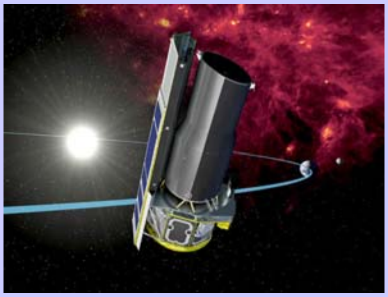
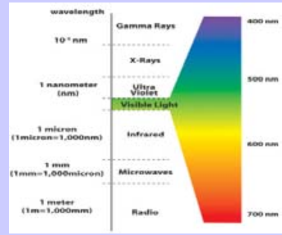
The Spitzer Space Telescope



Addison LeMessurier

Benefits of Infrared



- IR can reveal objects that don't emit visible light
- IR provides different information than visible light
- IR is better than visible for viewing cold objects

Instruments/Components of Spitzer

- Cryostat – cooling unit for scientific instruments
- MIC – Multiple Instrument Chamber
- IRS – Infrared Spectrometer
- MIPS – Multi-band Imaging Photometer
- IRAC – Infrared Array Camera

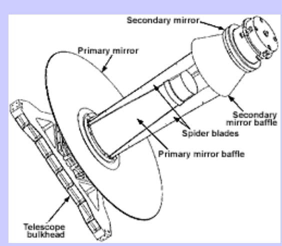
Cryostat

- IR instruments must be kept extremely cold
- Very slight temperature changes can interfere with observations

Cryostat (continued)

- Purpose: keep the spacecraft near absolute zero
- Launched with 360 liters of liquid helium
- The instrument chamber is inside the tank

Infrared Telescope



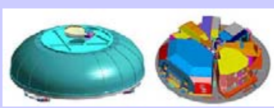
- Much smaller than an optical telescope
- Aperture size of only 85 cm
- Mirrors made of beryllium
- Total weight is less than 50kg

Telescope Design

- Reduce thermal expansion by using the same materials for almost everything
- Use a simple design to minimize the number of parts and lower costs
- Use lightweight materials with high stiffness to density ratio

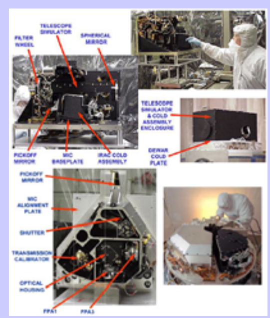
Telescope Under Construction

MIC



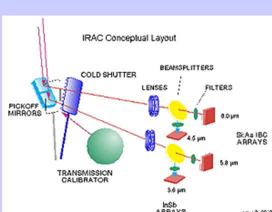
- Multiple Instrument Chamber
- Contains parts of IRAC, IRS and MIPS
- Chamber is kept extremely cold using the cryostat
- 84 cm wide, 24 cm high

IRAC



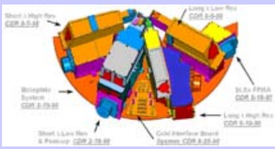
- Infrared Array Camera
- Takes pictures in near to mid IR
- Multi-purpose, used in many different studies

IRAC (continued)



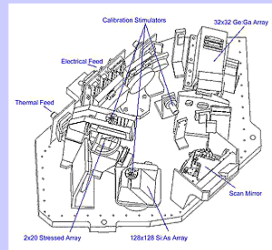
- Contains four 256x256 detectors to image simultaneously at slightly different wavelengths

IRS



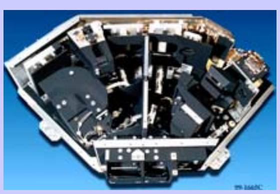
- Infrared Spectrograph
- Operates at mid-IR wavelengths
- High and low resolution images
- No moving parts
- Both warm and cold components

MIPS



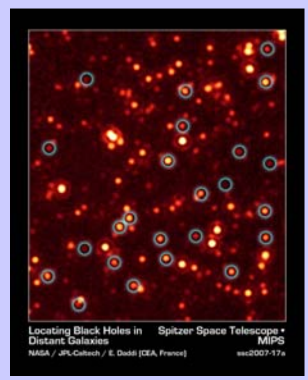
- Multiband Imaging Photometer
- Imaging and spectroscopy at far IR wavelengths
- Can image at 24, 70 and 160 microns using three separate detector arrays

MIPS (continued)



- Shares some warm electronics with the IRS instrument
- Sensors are designed to work at -457 F

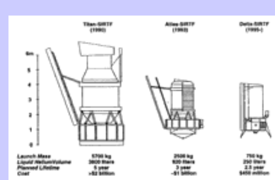
Observing Black Holes with MIPS



Origins

- The concept of an IR space telescope dates back to the early 1970s
- Originally called SIRTF (Space Shuttle Infrared Telescope Facility), it was to be an attachment to the shuttle
- The success of earlier, simpler satellites led to a more ambitious approach to Spitzer

Evolution of Design



- Spitzer was originally going to be huge
- Technological advances and orbital innovations allowed it to carry much less cryogenic coolant than was originally planned

Orbital Innovation

- Placed in heliocentric instead of geocentric orbit to make cooling easier
- Spitzer avoids large, reflective objects such as Earth and the Moon
- Enough solar energy still reaches the panels as long as it stays pointed within 120 degrees of the Sun

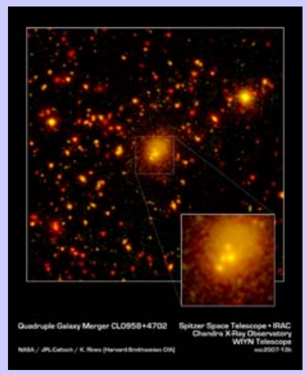
Launch of Spitzer

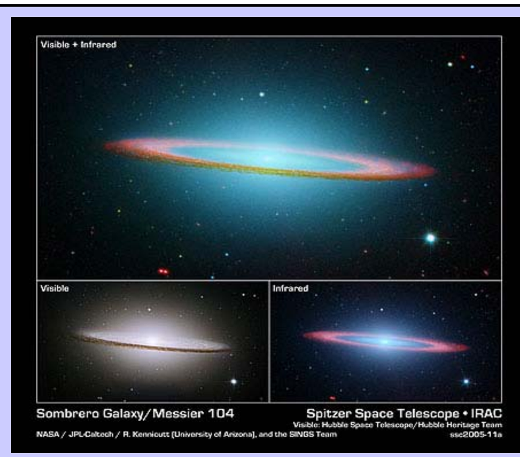
- Launched aboard a Delta II from Cape Canaveral
- August 25, 2003
- Placed in a heliocentric, Earth trailing orbit

Additional Details

- Mass: 950 kg
- Wavelength: 3 – 180 micrometers
- Diameter: 0.85 m
- Focal Length: 10.2 m
- Orbital Period: 1 Earth year
- Drifting away from Earth at: ~0.1 AU/year

Some Observations

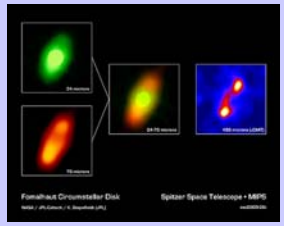




Some Objects Viewable with Spitzer

- Spitzer is mainly designed for long range observations, similar to Hubble
- Only minor spectroscopy can be done on most objects within our solar system
- The galactic nucleus, star clusters, black holes and distant galaxies are particularly interesting targets
- Circumstellar disks, where planets are believed to form show up nicely in IR

Planet Finding



- Potential planet forming regions show up very well in IR
- Spitzer can also see thermal emissions from some distant gas giants
- Some atmospheric measurements have also been done

Water Vapor on an Exoplanet

- In July, 2007 Spitzer found water vapor on an extrasolar gas giant using IR spectroscopy
- Similar instruments could some day be used to find water on Earth-like planets

ULIRGs

- Ultra Luminous Infrared Galaxies
- These galaxies emit more than 90% of their light in IR
- Vast clouds of cold interstellar dust are responsible for the low temperature IR emissions
- Spitzer is therefore a good tool for observing these objects

Star Formation

- The Orion Nebula is shown in visible and IR
- Notice how neither one highlights everything by itself

Summary

- Spitzer is a multi billion dollar space-based infrared observatory
- Combined with Hubble, Chandra and others, it has provided very valuable scientific data
- Spitzer has particularly increased understanding of extra solar planets, galaxy structure and star formation

Bibliography

- www.nasa.gov/spitzer
- spitzer.caltech.edu
- www.news.cornell.edu/stories/Feb06/ULIRGs.Spoon.lg.html