

Planetary Science Subcommittee Meeting, May 8-9, 2012

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Meeting Minutes

Jonathan Rall, Executive Secretary

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May 8, 2012

Welcome and Administrative Matters

Dr. James Bell, Acting Chair of the Planetary Science Subcommittee (PSS), welcomed members. Dr. Jonathan Rall, Executive Secretary of PSS, made some administrative remarks, noting an opportunity at the lunch break to attend a Planetary Society session with the House Science Committee at the nearby Rayburn Building.

Planetary Science Division Update

Dr. James Green, Director of the Planetary Science Division (PSD), presented a status report. PSD has accomplished a series of missions and tremendous science, including two comet encounters, the spacecraft MESSENGER at Mercury, Dawn at the asteroid Vesta, GRAIL (lunar gravity mapping, the selection of three new Discovery class candidates, and the New Frontiers mission, OSIRIS-REx. The Mars Science Laboratory (MSL) rover, Curiosity, is en route to Mars, with a landing planned in August of this year. There will be a Venus transit in June, the last one for 105 years, for which NASA is planning various Outreach activities. In mid-August, Dawn will leave Vesta to orbit Ceres, the largest asteroid in the asteroid belt. It has been a truly phenomenal time for planetary science.

Dawn has been in its low altitude orbit for many months and is beginning its reversal; it will be moving to higher altitude over the next several weeks, to break orbit in mid-August, to reach Ceres in February 2015. Some exciting discoveries have been made at Vesta, particularly an enormous impact crater, Rheasilvia, at the asteroid's south pole, with a central peak that is 20-25 km above the base. There appears to be an even older impact basin under Rheasilvia. A press conference is scheduled on May 10 to discuss science results at Vesta, such as having confirmed that HED meteorites originated from Vesta. Vesta is a differentiated body with an iron core, with evidence of global tectonic strain from impacts. Ceres is twice the size of Vesta, less dense, has a rocky core, and is believed to have a significant amount of water ice.

The top priority in PSD is the safe landing of MSL, scheduled for 6 August at 1 AM EST. The landing will take place in Gale Crater, with a landing ellipse of about 20 by 25 km, Sky Crane approach.

Mission Status

The Opportunity rover has been wintering over and preparing for exploration, gathering solar power at Greeley Haven. In the New Frontiers program, the OSIRIS-Rex mission, an asteroid sample return is in planning. The spacecraft will perform global mapping, gather chemistry and mineralogy data, and measuring the Yarkovsky effect, as it is a potentially hazardous asteroid. The mission has a launch readiness date (LRD) of 2016. The goal is to collect 60 g of regolith and have the sample re-enter Earth a la Stardust. In the Discovery program, MESSENGER has begun its extended mission (EM) at Mercury, and Deep Impact will be considered for extension in the Senior Review. GRAIL, after one month of operation, has created a lunar gravity map at far greater (23 km) resolution than previously done. The spacecraft have just completed their second month of observations (3-month mission). The Lunar Reconnaissance Orbiter (LRO) has completed a one-meter-resolution mapping of the Moon; and in combination with a mineralogy mapper is providing a rich set a data for future Moon landings, a possible sample return from

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Aiken basin, and the establishment of a Lunar Network. Dr. Green referred to Dr. Bell's recent article in *Sky and Telescope*; a new lunar globe has also been developed, based on the newest data. MAVEN, a Mars aeronomy mission, and LADEE, a lunar dust environment mission, are launching in 2013. Discovery has been down-selected to three missions: CHopper (comet hopper), InSight (stationary Mars lander), and TiME (Titan mare explorer). All step-2 proposals have arrived. The next Discovery Announcement of Opportunity (AO) will be in FY15. PSD is also conducting activities with the Human Exploration and Operations Mission Directorate (HEOMD), with likely targets being the Moon, Mars, and near-Earth asteroids. It is vital to maintain the science focus of peer-reviewed missions to these bodies. Both programs can benefit from cooperation; LRO is a good example of this cooperation. PSD and HEOMD have already benefited from successful collaborations on MSL, which includes two HEOMD instruments, RAD and MEDLI. There is co-funding in Research and Analysis (R&A), the Lunar and Advanced Science and Research (LASER) Program, and through the Lunar Science Institute. PSD is also working with astronauts in the field through analogue studies, and the division has joint charters with various analysis groups such as SBAG, LEAG, and MEPAG (Small Bodies, Lunar Exploration, and Mars Exploration Program). The Office of Management and Budget (OMB) has directed NASA to perform these joint activities with HEOMD, and has provided some funding (\$30M beginning in FY13) to support precursor activities to study boundary conditions of representative exploration environments. This represents a strong message from the Administration on human exploration. Mars is the ultimate destination for human exploration, and science must merge with HEOMD to carry out this goal.

Robotic precursor activities include continued development of instruments for both science and exploration in NASA and non-NASA missions, as well as international missions. PSD is developing a new cooperative agreement to charter a new institute to follow the Lunar Institute. A new strategy for Mars exploration has begun. PSD has added closer ties to the Office of the Chief Technologist (OCT) for development of cross-cutting technologies. The former Deputy Director of PSD, Dr. Jim Adams, has moved on to the OCT.

Senior Review guidelines were issued in September 2011, and proposals are due this month. A committee is being formed, and a final report is expected in July/August, in time to inform the budget submission to OMB in September. Senior Review results will be finalized in early 2013.

NASA is entering a "Space Act" agreement with B612, a private group that is putting together an asteroid survey mission called Sentinel. NASA will provide Deep Space Network (DSN) services, spacecraft navigation support, and an interface to the Near-Earth Object (NEO) data network. The mission is a space telescope that will reside near Venus and examine the IR signatures of asteroids. This is a true planetary mission that is not funded by NASA. Ball Aerospace is building the spacecraft, with NASA participating in the process. DSN is overseen by HEOMD. SMD and HEOMD are leveraging existing resources and infrastructure to support this mission. PSD funding is under negotiation, and is not expected to be significant. There is no active funding at present. The community will have access to data, as NASA will be managing data sets, analysis, and archiving, much like the WISE mission. Dr. T. Jens Feeley noted that he would check on proprietary data restrictions, but noted that if a hazard were to be detected, the data would be released in a timely manner.

NASA now has a contract with the Arecibo radar facility at \$2M/year; many more NEOs can now be observed, such as the binary object 1996 FG3, a future target of the European Space Agency (ESA) Marco Polo mission, which will have some NASA involvement

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As to the Pu-238 and radioisotope power system (RPS) status, no funds have been provided for re-start of domestic production of plutonium through the Department of Energy (DOE). However, PSD has provided study funds to assess a plan to produce about 1.5 kg of Pu-238 per year, and expects the assessment to be completed this calendar year. Pu-238 is considered critical for New Frontiers missions. NASA is planning a new funding strategy to enable a re-start but with a larger share of funding from NASA. The Advanced Stirling Radioisotope Generator (ASRG) program is completing Engineering and Qualifying Units and continues with life testing. Interactions have already begun with DOE. A re-start would cost from \$75-90M as currently estimated, with maintenance at about \$10-15M/year. The cost is amortized over a number of years. Once NASA receives a schedule, the yearly resource need can be determined. The request will not be in the FY14 process, but NASA is continuing to work on basic estimates. The U.S. has not produced Pu in two decades (Pu-238 has an 88-year lifetime). New and old Pu will be mixed to provide efficient use of resources. The estimate is to have new supplies in about 2019-2020, allowing the time necessary to allow Pu-236 to decay. There are no plans to procure Pu from Russia, as it had decided to cease production two years ago; NASA is still discussing renegotiation of a prior contract. ESA has been considering americium; however if NASA were to move to another isotope, everything (rockets, instruments) would have to go through a long series of technology development steps; NASA has good reasons to remain with Pu-238.

Outer planets

JUICE, a Jupiter mission, has been selected for ESA's L1 mission; PSD is elated with the choice. Fabio Favata, ESA's science planning and community coordinator, has sent a letter to NASA to assess US interest in science participation in JUICE, and has requested a formal statement in return. NASA's intent is to issue an AO immediately; NASA proposes to be a minor partner at a contribution of \$100M lifetime cost cycle (LCC) for a payload. More details will be provided at an upcoming bilateral meeting. This is not a full Europa mission; it will however provide two flybys of Europa while exploring Ganymede. There is no need for Participating Scientist planning just yet; this will be worked through the R&A program in the future (launch date is planned for 2022). PSD is planning a lean and mean hardware component effort, and a Principal Investigator identification process.

NASA Europa studies status

Earlier this year, Congress requested submissions of studies for a de-scoped Europa mission- all three studies have been submitted (flyby, orbiter, lander) to NASA. Although preliminary versions of the analyses have been submitted to OPAG, the reports will be reviewed internally by NASA before being released; the reports must be briefed to OMB, the Office of Science and Technology Policy (OSTP) and Congress first. The community has seen much of the information through the Outer Planets Analysis Group (OPAG), however. Dr. William McKinnon noted that preliminary versions are on-line and public. Dr. Green reported that NASA must respond in the fashion necessary, and must consider these studies as it would a proposal submission. PSD will report to PSS as soon as NASA briefs Congress; there is no intent to embargo these reports. NASA will take the reports as face value; the pre-Congressional analysis concerns just digestion and synthesis for the benefit of the stakeholders. The Science Mission Directorate (SMD) Associate Administrator (AA) has already been briefed once; Dr. Julie Castillo-Rogez asked whether the selection of JUICE influences these studies. Dr. Green reiterated that NASA does not

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consider JUICE a substitute for the Europa mission; however, JUICE can provide information about Europa; it is carrying instrumentation that was not on Galileo. Dr. Bell asked if there was an intent to provide a ranking of mission options. Dr. Green replied that ranking was under discussion.

PSD future budget/FY13

For FY13, PSD is funded at \$1.19B. Congress is deliberating on providing additional funds, indicating public interest in planetary science. Meanwhile, PSD is working on planning for FY14 and onward, addressing additional decreases in the outyears in the analysis of the future program. There is an uptick in FY16-17 that could provide planning for other missions. In the event of a continuing resolution (CR), SMD is funded at \$5B this year, and for the next year. The funding received in the event of a CR will be at SMD level; within that level PSD was at \$1.5B previously. Nonetheless, PSD is no longer ramping up for 2016 and 2018 Mars mission, meaning that SMD has the option to distribute monies as needed within the directorate. That does not give PSD any guarantees. PSD does not have the activities for which it could spend potential additional resources. Regarding cooperation between HEOMD and SMD, the plan is to continue programs like LASR and the NASA Lunar Science Institute (NLSI) as part of SMD's Lunar Quest Program- these will be eventually moved to the Planetary Science Research line, and HEOMD could provide instruments through that funding wedge. It is important to note that it is now clear that there is a funding wedge for these joint activities; that is a tremendous step forward and comes at a good time for PSD. Regarding a question on ESA cooperation with future Mars opportunities, Dr. Green reported that NASA had informed ESA in December 2011 that they would not deliver instruments to ESA. These instruments are now in ESA planning with Russia. NASA will still fund some instruments that had been intended for 2016/18 through preliminary design review (PDR) and mature them to a high degree, so that they can be proposed for later opportunities. While the situation is awkward, NASA is still supporting community and can contribute to future AOs, an important investment in the instrument community.

Dr. Green noted that NASA will do everything possible to participate in JUICE, and intends to honor all of PSD's international agreements. NASA has placed a number of ESA instruments on Dawn, MSL, and Phoenix, and is continuing to cooperate with Bepi-Columbo. There are NASA instruments on Rosetta, and NASA is still cooperating with the Cassini mission. For ESA's S-class call, there is the same NASA participation, and there has already been an NSPIRES announcement. NASA is interested in a minor role in the Marco Polo asteroid mission, which is still under study. There will be NASA/ESAS liaison as the mission is developed. NASA will not be supporting travel for scientists; there will be one observer from NASA HQ. Dr. Paul Steffes asked how DSN was functioning under HEOMD. Dr. Green explained that HEOMD is working hard to modernize an aging infrastructure; however DSN has continued to provide outstanding support, most recently through 3 launches in 4 months.

A new Committee on Astrobiology and Planetary Science (CAPS) has been convened at the National Academies, with a first meeting scheduled at the end of May. Dr. Green encouraged PSS members to attend this open meeting. The CAPS committee is the keeper of the Decadal Survey, and would review any resulting Mars architecture.

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Fiftieth Anniversary Activities

NASA is planning to celebrate the 50th anniversary of the August 1962 launch of Mariner, which ushered in the field of planetary science and revolutionized our understanding of the Solar System. A history conference will take place 23-25 October in the DC area. More information can be found at [\[\[solarsystem.nasa.gov/50th.\]\]](http://solarsystem.nasa.gov/50th) The event will be live-streamed, and an opening reception will take place at the National Geographic. There will also be an event at the Smithsonian Institution.

Mars Exploration Program Update

Mr. Doug McCuistion provided an update on the Mars Exploration Program (MEP) and recent re-planning activities. The rover Opportunity is in all-stellar mode to preserve life in its inertial measurement unit (IMU), and will return to star tracking mode in late June for preparation for the MSL landing. Opportunity will be on the move again shortly. The Mars Reconnaissance Orbiter (MRO) has started to prepare for MSL entry, descent and landing (EDL). MRO science will go silent just prior to the MSL landing. Hi-RISE will also attempt to image the EDL. MAVEN is doing well, its first flight instrument having been just delivered; the mission is on schedule and on budget.

MSL's RAD instrument was turned on during cruise, solving some issues on the way. There have been no significant problems. RAD detected solar flares in January, and will provide good information for future human exploration. The program is heavily engaged in landing preparation; there will be a public outreach event at the Delaware House on I-95; and NASA is working with 400-500 museums to hold "Snoozeums," sleepovers designed for viewing the landing. Mr. McCuistion reported having given a talk at the Smithsonian Udvar-Hazy museum, which was filled to capacity. There are many other interesting venues in which these activities will take place; nontraditional audiences will be an important target.

Currently the spacecraft is in guided entry phase, pointed at the top of the atmosphere. The landing ellipse represents a huge step forward in terms of precision; MSL will explore alluvial fans, layered rock, phyllosilicates, clays, sulfates, cemented fractures and other features at Gale Crater.

Despite recent budget impacts, MSL remains a priority. Safe landing is absolutely critical. MAVEN is a second priority, followed by operating missions, Odyssey, MRO and Opportunity, all of which are fully funded and essential to the long-term execution of the MSL mission. There are no issues with Mars R&A lines. Opportunities for Discovery missions and Planetary Science R&A programs will continue. The MEP is revisiting all the funding numbers in order to maintain science and safe operations. Mars Odyssey has fuel through 2017, and will be fully funded through that period. The Senior Review will also influence the future budget. In the Mars R&A, program, selection rates have been low. NASA is trying to maintain the program at FY12 levels, which is not bad considering the current budget.

The Mars program had been anticipating budget declines for quite some time. The notional budget run-out starts to increase in 2017, and consequently the program has tried to plan around the historical dips and increases. FY13 made the 2016 and 2018 participation opportunities with

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ESA impossible. NASA has an opportunity to fund a small Mars mission in 2018, but there is no budget or time for the 2016 opportunity. MEP is ramping budgets down for instruments for 2016 and 2018, however Electra is still desired by ESA and will be continued; these will be exact copies of MAVEN's Electra radios, which will provide an opportunity to maintain a communications infrastructure with Odyssey and MRO. Congressional intent is becoming clear, but NASA will still plan against the current budget until the law determines otherwise. Mars Next Decade activities may be given about \$100M above the request. In the meantime, a Mars Program Planning Group (MPPG) has been established by SMD to address next steps in Mars exploration. MEP intends to keep PSS well engaged. In response to a question, Mr. McCuiston reported that there is a low likelihood for US instrumentation in ESA/Russian plans for 2016/18, due to lack of space and budget. There are US co-investigators, however, working on the ExoMars NOMAD instrument.

MPPG

Dr. Orlando Figueroa, Chair of the recently formed Mars Program Planning Group (MPPG), briefed PSS on Mars re-planning efforts. MPPG is a focused study group created to provide the Agency with information to help select high pay-off missions, beginning with the 2018 launch opportunity, that demonstrate visible progress to a sample return mission, while engaging relevant support and expert community groups in the study. A final study report is due in August. The group's guiding principles are to provide options for program architectures that are responsive to the Decadal Survey and synergistic with progress toward human exploration of Mars. Furthermore, these missions must demonstrate collaboration between SMD, HEOMD, OCT and the Office of the Chief Scientist (OCS) to leverage capabilities, remain responsive to the President's challenge to make possible human travel to Mars in the 2030s, and maximize public engagement. MPPG is supported by technical and programmatic expertise at the Jet Propulsion Laboratory (JPL) and Johnson Space Center (JSC), and relevant technologies at other centers. MPPG has identified key members of the community to vet concepts and has begun interactions with formal committees, as well as with the international space community.

MPPG is developing figures of merit (FOMs) to assess the degree to which a program advances overarching scientific goals, advancing knowledge and capabilities, cost realities, risk reduction, and providing opportunities for participation. Since March 2012, MPPG has been examining candidate pathways and mission concepts based on the existing body of information, laying parallel "train tracks" for both science and human exploration advancement, while viewing Mars as the destination. An LPI workshop will be held in mid-June; informal interactions are taking place along the way with LPSC, MEPAG, and MPPG intends to interact with the International Mars Exploration Working Group (IMEWG) and CAPS. After the LPI workshop, MPPG will return to PSS with more information. Asked about the engagement of the small bodies community, Dr. Figueroa reported that PSAG is already engaged with small bodies, and that HEOMD is looking at Phobos and Deimos. Dr. Figueroa agreed to add interactions as recommended by PSS, such as the curation group CAPTEM, however any interaction must be very focused and deliberate to address time constraints. Dr. McCuiston encouraged interested members to engage in the LPI workshop.

MPPG is continuing to use the concept of pathways, which has been used as an effective vehicle in the past, employing them as a vehicle to analyze options against the FY13 budget and as a

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foundation for more strategic collaborations, new scientific discoveries, ideas and advances in technology. MPPG is using “Sampling Orbiting Mars NLT 2033” for return to Earth by humans and/or a robotic mission as a possible point of convergence.

Pathways are a series of interconnected investigations, based on significant advances in the state of knowledge, as well as the present experience base, allowing highly focused scientific interrogation that is responsive to the Decadal Survey. The pathways must fit within FY13 budget without missing more than one Mars opportunity (i.e., one mission every 4 years). Missions within a pathway are interconnected scientifically and in terms of capability. Pathways are responsive and driven by discoveries. Dr. Bell asked about pathways involving more favorable funding situations. Dr. Figueroa replied that MSL may open the door one way or another to a Mars we cannot imagine, or it may disconfirm the necessity for a sample return. There is no pressure on the Discovery and New Frontiers programs to accommodate these opportunities; Dr. Figueroa pointed out that no interactions have occurred to influence the work, and such discussions are stopped if they arise. There is nothing shared that can point the vector in one direction. Dr. Limaye expressed concern about the long-term budget outlook. Dr. Figueroa noted that MPPG is keenly aware of the budget, and has been making the assumption that the future is flat, and is providing options in as many cases as possible for each pathway. The focus is on early opportunities to find solutions; the trade space afterward becomes content. Mr. McCuiston commented that the MPPG is not the interface OMB. MPPG’s task is to create reasonable, cost-realistic concepts. It is up to NASA to engage with OMB and OSTP; the long term will be driven by science and human exploration.

Community inputs to the MPPG have been through MEPAG, various Analysis Group reports, white papers to the Decadal Survey, and published papers. MEPAG Chairs and Decadal Mars sub-panel members have also weighed in. MPPG has adopted a target interview approach for key questions, and has expanded outreach specifically for landed science. The MEPAG Executive Committee has been engaged in general discussion of MPPG science for their views and suggestions.

The first mission opportunity is 2018 or 2020, and is being considered in a \$700-800M class mission category, to leverage synergies between SMD, HEOMD and OCT, while being responsive to Decadal Survey priorities. Concepts include an orbiter to replenish the aging communication infrastructure at Mars. If the mission is a lander, it would provide an opportunity to investigate and select samples from a compelling site for return to earth. A stationary lander is not feasible in 2018; the first opportunity for a roving mission would be 2020.

Near-term plans aim to finalize early mission concepts and an initial set of pathways. An orbital reconnaissance mission is considered valuable, as it takes MRO to the next level, with direct relation to MSR-related goals. The payload has been evolving to two tiers. The community impression is that early landed science is more responsive to MSR, and PSAG is analyzing priorities in human exploration knowledge gaps. Community leaders appear to be pleased with the process. MPPG is also incorporating independent cost estimates.

Dr. Grant asked if the expectation were that HEOMD might pay for part of a payload. Dr. Figueroa that such discussions have been at the technology level; an example would be optical communications, as both HEOMD and OCT have this funding responsibility. Dr. Green noted

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that the JRPA joint robotic funding line would provide a competitive opportunity for joint funding. PSAG may also add to the list. MPPG would add other concepts to the list and consider what it means to the trade. Dr. Mike Wargo of HEOMD emphasized that the role for PSAG is to identify measurements needed for human exploration, to inform an investment in the JRPA program. Dr. Luhmann raised a concern about sufficiently defining a mission path that raises it above the threat of “dead-end” planning. Dr. Green referred to the Decadal Survey as the guidance that will transcend Congress and Presidents. Responding to a question on funds, Dr. Green made it clear that pathways will keep in step with the Decadal Survey, perhaps more slowly than desired, but remaining true to its goals. Dr. Rogez-Castillo questioned whether Mars efforts would dilute efforts for other Solar System targets. Dr. Green felt there was every reason to believe that the MPPG outcome would work well for both human exploration and general planetary science; if NASA does not come up with a feasible plan, it runs a real risk of losing the entire planetary program. Dr. George Tahu called attention to a new website, www.nasa.gov/marsplanning, which can be consulted for the latest MPPG results. He also encouraged submission of abstracts to LPI workshop call.

NRC Icy Bodies Assessment

Dr. Catharine Conley, NASA Planetary Protection Officer (PPO), introduced Dr. Geoffrey Collins and provided context for his briefing on a report from the NRC, Assessment of Planetary Protection Requirements for Spacecraft Missions to Icy Solar System Bodies. The report had been requested by NASA to assess the basis of planetary protection policies adopted from the Outer Space Treaty of 1967 and the Committee on Space Research (COSPAR) of the International Council for Science. The new report has recently been released in draft form, addressing uncertainties in current knowledge concerning planetary protection and the avoidance of contamination of icy bodies via spacecraft exploration.

Dr. Conley provided examples of how JUNO mission allocations and estimates were made in terms of planetary protection, including consideration of probabilities of spacecraft impact on Europa, etc. COSPAR organized two workshops in 2009 on icy bodies, which reviewed recommendations from the US Space Studies Board, and international groups on small bodies of the Solar System, Mars special regions, and Europa. A probabilistic reduction approach derived from the long-utilized Coleman-Sagan formula was further refined at these workshops. Dr. Green remarked that PSD also includes funding for planetary protection, as PPO itself is funded at a fairly low level of \$2M/year. In response to a question, Dr. Conley responded that if Dawn identifies liquid water at Ceres, planetary protection constraints will be adopted for the mission.

Dr. Collins presented the draft results of the NRC report, the charge of which was to review the findings of the 2000 NRC Europa report. Over an 18-month period of development, the report committee received a number of presentations ranging from reports on the limits of extreme life and nutrient requirements, planetary protection requirements, and sterilization techniques for spacecraft. The committee examined the Coleman-Sagan probabilistic estimate of contamination, based on various factors, which when combined must lead to a 10^{-4} probability of contamination of a region suspected of harboring the ability to contain or sustain life. The NRC team found that such values could not be confidently assigned to such factors as the number of cells present on a spacecraft, and that the multiplication of probabilities that are not necessarily independent (organisms that survive cruise and radiation-resistant organisms, e.g.) is inappropriate for

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assessing risk. For example, the chance of one microbe encountering a habitable environment is highly dependent on the chance of another microbe on the same spacecraft encountering a habitable environment. Dr. Collins averred that the Coleman-Sagan rationale would have led to the conclusion that only one lifeboat would have been needed for the Titanic, and that the risk of contaminating the Solar System is better characterized as a risk for a singular catastrophic event.

Major recommendations of the report include lack of support for continued reliance on the Coleman-Sagan formulation; planetary protection decisions should not rely on multiplication of probability factors and should be replaced with a series of binary (99.99% confident yes/no) decisions that consider one factor at a time to determine necessary levels of planetary protection.

Seven decision points were delineated: Decision point 1 was based on a survey of icy bodies to delineate areas of concern for the existence for potentially habitable bodies within the last hundred million years; this eliminates many icy bodies from concern. It has been concluded, for instance, that no significant liquid water on small irregularly shaped bodies. Thus the first decision point queries for the existence of liquid water at a destination. Decision point 2 concerns key elements and their bioavailability that would putatively support the survival of a terrestrial microorganism. Decision point 3 assesses physical constraints on support for known extremophiles. Decision point 4 considers whether current data indicate that minimal chemical energy sources (CO₂, electron donors and acceptors, e.g.) exist at the target destination. Decision point 5 considers the probability that a spacecraft is likely to contact a habitable environment (10^{-4}) in 10^3 years. Decision point 6 considers the presence or absence of complex and heterogeneous organic nutrients that might support life in aqueous environments on icy moons/bodies. Decision point 7 determines the conditions necessary for minimal planetary protection measures (60°C heat treatment for 5 hours), versus the most stringent (Viking-level, terminal bioload specifications for sterilization). As to decision point 7, the report concluded that this area would benefit from more intensive study, particularly of organisms that grow and proliferate at low temperatures. The current conclusion is that spores from psychrophilic bacteria are likely to be rendered inactive at temps above 40°C.

It is recognized that uncertainties are associated with assumptions underlying each decision point. Within the geophysical perspective for decision point 1, for instance, liquid water has generally been ruled out for small irregularly shaped icy bodies, but there is concern for Enceladus, given recent discoveries. Chemical modeling indicates that phosphorus on Titan is sequestered in phosphine, and not as bioavailable phosphate. Ice and salt or ice and ammonia at temperatures as low as -97°C can come close to water ice's melting point. There is also great uncertainty about the existence of redox couples. In terms of the risk of contacting habitable environments, ice shells are assumed to present a great impediment to microbial invasion of the subsurface. Europa, Enceladus, Titan and Triton have 10- to 100-km thick ice shells. However the "tiger stripes" on Enceladus as well as briny plumes can provide a worst-case scenario of fractures providing transport between surface and subsurface. Assumptions have also been made at estimating the youngest limit of surface age estimates. For Europa, these range from 10^7 to 10^8 years, for Triton 10^6 to 10^7 years, and for Enceladus a heterogeneous surface age has been assumed. These three bodies should be studied in more detail, the rest can be rejected at a certain decision point. Ganymede thus far appears to present no planetary protection issue for the ESA Jupiter Icy Moons Explorer (JUICE) to Jupiter and its moons. The caveat remains that there are many other icy bodies about which there are many unknowns, in the Uranian system, e.g.

Addressing the current period of protection from terrestrial contamination, the committee found no sound basis for a recommendation of 10,000 years or more, as it is impossible to estimate the

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timeframe of Solar System exploration, thus the report assumed the period of protection should extend for the next millennium. The report also recommends that NASA evaluate planetary protection requirements for Europa, Enceladus and Triton, but finds that the possibility for active transport of contaminants into a habitable region of Titan's interior over a 1000-year timescale is more remote than 10^{-4} , removing Titan from high levels of concern for planetary protection. From a biological perspective, decision points 1-4 are based on what is known about life on earth. For decision points 6 and 7, one must keep in mind the great diversity of microbial life; niche competition constrains optimal growth to limited conditions, and environmental sources of organisms on spacecraft will dictate their ability to grow. Decision point 6 assumes that the ability to repair damage from radiation exposure requires complex heterogeneous nutrients including complex forms of carbon that to the best of knowledge are not available on icy bodies in the Outer Solar System. Decision point 7 is affected by uncertainties about psychrophiles that can grow between -5°C and 40°C . One must also subdivide non-spore forming obligate psychrophiles and non-spore-forming facultative psychrophiles. For spore formers, more study will be needed to more confidently assess what sort of heat treatment is necessary to eliminate them.

The report further recommends that molecular-based inventories are needed for characterizing spacecraft contamination, and calls for improved estimations of bioburden, improved molecular techniques, and further categorization of icy body environments in terms of key elements and global chemical/transport cycles on the icy bodies. The final version of the report will be released in the June/July timeframe

Status of ESA JUICE Mission

Ms. Joan Salute presented a status of the ESA JUICE (Jupiter Icy Moons Explorer) mission. A major change to previously the designed mission, J-GO, is the addition of two flybys of Europa. JUICE was approved as the first Large-class mission in ESA's Cosmic Vision program on May 2, 2012. NASA has formally expressed a desire to collaborate as a minor partner on the mission for a \$100M total collaboration. Near-term, ESA and NASA would like to hold a joint press release, and put out an AO "alert" to be issued by ESA prior to the AO, as soon as mid-May. The call would take place as a European-led AO, and NASA would issue a Stand-Alone Mission of Opportunity (SALMON) call referring to the ESA AO. Ms. Salute believed there would be a full and open call for all 11 instruments, and that there would be US participation in the selection process. ESA is planning a release in June, with proposals due in September. NASA is pushing for a later release. The payload flight model delivery to ESA would be expected by May 2018-19, and a launch planned for 2022. After an 8-year cruise to Jupiter's orbit, the mission is planned for an 11-year lifetime. The model payload currently includes 11 instruments but there is potential for other suggested instruments. This information is contained in ESA's Yellow Book [[http://sci2.esa.int/cosmic-vision/JUICE_Yellow_Book_Issue1.pdf]]. Dr. Green added that NASA would prefer a model as carried out in past AOs, with dual selecting officials, and inclusion of a programmatic element that would be dependent on the budget.

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Discussion

Dr. Rall suggested that PSS plan a short teleconference before the NAC Science Committee in July, and further recommended a future PSS meeting date of 23-24 October 2012.

R&A Update

Dr. Rall, the R&A Lead for PSD, presented an overview on Planetary R&A. He noted that this information had been briefed previously to Anne Connor (U.S. House of Representatives), noting the minor agenda change. Dr. Rall reported PSD's R&A staff is very overworked, despite their number, overseeing programs including Planetary Science Research, Mars R&A, Discovery research, and Outer Planets. R&A is graded annually on performance goals, and for the last 5 years has been receiving Green grades from PSS on its fundamental science objectives. Government Performance Rating Act (GPRA) metrics in execution, however, have been poor. For the metric of reducing time within which 80% of NASA Research Announcement grants are awarded, PSD R&A was graded Red for 2011. The Continuing Resolution (CR) affected some of this grade, however it was eventually concluded that the CR was not the primary cause. Dr. Green added that in 2011, missions had to be fed first, but R&A was still understaffed, nonetheless. PSD gets a quarterly allotment, and must make decisions on where the money should be spent first, before R&A money can be distributed. The launch windows in 2011 were all late, as well. This year, Dr. Green noted particular attention would be given to distributing awards. There was a brief discussion as to the factors influencing release of award monies, ranging from reluctance of Program Officers to commit funds, to lag times between the budget announcement and actual monies released within the Agency. Budget woes are continuing, thus Dr. Green noted that most programs this year will be affected by reduced selection rates as a result. PSD will be unable to fund "selectable" proposals; the bottom line for PSD is meeting the commitment of \$249M this fiscal year. Dr. Rall added that proposal pressure is up, particularly the MDAP, which is at an all-time high. The program will also start to reflect the effects of 4- and 5-year proposals, and the increased average dollar amount per grant, which is now up to \$110-120K. Dr. Max Bernstein offered to provide a more complete analysis of specific proposal pressure areas and an averaging out of costs over time. Dr. Green emphasized that despite program inequities, PSD has kept the commitment to increasing the R&A budget, \$100M over the last 10 years.

Dr. Rall presented data from ROSES calls showing some selection rates being affected by proposal pressure. Dr. Bernstein added that longer decision times would drive an increase in re-proposers, helping to drive selection rates well below 25%. Dr. Sykes commented that one way to solve this problem was to add more money, and the second would be to put priority on programmatic stability; i.e. keeping due dates. The Astrophysics R&A model was suggested as an exemplar, as it uses a reduced number of elements (similar elements grouped together, then selected on the basis of simultaneous due dates and large panel reviews to review proposals *en masse*). In addition, if PSD were to commit R&A funds at the beginning of the fiscal year, it could commit to making selections in a timely fashion. Dr. Green noted that PSS could provide tactical aid by recommending a similar implementation for PSD R&A. Dr. Rall agreed, adding that PSD had tried a small experiment this year by combining two elements in R&A, which worked well.

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Dr. Prockter remarked that some of the planetary programs did make their awards on time; the community perception is that some programs struggle more than others. Dr. Rall noted that PSD plans to correct the specific programs in question. Dr. Mary Voytek commented that if a program does not have its budget, it cannot make an award; for some programs, this is a chronic issue. PSD can give 80% of what is available to all the programs, or get some programs fully funded while letting others wait. The latter is what PSD has been doing. Dr. Sykes supported the idea of categorizing proposals as “selected/selectable/not selectable,” allowing decisions to be made early on with 80% of the budget. Dr. Green expressed support for this approach.

The subcommittee went on to discuss the pros and cons of a two-step proposal process. Dr. Bernstein described an experiment in CDAP using a phase 1 step comprised of a three-page notice of intent. The upshot was that it was very difficult to predict which proposals were definitely unacceptable and therefore graders did not feel confident enough to eliminate anyone. The Heliophysics Division tried a similar approach with several-sentence NOIs and regretted it. In the Earth Science Division, one small and narrowly defined program uses a two-step process. While there is generally a fair amount of agreement on what the lowest-grade proposals are, it is felt that a greater degree of confidence is needed. Dr. Green encouraged the community to use the NASA SARA website to submit anonymous comments- this allows transparency and response.

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Morning Discussion

Dr. Bell opened the morning session, and officially introduced Dr. Janet Luhmann as the new Chair of PSS. Dr. Bell retains his position as Deputy Chair. Dr. Luhmann asked members to raise their concerns and interests.

Dr. Limaye expressed his abiding interest in Venus, and commented that PSS should consider the Mars re-plan in the context of an architecture that is sustainable over time and future Administrations.

Dr. Prockter was concerned about R&A pressures, the long-lived Europa study, cuts in the Discovery program, and keeping to the recommendations of the Decadal Survey.

Dr. Sunshine felt concerned about the slowing pace of Discovery and New Frontiers, the basic level of Decadal Survey missions being carried out, and R&A.

Dr. Bell expressed interest in the Mars re-planning process and his commitment to helping NASA managers, and to advocate for NASA.

Dr. Sykes was concerned about the loss of focus on the smaller Discovery mission and the health of foundational elements such as skill sets and work force. The stability and viability of R&A programs is also problematic.

Dr. Wadwha felt it important to keep Decadal Survey recommendations consistent with NASA science, as well as to re-cast Mars Sample Return (MSR) to reflect its high priority in the Survey.

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Dr. Grant felt that NASA could communicate more directly to the community to suppress festering rumors. PSS presentations, or high points of PSS discussions, should be made widely available and R&A presentations should be placed on the SARA website, for instance. Dr. Green noted that PSD had just started implementing “rumor vs. truth activities” in staff meetings, helping to address the changeable atmosphere. A well-moderated website could respond to rumors and directly post answers to pressing questions.

Dr. Des Marais called for the community to support an increase in capabilities and technologies in the face of budget constraints, and felt that PSS could function to reinforce a coordinated effort, keeping the community unified. Strong international partnerships and a broadened support base will be necessary.

Dr. Rogez-Castillo was concerned about R&A and small missions, and the recruitment of more young planetary scientists. As soon as there are budget cuts, the post-docs are the first to go. Dr. Rogez-Castillo took an action to send candidate names to Dr. Rall.

Dr. Steffes was concerned about the success of graduate students and their entry into the planetary discipline; at present, most are going to Earth Science. Perhaps R&A discipline scientists could offer to fund young investigators. Dr. Green noted that PSD recognized this need, which is announced through ROSES. Dr. Steffes felt that smaller missions are better at bringing in young investigators (JUNO, e.g.). Dr. Luhmann recommended consulting Fran Bagenal’s on-line, planetary work force survey. The Cassini program was also cited as doing well in serving young investigators.

Dr. McKinnon expressed interest in maintaining the “big picture,” the overall budget, major missions, long-term efforts in the Solar System, the return to Jupiter, and a focused mission to Europa, and missions that produce transformative, paradigm-shifting science.

Analysis Group Reports

Small Bodies Analysis Group (SBAG)

Dr. Sykes reported on the result of the January 2012 SBAG meeting, which focused on the possible expansion of the Lunar Science Institute to include NEOs; cornerstone projects; multi-decadal efforts to characterize objects with ground-based assets (which also provide opportunities to engage the public and students); roadmap development; an assessment of the negative impacts of the FY13 budget; and a co-chartering with MEPAG and LEAG with HEOMD. SBAG is beginning to respond to the precursor science analysis group (PSAG) on Phobos and Deimos, and is standing up a strategic knowledge gap (SKG) team for missions to small bodies. Dr. Sykes displayed Vesta imagery, featuring highly contrasting material, high albedo surfaces and very dark surfaces, potential ancient volcanic flows, and intrusions exposed by the Marcia impact.

Venus Exploration Analysis Group (VEXAG)

Dr. Limaye presented results of the latest VEXAG meeting held during the last meeting of the AGU, which featured reports on planetary science from balloon platforms, a well-subscribed session on Venus volcanism, and many young graduate students. A VEXAG Town Hall meeting

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was held at the LPSC, and the International Venus Exploration Focus Group met during EGU 2012. The community is preparing and coordinating for June's Venus transit. A bi-monthly newsletter for the Venus community is now posted on the VEXAG URL and is announced through PEN and has received valuable contributions. VEXAG is starting new discussion boards for the community, developed through JPL, and available at lpi.usra.edu/vexag. An effort is also under way to update the VEXAG Goals Objectives and Investigations document, as well to develop a focus group on technology and laboratory measurements, an International Venus Working Group, and Young Scientists and Students Focus Group.

There is a new plan to update the Venus International Reference Atmosphere (VIRA), originally published in 1985, to consider a solid body reference model. VEXAG is forming working groups to document what is known about the surface of Venus. A solid planet model based on more data may be worthwhile to support future landed missions. Venus Express data has indicated recently that there are discrepancies in the spin rate of Venus: is this a data artifact or is the spin rate of Venus really variable? It is impossible to determine wind speed closer to the surface and data about angular momentum, thus radar measurements are needed to monitor the spin rate over long seasons. Arecibo radar observations might help to answer this question. Dr. Green suggested investigating NASA opportunities for using Arecibo time.

Future attractions for VEXAG include the Venus transit, an International Planetary Probes Workshop in Toulouse, France, 18-22 June 2012. A Comparative Climatology of Terrestrial Planets conference will be in Boulder, CO supported by all four science divisions of SMD, 25-28 June 2012. The group will hold its next meeting in late October in DC. Potential themes are Venus reference models and exploration sites.

Venus Express has been extended through end of 2014; plans to initiate aerobraking operations to reduce orbit period have been postponed; otherwise operations remain normal. The VIRTIS cooler has reached the end of its lifetime, thus is returning only visible data; a long radio occultation season is now under way. Most data is available through PDS/PDA. The amount of funding to extend the Venus Express mission will be decided in June 2012.

The JAXA mission to Venus, Akatsuki, which launched in May 2010 but did not achieve orbit, has conducted orbital maneuvers to attempt a close fly-by of the planet in 2015, followed by options to enter into a long equatorial orbit in 2016. NASA is providing tracking support for this mission through the DSN.

India's space agency (ISRO) announced a preliminary study of a future Venus orbiter in February 2012, however the mission is not yet in their 5-year plan. At a Town Hall in Vienna, Austria, community members discussed how to coordinate efforts for this mission. Dr. John Clark's suborbital Venus mission has been delayed to 2013 but has successfully undergone the peer-review process. Balloons can observe planets for 2-3 months. Dr. Limaye will present a status at the next PSS that will propose to leverage the Astrophysics high-altitude balloon program.

A network of coronagraphs is being deployed around the world to observe the ingress and egress of Venus during the upcoming transit; imagery will be transmitted to the NASA TV/Edge Coverage of the event. Dr. Limaye remarked that ACRIMSAT had observed a 0.1% decrease in solar output during the Venus transit of 2004.

Outer Planets Analysis Group (OPAG)

Dr. McKinnon provided an update on OPAG activities, which included reports from the Europa science definition team (SDT), which considered 3 Europa de-scoped mission concepts. OPAG findings included concerns about the long-term health of the Cassini mission due to budget cuts and notional outyear numbers. OPAG finds that Cassini should be supported through its 2017 terminus, and is concerned about loss of personnel. The mission is still carrying out significant science such as the first VIMS (near-IR) detection of thermal emission from Enceladus tiger stripes; modeling results seem to indicate a core temperature of 217°K. Oxygen and carbon dioxide have been detected in the atmospheres at Rhea and Dione. In response to a question, Dr. Green observed that the funding outlook for the Cassini extended mission is not too bad, but not overly healthy, and will likely be adjusted according to the results of the Senior Review. OPAG continues to strongly urge NASA to fund the Cassini Solstice mission.

OPAG lauds the selection of the ESA JUICE mission, and strongly urges NASA to enable meaningful US participation in JUICE through provision of instruments, instrument components, and support for US co-investigators and Participating Scientists. OPAG emphatically applauds the efforts of NASA, OMB and OSTP to date, particularly the most recent efforts of Dr. Green.

In light of the budget and 20% reduction to PSD, OPAG urges that NASA make every effort to restore the cadence of PI-led missions (Discovery and NF), because it provides a tide that lifts all boats, a cross-cutting issue for science.

OPAG continues to support NASA in its efforts to re-start Pu-238, and supports making ASRGs available for the next Discovery and New Frontiers calls.

OPAG finds that in particular, Thermal Protection Systems (TPS) for Outer Planets (OP) probes are a concern in the technology development program, and that OP technology efforts are both inadequate and uncoordinated. OPAG finds in addition that investment in balloon-borne astronomy could be cost-effective and scientifically productive for OP planetary science, and asks that PSD investigate this avenue.

OPAG lauds the selection of 12 Program Scientists (8 US and 4 European) for the Cassini mission and hopes to see this trend continue. However, OPAG is dismayed by the most recent selection for the OP Research program and urges NASA to bring the selection rate up to be consistent with other programs.

Dr. McKinnon reviewed background information leading to the three de-scoped Europa mission studies that are currently being assessed by NASA. The original mission was costed at \$4.7B; the Decadal Survey recommended that the mission be de-scoped, and gave this charge to the Europa SDT. The science goal objective and themes of the mission are to explore Europa to investigate its habitability and determine its composition, chemistry, and geology. The mission was subsequently split into two elements: an orbiter to focus on the putative ocean and Europa's ice shell; and a fly-by to carry out a remote sensing regimen to study chemistry and energy science themes. A sample orbiter payload would contain a radio subsystem, a laser altimeter to measure tides, a magnetometer, fly-by ice-penetrating radar, and a shortwave IR spectrometer, with instruments tailored to mission architecture, with features such as low-power, small mass, and

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lower data rates. A Europa lander for *in situ* measurements was also considered, with a mass spectrometer, Raman spectroscopy, magnetometer, site imaging system, etc.

Key science questions to be answered include the thickness of Europa's ice shell and assessments of its activity. Internal cost estimates for these missions (via JPL and JPL-led assessments): Orbiter \$1.6B, low-risk; fly-by \$1.9B, low-risk; and lander \$2.8-3.5B, high-risk. Aerospace Corporation's independent cost review found that there are no significant technical risks or schedule threats for the orbiter or fly-by missions. The OPAG community feels that the lander is too risky by comparison. While OPAG feels that all three mission options are highly meritorious in terms of science and Decadal Survey response, it supports either the orbiter or fly-by mission as candidates that should move forward for further study. OPAG also recommends that PSS receive a full briefing from the SDT on all three mission studies in a timely manner. The JUICE mission will not change the character of a U.S. mission as it provides only two Europa fly-bys vs. 30+ fly-bys as proposed by the SDT. The fly-bys also allow detailed measurements of composition and topography of the surface, compared to an orbiter mission.

The strong majority of the community feels that the multiple fly-by mission offers the greatest science return per dollar, greatest public engagement, and greatest flow-through to future exploration. Dr. Luhmann asked whether NASA's buy-in to JUICE could leverage more fly-by science for Europa. Dr. Prockter pointed out that JUICE's fly-by instruments are optimized for Ganymede, which would require a significant re-plan of the ESA mission. The radiation environment of Europa is also a risk to the Ganymede orbiter.

Mars Exploration Program Analysis Group (MEPAG)

Dr. Des Marais reviewed the findings of the most recent MEPAG meeting. The Mars rover Opportunity is now on the move and will be exploring Noachian terrain at Endeavour Crater, including impact breccias, evidence of post-aqueous alteration, and exposed veins of calcium sulfates, (likely gypsum). Odyssey science highlights include evidence of changes in seasonal circulation of argon as seen by the gamma-ray spectrometer on Mars Odyssey. The rovers are seeing variations on the ground, as opposed to little change seen by remote sensors. MRO CRISM data on Gusev Crater on phyllosilicate and carbonate distribution has concluded that the floor of the crater was lava flow, and is now confirming extensive aqueous alteration of crater floor deposits. These take the form of Both Al- and Mg-rich phyllosilicates, indicating there was a body of water at one point. Much of Mars' oldest crust has been altered by water at high temperatures, making it more comparable to metamorphic rock on Earth rather than impact debris on the Moon. The understanding of potential habitability, particularly of early Mars, is being broadened. MRO HiRISE is also providing significant evidence of seasonal flows on warm Martian slopes, which seem to be most consistent with brines.

MEPAG has taken steps to assess the Mars program re-planning effort, and has assembled a precursor SAG (PSAG), which has issued a preliminary report on updated Strategic Knowledge Gaps (SKGs) (with an added emphasis on HEOMD), and is also discussing the ongoing formulation of pathways, noting the very accelerated schedule. The challenge is to organize over the next few weeks, with some interaction with MPPG. Deliverables for PSAG include a reconsideration of the SKGs that could support the first human missions to the Mars vicinity; identification of key science objectives and technology/demonstration opportunities; classification each of the opportunities by platform (rover, lander, etc). The real job of PSAG is to

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identify what needs to be done to acquire enough knowledge to allow human exploration of Mars. Dr. Prockter asked why there is a mad scramble to figure this out right now. Dr. Green explained that the effort will provide input into a broader strategic path for human exploration, and an opportunity to see what the overlaps and connections are between SMD and HEOMD. This will help determine success for both science and exploration, especially in light of the newly constrained program, which requires careful prioritization of Agency efforts. Mr. Michael Meyer noted that there is already a rich amount of MEPAG data; the hurried schedule is precipitated by having to incorporate the newest data into identifying potential missions with an acceptable cost cap. Dr. Mike Wargo of HEOMD provided further context by describing a similar process that is under way with SBAG and the Lunar Exploration Analysis Group (LEAG). As NASA plans for JRPA, it is trying to identify what we don't know, and when we need to know it, to create architectures for future missions. There happened to be a natural alignment with the work needed for the MPPG. There will also be international effort to get an integrated plan in place to serve all the stakeholders.

Dr. Luhmann commented that PSS wants to support the larger vision at the top, but was a little concerned about the manpower going into the effort, possibly compromising science. Dr. Green conceded that this was a valid concern.

Dr. Des Marais, in response to a question, did not anticipate any structure and prioritization change as a result from MSL observations. The re-plan is trying to develop a framework for a joint enterprise, which will help to lead to R&A calls and AOs once needed measurements are identified. There is an SKG dealing with developing guidelines for the community. The cooperation between MEPAG and SBAG is ongoing and has been very productive for Phobos/Deimos, however the tight schedule is a key issue. The Next MEPAG meeting will take place 3-4 October 2012 in Pasadena, CA.

MEPAG is encouraged by Congressional actions that have supported Mars exploration. MEPAG again notes the high scientific and programmatic values of ongoing Mars missions. MEPAG strongly urges MPPG to take full advantage of the existing work of the MEPAG SAGs, and is looking forward to the landing of MSL. Dr. Luhmann cautioned against distractions that could compromise science; politically and administratively connected activities shouldn't undermine the science focus of PSD.

Lunar Exploration Analysis Group (LEAG)

Dr. Charles Shearer, Chair of the LEAG Executive Committee, reported by telephone on the activities of the LEAG. LRO data has revealed some relatively recent (100s of millions y.o.) formations of grabens and lobate scarps that appear relevant to the loss of heat from the lunar mantle. Additional geologic activity on the lunar far side (Compton-Belkovich) that may be tens to hundreds of millions y.o. has also been observed. These have been attributed to non-mare silicic volcanism, akin to terrestrial domes. The LEAG annual meeting will take place at Goddard Space Flight Center in October 2012 [lpi.usra.edu/meetings/leag2012]; themes will include the 40th anniversary of Apollo 17, the last humans on the Moon, the changing view of the Moon, and the next decade for lunar science/exploration. LEAG, CAPTEM, LPI, and NLSI will be sponsoring a workshop in Montana, a second conference on lunar highlands crust, 13-15 July

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2012. The workshop will offer several field trips to the Stillwater complex, a large layered intrusion that may be analogous to some lunar crust features. A Town Hall meeting was held at LPSC in March 2012, which covered discussions on ESA's Robotic Lander, Joint Robotic Precursor Activities (JRPA), and Global Exploration Roadmap activities. A new Town Hall meeting will be held at the Lunar Forum 2012, which will review some results of SKG studies.

Specific Action Team (SAT) activities include the GAP-SAT on the "Moon First" Human Exploration Scenario, and LEAG L-2 SAT on an Earth-Moon L2 Research Facility. Results of LEAG SAT activities are available at www.lpi.usra.edu/leag/. Some highlights of the GAP-SAT include themes dealing with understanding lunar resource potential, the lunar environment in the context of human life (solar activity, radiation environment, biological impacts of lunar dust, maintenance of peak human health), and understanding how to work and live and work on the lunar surface (dust, plasma environment and charging, etc.). SKGs have been identified from these themes.

LEAG findings:

- Following completion of LRO, there are no SKGs that would inhibit an Apollo-style mission to Moon.
- Within the Moon First Scenario, however, there are numerous SKGs that enable and enhance more mature exploration of the Moon.
- In situ resource utilization (ISRU) is a game-changer in how humans explore the Solar System in creating an infrastructure that enables a sustainable human presence.

Dr. Prockter asked how LADEE results might influence SKGs. Dr. Shearer expected to obtain a better understanding of dust, and plasma/dust environment through the mission, which will partially fill some SKGs. It was noted that SBAG is studying an "Asteroid First" scenario. Dr. Shearer added that groups representing all three destinations (Moon, Mars, asteroid) will attempt to integrate these analyses. Dr. Wargo mentioned that an international coordination group of 14 space-faring nations is also working on similar themes, and has created a Global Exploration Roadmap, which included 2 scenarios starting at ISS, and both ending at Mars. One is Moon First and the other Asteroid First. These themes will be covered comprehensively at the GALEX conference.

Dr. Shearer felt that while the analysis groups are making headway, they must continually consult with the community to vet the evolving product. Asked about the status of the ESA lunar rover, Dr. Shearer assured PSS that NASA is in constant contact with group developing the lander and is trying to make it accessible to the US planetary community.

Curation and Analysis Planning Team for Extraterrestrial Materials (CAPTEM)

Dr. Wadwha provided a status of NASA curation activities as performed through CAPTEM. The group met in March 2012 and continues to oversee its five main allocation groups: lunar samples, Stardust, Genesis, Cosmic Dust, and Hayabusa. CAPTEM's next meeting will occur in October /November 2012.

CAPTEM is establishing an *ad-hoc* committee for Stardust interstellar dust (aerogel and aluminum foils) to review proposals, and is preparing for the first allocation of Hayabusa

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samples; per an MOU with JAXA, NASA has thus far received 15 particles. Allocations will begin in June 2012. All samples received to date have been subject to scanning electron microscopy, precipitating concerns about degradation, and “cherry-picking.” NASA may not have an opportunity to see rare particles. CAPTEM anticipates receiving a total of 1500 particles, and is currently formulating a letter to JAXA delineating its concerns over these prior analyses. Dr. Green agreed to transmit the letter at upcoming bilateral meetings.

CAPTEM is assessing the response of the Johnson Space Center (JSC) Astromaterials Curation Office to an Inspector General (IG) report on concerns about sample handling. CAPTEM is reviewing loan agreements and inventory procedure documents for each collection, and expects the review to be complete by 4 June. There are many concerns, including archiving procedures to preserve integrity and particular characteristics of samples. CAPTEM is also reviewing management aspects of the JSC Astromaterials Curation Office, to determine whether resources are being allocated appropriately (Task 1), and a longer-term look (Task 2) at future needs for JSC curation. The Task 1 report is currently being prepared.

CAPTEM will sponsor a workshop on results from the Dawn mission (Spring 2013) and a curation and handling of cold samples in Summer 2013. Dr. Wadwha highly recommended recent research highlights, including a special issue of PNAS that focused on various aspects of cosmochemistry [PNAS 2011, 108 (48)]. Dr. Wadwha requested that PSS take more thorough advantage of CAPTEM expertise, and utilize it as a resource, through more connection with other AGs in planning activities. Regarding curation of Antarctic meteorites, which is the purview of the National Science Foundation (NSF), NASA has been re-visiting an MOU with NSF on this issue to ensure that it is up to date, and also to look at cost-sharing aspects. Thus far the MOU with NSF has been very cost-effective; NASA typically obtains 600-800 meteorites a year in this manner.

R&A Discussion

Dr. Luhmann and the PSS considered ways to approach the community’s concerns about R&A, including consolidating various data analysis programs, as opposed to separate line items, etc., as has been practiced by the Astrophysics Division. Dr. Voytek commented that R&A leads have been considering dividing proposals by science questions within Astrobiology, Mars, Atmospheres, etc., and run the reviews with subpanels, as opposed to target. PSS debated pros and cons of this approach, and Dr. Bernstein offered some scenarios for PSS to consider. Dr. Sunshine felt that Program Officers could benefit from increased programmatic efficiency. Dr. Voytek noted that the timing of the distribution of funding still remains a major issue. Staffing needs, experimenting with various forms of two-step proposals, consolidation of review panels, revisiting community surveys on proposal formats, early fiscal year commitments to R&A, a more aggressive managerial approach, and other means of change were debated. Dr. Michael New, citing his own experience in reviewing proposals, commented that PSS must decide on high-quality, deep reviews versus quick and faster, more efficient panel processes, and reported that his own feedback has indicated that proposers prefer the NASA (thorough review) process.

Dr. Green added the important point that planetary science is uniquely a NASA program. Proposers in astrophysics, heliophysics and Earth science can more easily propose to NSF. As planetary missions diminish, the R&A pressure will only increase. In addition, it is always

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important for NASA to review high-risk, high-payoff proposals in the gray areas; these gray areas can be lost in the two-step process. Dr. Sykes noted that the Program Officer (PO) must also consider preservation of subject matter expertise in terms of scoring proposals. Dr. Green stressed the importance of clearly written proposals that provide sufficient background in clear, rational terms. Asked about PSD's efforts in early career funding, Dr. Green reported that he had just learned of the issue and has instituted remedial steps on cleaning up the backlog.

Dr. Luhmann reviewed potential agenda items for the next PSS meeting: PSD update; MSL; July Discovery selection; Senior Review; update on the restoration of Discovery and New Frontiers; update on Mars re-planning and human exploration; update on JUICE; briefing on Europa de-scoping studies; a revisit of the R&A discussion; workforce survey results from Fran Bagenal; technology development support update (balloons, rockets, radar); report on PDS; webpage with comment box and shared PDS experiences from community; the effectiveness of the NASA Institutes program; an NRC CAPS committee presentation/interaction, get input on science/human exploration; and analysis group (AG) reports.

PSS reviewed findings:

PSS regards the restoration of PI-led mission cadence as critical

PSS supports HEOMD cooperation with PSD to promote the Mars vision

PSS expresses strong support/delight for NASA's support of JUICE

PSS urges careful consideration of Europa de-scoped studies

PSS advocates for a strong science plan for moving Mars program forward re: 2018 opportunity

PSS supports the Pu-238 re-start and urges efforts to continue, while recognizing the increasing cost risk

PSS recognizes the R&A program as a vital part of PSD, and supports internal efforts to streamline/improve ways of managing the program, increasing efficiency, and minimizing time to award.

PSS recommended that Dr. Green should convey target/commitment budget numbers to POs, commit to an identified percentage of budget early on, allowing POs to plan for proposers, inform proposers in a timely manner, and possibly merge programs for a panel review process. PSS also recognized the need to communicate to the community a better understanding of R&A procedures.

Dr. Luhmann adjourned the meeting.

Appendix A
Attendees

Subcommittee Members

Janet Luhmann, Chair PSS, University of California, Berkeley

James Bell, Carnegie Institute of Washington

Julie Castillo-Rogez, NASA Jet Propulsion Laboratory

David Des Marais, NASA Ames Research Center

John Grant, Smithsonian Institution

Sanjay Limaye, University of Wisconsin

Louise Prockter, Johns Hopkins University

James Head, Brown University

William B. McKinnon, Washington University

Anna-Louise Reysenbach, Portland State University

Paul Steffes, Georgia Institute of Technology

Jessica Sunshine, University of Maryland

Mark V. Sykes, Planetary Science Institute

Meenakshi Wadhwa, Arizona State University

Jonathan A. R. Rall, Executive Secretary, NASA HQ

NASA Attendees

Max Bernstein, NASA HQ

Janice Buckner, NASA HQ

Catharine Conley, NASA HQ

Shawn Donegal-Goldman, NASA

Leonard Dudzinski, NASA HQ

T. Jens Feeley, NASA HQ

Kristen Erickson, NASA PSD

Chris Flaherty, NASA HQ

Michelle Gates, NASA HQ

Ed Grayzech, NASA

James Green, PSD, NASA HQ

Jennifer Kearns, NASA HQ

Doug McCuiston, NASA

Michael Meyer, NASA HQ

Michael New, NASA HQ

Marian Norris, NASA HQ

Sarah Noble, NASA

Curt Niebur, NASA HQ

Joan Salute, NASA PSD

Heather Smith, NASA HQ

George Tahu, NASA HQ

Richard Vondrak, NASA GSFC

Mary Voytek, NASA HQ

Dan Woods, NASA SMD

Michael Wargo, NASA ESMD

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Gregg Vane, NASA JPL

Non-NASA Attendees

Francesco Bordi, Aerospace Corp.

Kaitlin Chell, Caltech

Anne Connor, U.S. House Science Committee

Dom Conte, Orbital Sciences

Dwayne Day, NRC

Tammy Dickinson, OSTP/EOP

Orlando Figueroa, Consultant to NASA HQ

Steve Mackwell, USRA LPI

Jon Malay, Lockheed Martin

Louis Mayo, Honeywell/Goddard

Frank Morris Jr., Aviation Week

Sfen Odenwald, ADNET Sys.

Kim Terrell, KIMS

Joan Zimmermann, Zantech IT

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Appendix B
Membership Roster
Planetary Science Subcommittee

Janet Luhmann (Chair)

Senior Fellow
Space Sciences Laboratory
University of California, Berkeley

Julie Castillo-Rogez
Jet Propulsion Laboratory

David Des Marais
NASA Ames Research Center

John Grant
National Air and Space Museum
Smithsonian Institution

Sanjay Limaye
Space Science and Engineering Center
University of Wisconsin

Jonathan A. R. Rall, Executive Secretary

Research & Analysis Program - Lead
Planetary Science Division
Science Mission Directorate

William B. McKinnon
Department of Earth and Planetary Sciences
Washington University

Louise Prockter
Department of Space Physics
Johns Hopkins University

Anna-Louise Reysenbach
Portland State University
Department of Biology

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Charles Shearer
Institute of Meteoritics
University of New Mexico

Paul Steffes
School of Electrical and Computer Engineering
Georgia Institute of Technology

Jessica Sunshine
Department of Astronomy
University of Maryland

Mark V. Sykes
CEO and Director
Planetary Science Institute

Meenakshi Wadhwa
Director
Center For Meteorite Studies
Arizona State University

Subcommittee Administrative Support:

Ms. Marian R. Norris
Management Support Specialist
Science Mission Directorate
NASA Headquarters

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Appendix C
List of Presentation Materials

1. Planetary Science Division Update; *James Green*
2. Mars Exploration Program Update; *Douglas McCuiston*
3. Assessment of Planetary Protection Requirements for Spacecraft Missions to Icy Solar System Bodies; *Geoffrey Collins*
4. Status of the ESA JUICE Mission; *Joan Salute*
5. PSD Research and Analysis Update; *Jonathan Rall*
6. Small Bodies Analysis Group; *Mark Sykes*
7. Venus Exploration Analysis Group; *Sanjay Limaye*
8. Outer Planets Analysis Group; *William McKinnon*
9. Mars Exploration Program Analysis Group; *David Des Marais*
10. Lunar Exploration Analysis Group; *Charles Shearer*
11. Curation and Analysis Planning Team for Extraterrestrial Materials; *Meenakshi Wadwha*

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Appendix D
Agenda

Planetary Science Subcommittee Meeting

May. 8-9, 2012
NASA Headquarters
Washington D.C.

8 May (8:30-5:00, Room TBD)

- 8:30 Welcome, agenda, announcements(Luhman, Green)
- 8:45 PSD status (Green)
- 10:15 Break
- 10:30 Mars Program Status update (McCustion)
- 11:30 Lunch (on own)
- 1:00 Europa Descope Options.....(Niebur)
- 2:00 Break
- 2:15 ESA-JUICE programmatic status update.....(Salute)
- 3:15 Discussion (including next meetings)
- 5:00 Adjourn
- 6:00 Group Dinner (TBD)

9 May (8:30-5:00, Room TBD)

- 8:30 Face time with SMD AA Grunsfeld (TBD)
- 8:45 VEXAG report(Limaye)
- 9:15 SBAG report (Sykes)
- 9:45 OPAG report(McKinnon)
- 10:15 Break
- 10:30 LEAG report(Shearer)
- 11:00 MEPAG report(Des Marais)
- 11:30 CAPTEM report.....(Wadhwa)
- 12:00 Lunch (on own)
- 1:00 R&A Update (Rall)
- 2:30 Discussion
- 4:00 Adjourn

