45 Years of Infrared Astronomy at the Air Force Laboratory

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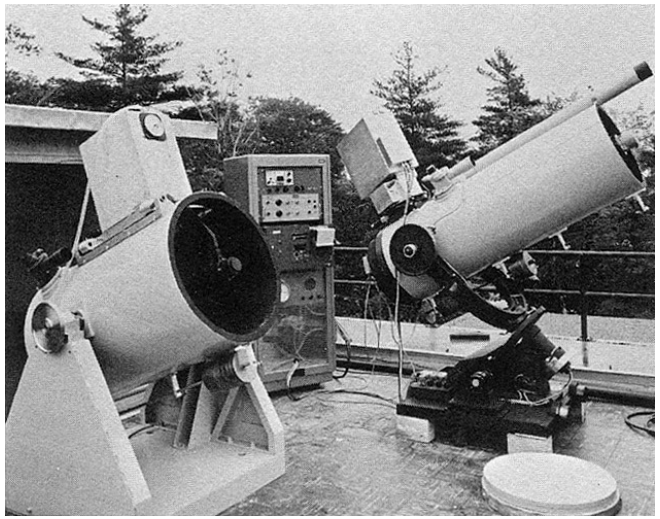
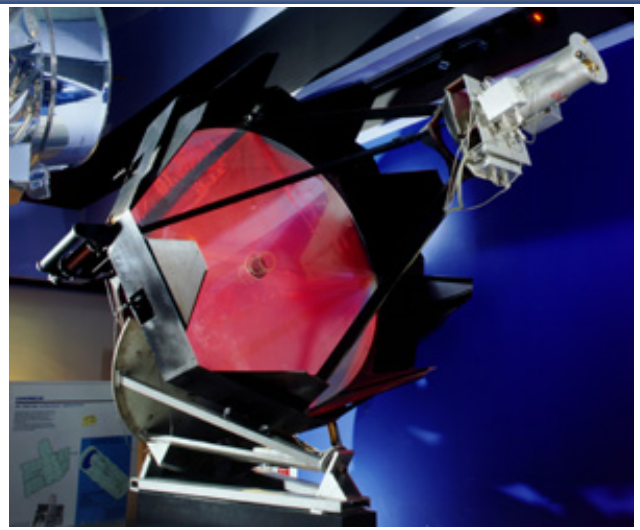
Space Vehicles Directorate

First Near IR Surveys



← ITT telescope

TMSS →



ITT southern survey sensor

- Freeman Hall conducted the first IR survey (1962)
- TMSS (1965 – 1967) by Neugebauer and Leighton
- Southern sky (1966 – 1967) by Price

Infrared Celestial Backgrounds Program

- Define the nature & detailed character of the infrared celestial background
- Probe-rocket based experiments (1970 – 1985)
  - 20 successes out of 23 attempts
- Satellites
  - Midcourse Space Experiment (1996 – 1997)
  - Observations with ISO and Spitzer
- 2MASS
  - Supported proof of concept study

First AFCRL Experiments

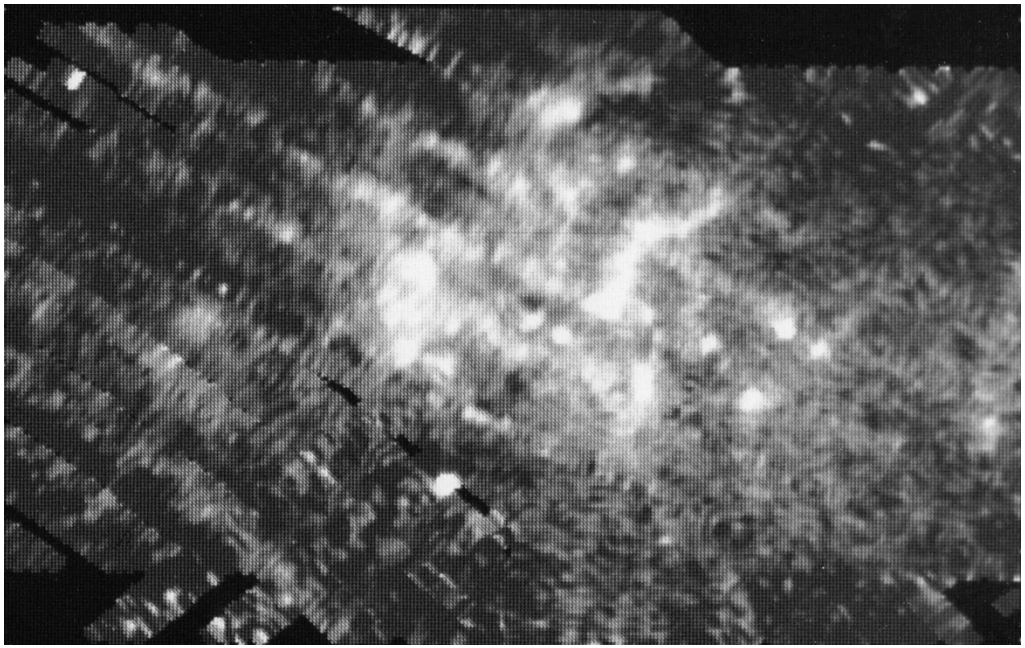
- Sensor (top left)
  - Double folded optics
  - 4” primary mirror
  - Linear array of 6 Mid-IR detectors

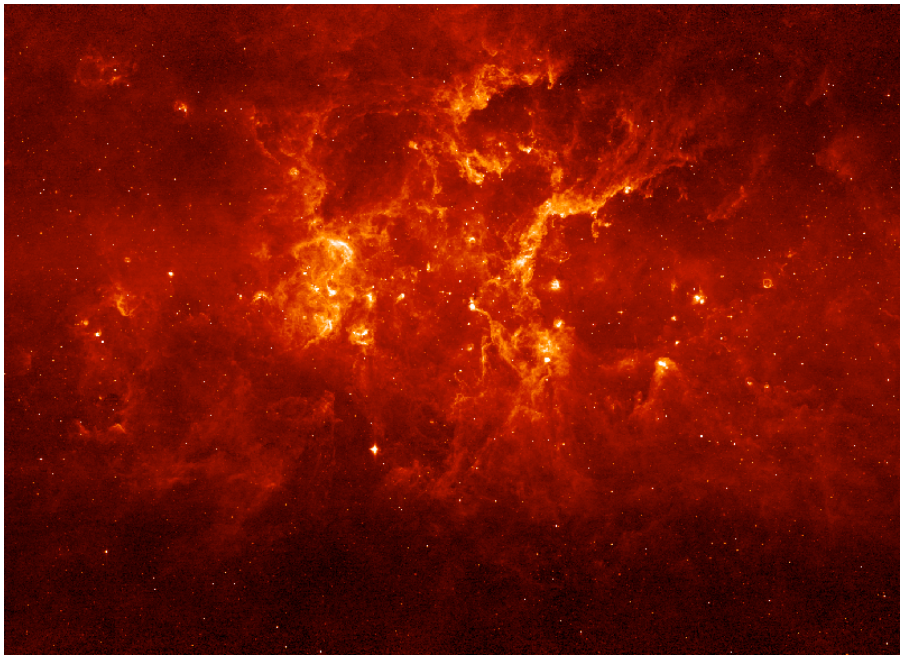
- Two proof of concept flights in 1970
  - Piggy-backed on an atmospheric experiment
  - Detected Orion Nebula
  - Lessons learned
- ARPA & AFCRL also provided funds for
  - Four Cornell rocket-based experiments (1970 – 1976)
  - Caltech & U. of Ariz. for 5 and 10 μm ground-based surveys.

HISTAR & HIStar South

- First successful mid-IR survey
  - HISTAR from White Sands
    - April 1971 – Dec 1972 (7 flights in 20 months)
  - HI Star South (Woomera)
    - 1974
    - Southern sky survey
- Results
  - 4, 11, 21 and 27 μm point source catalog
  - First large scale maps of the diffuse IR emission from the galactic plane & the zodiacal background

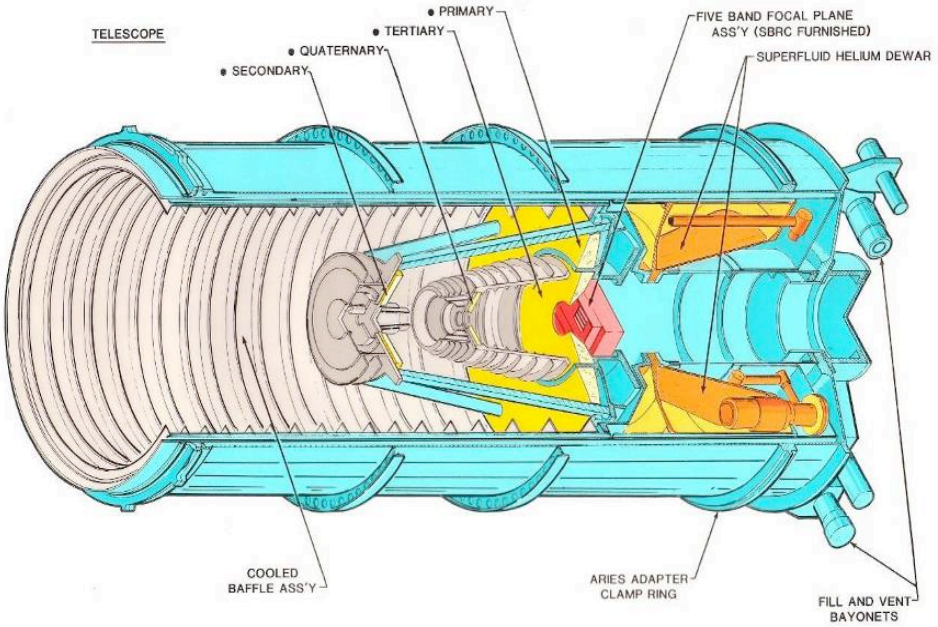
Cygnus X – HISTAR vs MSX





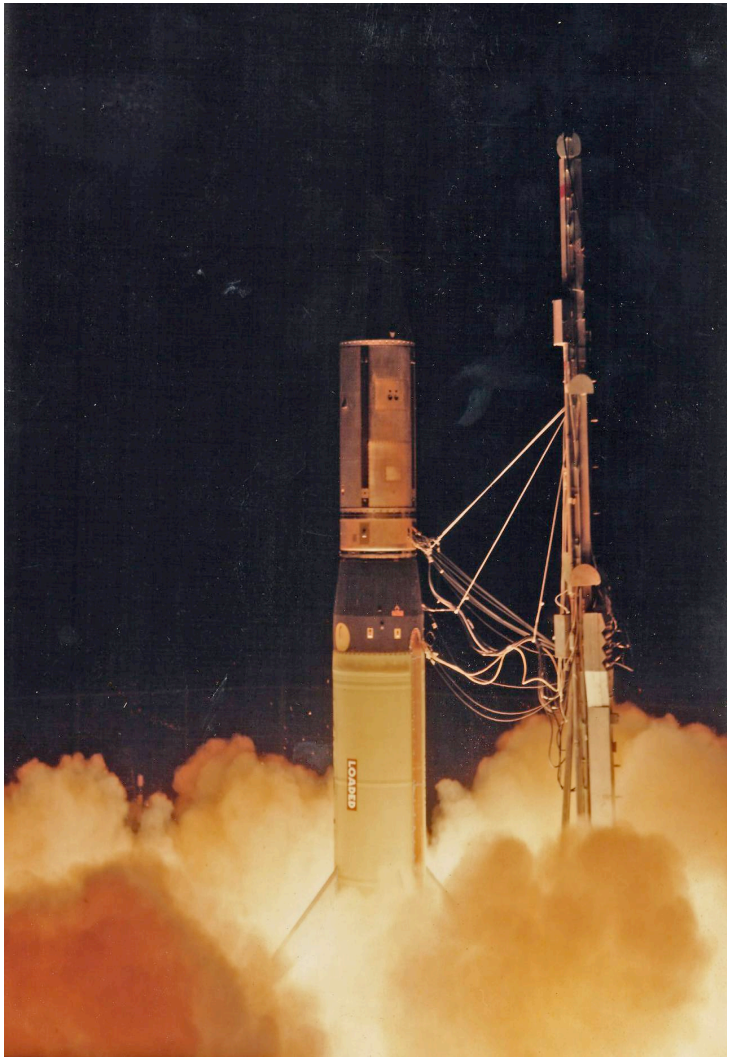
- **HISTAR had ac coupled electronics**
  - **Extended emission extracted by digitally inverting the high frequency attenuation**
  - **A comparison of the HI STAR Cygnus X map to a higher resolution MSX image is shown**

Background Measurements Program



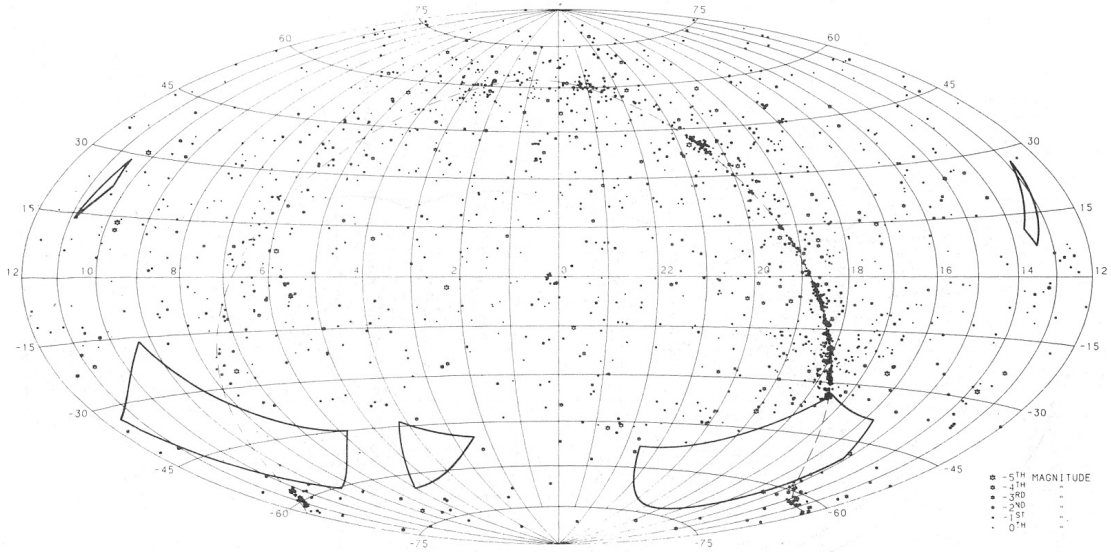
- 35 cm diam. telescopes
- SPICE (left)
  - 11-, 20- & 27 μm
- FIRSSE (above)
  - 20, 27, 50 & 90 μm
- X10 HISTAR sensitivity

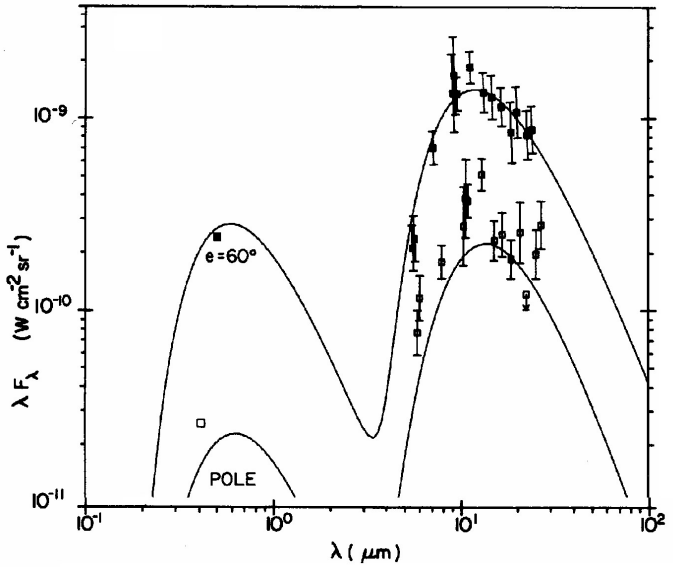
Launch of CB Experiment

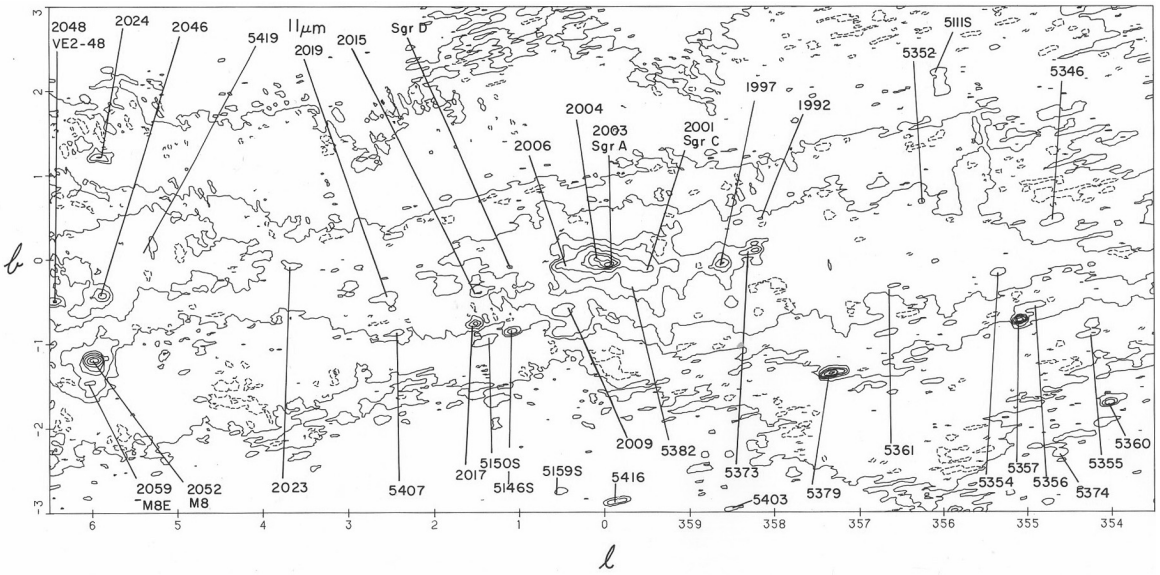


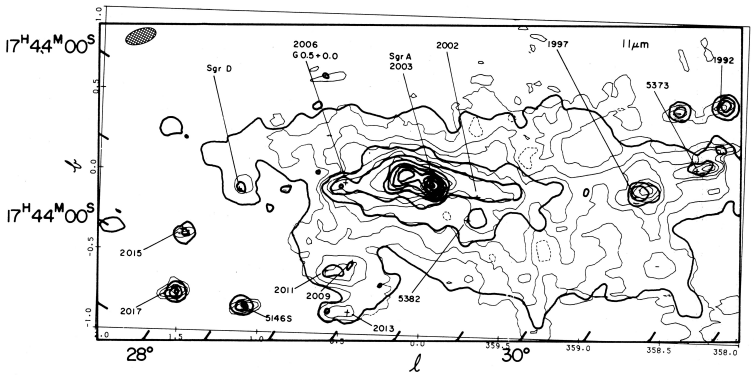
- T-3 day rehearsal above
- Launch at left

BMP Results

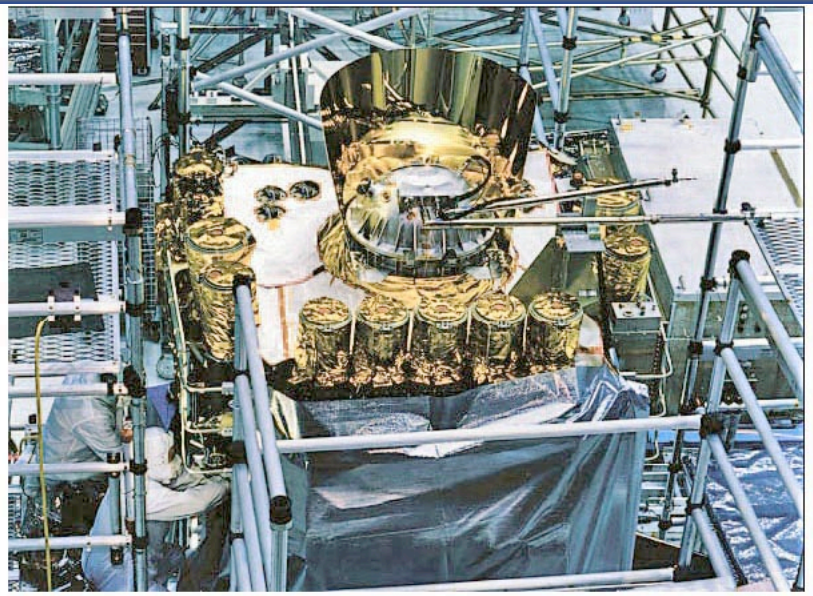

-5TH MAGNITUDE
-4TH
-3RD
-2ND
-1ST
0TH

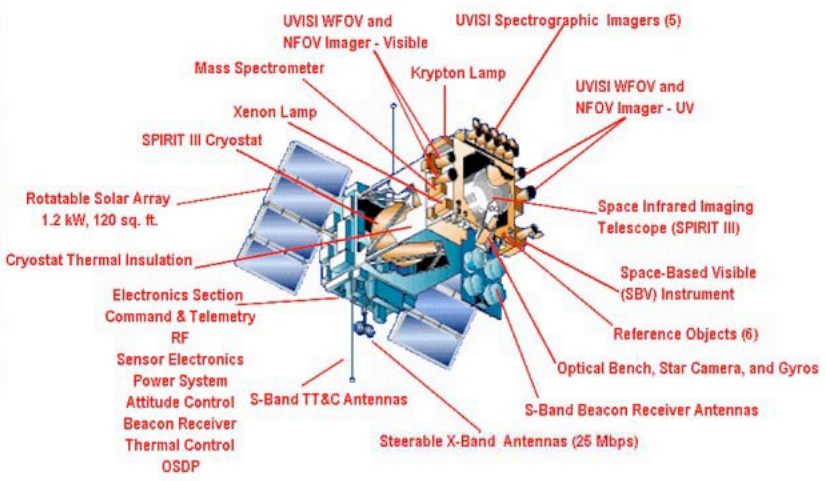

e=60°
POLE
λ F_λ (W cm^-2 sr^-1)
λ (μm)


11μm
2048 VE2-48
2024
2046
5419
2019
2015
Sgr D
2004
2006
2003 Sgr A
2001 Sgr C
1997
1992
5111S
5352
5346
2059 M8E
2052 M8
2023
5407
2017
5150S
5146S
5159S
2009
5382
5416
5373
5403
5379
5361
5354
5357
5356
5355
5360
5374
b
l

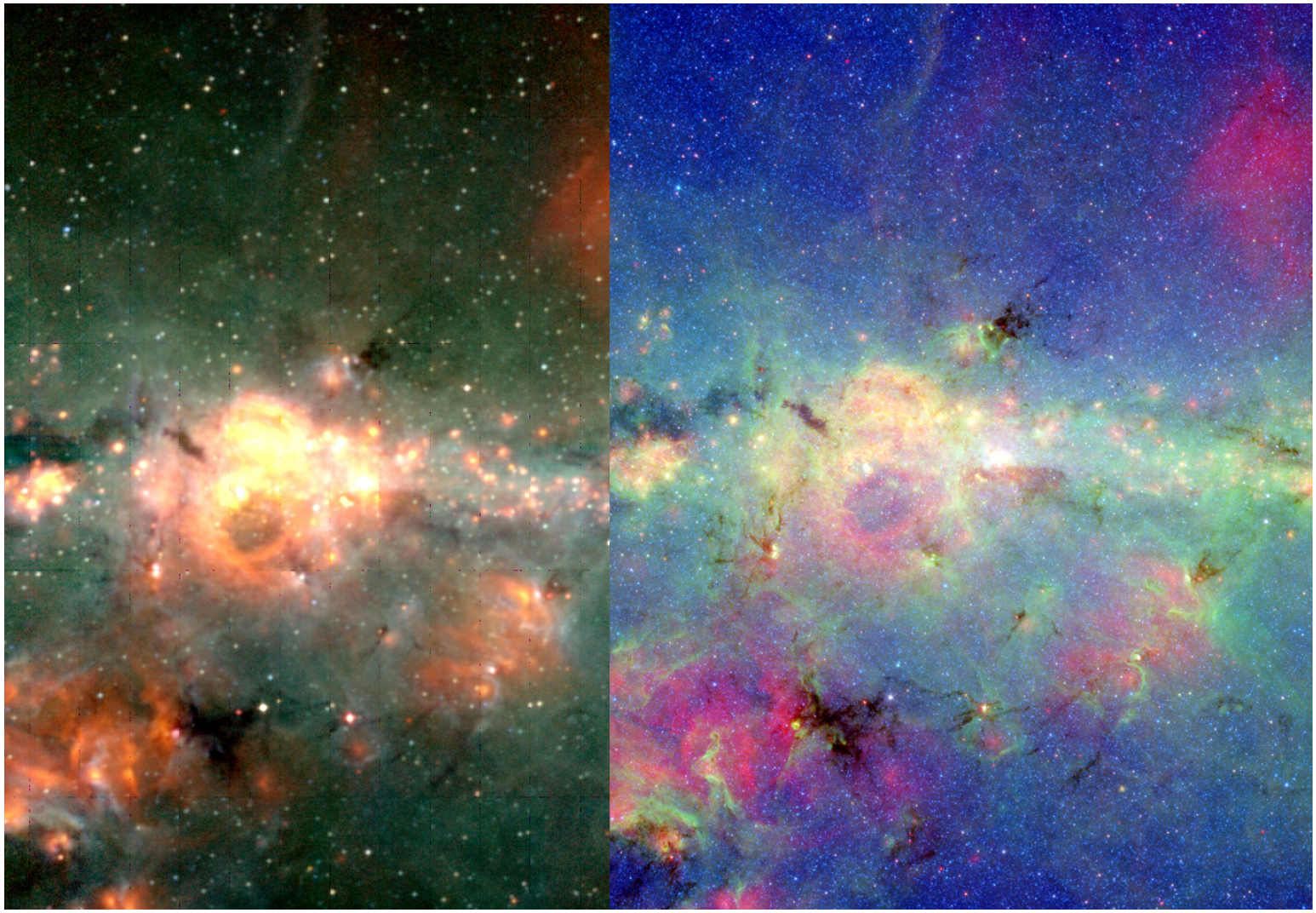

17H44M00S
17H44M00S
Sgr D
2006 G0.5+0.0
Sgr A 2003
2002
1997
11μm
1992
5373
2015
2011
2009
2017
5146S
5382
2013
28°
30°
l

Midcourse Space Experiment (MSX)



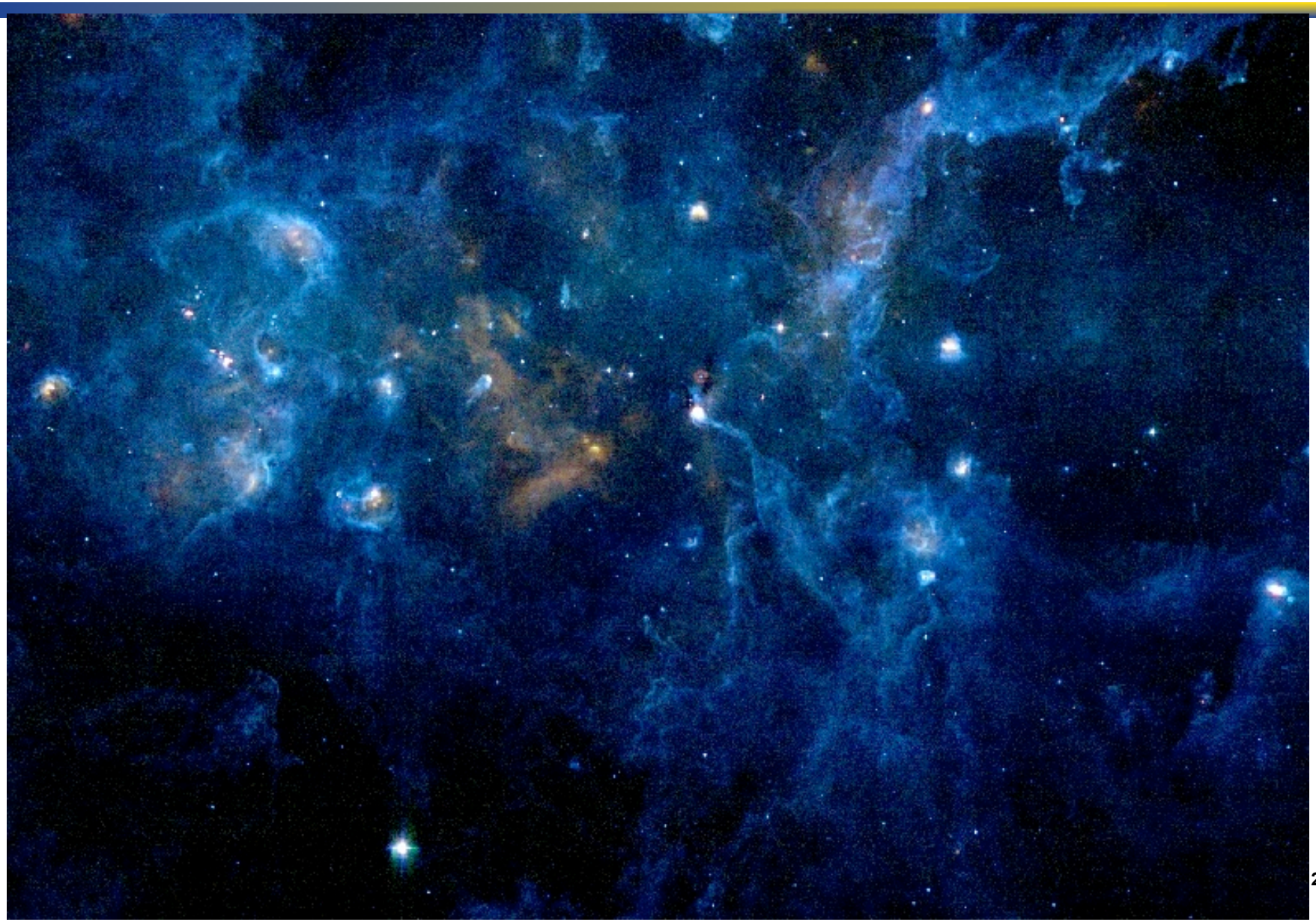


The IR Galactic Center



MSX (left) and Spitzer (right): IR 3 color images of the Galactic center

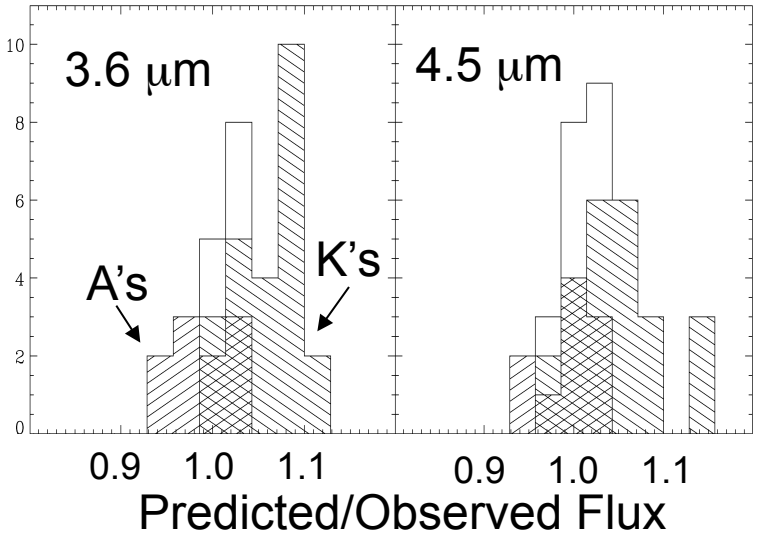
MSX Cygnus X 3-color Image



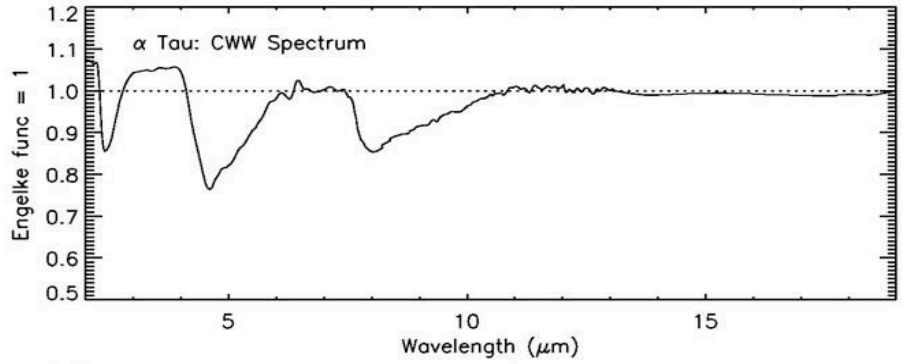
Current Activities

- **Extend the absolute spectral fluxes of the calibration network stars into SWIR & visible to support system calibration at these wavelengths**
- **Upgrade entire calibration network**
  - **Create 0.4 – 30 µm spectral templates**
  - **Apply templates to all tertiary standards**
  - **Include additional spectral types**
  - **Add best characterized stars from the Bright Star Atlas to calibration network**
- **Thermo-physical lunar model**

Application: *Spitzer Space Telescope*



***Spitzer* Infrared Array Camera calibration paper*:**
Systematic bias between K star calibrators and A star calibrators in the 3.6 and 4.5 μm bands – K stars rejected



Original CWW spectrum of α Tau: bias at wavelengths <5 μm

New SWS+*MSX* K star spectra remove the bias allowing use of K star calibrators

***Reach et al. 2005**

The Moon for Calibration

- USGS products

  36 narrow spectral bands 0.35 μm < λ < 2.39 μm

- Extended ~0.5° source
  - Only celestial object beside the Sun for radiance calibration
  - Radiance comparable to that from the Earth – within dynamic range of Earth looking sensors
- Irradiance calibration for low resolution and low sensitivity instruments
- Complicated model needed
  - Complex viewing geometry due to lunar orbit
  - Complex albedo distribution
  - Thermo-physical model