Contemplating A Warm Future

Spitzer Science
In The
Post Cryogen Phase

Just What Are We Talking About?

What we will lose:
- Imaging at $\lambda > 5\mu m$
- Spectroscopy at all $\lambda$

What we will retain:
- Imaging at 3.5 & 4.5$\mu m$

How long do we have:
- 3 - 5 years - 21-35,000 hrs

15 years of HST
3000 yrs of Keck at 3.5$\mu m$
Your very own MidEx mission!

Sensitivity
Mapping
- Spatial resolution
- Spectral Coverage
Big Picture Science Questions

…. Its not a sure thing

Science Priorities from the Decadal Survey:
• Large-Scale properties of the Universe, Matter, Energy, Expansion History ✓
• First Stars and Galaxies ✓
• Formation and Evolution of Black Holes ?
• Formation of Stars and Planetary Systems ✓
• Impact of Astronomical Environment on the Earth ✓

Big Picture Science Questions

Other Science Questions:
• Is there evidence that the Universe was created?
• How and when did the Sun and Moon form?
• What are stars and how did they form?
• What are redshifts and do they support a Big Bang?
• What about black holes?

How did Noah get all those dinosaurs on the Arc?
Where are We in the Big Picture?

- Integrated Extragalactic Background Light
- Photospheres of stars and accretion disks
- Reprocessed light from stars and accretion disks

$Z \sim 1 - 3$ galaxies
Evolved Galaxies

1.6 $\mu$m H$^{-}$ peak

$Z = 0$

1.0

2.0

3.0

Spitzer Warm Mission Workshop 7

Evolved Galaxies

$V - 4.5 \mu m$

No Evol.

E/S0

Disks

Dwarfs

Spitzer Warm Mission Workshop 8

Evolved Galaxies

$V - 4.5 \mu m$

Redshift
**Z = 6 Galaxies**

3.6x10^{10} M_{\text{sun}}

Balmer Break

Ly\alpha forest

1450 Myr

10 Myr burst (0.7%)

**Cool Stars & Hot Planets**

5 Gyr models (R=1000) at 20 pc

T_{\text{eff}}
Type I & II AGNs

What Should We Be Observing?

GOOD
Galaxies 1 < z < 2
Galaxy Clusters
Cool & Giant Stars
Exoplanets
Planets & Small Bodies

Less GOOD
Star Forming Galaxies
AGN
ULIRGs
AGN
Hot Stars
Key Science Questions

• What is the halo mass distribution as a $f$(time,environment)
  
  *IRAC probes $z > 6$ to $z \sim 1$
• Does light trace mass (no!) - what is the bias?
  
  *Spitzer & HST synergy via weak lensing
• When did the red sequence form and when did clusters & groups turn around?
  
  *IRAC and ground-based Vis - Near-IR surveys
• How are stellar disks structured, how are they built and what truncates them?
  
  *IRAC surface brightness sensitivity
• Do we understand the components and structure of the MW?
  
  *Dust-penetrating & mapping power

Key Science Questions

• What is the stellar/substellar mass distribution as a $f([\text{Fe/H}],\text{environment})$
  
  *IRAC probes the bottom of the MS and beyond
• How do protoplanetary disks form and evolve?
  
  *Spitzer probes hot dust
• What sets the equilibrium radii of giant planets & how are they inflated?
  
  *300 micro-magnitude eclipse photometry!
Extragalactic Surveys

Galactic Plane Surveys: A Comparison
How Should We Observe?

Top Level Science Goals

Legacy Program

- Large Surveys
- Data Products
- Ancillary Data
- Science Papers
- Follow-up Observing Programs

GO Program

- Targeted Science Papers
- Follow-up Observing Programs

Grass Roots Science Priorities

Where will the supporting data come from?

From the ground:
- SDSS, HyperSuprime, VST, PanStarrs, LSST
- UKIIDS, NEWFIRM, VISTA
- CARMA, ALMA

From Orbit:
- HST/WFC3, JWST, JDEM

Spectroscopy:
- VIMOS, IMACS, Gemini/Subaru WFMOS

Should we attempt coordination or continue with laissez faire & (caveat emptor!)?
Questions?

- What are the most important science drivers for a warm Spitzer mission? *We’re working on it*
- What should be the duration of the warm mission? *As long as possible/practical*
- What is the appropriate balance between smaller and larger programs? *One size does not fit all!*

“Far” extragalactic best served by large/huge programs
“simple” experiments at point of diminishing returns?
“Near” extragalactic best addressed with medium programs?
*Objects are diverse and low sky density*
Milky Way & Stellar Astrophysics needs a mix
*Contiguous surveys and target programs*
Planets and Exoplanets work well in the current model
*The field moves too fast to commit for long periods of time*
Questions?

- Should any science programs be specifically solicited for the warm mission?
- Are there any ‘huge’ (> 5000 hours) projects that should be done? If yes, how should they be selected and organized?
- How does the community participate in science of big projects if not part of the executing teams?
- Can most of the review process be done remotely instead of bringing 100 people to Pasadena annually for week?

* A Modest Proposal.... *

Science Planning in the Warm Era

Consider this:

*There is only one observing mode*

PI’s propose: (1) What science they want to do, (2) *where to point*, (3) *how long to expose*, and (4) how they will analyze their data.

Reviewers will discuss: (1) did they write a good science story, (2) *are they pointing in a sensible place*, (3) *are they exposing for the right duration*, and (4) can they properly analyze their data.

*The proposal process should not be a creative writing contest with Spitzer time as the first prize*
Science Planning in the Warm Era

Alternatively one could:

- Identify a number of Key Science Areas and some guidelines for programs that address these
- Invite teams to propose (1) where to point and (2) how long to expose, and describe what ancillary data they can bring to bear on a problem.
- Invite teams to propose for funding to deliver high-level data products and tools to the Spitzer archive
- Enable coordination with other large data sets & instruments/facilities
- Allow proposals for large programs outside the Key Science Areas
- Set a threshold below which proposals are reviewed and judged by a standing review committee (30 hours?) Change the cadence for these?
- Decouple funds from observing time for small programs (?)
- Remove proprietary period for programs above the internal review threshold

Questions?

- How should we balance archival support vs. support for new data?
- What public ‘HDF-style’ program should be prepared for the cryo/warm transition period?
- Are ToOs an important component of the warm mission? If yes, at what level?
Some Possible Key Science Programs

• Complete surveys of galactic plane (GLIMPSE2/360?)
• Survey of open clusters
• Structure of disk galaxies
• Exoplanet transits/eclipses
• Survey of SS small bodies
• Searches for T & Y dwarfs in parallel?
• IR-excess in white dwarfs
• Ultra-Deep survey of the end of the Dark Ages
• Spitzer deep survey for galaxy and structure building
• Ultra-wide survey for clusters at z > 1

Questions?

WHERE DO WE GO FROM HERE?

More science planning discussions, coordination with VISTA, UKIIDS, VST, Gemini/Subaru WFMOS, discussions with STScI RE WFC3

Refine science priorities and straw person programs
How do we engage a larger community?
How would this community like to engage in the future?