: 32 minutes
Eclipses: none
Propellant
 remaining: 20.0 kg

On Saturday, December 19, the spacecraft will be placed into a orbit with an average altitude of 40 km. This will be a transition orbit, between the nominal mapping orbit (with altitude 100 km) and the extended mission orbit (with altitude 25-30 km), where the gravity model will be verified. The maneuver to the extended mission orbit is scheduled for January 16, 1999.

==========

Date: Mon, 21 Dec 1998 16:52:46 -0700
Subject: Lunar Prospector Status 12/21/98 report #62

The Lunar Prospector spacecraft is operating well and all instruments continue to collect good data.

On Saturday, December 19, the spacecraft was placed into a orbit with an average altitude of 40 km. This is a transition orbit, between the nominal mapping orbit (with altitude 100 km) and the extended mission orbit (with altitude 25-30 km), where the gravity model will be verified.

The timeline is given below:

353/1740 cmd'd thruster heaters on
353/1811 fired A3/A4 thrusters for 46.8 sec
353/1840 cmd'd thruster heaters on
353/1911 fired A1/A2 thrusters for 150.4 sec
353/1917 cmd'd thruster heater on
353/1937 fired T1 thrusters for 0.65 sec

The starting orbit was 77.5 km x 122.5 km. The first burn was at apoapsis to lower periapsis from 77.5 km to 50.5 km. The second burn was at the ascending node to set new periapsis altitude to 25 km at desired argument of periapsis. The resulting orbit was 25 km x 55 km. The gravity field will tend to circularize it over the next few days. The attitude reorientation maneuver was cancelled and the third burn trimmed the spacecraft spin rate back to its nominal value.

There were very high winds in the California high desert and there was concern that the antenna (DSS 27) would have to be stowed mid-way during the maneuver, but fortunately the winds stayed below the limits and everything went on time.

Eclipses started as predicted at 353/2005 but their length will decrease with time and the season will end before Christmas.

Current spacecraft state (0000 GMT 12/21/98, DOY 355):

Orbit: 4184
Downlink: 3600 bps
Spin Rate: 11.99 rpm
Spin Axis Attitude (ecliptic):
  Latitude: -87.76 deg
  Longitude: 236.75 deg
Trajectory:
  Periapsis Alt: 29 km
  Apoapsis Alt: 52 km
  Period: 112 min
Occultations: 10 minutes
Eclipses: 23 minutes
Propellant
 remaining: 17.45 kg

==========
Date: Wed, 30 Dec 1998 10:45:12 -0700
Subject: Lunar Prospector Status 12/30/98 report #63

The Lunar Prospector spacecraft is operating well and all instruments continue to collect good data.

There was no commanding this week.

Current spacecraft state (0000 GMT 12/30/98, DOY 364):

Orbit: 4300
Downlink: 3600 bps
Spin Rate: 11.99 rpm
Spin Axis Attitude (ecliptic):
  Latitude: -87.44 deg

Longitude: 230.69 deg
Trajectory:
Periapsis Alt: 29 km
Apoapsis Alt: 52 km
Period: 112 min
Occultations: 46 minutes
Eclipses: none
Propellant
remaining: 17.45 kg

The spacecraft has now been in the 40 km average altitude orbit for over 10 days. Doppler data is being collected to verify that the lunar gravity model is accurate at this low altitude. The tracking schedule has been changed many times this last week due to problems with other spacecraft, but in general we have maintained good coverage and should have an updated gravity model in about a week. Data so far indicates that the gravity model we have used is very good.

Data is currently being reviewed from the Clementine project to ensure adequate clearance over the lunar terrain in the extended mission orbit. Whatever orbit the spacecraft is placed in, the asymmetries in the lunar gravity field cause the orbit to become elliptical, so that over a two week period, the altitude will vary by +/- 15 km. For highest science resolution, it is desired to place the spacecraft in an orbit with an average altitude of 25 km, but this means that the spacecraft will get to within 10 km of the average lunar surface during the two weeks between maneuvers. The moon is not flat, however, and there are several high mountains on the surface. The project is currently getting the latest data on the terrain from the Clementine project to run the orbit profiles over and ensure at least a 6 km margin at all times. If the 25 km orbit does not provide this margin, the spacecraft will be placed in a 30 km average altitude orbit for the extended mission. The maneuver to lower the orbit for the extended mission is scheduled for January 16.

==========
Date: Fri, 8 Jan 1999 10:30:46 -0700
Subject: Lunar Prospector Status 1/8/99 report #64

The Lunar Prospector spacecraft is operating well and all instruments continue to collect good data. The project celebrated the completion of the first year after launch this week; the science data has been of higher resolution than expected and all baseline mission objectives have been met.

There was no commanding this week.

Current spacecraft state (0000 GMT 1/8/99, DOY 008):

Orbit: 4415
Downlink: 3600 bps
Spin Rate: 11.99 rpm

Spin Axis Attitude (ecliptic):
Latitude: -87.74 deg
Longitude: 222.11 deg
Trajectory:
Periapsis Alt: 31 km
Apoapsis Alt: 49 km
Period: 112 min
Occultations: 49 minutes
Eclipses: none
Propellant
remaining: 17.45 kg

The lunar gravity model has been updated using Doppler data collected in the 40-km altitude orbit. This model will be used to plan for extended mission operations. The magnetometer has already seen an order of magnitude increase in signal level due to the lower transition orbit, and they are looking forward to an even higher resolution data in the extended mission orbit.

The final orbit for the extended mission was decided upon last week after a review of the lunar topography data with the Clementine team. Although a very low orbit (25-km average altitude) would provide somewhat higher resolution data, the project decided that a 30-km average altitude orbit would be used for the extended mission. The Clementine terrain data is very accurate (100 m), but there are large spatial gaps in the data (as large as 100 km), which mean that there could be mountain peaks on the order of several kilometers higher than the terrain maps indicate. The 30-km average altitude orbit will maintain a clearance of 9 km above known terrain, providing significant margin above the actual terrain.

The maneuver to go to the extended mission orbit is scheduled for January 15, 1999 (January 16 0200 GMT). Trajectory correction burns will be required every 28 days to maintain this orbit.

==========
Date: Fri, 15 Jan 1999 12:57:55 -0700
Subject: Lunar Prospector Status 1/15/99 report #65

The Lunar Prospector spacecraft is operating well and all instruments continue to collect good data.

An attitude reorientation maneuver was successfully completed this morning. Thrusters A1/A4 were pulsed 22 times to precess the spin axis attitude by 4.2 deg. The timeline is given below (times are GMT).
015/16:15 A1/A4 thruster heaters on
015/16:44 Fire A1/A4 thrusters for 22 0.2 sec pulses (used 0.06 kg propellant)

Current spacecraft state (1800 GMT 1/15/99, DOY 015):

Orbit: 4515

Downlink: 3600 bps
Spin Rate: 12.00 rpm
Spin Axis Attitude (ecliptic) [maneuver target]:
    Latitude: -89.39 deg
    Longitude: 323.85 deg
Trajectory:
    Periapsis Alt: 30 km
    Apoapsis Alt: 50 km
    Period: 112 min
Occultations: 6 minutes
Eclipses: 17 minutes
Propellant
  remaining: 17.39 kg

The maneuver to lower the average orbit altitude from 40 km to 30 km, which was scheduled for this afternoon, has been postponed for 2 weeks. Analysis by the gravity scientist indicated that the planned 30 km orbit would always have periapsis (closest approach) on the far side of the moon. Because the gravity data can only be collected when the spacecraft is in direct contact with the Earth receiving stations, this means that all of the gravity data during the extended mission would have been collected at higher altitudes than desired. The instruments also prefer to have distributed periapsis coverage, not just on the far side.

For the next two weeks, the 40-km orbit will become more and more elliptical, with its closest approach lowering to 15 km on the front side of the moon. The new orbit that we will enter in two weeks (planned for January 29) will also have periapsis on the front side. Good data will then be collected on the front side over the next couple of months. Then we will maneuver the spacecraft into the original 30-km orbit, giving far side coverage for periapsis for the spectrometers and magnetometer instruments.

==========
Date: Fri, 22 Jan 1999 10:24:42 -0700
Subject: Lunar Prospector Status 1/22/99 report #66

The Lunar Prospector spacecraft is operating well and all instruments continue to collect good data.

On Jan 19, the GRS high voltage gain was tweaked. Also, the APS instrument was commanded to investigate an ongoing noise/saturation problem with two of the instruments five faces. At the end of the test, face #5 was commanded off, to prevent it from saturating the other four faces. A total of 8 commands were sent.

Current spacecraft state (0000 GMT 1/22/99, DOY 022):

Orbit: 4595
Downlink: 3600 bps

Spin Rate: 12.00 rpm
Spin Axis Attitude (ecliptic):
Latitude: -89.48 deg
Longitude: 322.83 deg
Trajectory:
Periapsis Alt: 22 km
Apoapsis Alt: 58 km
Period: 112 min
Occultations: 49 minutes
Eclipses: 34 minutes
Propellant
remaining: 17.39 kg

Cycling of the spacecraft transmitter power during propellant tank heater events is expected to resume on Jan 25. This power cycling is necessary to prevent excessive discharge of the battery during eclipses.

The maneuver to lower the orbit to the 30-km average altitude extended mission orbit is scheduled for Jan 29 (late on the evening of Jan 28 local time).

==========
Fri Jan 22 16:21:20 1999
Subject: correction to Lunar Prospector Status 1/22/99

One small correction to today's report:

The current configuration of the APS instrument is face#3 is off (not face#5).

==========
Date: Fri, 29 Jan 1999 10:44:05 -0700
Subject: Lunar Prospector Status 1/29/99 report #67

The Lunar Prospector spacecraft is operating well.

The noise in the Alpha Particle Spectrometer (APS) instrument has begun again, and this time seems to be affecting the Neutron Spectrometer (NS) as well. As reported last week, Face #3 was turned off on DOY 019. On DOY 022, Face #5 was powered off as well. Data analysis also indicated that there has been cross-talk between the APS and NS, and that the noise in the APS is also saturating the NS. The APS was commanded off on DOY 025, and the noise in the NS disappeared. Because it is believed that the noise from the APS is related to a light leak in that instrument, the APS was turned on before last night's orbit maneuver, when the attitude was changed to provide better shading to the instrument. The data will be collected for a couple of days for analysis by the instrument team, but if the noise continues, the APS will be turned off this weekend. These two instruments share one of the three science booms on the spacecraft, and they also, along with the Gamma Ray Spectrometer, share the same electronics box. The anomaly is under investigation.

The spacecraft was successfully maneuvered into the extended mission orbit last night. Two burn sequences placed the spacecraft in a 15 km x 45 km altitude orbit, which will maintain an average altitude above the surface of 30 km. After the orbit change burns, the attitude was precessed slightly to change the sun angle for the spectrometer instruments.

The maneuver timeline is given below. The combined set of maneuvers consumed 1.44 kg of propellant.

DOY 029, times are GMT:
06:29 thruster heaters ON
06:35 APS ON
06:39 load maneuver parameters
06:55 fire part 1, A1/A2 thrusters for 40.4 sec, 6.34 m/s
raised periapsis, new orbit 43 km x 63 km altitude
07:30 thruster heaters ON
07:32 load maneuver parameters
07:43 fire part 2, A1/A2 thrusters for 71.6 sec, 11.34 m/s
lower periapsis, new orbit 15 km x 45 km
08:05 thruster heaters ON
08:20 load maneuver parameters
08:24 fire reorientation, A1/A4 thrusters, 8 0.2-sec pulses, slew 1.5 deg

Cycling of the spacecraft transmitter began this morning. The transmitter is powered off for occultations (when the spacecraft goes behind the moon and no data is received at Earth anyway) to reduce battery drain during propellant tank heater events.

Current spacecraft state (0000 GMT 1/29/99, DOY 029):

Orbit: 4698
Downlink: 3600 bps
Spin Rate: 12.09 rpm
Spin Axis Attitude (ecliptic) [maneuver target]:
Latitude: -88.36 deg
Longitude: 333.53 deg
Trajectory:
Periapsis Alt: 17 km
Apoapsis Alt: 43 km
Period: 111 min
Occultations: none
Eclipses: 40 minutes
Propellant
remaining: 15.95 kg

On January 31, 1999, from 14:04 to 18:30 GMT, the Earth will partially block the Sun as seen by the moon. The LP spacecraft will enter and exit partial shadow twice as it circles the moon. Since the LP spacecraft will also be experiencing 42 minute nightside passes once each 111 minute orbit, the loss of full sun between

nightside passes will slow battery recharge. The LP project will be closely monitoring the power and thermal subsystems during this event, and power cycling of the transmitter is expected.

==========
Date: Fri, 5 Feb 1999 08:05:26 -0700
Subject: Lunar Prospector Status 2/4/99 report #68

The Lunar Prospector spacecraft is operating well and collecting science data in the extended mission orbit.

On January 31, the moon went through Earth's penumbral shadow (a partial eclipse) from 14:04 to 18:30 GMT. The loss of full sunlight cooled the LP spacecraft and prevented full recharging of the battery between nightside passages each orbit. To prevent excessive battery discharge, the spacecraft transmitter was powered off for much of the event, and the primary heater circuits were powered off for a short time as well. The timeline is given below.

DOY 031 (all times GMT):
15:00 Transmitter OFF. (Enter occultation and nightside eclipse 15:03)
15:45 Exit occultation and nightside eclipse but deep in partial shadow (over 90% of the sun blocked). Transmitter left off - no data
16:40 Transmitter ON for data snapshot. Battery voltage good but propellant tank heater was ON (high load). Tried to command primary heater circuit off, but not enough time before next occultation.
16:42 Exit partial shadow - full sun for a while
16:51 Transmitter OFF. (Enter occultation and nightside eclipse 16:54)
17:37 Exit occultation and nightside eclipse but back in partial shadow (about 30% of sun blocked)
17:39 Transmitter ON for data snapshot. Battery voltage okay but dropping quickly due to heater and transmitter loads.
17:42 Primary heater circuit OFF. Battery voltage began to recover immediately.
17:43 Transmitter OFF
18:05 Transmitter ON. Data snapshot showed battery recharging.
18:11 Exit partial shadow - full sun again
18:18 Transmitter OFF
18:45 Enter occultation and nightside eclipse
19:28 Exit occultation and nightside eclipse
19:29 Transmitter ON. Battery recharging.
19:38 Primary heater circuit ON. Back to normal operations.

Cycling of the spacecraft transmitter continues. The transmitter is powered off for occultations (when the spacecraft goes behind the moon and no data is received at Earth anyway) to reduce battery drain during propellant tank heater events. On January 31, a ground station problem prevented turn on of the transmitter at occultation exit, and 34 minutes of data were lost.

The investigation of the noise in the Alpha Particle Spectrometer (APS) instrument continues. The instrument continues to intermittently see noise that saturates the electronics, occasionally affecting the Neutron Spectrometer (NS) data as well.

The analysis of the orbit data since the maneuver last week shows good results. The performance of the thrusters was within 0.5% of predicted and the orbit is evolving as expected. The next maneuver is scheduled for February 25.

Current spacecraft state (0000 GMT 2/3/99, DOY 034):

Orbit: 4750
Downlink: 3600 bps
Spin Rate: 12.09 rpm
Spin Axis Attitude (ecliptic):
  Latitude: -88.58 deg
  Longitude: 324.18 deg
Trajectory:
  Periapsis Alt: 21 km
  Apoapsis Alt: 39 km
  Period: 111 min
Occultations: 48 minutes
Eclipses: 42 minutes
Propellant
 remaining: 15.95 kg

==========
Date: Thu, 11 Feb 1999 09:10:59 -0700
Subject: Lunar Prospector Status 2/11/99 report #69

The Lunar Prospector spacecraft is operating well and collecting good science data in the extended mission orbit.

The Alpha Particle Spectrometer (APS) instrument was turned off Feb. 8 because it was generating noise that was affecting the Neutron Spectrometer (NS) instrument. The APS will be left off for one month to ensure at least one month of clean data from the NS. After one month, the APS will be turned on again to continue investigation of the anomaly.

Cycling of the spacecraft transmitter continues. The transmitter is powered off for occultations (when the spacecraft goes behind the moon and no data is received at Earth anyway) to reduce battery drain during propellant tank heater events. During one heater event (Feb. 7), the station was not properly configured and the command did not transmit. There was no effect on the battery.

A new gravity model was delivered to the project today by the Doppler Gravity Experiment Investigator. Doppler data from the first 10 days of operations in the 30 km altitude orbit was included in the data set to generate this model.

Current spacecraft state (0000 GMT 2/11/99, DOY 042):

Orbit: 4853
Downlink: 3600 bps
Spin Rate: 12.09 rpm
Spin Axis Attitude (ecliptic):
Latitude: -88.82 deg
Longitude: 310.09 deg
Trajectory:
Periapsis Alt: 26.5 km
Apoapsis Alt: 33.5 km
Period: 111 min
Occultations: 40 minutes
Eclipses: 45 minutes
Propellant
remaining: 15.95 kg

==========
Date: Fri, 19 Feb 1999 10:03:52 -0700
Subject: Lunar Prospector Status 2/19/99 report #70

The Lunar Prospector spacecraft is operating well and collecting good science data in the extended mission orbit. Four of five science instruments are on: the Gamma Ray Spectrometer (GRS), the Neutron Spectrometer (NS), the Magnetometer (MAG) and the Electron Reflectometer (ER). Data continues to be collected for the Doppler Gravity Experiment (DGE) as well.

Cycling of the spacecraft transmitter continues. The transmitter is powered off for occultations (when the spacecraft goes behind the moon and no data is received at Earth anyway) to reduce battery drain during propellant tank heater events.

On Feb 16 (DOY 047), there was an annular solar eclipse, which caused a 3 hour outage in LP data.

Three commands were sent this week (DOY 047) to read out the MAG/ER memory.

Current spacecraft state (0000 GMT 2/19/99, DOY 050):

Orbit: 4957
Downlink: 3600 bps
Spin Rate: 12.09 rpm
Spin Axis Attitude (ecliptic):
Latitude: -88.96 deg
Longitude: 282.23 deg
Trajectory:
Periapsis Alt: 20.0 km

Apoapsis Alt: 40.0 km
Period: 111 min
Occultations: 49 minutes
Eclipses: 47 minutes
Propellant
remaining: 15.95 kg

==========
Date: Fri, 26 Feb 1999 10:01:53 -0700
Subject: Lunar Prospector Status 2/26/99 report #71

The Lunar Prospector spacecraft is operating well and collecting good science data in the extended mission orbit. Four of five science instruments are on: the Gamma Ray Spectrometer (GRS), the Neutron Spectrometer (NS), the Magnetometer (MAG) and the Electron Reflectometer (ER). Data continues to be collected for the Doppler Gravity Experiment (DGE) as well.

Cycling of the spacecraft transmitter continues. The transmitter is powered off for occultations (when the spacecraft goes behind the moon and no data is received at Earth anyway) to reduce battery drain during propellant tank heater events. There was one instance (DOY 050) when the commands to turn off the transmitter were not sent because of station configuration problems, but there was no impact on the battery. On DOY 051, commands to turn the transmitter back on were delayed due to station configuration problems, and 28 minutes of data were lost.

On DOY 056, thrusters were fired to maintain the extended mission orbit for another 28 days. The timeline is given below (all times are GMT):

056/10:45 Turn A1,A2 thruster heaters on
056/10:50 Load maneuver parameter file
056/11:16 Fire part 1: A1/A2 for 43.5 sec; $\Delta V = 6.85$ m/s
Raise periapsis from 15.8 km to 40.5 km; used 0.55 kg propellant
056/11:24 Turn A1,A2 thruster heaters on
056/11:30 Load maneuver parameter file
056/11:55 Fire part 2: A1/A2 for 46.5 sec; $\Delta V = 7.34$ m/s
Set new periapsis - new orbit 15 x 45 km; used 0.59 kg propellant
056/12:04 Turn A1,A4 thruster heaters on
056/12:40 Load maneuver parameter file
056/12:44 Fire reorientation maneuver: 7 0.2-sec pulses of A1/A4
Precess spin axis 1.2 deg; target attitude 348/-89.1; 0.02 kg prop
056/12:48 Turn T1 thruster heater on
056/12:59 Load maneuver parameter file
056/13:02 Fire spin trim: T1 for 0.62 sec; $\Delta w = 0.155$ rpm
Target spin rate 12.00 rpm; used 0.003 kg propellant

On DOY 057, two commands were sent to reset the gain of the GRS instrument.

Current spacecraft state (0000 GMT 2/26/99, DOY 057):

Orbit: 5048
Downlink: 3600 bps
Spin Rate: 12.00 rpm
Spin Axis Attitude (ecliptic):
Latitude: -89.2 deg
Longitude: 345.41 deg
Trajectory:
Periapsis Alt: 15.9 km
Apoapsis Alt: 44.1 km
Period: 111 min
Occultations: none
Eclipses: 47 minutes
Propellant
remaining: 14.78 kg

Preliminary results of the maneuver Thursday show excellent performance. The next maneuver is scheduled for March 25.

==========

Date: Fri, 5 Mar 1999 10:03:33 -0700
Subject: Lunar Prospector Status 3/5/99 report #72

The Lunar Prospector spacecraft is operating well and collecting good science data in the extended mission orbit. Four of five science instruments are on: the Gamma Ray Spectrometer (GRS), the Neutron Spectrometer (NS), the Magnetometer (MAG) and the Electron Reflectometer (ER). Data continues to be collected for the Doppler Gravity Experiment (DGE) as well.

Cycling of the spacecraft transmitter continues. There was one instance were the transmitter on commands were delayed due to station configuration problems and 4 minutes of data were lost (DOY 059).

On DOY 061, two commands were sent to reset the gain of the GRS instrument. On DOY 062, 87 commands were sent to reload part of the ER instrument memory to improve data return in the low altitude orbit.

Current spacecraft state (0000 GMT 3/5/99, DOY 064):

Orbit: 5138
Downlink: 3600 bps
Spin Rate: 12.00 rpm
Spin Axis Attitude (ecliptic):
Latitude: -89.41 deg
Longitude: 345.2 deg
Trajectory:
Periapsis Alt: 27.4 km
Apoapsis Alt: 32.6 km
Period: 111 min

Occultations: 49 minutes
Eclipses: 48 minutes
Propellant
 remaining: 14.78 kg

==========
Date: Fri, 12 Mar 1999 08:15:16 -0700
Subject: Lunar Prospector Status 3/12/99 report #73

The Lunar Prospector spacecraft is operating well and collecting good science data in the extended mission orbit. Four of five science instruments are on: the Gamma Ray Spectrometer (GRS), the Neutron Spectrometer (NS), the Magnetometer (MAG) and the Electron Reflectometer (ER). Data continues to be collected for the Doppler Gravity Experiment (DGE) as well.

Cycling of the spacecraft transmitter was discontinued on DOY 065 (March 6). The transmitter had been cycled during propellant tank heater events but the heater events have become shorter due to fuel burn (used in lowering and maintaining the orbit) and there are no longer two complete night passes during a single heater on event. Review of recent data indicated that the transmitter cycling should not be required and so it has been tentatively discontinued. A procedure has been established to closely monitor the power system during heater events.

Also on DOY 065, the Propellant Tank Pressure Transducer and the Earth Moon Limb Sensor were turned off. These systems were turned off to reduce the load on the spacecraft, and will be turned on periodically as needed for maneuvers and attitude determinations.

Current spacecraft state (0000 GMT 3/12/99, DOY 071):

Orbit: 5229
Downlink: 3600 bps
Spin Rate: 12.00 rpm
Spin Axis Attitude (ecliptic):
  Latitude: -89.59 deg
  Longitude: 311.29 deg
Trajectory:
  Periapsis Alt: 23.5 km
  Apoapsis Alt: 36.5 km
  Period: 111 min
Occultations: none
Eclipses: 48 minutes
Propellant
 remaining: 14.78 kg

==========
Date: Fri, 19 Mar 1999 08:15:14 -0700
Subject: Lunar Prospector Status 3/19/99 report #74

The Lunar Prospector spacecraft is operating well and collecting good science data in the extended mission orbit. Four of five science instruments are on: the Gamma Ray Spectrometer (GRS), the Neutron Spectrometer (NS), the Magnetometer (MAG) and the Electron Reflectometer (ER). Data continues to be collected for the Doppler Gravity Experiment (DGE) as well.

Cycling of the spacecraft transmitter was reinitiated on DOY 071 (March 12). During two eclipses after canceling the procedure, the battery voltage reached the top of the yellow low limit, so the procedure was reestablished to increase margin as eclipses lengthen slightly before reaching a maximum in early April. There was one event (DOY 072), where the transmitter on command was delayed due to station problems, causing a 96 minute loss of data.

On DOY 072, the battery voltage reached the top of the yellow low limit even with the transmitter cycling procedure being implemented. Because the transmitter cannot be turned off for longer periods without losing data and the risk to the spacecraft is considered low, the procedure has not been modified, but the battery is being very closely monitored.

On DOY 076, commands were sent to the MAG/ER instrument to collect bursts of high rate data sets over the largest magnetic anomaly on the moon.

Current spacecraft state (0000 GMT 3/19/99, DOY 078):

Orbit: 5319
Downlink: 3600 bps
Spin Rate: 12.00 rpm
Spin Axis Attitude (ecliptic):
  Latitude: -89.76 deg
  Longitude: 283.81 deg
Trajectory:
  Periapsis Alt: 14.8 km
  Apoapsis Alt: 45.2 km
  Period: 111 min
Occultations: 49 minutes
Eclipses: 48 minutes
Propellant
 remaining: 14.78 kg

The next orbital maintenance burn is scheduled for March 24.

==========
Date: Thu, 25 Mar 1999 17:17:44 -0700
Subject: Lunar Prospector Status 3/25/99 report #75

The Lunar Prospector spacecraft continues to collect good science data in the extended mission orbit. Four of five science instruments are on: the Gamma Ray Spectrometer (GRS), the Neutron Spectrometer (NS), the Magnetometer

(MAG) and the Electron Reflectometer (ER). Data continues to be collected for the Doppler Gravity Experiment (DGE) as well.

Cycling of the spacecraft transmitter continued through most of the period. The transmitter has been powered off for short periods when the propellant tank heater is on to reduce battery drain. As the propellant is used for orbit maintenance burns, the time the heater is on becomes shorter. After the orbit maintenance burn fired yesterday (DOY 083), the on-time has become short enough that cycling of the transmitter has been discontinued.

The orbit maintenance burn to maintain the extended mission 30-km average altitude orbit was successfully fired yesterday (DOY 083). The next orbit maintenance burn is scheduled for April 21. There were some anomalous commanding events during the maneuver burn, and the reorientation burn scheduled for after the orbit maintenance burn was postponed. During the maneuver sequence, three commands that were transmitted to the spacecraft were not properly received and did not execute. The first two were retransmitted, executed successfully, and the sequence continued. When the third command did not process correctly, the decision was made to discontinue the procedure until some investigation could be made. By then, the orbit maintenance burns had completed successfully and on time (with preliminary analysis from the navigation team showing a performance error of less than 1 percent.) The reorientation burns were not critical and were postponed.

So far, there has been no conclusion on what might have caused the commands to fail to execute. The DSN staff is looking into possible problems with the station (DSS 66) transmitter and the spacecraft team is reviewing all the spacecraft data.

The maneuver timeline is given below (times are GMT):
082/1640 Earth Moon Sensor ON; Pressure transducer ON
083/1704 A1/A2 thruster heaters ON
    [one cmd in this file had to be resent]
084/1710 load maneuver parameters
084/1730 fire part 1 - A1/A2 - 43.8 sec burn - 6.87 m/s - 0.55 kg propellant
084/1738 A1/A2 thruster heaters ON
084/1743 load maneuver parameters
084/1810 fire part 2 - A1/A2 - 47.1 sec burn - 7.39 m/s - 0.59 kg propellant
084/1828 A1/A4 thruster heaters ON (for reorientation maneuver)
    [one cmd in this file had to be resent]
084/1854 load maneuver parameter file (for reor)
    [one cmd did not execute and decision made to cancel reor]
084/1901 clear maneuver parameter registers
084/1908 turn thruster heaters OFF

Current spacecraft state (0000 GMT 3/25/99, DOY 084):

Orbit: 5397

Downlink: 3600 bps
Spin Rate: 12.09 rpm
Spin Axis Attitude (ecliptic):
Latitude: -89.65 deg
Longitude: 247.75 deg
Trajectory:
Periapsis Alt: 15.0 km
Apoapsis Alt: 45.0 km
Period: 111 min
Occultations: none
Eclipses: 49 minutes
Propellant
remaining: 13.64 kg

The reorientation burn has been tentatively scheduled for March 29 (DOY 088).

==========
Date: Thu, 1 Apr 1999 15:54:26 -0700
Subject: Lunar Prospector Status 4/2/99 report #76

The Lunar Prospector spacecraft continues to collect good science data in the extended mission orbit. Four of five science instruments are on: the Gamma Ray Spectrometer (GRS), the Neutron Spectrometer (NS), the Magnetometer (MAG) and the Electron Reflectometer (ER). Data continues to be collected for the Doppler Gravity Experiment (DGE) as well.

Investigation into the commanding anomalies during last week's maneuver sequence continues. There have been two commanding sequences since that maneuver for an attitude reorientation trim (DOY 088) and ER configuration commanding (DOY 089). The attitude sequence (17 cmds) was transmitted over DSS 61 with no anomalies. The ER sequence (19 cmds) was transmitted over DSS 16 and one command did not execute and had to be retransmitted. Both commanding sequences with failures were over 26-m DSN antenna sites, where the downlink telemetry also shows periods of noise.

The attitude reorientation timeline is given below (times are GMT, DOY 088):
1730 Clear maneuver registers
1734 Heaters ON
1740 GRS HV to 218 (not related to maneuver)
1742 Load maneuver parameters
1800 Fire 11 A1/A4 0.2 sec pulses (SEA change from -0.37 to 1.41)
1803 Safing

The attitude was precessed 1.4 deg; 0.03 kg of propellant was used.

Cycling of the transmitter during propellant tank heater events was discontinued on DOY 083. There have been 4 events where the battery voltage reached the yellow low voltage limit at the end of eclipse. Maximum eclipse occurs this

weekend (DOY 093) and the decision was made to not reinstitute transmitter cycling but to closely monitor the battery voltage.

The Earth Moon Sensor and the Pressure Transducer were powered off at the end of the ER sequence (089/0446) to reduce the power load. Since then, there have been no battery yellow limit events. The ER commanding was to optimize data collection during the period of full moon, when the earth blocks the magnetic field of the sun and allows higher resolution of the lunar field.

Current spacecraft state (0000 GMT 4/2/99, DOY 092):

Orbit: 5501
Downlink: 3600 bps
Spin Rate: 12.09 rpm
Spin Axis Attitude (ecliptic):
  Latitude: -88.59 deg
  Longitude: 12.77 deg
Trajectory:
  Periapsis Alt: 27.4 km
  Apoapsis Alt: 32.6 km
  Period: 111 min
Occultations: 49 minutes
Eclipses: 49 minutes
Propellant
 remaining: 13.61 kg

==========
Date: Fri, 9 Apr 1999 14:17:40 -0700
Subject: Lunar Prospector Status 4/9/99 report #77

The Lunar Prospector spacecraft continues to collect good science data in the extended mission orbit. Four of five science instruments are on: the Gamma Ray Spectrometer (GRS), the Neutron Spectrometer (NS), the Magnetometer (MAG) and the Electron Reflectometer (ER). Data continues to be collected for the Doppler Gravity Experiment (DGE) as well.

Investigation into the commanding anomalies during last week's maneuver sequence continues. Since the last report, all commands (a total of 42) have executed normally. Procedures are being generated to allow for redundant commanding if required during maneuver commanding.

Cycling of the transmitter during propellant tank heater events was discontinued on DOY 083. Even with the load slightly reduced by keeping the Earth Moon Sensor and Pressure Transducer off, there have been 4 eclipses during heater events where the battery has dropped to the yellow low voltage limit. The maximum eclipse occurred on April 3 and the length of eclipses will slowly get shorter. Also, as fuel is burned during orbit maintenance burns, the heater cycle will shorten, causing less of an impact during a given orbit.

Current spacecraft state (0000 GMT 4/9/99, DOY 099):

Orbit: 5591
Downlink: 3600 bps
Spin Rate: 12.09 rpm
Spin Axis Attitude (ecliptic):
Latitude: -88.79 deg
Longitude: 13.48 deg
Trajectory:
Periapsis Alt: 22.5 km
Apoapsis Alt: 37.5 km
Period: 111 min
Occultations: none
Eclipses: 49 minutes
Propellant
remaining: 13.61 kg

The next orbit maintenance burn is scheduled for late in the afternoon local time on April 20 (DOY 111 GMT).

==========
Date: Fri, 16 Apr 1999 08:58:47 -0700
Subject: Lunar Prospector Status 4/16/99 report #78

The Lunar Prospector spacecraft continues to collect good science data in the extended mission orbit. Four of five science instruments are on: the Gamma Ray Spectrometer (GRS), the Neutron Spectrometer (NS), the Magnetometer (MAG) and the Electron Reflectometer (ER). Data continues to be collected for the Doppler Gravity Experiment (DGE) as well.

Investigation into the commanding anomaly continues. Since the last report, all commands (a total of 26) have executed normally.

During the last week, there have been 4 (of 11) occurrences of the battery voltage reaching the yellow low-voltage limit during an eclipse while the propellant tank heater was on.

Current spacecraft state (0000 GMT 4/16/99, DOY 106):

Orbit: 5682
Downlink: 3600 bps
Spin Rate: 12.09 rpm
Spin Axis Attitude (ecliptic):
Latitude: -88.91 deg
Longitude: 20.65 deg
Trajectory:
Periapsis Alt: 12.4 km
Apoapsis Alt: 47.6 km
Period: 111 min

Occultations: 49 minutes
Eclipses: 49 minutes
Propellant
remaining: 13.61 kg

The next orbit maintenance burn is scheduled for late in the afternoon local time on April 20 (DOY 111 GMT).

==========

Date: Fri, 23 Apr 1999 09:23:08 -0700
Subject: Lunar Prospector Status 4/23/99 report #79

The Lunar Prospector spacecraft continues to collect good science data in the extended mission orbit. All five science instruments are on: the Gamma Ray Spectrometer (GRS), the Neutron Spectrometer (NS), the Magnetometer (MAG), the Electron Reflectometer (ER), and the Alpha Particle Spectrometer (APS). Data continues to be collected for the Doppler Gravity Experiment (DGE) as well.

Investigation into the commanding anomaly continues. Since the last report, only one command (out of a total of 72) has not executed normally. Again, this command did not fire when the downlink signal was showing lots of noise and the spacecraft was in the northern hemisphere. It is believed that the uplink signal may occasionally be corrupted because of coherent reflections from the surface of the moon.

During the last week, there have been 4 (of 11) occurrences of the battery voltage reaching the yellow low-voltage limit during an eclipse while the propellant tank heater was on.

The extended mission orbit maintenance burn was successful executed on April 20 (DOY 111 GMT). There were no command anomalies during this event. A timeline is given below.

111/01:00 Turn Earth-Moon Sensor (EMS) ON
111/01:01 Turn Pressure Transducer ON
111/01:06 Turn A1/A2 heaters ON
111/01:08 Load maneuver parameters
111/01:32 Fire delta-V part 1 (A1/A2 for 45.2 sec, 7.10 m/s burn, 0.57 kg fuel)
111/01:36 Turn A1/A2 heaters ON
111/01:43 Load maneuver parameters
111/02:14 Fire delta-V part 2 (A1/A2 for 45.3 sec, 7.12 m/s burn, 0.56 kg fuel)
111/02:17 Turn A1/A4 heaters ON
111/02:53 Load maneuver parameters
111/02:58 Fire reorientation (A1/A4 for 4 pulses, 0.7 deg precession, 0.01 kg)
111/03:01 Turn T1 heater ON
111/03:16 Load maneuver parameters
111/03:19 Fire spin trim (T1 for 0.63 sec, 0.155 rpm change, 0.003 kg fuel)
111/03:21 Turn Pressure Transducer OFF

The command failure occurred when the EMS was being turned off the day after the maneuver. Resending the command turned the sensor off.

On April 21, the Alpha Particle Spectrometer was turned on. It had been turned off since February 8 when noise from this instrument was seen to interfere with the Neutron Spectrometer. The APS is currently collecting good data and does not seem to be generating noise. The data will continue to be monitored.

Current spacecraft state (0000 GMT 4/23/99, DOY 113):

Orbit: 5773
Downlink: 3600 bps
Spin Rate: 12.00 rpm
Spin Axis Attitude (ecliptic):
  Latitude: -88.57 deg
  Longitude: 39.40 deg
Trajectory:
  Periapsis Alt: 21.6 km
  Apoapsis Alt: 38.4 km
  Period: 111 min
Occultations: 39 minutes
Eclipses: 49 minutes
Propellant
 remaining: 12.47 kg

The next orbit maintenance burn is scheduled for May 5. This maneuver will put the spacecraft into a similar 30-km average altitude orbit, but one that will have periapsis on the far side of the moon for most of the time, rather than the near side of the moon as the current orbit has. Maneuvers will then continue once every 28 days through the end of mission.

==========
Date: Fri, 30 Apr 1999 10:55:49 -0700
Subject: Lunar Prospector Status 4/30/99 report #80

The Lunar Prospector spacecraft continues to collect good science data in the extended mission orbit. All five science instruments are on: the Gamma Ray Spectrometer (GRS), the Neutron Spectrometer (NS), the Magnetometer (MAG), the Electron Reflectometer (ER), and the Alpha Particle Spectrometer (APS). Data continues to be collected for the Doppler Gravity Experiment (DGE) as well.

During the last week, there have been 8 (of 13) occurrences of the battery voltage reaching the yellow low-voltage limit (24.5 V) during an eclipse while the propellant tank heater was on.

On April 28, 14 commands were sent to configure the MAG/ER instrument to collect high resolution data during full moon. Since the solar magnetic field is much stronger than the lunar magnetic field, the best lunar magnetic field data is collected during full moon, when the earth is between the sun and the moon,

blocking the solar magnetic field, and the moon's field is more easily measured. Full moon will occur April 30. All commands executed nominally.

Current spacecraft state (0000 GMT 4/30/99, DOY 120):

Orbit: 5863
Downlink: 3600 bps
Spin Rate: 12.00 rpm
Spin Axis Attitude (ecliptic):
  Latitude: -88.5 deg
  Longitude: 40.29 deg
Trajectory:
  Periapsis Alt: 23.7 km
  Apoapsis Alt: 36.3 km
  Period: 111 min
Occultations: 49 minutes
Eclipses: 48 minutes
Propellant
 remaining: 12.47 kg

The next orbit maintenance burn is scheduled for May 5. This maneuver will put the spacecraft into a similar 30-km average altitude orbit, but one that will have periapsis on the far side of the moon for most of the time, rather than the near side of the moon as the current orbit has. Maneuvers will then continue once every 28 days through the end of mission.

==========
Date: Thu, 6 May 1999 15:38:33 -0700
Subject: Lunar Prospector Status 5/7/99 report #81

The Lunar Prospector spacecraft continues to collect good science data in the extended mission orbit. All five science instruments are on: the Gamma Ray Spectrometer (GRS), the Neutron Spectrometer (NS), the Magnetometer (MAG), the Electron Reflectometer (ER), and the Alpha Particle Spectrometer (APS). Data continues to be collected for the Doppler Gravity Experiment (DGE) as well.

During the last week, there were 2 occurrences where the battery voltage dropped to below the red limit during eclipse with the propellant tank heater on. Since these events (DOY 121 and 123), the transmitter has been cycled off during heater event eclipses if the battery has not been fully recharged.

On May 2, the MAG/ER was reconfigured for normal data collection, as the full moon period ended.

On May 5, the 5th orbit burn sequence to maintain the extended mission orbit was executed. This maneuver moved periapsis to the far side, where it will generally remain through the end of mission. A timeline is given below (transmit times in HHMM GMT on Day of Year 125).

125/1707 EM/Pressure transducer ON
125/1709 thruster A1/A2 heaters on
125/1714 maneuver parameters loaded
125/1735 fire part 1 delta-V, A1/A2 for 25.5 sec, 4.0 m/s, 0.33 kg fuel)
125/1742 thruster A1/A2 heaters on
125/1755 maneuver parameters loaded
125/1833 fire part 2 delta-V, A1/A2 for 26.0 sec, 4.1 m/s, 0.33 kg fuel)
125/1834 thrusters safed

All commands (58 total) executed normally this week.

Current spacecraft state (0000 GMT 5/7/99, DOY 127):

Orbit: 5954
Downlink: 3600 bps
Spin Rate: 12.04 rpm
Spin Axis Attitude (ecliptic):
  Latitude: -88.54 deg
  Longitude: 37.73 deg
Trajectory:
  Periapsis Alt: 21.4 km
  Apoapsis Alt: 38.6 km
  Period: 111 min
Occultations: 21 minutes
Eclipses: 48 minutes
Propellant
 remaining: 11.81 kg

==========
Date: Fri, 14 May 1999 09:56:44 -0700
Subject: Lunar Prospector Status 5/14/99 report #82

The Lunar Prospector spacecraft continues to collect good science data in the extended mission orbit. All five science instruments are on: the Gamma Ray Spectrometer (GRS), the Neutron Spectrometer (NS), the Magnetometer (MAG), the Electron Reflectometer (ER), and the Alpha Particle Spectrometer (APS). Data continues to be collected for the Doppler Gravity Experiment (DGE) as well.

The transmitter was turned off for short intervals three times this week during eclipse periods when the propellant tank heater was on. The battery voltage dropped to the yellow low limit for 10 of 16 heater events, but never reached the red limit.

All commands (16 total) executed normally this week.

Current spacecraft state (0000 GMT 5/14/99, DOY 134):

Orbit: 6045
Downlink: 3600 bps

Spin Rate: 12.04 rpm
Spin Axis Attitude (ecliptic):
    Latitude: -88.5 deg
    Longitude: 42.02 deg
Trajectory:
    Periapsis Alt: 19.3 km
    Apoapsis Alt: 40.7 km
    Period: 111 min
Occultations: 48 minutes
Eclipses: 47 minutes
Propellant
  remaining: 11.81 kg

==========
Date: Fri, 21 May 1999 13:56:02 -0700
Subject: Lunar Prospector Status 5/21/99 report #83

The Lunar Prospector spacecraft continues to collect good science data in the extended mission orbit. All five science instruments are on: the Gamma Ray Spectrometer (GRS), the Neutron Spectrometer (NS), the Magnetometer (MAG), the Electron Reflectometer (ER), and the Alpha Particle Spectrometer (APS). Data continues to be collected for the Doppler Gravity Experiment (DGE) as well.

The transmitter was turned off for short intervals five times this week during eclipse periods when the propellant tank heater was on. The battery voltage dropped to the yellow low limit for 5 heater events and to the red low limit for one event (out of 18 events).

All commands (24 total) executed normally this week.

Current spacecraft state (0000 GMT 5/21/99, DOY 141):

Orbit: 6135
Downlink: 3600 bps
Spin Rate: 12.04 rpm
Spin Axis Attitude (ecliptic):
    Latitude: -88.55 deg
    Longitude: 45.70 deg
Trajectory:
    Periapsis Alt: 16.6 km
    Apoapsis Alt: 43.4 km
    Period: 111 min
Occultations: 44 minutes
Eclipses: 46 minutes
Propellant
  remaining: 11.81 kg

The next orbit maintenance burn is scheduled for June 2, GMT (afternoon of June 1, PST).

==========
Date: Thu, 27 May 1999 15:19:16 -0700
Subject: Lunar Prospector Status 5/28/99 report #84

The Lunar Prospector spacecraft continues to collect good science data in the extended mission orbit. Four of five science instruments are on: the Gamma Ray Spectrometer (GRS), the Neutron Spectrometer (NS), the Magnetometer (MAG), and the Electron Reflectometer (ER). Data continues to be collected for the Doppler Gravity Experiment (DGE) as well.

The Alpha Particle Spectrometer was turned off May 24. The instrument has periodically seen noise throughout the mission and early this year the noise began to affect the NS instrument as well. It was turned off in February for two months to ensure collection of clean NS data at low altitude. It was turned back on April 21 and had been working well; however in the last week it began to see noise again and the noise was again affecting the NS. So the instrument has been turned off for an indefinite period of time.

The transmitter was turned off for short intervals 12 times this week during eclipse periods when the propellant tank heater was on. As eclipses are overlapped with occultations (when the spacecraft cannot see the earth), no data was lost. The battery voltage dropped to the yellow low limit for 3 heater events and to the red low limit for 3 events (out of 20 events).

All commands (68 total) executed normally this week.

Current spacecraft state (0000 GMT 5/28/99, DOY 148):

Orbit: 6226
Downlink: 3600 bps
Spin Rate: 12.04 rpm
Spin Axis Attitude (ecliptic):
  Latitude: -88.46 deg
  Longitude: 45.72 deg
Trajectory:
  Periapsis Alt: 17.9 km
  Apoapsis Alt: 42.1 km
  Period: 111 min
Occultations: 48 minutes
Eclipses: 44 minutes
Propellant
  remaining: 11.81 kg

The next orbit maintenance burn is scheduled for June 2, GMT (afternoon of June 1, PST).

==========
Date: Fri, 4 Jun 1999 10:42:08 -0700

Subject: Lunar Prospector Status 6/4/99 report #85

The Lunar Prospector spacecraft continues to collect good science data in the extended mission orbit. Four of five science instruments are on: the Gamma Ray Spectrometer (GRS), the Neutron Spectrometer (NS), the Magnetometer (MAG), and the Electron Reflectometer (ER). Data continues to be collected for the Doppler Gravity Experiment (DGE) as well.

The transmitter was turned off for short intervals 22 times this week during eclipse periods when the propellant tank heater was on. Burning propellant has reduced the period of the heater, and we are now experiencing about 3 heater events each day. The battery voltage dropped to the yellow low limit for 2 heater events.

The MAG/ER was commanded to higher resolution mode on 5/28 for the full moon passage 5/30; and was commanded back to normal mode 5/31.

On June 1 (local), the sixth maneuver to maintain the extended orbit was executed. There were no anomalies and the timeline is given below. No spin or attitude reorientation trims were required.

152/23:15 A1/A2 thruster heaters commanded on
152/23:20 Loaded maneuver parameters
152/23:40 Fire part 1 - A1/A2 thrusters 45.7 sec (7.2 m/s; used 0.57 kg prop)
153/00:20 Commanded A1/A2 thruster heaters on
153/00:22 Loaded maneuver parameters
153/00:51 Fire part 2 - A1/A2 thrusters 45.1 sec (7.1 m/s; used 0.55 kg prop)
153/00:52 Safe spacecraft

All commands (148 total) executed normally this week.

Current spacecraft state (0000 GMT 6/4/99, DOY 155):

Orbit: 6317
Downlink: 3600 bps
Spin Rate: 12.12 rpm
Spin Axis Attitude (ecliptic):
  Latitude: -88.45 deg
  Longitude: 39.66 deg
Trajectory:
  Periapsis Alt: 17.5 km
  Apoapsis Alt: 42.5 km
  Period: 111 min
Occultations: 44 minutes
Eclipses: 42 minutes
Propellant
 remaining: 10.68 kg

The next orbit maintenance burn is scheduled for June 28, 1999.

==========
Date: Fri, 11 Jun 1999 14:48:38 -0700
Subject: Lunar Prospector Status 6/11/99 report #86

The Lunar Prospector spacecraft continues to collect good science data in the extended mission orbit. Four of five science instruments are on: the Gamma Ray Spectrometer (GRS), the Neutron Spectrometer (NS), the Magnetometer (MAG), and the Electron Reflectometer (ER). Data continues to be collected for the Doppler Gravity Experiment (DGE) as well.

The transmitter was turned off for short intervals 7 times this week during eclipse periods when the propellant tank heater was on. The battery voltage remained within green limits all week. Although the number of heater events is slowly increasing (there were 24 events this week), the battery load is decreasing as the heater on-time and the eclipses are both getting shorter.

The MAG/ER was commanded to burst mode on 6/8 to collect high resolution data for a short period of time.

All commands (30 total) executed normally this week.

Current spacecraft state (0000 GMT 6/11/99, DOY 162):

Orbit: 6407
Downlink: 3600 bps
Spin Rate: 12.12 rpm
Spin Axis Attitude (ecliptic):
  Latitude: -88.4 deg
  Longitude: 41.27 deg
Trajectory:
  Periapsis Alt: 17.5 km
  Apoapsis Alt: 42.5 km
  Period: 111 min
Occultations: 49 minutes
Eclipses: 37 minutes
Propellant
 remaining: 10.68 kg

The next orbit maintenance burn is scheduled for June 28, 1999.

==========
Date: Fri, 18 Jun 1999 10:03:47 -0700
Subject: Lunar Prospector Status 6/18/99 report #87

The Lunar Prospector spacecraft continues to collect good science data in the extended mission orbit. Four of five science instruments are on: the Gamma Ray Spectrometer (GRS), the Neutron Spectrometer (NS), the Magnetometer

(MAG), and the Electron Reflectometer (ER). Data continues to be collected for the Doppler Gravity Experiment (DGE) as well.

The transmitter was turned off for a short interval only once this week during an eclipse period when the propellant tank heater was on. The battery voltage remained within green limits all week. As eclipse have gotten shorter (the season ends in about a week and then there is a 3 week period with no eclipses at all), it is expected that transmitter cycling will not be required again on a regular basis.

The GRS gain setting was tweaked on 6/11.

All commands (6 total) executed normally this week.

Current spacecraft state (0000 GMT 6/18/99, DOY 169):

Orbit: 6498
Downlink: 3600 bps
Spin Rate: 12.12 rpm
Spin Axis Attitude (ecliptic):
  Latitude: -88.66 deg
  Longitude: 55.18 deg
Trajectory:
  Periapsis Alt: 14.1 km
  Apoapsis Alt: 45.9 km
  Period: 111 min
Occultations: 46 minutes
Eclipses: 32 minutes
Propellant
 remaining: 10.68 kg

The next orbit maintenance burn is scheduled for June 28, 1999.

==========
Date: Fri, 25 Jun 1999 11:41:07 -0700
Subject: Lunar Prospector Status 6/25/99 report #88

The Lunar Prospector spacecraft continues to collect good science data in the extended mission orbit. Four of five science instruments are on: the Gamma Ray Spectrometer (GRS), the Neutron Spectrometer (NS), the Magnetometer (MAG), and the Electron Reflectometer (ER). Data continues to be collected for the Doppler Gravity Experiment (DGE) as well.

Eclipses ended this week and the spacecraft will remain in sunlight for the next 3 weeks as the orbit is perpendicular to the sun/moon line.

There was no commanding this week.

Current spacecraft state (0000 GMT 6/25/99, DOY 176):

Orbit: 6589
Downlink: 3600 bps
Spin Rate: 12.12 rpm
Spin Axis Attitude (ecliptic):
Latitude: -88.5 deg
Longitude: 48.65 deg
Trajectory:
Periapsis Alt: 18.0 km
Apoapsis Alt: 42.0 km
Period: 111 min
Occultations: 47 minutes
Eclipses: none
Propellant
remaining: 10.68 kg

The next orbit maintenance burn is scheduled for June 29, 1999, 1512 GMT(morning of June 29, PST).

Plans are being finalized for the end-of-mission activities. On June 26, there will be a final orbit maintenance burn. On June 28, there is a lunar eclipse and special power maintenance activities are expected to reduce the battery load during that event. Over the next few days, the spacecraft will be commanded to impact the moon into a perennially shadowed crater near the South Pole. Scientists will observe the impact from Earth-based telescope and from Hubble Space Telescope and hope to see evidence of water ice in the impact debris cloud. Currently the impact is scheduled for 09:52 GMT on July 31.

==========
Date: Thu, 1 Jul 1999 11:17:52 -0700
Subject: Lunar Prospector Status 7/1/99 report #89

The Lunar Prospector spacecraft continues to collect good science data in the extended mission orbit. Four of five science instruments are on: the Gamma Ray Spectrometer (GRS), the Neutron Spectrometer (NS), the Magnetometer (MAG), and the Electron Reflectometer (ER). Data continues to be collected for the Doppler Gravity Experiment (DGE) as well.

On June 27, the ER instrument was commanded to high resolution mode to collect data during the full moon (which occurred June 28). On June 30, it was commanded back to normal mode. During the commanding on June 30, there was one command that did not get received by the spacecraft. Because of that, as well as noise in the downlink (which prevented verification of the uplink) and a procedural error, the commands had to be resent several times. The instrument is operating well and there were no unexplained anomalies.

On June 29, the 7th Extended Mission Orbit Correction burn was executed. There were no anomalies and the timeline is summarized below. Analysis shows that performance was only 0.3% off from the prediction.

180/14:45 thruster heaters commanded on
180/14:49 loaded maneuver parameters
180/15:11 fired A1/A2 thrusters for 47.3 sec (7.51 m/s ΔV, 0.59 kg propellant)
180/15:55 thruster heaters commanded on
180/15:58 loaded maneuver parameters
180/16:22 fired A1/A2 thrusters for 46.9 sec (7.47 m/s ΔV, 0.58 kg propellant)
180/16:24 safed spacecraft (cleared maneuver parameters)

Of 74 commands transmitted to the spacecraft this week, only one did not execute (ER command 6/30). It is believed that this was due to intermittent coherent interference to the uplink due to reflections off the moon.

Current spacecraft state (0000 GMT 7/1/99, DOY 182):

Orbit: 6666
Downlink: 3600 bps
Spin Rate: 12.12 rpm
Spin Axis Attitude (ecliptic):
  Latitude: -88.41 deg
  Longitude: 46.08 deg
Trajectory:
  Periapsis Alt: 17.6 km
  Apoapsis Alt: 42.4 km
  Period: 111 min
Occultations: 38 minutes
Eclipses: none
Propellant
 remaining: 9.51 kg

The next orbit maintenance burn is scheduled for July 26. It will be much smaller than previous burns, since the orbit only has to be maintained for a few days before setting up for the targeted impact scheduled for July 31.

==========
Date: Fri, 9 Jul 1999 11:12:46 -0700
Subject: Lunar Prospector Status 7/9/99 report #90

The Lunar Prospector spacecraft continues to collect good science data in the extended mission orbit. Four of five science instruments are on: the Gamma Ray Spectrometer (GRS), the Neutron Spectrometer (NS), the Magnetometer (MAG), and the Electron Reflectometer (ER). Data continues to be collected for the Doppler Gravity Experiment (DGE) as well.

On July 4, the ER was commanded to burst mode for a short period, to collect higher resolution data over a particular location on the moon.

Only 2 commands were transmitted this week, both executed normally.

Current spacecraft state (0000 GMT 7/9/99, DOY 190):

Orbit: 6770
Downlink: 3600 bps
Spin Rate: 12.12 rpm
Spin Axis Attitude (ecliptic):
Latitude: -88.58 deg
Longitude: 49.39 deg
Trajectory:
Periapsis Alt: 18.1 km
Apoapsis Alt: 41.9 km
Period: 111 min
Occultations: 47 minutes
Eclipses: none
Propellant
remaining: 9.51 kg

The next orbit maintenance burn is scheduled for July 26. It will be much smaller than previous burns, since the orbit only has to be maintained for a few days before setting up for the targeted impact scheduled for July 31. Plans are being finalized for the impact events, as well as for the lunar eclipse which will occur July 28.

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Date: Fri, 16 Jul 1999 14:36:10 -0700
Subject: Lunar Prospector Status 7/16/99 report #91

The Lunar Prospector spacecraft continues to collect good science data in the extended mission orbit. Four of five science instruments are on: the Gamma Ray Spectrometer (GRS), the Neutron Spectrometer (NS), the Magnetometer (MAG), and the Electron Reflectometer (ER). Data continues to be collected for the Doppler Gravity Experiment (DGE) as well.

There was no commanding this week.

Current spacecraft state (0000 GMT 7/16/99, DOY 197):

Orbit: 6860
Downlink: 3600 bps
Spin Rate: 12.12 rpm
Spin Axis Attitude (ecliptic):
Latitude: -88.9 deg
Longitude: 59.97 deg
Trajectory:
Periapsis Alt: 19.4 km
Apoapsis Alt: 40.6 km
Period: 111 min
Occultations: 47 minutes
Eclipses: none

Propellant
  remaining: 9.51 kg

Eclipses begin to occur once each orbit later today.

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Date: Fri, 23 Jul 1999 14:26:15 -0700
Subject: Lunar Prospector Status 7/23/99 report #92

The Lunar Prospector spacecraft continues to collect good science data in the extended mission orbit. Four of five science instruments are on: the Gamma Ray Spectrometer (GRS), the Neutron Spectrometer (NS), the Magnetometer (MAG), and the Electron Reflectometer (ER). Data continues to be collected for the Doppler Gravity Experiment (DGE) as well.

There was no commanding this week.

Current spacecraft state (0000 GMT 7/23/99, DOY 204):

Orbit: 6951
Downlink: 3600 bps
Spin Rate: 12.12 rpm
Spin Axis Attitude (ecliptic):
    Latitude: -88.53 deg
    Longitude: 49.40 deg
Trajectory:
    Periapsis Alt: 20.4 km
    Apoapsis Alt: 39.6 km
    Period: 111 min
Occultations: 46 minutes
Eclipses: 30 minutes
Propellant
  remaining: 9.51 kg

Next week, the last week of operations, there will be several critical activities.

On July 26 at 14:02 GMT, a small orbit correction maneuver will be fired to raise periapsis up just enough (about 5 km) to last through the end of the week. The velocity will be changed only 1.44 m/s and only 0.12 kg of propellant will be used. Also on July 26, the MAG/ER instrument will be commanded to get better resolution data during the full moon period.

On July 28, there will be a lunar eclipse: the moon goes into the earth's shadow. This means that for several hours, the spacecraft does not see full sunlight even when its on the sun side of the moon, and so it will not be able to fully recharge the battery between nightside passes. Plans are to turn off non-critical subsystems as well as cycle the transmitter (the biggest power user on the spacecraft) as required to keep the battery from discharging below critical levels. The spectrometer instruments will be powered off before the eclipse and will be

left off for the last 3 days of the mission. The moon begins to enter Earth shadow at 08:56 GMT and exits Earth shadow at 14:11 GMT. During that interval, as the spacecraft orbits the moon, it goes in and out of moon shadow as well as in and out of earth shadow.

On July 29, the spacecraft will be spun up to 23.7 rpm (from nominal 12 rpm) at 15:30 GMT. This is in preparation for the velocity change maneuvers later in the week, which will target the spacecraft for impact. Because these maneuvers will use the remaining usable fuel, the spacecraft must be spun up to allow the fuel to reach the fuel lines to the jets. Without the spin up, the acceleration from the thruster firing would move the last pools of fuel away from the fuel lines, cutting the maneuver short. The spin up will use 0.22 kg of propellant.

On July 30 at 08:15, a maneuver will be fired to raise apoapsis, putting the spacecraft into a more elliptical orbit. Almost half of the remaining propellant will be used to do this maneuver. This will be done so that when we target for impact on July 31, we come in as steeply as possible to hit the crater floor after passing over the rim of the crater. The spacecraft velocity will be increased by 40 m/s and 3.00 kg of propellant will be used.

On July 31 at 09:16, the final maneuver will be fired to lower periapsis beneath the lunar surface such that it will impact at the target point of -87.7 deg latitude, 42 deg longitude. The velocity will be decreased by 45 m/s, using 3.32 kg of propellant. The remaining 2.85 kg of propellant is unusable, trapped in the propellant tank and lines. Because this maneuver must be fired when the spacecraft is on the far side of the moon as seen from earth, these commands will be loaded about an hour earlier with a time delay built in so that they will occur at the proper time. If all goes well, when the spacecraft passes behind the moon at 08:59 GMT, that will be the last we hear from it. The impact site is so close to the pole, and the spacecraft impact angle is so low (6.3 deg), the spacecraft will never be in view of the tracking station before impact. The impact will occur at 09:52 GMT (2:52 am PDT).

Ground based and space based telescopes, however, will be able to observe the impact plume cloud. These observations are described on the University of Texas's web page: http://www.ae.utexas.edu/~cfpl/lunar/.

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Date: Wed, 28 Jul 1999 14:46:20 -0700
Subject: Lunar Prospector Status 7/28/99 report #93

The Lunar Prospector spacecraft continues to collect good science data in the extended mission orbit. Two of five science instruments are on: the Magnetometer (MAG) and the Electron Reflectometer (ER). The spectrometers were powered off today as part of the eclipse power sharing activities as described below.

The Lunar Prospector orbit was trimmed successfully Monday. This maneuver raised the altitude of periapsis by about 5 km to allow the spacecraft to safely

orbit through the rest of the week. A brief timeline is below. Times are GMT, on DOY 207 [7/26/99]:

13:36 Thruster heaters commanded on
13:39 Loaded maneuver parameter file
14:01 Fire A1/A2 for 9.0 sec (1.44 m/s delta-V, 0.13 kg prop used)
14:04 Safed spacecraft

After the maneuver, the MAG/ER was configured to collect high resolution data during the full moon passage. A total of 27 commands were transmitted with no anomalies.

The LP spacecraft successfully survived today's lunar eclipse. Because the moon passed through the earth's shadow, the time of no sunlight was increased from the once per orbit lunar shadow duration of 36 minutes, to 67 minutes. For another 2:31, the sun was partially eclipsed by the earth, preventing the normal recharge of batteries. The spacecraft was not designed to survive this eclipse.

To increase the chance of survival, the spectrometer instruments were turned off, reducing the load. Because they would get very cold during the eclipse while they were turned off, they will not be turned on again during the last 3 days of the mission. The impact to their science analysis will be negligible. The MAG/ER was left on so that it could continue to get the high resolution full moon data through the end of the mission. Other non-essential loads were powered off: the pressure transducer which measures the propellant tank pressure, and the earth-moon limb sensor. These were turned back on at the end of the event. Also turned off was the primary heater relay. This prevented the highest load of the spacecraft, the propellant tank heaters, from coming on at a time when the battery was unable to support the load. This relay was turned back on at the end of the event as well.

The spacecraft transmitter is the second highest load on the spacecraft, and it was turned off for every occultation (when the s/c is behind the moon as seen from the tracking station), plus extra time as needed to allow battery recharge. It was turned on as much as power allowed to prevent it from getting too cold as well as to allow collection of data to monitor the spacecraft status.

Activities are listed below, times are GMT, DOY 209 (7/28/99). Umbra is when the entire sun is blocked by the earth as seen from the spacecraft. Penumbra is when only part of the sun is blocked. Occultation times are not listed, but they overlap closely with the lunar shadow events.

07:25 - Pressure Transducer commanded off
07:26 - Earth/Moon Sensor Commanded off
07:33 - Spectrometers commanded off
08:32 - Transmitter commanded off
08:37 - Entered Lunar Shadow
09:02 - Entered Earth Penumbra (first time)
(can't tell from data since sun still blocked by moon)

09:12 - Exit Lunar Shadow
09:22 - Transmitter commanded on
09:30 - Exit Earth Penumbra (first time)
10:16 - Entered Earth Penumbra (2nd time)
10:23 - Transmitter commanded off
10:29 - Entered Lunar Shadow
10:52 - Entered Earth Umbra (can't tell, since sun is already blocked by moon)
11:03 - Exit Lunar Shadow (can't tell, since sun is still blocked by earth)
11:34 - Transmitter commanded on
11:36 - Exit Earth Umbra but only partial sun (3rd interval of Earth Penumbra)
12:06 - Transmitter commanded off
12:20 - Entered Lunar Shadow
12:55 - Exit Lunar Shadow
13:13 - Transmitter commanded on - battery voltage very low (21.5 V)
13:14 - Primary Heaters commanded off
13:15 - Transmitter commanded off
13:42 - Exit Earth Penumbra
13:54 - Transmitter commanded on - battery charging, at 30.1 V
14:04 - Transmitter commanded off
14:11 - Enter Lunar Shadow
14:47 - Exit Lunar Shadow
14:54 - Transmitter commanded on - battery charging, at 29.0 V
15:52 - Transmitter commanded off
16:03 - Enter Lunar Shadow
16:38 - Exit Lunar Shadow
16:42 - Transmitter commanded on - battery charging, at 29.8 V
17:18 - Battery fully charged (33.0 V); EMS commanded on
17:19 - Pressure Transducer commanded on
17:20 - Primary Heaters commanded on (creates very high load as all heaters turn on at once)
17:47 - Transmitter commanded off
17:54 - Enter Lunar Shadow
18:30 - Exit Lunar Shadow
18:37 - Transmitter commanded on - battery charging very slowly (all heaters are on), at 28.7 V
19:14 - Transmitter commanded off
19:46 - Enter Lunar Shadow
20:22 - Exit Lunar Shadow
21:00 - Transmitter commanded on - battery fully charged (33.3 V), heater load back to normal.

A total of 53 commands were sent with no anomalies.

The spacecraft is still cooler than normal but is warming as expected.

Current spacecraft state (2110 GMT 7/28/99, DOY 209):

Orbit: 7028
Downlink: 3600 bps

Spin Rate: 12.18 rpm
Spin Axis Attitude (ecliptic):
    Latitude: -88.61 deg
    Longitude: 51.61 deg
Trajectory:
    Periapsis Alt: 10.9 km
    Apoapsis Alt: 49.1 km
    Period: 111 min
Occultations: 41 minutes
Eclipses: 36 minutes
Propellant
  remaining: 9.38 kg

The next activity is the spin-up, scheduled for tomorrow, 7/29 at 15:32 GMT. This will be the first step in setting the spacecraft up for the targeted impact. Impact is now scheduled for 09:51 GMT on 7/31 (one minute earlier than reported last week). It was moved up to optimize timing with Hubble Space Telescope observations.

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Date: Fri, 30 Jul 1999 02:39:09 -0700
Subject: Lunar Prospector Status 7/30/99 report #94

The Lunar Prospector is now ready for the final burn to target it for impact in a permanently shadowed crater near the south pole of the moon. Yesterday, 7/29/99, LP was spun up to 23.4 rpm. This provided centrifugal force so that the propellant will stay over the lines feeding the thrusters during the large burns required for impact targeting. Today, the spacecraft was placed into an elliptical orbit in preparation for targeting to impact tomorrow night.

The spin up timeline is below. All times are GMT on DOY 210 (July 29).

15:07 T2 thruster heater commanded on
15:10 MAG/ER configuration change
15:15 Maneuver parameter file loaded and verified
15:32 T2 fired for 36.2 sec; spin rate changed from 12.2 to 23.4 rpm;
        0.22 kg of propellant used
15:35 Spacecraft safed

12 commands were sent with no anomalies. The MAG/ER instrument was reconfigured to allow data collection at the higher spin rate. It continues to collect its highest priority data, near full moon, when the earth blocks the solar magnetic field, allowing high resolution measurements of the moon's field.

The velocity change maneuver timeline is below. All times are GMT on DOY 211 (July 30).

06:48 A3/A4 thruster heaters commanded on
06:56 Maneuver parameter file loaded and verified

06:58-07:45 occultation
07:55 Maneuver parameter configuration completed
08:03 Execute command sent (file built with 10 minute delay)
08:13 A3/A4 fired for 256 sec; velocity changed 40.5 m/s; 3.18 kg of prop used)
08:20 Spacecraft safed.

When the spacecraft came out of occultation at 07:45, the ground stations locked up on the telemetry as expected but the data could not flow to the LP Mission Control Center due to an equipment failure at the Data Control center at JPL. So the maneuver commands were sent in the blind, without telemetry verification. Telemetry flow was reestablished less than one minute before the start of the burn. The burn was confirmed in telemetry and by the navigation team. Preliminary estimates are that the burn performance was within 1% of predicted.

This maneuver changed the orbit from an almost circular orbit with an average altitude of 30 km above the surface, to a somewhat elliptical orbit, with an apoapsis of 230 km altitude. A nice side effect of this maneuver was that it raised the orbit over the nightside, and the spacecraft will not see eclipses again before impact.

Raising apoapsis allows us to fire tomorrow's maneuver from a greater height, so that the spacecraft can come in steeper, hitting the crater floor without hitting the crater rim on the way in. But it takes a lot of energy to change the orbit that much, and even using all of the usable fuel left, the trajectory will still be shallow, only 6.3 deg below the horizon. Also, the uncertainty in the terrain profile in the region near the South Pole is fairly high, so there still is a chance the rim will be higher than expected and the spacecraft will hit it.

Current spacecraft state (0900 GMT 7/30/99, DOY 211):

Orbit: 7046
Downlink: 3600 bps
Spin Rate: 23.8 rpm
Spin Axis Attitude (ecliptic):
  Latitude: -88.59 deg
  Longitude: 51.71 deg
Trajectory:
  Periapsis Alt: 17.1 km
  Apoapsis Alt: 234.0 km
  Period: 120 min
Occultations: 41 minutes
Eclipses: none
Propellant
 remaining: 5.98 kg

Tomorrow night the final burn will be performed. The commands will be loaded an hour before actual burn, since the burn will occur on the far side of the moon, out of radio communication. The burn is scheduled to occur at 09:15 GMT 7/31/99 for impact at 09:51 GMT (02:51 am PDT).

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Date: Sat, 31 Jul 1999 04:10:55 -0700
Subject: Lunar Prospector Status 7/31/99 End of Mission Report #95

The Lunar Prospector spacecraft impacted the moon this morning at 09:52 GMT (02:52 am PDT) July 31, 1999. The final targeting burn was commanded an hour earlier to target the impact to hit a permanently shadowed crater near the south pole, at -87.7 deg latitude, 42 deg longitude. The timeline of maneuver activities is below (all times GMT, DOY 212, 7/31/99):

08:06 A3/A4 thruster heaters commanded on
08:11 Maneuver parameter file loaded and verified
08:16 Maneuver execute sent (started timer counting down for 1 hour)
08:59 Spacecraft passed over North Pole behind the moon as seen from earth
This is the last time data was expected from the spacecraft.
09:16 Maneuver fired A3/A4 fired 276.5 sec, velocity decreased 44.3 m/s;
3.38 kg of propellant used (2.60 remaining is unusable)
09:52 Impact right over the south horizon as seen from earth

The University of Texas' David Goldstein coordinated the observations of the impact to look for confirmation that the hydrogen Lunar Prospector measured at the poles was really water. Two space telescopes monitored the impact: Hubble Space Telescope and SWAS. Two ground telescopes monitored the impact: McDonald Observatory at the University of Texas, and Keck Observatory in Hawaii. Other professional and amateur astronomers also observed.

No observatory reported seeing the debris plume. Data from the orbiting observatories will not be available until tomorrow. Analysis of the data from both the ground and orbiting observatories will take several days to determine whether or not the OH dissociation product of water was seen. Results will be reported at the Lunar Prospector web page, and the University of Texas' web page.

The spacecraft continued to collect and return good data for the MAG/ER instrument up until it last passed behind the moon at 08:59 GMT.

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