The Space InfraRed Telescope Facility - *SIRTF*

SIRTF – an Overview

Jay A. Frogel

SIRTF Program Scientist, NASA

Michael Werner

SIRTF Project Scientist, JPL/Caltech

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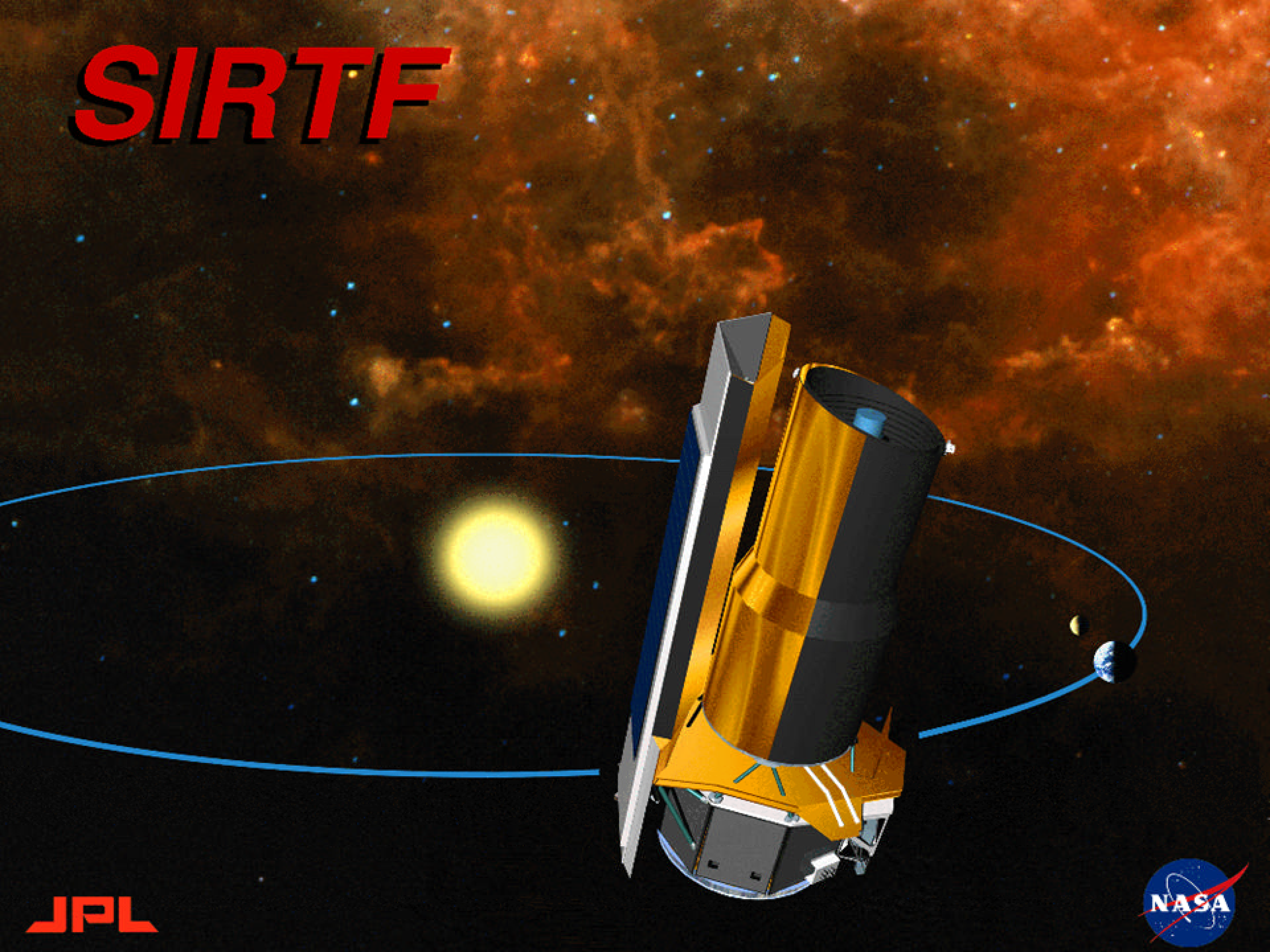
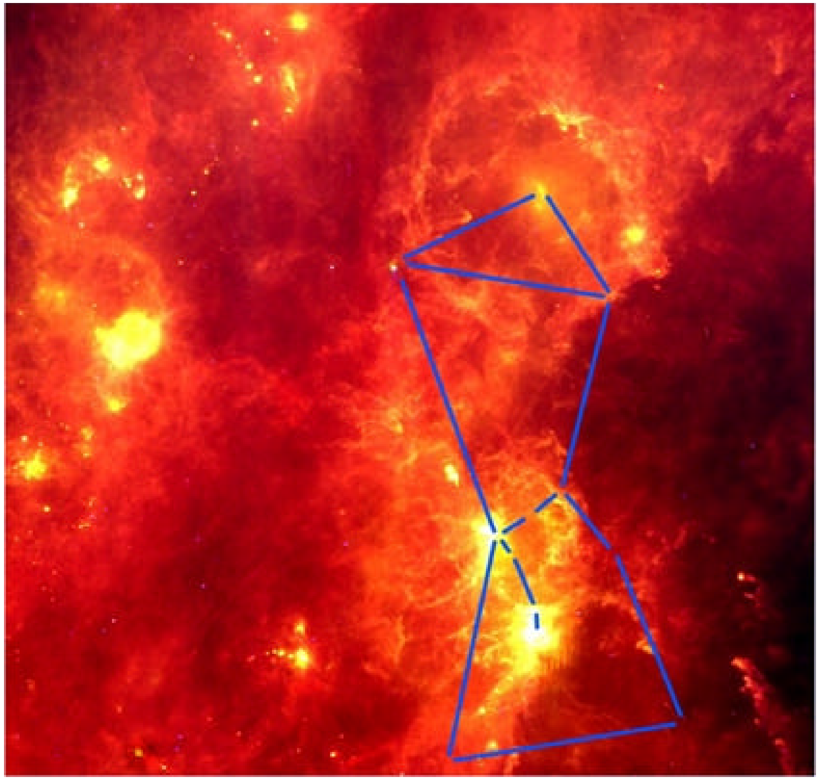
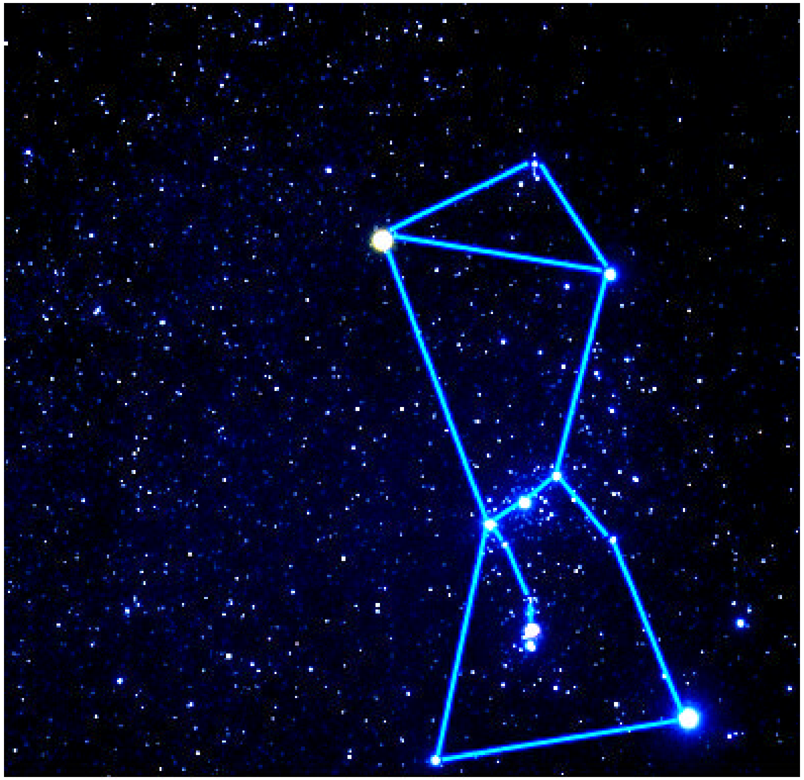

SIRTF
JPL
NASA

Views of Orion

Infrared (IRAS)



Visible Light (Akira Fujii)



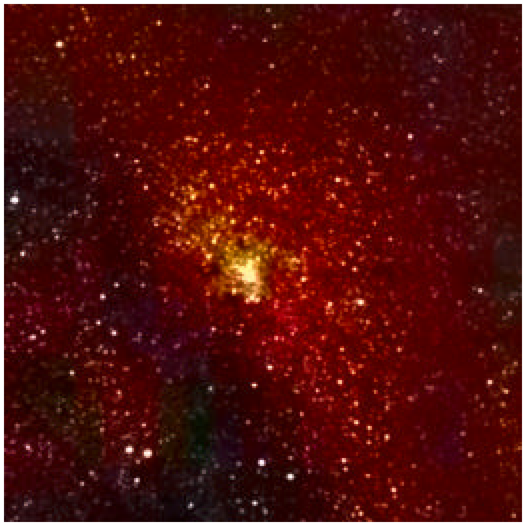
The familiar constellation Orion looks dramatically different in the infrared than in the visible; SIRTF will open the infrared window on the Universe

Two Key Science Questions for SIRTF

Astronomy Across The Spectrum

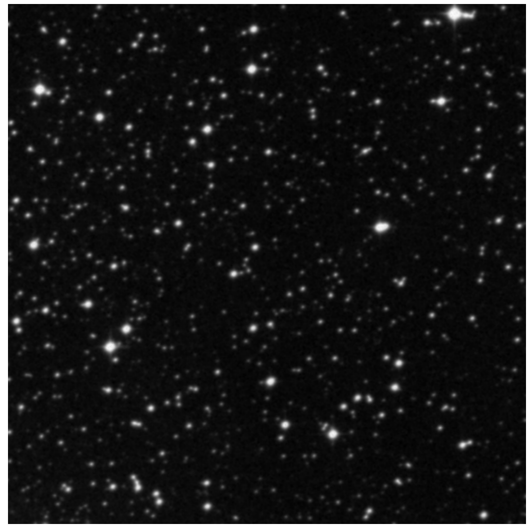
100 light years

2-MASS



Infrared

Digital Palomar Sky Survey



Optical

Chandra

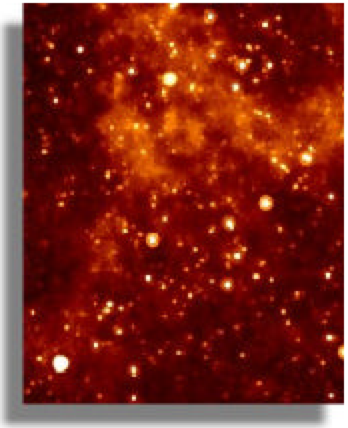
X-Ray

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

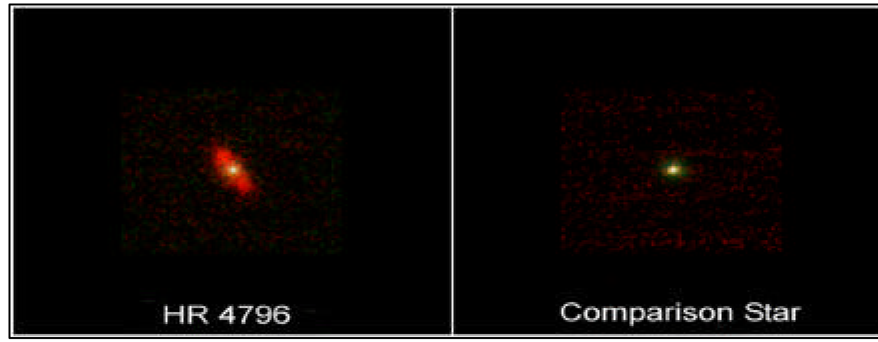
Why Infrared Astronomy?

Infrared Observations Probe:

MIPS 70um simulation



20um images from Keck



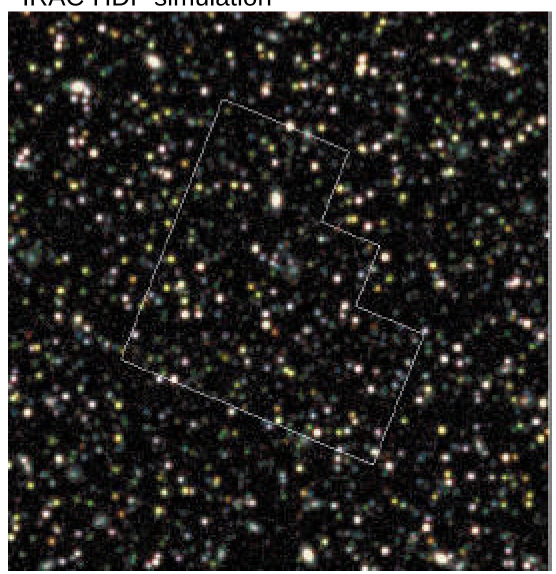
The Cold Universe

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 inter-stellar dust and gas that are opaque to visible light.

IRAC HDF simulation

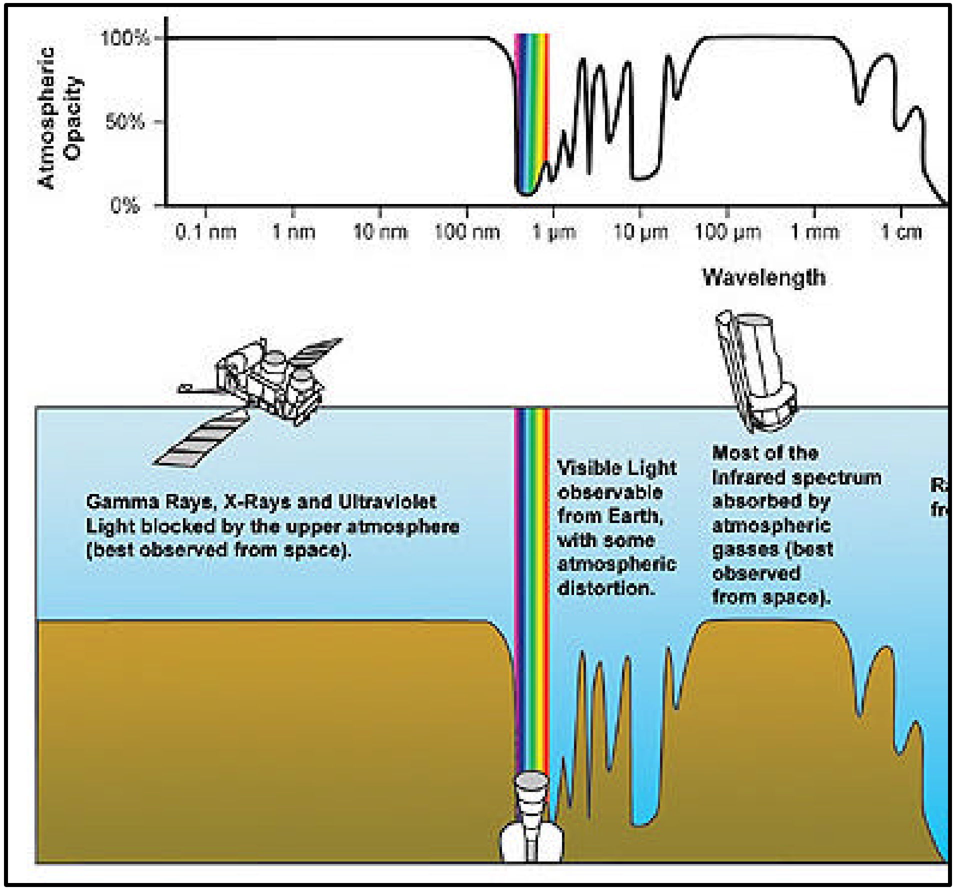


The Distant Universe

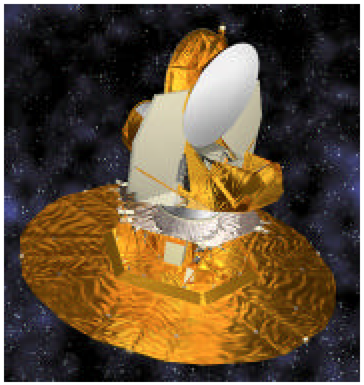
Most of the light that comes to us from distant galaxies is in the infrared.

Why Infrared from Space?

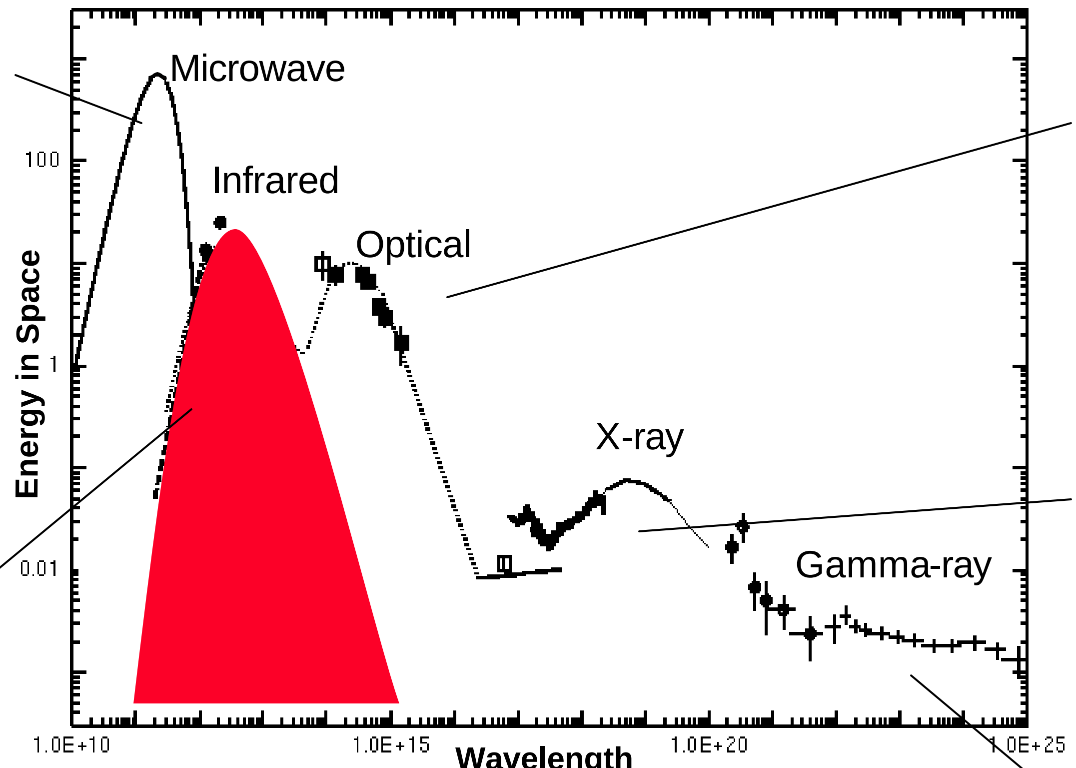
- The Earth's atmosphere absorbs most of the radiation falling on it from space, especially in the infrared
- The Earth's atmosphere is warm and emits copious amounts of infrared radiation that greatly limit the ability to measure faint objects from the ground. Space is cold.



What Did the Early Universe Look Like?



MAP



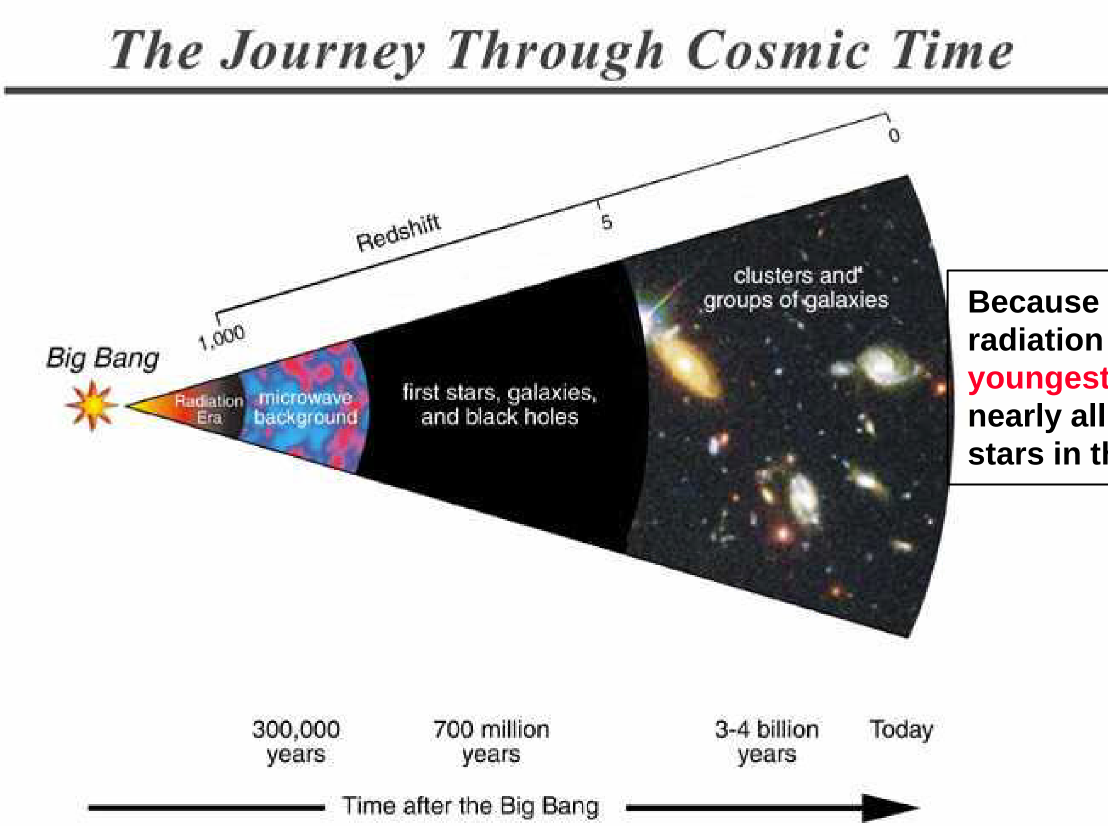
Hubble

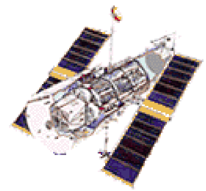
Chandra

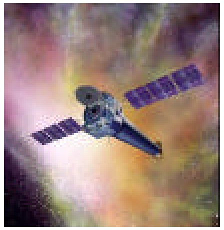
Compton

Almost half of the energy emitted in the Universe after the Big Bang is in the infrared. SIRTF will search for its origin.

When Did the Youngest and Most Luminous Galaxies Form?

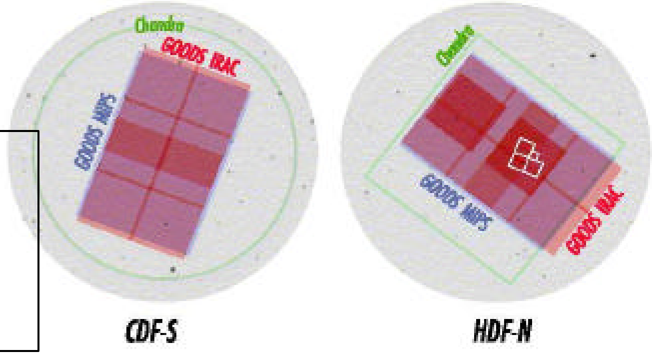






Because **SIRTF** will be extraordinarily sensitive to mid-IR radiation (~10 to 160 microns) it **will be able to detect the youngest and most luminous galaxies.** Their radiation, nearly all of which is emitted in the mid-IR, comes from stars in the process of forming and from dust clouds.

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.**



Star Formation Through Space and Time

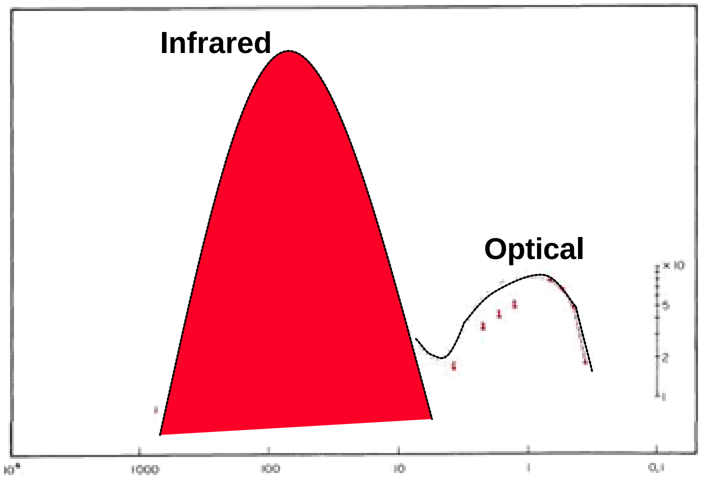
SIRTF's predecessor, IRAS, found a class of luminous "starburst" galaxies undergoing runaway star formation. Much of this star formation is obscured by dust and invisible in the UV or optical.

NGC2207 and IC2163 (WFPC2/HST)

Hoag's Object (WFPC2)

Seyfert's Sextet (WFPC2/HST)

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

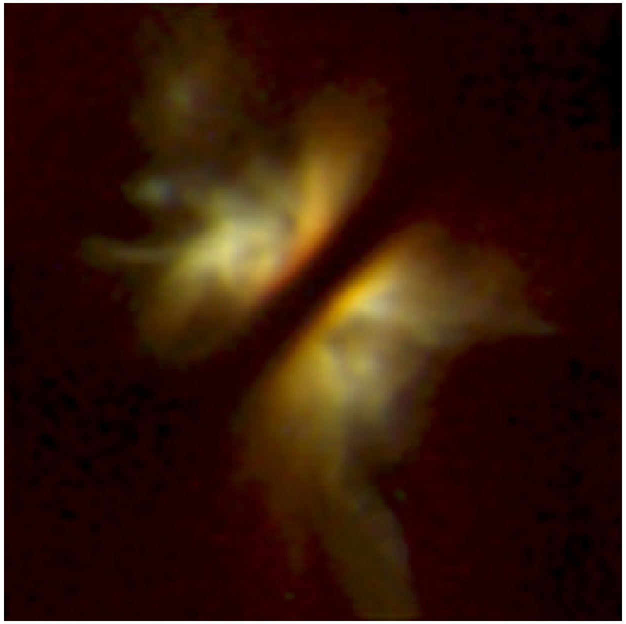


SIRTF will vastly improve the census of luminous starbursts across cosmic history. These galaxies pinpoint where approximately half the stars in the Universe were formed.

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.

Visible light image of dark globule B68



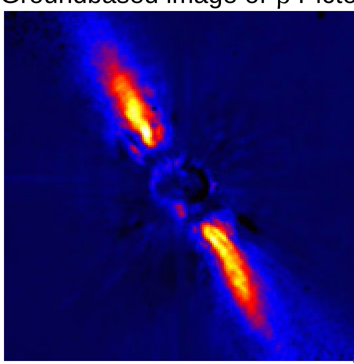
HST/NICMOS image of an edge-on disk in Taurus

- These “circumstellar” disks are best seen in infrared light
- SIRTF can study the evolution of disks in the key phase of Earthlike planet formation

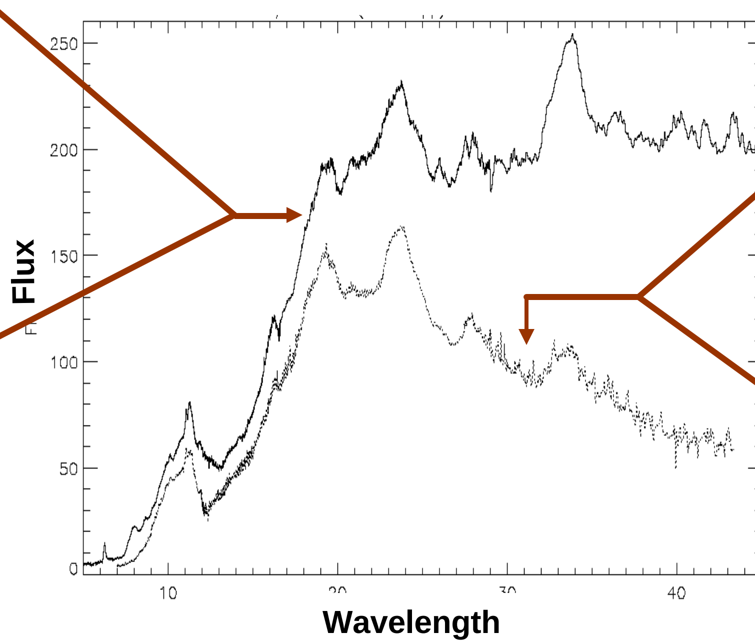
What is the Raw Material for Planet Formation ?

- 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.

Groundbased image of β Pictoris



Planet-forming Disk

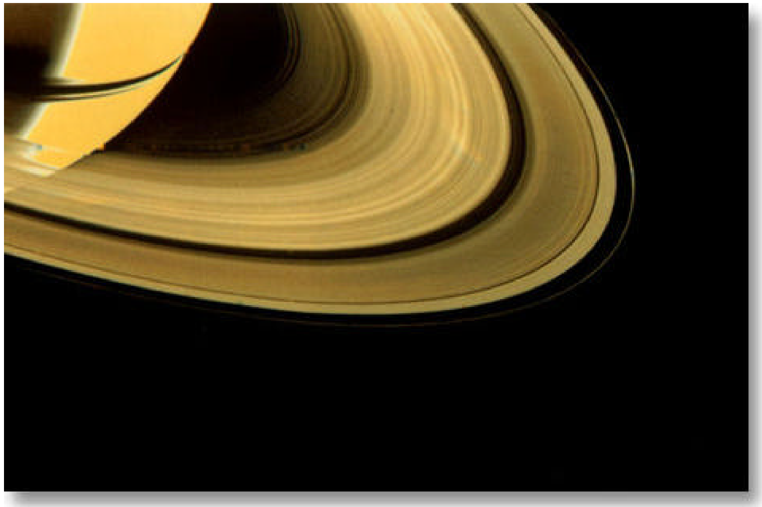


Groundbased visible image

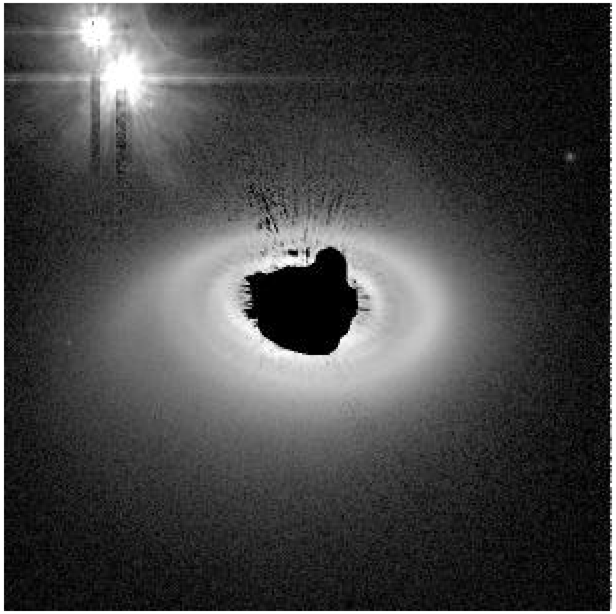
Comet Hale-Bopp

How Can SIRTF Sense Planets Around Other Stars?

- Even when a planet itself is too faint to see directly, its gravitational influence on its star's dust disk can still be visible, just as small moons sculpt Saturn's rings.



Voyager image of Saturn's rings



HST/ACS visible light image of a debris disk HD141569

- SIRTF will provide the first images of many nearby circum-stellar disks. Holes, clumps, or sharp edges in these disks may betray the presence of planets.

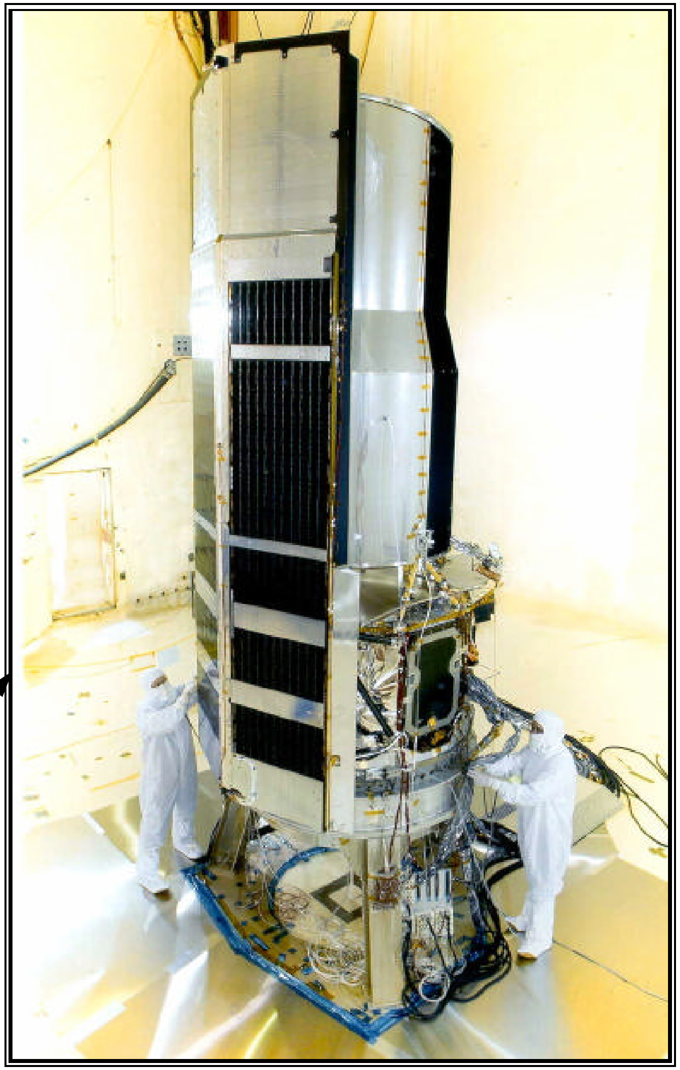
The SIRTF Observatory

- **Multi-purpose observatory cooled passively and with liquid-helium for astronomical observations in the infrared**
- **Launch in April 2003 for a 2.5 to 5 year mission**
- **Provides a >100 fold increase in infrared capabilities over all previous space missions**
- **Completes NASA's Great Observatories**
- **Provides critical precursor science for NASA's Origins Theme**

Assembled SIRTF Observatory at Lockheed-Martin, Sunnyvale.

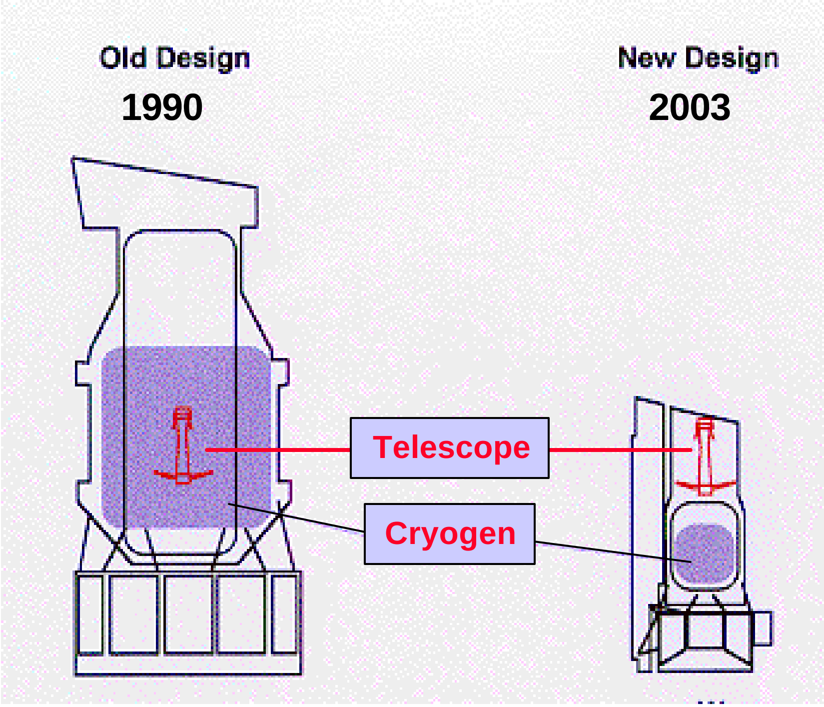
Key Characteristics:

Aperture – 85 cm
Wavelength Range - 3-to-180um
Telescope Temperature – 5.5K
Mass – 870kg
Height – 4m



SIRTF's Design Provides Huge Savings

- The SIRTF telescope will be launched warm and cooled down in orbit.
- A cool down in orbit is possible because it will be a solar orbit
- This novel approach yields significant ***cost and weight savings*** over cold launch designs with ***no reduction in telescope size*** for a given desired lifetime.
- Future NASA missions, e.g. TPF & JWST, will use this same approach

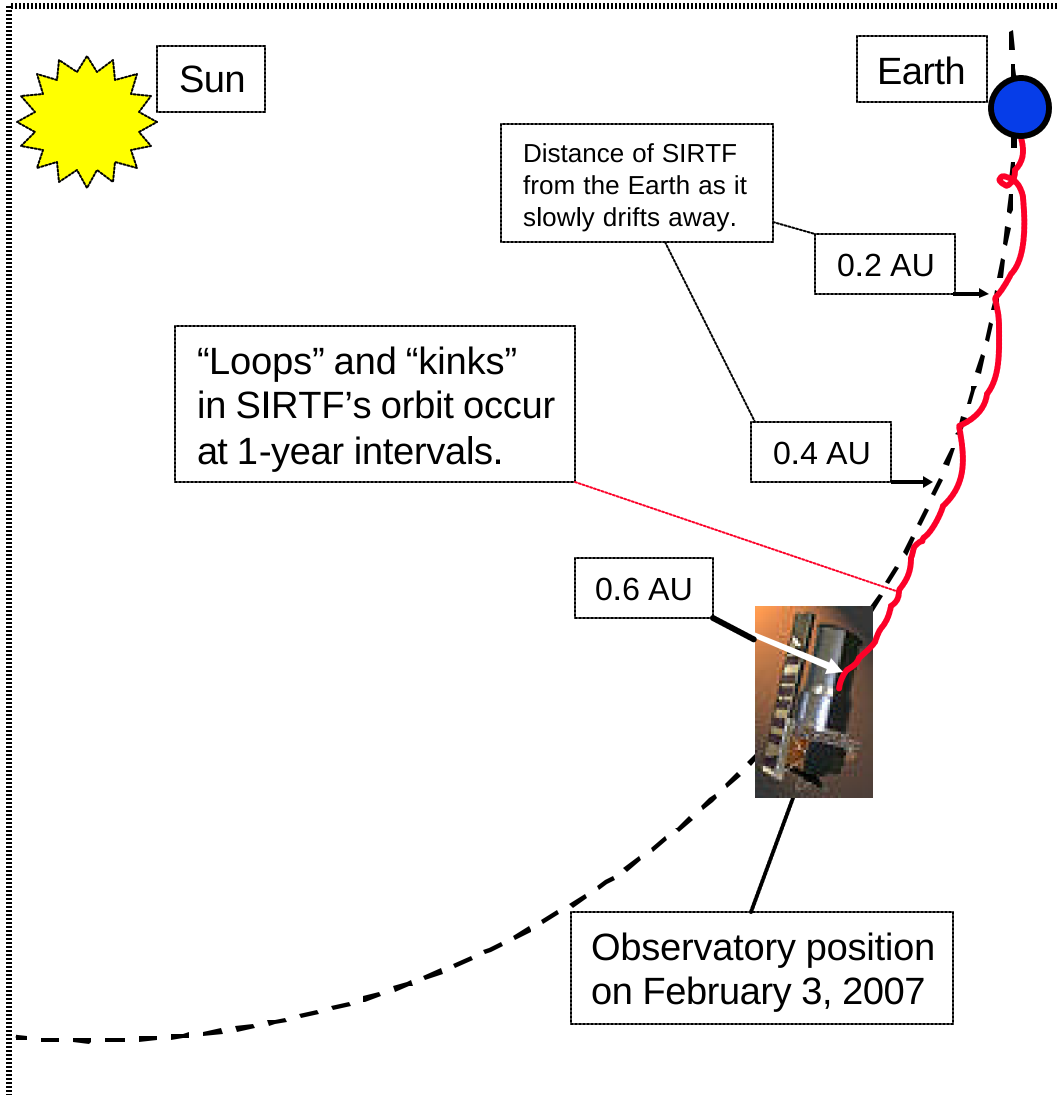


Cold launch	Architecture	Warm launch
Earth Orbit	Type of Orbit	Solar Orbit
5700 kg	Launch Mass	870 kg
3800 liters	Cryogen Volume	360 liters
5 years	Lifetime	5 years
~$2.2 B	Development Cost	$0.74 B
Titan IV	Launch Vehicle	Delta
~$0.4B	Launch Cost	$0.07B

SIRTF Orbits the Sun - A Solar Orbit is a Better Orbit!

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)



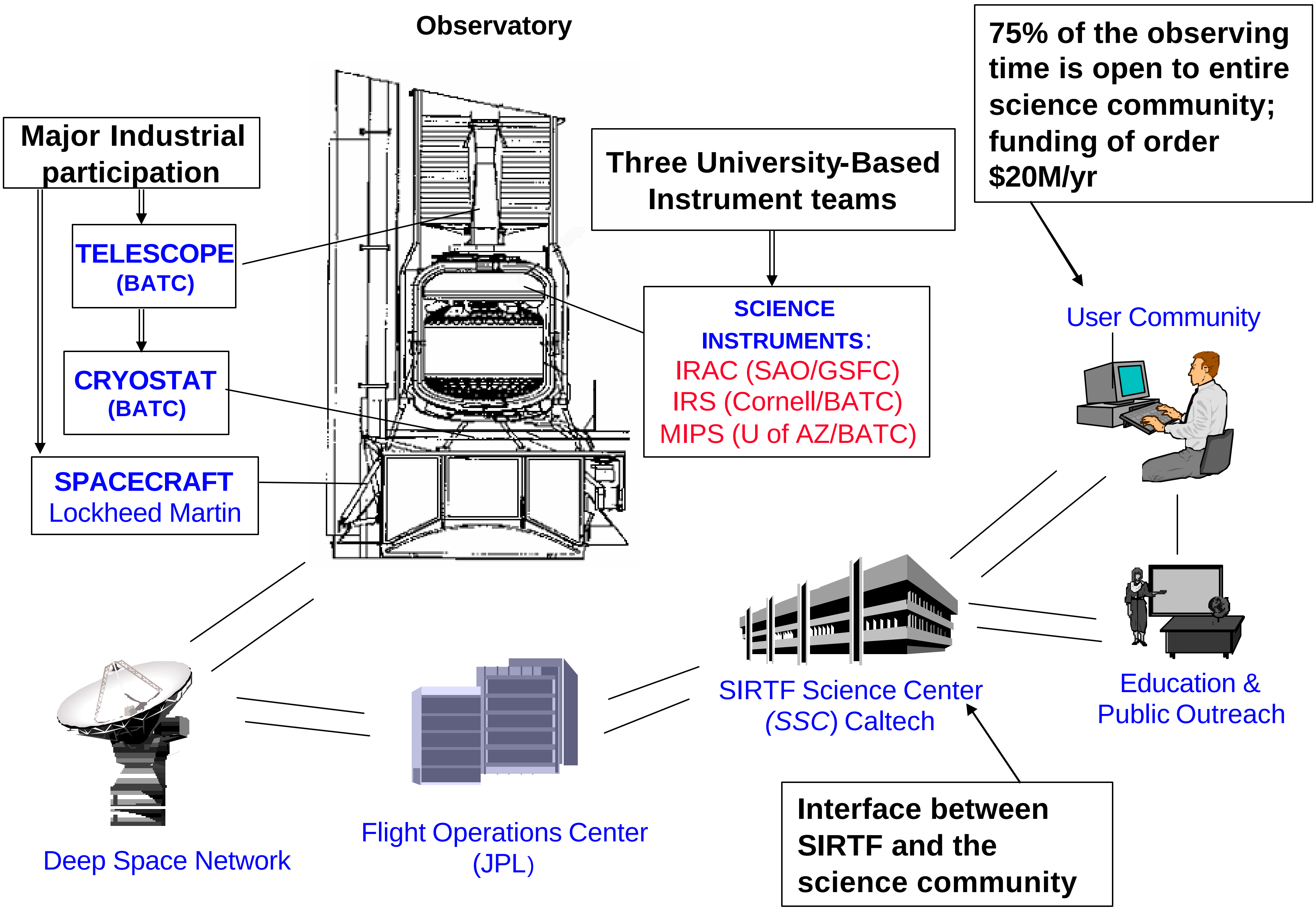
SIRTF's Three Instruments Use State-of-the-Art Detectors

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)*

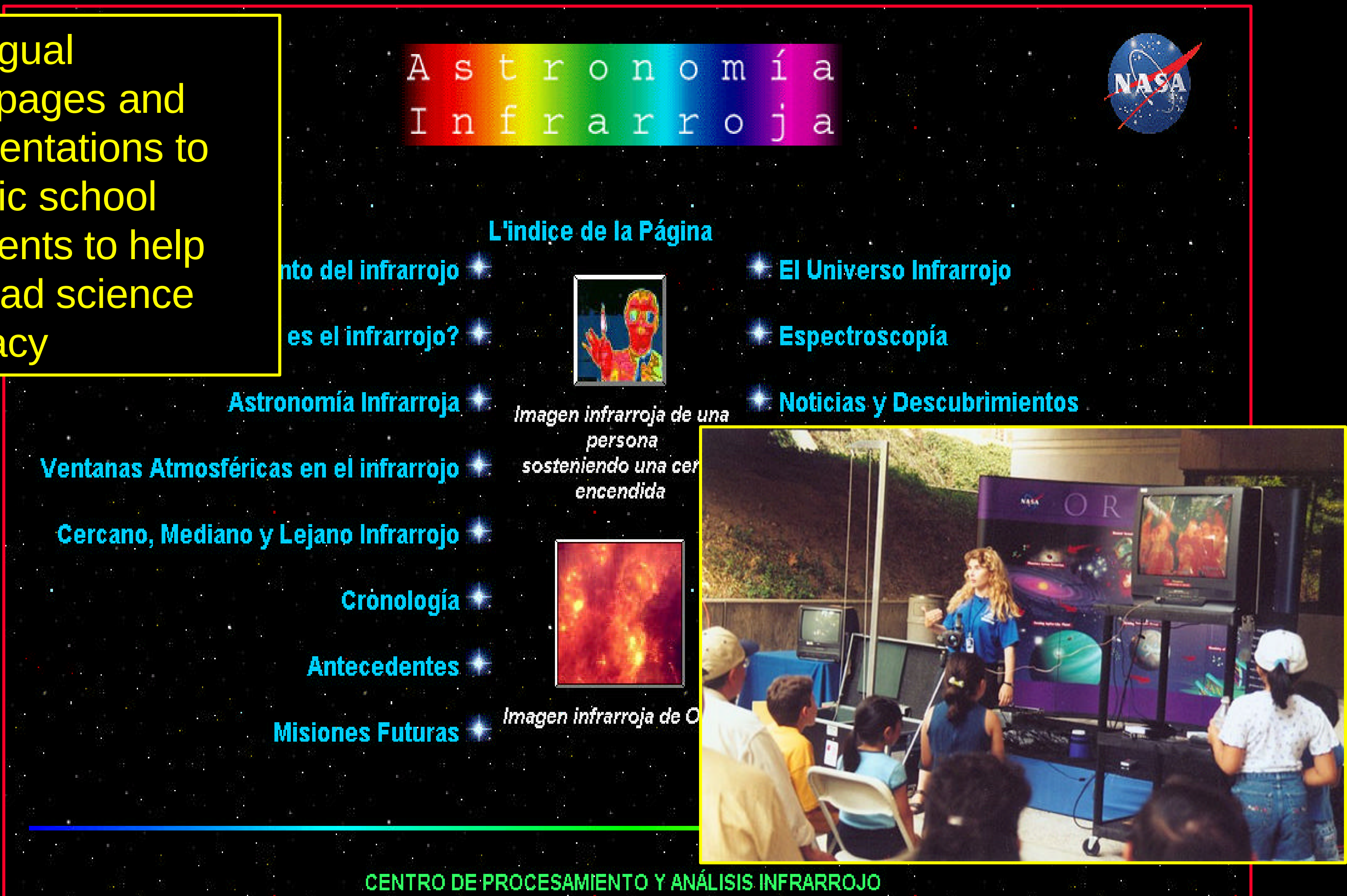
Instrument integration at Ball Aerospace

The SIRTF Team & The User Community



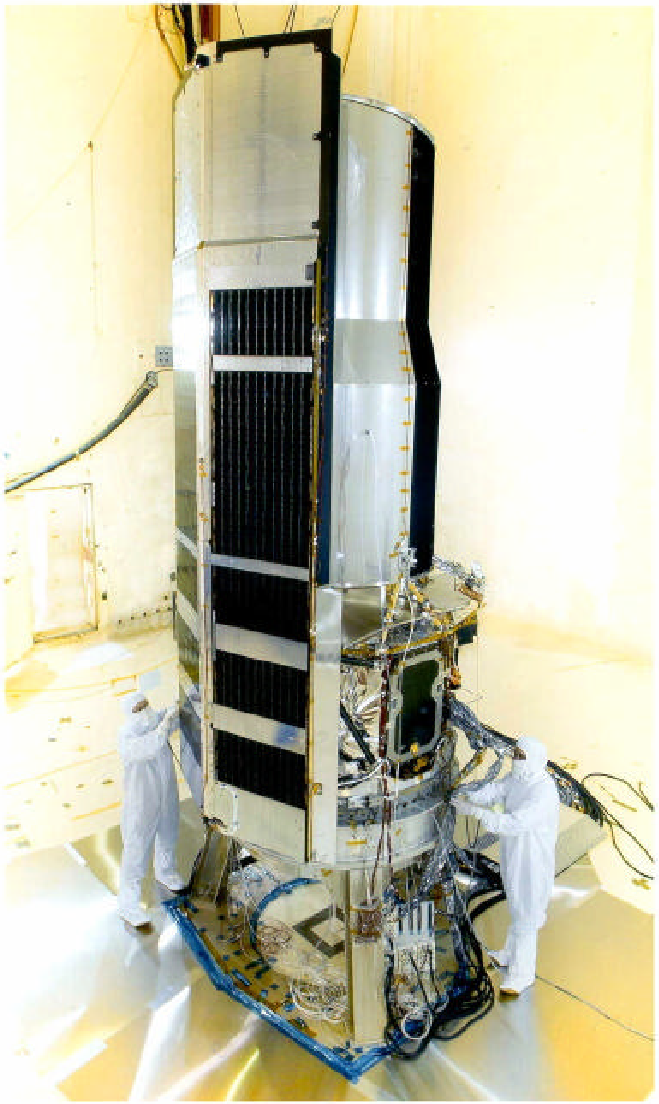
SIRTF Education and Outreach

Bilingual webpages and presentations to public school students to help spread science literacy



SIRTF: The Road to Launch

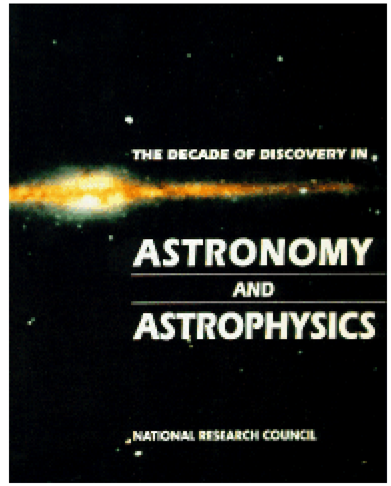
- The assembled SIRTF Observatory has been under test for more than a year
- The hardware is complete, and all environmental tests have been completed successfully
- The final refinements to the flight software and to the operational systems are being put into place
- The scientific programs for the first year of the mission have been defined
- Remaining milestones:
  - March 3 – ship to KSC
  - April 15 – launch window opens
  - Launch + 3 mos – start of science ops
  - Launch + 4 mos – first data release



The Scientific Promise of SIRTF Will be Fulfilled this Year

“The highest priority for a major new program in space-based astronomy is the Space Infrared Telescope Facility (SIRTF).”

National Research Council, Astronomy and Astrophysics Survey (Bahcall) Committee, 1991



“SIRTF remains unparalleled in its potential for addressing the major questions of modern astrophysics.”

National Research Council, Committee on Astronomy and Astrophysics, 1994

“Taken together, the projects we recommend represent an exciting use of NASA’s next major astrophysical observatory. Each of the projects will yield superb science that we expect of a major investment of time in a NASA Great Observatory. A hallmark of each of these projects is that they fully exploit the unique and special capabilities of SIRTF that make it a major NASA mission and the highest priority space project of the 1991 National Academy of Sciences Decade Review.”

Letter from SIRTF Legacy Science TAC Chair, John Bahcall, to SSC Director Tom Soifer (November, 2000)