

OPAG Report
January 2014

NASA's Outer Planets Assessment Group (OPAG) met 13-14 January 2014 in Tucson AZ. OPAG assembles twice per year, engaging the widest community possible, to assess the current state of outer solar system exploration, goals for future exploration, and technology development needed to achieve those goals.

The present status of outer solar system exploration is very exciting - we heard reports from two currently flying missions: *Juno* and *Cassini*. The *Juno* spacecraft is healthy and is en route to a 2016 arrival at Jupiter following a successful Earth flyby gravity assist in October. The *Cassini* spacecraft and instruments are healthy and *Cassini* continues to build a rich data set. The final three years of the *Cassini* mission promise entirely new discoveries as the orbit of the spacecraft is cranked to high inclination and periapse is brought inside the rings. The extended mission, continued through the close-in "proximal orbits", offers an unprecedented observation geometry of Saturn's interior, magnetic field, and magnetosphere, as well as a new view of the ring system from above. It is a unique opportunity that will confidently deliver ground-breaking new scientific discoveries in the Saturn system.

The future of outer solar system exploration is bleak, however. With the completion of the *Juno* and *Cassini* missions in 2017 there remains only the *New Horizons* flyby of a yet-to-be found Kuiper Belt Object in its path. There are a few bright spots: the Pu238 domestic production restart, the European JUICE mission, and the potential opening of Discovery mission opportunities to outer solar system destinations. But there are no new US missions to the outer solar system on the drawing board. The 2013 - 2022 decade will take spacecraft only as far as the asteroid belt, not beyond, ending the era of American leadership in exploration of the outer planets.

A flagship-class mission to Europa was a very high priority in the 2003 and 2013 Decadal Surveys. The original Europa mission (as described in the 2013 Decadal Survey) however was too expensive. As a result, more focused and cost-effective mission concepts have been developed. OPAG was briefed on the Europa Science Definition Team's (ESDT) continuing efforts. We were also briefed on the potentially paradigm-shifting new discovery (released at AGU): the detection of possible water vapor plumes erupting from Europa. We continue to support the Europa Clipper mission as a scientifically compelling, technologically feasible and fiscally responsible approach to exploration of Europa. The Europa Clipper mission meets the requirements of the 2013-2022 Decadal Survey: it will accomplish flagship-worthy science by investigating Europa and its subsurface ocean, a potential habitable zone.

Jim Green gave a detailed report on the re-structure of the Research and Analysis (R&A) program. Of most interest to the outer solar system community is that the Outer Planets Research (OPR) program will be supported within the Solar System

Workings program. It is anticipated that the amount of funding to go to outer solar system science objectives will equal the OPR budget; this is something that we will want to track in future years. CDAPS will be unchanged, but the number of new Participating Scientists selected is likely to be very small this year, which is unfortunate, and in our view, unnecessary. Comments from the OPAG community on the restructure have been compiled, delivered to Jim Green and Jonathan Rall, and are posted on the OPAG website, on the “updates” page: <http://www.lpi.usra.edu/opag/updates.shtml>.

OPAG heard the reasons that the Advanced Stirling Radio-isotope Generator (ASRG) development program has been put on hold. With NASA’s commitment to ensure a continued supply of Pu238, via sustained production under Department of Energy (DOE) auspices, the issue of supply depletion has been resolved. The ASRGs offered other benefits however, in efficiency and lower mass.

OPAG heard a report from the SLS group. It may be possible to use the SLS to launch outer solar system missions. These missions could potentially benefit from the higher mass that could be launched, and the much shorter cruise times. There is room in the manifest for a launch supporting a putative Europa Mission, but schedule and budget concerns (affordability to PSD) are an issue that must be resolved before SLS launch capability is considered a serious option for outer planets missions.

The meeting culminated with a look ahead to an eventual Uranus orbiter mission. Reports were heard on a mission study done at the planetary science summer school, progress on technology development, establishment of a new subcommittee to close knowledge gaps hindering a future mission, and an invitation to a summer 2014 workshop on Ice Giant science objectives.

OPAG FINDINGS

1. **Cassini.** *Cassini remains NASA’s premier flagship mission.* Cassini’s data return from the Saturn system continues to inspire, challenge and enchant us. The final 3 years of the Cassini Solstice Mission (2015, 2016, and 2017) offer opportunities to study seasonal changes in Titan’s weather patterns, dynamic interactions of small moons with Saturn’s rings, and the investigation of Enceladus’ enigmatic plume. In its final (“proximal”) orbits, Cassini will return unprecedented data on the structure of Saturn’s magnetic field and interior, in a manner comparable to the *Juno* New Frontiers mission at Jupiter – data that promises to profoundly change our understanding of these giant planets and the evolution of our solar system.

OPAG is concerned with the transparency of the senior review process. OPAG would like clarity on the process and a better understanding of the ground rules for these reviews.

OPAG finding: OPAG asserts that the new science return from the Cassini end-of-mission observations strongly warrants continuing the mission to enable the highly valuable science planned for the final three years of the mission through September 2017, including: three close flybys of Enceladus; the opportunity to observe seasonal changes in Titan's lakes and weather and Saturn's atmosphere; and the unprecedented science return of the "proximal" orbits for Saturn's rings and its interior via this unique opportunity for gravity and magnetic field measurements.

2. **Europa.** The US Congress has mandated funding to support Europa mission studies in the current fiscal year and may continue to do so in the future. OPAG notes the following:

a) It is vital that the outer planets scientific community be kept abreast of the progress of such studies. We suggest that approximately every six months the outer planets community be explicitly briefed on the status of congressionally mandated Europa studies for operations, platform development, instrument accommodation, instrument development and continuing science/reconnaissance concept development. We are pleased that a significant fraction of the study funding has been allocated to instrument maturation efforts selected through the competitive Instrument Concepts for Europa Exploration (ICEE) process.

b) It is key that the extensive expertise of the outer planets community be harnessed for these tasks to produce the best possible Europa mission while limiting cost and risk. We were pleased that instrument providers not selected via ICEE are still encouraged to engage with the project.

c) The science (and reconnaissance) traceability for these expenditures should be monitored routinely by OPAG and the Europa Science Advisory Group (ESAG), a subset of the ESDT; in addition ESAG should naturally consider how the current mission architecture can inform new possible discoveries such as the putative European plumes.

OPAG finding: We are pleased that NASA is funding studies of a potential Europa mission, that NASA has allocated a significant fraction of the funds to instrument maturation via ICEE, and that the Mission Concept Review will be this year, paving the way for a potential Phase-A start for the Europa Clipper – a mission concept OPAG strongly endorses. It is important that the outer planets community be kept up-to-date on the goals, balance, and progress of these studies, such as via frequent regular reports to the Europa Science Advisory Group and OPAG.

3. **R&A restructure.** The OPAG community is wary of the restructure because we are concerned that the implementation details have not been worked out. The

response of the OPAG community to the request for comments was documented promptly however only a fraction of the concerns have been answered.

We note that the lack of communication to the broad planetary community over the last three years about the progress of the restructure has resulted in unnecessary suspicion of these actions. We register our serious disappointment that feedback from the affected community was not sought and incorporated.

OPAG Finding: The advantages of the R&A restructure do not warrant serious disruptions to careers. We are pleased that the proposal due date for the Solar System Workings program has been moved up to July 2014, however we remain concerned that many of the implementation details have not been worked out. Going forward, the progress of the restructure should be reported frequently to all affected groups.

4. Discovery Announcement of Opportunity (AO). OPAG submitted 13 responses to the Request for Information (RFI) requesting comments on the Discovery and New Frontiers AO's. The FY14 budget from Congress recommends that the AO for the next Discovery mission come out in May, 2014.

OPAG finding: We emphatically request that OPAG's responses to the RFI, for AO lessons learned, be incorporated into the next Discovery AO.

5. RPS for competed outer solar system missions. There are many potential planetary missions that require use of Radio-isotope Power Systems (RPS), including all that would venture beyond Jupiter. The cost of such power systems severely limits what can be proposed under the Discovery program, and impacts New Frontiers as well. Providing an RPS power system as Government Furnished Equipment (GFE), along with a credit for associated National Environmental Policy Act (NEPA) costs, will enable additional competed missions to the outer solar system.

Furthermore, a number of mission concepts proposed in Discovery 2010 and in the 2011 Decadal studies are not viable without ASRGs, because alternates such as Multi-Mission Radio-isotope Thermo-electric Generators (MMRTGs) are too heavy and expensive. For these missions it may also be necessary to offset costs for larger launch vehicles.

OPAG Finding: In the Discovery and New Frontiers programs, we recommend that RPS be supplied as Government Furnished Equipment, along with associated costs such as those for NEPA, and, if needed, offsets for larger launch vehicle costs.

6. **Plutonium.** OPAG wishes to express its deep gratitude to NASA for persisting and now succeeding in the quest to re-start domestic production of Pu238. Without the availability of this fuel, access to the outer solar system would be severely curtailed if not terminated, as exemplified by the exclusion of missions requiring a nuclear power system in the New Frontiers 3 Announcement of Opportunity. In addition to its importance to exploration of the outer solar system OPAG notes that Pu238 also enables some missions in the inner solar system.

OPAG finding: The re-start of domestic production of Pu238 is a significant achievement and enables our continued exploration of the outer solar system. We support NASA's overall plan described for sustained production of Pu238 with the understanding that RTGs and Radioactive Heating Units (RHUs) will be made available for outer planets exploration.

7. **Technology.** NASA's Space Technology Mission Directorate (STMD) has approved two new entry vehicle technology efforts for maturation that impact New Frontiers missions of interest, including specifically the Saturn Probe mission recommended in the Decadal Survey.

The remaining challenge is defining exactly what will be delivered under the efforts, how the stakeholders will coordinate, and how the Planetary Science Division (PSD) will monitor the technology development progress.

OPAG Finding: OPAG is pleased with the progress that has been made on probe technology. OPAG would like to see a plan that documents the process for handing off technologies from STMD to PSD for potential PSD missions (e.g. Saturn probe) such that proposers can confidently include this technology.

8. **Uranus studies.** A Uranus Orbiter was 3rd on the "Visions and Voyages" list for future flagship missions. Although a new start is some number of years in the future, there are mission aspects that should be studied now, for example studies addressing the integrated problem of Uranus probe delivery, entry, relay communication, and orbit insertion trajectory. OPAG is also forming a subcommittee to explore what data to acquire telescopically, and what scientific modeling to undertake that might enable future missions.

OPAG finding: Studies related to Ice Giant missions and their enabling technologies should be undertaken, in line with the funding priorities outlined in the recent Decadal Survey.

9. **Decadal Survey midterm review.** OPAG is deeply concerned with the future of Outer Solar System exploration. As stated earlier, after 2017 the Outer Solar System will go "radio quiet," limited to the modest transmissions from the Voyager

Interstellar mission, possible New Horizons post-Pluto Kuiper belt exploration, and the arrival of ESA's JUICE mission at the Jupiter system in the 2030s. At the January 2013 OPAG meeting, there was much discussion of the possibility (and wisdom) of unifying the Decadal Survey's New Frontiers 4 and 5 lists. Driving this discussion was the apprehension that there may only be one New Frontiers opportunity in the decade covered by the Survey (2013-2022) rather than the two mission opportunities recommended. On the other hand, the Decadal Survey is a carefully crafted, consensus document, and one that should not be revised in an ad hoc manner. We suggest that one avenue to address the general issue of when or if the Decadal Survey recommendations might be amended in order to better address drastically changed budgetary or scientific priorities would be through the midterm review process (akin to the NOSSE review of the previous Planetary Decadal Survey).

OPAG finding: Given ongoing uncertainties in the planetary budget, and the drastic changes that took place just months after Visions and Voyages was published, OPAG suggests that NASA ask the NRC Committee on Astrobiology and Planetary Science (CAPS) to advance a midterm review.

10. US JUICE Participation. Strong international collaborations extend the capabilities and reach of any individual space-faring institution – cooperation on the Cassini-Huygens mission for example has been particularly beneficial for NASA and ESA. The ESA JUper ICy moons Explorer (JUICE) flagship-class mission is a logical successor to this fruitful partnership. As in previous assessments, OPAG lauds NASA's commitment of \$100M (total lifecycle) to enable U.S. participation. OPAG is, however, concerned about the NASA announcement that it will not be able to fund US Co-Is on selected European instruments if they were not directly associated with selected hardware. This unfortunate decision misses an opportunity to fully capitalize on the scientific potential of JUICE and the value of NASA's contribution to the Mission. It also casts a dark cloud over international collaboration.

OPAG therefore requests that NASA continue the dialogue with ESA to better understand critical scientific needs. In addition, OPAG requests that the PSD provide a phased budget profile for the potential cost of supporting the presently unfunded CoI's on European instruments for the next decade, to better assess the magnitude of this support and the potential impact to other PSD endeavors if they were to be funded.

OPAG finding: OPAG remains concerned that not funding US JUICE Co-I's damages US science and reduces the yield from NASA's JUICE investment. Such reduced international scientific cooperation risks the isolation of scientific communities in Europe and the US. The collaborative international framework built by Cassini-Huygens represents years of effort and investment, and is a benefit to science that should be nurtured.

Meeting Outline

Presentations were heard as follows:

Monday, Jan. 13

Welcome, meeting objectives, logistics
Candy Hansen, Planetary Science Institute

Remarks from NASA Chief Scientist
Ellen Stofan, NASA Headquarters

Status of PSD, budget, R&A restructuring
Jim Green, NASA Headquarters

Outer planet updates, incl. ICEE
Curt Niebur, NASA Headquarters

Power to the outer solar system
OPAG responses to AO RFI (RPS related)
Kevin Baines, Jet Propulsion Laboratory
RPS/ASRG review report
Ralph McNutt, Applied Physics Laboratory
Zero Baseline Review, ASRG termination,
power to the outer planets trades
Jim Green, NASA Headquarters

OPAG responses to AO RFI (non-RPS)
Kevin Baines, Jet Propulsion Laboratory
NASA responses to AO RFI submissions
Michael New, NASA Headquarters
Curt Niebur, NASA Headquarters

Europa plume discovery
Lorenz Roth, Southwest Research Institute

Europa study report update
Barry Goldstein, Jet Propulsion Laboratory
Bob Pappalardo, Jet Propulsion Laboratory
Brian Cooke, Jet Propulsion Laboratory

Cassini Report, EOM, plans for Senior Review
Linda Spilker, Jet Propulsion Laboratory

NASA plans for Senior Review
Bill Knopf, NASA Headquarters

Outer planet science with BRISSON
Karl Hibbits, Applied Physics Laboratory

JWST Status Update, 'Beyond JWST' Study
Heidi Hammel, AURA astronomy

Tuesday, Jan. 14

Reconvene, OPAG items
Candy Hansen, Planetary Science Institute

Planetary Science Summer School:
Neptune mission study
Kyle Uckert, New Mexico State University

JUICE report
Dmitri Titov, European Space Agency

JUICE PI's reports
UVS - Randy Gladstone, Southwest Research
Institute
RIME - Jeff Plaut, Jet Propulsion Laboratory
PEP - Pontus Brandt, Applied Physics
Laboratory

Juno Mission
Scott Bolton, Southwest Research Institute

Io Workshop / EXCEED
Julie Rathbun, Planetary Science Institute

Technology updates
Propulsion systems for the outer solar system
David Anderson, NASA Headquarters
STMD updates
Pat Beauchamp, Jet Propulsion Laboratory

Overview and Status of the SLS
Steve Creech, NASA Headquarters

Uranus
Planetary Science Summer School:
Uranus mission study
Ingrid Daubar, University of Arizona, Tucson

Update on the Uranus Entry Study
Parul Agrawal, NASA Ames Research Center
Ground Test Facility Capabilities for Outer
Planet Entry Missions
Helen Hwang, NASA Ames Research Center
TPS for Saturn and Uranus
Ethiraj Venkatapathy, NASA Ames Research
Center

Formation of OPAG subcommittee
Mark Hofstadter, Jet Propulsion Laboratory

Future Uranus workshop
Amy Simon, Goddard Space Flight Center