Implementing Portals of the Universe: Lessons Learned

Spitzer Space Telescope

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Basic Parameters

Mission Duration: 8+ years: year 3 of Warm +5.5 yr Cryogenic Mission

Userbase: international, thousands

Archive Data Volume: > 50 TB, tens of millions of data files

Instruments: Warm Mission -- IRAC 3.6 and 4.5 micron imaging

Cryogenic Mission: IRAC (3.6 – 8 micron imaging), MIPS (24, 70, 160 micron imaging+ SED mode), IRS (5-40 micron spec. +16 micron imaging)

Program Model: 100% GO time for Warm Mission

Cryogenic Mission: 80-85% GO, 15-20% GTO + Archive & Theory programs

Proposals/Cycle: Warm Mission 150-200 (by design)

Cryogenic Mission: 650 – 850

Users: >8,000 PI/CoIs for mission (10% unique), 20% PIs new in Cycle-8

53 Legacy/Exploration Science programs have engaged community in new way

Legacy program was pioneered by Spitzer with input from community task force

Funding model: Formulaic data analysis funding

Warm Mission: $5-10m/cycle GO funding 7000 – 8000 hours/year

Cryogenic mission: $20-25m/cycle GO funding 6000 – 6500 hours/year

Default proprietary data period:

Exploration Science (80% of Warm Mission hrs) – no proprietary period

Cryogenic mission – Legacy programs also had zero proprietary period

Regular GO programs – 1 year

Best Practices

Highlight #1: Major Mission Evolution is Possible*

- Cutting-edge science = first requirement
- Community input is key for major science operations changes
  - 6-month community input process, followed by the Warm Mission Workshop, was key in helping us formulate final science operations changes moving from cryo to warm operations
- Minimize additional risk to the mission hardware
- Accept some additional risk to the science
  - Fewer detailed technical reviews of proposals
  - Slower recovery from anomalies

*Without changes in hardware

Highlight #2:
Complexity does not equal Performance

- Total Spitzer instrument moving parts = 2
  - Only one of these has ever been used (MIPS scan mirror)
  - IRS & MIPS were fully functional when shut off after 5.5 years of cryogenic operations
  - The IRAC instrument is in its 8th year operations and was last power-cycled 1,022 days ago.
- Defined Observing Modes [only 8 in cryo-mission]
  - AOTs – Astronomical Observation Templates
    - Several sets of parameters available in each AOT
  - Added additional AOT for IRS imaging in cryo-mission
  - Added warm IRAC imaging mode
  - Just added new peak-up feature to warm IRAC imaging
  - IERS (Instrument Engineering Requests) used to support high-impact science not available with AOT

Highlight #3:
Formulaic Data Analysis Funding

- With sufficient available funding, using a funding formula based on the program size and complexity will facilitate completion and publication of the proposed research
  - We have no evidence that not including institutional overhead as a factor harms the research
  - It is not an efficient use of funds to pay a staff of people to handle modifications of budgets moving $1000 from travel to post-doc salaries with multiple levels of approvals required
- Optimally, special funding requests should be able to be handled at the Director's level

What are the Constraints in Current Policies?

Suggestions & Concerns #1

- For Community Observatories that face cancellation in the Senior Review as a real option, the timing of the SR makes it extremely difficult to plan and execute the cycles that span the SR funding boundary
  - Hubble & Chandra can plan cycles across SR boundaries
  - Spitzer can't without selecting several months of observations that may not be executed – even 3 more months of funded operations through the calendar make a big difference in the planning

Suggestions & Concerns #2

- Reducing your instrument complement from three to 2 channels of a 4-channel instrument does not mean your observatory can reduce its operating costs by 5/6
- The infrastructure that each observatory is designed with will provide hard constraints on the minimum cost to operate
- A detailed project staffing review does have benefit for both NASA and the project involved

Suggestions & Concerns #3

- The last decade has been a true golden age for space astrophysics.
- During the next decade we are in serious danger of losing much of the intellectual capital and mission expertise that made this possible.

Summary

- The Spitzer mission is a prime example of why NASA builds space astrophysics observatories.
  - The mission successfully accomplished the science mission it was built to execute.
    - CURRENT MAJOR SCIENCE THEMES WERE NOT PART OF SCIENCE MISSION WHEN DESIGNED, BUILT
    - CAPABILITY ABLE TO MATCH COMMUNITY SCIENCE NEEDED
  - Spitzer has evolved into NASA's primary exoplanet characterization instrument, a science field didn't exist when the observatory was originally planned. Capability exists due to:
    1. The robust design and engineering of the observatory and instruments and the unique orbit.
    2. The quality and dedication of the science and operations staff flying the mission.
    3. The creativity of the science community.
  - Spitzer has been able to benefit from/capitalize on progress from other missions – HST-WF3/Herschel/WISE/Kepler/etc. to keep our science palette fresh