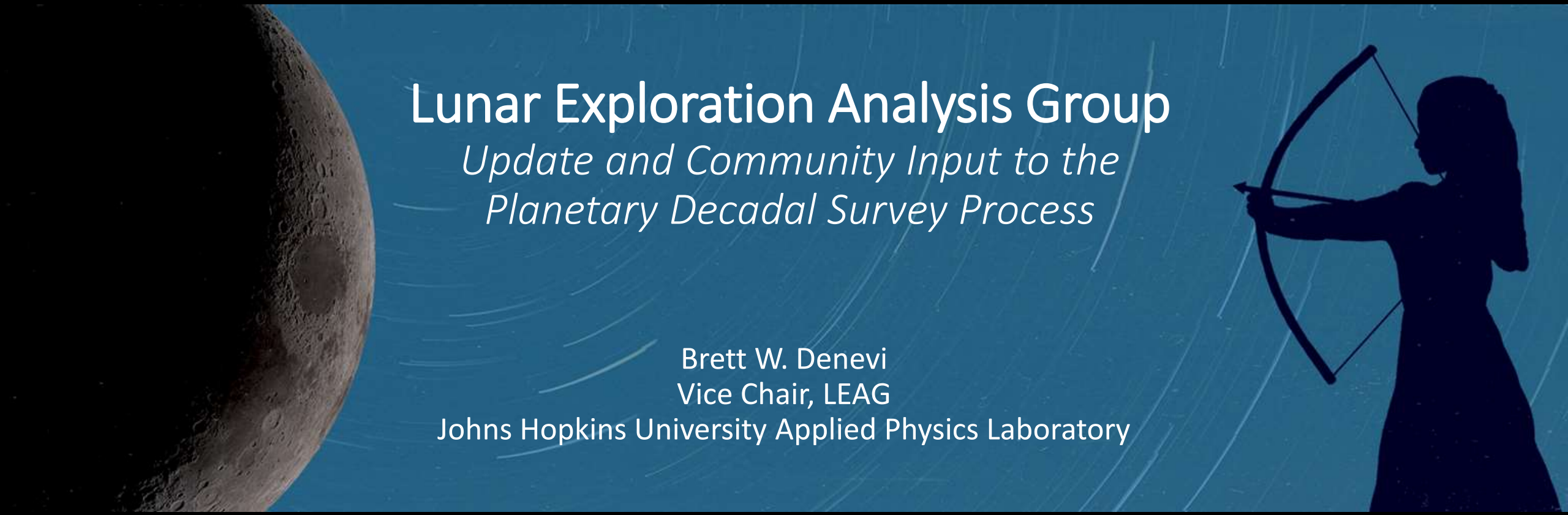

Lunar Exploration Analysis Group

Update and Community Input to the Planetary Decadal Survey Process

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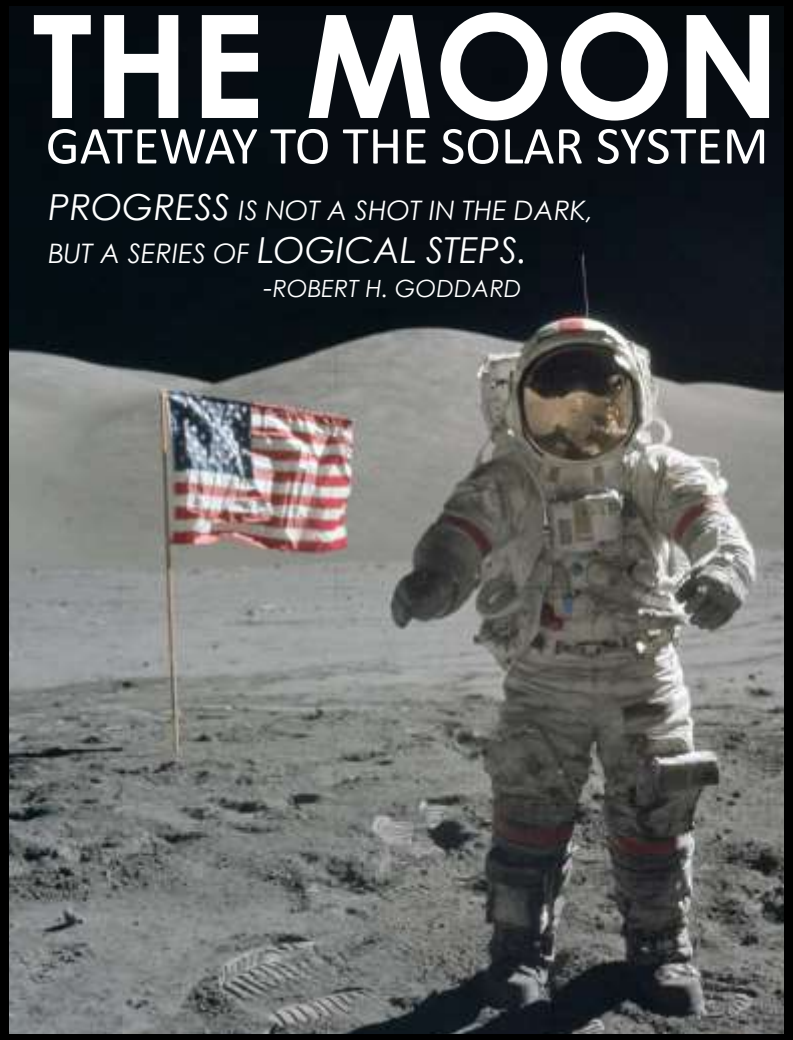
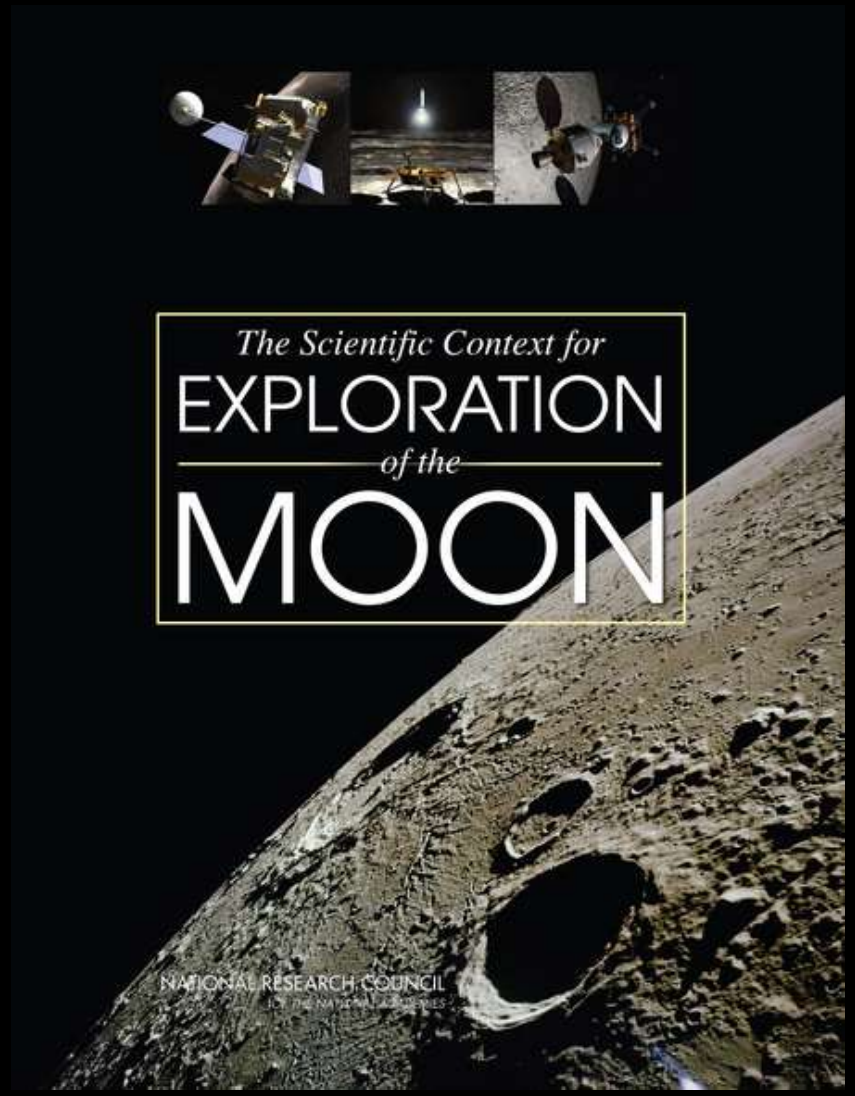
Meeting of the Committee on Astrobiology and Planetary Science, September 10-12, 2019
California Institute of Technology Keck Institute for Space Studies

LEAG Goals

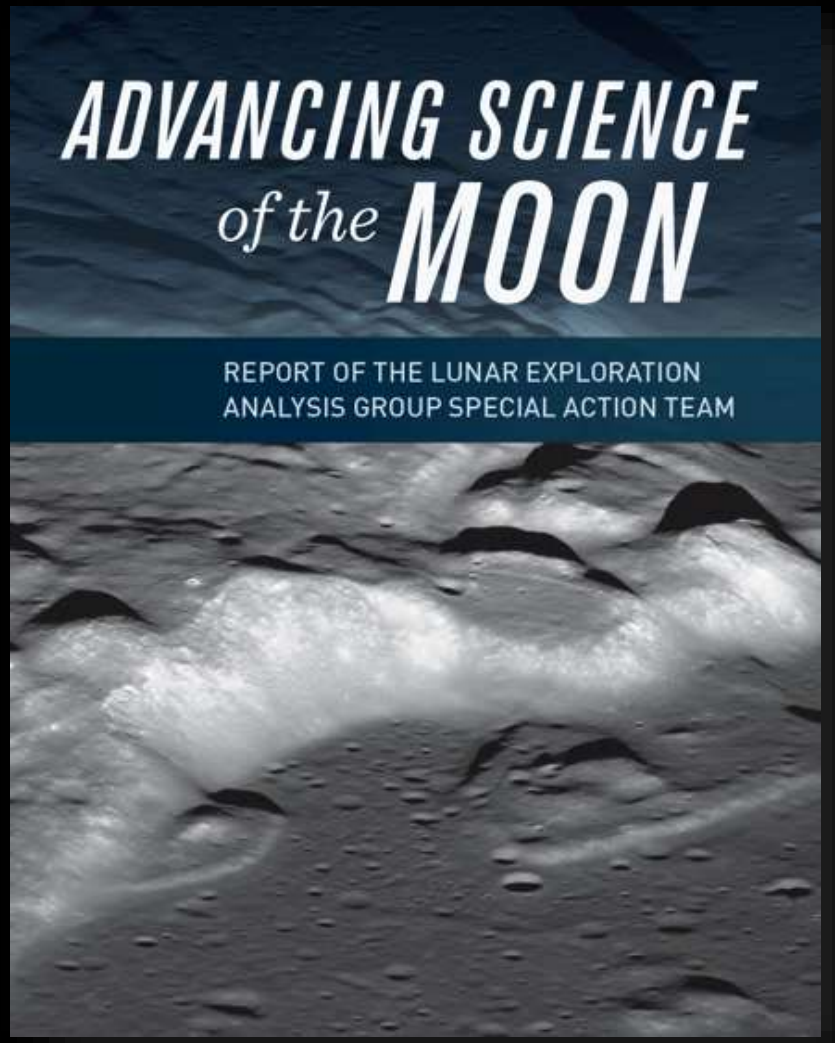
- LEAG maintains the Lunar Exploration Roadmap, a living document that provides an integrated plan for exploration of the Moon and beyond. The Roadmap includes three themes:
  - *Science Theme:* represents community consensus on high-priority science goals that can be achieved through lunar exploration
  - *Feed Forward Theme:* describes the goals and objectives of using the Moon to prepare for future missions to Mars and other destinations
  - *Sustainability Theme:* examines how a sustained human presence can be extended to the Moon
- LEAG is developing a stand-alone science goals document to accompany the LER
  - A lot to draw from: Lunar Exploration Roadmap, Scientific Context for Exploration of the Moon, Advancing Science of the Moon report, among others



Lunar Exploration Roadmap
Science, Feed Forward, and Sustainability themes, updated in 2016



2007 NRC Report
8 prioritized science concepts and associated science goals



2017 update from 2007 NRC Report
Current statement of the LEAG community science goals; not reprioritized

Decadal Survey: Six Big Questions

- Generally positive community reception to the “Big Question” concept for organizing the next Decadal
  - Of course, not uniformly positive, some strong feelings about preserving body-centric organization
  - Firm section page limits could help prevent any one question from overwhelming the others

- How do solar systems form and evolve over time, and when did major solar system events happen?
  - Solar system dynamics, bombardment chronology, and observations of nascent extrasolar systems
- How do planetary interiors differentiate and evolve through time, and how are interior processes expressed through surface–atmosphere interactions?
  - Geophysical studies of the lunar interior, volcanic processes, and outgassing
- What processes shape planetary surfaces and how do these surfaces record solar system history?
  - Planetary geology, lunar volatiles, and solar wind/plasma interactions
- How do worlds become habitable, and how is habitability sustained over time?
  - Most relevant to Mars and Ocean Worlds; also includes volatile formation, transport, and delivery: the volatile history of the Earth–Moon system may be preserved on the Moon
- Why are the climates of planetary bodies so diverse, and how did they evolve over time?
  - Atmospheres, the history of the Sun, aspects of habitability, parts of Venus-related science, and other key topics
- Is there life elsewhere in the solar system?
  - Astrobiology as it relates to Ocean Worlds, Mars exploration, studies of meteorites, and other key topics

One Big Complicated Question

- What are the resources and hazards of the Solar System for human exploration?
  - This question would encompass locating resources on the Moon, small bodies, the Jovian system, and Mars (i.e., extraterrestrial economic geology), and identification of potential hazards (e.g., radiation) to human exploration and settlement of the Solar System
  - Similar to planetary defense, planetary science is well poised to answer this question
  - Currently, resource potential is “bonus” science, same with radiation hazards
  - Worth considering some form of this question in order to increase interconnectivity and examine priorities for an area on the boundary of planetary science and human exploration
- Previous decadal surveys have taken a generally hands-off approach to human space exploration, but a couple of important things to note:
  - Human exploration is one avenue for NASA to implement decadal science priorities
  - Decadal should refrain from “value judgements” about the role of human exploration

On new implementation opportunities

- CAPS will discuss “New Topic” areas, including commercial entities, public/private partnerships, philanthropic spaceflight
- LEAG feels that these are not “new topics” for the decadal panels to consider but rather new modes of acquisition and new opportunities for implementation
- Decadal provides science priorities → NASA implements them using all the tools at their disposal, which include R&A, competed and directed SMD missions, HEO partnerships, pay-for-data or pay-for-delivery commercial models, public/private partnerships, philanthropic spaceflight
- Could be value-added for the decadal to spend a chapter highlighting how science priorities (from all AGs, not just lunar! – e.g. Mars, planetary defense, etc.) might be mapped to emerging opportunities. The makeup of such a panel could be augmented with expertise in emerging opportunities.

On the question of New Frontiers

- The LEAG community consensus is that New Frontiers mission priorities should be determined by the decadal process, and updated in a mid-decadal review if necessary
- The decadal process makes a thorough attempt to determine community priorities. If left open:
  - Individual managing institutions would become the gatekeepers of what is submitted
  - No guarantee that NF reviewers will have the same broad, informed perspective
- Related: Numerous lunar submissions to the Planetary Mission Concept Studies
  - Community still unclear on prioritization of selections, how/if further concept studies will flow from white paper input

LEAG will devote the first day of our October meeting to discussions related to the next decadal survey, developing consensus on community priorities, and the formulation of white papers
https://www.hou.usra.edu/meetings/leag2019/