PSDS 2013-2022 White Papers

Community Input Received by Planetary Science Decadal Survey

Authors	Title	Summary	Panel Selection
Mark Allen **Co-Authors:** Carrie Anderson, Andrew Coates, A. James Friedson, Murthy Gudipati, Kostas Kalogerakis, Ralph Lorenz, Jonathan Lunine, Catherine Neish, Conor Nixon, Lucy Norman	Astrobiological Research Priorities for Titan	Titan, the haze-enshrouded moon of Saturn, has the largest accessible inventory of organic molecules in the Solar System outside of the Earth. The prospects are high for the formation of prebiotic compounds not unlike what might have preceded the origin of life in the early history of the Earth.	Satellites: Galilean satellites, Titan, and the other satellites of the giant planets.

Candice Hansen **Co-Authors:** A.S.Aljabri, D.Banfield, E.B.Bierhaus, M.Brown, J.E.Colwell, M.Dougherty, A.R.Hendrix, H.Hussmann, K.Khurana, D.Landau, A.McEwen, D.A.Paige, C.Paranicas, C.M.Satter, B.Schmidt, M.Showalter, L.J.Spilker, T.Spilker, J.Stansberry, N.Strange, M.Tiscareno, Steve Vance	Triton science with Argo - A Voyage through the Outer Solar System	Argo is an innovative pragmatic concept for a New Frontiers 4 mission to significantly expand our knowledge of the outer Solar System. It exploits an upcoming launch window that permits a close Triton encounter during a flyby through the Neptune system, and then continues on to a scientifically-sel	Satellites: Galilean satellites, Titan, and the other satellites of the giant planets.
Peter Tsou **Co-Authors:** Donald E. Brownlee, Isik Kanic, Christophe Sotin, Linda J. Spilker, Nathan Strange, Joseph Vellinga	Enceladus Flyby Sample Return, LIFE (Life Investigation For Enceladus)	One of the most significant discoveries made by the Cassini Mission was finding water ice particles containing organic compounds in the plume emanating from the south pole of Enceladus. Several theories for the origin of life on Earth would also apply to Enceladus. Therefore, it should be of utmos	Satellites: Galilean satellites, Titan, and the other satellites of the giant planets.

Ralph Lorenz **Co-Authors:** Terry Hurford, Bruce Bills, Frank Sohl, James Roberts, Christophe Sotin, Hauke Hussmann	The Case for a Titan Geophysical Network Mission	Notes the science value of a network of small inexpensive landers focussed on Titan geophysics and that if appropriate radioisotope sources are available, this mission could be affordable under New Frontiers.	Satellites: Galilean satellites, Titan, and the other satellites of the giant planets.
Terry Hurford **Co-Authors:** B. Buratti, A. Coustenis, A. Dombard, R. Greenberg, H. Hussmann, M. Kirchoff, C. Porco, A. Rymer	The Case for an Enceladus New Frontiers Mission	In this white paper, we will summarize one possible mission concept to explore Enceladus within a New Frontiers-level mission: to stay below the cost cap of $650M (FY09 dollars) and within the launch capability of the Atlas V 551. We imagine that there are other possible mission scenarios...	Satellites: Galilean satellites, Titan, and the other satellites of the giant planets.
Terry Hurford **Co-Authors:** B. Buratti, A. Coustenis, A. Dombard, R. Greenberg, H. Hussmann, M. Kirchoff, C. Porco, A. Rymer, S. Vance, A. Verbiscer	The Case for Enceladus Science	In this white paper, we will outline important science questions regarding Enceladus and show the link between these science questions and major themes of exploration as identified by NASA.	Satellites: Galilean satellites, Titan, and the other satellites of the giant planets.

David E. Smith	A budget phasing approach to Europa Jupiter System Mission Science	Due to budget constraints, the proposed Europa Jupiter System Mission is unlikely to occur as planned. We propose to split EJSM into three small, more affordable and less risky missions that return science earlier (about the same time as the launch date of ELSM) and in easier to accomodate budgets.	Satellites: Galilean satellites, Titan, and the other satellites of the giant planets.
Julian Nott	Titan's unique attraction: it is an ideal destination for humans	With so many opportunities in the Solar System it may be hard to choose destinations. Titan has a one quality that sets it apart: it is uniquely suitable for humans. One reason for robotic Mars exploration is that humans will arrive in due course. An identical justification applies to exploring Titan	Satellites: Galilean satellites, Titan, and the other satellites of the giant planets.

Julian Nott **Co-Authors:** Kim Reh, Jonathan Lunine, David L. Pierce, Patricia Beauchamp, Tim Colonius, R.C. Downs, Jerrold Marsden, Carl F. Braun, Don Day, Michael Arnold, Wade Allmon, Dick Bohannnon, Alberto Elfes, John Elliot, Debora Fairbrother, Jack Jones, Jeff Hall, Greg Mungas, Michael Pauken, Rob Sinclair, Luke Brooke, David Wakefield	Advanced Titan Balloon Design Concepts	Numerous studies agree that Titan is of outstanding scientific interest and Montgolfiere balloons ideal for its exploration. This paper examines balloon operations, weather and steering. It suggests novel concepts that may encourage radical thinking about Titan balloon designs.	Satellites: Galilean satellites, Titan, and the other satellites of the giant planets.
Athena Coustenis **Co-Authors:** J. Lunine, D. Matson, K. Reh, P. Beauchamp, J.-M.Charbonnier, L. Bruzzone, M.-T. Capria, A. Coates, C. Hansen, R. Jaumann, J.-P. Lebreton, R. Lopes, R. Lorenz, I. Mueller-Wodarg, F. Raulin, E. Sittler, J. Soderblom, F. Sohl, C. Sotin, T. Spilker, N.			

Strange, T. Tokano, E. Turtle, H. Waite, L. Gurvits, C. Nixon, T. Livengood, J. Blamont, R. Achterberg, M. Allen, C. Anderson, D. Atkinson, T. Balint, G. Bampasidis, D. Banfield, A. Bar-Nun, J. Barnes, R. Beebe, E. Bierhaus, G. Bjoraker, D. Burr, F. Crary, J. Cui, J. Elliott, M. Flasar, A. Friedson, M. Galand, D. Gautier, M. Gurwell, J. Head, M. Hirtzig, T. Hurford, T. Johnson, K. Klaus, W. Kurth, E. Lellouch, J. Martin-Torres, K. Mitchell, X. Moussas, M. Munk, C. Neish, L. Norman, B. Noyelles, G. Orton, A. Pankine, D. Pascu , E. Pencil, S. Rafkin, T. Ray, F. Rocard, S. Rodriguez, A. Solomonidou, L. Spilker, R. West, D. Williams, E. Wilson, M. Wright, V. Zivkovic	Future in situ balloon exploration of Titan's atmosphere and surface	Many of the questions remaining to be addressed after the Cassini-Huygens mission require both remote and in situ exploration. Our understanding of the lower atmosphere, surface and interior of Titan will benefit greatly from detailed investigations by a montgolfiere, reaching a variety of locations	Satellites: Galilean satellites, Titan, and the other satellites of the giant planets.

Cynthia Phillips **Co-Authors:** D. L. Blaney, R. T. Pappalardo, H. Hussman, G. C. Collins, R. M. Mastrapa, J. F. Cooper, R. Greeley, J. B. Dalton, T. A. Hurford, E. B. Bierhaus, F. Nimmo, D. A. Williams, D. A. Senske , D. Grinspoon, R. E. Johnson, S. Kattenhorn, P. Hayne, B. Betts, W. B. McKinnon, L. M. Prockter, A. P. Showman, J. H. Shirley, K. Khurana, S. Grasby, B. G. Bills, L. Friedman, J. Castillo, C. Sotin, G. Hansen, K. Klaus, B. J. Buratti, S. W. Asmar, M. J. S. Belton, E. Heggy, L. Sklar, A. R. Hendrix, J. R. Spear, S. Ulamec, L. Bruzzone, F. Tosi, R. Jaumann, G. Strazzulla, A. Coates, J. Emery, L. Allamandola, A. Coustenis, R. W.	Exploration of Europa	Europa''s icy surface may hide an ocean of liquid water. We summarize the unanswered questions pertaining to Europa following the Galileo mission, and address how those questions will be answered by suggested missions such as EJSM and a lander, as well as new telescopic and laboratory measurements.	Satellites: Galilean satellites, Titan, and the other satellites of the giant planets.

Carlson, W. Grundy, S. D. Vance, G. Branduardi-Raymont, M. Barmatz, P. M. Beauchamp, A. D. Anbar, C. A. Raymond, K. P. Hand, E. Shock, K. Stephan, D. L. Goldsby, D. D. Blankenship, M. Choukroun, W. Moore, E. P. Turtle, T. Pierson, S. Neuer, M. Zolotov			
J. Hunter, Jr. Waite **Co-Authors:** T. Brockwell, D.T. Young, W.S. Lewis, C.P. McKay, Francois Raulin, G. Schubert	Titan Lake Probe	This White Paper describes the concept for a Titan Lake Probe, which could be implemented either as an element of a TSSM-type mission or as a stand-alone New Frontiers mission. The Lake Probe could be configured either as a boat or, for increased science return, as a submersible.	Satellites: Galilean satellites, Titan, and the other satellites of the giant planets.

Jonathan I. Lunine **Co-Authors:** A. Coustenis, P. Beauchamp, K. Reh, G. Bampasitis, L. Bruzzone, M.T. Capria, Coates, A., A.J. Friedson, D. Gautier, R. Jaumann, K.K. Klaus, J-P. Lebreton, T. Livengood, R. Lopes-Gautier, E. Lellouch, R. Lorenz, F-J. Martin-Torres, X. Moussas, C. Nixon, J. Nott, S. Rafkin, F. RaulinLISA Univ. Paris, S. Rodriguez, F. Sohl, A. Solomonidou, E.C. Sitler, J. Soderblom, R. West, M. Wright	The Science of Titan and its Future Exploration	This paper describes the science rationale for the next steps beyond Cassini-Huygens of exploration of Saturn''s moon Titan.	Satellites: Galilean satellites, Titan, and the other satellites of the giant planets.
Roger Yelle **Co-Authors:** S. Horst, M. Allen, R. Amils, S. K. Atreya G. Bampasidis, A. Bar-Nun, P. Beauchamp, M. Cabane, M. Capria, R. Carlson, N. Carrasco, A. Coates, J. Cooper,			

M. Combes, T. Cours, H. Cottin, A. Coustenis, T. Cravens, J. Cui, R. de Kok, I. dePater, M. Dobrijevic, G. Durry, Y. Dutil, O. Dutuit, M. Fulchignoni, M. Galand, Y. Gao, D. Gautier, M. Gurwell, E. Hebrard, F. Hersant, H. Imanaka; W. Ip, R. Jaumann, A. Jolly, S. Karoly, E. Kostiuk, L.-M. Lara, P. Lavvas, S. Lebonnois, J.- P. Lebreton, M. Leese, S. Le Mou_elic, T. Livengood, R. Lopes, J. Lopez-Moreno, J. Lunine, P. Mahaffy, V. Mangano, T. McCord, R. Modolo, A. Morse, O. Mousis, I. Muller-Wodarg, A. Mura, G. Murthy C. Nixon, D. Nna-Mvondo, L. Norman, G. Ortega, G. Orton, M. Patel, A. Pavlov, C. Plainaki, P. Rannou K. Reh, M. Rengel, F. Robb, S. Rodriguez, R.	Prebiotic Atmospheric Chemistry on Titan	Cassini measurements reveal that organic molecules with molecular weights of hundreds of amu are formed by photochemistry in Titan''s upper atmosphere. Investigating this chemistry is important for understanding the production of biological building blocks by naturally occurring processes.	Satellites: Galilean satellites, Titan, and the other satellites of the giant planets.

Rodrigo, E. Schaller, B. Schmitt, D. Schulze-Makuch, E. Sciamma O''Brien, J. Soderblom, A. Somogyi, E. Sittler, D. Strobel, L. Spilker, T. Spilker, M. Smith, A. Steele, K. Stephan, N. Strange, C. Szopa, R. Thissen, F. Tosi, D. Toublanc, M. Trainer S. Tripathi, S. Ulamec, S. Vinatier, V. Vuitton, J.-E. Wahlund, J. H. Waite, M. Yamauchi, J. Zarnecki			
Conor A. Nixon **Co-Authors:** Carrie M. Anderson, F. Michael Flasar, Christophe Sotin, J. Hunter Waite Jr., V. Malathy Devi, Olivier Mousis, Kim R. Reh, Konstantinos Kalogerakis, A. James Friedson, Henry Roe, Yuk L. Yung, Valeria Cottini, Giorgos Bampasidis,			

Richard K. Achterberg, Nicholas A. Teanby, Gordon L. Bjoraker, Eric H. Wilson, Tilak Hewagama, Mark A. Gurwell, Roger Yelle, Mark A. Allen, Nathan J. Strange, Linda J. Spilker, Glenn Orton, Candice J. Hansen, Jason W. Barnes, Jason M. Soderblom, Vladimir B. Zivkovic, Anezina Solomonidou, David L. Huestis, Mark A. Smith, David H. Atkinson, Patrick G. J. Irwin, Mathieu Hirtzig, Simon B. Calcutt, Timothy A. Livengood, Sandrine Vinatier, Theodor Kostiuk, Antoine Jolly, Nasser Moazzen-Ahmadi, Darrell F. Strobel, Mao-Chang Liang, Patricia M. Beauchamp, Remco de Kok, Robert Pappalardo, Imke de Pater, Véronique Vuitton, Paul N. Romani, Robert A. West, Lucy H. Norman,	Titan''s Greenhouse Effect and Climate	Herein we examine the atmospheric parallels between the Earth and Titan including the possibility of dramatic climate change. In the next decade, we urge extending the duration of the Cassini mission, planning for a future mission focused on Titan's climate and other measures.	Satellites: Galilean satellites, Titan, and the other satellites of the giant planets.

Mary Ann H. Smith, Kathleen Mandt, Sebastien Rodriguez, Máté Ádámkovics, Jean-Marie Flaud, Kurt K. Klaus, Michael Wong, Jean-Pierre Lebreton, Neil Bowles			
Dirk Schulze-Makuch **Co-Authors:** Francois Raulin, Cynthia Phillips, Kevin Hand, Susanne Neuer, Brad Dalton	Astrobiology Research Priorities for the Outer Solar System	The outer solar system provides a rewarding assortment of planetary diversity of high interest to astrobiology. This White Paper for the 2009-2011 Planetary Science Decadal Survey evaluates the planetary bodies in the outer solar system and their value to the search for life and astrobiology.	Satellites: Galilean satellites, Titan, and the other satellites of the giant planets.
Geoffrey Collins **Co-Authors:** Claudia J. Alexander, Amy C. Barr, Edward B. Bierhaus, Michael T. Bland, Veronica J. ray, Lorenzo Bruzzone, Emma Bunce, Andrew Coates, John F. Cooper, Frank Crary, Andrew J. Dombard, Gianrico Filacchione, Olivier Grasset, Gary B. Hansen, Amanda R. Hendrix, Charles			

A. Hibbitts, Terry A. Hurford, Hauke Hussmann, Ralf Jaumann, Ozgur Karatekin, Krishan K. Khurana, Michelle R. Kirchoff, Jean-Pierre Lebreton, Melissa A. McGrath, Jeffrey M. Moore, Robert T. Pappalardo, G. Wesley Patterson, Christina Plainaki, Louise M. Prockter, Kurt Retherford, James H. Roberts, Paul M. Schenk, David A. Senske, Adam P. Showman, Katrin Stephan, Federico Tosi, Roland J. Wagner	Ganymede science questions and future exploration	This paper summarizes outstanding science questions about Ganymede and its place in the Jupiter system, and how further exploration would answer these questions.	Satellites: Galilean satellites, Titan, and the other satellites of the giant planets.
Robert Hodyss **Co-Authors:** Paul D. Cooper, Reggie Hudson, Robert Carlson, Paul V. Johnson, Arthur L. Lane, Marla Moore, Louis J. Allamandola	Recommended Laboratory Studies in Support of Planetary Science: Surface Chemistry of Icy Bodies	We identify several areas where an increased emphasis on laboratory activities would lead to a significant return in scientific results, based on an enhanced understanding of the fundamental surface chemistry of icy bodies.	Satellites: Galilean satellites, Titan, and the other satellites of the giant planets. Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.

Steve Vance **Co-Authors:** Ariel Anbar, Donald D. Blankenship, Bonnie Buratti, Julie Castillo, Geoffrey C. Collins, James B. Dalton III, Jack Farmer, Eberhard Grun, Candice Hansen, Terry Hurford, Hauke Hussmann, Jeff Moore, Robert Pappalardo, Cynthia B. Phillips, Frank Postberg, Elizabeth Turtle, Robert Tyler	Icy Satellite Processes in the Solar System: A plurality of worlds	A comprehensive strategy for Solar System exploration must identify processes common to icy worlds. Such an approach requires continued investment in discovery focused on icy satellites in the size regime 100 km and larger. We elaborate on this concept, giving specific examples and recommendations	Satellites: Galilean satellites, Titan, and the other satellites of the giant planets. Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.

Robert J. Noble **Co-Authors:** Rashied Amini, Patricia M. Beauchamp, Gary L. Bennett, John R. Brophy, Bonnie J. Buratti, Joan Ervin, Yan R. Fernandez, Will Grundy, Mohammed Omair Khan, David Q. King, Jared Lang, Karen J. Meech, Alan Newhouse, Steven R. Oleson, George R. Schmidt, Thomas Spilker, John L. West	New Opportunities for Outer Solar System Science using Radioisotope Electric Propulsion	This whitepaper discusses how mobility provided by radioisotope electric propulsion (REP) opens up entirely new science opportunities for robotic missions to distant primitive bodies. We also give an overview of REP technology developments and the required next steps to realize REP.	Satellites: Galilean satellites, Titan, and the other satellites of the giant planets. Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.
James T. Struck	Some Anthropology of Humans in Space. Can Human Stability Provide Some Support for Non-Evolutionary or Religious Concepts? Are we able to Speak of a Homo-Astronomicus or a Human Group Involved in Space Travel? What Happens to Humans in Space? (ID-0135)	Some anthropology of humans and space. I propose a relationship between religious artifacts and astronomical stability. I establish why calling humans in space a new species fits current species understandings and mention 2 other groups-slavery and sending objects a distance. Space effects raised.	Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust. None of the above.
Michael Nolan **Co-Authors:** Paul Abell, Erik			

Asphaug, MiMi Aung, Julie Bellerose, Mehdi Benna, Lance Benner, David Blewett, William Bottke, Daniel Britt, Donald Campbell, Humberto Campins, Clark Chapman, Andrew Cheng, Harold C. Connolly Jr., Don Davis, Richard Dissley, Gerhard Drolshagen, Dan Durda, Eugene Fahnestock, Yanga Fernandez, Michael J. Gaffey, Mark Hammergren, James Head, Carl Hergenrother, Ellen Howell, Robert Jedicke, Steve Kortenkamp, Ekkehard Kuehrt, Stephen Larson, Dante Lauretta, Larry Lebofsky, Carey Lisse, Amy Lovell, Joseph Masiero, Lucy McFadden, William Merline, Patrick Michel, Beatrice Mueller, Joseph Nuth, David O"Brien, William Owen, Joseph Riedel,	Small Bodies Community White Paper: Near-Earth Asteroids	This paper identifies the top-level science issues, mission priorities, research and technology needs, and programmatic balance for the exploration of Near-Earth Objects. This paper was organized by the Small Bodies Assessment Group.	Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.

Harold Reitsema, Nalin Samarasinha, Daniel Scheeres, Derek Sears, Michael Shepard, Mark Sykes, Josep M. Trigo-Rodriguez, David Trilling, Ronald Vervack, James Walker, Benjamin Weiss, Hajime Yano, Donald Yeomans, Eliot Young, Michael Zolensky			
Thomas D. Jones **Co-Authors:** Rob R. Landis, David J. Korsmeyer, Paul A. Abell, Daniel R. Adamo	Strengthening U.S. Exploration Policy via Human Expeditions to Near-Earth Objects	By conducting a series of piloted Near-Earth Object (NEO) missions beginning about 2020, the U.S. will reinforce the scientific, economic, programmatic, operations, planetary defense, and public outreach elements of its human exploration program.	Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.
Robert F. Arentz **Co-Author:** Harold Reitsema	NEO Survey: An Efficient Search for Near-Earth Objects by an IR Observatory in a Venus like Orbit	We present a conceptual design based on high-heritage flight systems from the Spitzer Space Telescope and the Kepler mission which will find 90% of all 140-meter NEOS in 7 years after launch, and by 2020, if started soon.	Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.

Michael C. Nolan **Co-Authors:** Lance A. M. Benner, Marina Brozovic, Ellen S. Howell, Jean-Luc Margot	Imaging of Near-Earth Asteroids	Imaging of asteroids is necessary to understand their physical structure for studies of solar system formation, impact hazard, and resources for exploration. Ground based imaging is required to study the population of asteroids. Radar imaging at Arecibo and Goldstone currently best achieve this task	Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.
Andreas Rathke	Testing for the Pioneer Anomaly on a Pluto Exploration Mission	An overview of the phenomenon, commonly dubbed the Pioneer anomaly, is given and the possibility for an experimental test of the anomaly as a secondary goal of an upcoming space mission is discussed using a putative Pluto Orbiter Probe as a paradigm.	Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.
Andreas Rathke **Co-Authors:** Torsten Bondo, Roger Walker, Andrew Willig, Dario Izzo, Mark Ayre	Preliminary Design of an Advanced Mission to Pluto	A technology assessment and feasibility study is being performed within the ESA Advanced Concepts Team on sending a small-to-medium (700-900 kg) Nuclear Electric Propulsion spacecraft into orbit around Pluto with a mission launch in 2016 using existing or emerging space technology.	Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.

Charles Alcock **Co-Authors:** Matthew Holman, Matthew Lehner, Stephen Murray, Pavlos Protopapas, Michael Werner	Whipple: Exploring the Solar System beyond Neptune Using a Survey for Occultations of Bright Stars	Whipple is a Discovery class mission to explore the outer Solar System. A small telescope will compile lightcurves of ~40,000 stars sampled at 40 Hz. Small bodies from the Kuiper Belt to the Oort Cloud will occult targeted stars, revealing their distances, sizes, and abundances.	Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.

Bonnie Buratti **Co-Authors:** Eleonora Ammannito, Erik Asphaug, MiMi Aung, James Bauer, Julie Bellerose, David Blewett, William Bottke, Daniel Britt, Julie Castillo-Rogez, Tommy Grav, Eberhard Gruen, Nader Haghighipour, Doug Hamilton, James Head, Andrew Klesh, Steve Kortenkamp, Jian-Yang Li, Scott Murchie, David Nesvorny, Catherine Olkin, William Owen, Joseph Riedel, Andrew Rivkin, Daniel Scheeres, Scott S. Sheppard, Mark V. Sykes, Peter Thomas, Anne Verbiscer, Faith Vilas, Hajime Yano, Eliot Young	Small Bodies Community White Paper: The Small Satellites of the Solar System	This paper identifies the top-level science issues, mission priorities, research and technology needs, and programmatic balance for the exploration of Small Satellites. This paper was organized by the Small Bodies Assessment Group.	Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.

Jon D. Giorgini **Co-Authors:** Lance A. M. Benner, Marina Brozovic, Michael W. Busch, Donald B. Campbell, Steven R. Chesley, Paul W. Chodas, Ellen Howell, Jean-Luc Margot, Andrea Milani Petr Pravec, Robert A. Preston, Maria-Eugenia Sansaturio, Daniel J. Scheeres, Michael K. Shepard, Arnold Silva, Martin A. Slade, Patrick A. Taylor, Giovanni Valsecchi, David Vokrouhlický, Donald K. Yeomans	Radar Astrometry of Small Bodies: Detection, Characterization, Trajectory Prediction, and Hazard Assessment	Radar astrometry reduces trajectory uncertainties by orders of magnitude, thereby improving prediction, targeting, and impact probability estimates for small-bodies, while characterizing some at levels comparable to a spacecraft flyby. This improves resource use for ground and flight investigations.	Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.

Candice Hansen **Co-Authors:** J.A. Stansberry, A.S. Aljabri, D. Banfield, E.B. Bierhaus, M. Brown, J. E. Colwell, M. Dougherty, A.R. Hendrix, K. Khurana, D. Landau, A. McEwen, D.A. Paige, C. Paranicas, C.M. Satter, B. Schmidt, M. Showalter, T. Spilker, L.J. Spilker, N. Strange, M. Tiscareno, W.M. Grundy, N. Haghighipour, K.S. Noll, E. Schaller, S. Sheppard	KBO Science with Argo - A Voyage through the Outer Solar System	Argo is an innovative pragmatic concept for a New Frontiers 4 mission which exploits an upcoming launch window that permits a close Triton encounter during a flyby through the Neptune system, and then continues on to a scientifically-selected Kuiper Belt Object.	Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.

Linda Spilker **Co-Authors:** Robert Pappalardo, Robert Mitchell, Michel Blanc, Robert Brown, Jeff Cuzzi, Michele Dougherty, Charles Elachi, Larry Esposito, Michael Flasar, Daniel Gautier, Tamas Gombosi, Donald Gurnett, Arvydas Kliore, Stamatios Krimigis, Jonathan Lunine, Tobias Owen, Carolyn Porco, Francois Raulin, Laurence Soderblom, Ralf Srama, Darrell Strobel, Hunter Waite, David Young	Cassini-Huygens Solstice Mission	Understanding the Saturn system has been greatly enhanced by the Cassini-Huygens mission. The proposed 7-year Cassini Solstice Mission would address new questions that have arisen during the mission, and observe seasonal and temporal change in the Saturn system to prepare for future missions.	Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.
Andrew F. Cheng **Co-Authors:** Andrew Rivkin, Patrick Michel, Carey Lisse, Kevin Walsh, Keith Noll, Darin Ragozzine, Clark Chapman, William Merline, Lance Benner, Daniel Scheeres	Binary and Multiple Systems	A sizable fraction of small bodies is found in binary or multiple systems. Understanding the formation processes of such systems is critical to understanding collisional and dynamical evolution. Missions can offer enhanced science return if they target binaries or multiples. [FINAL version]	Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.

Scott L. Murchie **Co-Authors:** Andrew S. Rivkin, Joseph Veverka, Peter C. Thomas, Nancy L. Chabot	The Scientific Rationale for Robotic Exploration of Phobos and Deimos	Mars" two moons, Phobos and Deimos, are D-type small bodies that may be remnants of the population that delivered volatiles to the inner solar system. A Discovery class mission can address key science questions at the moons, and prepare for future human exploration.	Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.
Andrew Rivkin **Co-Authors:** Joshua Emery, Antonella Barucci, James F. Bell, William F. Bottke, Elisabetta Dotto, Robert Gold, Carey Lisse, Javier Licandro, Louise Prockter, Charles Hibbits, Michael Paul, Alessondra Springmann, Bin Yang	The Trojan Asteroids: Keys to Many Locks	The Trojan asteroids of Jupiter lie at the crux of several of the most interesting outstanding issues regarding the formation and evolution of the Solar System. We present science questions centering on the Trojans are lay out recommendations for their future study and exploration.	Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.

Andrew S. Rivkin **Co-Authors:** Julie C. Castillo-Rogez, Neyda M. Abreu, Erik Asphaug, Andrew F. Cheng, Beth E. Clark, Barbara A. Cohen, Pamela G. Conrad, Paul Hayne, Ellen S. Howell, Torrence V. Johnson, Georgiana Kramer, Jian-Yang Li, Larry A. Lebofsky, Lucy F. Lim, Amy J. Lovell, Dennis L. Matson, Thomas M. McCord, Lucy-Ann McFadden, William B. McKinnon, Ralph E. Milliken, William Moore, James H. Roberts, Christopher T. Russell, Britney E. Schmidt, Mark V. Sykes, Peter C. Thomas, Mikhail Zolotov	The Case for Ceres: Report to the Planetary Science Decadal Survey Committee	We present recent findings about Ceres, stressing its unique nature. Outstanding remaining science questions are discussed along with recommendations for the next steps in Ceres research in the Dawn and post-Dawn era.	Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.
Hal Weaver **Co-Authors:** K. J. Meech, P. Abell, E. Ammannito, E. Asphaug, M. Aung, J. Bellerose, M. J. S. Belton, M. Benna, J. Blum, F.			

Brenker, D. Britt, D. Brownlee, B. Buratti, H. Campins, A. Cangahuala, J. Castillo-Rogez, A. Cochran, M. Combi, H. C. Connolly, Jr., N. Dello Russo, M. De Sanctis, M. DiSanti, R. Dissly, T. Farnham, L. Feaga, P. Feldman, Y. R. Fernández, E. Gruen, N. Haghighipour, W. M. Harris, C. Hergenrother, M. Horanyi, E. Howell, W. Irvine, M. Kueppers, E. Kuehrt, S. Larson, J.-Y. Li, C. M. Lisse, A. Lovell, K. Magee-Sauer, L. A. McFadden, J. P. Morgenthaler, B. E. A. Mueller, M. Nolan, J. Nuth, W. M. Owen, P. Palumbo, W. Reach, J. Riedel, N. Samarasinha, D. Scheeres, M. Sitko, M. V. Sykes, J. M. Trigo-Rodríguez, J. Veverka, R. Vervack, H. Yano, E. Young, M. Zolensky	Small Bodies Community White Paper: Goals and Priorities for the Study of Comets in the Next Decade (2011-2020)	This paper identifies the top-level science issues, mission priorities, research and technology needs, and programmatic balance for the exploration of Comets. This paper was organized by the Small Bodies Assessment Group.	Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.

Scott Messenger **Co-Authors:** Andrew Davis, George Flynn, Lindsay Keller, Allan Treiman, Meenakshi Wadhwa, Andrew Westphal	Sample Return from Primitive Asteroids and Comets	This white paper makes the case for sample return from primitive asteroids and comets in the next decade to address some of the most important questions in planetary science relating to the origin and history (and particularly the origin and distribution of organics and water) of the Solar System.	Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.

William Grundy **Co-Authors:** W.B. McKinnon, E. Ammannito, M. Aung, J. Bellerose, F. Brenker, D. Blewett, J.C. Castillo, A.F. Cheng, M.C. De Sanctis, J.P. Emery, J.-Y. Li, C. Hansen-Koharcheck, M.J. Kuchner, A. Lovell, L.A. McFadden, W.J. Merline, K.S. Noll, C.B. Olkin, W.M. Owen, N. Pinilla-Alonso, D. Ragozzine, J.E. Riedel, A.S. Rivkin, C.T. Russell, J.A. Stansberry, M.V. Sykes, S.C. Tegler, A.J. Verbiscer, F. Vilas, H.A. Weaver, H. Yano, E.F. Young	Small Bodies Community White Paper: Exploration Strategy for the Ice Dwarf Planets 2013-2022	This paper identifies the top-level science issues, mission priorities, research and technology needs, and programmatic balance for the exploration of Dwarf Planets. This paper was organized by the Small Bodies Assessment Group.	Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.

Scott Sandford **Co-Authors:** Michael A'Hearn, Louis J. Allamandola, Daniel Britt, Benton Clark, Jason P. Dworkin, George Flynn, Danny Glavin, Robert Hanel, Martha Hanner, Fred Hörz, Lindsay Keller, Scott Messenger, Nicholas Smith, Frank Stadermann, Darren Wade, Ernst Zinner, Michael E. Zolensky	The Comet Coma Rendezvous Sample Return (CCRSR) Mission Concept – The Next Step Beyond Stardust	This paper describes the scientific goals and implementation design of the Comet Coma Rendezvous and Sample Return (CCRSR) mission, one of the concept study missions funded by the recent NASA DSCME Program.	Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.
Ethiraj Venkatapathy **Co-Authors:** Christine E. Szalai, Bernard Laub, Helen H. Hwang, Joseph L. Conley, James Arnold, Jim Tibaudo, Robert Knudsen, Andrew Chambers, David Atkinson, Sushil K. Atreva, Joseph M. Vellinga, William H. Willcockson, Janine M. Thornton, Nicholas G. Smith, Richard A. Hund, John			

Dec, Max L. Blosser, Michelle M. Munk, Robert Maddock, Prasun N. Desai, Walter Engelund, Stephen Sandford, David A. Gilman, Steven W. Gayle, John Kowal, Christopher B. Madden, Stan Bouslog, Brian J. Remark, Donald Curry, Scott Coughlin, Adam J. Amar, Kevin H. Baines, Tibor Balint, Bernard Bienstock, George T. Chen, James A. Cutts, Jeffery L. Hall, Samad A. Hayati, Pamela J. Hoffman, Linda Spilker, Romasso P. Rivellini, Robert Manning, Eric M. Slimko, Adam D. Steltzner, Thomas Spilker, Jeffrey Umland, Charles Kiskiras, Duane Baker, Thomas Foster, Dominic Calamito, James B. Garvin, Timothy A. Sauerwein, Sharon Seipel, Lori S. Glaze, Spencer Stolis, Mark Lippold, Francis Schwind, James Thompson, Raj	Thermal Protection System Technologies for Enabling Future Sample Return Missions	Currently available TPS materials can meet the needs of Sample Return missions with entry velocity 13 km/s, heritage carbon phenolic is fully capable, but potentially unavailable and currently available TPS will need to be qualified.	Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.

Narayan, Thomas Andrews, Conley Thatcher, Edwin B. Curry, John McKinney, Robert Frampton, Todd Stever, Charley Bown, William Congdon, Jennifer Congdon, Daniel M. Empey, Joe Hartman, Dinesh Prabhu, Nancy L. Mangini, Kristina A. Skokova, Margaret M. Stackpoole, Tood White, Howard Goldstein, Melmoth Covington, Robin A. Beck, Carol W. Carroll, Charles A. Smith, Deepak Bose, Anthony Colaprete, David M. Driver, Edward Martinez, Donald T. Ellerby, Matthew J. Gasch, Aga M. Goodsell, James Reuther, Sylvia M. Johnson, Dean Kontinos, Mary Livingston, Michael J. Wright, Harry Partridge, George A. Raiche, Huy K. Tran, Kerry A. Trumble			

Paul A. Abell **Co-Authors:** Daniel Adamo, Thomas Jones, David Korsmeyer, Rob Landis	Scientific Investigation of Near-Earth Objects via the Orion Crew Exploration Vehicle	NASA has examined the feasibility of sending the Orion Crew Exploration Vehicle to near-Earth objects during the next decade and beyond as part of its future Human Space Flight program. This paper describes the in-depth scientific investigations that could be accomplished by such missions.	Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.
James D. Walker **Co-Authors:** Walter F. Huebner, Sidney Chocron, Walt Gray, Daniel Boice	Active Seismology of Asteroids through Impact and/or Blast Loading	We have no direct data on the interior structure of primitive bodies. The interior structure of asteroids is relevant to most solar system formation and evolution theories. Seismology is the only method for determining the interior structure for a range of sizes of asteroids to address.	Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.
William B.C. Crandall	A Decadal Shift: From Space Exploration Science to Space Utilization Science	We urge the Decadal Survey Committee, which is charged with developing “a comprehensive science and mission strategy for planetary science,” to temporarily shift research priorities in the United States from space exploration science to space utilization science.	Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.
Dante S. Lauretta **Co-Authors:** Paul Abell, Carlton Allen, Ariel Anbar, Olivier Barnouin-Jha, M. Antonella			

Barucci, E. Beau Bierhaus, Richard P. Binzel, William F. Bottke, Steven R. Chesley, Beth E. Clark, Edward Cloutis, Harold C. Connolly, Jr., Michael J. Drake, Jason P. Dworkin, M. Darby Dyar, Jack Farmer, Rebecca Ghent, Daniel P. Glavin, Nader Haghighipour, Vicky E. Hamilton, Carl W. Hergenrother, Kip Hodges, Lindsay P. Keller, Detlef Koschny, John Marshall, Scott Messenger, Steven Mielke, Keiko Nakamura-Messenger, Joseph A. Nuth, Dennis Reuter, Frans J. M. Rietmeijer, Kevin Righter, Waddell Robey, Michal Rozyczka, Nicolaus Copernicus, Farid Salama, Scott A. Sandford, Daniel J. Scheeres, Everett Shock, Steve Vance, Brian D. Wade, Kosei E. Yamaguchi	Astrobiology Research Priorities for Primitive Asteroids	Study of primitive asteroids is fundamental to understanding the origin, distribution, and evolution of volatile and organic compounds in the early Solar System. This paper outlines six major research focus areas and recommends three mission concepts, which are listed in priority order.	Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.

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Mehdi Benna, Lance Benner, David Blewett, William Bottke, Frank Brenker, Humberto Campins, Julie Castillo-Rogez, Andrew Cheng, Clark Chapman, Harold C. Connolly Jr., Maria Cristina De Sanctis, Richard Dissley, Dan Durda, Joshua Emery, Eugene Fahnestock, Yanga Fernandez, Michael J. Gaffey, Nader Haghighipour, Mark Hammergren, Paul Hardersen, Mihaly Horanyi, Ellen Howell, Robert Jedicke, Andrew Klesh, Steve Kortenkamp, Marc Kuchner, Stephen Larson, Dante Lauretta, Larry Lebofsky, Jian-Yang Li, Amy Lovell, Franck Marchis, Joseph Masiero, Lucy McFadden, Karen Meech, William Merline, Patrick Michel, Beatrice Mueller, David	Small Bodies Community White Paper: Asteroids	This paper identifies the top-level science issues, mission priorities, research and technology needs, and programmatic balance for the exploration of Asteroids. This paper was organized by the Small Bodies Assessment Group.	Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.

Nesvorny, Michael Nolan, Joseph Nuth, David O"Brien, William Owen, Vishnu Reddy, Joseph Riedel, Andrew Rivkin, Chris Russell, Daniel Scheeres, Michael Shepard, Mark V. Sykes, Paolo Tanga, Josep M. Trigo-Rodriguez, David Trilling, Ronald Vervack, Faith Vilas, James Walker, Benjamin Weiss, Hajime Yano, Eliot Young, Michael Zolensky			

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Erin Lee Ryan **Co-Authors:** Sarah M. Hörst, Michael P.J. Benfield, Fred Calef III, Dario Cersosimo, Valeria Cottini, Robert Citron, Katherine E. Gibson, Joel A. Hesch, Dana Ionita, Craig C. Jolley, Driss Takir, Matthew Turner, Elizabeth A. Jensen	The TRACER mission: a proposed Trojan and Centaur flyby mission	This paper presents a proposed flyby mission for one Trojan and one Centaur as designed by the participants of the JPL Planetary Science Summer School. This mission meets the current New Horizons guidelines and will address fundamental questions about the history of the solar system.	Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.
James T. Struck	Nobel Prize in Physics and Chemistry Could Be Awarded to Almost Anyone Who Has Done Any work In fields Including me	Almost anyone with work in chemistry and physics could be awarded the Nobel Prize; me too. Many contributions in chemistry and physics go on for several pages. The work of many are not recognized when the award is given to 1 or 2 people. Award could be given to any finding, article or discovery.	Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust. None of the above.
Rhawn Joseph	Life on Earth Came From Other Planets - 7 Page Summary/Press release	If life were to appear on a desert island we wouldn"t claim it was assembled in an organic soup or created by God; we"d conclude it washed to shore or fell from the sky. The Earth too, is an island, orbiting in a sea of space and this is how life on our planet began.	None of the above.

Rhawn Joseph	Life on Earth Came From Other Planets	Life on Earth Came From Other Planets, reviews the evidence presented in over 100 peer reviewed scientific papers published in prestigious scientific journals, and explains how life on Earth originated on other planets. The entire 45 page paper will be published in the journal, Cosmology, on 12/2009	None of the above.
Linda R. Brown **Co-Authors:** Pin Chen, Brian J. Drouin, Charles E. Miller, John Pearson, Stanley P. Sander, Keeyoon Sung, Robert A. Toth, ShanShan Yu	Laboratory Spectroscopy to Support Remote Sensing of Atmospheric Composition	This paper discusses the declining state of laboratory studies that are essential to support and enable remote sensing of planetary bodies. Five recommendations are given to improve this situation.	None of the above.
Andrew Pohorille **Co-Authors:** Leslie Bebout, Devaki Bhaya, Rocco Mancinelli	Limits of Terrestrial Life in Space	To pursue a better understanding of life in space and link it to future missions we propose a strategy aimed at determining the potential for terrestrial microbial life to adapt and evolve in space environments. This strategy involves ground-based research, small satellite missions and will culminat	None of the above.
Robert Schingler **Co-Authors:** William Marshall, Alex MacDonald, Mark Lupisella, Brian Lewis	ROSI - Return on Science Investment	A system for mission evaluation based on maximizing science	None of the above.

Walter Harris **Co-Authors:** Walter Harris, Eric Burgh, John Clarke, Joshua Colwell, Michael Davis, Daniel Durda, Charles Hibbitts, Stephan McCandliss, Jeffrey Morgenthaler, Kurt Retherford, Ronald Vervack	Solar System Suborbital Research: A Vital Investment in the Scientific Techniques, Technology, and Investigators of Space Exploration in the 21st Century.	Recent calls for increased NASA technology and training development cite shortages with current trends. Suborbital and Explorer missions are key this but have been cut in the past 20 years. Planetary research supports no small missions at all. We describe how suborbital research can address this gap	None of the above.
Janet A. Vertesi **Co-Authors:** Robert Pappalardo, Claudia Alexander, William J. Clancey, Barbara Cohen, Paul Dourish, Jeffrey Johnson, Barbara Larsen, Kimberly Lichtenberg, Charlotte Linde, Scott Maxwell, Zara Mirmalek, Jeff Moore	Sociological Considerations for the Success of Planetary Exploration Missions	Alongside scientific and technical considerations, the Planetary Science Decadal Survey should require that missions incorporate deeper consideration of the social science of spacecraft operations to maximize their missions' scientific, technical and fiscal success.	None of the above.
Alan Tokunaga **Co-Authors:** S.J. Bus, J.T. Rayner, E.V. Tollestrup	The NASA Infrared Telescope Facility	This white paper describes the NASA Infrared Telescope Facility, its capabilities, and its role in current and future research in planetary astronomy.	None of the above.
Ethiraj Venkatapathy **Co-Authors:**			

Bernard Laub, Joseph L. Conley, Helen H. Hwang, James Arnold, Christine E. Szalai, Jim Tibaudo, Robert Knudsen, Andrew Chambers, David Atkinson, Sushil K. Atreva, Joseph M. Vellinga, William H. Willcockson, Janine M. Thornton, Nicholas G. Smith, Richard A. Hund, John Dec, Max L. Blosser, Michelle M. Munk, Robert Maddock, Prasun N. Desai, Walter Engelund, Stephen Sandford, David A. Gilman, Steven W. Gayle, John Kowal, Christopher B. Madden, Stan Bouslog, Brian J. Remark, Donald Curry, Scott Coughlin, Adam J. Amar, Kevin H. Baines, Tibor Balint, Bernard Bienstock, George T. Chen, James A. Cutts, Jeffery L. Hall, Samad A. Hayati, Pamela J. Hoffman, Linda Spilker, Romasso P. Rivellini, Robert		This paper describes	

Manning, Eric M. Slimko, Adam D. Steltzner, Thomas Spilker, Jeffrey Umland, Charles Kiskiras, Duane Baker, Thomas Foster, Dominic Calamito, James B. Garvin, Timothy A. Sauerwein, Sharon Seipel, Lori S. Glaze, Spencer Stolis, Mark Lippold, Francis Schwind, James Thompson, Raj Narayan, Thomas Andrews, Conley Thatcher, Edwin B. Curry, John McKinney, Robert Frampton, Todd Stever, Charley Bown, William Congdon, Jennifer Congdon, Daniel M. Empey, Joe Hartman, Dinesh Prabhu, Nancy L. Mangini, Kristina A. Skokova, Margaret M. Stackpoole, Tood White, Howard Goldstein, Melmoth Covington, Robin A. Beck, Carol W. Carroll, Charles A. Smith, Deepak Bose, Anthony	Thermal Protection System Technologies for Enabling Future Mars/Titan Science Missions	currently available TPS technologies and identifies new technologies needed to support Mars missions in the 2013 - 2022 timeframe, drawing on past mission studies, recent Mars Technology workshop for Mars Sample Return Mission, and the Solar System Exploration road map.	Mars: Not Phobos and Deimos.Satellites: Galilean satellites, Titan, and the other satellites of the giant planets.

Colaprete, David M. Driver, Edward Martinez, Donald T. Ellerby, Matthew J. Gasch, Aga M. Goodsell, James Reuther, Sylvia M. Johnson, Dean Kontinos, Mary Livingston, Michael J. Wright, Harry Partridge, George A. Raiche, Huy K. Tran, Kerry A. Trumble			
Jack D. Farmer **Co-Authors:** Mark Allen, Tori Hoehler, Michael Mischna	Astrobiology Research and Technology Priorities for Mars	This white paper provides a broad overview of the major science and technology drivers for the next decade of Mars exploration.	Mars: Not Phobos and Deimos.
Vincent F. Chevrier **Co-Authors:** Derek Sears, Megan Elwood Madden, Essam Heggy	Laboratory Measurements in Support of Present and Future Missions to Mars	The case is made that supporting laboratory measurements and facilities should be considered an integral element of the Nation's Mars exploration program, since they provide a meaningful interpretation of the returned data, validation of theoretical models, and calibration of instruments.	Mars: Not Phobos and Deimos.
Paul Withers **Co-Authors:** Jared Espley, Rob Lillis, Dave Morgan, Laila Andersson, Mathieu Barthélemy, Stephen Bougher,			

David Brain, Stephen Brecht, Tom Cravens, Geoff Crowley, Justin Deighan, Scott England, Jeffrey Forbes, Matt Fillingim, Jane Fox, Markus Fraenz, Brian Gilchrist, Erika Harnett, Faridah Honary, Dana Hurley, Muffarah Jahangeer, Robert Johnson, Donald Kirchner, Francois Leblanc, Mark Lester, Michael Liemohn, Jean Lilensten, Janet Luhmann, Rickard Lundin, Anthony Mannucci, Susan McKenna-Lawlor, Michael Mendillo, Erling Nielsen, Martin Pätzold, Carol Paty, Kurt Retherford, Cyril Simon, James Slavin, Bob Strangeway, Roland Thissen, Feng Tian, Olivier Witasse	The ionosphere of Mars and its importance for climate evolution	The ionosphere of Mars is a key part of the boundary between Mars and the solar wind. The MAVEN mission will improve our understanding of ionospheric properties and processes, including how they affect the escape to space of atmospheric species, but other important questions will remain unanswered.	Mars: Not Phobos and Deimos.

Dr. John F. Mustard	Why Mars Remains a Compelling Target for Planetary Exploration	Mars has been an extremely compelling exploration target. The Decadal Survey is re-evaluating the priority of different sectors of the planetary exploration program. Based on the data collected since 2002, our conclusion is that the exploration of Mars is even more compelling now than it was then.	Mars: Not Phobos and Deimos.
John F. Mustard	Seeking Signs of Life on a Terrestrial Planet: An Integrated Strategy for the Next Decade of Mars Exploration	We propose an integrated strategy to implement missions of high scientific priority, as recommended by the last decadal survey, while still responding to new discoveries. The proposed step-by-step approach to sample return would provide a credible path and conduct important in situ science.	Mars: Not Phobos and Deimos.
Andrew Steele **Co-Authors:** Amundsen H.E.F., Benning L., Blake D., Borg L., Bower D.M., Brantley S., Brinkerhoff W., Cleaves J., Coates A., Cody G., Conrad P.G., Dieing T., Fogel M., Foing B., Fries M., Fritz J., Fsicher H., Glamoclija M., Garrett M., Glotch T., Hauber E., Hoffman H.,			

Huntsberger T., Jaumann R., Johnson C., Karunatillake S., Kish A., Kress M., Hoehler T., McCollom T., McCubbin F.M., Ming D., Monaco L., Morrill P., Ohmoto H., Paar G., Pacros A., Pullan D., Robb F., Rull F., Sarrazin P., Schmitz N., Schoonen M.A.A., Schrenk M., Shahar A., Sherwood-Lollar B., Shirey S., Siljstrom S., Sims M., Smirnov A., Starke V., Toporski J.K.W., Vago, J., Wainwright N., Weishaupt K., Westall, F., Yonse, P., Zare R.N.	Astrobiology Sample Acquisition and Return	This paper outlines an Astrobiology Sample Acquisition and Return mission based on the MEPAG Mid Range Rover concept mission for Mars exploration.	Mars: Not Phobos and Deimos.

Thomas Ruedas **Co-Authors:** Nicholas Schmerr, Natalia Gómez Pérez¸ W. Bruce Banerdt, Constance M. Bertka, Mathieu Choukroun, Yingwei Fei, Matthew J. Fouch, Walter S. Kiefer, Philippe Lognonné, Amy C. McAdam, Andrew Steele¸ Bernhard Steinberger	Seismological investigations of Mars" deep interior	This paper explains the importance of investigating the deep interior of Mars by seismological methods. Seismometers on Mars can bring insights to questions concerning planetary structure, tectonics, mantle and core dynamics, dynamo and mantle chemistry. The technical feasibility is assessed.	Mars: Not Phobos and Deimos.

Lisa Pratt **Co-Authors:** Carl Allen, Abby Allwood, Ariel Anbar, Sushil Atreya, Mike Carr, Dave Des Marais, Daniel Glavin, John Grant, Vicky Hamilton, Ken Herkenhoff, Vicky Hipkin, Tom McCollom, Scott McLennan, Ralph Milliken, Doug Ming, Gian Gabrielle Ori, John Parnell, Francois Poulet (Univ. Paris), Barbara Sherwood Lollar, Frances Westall, David Beaty, Joy Crisp, Chris Salvo, Charles Whetsel, Mike Wilson	Mars Astrobiology Explorer-Cacher (MAX-C): A Potential Rover Mission for 2018	This white paper describes a potential rover mission to Mars, with the name Mars Astrobiology Explorer-Cacher (MAX-C) that could be launched in 2018. The mission would conduct high-priority in situ science and make concrete steps towards the potential future return of martian samples to Earth.	Mars: Not Phobos and Deimos.

William Bruce Banerdt **Co-Authors:** Bruce Banerdt, Tilman Spohn, Ulli Christensen, Veronique Dehant, Linda Elkins-Tanton, Robert Grimm, Matthias Grott, Bob Haberle, Martin Knapmeyer, Philippe Lognonné, Franck Montmessin, Yosio Nakamura, Roger Phillips, Scot Rafkin, Peter Read, Gerald Schubert, Sue Smrekar, Mike Wilson	The Rationale for a Long-Lived Geophysical Network Mission to Mars	We advocate the placement of a geophysical network on Mars to investigate the deep interior using seismic, heat flow, precision tracking and electromagnetic sounding measurements. These stations should also support meteorological atmospheric boundary layer experiments.	Mars: Not Phobos and Deimos.
Pamela G. Conrad **Co-Authors:** F. Scott Anderson, Robert C. Anderson, William J. Brinckerhoff, Peter Doran, Victoria E. Hamilton, Joel A. Hurowitz, Alfred S. McEwan, Douglas W. Ming , Dimitri A. Papanastassiou, Timothy D. Swindle	Geochronology and Mars Exploration: Critical Measurements for 21st Century Planetary Science	We present arguments for geochronology as a high scientific priority for Mars exploration in specific and planetary science in general. We also recommend funding four specific activities toward achieving technical readiness for addressing this priority.	Mars: Not Phobos and Deimos.

Charles D., Jr. Edwards **Co-Authors:** William B. Banerdt, David W. Beaty, Leslie K. Tamppari, Richard W. Zurek	Relay Orbiters for Enhancing and Enabling Mars In Situ Exploration	This white paper describes the role that orbital relay telecommunications have played as an integral part of science investigation of Mars, and the importance and continuing evolution for support to future missions.	Mars: Not Phobos and Deimos.
Samad A. Hayati **Co-Authors:** Michelle Munk, Dick Powell, Bob Gershman, Ying Lin, Karen Buxbaum, Paul Backes, Steve Gorevan, Dave Stephenson, Dave Anderson, John Dankanich, Carl Allen, Don Pearson, Tom Rivellini, Issa Nesnas, Gary Bolotin, Charles Budney, Aron Wolf, Joseph Riedel	Strategic Technology Development for Future Mars Missions (2013-2022)	This white paper focuses on enabling technologies for several candidate concepts for future Mars missions. These missions are described in MEPAG position white papers developed for the decadal survey. The technologies, their current status, and their approximate costs and schedules are described.	Mars: Not Phobos and Deimos.
Michael Hecht **Co-Authors:** W. Thomas Pike, Walter Goetz, Morten Bo Madsen, Janice L. Bishop, Urs Staufer, Kjartan M. Kinch, Kristoffer Leer	The microstructure of the martian surface	Martian soil is a microcosm of the mineralogical history of the planet, and it exerts a primary influence on atmospheric, geological, and periglacial properties. We propose an increased emphasis on microanalysis in future Mars surface exploration.	Mars: Not Phobos and Deimos.

Michael Hecht **Co-Authors:** Kathryn Fishbaugh, Shane Byrne, Ken Herkenhoff, Stephen Clifford, Timothy N. Titus, Oded Aharonson	Next Steps in Mars Polar Science: In Situ Subsurface Exploration of the North Polar Layered Deposits	The polar regions of Mars represent a unique environment for determining the mechanisms of martian climate change over geological time. Using terrestrial paleoclimatology methods, subsurface access to the polar layer deposits should be a high priority for future Mars exploration.	Mars: Not Phobos and Deimos.
Michael Mischna **Co-Authors:** Michael Smith, Rob Kursinski, Don Banfield	Atmospheric Science Research Priorities for Mars	This paper addresses the exploration of the martian atmosphere, and focuses on broad atmospheric science goals that can be obtained from orbit. It presents the key questions in atmospheric science that remain unanswered, and what progress can be made towards answering them in the coming decade.	Mars: Not Phobos and Deimos.
David Oh **Co-Authors:** Richard R. Hofer, Ira Katz, Jon A. Sims, Noah Z. Warner, Thomas M. Randolph, Ronald T. Reeve, and Robert C. Moeller	Single Launch Architecture for Potential Mars Sample Return Mission Using Electric Propulsion	Paper describes how a single launch Mars Sample Return (MSR) mission could potentially be enabled by using of Electric Propulsion with Hall Thrusters: a well established, off-the-shelf technology commonly used on communications satellites today.	Mars: Not Phobos and Deimos.

Lars Borg **Co-Authors:** Carl Allen, Dave Beaty, Karen Buxbaum, Joy Crisp, Dave Des Marais, Danny Glavin, Monica Grady, Ken Herkenhoff, Richard Mattingly, Scott McLennan, Denis Moura, John Mustard, Lisa Pratt, Steve Symes, Meenakshi Wadhwa	A Consensus Vision for Mars Sample Return	A consensus vision of a Mars Sample Return (MSR) mission concept is presented, reflecting the integration of multiple recent community-based planning discussions. It summarizes the current state of thought regarding the science goals that would be best addressed by samples returned from Mars.	Mars: Not Phobos and Deimos.
Susanne P. Schwenzer **Co-Authors:** O. Abramov, C. Allen, S. Clifford, J. Filiberto, D.A. Kring, J. Lasue, P.J. McGovern, H.E. Newsom, A.H. Treiman, A. Wittmann	The importance of (Noachian) impact craters as windows to the sub-surface and as potential hosts of life	The paper demonstrated the research that can be done in small craters punctuating larger Noachian craters. Topics include: small craters as natural drills, impact-generated hydrothermal systems and lakes in Noachian craters, and the ecological niches created by them.	Mars: Not Phobos and Deimos.

Allan Treiman **Co-Authors:** Meenakshi Wadhwa, Charles K. Shearer Jr., Glenn J. MacPherson, James J. Papike, Gerald J. Wasserburg, Christine Floss, Malcolm J. Rutherford, George J. Flynn, Dimitri Papanastassiou, Andrew Westphal, Clive Neal, John H. Jones, Ralph P. Harvey, Susanne Schwenzer	Groundbreaking Sample Return from Mars: The Next Giant Leap in Understanding the Red Planet	The purpose of this white paper is to urge consideration of a groundbreaking sample return from Mars from a previously well characterized site that requires a simple mission architecture to minimize cost and engineering risk, while gaining substantial scientific return.	Mars: Not Phobos and Deimos.
Michael D. Max **Co-Authors:** Stephen M. Clifford, Arthur H. Johnson, Jeremie Lasue	Is a Resource-Mars a Stepping-Stone to Human Exploration of the Solar System?	Methane and water on Mars are the key to a resource base to support sustainable exploration of Mars and beyond	Mars: Not Phobos and Deimos.
Michael D. Smith **Co-Authors:** Mark Allen, Donald Banfield, Jeffrey Barnes, R. Todd Clancy, Philip James, James Kasting, Paul Wennberg, Daniel Winterhalter, Michael Wolff, Richard Zurek	Mars Trace Gas Mission: Scientific Goals and Measurement Objectives	Trace gases are a sensitive indicator of current martian activity, whether photochemical or biogeochemical. A Trace Gas Mission measuring atmospheric composition, circulation and state, and locating active sources would characterize this activity and its implications for climate and astrobiology.	Mars: Not Phobos and Deimos.

Michael J. Kavaya	Mars Orbiting Pulsed Doppler Wind Lidar for Characterization of Wind and Dust	Technology is described which is well developed and on a path for space. This technology could be used in Mars orbit to provide a global climatology of wind and relative dust as a function of location and altitude.	Mars: Not Phobos and Deimos.
Naoya Imae	Supporting the sample return from Mars	I heartfully indicate the support on the sample return mission from Mars, and the indispensable facilities in laboratories. Because the sample return mission is the keys of essential problems for Planetary Science.	Mars: Not Phobos and Deimos.
Eldar Z. Noe Dobrea **Co-Authors:** S. Murchie, J.F. Mustard, J.L. Bishop, N.K. McKeown	Near-Infrared imaging spectroscopy of the surface of Mars at meter-scales to constrain the geological origin of hydrous alteration products, identify candidate sites and samples for future in-situ and sample return missions, and guide rover operations	Near-infrared imaging spectrometers capable of mapping hydrous minerals on the surface of Mars at meter-scales from orbit, as well as hypespectral NIR imagers on landed rovers not only enhance the scientific return of orbital and rover missions, but will be critical in guiding future rover operation	Mars: Not Phobos and Deimos.

Kimberly R. Kuhlman **Co-Authors:** Alberto Behar, Jack Jones, Penelope Boston, Jeffrey Antol, Gregory Hajos, Warren Kelliher, Max Coleman, Ronald Crawford, Lynn Rothschild, Martin Buehler, Greg Bearman, Daniel W. Wilson, Christopher P. McKay	Tumbleweed: A New Paradigm for Surveying the Surface of Mars	Tumbleweeds are lightweight, highly configurable and inexpensive wind-driven vehicles that could enable long-range surveys of the surface of Mars. Their analytical capabilities can be optimized for measurements for astrobiology or in situ resources over relatively large swaths of terrain.	Mars: Not Phobos and Deimos.
Jeffrey L. Bada **Co-Authors:** Andrew D. Aubrey, Frank J. Grunthaner, Michael Hecht, Richard Quinn, Richard Mathies, Aaron Zent, John H. Chalmers	Seeking Signs of Life on Mars: In Situ Investigations as Prerequisites to Sample Return Missions	We argue for deployment of increasingly sophisticated in situ techniques to definitively identify biomarkers before engaging in Mars Sample Return. We focus on "following the nitrogen," using techniques such as micro capillary electrophoresis to identify and determine the chirality of primary amines	Mars: Not Phobos and Deimos.

Bruce A. Campbell **Co-Authors:** John A. Grant, Ted Maxwell, Jeffrey J. Plaut, Anthony Freeman	Exploring the Shallow Subsurface of Mars with Imaging Radar: Scientific Promise and Technical Rationale	Global information on martian near-surface features and physical properties represents a great untapped aspect of the search for habitable zones and evidence of past climate. Imaging radar measurements can penetrate several meters of mantling material and 10's of meters into ice.	Mars: Not Phobos and Deimos.
John Grant **Co-Authors:** Matt Golombek, Alfred McEwen, Scott Murchie, Frank Seelos, John Mustard, David Des Marais, Ken Tanaka, Gian Ori, Nicolas Mangold, Kate Fishbaugh, Steve Ruff, Dawn Sumner, Brad Jolliff, Ralph Harvey	Future Mars Landing Site Selection Activities	A process for identifying candidate landing sites for future missions should be started and accompanied by creation of funding to support landing site characterization activities. NASA should provide resources to existing missions to enable these activities and consider including instruments for sit	Mars: Not Phobos and Deimos.
Scot Rafkin **Co-Authors:** Robert. M. Haberle, Don Banfield, Jeff. Barnes	The Value of Landed Meteorological Investigations on Mars: The Next Advance for Climate Science	Major advances in the understanding of the present and past Mars climate system are most likely to be accomplished by in situ meteorological surface measurements operating from both a network configuration and individual stations.	Mars: Not Phobos and Deimos.

Douglas Stetson **Co-Authors:** Jim Bell, Lou Friedman	Mars Exploration 2016-2032: Rationale and Principles for a Strategic Program	The Mars Exploration Program, one of the most visible and dynamic elements of NASA space science, is at a crossroads. To ensure a robust future it must embrace the related goals of life and sample return, and must begin to bridge the historical gap between robotic and human exploration.	Mars: Not Phobos and Deimos.
E. Robert Kursinski **Co-Authors:** James Lyons, Claire Newman, Mark Richardson	A Dual Satellite Mission Concept for Martian Climate and Chemistry	mm-wavelength satellite to satellite occultations combined with solar occultation and thermal IR emission aerosol measurements will tightly and uniquely constrain processes to answer key open questions about the chemistry and climate of Mars.	Mars: Not Phobos and Deimos.

Robert J. Lillis **Co-Authors:** J. Arkani-Hamed, D. A. Brain, J. C. Cain, J. E. P. Connerney, G. T. Delory, J. Espley, M. Fuller, J. Gattecceca, J. S. Halekas, L. L. Hood, C. L. Johnson, D. Jurdy, G. Kletetschka, B. Langlais, R. P. Lin, K. L. Louzada, M. Manga, C. Milbury, D. Mozzoni, M. Purucker, D. Ravat, J. H. Roberts, P. Rochette, C.T. Russell, S. Smrekar, S. T. Stewart, S. Vennerstrom, B. P. Weiss, K. Whaler	Mars" Ancient Dynamo and Crustal Remanent Magnetism	Mars" crustal magnetization is unique and enigmatic. It is pertinent to Mars science questions as diverse as the structure of the interior and the evolution of climate. To study it, we recommend 1) extending the MAVEN mission, 2) rover-mounted surface magnetometers and 3) oriented sample return.	Mars: Not Phobos and Deimos.
Bruce Jakosky **Co-Authors:** Richard W. Zurek, Jan Amend, Michael H. Carr, Daniel J. McCleese, John F. Mustard, Kenneth Nealson, Roger Summons	Update: Are There Signs of Life on Mars? A Scientific Rationale for a Mars Sample-Return Campaign As The Next Step in Solar System Exploration	Update: Discussion of the scientific rationale for Mars sample return as the next step in understanding solar-system exploration and Mars astrobiology. Sample return is discussed in the context of a Mars exploration program and the fiscal reality of the Mars program.	Mars: Not Phobos and Deimos.

Jeffrey R. Johnson **Co-Authors:** Tori Hoehler, Frances Westall, Scot Rafkin, Paul Withers, Jeffrey Plescia, Victoria Hamilton, Abhi Tripathi, Darlene Lim	Summary of the Mars Science Goals, Objectives, Investigations, and Priorities	This document reflects the synthesis of recent MEPAG Goals Committee activities, MEPAG Science Analysis Groups, workshops, feedback, and discussion of these topics at recent MEPAG meetings. It was prepared by the MEPAG Goals and Executive Committees with assistance of many Mars community members.	Mars: Not Phobos and Deimos.
Timothy N. Titus **Co-Authors:** Thomas H. Prettyman, Timothy I. Michaels, Jeffrey Barnes, Hugh H. Kieffer, Adrian Brown, Shane Byrne, Kathryn E. Fishbaugh, Michael H. Hecht	Mars Polar Science for the Next Decade	This white paper is intended to be a consensus of many of the active members of the Mars polar science community, and is the culmination of discussions held at the 3rd International Mars Polar Energy Balance and CO2 Cycle workshop (MPEB2009) held in Seattle, WA, 21-24 July 2009.	Mars: Not Phobos and Deimos.
Steven Howe **Co-Authors:** Brian Gross, Jeff Katalenich, Robert O'Brien, Logan Sailer	The Mars Hopper: Long Range Mobile Platform Powered by Martian In-Situ Resources	The CSNR is designing an instrumented platform that can acquire detailed data at hundreds of locations during its 10 year lifetime - a Mars Hopper. By accumulating thermal power from a radioisotope source, the platform will be able to "hop" from one location to the next every 2-3 days with a separa	Mars: Not Phobos and Deimos. Satellites: Galilean satellites, Titan, and the other satellites of the giant planets.

Mark Skidmore **Co-Authors:** John Priscu, Brent Christner	Planetary Science & Astrobiology: Cold habitats for life in the Solar system	The paper highlights that improved knowledge of the carbon and energy transformations necessary to support life at sub-zero temperatures is key to future planetary science and astrobiological research given ice is the most abundant phase of water in the Solar system.	Mars: Not Phobos and Deimos. Satellites: Galilean satellites, Titan, and the other satellites of the giant planets.
Ariel D. Anbar **Co-Authors:** David Grinspoon, Sean C. Solomon, G. Jeffrey Taylor	Astrobiology Research Priorities for Mercury, Venus, and the Moon	This paper describes the value of exploration of Mercury, Venus and the Moon for the field of astrobiology and specifies high priority goals.	Inner Planets: Mercury, Venus, and the Moon.
Sarah E. Braden **Co-Authors:** Samuel J. Lawrence, Mark S. Robinson, Bradley L. Jolliff, Julie D. Stopar, Lillian R. Ostrach, Lisa R. Gaddis, Justin J. Hagerty, Steven B. Simon, B. Ray Hawke	Unexplored Areas of the Moon: Nonmare Domes	Analysis of samples returned from unexplored areas of lunar volcanism such as the Gruithuisen Domes will (1) increase our knowledge of the history of the Earth-Moon system, (2) advance theories of lunar magmatic evolution and (3) provide valuable points of comparison with other terrestrial planets.	Inner Planets: Mercury, Venus, and the Moon.

Samuel J. Lawrence **Co-Authors:** Georgiana Y. Kramer, Bradley L. Jolliff, B. Ray Hawke, Mark S. Robinson, Justin J. Hagerty, G. Jeffrey Taylor, Jeffrey Plescia, W. Brent Garry, Julie D. Stopar, Brett W. Denevi, S. E. Braden, L. R. Ostrach, David T. Blewett, Tomas Magna, Thomas R. Watters, Lisa R. Gaddis, Rongxing Li, Clive R. Neal, Jeffrey Gillis-Davis	Sampling the Age Extremes of Lunar Volcanism: the Youngest and Oldest Lunar Basalts	Automated sample return missions to the youngest (Procellarum) and oldest (cryptomaria) basalts on the lunar surface will help improve our absolute chronology for the inner Solar System by providing the timing for the beginning and end of lunar basaltic volcanism.	Inner Planets: Mercury, Venus, and the Moon.
Georgiana Young Kramer **Co-Authors:** David Blewett, Lon Hood, Jasper Halekas, Sarah Noble, Bernard Ray Hawke, Gunther Kletetschka, Erika Harnett, and Ian Garrick-Bethell	The Lunar Swirls	The lunar swirls are high albedo curvilinear surface features coincident with regions of strong remanent magnetism. Investigating the lunar swirls is important to understand the Earth-Moon system, the interaction of planetary surfaces with the solar wind, and how to best explore our solar system.	Inner Planets: Mercury, Venus, and the Moon.

Ian Crawford **Co-Authors:** Mahesh Anand, Professor Mark Burchell, James Carpenter, Barbara Cohen, Leon Croukamp, Andrew Daga, Hilary Downes, Sarah Fagents, Terence Hackwill, James N Head, Essam Heggy, Adrian Jones, Katherine Joy, Christian Koeberl, Philippe Lognonné, Clive Neal, Noah Petro, Professor Sara Russell, Joshua Snape, Larry Taylor, Allan Treiman, Shoshana Weider, Mark Wieczorek, Lionel Wilson	The Scientific Rationale for Renewed Human Exploration of the Moon	This paper outlines the scientific benefits that will follow from renewed human exploration of the Moon. [Final version with updated author list]	Inner Planets: Mercury, Venus, and the Moon.
Ian Garrick-Bethell **Co-Authors:** Cassandra Runyon, Carle Pieters, Michael Wyatt, Peter Isaacson, Linda Elkins-Tanton	Ensuring United States Competitiveness in the 21st Century Global Economy with a Long-Term Lunar Exploration Program	A focused Lunar Exploration Program can help retain United States economic and strategic leadership in the 21st century.	Inner Planets: Mercury, Venus, and the Moon.

Carle M. Pieters **Co-Authors:** Carlton Allen, Mahesh Anand, W. Bruce Banerdt, William Bottke, Barbara Cohen, Ian A. Crawford, Andrew Daga, Rick Elphic, Bernard Foing, Lisa R. Gaddis, James B. Garvin, Timothy L. Grove, B. Ray Hawke, Jennifer Heldmann, Dana M. Hurley, Brad Jolliff, Christian Koeberl, Clive Neal, Brian J. O'Brien, Anne Peslier, Noah Petro, Jeffery Plescia, Amalie Sinclair, Timothy J. Stubbs, Ross Taylor, Stefanie Tompkins, Allan H. Treiman,Elizabeth Turtle, Mark Wieczorek, Lionel Wilson, Aileen Yingst	Summary and Highlights of the NRC 2007 Report: The Scientific Context for the Exploration of the Moon (SCEM)	Understanding processes that have occurred on the Moon provide a framework for understanding the origin and evolution of the other terrestrial planets. The SCEM science goals and priorities remain fundamentally relevant to our understanding of the solar system and central to its exploration.	Inner Planets: Mercury, Venus, and the Moon.

Arlin Crotts	On Lunar Volatiles and Their Importance to Resource Utilization and Lunar Science	We discuss recent, compelling evidence for major lunar volatiles not necessarily found in polar permanently-shadowed crater cold traps, but originating from the deep interior. We also discuss programs underway to study lunar volatiles, which unfortunately fall far short of the NRC"s SCEM goals.	Inner Planets: Mercury, Venus, and the Moon.
Yasunori Miura	New lunar science and engineering with carbon cycle.	New idea and technique with carbon cycle can be applied at lunar crust origin, lunar interior and lunar double construction (surfae and underground) building at the lunar base in future from new carbon-fixing cycle.	Inner Planets: Mercury, Venus, and the Moon.
Krishan Khurana **Co-Authors:** V. Angelopoulos, Charles W. Carlson, Gregory T. Delory, William M. Farrell, Robert E. Grimm, Ian Garrick-Bethell, Jasper S. Halekas, L. L. Hood, M. Horanyi, Robert J.Lillis, Robert P. Lin, Clive R. Neal, M. E. Purucker, Chris T. Russell, Gerry Schubert, D. G. Sibeck, Pavel Travnicek	Lunar Science with ARTEMIS: A Journey from the Moon’s Exosphere to its Core [version 2]	This white paper describes the planetary science objectives to be achieved by ARTEMIS, a two-spacecraft constellation en route to the Moon, and presents recommendations pertaining to future lunar science. [version 2]	Inner Planets: Mercury, Venus, and the Moon.

Kevin H. Baines **Co-Authors:** Sushil Atreya, Tibor Balint, David Crisp, David Grinspoon, Jeffery L. Hall, Gary W. Hunter, Sanjay Limaye, Viktor Kerzhanovich, Paul R. Mahaffy, Christopher T. Russell, David Senske, Stuart K. Stephens, Chris R. Webster	Venus Atmospheric Explorer New Frontiers Mission Concept	A multiple-platform mission to Venus that includes a long-duration, circumnavigating balloon-based element, two drop sondes, and an orbiter, is described that directly addresses fundamental science iissues of planetary formation/evolution, dynamics/circulation, chemistry, meteorology, and geology.	Inner Planets: Mercury, Venus, and the Moon.
Tibor Balint **Co-Authors:** James Cutts, Mark Bullock, James Garvin, Stephen Gorevan, Jeffery Hall, Peter Hughes, Gary Hunter, Satish Khanna, Elizabeth Kolawa, Viktor Kerzhanovich, Ethiraj Venkatapathy	Technologies for Future Venus Exploration	This VEXAG community white paper covers both heritage, and key enhancing and enabling technologies, which are required for future Venus exploration missions in all three mission classes. It also argues for a targeted technology development program, including a large environmental test chamber.	Inner Planets: Mercury, Venus, and the Moon.

Marc Fries **Co-Authors:** John Armstrong, James Ashley, Luther Beegle, Timothy Jull, Glenn Sellar	Extralunar Materials in Lunar Regolith	This paper describes the scientific rationale for locating and studying extralunar material found in lunar regolith. The extreme age and lack of weathering of lunar regolith make it a natural repository for samples from a wide range of parent bodies and across a vast span of solar system history.	Inner Planets: Mercury, Venus, and the Moon.
Sue Smrekar **Co-Author:** Sanjay Limaye	Venus Exploration Goals, Objectives, Investigations, and Priorities	This white paper describes the science priorities developed by the Venus Exploration Analysis Group, through a series of meetings with the Venus science community. The science themes for Venus are Origin and Evolution, Venus as a Terrestrial Planet, and Climate Change and the Future of Earth.	Inner Planets: Mercury, Venus, and the Moon.

James G. Williams **Co-Authors:** James G. Williams, Slava G. Turyshev, Richard T. Baran, Kevin M. Birnbaum, Douglas Currie, William M. Folkner, Gary M. Gutt, Hideo Hanada, Hamid Hemmati, Stephen M. Merkowitz,, Kenneth L. Nordtvedt, Thomas W. Murphy, Jr., Jürgen Müller, Nicolas Rambaux, Peter J. Shelus, Ruwan Somawardhana, Robert Spero	Lunar Science and Lunar Laser Ranging	Lunar Laser Ranging studies the Moon’s internal structure and properties by tracking the variations in the orientation and tidal distortion of the Moon as a function of time. Future missions to the Moon’s surface should include new laser ranging instrumentation capable of improved range accuracy.	Inner Planets: Mercury, Venus, and the Moon.

Dana M. Hurley **Co-Authors:** David J. Lawrence, Raul Baragiola, D. Benjamin Bussey, Anthony Colaprete, M. Darby Dyar, Anthony F. Egan, Richard C. Elphic, William Farrell, William Feldman, James R. Gaier, Jacob Grimes, Jasper S. Halekas, Erika Harnett, James N. Head, Jennifer Heldmann, Amanda Hendrix, Charles A. Hibbitts, Kurt D. Retherford, Catherine Neish, Sarah Noble, Carle Pieters, Paul D. Spudis, Timothy J. Stubbs, Bradley J. Thomson, Kris Zacny	Lunar Polar Volatiles and Associated Processes	A landed/mobile mission to a lunar permanently shadowed region (PSR) should identify the composition, abundance, and distribution of volatiles in lunar PSRs. The next step is obtaining a detailed understanding of the transport/deposition/retention system to unravel the history of polar volatiles.	Inner Planets: Mercury, Venus, and the Moon.
Larry W. Esposito	Mission Concept: Venus in situ Explorer (VISE)	A proposed New Frontiers mission concept for Venus lander.	Inner Planets: Mercury, Venus, and the Moon.

Allan Treiman **Co-Authors:** Meenakshi Wadhwa, Clive R. Neal, Charles K. Shearer, Bradley L. Jolliff, Lars E. Borg, Dimitri Papanastassiou, Malcolm J. Rutherford, Christine Floss, Andrew M. Davis, Steven Symes, Susanne Schwenzer, Mark D. Fries, Andrew Westphall, Barbara Cohen, David A. Kring	Sample Return from the Earth's Moon	This white paper makes the case that sample return from selected locations on the Moon in the coming decade will provide extraordinary advances in lunar and Solar System science.	Inner Planets: Mercury, Venus, and the Moon.
David J. Loftus **Co-Authors:** Erin M. Tranfield, Jon C. Rask, Clara McCrosssin	The Chemical Reactivity of Lunar Dust Relevant to Human Exploration	As NASA prepares to return to the Moon, a clear understanding of the chemistry of lunar dust is required to set the stage for extended duration lunar surface operations. All aspects of the unique environment of the Moon—micrometeorite bombardment, UV light exposure, solar wind radiation, solar parti	Inner Planets: Mercury, Venus, and the Moon.
Tore Straume	Solar Radiation Output: Reading the Record of Lunar Rocks	Reconstructing solar energetic particle output by measuring signatures in lunar surface samples	Inner Planets: Mercury, Venus, and the Moon.
Ethiraj Venkatapathy			

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Helen H. Hwang, Bernard Laub, Joseph L. Conley, James Arnold, Christine E. Szalai, Jim Tibaudo, Robert Knudsen, Andrew Chambers, David Atkinson, Sushil K. Atreva, Joseph M. Vellinga, William H. Willcockson, Janine M. Thornton, Nicholas G. Smith, Richard A. Hund, John Dec,Max L. Blosser, Michelle M. Munk, Robert Maddock, Prasun N. Desai, Walter Engelund, Stephen Sandford, David A. Gilman, Steven W. Gayle, John Kowal, Christopher B. Madden, Stan Bouslog, Brian J. Remark, Donald Curry, Scott Coughlin, Adam J. Amar, Kevin H. Baines, Tibor Balint, Bernard Bienstock, George T. Chen, James A. Cutts, Jeffery L. Hall, Samad A. Hayati, Pamela J. Hoffman, Linda

Spilker, Romasso P. Rivellini, Robert Manning, Eric M. Slimko, Adam D. Steltzner, Thomas Spilker, Jeffrey Umland, Charles Kiskiras, Duane Baker, Thomas Foster, Dominic Calamito, James B. Garvin, Timothy A. Sauerwein, Sharon Seipel, Lori S. Glaze, Spencer Stolis, Mark Lippold, Francis Schwind, James Thompson, Raj Narayan, Thomas Andrews, Conley Thatcher, Edwin B. Curry, John McKinney, Robert Frampton, Todd Stever, Charley Bown, William Congdon, Jennifer Congdon, Daniel M. Empey, Joe Hartman, Dinesh Prabhu, Nancy L. Mangini, Kristina A. Skokova, Margaret M. Stackpoole, Tood White, Howard Goldstein, Melmoth Covington, Robin A. Beck, Carol W. Carroll, Charles A. Smith, Deepak	Thermal Protection System Technologies for Enabling Future Venus Exploration	This paper discusses the capability of currently available TPS and the availability of heritage carbon phenolic used on the Pioneer-Venus probes. A prime conclusion is that there are important issues regarding the availability of the TPS required for future Venus entry probes.	Inner Planets: Mercury, Venus, and the Moon.

Bose, Anthony Colaprete, David M. Driver, Edward Martinez, Donald T. Ellerby, Matthew J. Gasch, Aga M. Goodsell, James Reuther, Sylvia M. Johnson, Dean Kontinos, Mary Livingston, Michael J. Wright, Harry Partridge, George A. Raiche, Huy K. Tran, Kerry A. Trumble			

Michael R. Collier **Co-Authors:** Thomas E. Cravens, Mats Holmstrom, James Burch, Konrad Dennerl, Herbert Gunell, David G. Sibeck, Steven Snowden, F. Scott Porter, Ina P. Robertson, Nick Omidi, Kip Kuntz, Steven Sembay, Jennifer Carter, Andrew Read, Dimitra Koutroumpa, Massimiliano Galeazzi, Susan Lepri, K.C. Hansen, Dan McCammon, Ruth Skoug, H. Kent Hills, Timothy J. Stubbs, Pavel M. Travnicek, George Fraser, Mark Lester	Global Imaging of Solar Wind-Planetary Body Interactions using Soft X-ray Cameras	We show in this white paper that, with suitable instrumentation on planetary and terrestrial spacecraft, soft X-ray emission associated with the solar wind interaction with planetary neutral atoms can map out the solar wind distribution around planets, including the locations of plasma boundaries.	Inner Planets: Mercury, Venus, and the Moon.

James B. Garvin **Co-Authors:** Lori S. Glaze, Sushil Atreya, Bruce Campbell, Don Campbell, Peter Ford, Walter Kiefer, Frank Lemoine, Greg Neumann, Roger Phillips, Keith Raney	Venus: Constraining Crustal Evolution from Orbit Via High-Resolution Geophysical and Geological Reconnaissance	Major gaps in understanding Venus include how planetary-scale crustal resurfacing operated, the formation and evolution of highlands, and whether evidence of past environments is preserved. These questions can be addressed through an orbiting radar altimeter and high resolution SAR imager.	Inner Planets: Mercury, Venus, and the Moon.
Stephen M. Merkowitz **Co-Authors:** Edward Aaron, Neil Ashby, David Carrier, Douglas Currie, John J. Degnan, Simone Dell'Agnello, Giovanni Delle Monache, Jan McGarry, Thomas W. Murphy, Jr., Kenneth Nordtvedt, Robert D. Reasenberg, Slava G. Turyshev, James G. Williams, Thomas Zagwodzki	The Moon as a Test Body for General Relativity	This whitepaper describes how the next generation of lunar laser ranging addresses four key gravitational science questions. In addition, we discuss the current state of retroreflector technology and describe ways in which further advances can be made in laser ranging technologies.	Inner Planets: Mercury, Venus, and the Moon.

W. M. Farrell **Co-Author:** Mihaly Horanyi	The Lunar Dusty Exosphere: The Extreme Case of an Inner Planetary Atmosphere	The Moon is an extreme type of atmosphere – a surface bounded exosphere – and may represent the final 'ground state' of any geologically dormant body. Neutral gas and dust are emitted from its surface via universal processes believed to be occurring at all near-airless bodies.	Inner Planets: Mercury, Venus, and the Moon.
Robert M. Kelso	A commercially-leveraged, science-focused, lunar exploration program	Summarizes the NASA work in assessing use of commercially-demonstrated landers and comm systems to enable early access to the lunar surface for science and exploration.	Inner Planets: Mercury, Venus, and the Moon.
Mian. M. Abbas **Co-Authors:** A.C. LeClair, D. Tankosic, D.L. Gallagher, R.B. Sheldon, E.A. West, J.C. Brasunas, D.E. Jennings	Global Distributions of Gas & Dust in the Lunar Atmosphere from Solar Infrared Absorption Measurements with a Fourier Transform Spectrometer	Global Distributions of Dust & Gas in the Lunar Atmosphere may be determined most accurately with the highly sensitive technique of measurements of Solar IR Absorptions with a Infrared Spectrometer on a Lunar Orbiter, in full compliance with the NRC goal of measurements of Global Distributions.	Inner Planets: Mercury, Venus, and the Moon.

Mian M. Abbas **Co-Authors:** A.C. LeClair, D. Tankosic, P.D. Craven, J.F. Spann, E.A. West	Importance of Measurements of Charging Properties of Individual Submicron Size Lunar Dust Grains	It is absolutely necessary and of utmost importance to conduct the proposed measurements of charging properties of individual Apollo 11-17 submicron size dust grains by UV radiation and electron impact, at the lunar thermal cycle, for developing any believable lunar dust transportation models.	Inner Planets: Mercury, Venus, and the Moon.
William F. Bottke **Co-Authors:** Carlton Allen, Mahesh Anand, Nadine Barlow, Donald Bogard, Gwen Barnes, Clark Chapman, Barbara A. Cohen, Ian A. Crawford, Andrew Daga, Luke Dones, Dean Eppler, Vera Assis Fernandes, Bernard H. Foing, Lisa R. Gaddis, Jim N. Head, Fredrick P. Horz, Brad Jolliff, Christian Koeberl, Michelle Kirchoff, David Kring, Harold F., Levison, Simone Marchi, Charles Meyer, David A. Minton, Stephen J. Mojzsis, Clive Neal, Laurence E. Nyquist, David	Exploring the Bombardment History of the Moon	We discuss our priorities for exploring the Moon"s bombardment history: (1) Test the idea of a massive impactor spike 3.8-4.0 billion years ago. (2) Anchor the early Earth-Moon impact flux curve by determining the age of South Pole-Aitken Basin. (3) Establish a precise absolute chronology.	Inner Planets: Mercury, Venus, and the Moon.

Nesvorny, Anne Peslier, Noah Petro, Carle Pieters, Jeff Plescia, Mark Robinson, Greg Schmidt, Sen. Harrison H. Schmitt, John Spray, Sarah Stewart-Mukhopadhyay, Timothy Swindle, Lawrence Taylor, Ross Taylor, Mark Wieczorek, Nicolle Zellner, Maria Zuber			

Mark A. Bullock **Co-Authors:** David A. Senske, Tibor. S. Balint, Alexis Benz, Bruce A. Campbell, Eric Chassefiere, Anthony Colaprete, James A. Cutts, Lori Glaze, Stephen Gorevan, David H. Grinspoon, Jeff Hall, George L. Hashimoto, James W. Head, Gary Hunter, Natasha Johnson, Viktor V. Kerzhanovich, Walter S. Kiefer, Elizabeth A. Kolawa, Tibor Kremic, Johnny Kwok, Sanjay S. Limaye, Stephen J. Mackwell, Mikhail Y. Marov, Adriana Ocampo, Gerald Schubert, Ellen R. Stofan, Hakan Svedhem, Dimitri V. Titov, Allen H. Treiman	The Venus Science and Technology Definition Team Flagship	This white paper describes the scientific goals, objectives, instruments and mission architecture and design for a Flagship class mission to Venus.	Inner Planets: Mercury, Venus, and the Moon.

Amalie Sinclair	Lunar Light - Planetary Renewal- A Holistic Viewpoint	This paper sets out some rationales for an integrated US space development platform within the UN forums . Such a platform might include for an international lunar settlement and for a related space sciences initiative into global development	Inner Planets: Mercury, Venus, and the Moon.
Jasper Halekas **Co-Authors:** M. Fuller, I. Garrick-Bethell, L. L. Hood, C. L. Johnson, K. Lawrence, R. J. Lillis, R. P. Lin, M. Manga, M. E. Purucker, B. P. Weiss	Determining the origins of lunar remanent crustal magnetism	The discovery of lunar magnetic fields of crustal origin was a major scientific surprise of the Apollo program. Solving the enigma of lunar remanent crustal magnetization will provide fundamental insights into the thermal history of the lunar core/dynamo, mantle, and crust, and into the processes by which crustal magnetization is acquired on airless bodies - for instance, large basin-forming impacts. Determining the origin and history of lunar crustal magnetism will require the return of oriented samples...	Inner Planets: Mercury, Venus, and the Moon.

Jack Burns **Co-Authors:** E. Hallman, D. Duncan, J. Darling, & J. Stocke, J. Lazio, K. Weiler, J. Hewitt, C. Carilli, R. Bradley, T. Bastian, J. Ulvestad, J. Kasper & L. Greenhill, R. MacDowall, S. Merkowitz, J. McGarry, Zagwodzki, P. Yeh, H. Thronson, S. Ne, D. Currie, T. Murphy, S. Furlanetto & A. Mesinger, A. Loeb, J. Pritchard & E. Visbal, D. Jones, G. Taylor, K. Nordtvedt, J. Bowman, J. Grunsfeld, S. Bale, B. Wandelt, H. Falcke	Science from the Moon: The NASA/NLSI Lunar University Network for Astrophysics Research (LUNAR)	The Moon is a unique platform for fundamental astrophysical measurements of gravitation, the Sun, and the Universe. With the aim of providing additional perspective on the Moon as a scientific platform, this white paper describes key research projects involving astrophysics from the Moon.	Inner Planets: Mercury, Venus, and the Moon.

Clive R. Neal **Co-Authors:** Brad Bailey, Dave Beaty, Mary Sue Bell, Mike Duke, Paul Eckert, John Gruener, Jeff Jones, Robert Kelso, David Kring, Dan Lester, Paul Neitzel, Lewis Peach, Neal Pellis, Mike Ramsey, Debra Reiss-Bubenheim, James Rice, Gerald Sanders, Kurt Sacksteder, Greg Schmidt, Charles Shearer, Kelly Snook, Jim Spann, Paul Spudis, George Tahu, G. Jeffrey Taylor, Lawrence Taylor, Jeff Volosin, Michael Wargo	The Lunar Exploration Roadmap. Exploring the Moon in the 21st Century: Themes, Goals, Objectives, Investigations, and Priorities, 2009	This paper summarizes the long term Lunar Exploration Roadmap that has been developed by the lunar community and coordinated by the Lunar Exploration Analysis Group.	Inner Planets: Mercury, Venus, and the Moon.
Clive R. Neal **Co-Authors:** Bruce Banerdt, Don Bogard, Bill Bottke, Jack Burns, Ben Bussey, Barbara Cohen, Greg Delory, Richard Elphic, Bill Farrell, Lisa Gaddis, Ian Garrick-Bethel, Timothy Grove,			

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Banaszkiewicz, Bruce Banerdt, Bruce Bills, James Carpenter, Peter Chi, Ulli Christensen, Eric Clévédé, Barbara Cohen, Ian Crawford, Doug Currie, Paul Davis, Veronique Dehant, Simone Dell'Agnello, Andrew Dombard, Fred Duennebier, Linda Elkins-Tanton, Matthew Fouch, Cliff Frohlich, Jeannine Gagnepain-Beyneix, Raphael F. Garcia, Ed Garnero, Ian Garrick-Bethel, Domenico Giardini Robert Grimm, Matthias Grott, Jasper Halekas, Lon Hood, Berengere Houdou, Shaopeng Huang, Catherine Johnson, Bradley Jolliff, Katie Joy, Amir Khan, Oleg Khavroshkin, Krishan Khurana, Walter Kiefer, Naoki Kobayashi, Junji Koyama, Oleg Kuskov, Jesse Lawrence, Mathieu Lefeuvre, Lynn	The Rationale for Deployment of a Long-Lived Geophysical	This paper outlines the rationale establishing a global lunar geophysical network and the authorship demonstrates the broad	Inner Planets: Mercury, Venus,

Lewis, John Longhi, Philippe Lognonné, Mioara Mandea, Michael Manga, Pat McGovern, David Mimoun, Antoine Mocquet, Jean-Paul Montagner, Paul Morgan, Seiichi Nagihara, Yosio Nakamura, Jürgen Oberst, Roger Phillips, Jeff Plescia, J. Todd Ratcliff, Lutz Richter, Chris Russell, Yoshifumi Saito, Gerald Schubert, Nikolai Shapiro, Charles Shearer, Hiroaki Shiraishi, Sue Smrekar, Tilman Spohn, Bob Strangeway, Eléonore Stutzmann, Satoshi Tanaka, Toshiro Tanimoto, Patrick Taylor, Ross Taylor, Junya Terazono, Mike Thorne, Nafi Toksöz, Vincent Tong, Elizabeth Turtle, Slava Turyshev, Roman Wawrzazek, Renee Weber, Jonathan Weinberg, Ben Weiss, Mark	Network on the Moon	community support for such an endeavor, both within the USA and internationally.	and the Moon.

Wieczorek, James Williams, Maria Zuber			
Brian J. O"Brien **Co-Author:** James R.Gaier	Indicative Basic Issues about Lunar Dust in the Lunar Environment	Basic issues of lunar dust - including recent discoveries - so fundamental they affect a wide range of lunar research and exploration must be recognised as priorities. Four Recommendations and Outcomes are given.	Inner Planets: Mercury, Venus, and the Moon.
Sanjay S. Limaye **Co-Authors:** Mark Allen, Sushil Atreya, Kevin H. Baines, Jean-Loup Bertaux, Gordon Bjoraker, Jacques Blamont, Mark Bullock, Eric Chassefiere, Gordon Chin, Curt Covey, David Grinspoon, Samuel Gulkis, Viktor Kerzhanovich, Stephen Lewis, Kevin McGouldrick, W. J. Markiewicz, Rosalyn A. Pertzborn, Christopher Rozoff, Giuseppe Piccioni, Gerald Schubert, Lawrence A. Sromovsky, Colin F. Wilson, Yuk Yung	Venus Atmosphere: Major Questions and Required Observations	This paper describes the major questions about the atmosphere of Venus and the observations required to understand it. “How Does Venus atmosphere work?” A dedicated and renewed exploration effort is required to address this fundamental question. Key questions requiring new observations include: H	Inner Planets: Mercury, Venus, and the Moon.

Harrison H. Schmitt	Lunar Pyroclastic Deposits and the Origin of the Moon	he primary difficulty in accepting the computer modeled "giant impact" hypothesis for the origin of the Moon, versus independent derivation, comes from the analysis of the non-glass components of lunar pyroclastic deposits. These prove that volatile reservoirs exist in the mantle of the Moon.	Inner Planets: Mercury, Venus, and the Moon.
Harrison H. Schmitt **Co-Authors:** Bernard H. Foing, Mark Helper, Friedrich P. Horz, Jeff Plescia, Authur Snoke, Kris Zacny	Lunar Field Geological Exploration	Geological exploration by experience and highly trained field geologists provides the foundation for interpretation of lunar samples in the context of the origin and evolution of the terrestrial planets. Future lunar exploration should fully utilize the best available field geologists.	Inner Planets: Mercury, Venus, and the Moon.
Harrison H. Schmitt	Observations Necessary for Useful Global Climate Models	Critical differences exist between scientists who observe weather and climate and those who attempt to model nature’s complexities. The modelers believe complex mathematics and broad assumptions can forecast the future of climate, Earth’s most complex system. Long-term observation is essential.	Inner Planets: Mercury, Venus, and the Moon.

Harrison H. Schmitt **Co-Authors:** Andy Daga,Jeff Plescia	Geopolitical Context of Lunar Exploration and Settlement	The Moon has attracted international attention as the current focus of peaceful competition in space. This competition has long term implications for the future of liberty on Earth. If non-democratic regimes dominate exploration and settlement of the Moon, liberty will be at risk. Only the United St	Inner Planets: Mercury, Venus, and the Moon.
Harrison H. Schmitt **Co-Authors:** Mark W. Henley, Kim Kuhlman, Gerald. L. Kulcinski, John F. Santarius, Lawrence A. Taylor	Lunar Helium-3 Fusion Resource Distribution	The Moon''s regolith contains vast resources of helium-3, an ideal fuel for terrestrial fusion power systems. Development of plans for private sector investment in obtaining helium-3 and its by-products requires detailed definition of that isotope''s selenographic distribution.	Inner Planets: Mercury, Venus, and the Moon.

Brad Jolliff **Co-Authors:** Noah Petro, Leon Alkalai, Carlton Allen, Irene Antonenko, Lars Borg, William Bottke, Barbara Cohen, Michael Duke, Amy Fagan, Bernard Foing, Lisa Gaddis, John Gruener, Justin Hagerty, James Head III, Harold Hiesinger, Peter Isaacson, Randy Korotev, Georgiana Kramer, Samuel Lawrence, Gary Lofgren, Tomas Magna, Clive Neal, Marc Norman, Larry Nyquist, Gordon Osinski, Dimitri Papanastassiou, Carle Pieters, Bhairavi Shankar, Tim Swindle, G. Jeffrey Taylor, Allan Treiman, Paul Warren, Mark Wieczorek, Ryan Zeigler, Nicolle Zellner	Constraining Solar System impact history and evolution of the terrestrial planets with exploration of and samples from the Moon's South Pole-Aitken Basin	A fundamental issue of Solar System science is determining the early history of the terrestrial planets, including giant impact bombardment and the evolution of differentiated crust. Exploration and sampling of the Moon's South Pole–Aitken Basin can illuminate these formative planetary processes.	Inner Planets: Mercury, Venus, and the Moon.

Richard S. Miller **Co-Authors:** M. Bonamente, S. O'Brien, W. S. Paciesas, M. Bonamente, S. O'Brien, W. S. Paciesas, C. A. Young, D. Ebbets	Lunar Occultation Observer - A Nuclear Astrophysics Mission Concept using the Moon as a Platform for Science	The Lunar Occultation Observer (LOCO) is a gamma-ray astrophysics mission concept being developed to probe the nuclear regime. Using the Moon to occult astrophysical sources as they rise and set along the lunar limb, the encoded temporal modulation will be used to image the sky and enable science.	Inner Planets: Mercury, Venus, and the Moon. None of the above.
Andrew Daga **Co-Authors:** Carlton Allen, James Burke, Ian Crawford, Richard Leveille, Steven Simon, Lin Tze Tan	Lunar and Martian Lava Tube Exploration as Part of an Overall Scientific Survey	This paper discusses the opportunity to search for and exploit lava tubes on the surfaces of the Moon and Mars as a means of enabling ambitious planetary science missions. [FINAL VERSION]	Inner Planets: Mercury, Venus, and the Moon. Mars: Not Phobos and Deimos.
David Grinspoon **Co-Authors:** Mark Bullock, James Kasting, Janet Luhmann, Peter Read, Scot Rafkin, Sanjay Limaye, Kevin McGouldrick, Gordon Chin, Samuel Gulkis, Feng Tian, Eric Chassefiere, Hakan Svedhem, Vikki Meadows	Comparative Planetary Climate Studies	It is the purpose of this White Paper to draw attention to, and summarize, the important role that planetary exploration, and research with a comparative planetology focus, have played and should continue to play in our understanding of climate, and climate change, on Earth.	Inner Planets: Mercury, Venus, and the Moon. Mars: Not Phobos and Deimos.

Friedemann T. Freund	Previously Overlooked/Ignored Electronic Charge Carriers in Rocks	I would like to draw the attention of members of the Decadal Survey Committee to a rather fundamental discovery, which (I believe) will have a major impact on the Earth and Planetary Sciences in the coming years.	Inner Planets: Mercury, Venus, and the Moon. Mars: Not Phobos and Deimos.
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Robert Grimm	Electromagnetic Sounding of Solid Planets and Satellites	EM methods can sense subsurface structure from meters to a thousand kilometers. This white paper gives a tutorial on material sensitivities, exploration depths, sources, and particularly what measurements must be made for different target bodies, without specific mission endorsements.	Inner Planets: Mercury, Venus, and the Moon. Mars: Not Phobos and Deimos. Satellites: Galilean satellites, Titan, and the other satellites of the giant planets. Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.
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Amy S. Lo **Co-Authors:** Howard Eller, Dean Dailey, Eric Drucker, James Wehner	Secondary Payloads Using LCROSS Architecture	The ESPA architecture used by the LCROSS mission enables two capable missions for the cost of one launch. This paper describes our approach for leveraging the capability of the new generation of EELVs to enable secondary planetary missions at well below the cost of an independently launched mission.	Inner Planets: Mercury, Venus, and the Moon. Mars: Not Phobos and Deimos. Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.

Andrew M. Davis **Co-Authors:** Meenakshi Wadhwa, Christine Floss, Bradley L. Jolliff, Scott Messenger, Dimitri A. Papanastassiou, Allan Treiman, Andrew J. Westphal	Development of Capabilities and Instrumentation for Curation and Analysis of Returned Samples	The purpose of this white paper is to emphasize the importance of investments in sample curation and analytical instrument development for the full realization of the science objectives of any sample return missions in the coming decade.	Inner Planets: Mercury, Venus, and the Moon. Mars: Not Phobos and Deimos. Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.
Clive R. Neal **Co-Authors:** Charles K. Shearer, Meenakshi Wadwha, Lars Borg, Bradley Jolliff, Allan Treiman	Developing Sample Return Technology using the Earth''s Moon as a Testing Ground	Lowering cost and risk through development of sample return technologies that can be used on various sample return mission styles is emphasized, as is using the Moon as a testing ground for such technologies.	Inner Planets: Mercury, Venus, and the Moon. Mars: Not Phobos and Deimos. Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.

John D. Rummel	Planetary Protection for Planetary Science and Exploration	A precis of planetary protection policy concerns, their history, and the role of the SSB and NASA internal advisory activities in ensuring progress and appropriate implementation of the policy.	Inner Planets: Mercury, Venus, and the Moon. Mars: Not Phobos and Deimos. Giant Planets: Jupiter, Saturn, Uranus, Neptune, and exoplanets, including rings and magnetic fields, but not their satellites. Satellites: Galilean satellites, Titan, and the other satellites of the giant planets. Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.

Saumitra Mukherjee	Effect of Star-burst on Sun-Earth environment	Starbursts produces extragalactic cosmic rays which initiate the Sun to develop low Planetary Indices (Kp) and low Electron flux (E-flux) condition of Sun-Earth Environment which leads to snowfall on earth and some changes in other plants of the solar system	Inner Planets: Mercury, Venus, and the Moon. Mars: Not Phobos and Deimos. Giant Planets: Jupiter, Saturn, Uranus, Neptune, and exoplanets, including rings and magnetic fields, but not their satellites. Satellites: Galilean satellites, Titan, and the other satellites of the giant planets. Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.
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Julie Castillo-Rogez **Co-Authors:** William B. Durham, Essam Heggy, Mathieu Choukroun, Jerome Noir, Sarah T. Stewart, Steve D. Vance, Christine M. McCarthy, Martin B. Barmatz, Pamela G. Conrad	Laboratory Studies in Support of Planetary Geophysics	We summarize the rationale for advocating a healthy and sustained program of laboratory research in support of the geophysical exploration of planetary bodies. We address the challenges inherent to this discipline, and we suggest recommendations for the review panel"s consideration.	Inner Planets: Mercury, Venus, and the Moon. Mars: Not Phobos and Deimos. Giant Planets: Jupiter, Saturn, Uranus, Neptune, and exoplanets, including rings and magnetic fields, but not their satellites. Satellites: Galilean satellites, Titan, and the other satellites of the giant planets. Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.

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Murthy Gudipati **Co-Authors:** Michael A"Hearn, Nancy Brickhouse, John Cowan, Paul Drake, Steven Federman, Gary Ferland, Adam Frank, Wick Haxton, Eric Herbst, Michael Mumma, Farid Salama, Daniel Wolf Savin, Lucy Ziurys	Laboratory Studies for Planetary Sciences	The WGLA of the AAS promotes collaboration and exchange of knowledge between astronomy and planetary sciences and the laboratory sciences (physics, chemistry, and biology). Laboratory data needs of ongoing and next generation planetary science missions are carefully evaluated and recommended.	Inner Planets: Mercury, Venus, and the Moon. Mars: Not Phobos and Deimos. Giant Planets: Jupiter, Saturn, Uranus, Neptune, and exoplanets, including rings and magnetic fields, but not their satellites. Satellites: Galilean satellites, Titan, and the other satellites of the giant planets. Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.

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David R. Thompson **Co-Authors:** David R. Thompson, Robert C. Anderson, Benjamin Bornstein, Nathalie A. Cabrol, Steve Chien, Tara Estlin, Terry Fong, Robert Hogan, Ralph Lorenz, Daniel Gaines, Martha S. Gilmore, Mario Parente, Liam Pedersen, Ted L. Roush, Giuseppe Marzo, David Wettergreen	Onboard Science Data Analysis: Implications for Future Missions	Onboard science data analysis enables new spacecraft operational modes that improve science yield. It can relieve constraints on time, bandwidth and power, and respond automatically to events on short time scales. We examine applications to rover, aerobot, and orbital platforms.	Inner Planets: Mercury, Venus, and the Moon. Mars: Not Phobos and Deimos. Giant Planets: Jupiter, Saturn, Uranus, Neptune, and exoplanets, including rings and magnetic fields, but not their satellites. Satellites: Galilean satellites, Titan, and the other satellites of the giant planets. Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.

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Edward R. Martinez **Co-Author:** Robert V. Frampton	Thermal Protection System Sensors	This paper advocates for the development of an aeroshell TPS sensor system to the benefit of all atmospheric reentry missions Agency wide.	Inner Planets: Mercury, Venus, and the Moon. Mars: Not Phobos and Deimos. Giant Planets: Jupiter, Saturn, Uranus, Neptune, and exoplanets, including rings and magnetic fields, but not their satellites. Satellites: Galilean satellites, Titan, and the other satellites of the giant planets. Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.

Carl Pilcher **Co-Authors:** Kevin P. Hand, Patricia M. Beauchamp, David Des Marais, David Grinspoon, Karen J. Meech, Sean N. Raymond	Astrobiology Priorities for Planetary Science Flight Missions	We have posited in another white paper that all of Planetary System Science can be seen through an astrobiological lens. In this paper we present priorities for flight mission investigations derived by applying that lens to the Planetary Science flight mission program.	Inner Planets: Mercury, Venus, and the Moon. Mars: Not Phobos and Deimos. Giant Planets: Jupiter, Saturn, Uranus, Neptune, and exoplanets, including rings and magnetic fields, but not their satellites. Satellites: Galilean satellites, Titan, and the other satellites of the giant planets. Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.

Carl Pilcher **Co-Authors:** Kevin P. Hand, Patricia M. Beauchamp, David Des Marais, David Grinspoon, Karen J. Meech, Sean N. Raymond	An Astrobiological Lens on Planetary System Science	Astrobiology provides a lens through which all of planetary science and solar system exploration, as well as life on Earth, can be viewed. Astrobiology, like planetary science, is a systems-level science. In planetary science, one must understand connections be [CHARACTERS NOT ACCEPTED BEYOND THIS	Inner Planets: Mercury, Venus, and the Moon. Mars: Not Phobos and Deimos. Giant Planets: Jupiter, Saturn, Uranus, Neptune, and exoplanets, including rings and magnetic fields, but not their satellites. Satellites: Galilean satellites, Titan, and the other satellites of the giant planets. Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.

Barry Geldzahler **Co-Author:** Les Deutsch	Future Plans for the Deep Space Network (DSN)	NASA’s Deep Space Network (DSN) is a critical part of every NASA solar system mission, serving as the entity that ties the spacecraft back to Earth and providing data from science instruments, information for navigating across the solar system, and valuable radio link science and radar observations.	Inner Planets: Mercury, Venus, and the Moon. Mars: Not Phobos and Deimos. Giant Planets: Jupiter, Saturn, Uranus, Neptune, and exoplanets, including rings and magnetic fields, but not their satellites. Satellites: Galilean satellites, Titan, and the other satellites of the giant planets. Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.

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Oleksandr Potashko	Atmosphere as Sign of Life	Is there a feature of presence of life on a macro-level? Could we say something about life on Neptune or on Halley’s Comet or on an exoplanet? Let’s consider that sign of life is an atmosphere. Let''s consider crustal planet. Whether planet has an atmosphere we may say that it is alive in geologi	Inner Planets: Mercury, Venus, and the Moon. Mars: Not Phobos and Deimos. Giant Planets: Jupiter, Saturn, Uranus, Neptune, and exoplanets, including rings and magnetic fields, but not their satellites. Satellites: Galilean satellites, Titan, and the other satellites of the giant planets. Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.

Eliot F. Young **Co-Authors:** Charles Hibbitts, Joshua Emery, Amanda Hendrix, William Merline, William Grundy, Kurt Retherford	Balloon-Borne Telescopes for Planetary Science: Imaging and Photometry	This white paper advocates the use of balloon-borne telescopes for diffraction-limited imaging in visible wavelengths by demonstrating their technical readiness and low cost relative to space- and ground-based facilities.	Inner Planets: Mercury, Venus, and the Moon. Mars: Not Phobos and Deimos. Giant Planets: Jupiter, Saturn, Uranus, Neptune, and exoplanets, including rings and magnetic fields, but not their satellites. Satellites: Galilean satellites, Titan, and the other satellites of the giant planets. Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.

Michael H. Wong **Co-Authors:** Máté Ádámkovics, Sushil K. Atreya, Don Banfield, Jim Bell, Susan Benecchi, Gordon Bjoraker, John R. Casani, John T. Clarke, Imke de Pater, Scott G. Edgington, Leigh N. Fletcher, Richard G. French, William Grundy, Amanda R. Hendrix, Erich Karkoschka, Jian-Yang Li, Franck Marchis, Melissa A. McGrath, William J. Merline, Julianne I. Moses, Keith Noll, Glenn S. Orton, Kathy A. Rages, Kurt Retherford, Kunio Sayanagi, Nick Schneider, Eric H. Smith, Lawrence A. Sromovsky, Nathan J. Strange, Anne Verbiscer, Padmavati A. Yanamandra-Fisher	A dedicated space observatory for time-domain solar system science	The specific requirements for time-domain solar system science are adequate sampling rates and campaign durations. The observatory must be spaceborne both to satisfy the time-domain requirements as well as to maintain access to the dynamically significant ultraviolet spectral range.	Inner Planets: Mercury, Venus, and the Moon. Mars: Not Phobos and Deimos. Giant Planets: Jupiter, Saturn, Uranus, Neptune, and exoplanets, including rings and magnetic fields, but not their satellites. Satellites: Galilean satellites, Titan, and the other satellites of the giant planets. Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.

Anthony Wesley **Co-Authors:** Glenn Orton, Padma Yanamandra-Fisher, Leigh Fletcher, Kevin Baines, Christopher Go, Makenzie Lystrup, Olivier Mousis, Imke de Pater, Jean-Pierre Lebreton, Kunio Sayanagi, Timothy Livengood, Tom Stallard, Henrik Mellin, Nigel Bannister	Ground-Based Support for Solar-System Exploration: Continuous Coverage Visible Light Imaging of Solar System Objects from a Network of Ground-Based Observatories	We propose that the needs of planetary science for event-detection and time-critical observations could be well-served by a global network of low-cost remote-controlled (or autonomous) telescopes optimized for high-resolution visible light imaging of solar system targets.	Inner Planets: Mercury, Venus, and the Moon. Giant Planets: Jupiter, Saturn, Uranus, Neptune, and exoplanets, including rings and magnetic fields, but not their satellites.

Eberhard Gruen **Co-Authors:** Frank Postberg, Harald Krüger, Mihaly Horanyi, Elmar Jessberger Sascha Kempf, Ralf Srama, Thomas Stephan, Zoltan Sternovsky	In-Situ Mass Spectrometry of Atmosphereless Planetary Objects	Dust particles emitted from atmosphereless planetary objects are samples of their surfaces. By mass analyzing these particles and tracing back their trajectories to their sources the surface composition of Mercury, planetary satellites, dusty rings sources, asteroids and comets can be obtained.	Inner Planets: Mercury, Venus, and the Moon. Giant Planets: Jupiter, Saturn, Uranus, Neptune, and exoplanets, including rings and magnetic fields, but not their satellites. Satellites: Galilean satellites, Titan, and the other satellites of the giant planets. Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.

John F. Cooper **Co-Authors:** Steven J. Sturner, Chris Paranicas, Matthew E. Hill, Abigail M. Rymer, Paul D. Cooper, Dan Pascu, Robert E. Johnson, Timothy A. Cassidy, Thomas M. Orlando, Kurt D. Retherford, Nathan A. Schwadron, Ralf I. Kaiser, François Leblanc, Louis J. Lanzerotti, Claudia J. Alexander, Henry B. Garrett, Amanda R. Hendrix, Wing H. Ip	Space Weathering Impact on Solar System Surfaces and Mission Science	Space weathering is the collection of physical processes acting to erode and chemically modify planetary surfaces directly exposed to space environments of planetary magnetospheres, the heliosphere, and the local interstellar environment of the solar system. Space weathering affects the physical and	Inner Planets: Mercury, Venus, and the Moon. Giant Planets: Jupiter, Saturn, Uranus, Neptune, and exoplanets, including rings and magnetic fields, but not their satellites. Satellites: Galilean satellites, Titan, and the other satellites of the giant planets. Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.

Dana Backman	SOFIA (Stratospheric Observatory for Infrared Astronomy) and Planetary Science	This paper consists of the intro & observatory capabilities (ch. 1) plus the planetary science (ch. 5) portions of the SOFIA Science Vision doc pub. in 2009 as an update of the scientific case for SOFIA. D. Backman produced this extract; the original doc is authored by the SOFIA Science Team.	Inner Planets: Mercury, Venus, and the Moon. Giant Planets: Jupiter, Saturn, Uranus, Neptune, and exoplanets, including rings and magnetic fields, but not their satellites. Satellites: Galilean satellites, Titan, and the other satellites of the giant planets. Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.
Allan H. Treiman	Venus Geochemistry: Progress, Prospects, and Future Missions	Report and recommendation of the February 2009 workshop of the same name.	Inner Planets - Mercury, Venus, and the Moon.

Olga Prieto Ballesteros **Co-Authors:** Kevin P. Hand, Ariel Anbar, Felipe Gómez-Gómez, Oleg Korablev, Ralph Lorenz, Ralph Milliken, Daniel Prieur, Francois Raulin, Steve Vance, Michel Viso	Astrobiology in Europa and Jupiter System Mission (EJSM)	This paper describe the Astrobiology science in EJSM and the opportunities of having in situ elements in future missions.	Giant Planets: Jupiter, Saturn, Uranus, Neptune, and exoplanets, including rings and magnetic fields, but not their satellites.
Matthew Tiscareno **Co-Authors:** Nicole Albers, Todd Bradley, Shawn M. Brooks, Joseph A. Burns, Carlos Chavez, Joshua E. Colwell, Jeffrey N. Cuzzi, Imke de Pater, Luke Dones, Gianrico Filacchione, Silvia M. Giuliatti Winter, Mitchell K. Gordon, Eberhard Gruen, Douglas P. Hamilton, Matthew M. Hedman, Mihaly Horanyi, Harald Krueger, Jack J. Lissauer, Philip D. Nicholson, Robert T. Pappalardo, Frank Postberg, Mark R. Showalter,		The study of planetary ring systems forms a key component of planetary science. We discuss priority activities for the next decade	Giant Planets: Jupiter, Saturn, Uranus, Neptune,

Frank Spahn, Linda J. Spilker, Joseph N. Spitale, Miodrag Sremcevic, Padma Yanamandra-Fisher, Gregory J. Black, André Brahic, Sébastien Charnoz, Richard H. Durisen, Michael W. Evans, Cecile Ferrari, Amara Graps, Sascha Kempf, Steven M. Larson, Mark C. Lewis, Essam A. Marouf, Colin J. Mitchell, Carl D. Murray, Cathy B. Olkin, Keiji Ohtsuki, Derek C. Richardson, Heikki Salo, Juergen Schmidt, David A. Seal, Ralf Srama, Glen R. Stewart, John W. Weiss	Rings Research in the Next Decade	including full support for the Cassini Solstice Mission, a spacecraft mission to Neptune and/or Uranus, and support for Earth-based research activities.	and exoplanets, including rings and magnetic fields, but not their satellites.
Alan P. Boss **Co-Authors:** Edward Young, Victoria Meadows, Nader Haghighipour	Astrobiology Research Priorities for Exoplanets	We recommend that the Decadal Survey place a high priority on continued, even expanded, support of the Research & Analysis programs that fund the efforts of exoplanet theorists, laboratory workers, and observers through NASA's and NSF"s research programs.	Giant Planets: Jupiter, Saturn, Uranus, Neptune, and exoplanets, including rings and magnetic fields, but not their satellites.

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Glenn Orton **Co-Authors:** Glenn Orton, Padma Yanamandra-Fisher, Leigh Fletcher, Kevin Baines, Imke de Pater, Olivier Mousis, Jean-Pierre Lebreton, Steve Miller5, Sang-Joon Kim, Makenzie Lystrup, Kunio Sayanagi, Tom Stallard,Paul Steffes	Earth-Based Observational Support for Spacecraft Exploration of Outer-Planet Atmospheres	This white paper advocates continued robust Earth-based observational support for spacecraft missions, addressing in particular investigations of Giant Planet atmospheres. Recommendations include upgrades to the NASA IRTF as well as cooperative investments in large or giant telescopes.	Giant Planets: Jupiter, Saturn, Uranus, Neptune, and exoplanets, including rings and magnetic fields, but not their satellites.

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Ethiraj Venkatapathy			

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Bose, Anthony Colaprete, David M. Driver, Edward Martinez, Donald T. Ellerby, Matthew J. Gasch, Aga M. Goodsell, James Reuther, Sylvia M. Johnson, Dean Kontinos, Mary Livingston, Michael J. Wright, Harry Partridge, George A. Raiche, Huy K. Tran, Kerry A. Trumble			
Jonathan J. Fortney **Co-Authors:** Kevin Zahnle, Isabelle Baraffe, Adam Burrows, Sarah E. Dodson-Robinson, Gilles Chabrier, Tristan Guillot, Ravit Helled, Franck Hersant, William B. Hubbard, Jack J. Lissauer, Mark S. Marley	Planetary Formation and Evolution Revealed with a Saturn Entry Probe: The Importance of Noble Gases	The determination of Saturn's atmospheric noble gas abundances are critical to understanding the formation and evolution of Saturn, and giant planets in general. These measurements can only be performed with an entry probe.	Giant Planets: Jupiter, Saturn, Uranus, Neptune, and exoplanets, including rings and magnetic fields, but not their satellites.
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David A. Williams **Co-Authors:** Jani Radebaugh, Rosaly M.C. Lopes, Imke de Pater, Nicholas M. Schneider, Frank Marchis, Julianne Moses, Ashley G. Davies, Jason Perry, Jeffrey S. Kargel, Laszlo P. Keszthelyi, Chris Paranicas, Alfred S. McEwen, Kandis Lea Jessup, David Goldstein, Melissa Bunte, Julie Rathbun, Melissa McGrath, Krishan Khurana, Sébastien Rodriguez, Terry A. Hurford, Amanda R. Hendrix, Michelle Kirchoff, Elizabeth Turtle	Future Io Exploration for 2013-2022 and Beyond, Part 1: Justification and Science Objectives	This white paper (revised draft) summarizes the current scientific questions regarding Jupiter"s volcanic moon Io, and the scientific objectives and measurements that need to be accomplished by future exploration. (Final version with additional coauthors).	Giant Planets: Jupiter, Saturn, Uranus, Neptune, and exoplanets, including rings and magnetic fields, but not their satellites. Satellites: Galilean satellites, Titan, and the other satellites of the giant planets.

David A. Williams **Co-Authors:** Jani Radebaugh, Rosaly M.C. Lopes, Imke de Pater, Nicholas M. Schneider, Frank Marchis, Julianne Moses, Ashley G. Davies, Jason Perry, Jeffrey S. Kargel, Laszlo P. Keszthelyi, Chris Paranicas, Alfred S. McEwen, Kandis Lea Jessup, David Goldstein, Melissa Bunte, Julie Rathbun, Melissa McGrath, Krishan Khurana, Sébastien Rodriguez, Terry A. Hurford, Amanda R. Hendrix, Michelle Kirchoff	Future Io Exploration for 2013-2022 and Beyond, Part 2: Recommendations for Missions	This revised white paper lists our recommendations for mission concepts and instruments to accomplish the science objectives for future exploration of Jupiter''s moon Io for the decade of 2013-2022 and beyond. (Final version with additional coauthors).	Giant Planets: Jupiter, Saturn, Uranus, Neptune, and exoplanets, including rings and magnetic fields, but not their satellites. Satellites: Galilean satellites, Titan, and the other satellites of the giant planets.
Patricia M. Beauchamp **Co-Authors:** William McKinnon, Thomas Magner, Sami Asmar, Hunter Waite, Stephen Lichten, Ethiraj Venkatapathy, Tibor Balint, Athena Coustenis,			

Jeffrey L. Hall, Michelle Munk, Alberto Elfes, Kim Reh, John Elliott, Jonathan Rall, Richard Barney, Tom Spilker, Thomas J. Sutliff, Craig Williams, Andy Spry, David Atkinson, Subbarao Surampudi, Nathan Strange, Robert Preston, Wayne Zimmerman, Mark Hofstadter, James Cutts, John Clarke, Kevin Baines, Mohammad Mojarradi, Eric Pencil, Jason Barnes, Conor Nixon, Maria Teresa Capria, Vladimir B. Zivkovic, Anezina Solomonidou, Carrie Anderson, Julie Castillo, Karl Mitchell, Leonid Gurvits, David A. Williams, Javier Martin-Torres, Andrew Coates, Robert West, Rosaly Lopez, Michael Wright, Linda Spilker, Jonathan Lunine, Jason Soderblom, Bill Kurth, Christophe Sotin,	Technologies for Outer Planet Missions: A Companion to the Outer Planet	This is the final version of a white paper which provides the OPAG recommendations for technology required to undertake outer planetary missions. The paper	Giant Planets: Jupiter, Saturn, Uranus, Neptune, and exoplanets, including rings and magnetic fields, but not

Olivier Mousis, Ralf Jaumann, Nicholas Teanby, Edward Sittler, Frank Sohl, George Bampasidis, Valeria Cottini, Eric Wilson, Roger Yelle, Ralph Lorenz, Sushil Atreya, Francois Raulin, Patrick Irwin, Mathieu Hirtzig, Julian Nott, Lucy Norman, Murthy Gudipati, Véronique Vuitton, Rolant Thissen, Henry Throop, Kurt Klaus, Sebastien Rodriguez, Ingo Mueller-Wodarg, James N. Head, Don Banfield, Paul Mahaffy, Robert Brown, Marina Galand, Bonnie J. Buratti , Glen Orton, Jesse Beauchamp, Samuel Gulkis, John Brophy, Timothy A. Livengood, Louise Prockter, Mark A. Gurwell, Lorenzo Bruzzone, Ronald Greeley, Paolo Tortora, Robert Pappalado, Mimi	Assessment Group (OPAG) Strategic Exploration White Paper	describes the need for an OP technology program and provides specific recommendations for NASA investments during the next decade.	their satellites. Satellites: Galilean satellites, Titan, and the other satellites of the giant planets.

Aung, Jesus Martinez-Frias, Jani Radebaugh, Jean-Pierre Lebreton David Senske, Alfred McEwen, Dirk Schulze-Makuch, Mark Smith, Dennis Matson, Matthew S. Tiscareno, Mathieu Choukroun, Elizabeth Turtle			
Karla B. Clark	Europa Jupiter System Mission	The baseline EJSM architecture consists the NASA-led Jupiter Europa Orbiter (JEO), and the ESA-led Jupiter Ganymede Orbiter (JGO). Complementary instruments monitor dynamic phenomena, map the Jovian magnetosphere and its interactions with the Galilean satellites, and characterize water oceans beneat	Giant Planets: Jupiter, Saturn, Uranus, Neptune, and exoplanets, including rings and magnetic fields, but not their satellites. Satellites: Galilean satellites, Titan, and the other satellites of the giant planets.
Robert Pappalardo **Co-Authors:** Michel Blanc, Emma Bunce, Michele Dougherty, Olivier Grasset, Ron Greeley, Torrence Johnson, Jean-Pierre Lebreton, David Senske, Louise Prockter	Science of the Europa Jupiter System Mission	The Europa Jupiter System Mission (EJSM) is guided by the overarching theme: the emergence of habitable worlds around gas giants, with goals to determine whether the Jupiter System harbors habitable worlds, and to characterize the processes within the Jupiter system.	Giant Planets: Jupiter, Saturn, Uranus, Neptune, and exoplanets, including rings and magnetic fields, but not their satellites. Satellites: Galilean satellites, Titan, and the other satellites of the giant planets.

Tsun-Yee Yan Yan **Co-Authors:** K. Clark, R. Rasmussen	Radiation Facts and Mitigation Strategies for the JEO Mission	The challenge associated with operating a spacecraft for long periods within the radiation belts of Jupiter cannot be underestimated. To realize the promise of incredible science the risk must be identified and controlled. Given the identified steps, the design is well in hand and would allow this s	Giant Planets: Jupiter, Saturn, Uranus, Neptune, and exoplanets, including rings and magnetic fields, but not their satellites. Satellites: Galilean satellites, Titan, and the other satellites of the giant planets.
Jonathan I. Lunine	Saturn''s Titan: A strict test for life''s cosmic ubiquity	In this white paper I argue that Titan provides a strict test for the Copernican hypothesis that life is a ubiquitous cosmic phenomenon. Planets with environments like Titan may be common in the cosmos, as they correspond to a roughly 1 AU orbit around M-dwarfs.	Giant Planets: Jupiter, Saturn, Uranus, Neptune, and exoplanets, including rings and magnetic fields, but not their satellites. Satellites: Galilean satellites, Titan, and the other satellites of the giant planets.

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George Sonneborn **Co-Authors:** J. Lunine, R. Doyon, M. McCoughrean, M. Rieke	Study of Planetary Systems and Solar System Objects with JWST	Determination of the physical and chemical properties of planetary systems is a key scientific goal of the James Webb Space Telescope (JWST). This white paper summarizes the mission's capabilities in our solar system and extrasolar planetary systems.	Giant Planets: Jupiter, Saturn, Uranus, Neptune, and exoplanets, including rings and magnetic fields, but not their satellites. Satellites: Galilean satellites, Titan, and the other satellites of the giant planets. Primitive Bodies: Asteroids, comets, Phobos, Deimos, Pluto/Charon and other Kuiper belt objects, meteorites, and interplanetary dust.

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