Spitzer Space Telescope Update

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NASA APAC  18 Oct 2017
• Science operations funded to 31 Mar 2019
  - Close-out to be completed in FY20

• Observatory & IRAC in excellent health
  - No degradation in sensitivity at 3.6 or 4.5 μm
    - 1 hour, 5σ: 3.6/4.5μm • 720/1040 nJy
    - Routinely achieve near-photon limited performance for high-precision photometric observations, precisions down to 30 ppm

• Orbital geometry is primary ops challenge
  - Spitzer is now ~1.57 au from earth, +0.1 au/year
Cycle-13 Science  
Oct 2016 – Oct 2018
14,753 hours selected • execute 7000+ hours per year

Exoplanets - 3600 hours
Near Earth Objects + Comets - 2020 hours
Early Universe
- 5300 hours NEP/CDFS
- 1500 hours COSMOS

- Exoplanets
- Brown Dwarfs
- Galactic Structure
- Star Formation & Debris Disks
- Young Stellar Object Variability
- Compact Objects & Evolved Stars
- Distant Universe & Cosmology
- Nearby Galaxies
- Galaxy Clusters
- AGN/ ULIRGS
- Solar System Objects
- Transient Universe
Selecting New Science
Director’s Discretionary Time (DDT)

• Two DDT proposal reviews

<table>
<thead>
<tr>
<th>DDT Review 2017</th>
<th># Submitted</th>
<th>Hours</th>
<th># Selected</th>
<th>Hours</th>
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<tbody>
<tr>
<td>February</td>
<td>20</td>
<td>1773</td>
<td>11</td>
<td>383</td>
</tr>
<tr>
<td>September</td>
<td>42</td>
<td>2252</td>
<td>19</td>
<td>467</td>
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85% of 2017 DDT time proposed is for exoplanets

• Cycle-14 • April 2018 deadline
  - final 5 months, Nov 2018 – Mar 2019
  - 3,000+ hours
Spitzer’s Earth-trailing Solar Orbit

October 2017
Spitzer is ~1.57 AU from earth
Benefits from the Orbit

- 20-day long observations with limited interruptions (TRAPPIST-1, GJ1214)
- Thermally stable environment
- One-third of the sky always visible
- Shortest visibility window is ~ 40 days, twice per year, in the ecliptic plane
Constraints from the Orbit
Observatory pitch angle

- Maximum pitch angle occurs in March each year

<table>
<thead>
<tr>
<th>Year</th>
<th>Maximum Downlink Pitch Angle</th>
<th>Hours</th>
<th>Data Rate (kbps)</th>
</tr>
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<tbody>
<tr>
<td>2017</td>
<td>44.5°</td>
<td>4</td>
<td>550</td>
</tr>
<tr>
<td>2018</td>
<td>48.5°</td>
<td>3.5</td>
<td>550</td>
</tr>
<tr>
<td>2019</td>
<td>52.5°</td>
<td>3</td>
<td>550</td>
</tr>
<tr>
<td>2020</td>
<td>56.5°</td>
<td>2.5</td>
<td>250</td>
</tr>
</tbody>
</table>

- Have empirically characterized observatory behavior at 48.5° – good through Nov. 2018

- After each downlink, 2 hours of science scheduled at <10° pitch for battery recharge
Impact on Science

- More time in lowest data volume modes due to availability of DSN passes and maximum length of downlinks

- Supporting a few long, higher-data volume observations with custom-built sequences (Instrument Engineering Requests – IERs)
What Spitzer Can Support • 2018 - 2020
Assumes DSN support comparable to 2017

- Extragalactic Surveys: 100-sec full array
- Exoplanets: 2-sec sub-array, 4.5µm
  - source brightness fainter than 7.5 mag
- Microlensing: 2017 level (350 hrs)
  - more hours if no ch2 data

Spitzer’s DSN requirements become more restrictive in 2018
> 40°elevation, 70m + 34m array to maintain 550 kbps
SPITZER SCIENCE BEYOND SPRING 2019

- Distant Universe – Giovanni Fazio, et al.

https://arxiv.org/abs/1710.04194
**Spitzer** Observations support Exoplanet Science with NASA Missions

- **Efficient and Effective Observations with JWST and HST**
  - Orbital parameters to enable characterization observations of transits and secondary eclipses of K2 and TESS discoveries
- **Long time baseline observations**
  - Discover additional planets in the system
  - Transit-timing observations to measure the masses of planets
  - Phase curves to interpret heat (re)distribution
  - Exoplanet atmospheric weather variability
- **Complements** *JWST*’s far-IR wavelengths and *HST*’s optical wavelengths.

*Spitzer* phase curve of WASP-43b
Spitzer microlensing parallax campaign is the most vibrant microlensing program in the United States – and the only space-based program in the world

- Critical role in preparing for the WFIRST microlensing mission
  - Spitzer program is making the first comparison of the occurrence rate of planets in the disk and the bulge.
  - Spitzer frames the scientific questions to be answered by WFIRST

- Validating microlensing techniques that will be used to characterize WFIRST microlensing planets

- Spitzer characterized a 1 Earth-mass planet around a Brown Dwarf
- The microlens parallax effect is clearly seen because Spitzer is ~1 AU from the Earth and able to observe the event simultaneously.
POSSIBLE NEW SPITZER SURVEYS ARE SHOWN IN RED AND DISCUSSED IN DETAIL IN THE WHITE PAPER
Brown dwarfs are prime JWST targets for:
- biosignature detection on habitable exoplanets

SDSS J1520+3546 (T0 brown dwarf) data from Spitzer GO 80179 (Metchev et al. 2015).

In 2000 hours Spitzer will detect >= 1 habitable exo-Earth around $i > 70^\circ$ brown dwarf rotators at ~95% confidence.

- studying exosolar atmospheric dynamics

Spitzer monitoring of 3 brown dwarfs revealed zones, spots, and planetary-scale waves (Apai et al. 2017).
Near Earth Objects

Measure thermal flux from NEOs

- Thermal model gives diameter and albedo

For most objects measure full/partial lightcurves

Spitzer
Extended Mission: About 10% of all NEOs per year

JWST cannot make these measurements

NEOWISE mission ends 2018

Legacy: LSST

No other facility can do this science
Summary

• Through ~ November 2020

  - Project has shown that Spitzer operations are feasible

  - Community has shown that Spitzer can execute important and exciting science