Panel Session II - SIRTF

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SIRTF

NASA’s Infrared Great Observatory

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Space Infrared Telescope Facility
WHAT IS IT?

- **Infrared Great Observatory**
  - Background Limited Performance 3 -- 180 μm
  - 85 cm f/12 Beryllium Telescope, $T < 5.5K$
  - 6.5 μm Diffraction Limit
  - New Generation Detector Arrays
  - Instrumental Capabilities
    - Imaging/Photometry, 3-180 μm
    - Spectroscopy, 5-40 μm
    - Spectrophotometry, 50-100 μm
  - Planetary Tracking, 1 arcsec/sec
  - 2.5 yr Lifetime/5 yr Goal
  - Launch in August 2003
  - Solar Orbit
Astronomy Across The Spectrum

Contrasting Views Towards the Central ~100 Light Years of our Milky Way Galaxy dramatize the complementarity of NASA’s three Great Observatories: SIRTF (Infrared), Hubble (Optical), and Chandra (Xray).
**Why Infrared Astronomy?**

**Infrared Observations Probe:**

**The Cold Universe**
Much of the IR light that is seen comes from cold clouds of interstellar and circumstellar gas and dust.

**The Dusty Universe**
Much IR light comes from diffuse clouds of interstellar dust and gas that are opaque to visible light.

**The Distant Universe**
Most of the light that comes to us from distant galaxies is in the infrared.
The familiar constellation Orion looks dramatically different in the infrared than in the visible; SIRTF will open the infrared window on the Universe.
M 31 – A NEARBY GALAXY LIKE OUR OWN

Far Infrared

Visible
Why Infrared from Space?

The Advantages of Space:

100% Transmission and a One-Million Fold Decrease in Sky Brightness
The Sensitivity of Infrared Telescopes

The diagram illustrates the sensitivity of different infrared telescopes over a range of wavelengths. The x-axis represents wavelength in micrometers (µm), while the y-axis represents limiting flux in microjansky (mJy). The curves for IRAS, Current State-of-the-Art, and SIRTF are plotted, showing the sensitivity of each telescope across the wavelength spectrum.
The observatory is ~4m tall and has a mass of ~865kg.
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Why a Better Choice?

- Better Thermal Environment (allows passive cooling)
- No Need for Earth-Moon Avoidance (Maximizes observing time)
- No Earth Radiation Belt (no damage to detectors or electronics)
Infrared Array Camera (IRAC)

Simultaneous imaging at 3.6, 4.5, 5.5 and 8 microns

2 adjacent 5’x5’ fields of view

No moving parts
Multiband Imaging Photometer for SIRTF (MIPS)

Simultaneous imaging at 24, 70 and 160 microns

3 adjacent 5’x5’ fields of view

Scan mirror is only moving part
Infrared Spectrograph (IRS)

Spectra from 5 - 40 microns
4 separate modules
Resolutions  60, 600
No moving parts
SIRTF technologies available to be used in future missions include:

- High Performance IR Detector Arrays (possible use in TPF, JWST)
- Lightweight all-Beryllium Telescope Optics at Low T (possible use in JWST)
- Efficient cooling system combining stored cryogens and passive cooling (TPF, JWST)
- Observatory operations in distant orbit (JWST, SIM, TPF)
SIRTF Telescope Installation
SIRTF AT THE CAPE

Final clean room preparations

Rocket fairing being installed
Two Key Science Questions for SIRTF

What did the Early Universe look like?

How do Stars and Planetary Systems form and evolve?
Almost half of the energy emitted in the Universe after the Big Bang is in the infrared. **SIRTF** will search for its origin.
Multiwavelength Imaging Surveys

- MIPS, IRAC (Deep), J,K
- MIPS, IRAC (Med), H
- DEEP/DEIMOS Spectra
- DEEP/CFHT B,R,I
- WFPC2/Groth V,I
- LBG/Steidel SCUBA
- XMM

Background: 2 x 2 deg from POSS
SIRTF’s predecessor, IRAS, found a class of luminous “starburst” galaxies undergoing runaway star formation. Much of this star formation is obscured by dust and invisible in the UV or optical.

… however, IRAS was only sensitive to local galaxies going through such a phase.

SIRTF will vastly improve the census of luminous starbursts across cosmic history. These galaxies pinpoint where approximately half the stars in the Universe were formed.
When Did the Youngest and Most Luminous Galaxies Form?

The deepest images taken by the Hubble Space Telescope, Chandra X-Ray Observatory, and SIRTF will be in the same patch of sky. Together, these coordinated panchromatic images will show us what galaxies looked like when they were first forming when the Universe was \(<10\%\) its current age.

Because SIRTF will be extraordinarily sensitive to mid-IR radiation (~10 to 160 microns) it will be able to detect the youngest and most luminous galaxies. Their radiation, nearly all of which is emitted in the mid-IR, comes from stars in the process of forming and from dust clouds.
SIRTF’s Own Discoveries Will Require Follow-up Observations

...will find sources without optical counterparts...

...which the IRS will study spectroscopically

SIRTF Imaging Surveys of Groth Strip and other regions.....

![Image of SIRTF Survey Imaging Limits and Spectroscopy Limits with flux density vs. wavelength graph]
How Do Stars and Planets Form and Evolve Now?

- New stars are still forming today from the dust and gas in dark interstellar clouds.
- Planets form in large disk-shaped clouds circling newborn stars.

- These “circumstellar” disks are best seen in infrared light.
- SIRTF can study the evolution of disks in the key phase of Earthlike planet formation.
Molecular Clouds: Cradles of Starbirth
What is the Raw Material for Planet Formation?

- The dust particles which form planets glow brightest at the infrared wavelengths where SIRTF will be observing.
- Comets in our own solar system also give off dust particles. SIRTF will show how the composition of our solar system relates to that of other planetary systems.
From Active Accretion to Planetary Debris Disks
Characterizing Planetary Systems:
Planetary Debris Disks in Time

1 Million years
100 Million years
4.6 Billion years
Formation & Evolution of Planetary Systems

SIRTF will study:

- Planetary embryo formation
- Growth of gas giants
- Evolution of mature planetary systems