Planetary Science with Astrophysical Assets

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NASA Planetary Science Advisory Committee, March 10, 2020
Purpose of the Small Bodies Assessment Group committee

• To compile a uniform set of basic capabilities that maximize the yield of Solar System science with future Astrophysics assets (white paper for 2020 Astrophysics Decadal Survey).
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• Solicited input from the community, including a call for input via a webform.
Motivation

PSAA benefits the missions as well as the Planetary Science community. Some of the astrophysics platforms that have yielded significant contributions to planetary science include:

Holler et al. 2018

TESS - view of 47P, Farnham et al. 2019
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- **Spitzer**: Numerous! TNO/Centaur Size Survey, SEPPCoN, NEO survey.
- **HST**: Numerous!… SL9 impact of Jupiter, MBC/AA, Early KBO/TNO surveys, 486958 Arrokoth

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- **Pan-STARRS**: One of the most prolific discoverers of small bodies in operation.
PSAA Topical Investigations

- **Scientific Investigations:**
  - Identify the most compelling subjects of study.
  - Identify the key capabilities that are unique to AA platforms for the highest-priority subjects.
  - Identify the range of Platform and Payload Criteria that are required to span the populations.

- **Technical Investigations:**
  - Identify the gaps in instrumentation and spacecraft architecture.
  - Investigate the trade spaces of the technical desirables.
  - Weigh implementation costs against the range of capabilities.
Examples of Capabilities and Science Drivers

- **Compelling Topics:**
  - Drivers of MBC activity.
  - Distribution and Composition of Oort Cloud Objects.
  - Giant Planet Aurorae.
  - Comet D/H ratios.
  - Planet IX
  - Tracing Solar System Evolution through asteroid composition

- **Key Capabilities:**
  - Non-sidereal Tracking/Guiding.
  - Large Area FOV.
  - High Spatial or High Spectral Resolution.
  - High sensitivity and collection area.
  - Rapid read-out/sampling.
  - Multiple visit cadence.
Major Capability: Non-sidereal Tracking

- Non-sidereal tracking capabilities are necessarily limited by the specifics of the platform.
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However, failure to accommodate non-sidereal tracking altogether greatly imperils the ability of a platform to have a fully active planetary science program, impacting the angular resolution, sensitivity, and astrometric and photometric accuracy.
Major Capability: Dynamic Range and Read-out

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- Owing to the motion of planetary objects on the sky, it is essential that individual observations be kept.
- Accurate station keeping is necessary for astrometry.
- Minimize scheduling penalties for accommodating Planetary Observations and Non-Sidereal tracking.
### Enhanced Capabilities and Benefits

<table>
<thead>
<tr>
<th>Capability/Priority</th>
<th>Small Bodies</th>
<th>Giant &amp; Terrestrial Planets</th>
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</thead>
<tbody>
<tr>
<td>Non-sidereal Tracking (1)</td>
<td>• Allows the full benefits of the observing platform to be used for planetary bodies.</td>
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<td>FOV/FOR (2)</td>
<td>• Large FOV allows simultaneous imaging of cometary coma, tails, and trails.</td>
<td>• A small FOV can impact the ability to monitor the planet’s full disk, or conduct simultaneous satellite observations.</td>
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<td></td>
<td>• Expanded FOR allows access of small bodies through more of their orbits.</td>
<td>• A limited FOR impacts the ability to study a given planet in the time-domain.</td>
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<td>Scheduling, MOS-GDS (3)</td>
<td>• Flexibility in scheduling without special penalties for planetary targets allows more complete exploration of the time-domain.</td>
<td>• Complete meta-data and well calibrated individual frames facilitates small body discoveries and characterization of temporal behavior.</td>
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<tr>
<td>Imaging, Dynamic Range and Readout (4)</td>
<td>• Larger dynamical range allows for comprehensive comet imaging.</td>
<td>• Limited dynamic range impacts imaging and spectroscopy of atmospheres, aurorae, and satellite volcanism.</td>
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<td>Spectroscopy (5)</td>
<td>• Flexibility for marginal alterations of wavelength coverage to include key spectral features can greatly impact planetary spectroscopy across categories.</td>
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<td>Survey cadence (6)</td>
<td>• For surveys, appropriate cadence considerations tailored to the planetary bodies of highest interest are critical to the survey success.</td>
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#### e.g. Impact on proposed modifications on Pl. Sci. Cases for WFIRST

<table>
<thead>
<tr>
<th>Category</th>
<th>Giant planet atmospheres</th>
<th>Io volcanoes</th>
<th>Europa plumes</th>
<th>Titan clouds</th>
<th>Smaller giant planet satellites</th>
<th>Binary astereoids w/ CGI</th>
<th>Asteroid families</th>
<th>Active astereoids</th>
<th>Trojan astereoids</th>
<th>Centaurs &amp; KBOs</th>
<th>Comets</th>
<th>Inner_Oort Cloud objects</th>
<th>Occultations</th>
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Holler et al. 2018

#### MILAM ET AL. 2016

![Graph showing spectroscopy with JWST](spectroscopy_w_jwst.png)
Conclusions

• PS-enabling capabilities should be considered early in the design.

• Planetary Science capabilities must be weighed in the balance of the overall platform capacities.

• Small alterations should be considered with other science goals for their impact on the Planetary Science usage cases, such as:
  - Flexibility for marginal alterations of wavelength.
  - For surveys, appropriate cadence considerations for surveys.