Spitzer Space Telescope
Current Status and Future Plans

Great Observatories Workshop
Pasadena, 22-24 May 2006

Current Status

- Instruments and Observatory are operating well
- Observing efficiency has continued to increase
- Executing 7000 hours of science/year
- Cycle-3 selection just completed
  - *June 2006 through June 2007*
  - *7500 hours total*
    - 6000 hours General Observer
    - 1125 hours Guaranteed Time Observer
    - 375 hours Director's Discretionary Time

Cycle-3 Selection

- General Observer
  - *Legacy 8 programs (4 lrg/4 med) 1832 hours*
  - *Large (>200 hrs) 1 program 307 hours*
  - *Medium (50-200 hrs) 11 programs 933 hours*
  - *Small (< 50 hrs) 175 program 3040 hours*

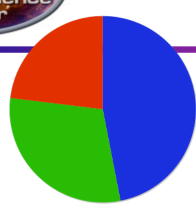
Total: 195 programs, 6112 hours

- Archival 13 programs $922,194
- Theory 12 programs $824,809

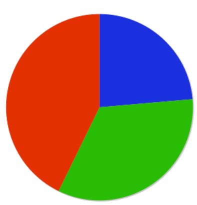
Total: $1.8 million (same as Cycle-2)

Instrument Usage

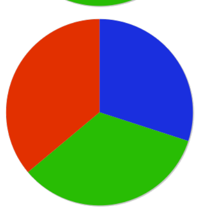
Cycle-0



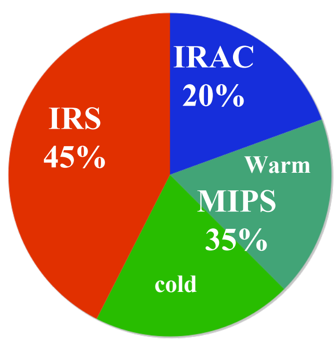
Cycle-1



Cycle-2



Awarded: Cycle-3



Future Cryogenic Cycles

- Expect a ~5.5 year cryogenic lifetime
  - *Through ~April 2009*
- Cycle-4 is a 12-month cryogenic cycle
- Cycle-5 is a 6-10 month cryogenic cycle
- Expect scheduling efficiency to remain high
- GTOs allocated 15% of cryo-mission observing time
- Up to10000 GO hours available in Cycles 4,5

The Spitzer Extended Mission

Our Vision: To Fully Exploit NASA's and the Community's Investment in the Spitzer Mission

We will do this by:

I Capturing the full legacy of Spitzer into a robust, permanent archive

II Extending the science from Spitzer beyond the Liquid Helium lifetime through a vigorous archival research program

III Utilizing the continuing observatory capabilities for unique, vital science possible only with Spitzer

III. The Asset of Post-Cryogen Spitzer

- At end of cryogenic phase, Spitzer will still be a unique space observatory
  - *Telescope should equilibrate at <30K in solar orbit*
  - *IRAC 5'×5' FOVs @3.6, 4.5μm will operate in parallel*
  - *3-5μm sensitivity essentially unchanged from cryogenic phase, unmatched until JWST flies*
    - No measurable degradation in the IRAC arrays to this point
  - *Observatory represents over a billion dollars cumulative investment*
- Powerful capabilities
  - *Finely tuned, calibrated science instrument*
  - *Wide-field, superb mapping engine*
  - *Time-domain access on all scales from milli-seconds to years*
- Well-honed operations,
  - *~ 6 years of experience and optimal efficiency*
  - *Stable, efficient ground support and data analysis system*

Spitzer Post-Cryo Sensitivity

IRAC 3.6 & 4.5μm bands match WISE bands 1&2 and lie in JWST sweet spot

~3 orders of magnitude between WISE and JWST sensitivity will be the domain of Spitzer/IRAC as the tool of choice

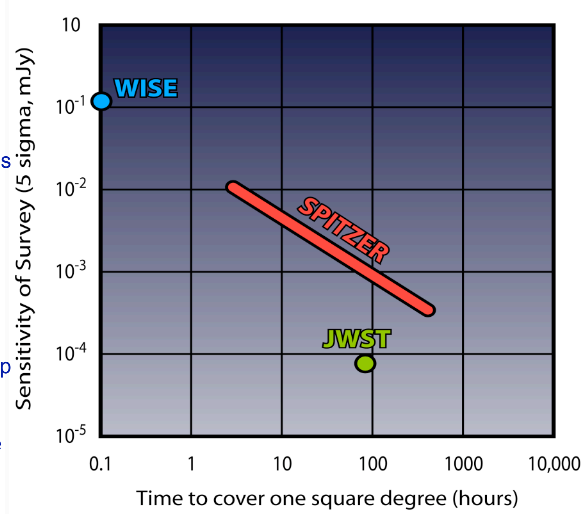
100 seconds (5σ)

Band	Spitzer	WISE
3.6μm	3μJy	120μJy
4.5μm	6μJy	160μJy

Shallow integrations will follow up on WISE

Deepest integrations will provide path-finding science for JWST

Survey Comparisons at 3.6 microns



The Science Opportunity of Post-Cryo Spitzer

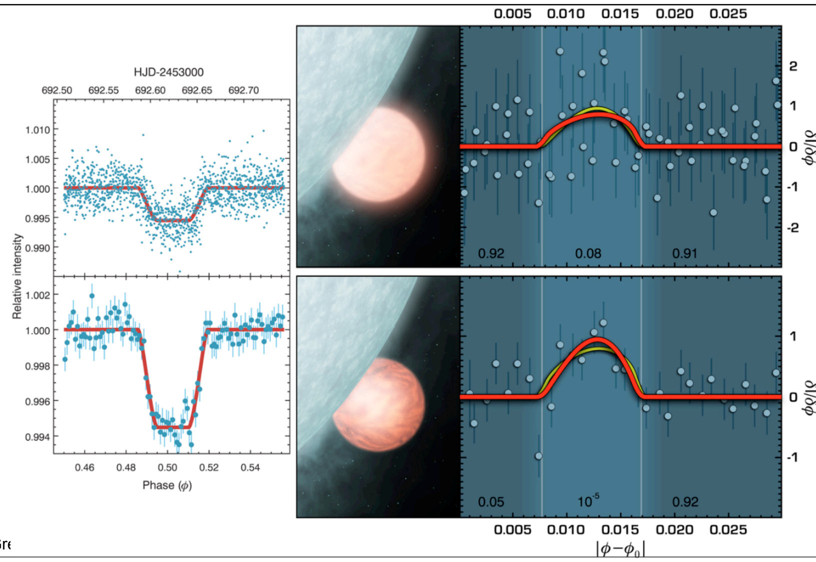
- There are many unique, exciting science opportunities for a warm Spitzer mission.
- Some examples of such large projects can be extrapolated from current science programs
  - *Extrasolar planet studies*
  - *Wide area, deep surveys for clusters of galaxies, high-z quasars*
  - *Finding most of the brown dwarfs in the solar neighborhood*
  - *Watching forming stars grow*

Science Example: Extrasolar Planets

- Extrasolar Planet Characterization:
  - *Spitzer IRAC's sensitivity allowed the first direct detection of radiation from extrasolar "hot Jupiters" via measurement of the depths of their secondary transits.*
    - These revolutionary observations provide unique constraints on extrasolar planet temperatures, atmospheres and orbits.
  - *A warm Spitzer can provide planetary characterization follow-up for the additional targets that will be found by the many ground-based and space-based surveys that will be undertaken in the next several years*
    - for ~100 targets, total time ~ 2000 hours.

Probing Structure on Extrasolar Planets

High signal-to-noise observations of occultations can probe temperature distribution of the illuminated surface, study the nature of planet's atmosphere



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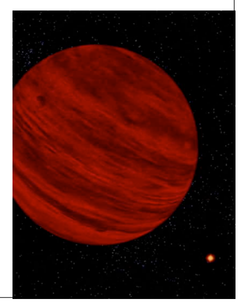
Science Example: Wide Area Surveys

- Survey a region of order 250 sq. degrees to a depth of order 3.5 and 6 μJy at 3.6 and 4.5μm
  - Will reach the same depth as SWIRE, but five times the area.
    - Can map ~ 4 square degrees/day, 100 seconds/pointing
  - Will locate a much larger sample of 1 < z < 2 galaxy clusters
  - Will combine with other large area surveys to allow identification of >1000 quasars with z>4
  - Will reveal a large sample of moderately obscured AGN
  - Total time ~ 1400 hours

Science Example: Finding Most of the Brown Dwarfs

- There are expected to be ~equal numbers of stars and brown dwarfs in the galaxy
  - Most brown dwarfs are expected to be cooler than we've observed (Called "Y Dwarfs")
  - None have been detected to date
- Spitzer should be able to identify dozens of Y dwarfs
  - Wide area surveys with Spitzer at 2 epochs
  - follow-up of WISE candidate list
- Spitzer sensitivity at 3.6 and 4.5μm is needed for detection
  - Invisible at shorter wavelengths



Science Example: Watching Forming Stars Grow

- How forming stars assemble themselves is unknown
  - What fraction of a star is a steady process? What fraction comes in large gulps?
  - Most important phase is when stars are embedded and hence invisible in optical
- A Spitzer monitoring project (with achieved accuracy of 0.1%) can establish temporal variability of hundreds of stars of age less than 10^6 yrs over timescales of minutes to years

What Limits Spitzer Operations?

- Projected Spitzer Lifetime constrained by:
  - *Adequacy of Consumables*
    - Cryogen Depletion anticipated to be May 1, 2009 ± 91 days
    - No Other Consumable Issues
  - *Launch + 11.3~ years represents natural end of Spitzer operational phase, because of telecom performance degradation*
    - Recovery of 40 bps (Safe Mode Rate) Over Low Gain Antenna No Longer Possible after December 2014

Observatory health capable of providing a credible mission for 5 years following cryogen exhaustion

Science Planning Challenges

- Orderly completion of Cryo Mission – Last Cryo Call (Cycle 5)

  ➔Prioritization of observations needed because of lifetime uncertainty
- Science in post-cryo mission selected through the standard proposal process:
  - *Usage of Spitzer archive, with substantial funding for increased activity*
  - *Usage of observatory to acquire ~7000 hrs/yr, with emphasis on large and "huge" legacy-style projects*
  - *SSC must support these efficiently with a greatly reduced staff, while completing the final reprocessing of the cryo-mission data*
- Spitzer project and SSC have estimated community funding and a bare-bones level of operations to meet these challenges
  - *NASA already committed significant funds to a Spitzer Post-Cryo Mission*
  - *~50% of annual budget allocated to user community*
    - Support substantial archive program
    - Support new IRAC GO science

Summary

All science, technical and programmatic elements are conducive to a robust post-cryogen Spitzer mission, consisting of the following three elements:

I - Capturing the legacy of Spitzer through a permanent archive

- *We will apply the full knowledge and understanding of Spitzer*
- *Timeliness is critical, while we still have the Spitzer experts*

II – Pursuing a vigorous Spitzer archival research program

- *Spitzer is impacting all major areas of astrophysics, and will continue to do so well beyond the cryogenic mission*
- *Spitzer archival research & observations will continue strong synergy with Hubble, Chandra, theory, lab astro, other facilities*

III - Utilizing the post-cryo observatory until its natural end

- *Unique resource will provide superb science that is unmatched at 3.6 and 4.5 µm until JWST starts its science mission*