# A brief history of infrared astronomy

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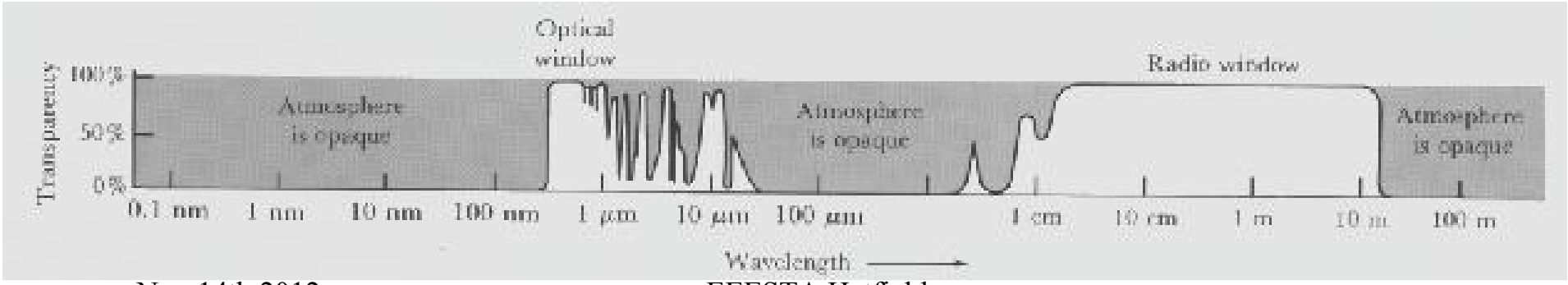
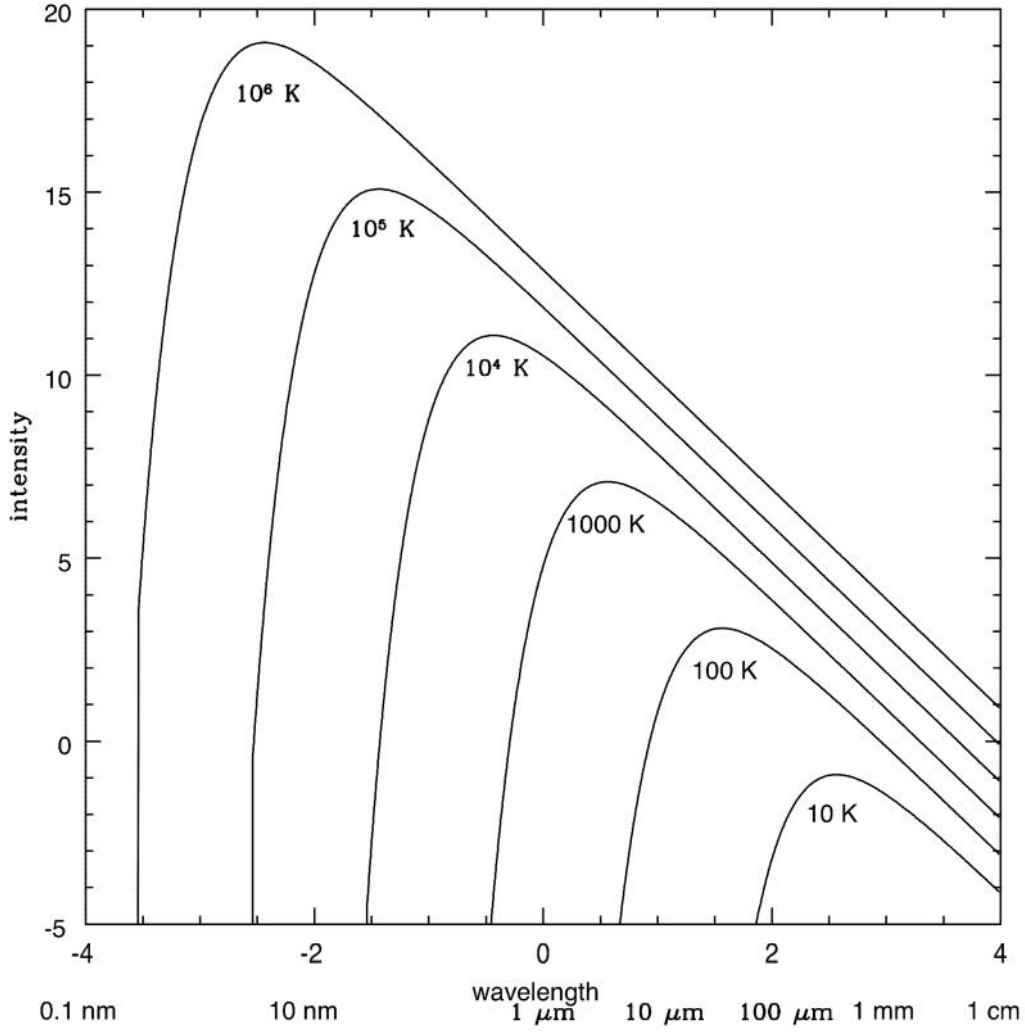
# William Herschel detects infrared radiation from the Sun, 1800

the infrared band:
1-1000 microns

- a few terrestrial windows



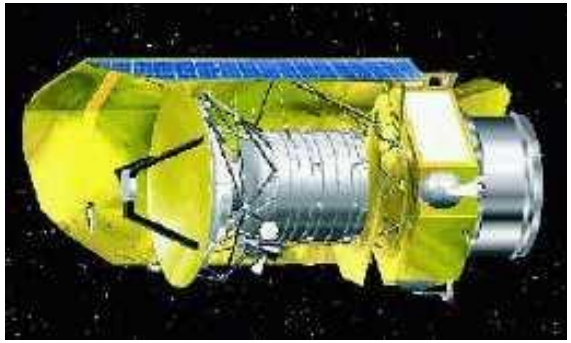
# different wavebands sample different temperatures

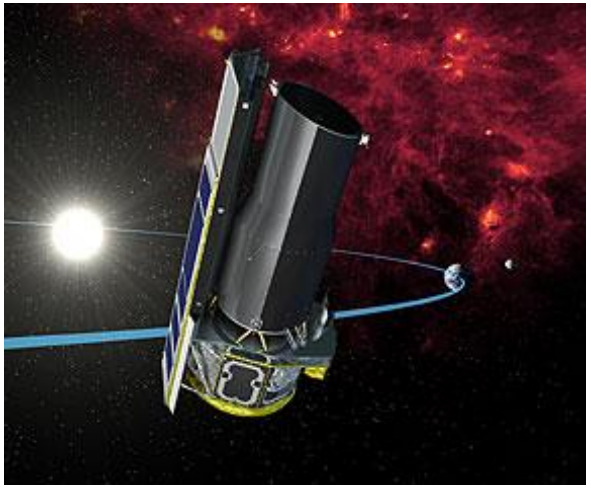


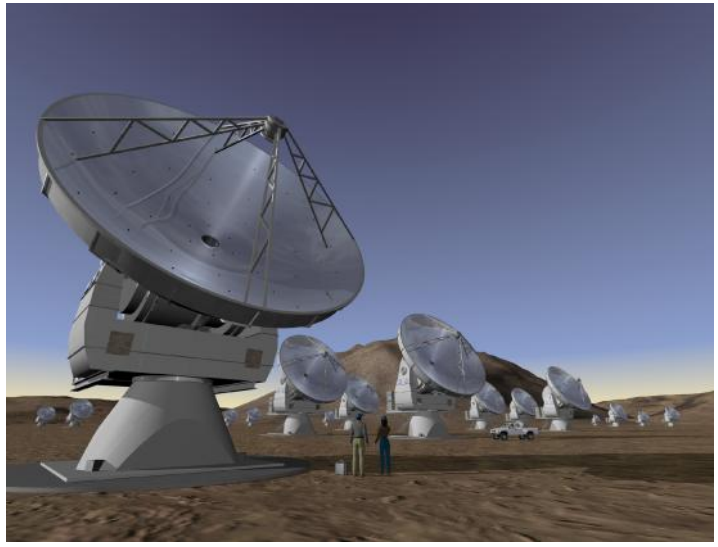

In the infrared we sample temperatures from 3000 K to 3 K as we go from 1 to 1000 microns.

So we see the cool universe, especially emission from dust around and between the stars.

# some of the tools of the trade







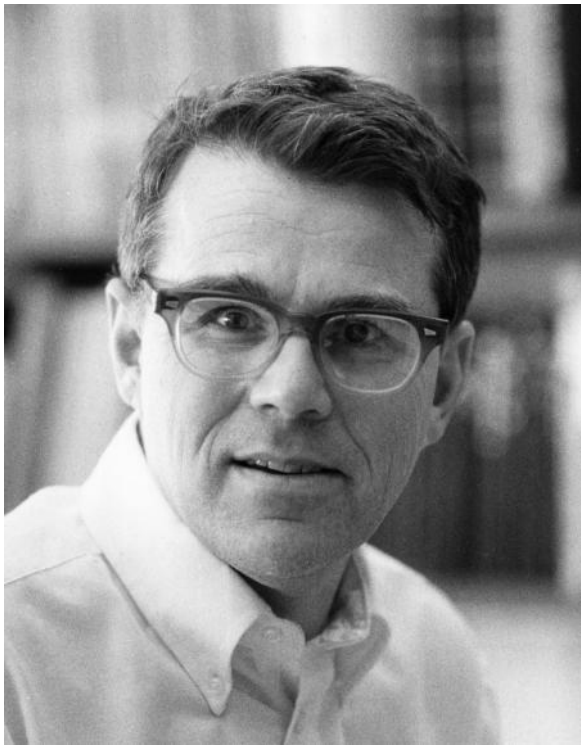
# Slow progress 1800-1950

Piazzi Smyth detected ir radiation from the Moon in 1856

brightest stars not reliably detected till 1901 (Ernest Nichols)

Harold Johnson (1921-1980) defined the 1-20 micron infrared bands and observed several thousand stars in the 1950s

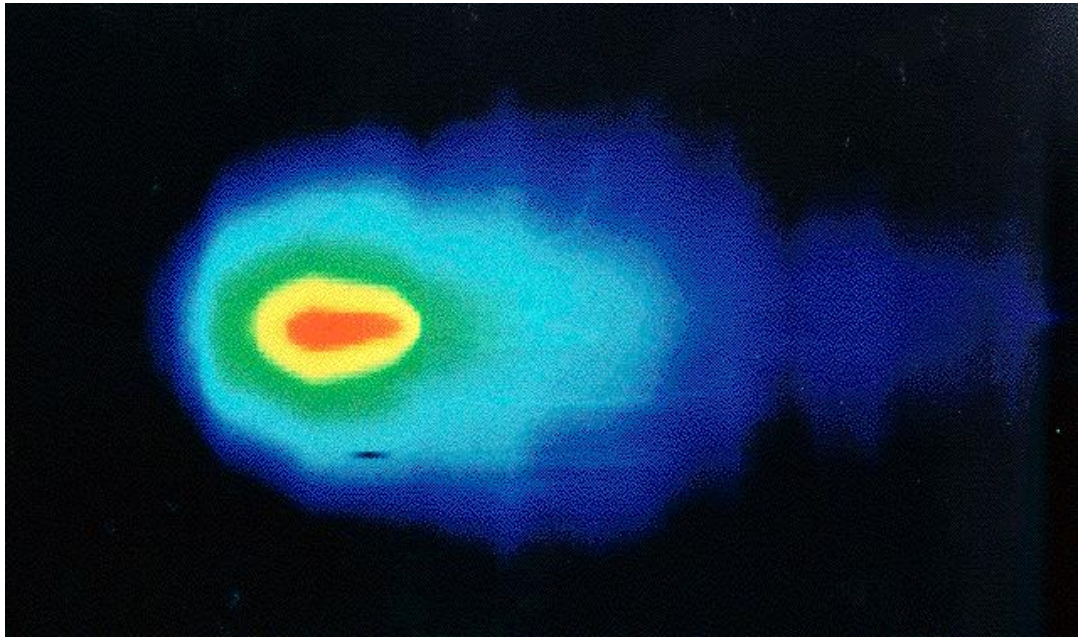
# Pioneering work of the 1960s



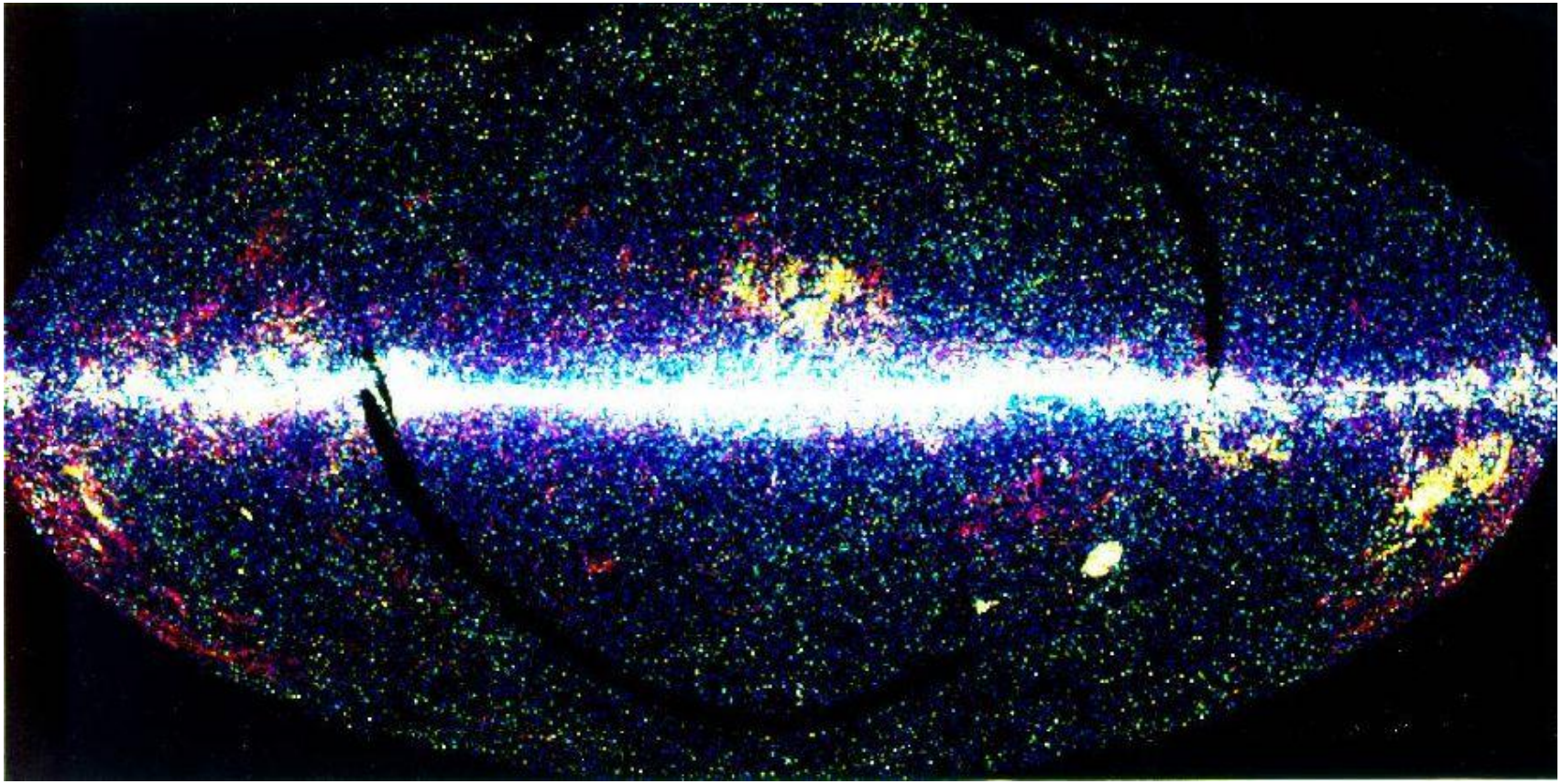
Gerry Neugebauer, with Bob Leighton, carried out the Two Micron Survey of northern sky in 1969, detecting dying stars and star being born

Frank Low pioneered mid and far infrared observations

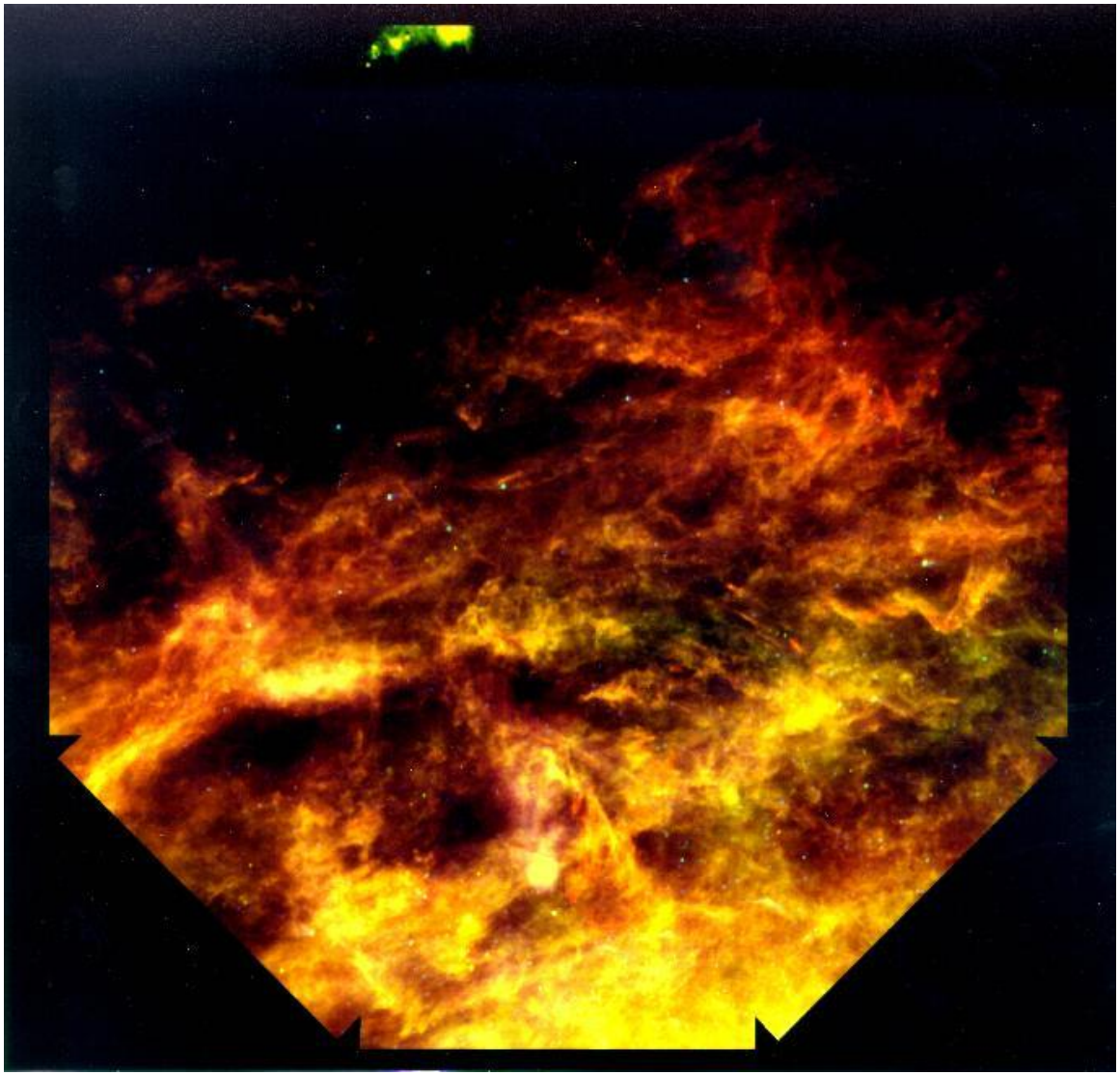
# IRAS (1983) transformed ir astronomy



# IRAS all-sky survey at 12-100 microns



# IRAS – cirrus, ir emission from interstellar dust

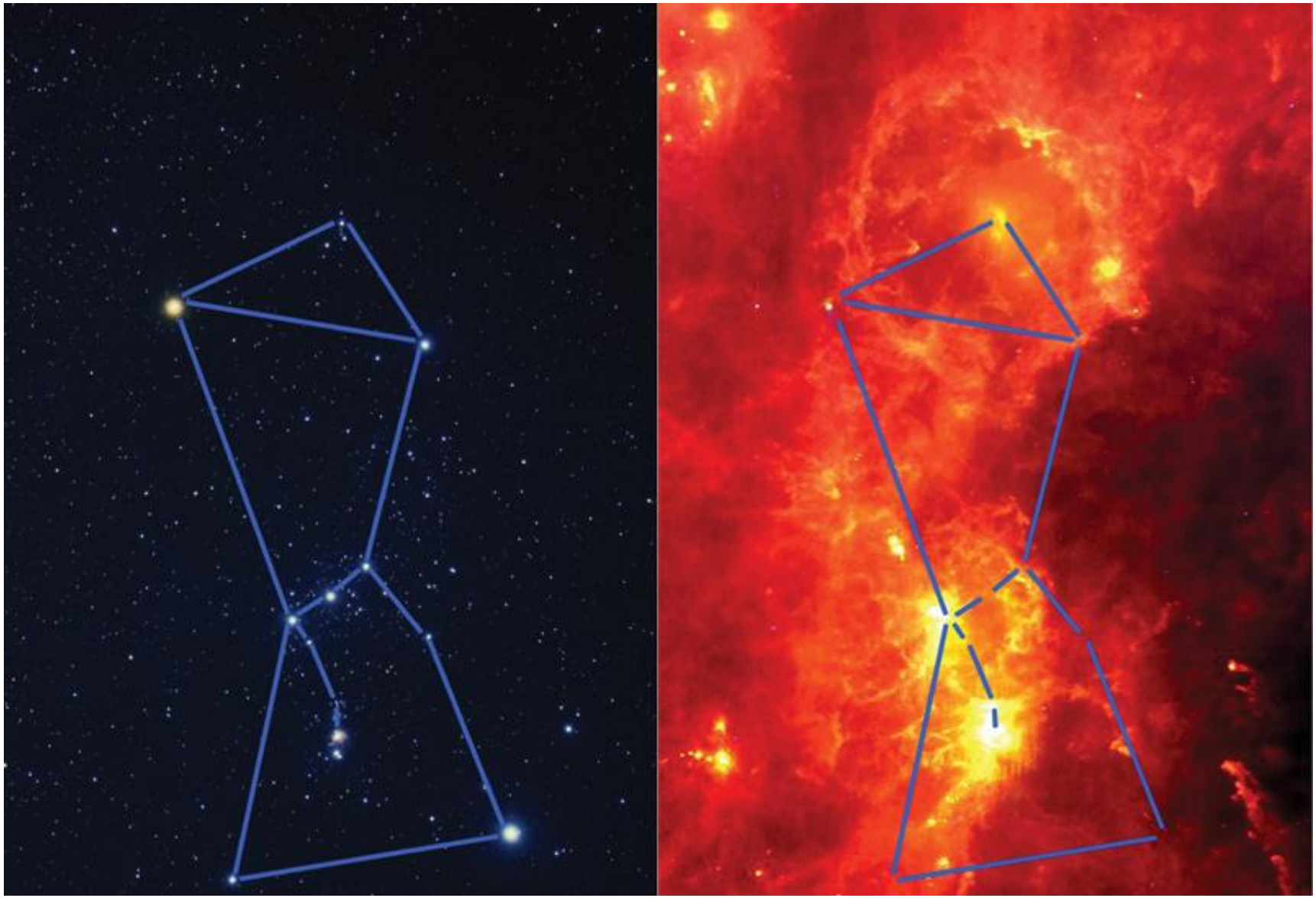


south celestial pole

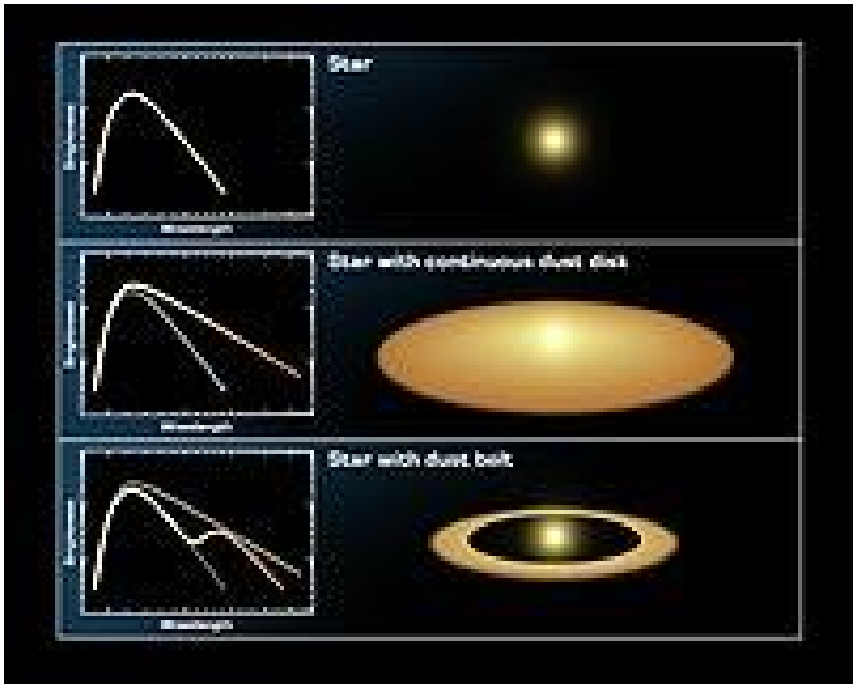
# IRAS - star forming regions

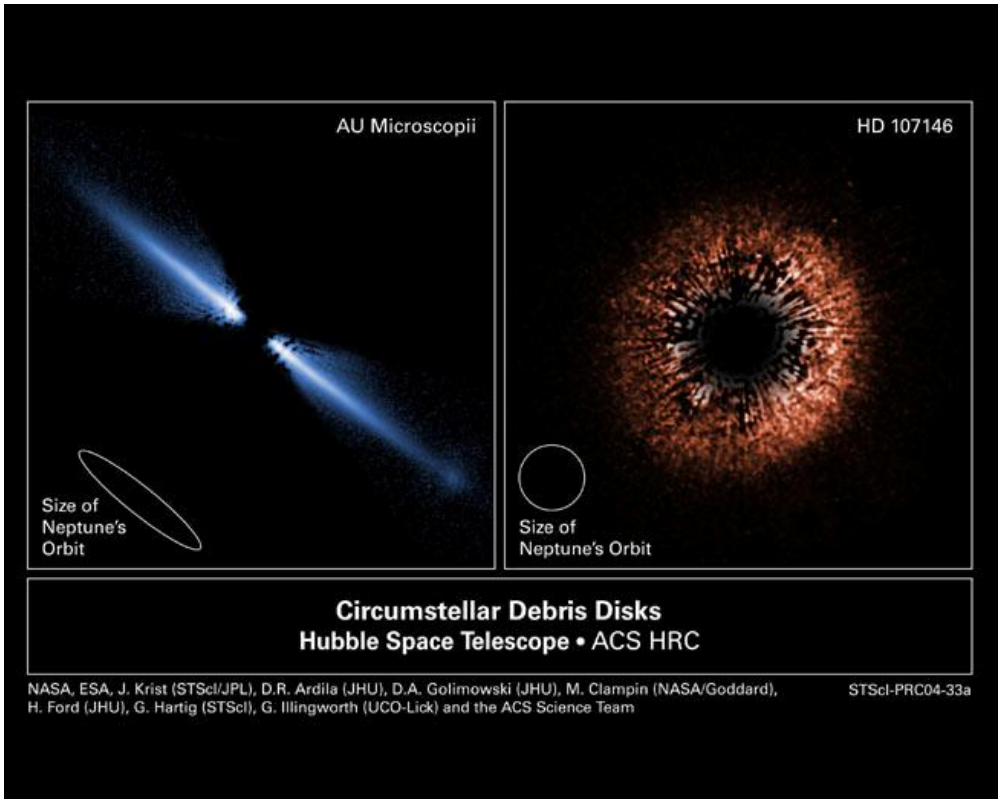
the Large Magellanic Cloud

# IRAS – constellation Orion



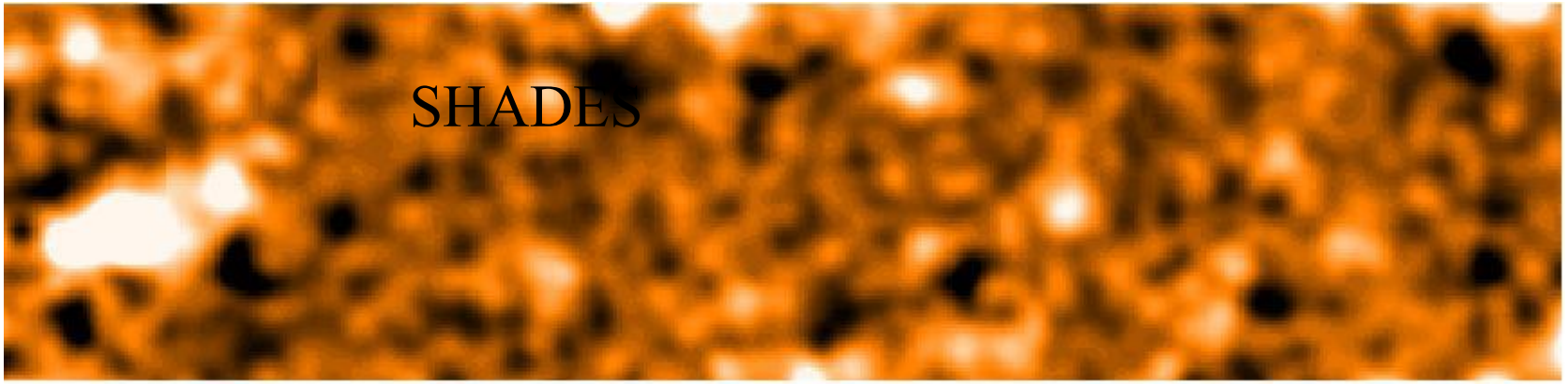
# IRAS - dust debris disks



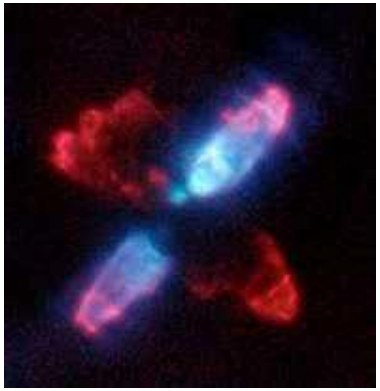



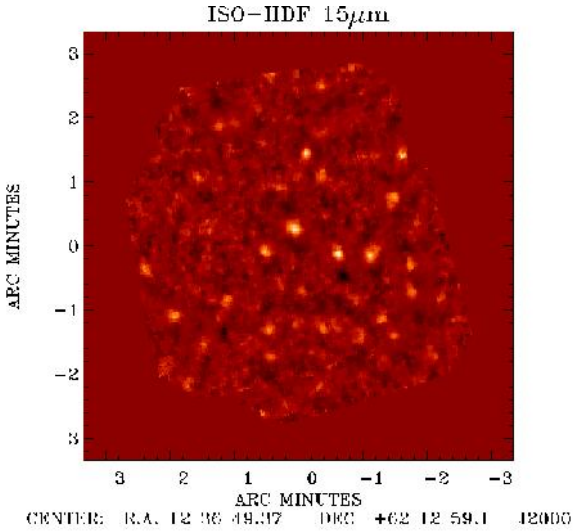
# impact of JCMT

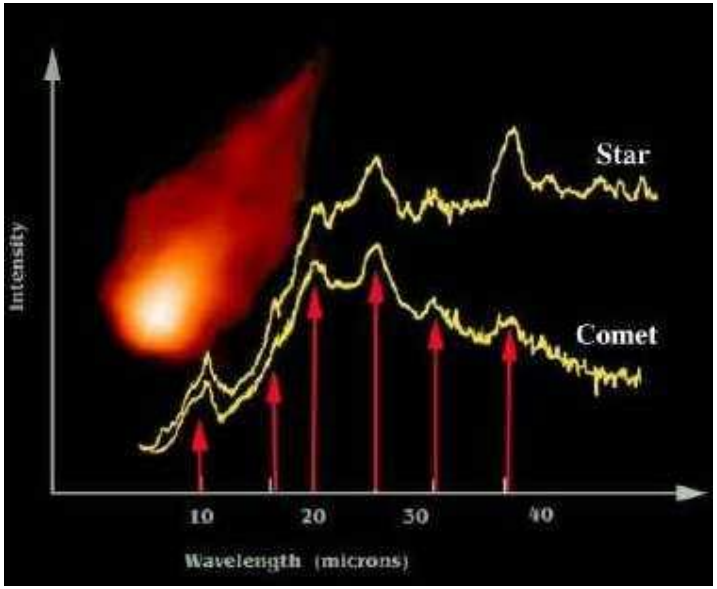

blank field surveys at 850 μm showed that we were able to survey the whole universe to redshift 5 with ultraluminous ir galaxies

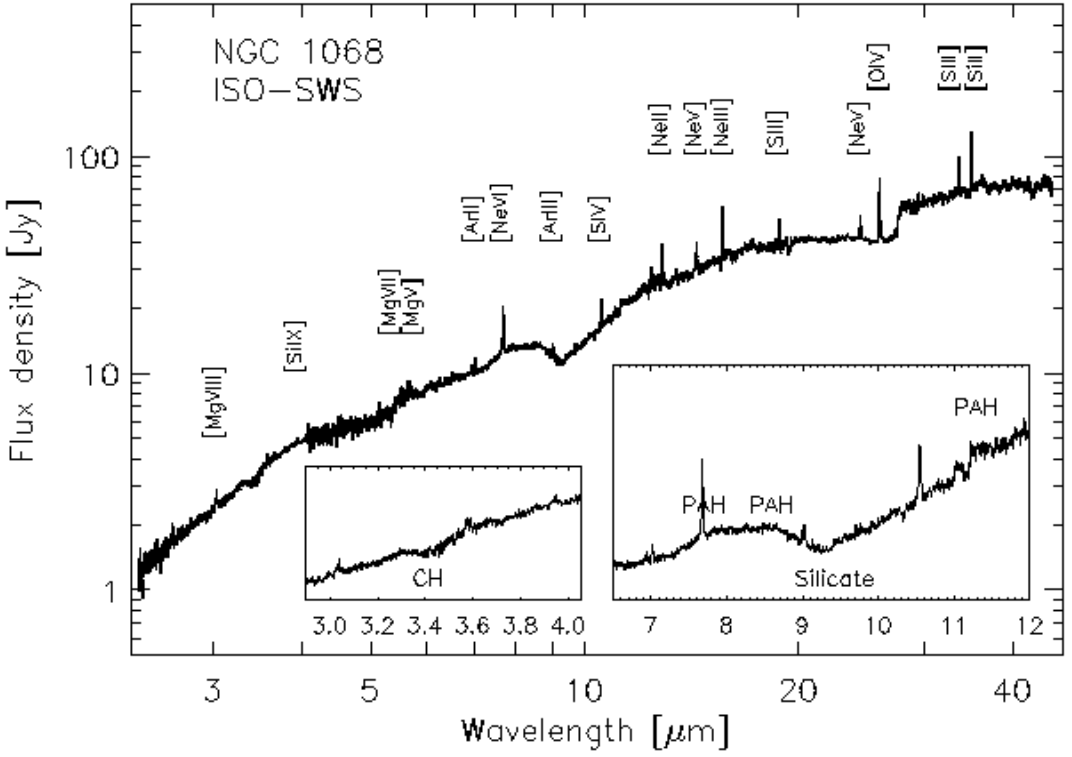


# ESA's ISO mission, 1995-8

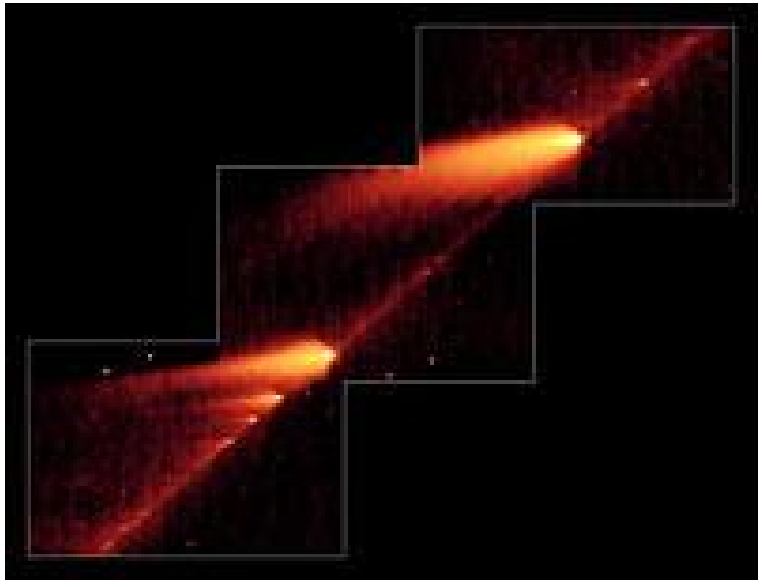


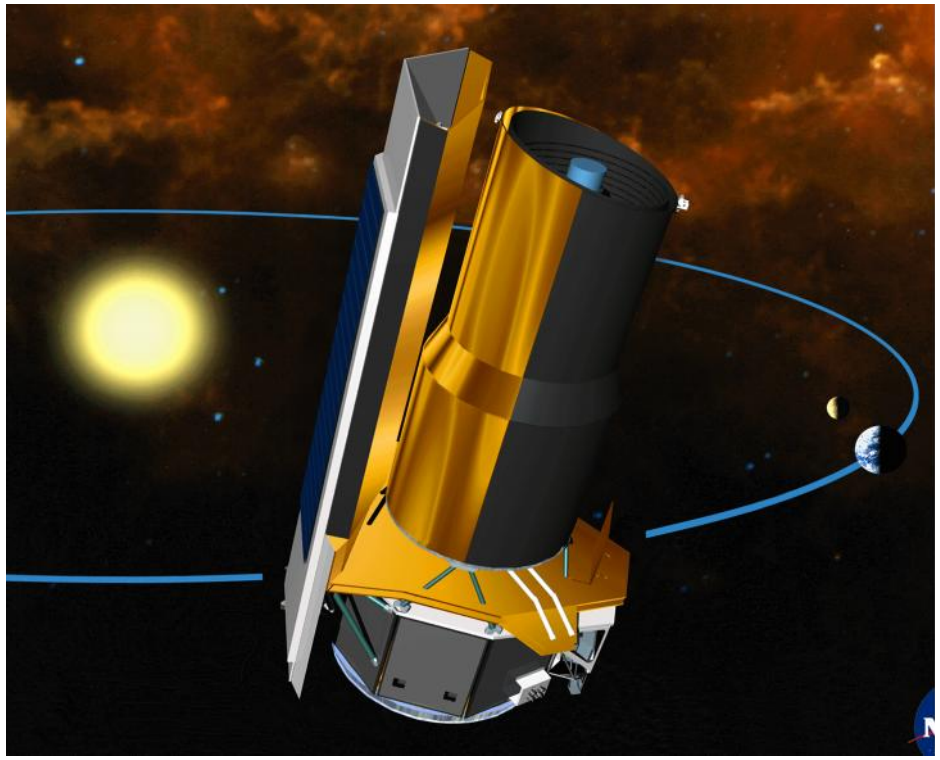


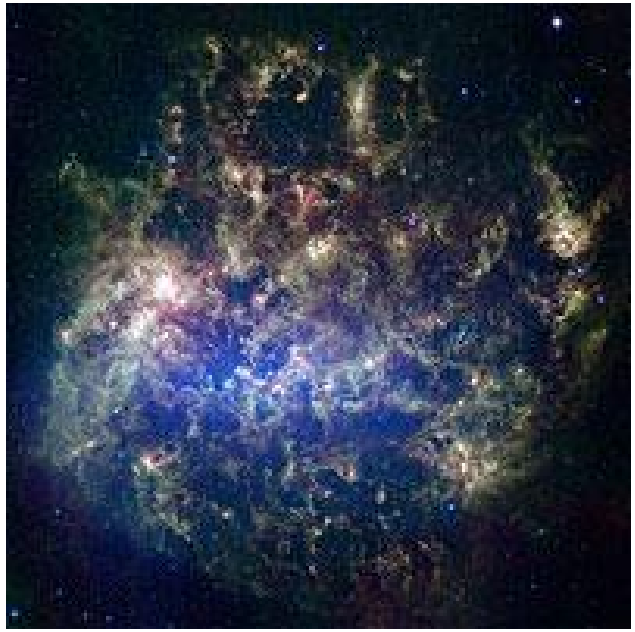



# SPITZER, 2003-



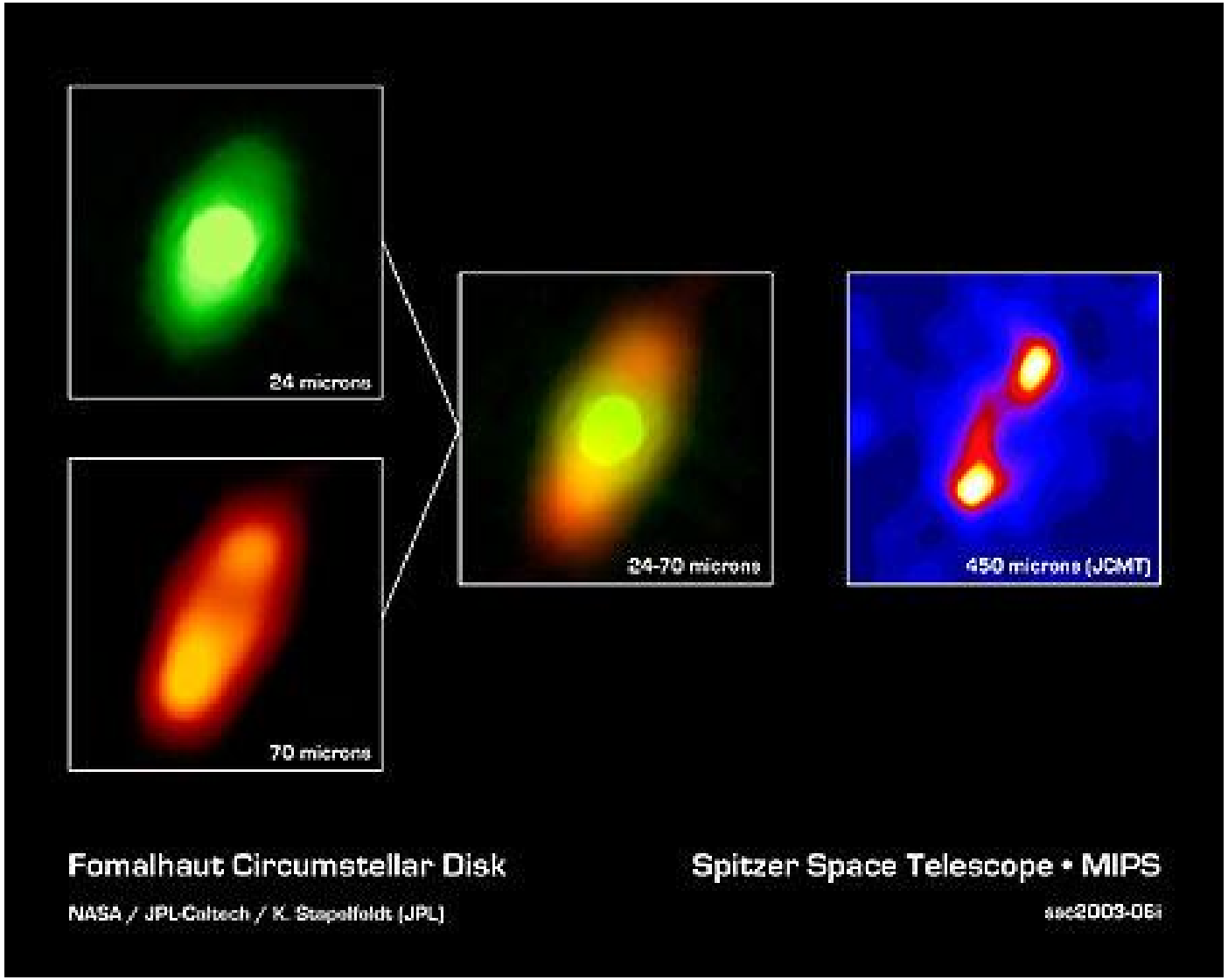




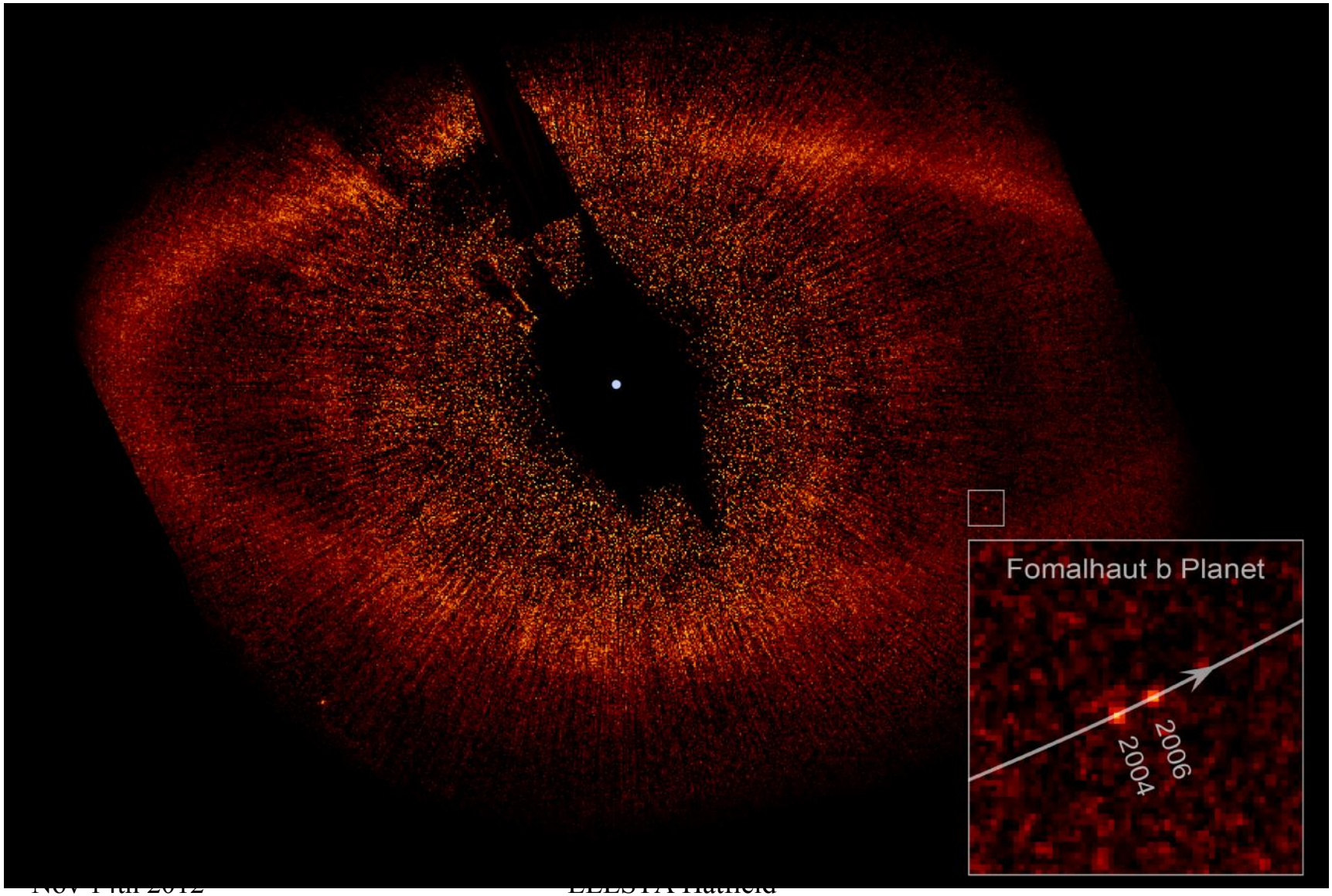
# Fomalhaut - circumstellar disk

- dust shell detected by IRAS, confirmed by JCMT at 450 μm
- the Spitzer 24 micron image shows the centre of ring is filled (in to at least 10 AU), cf zodiacal dust cloud around sun

[star has been subtracted]



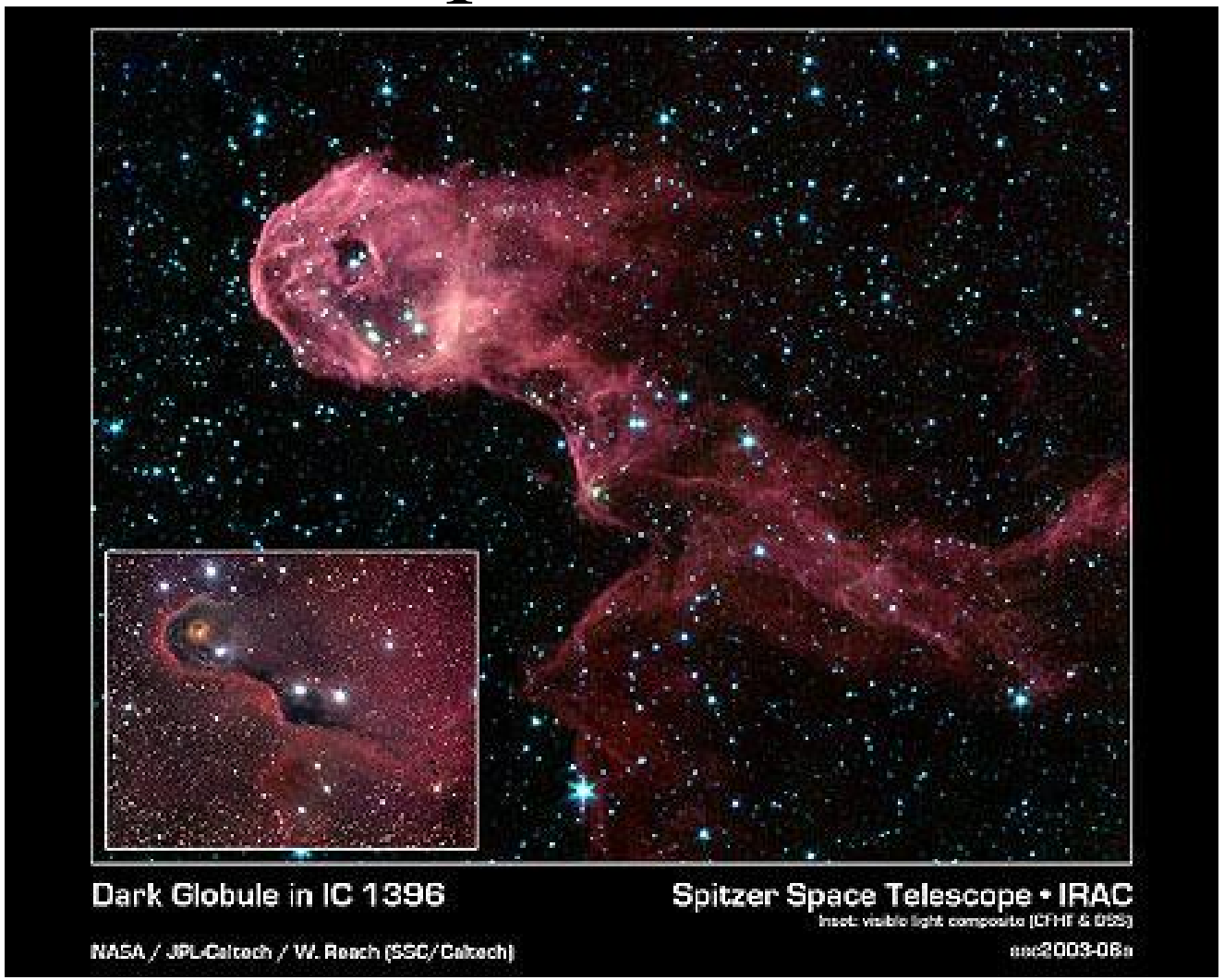
# Fomalhaut – debris disk and planet



# IC1396, the Elephant's Trunk

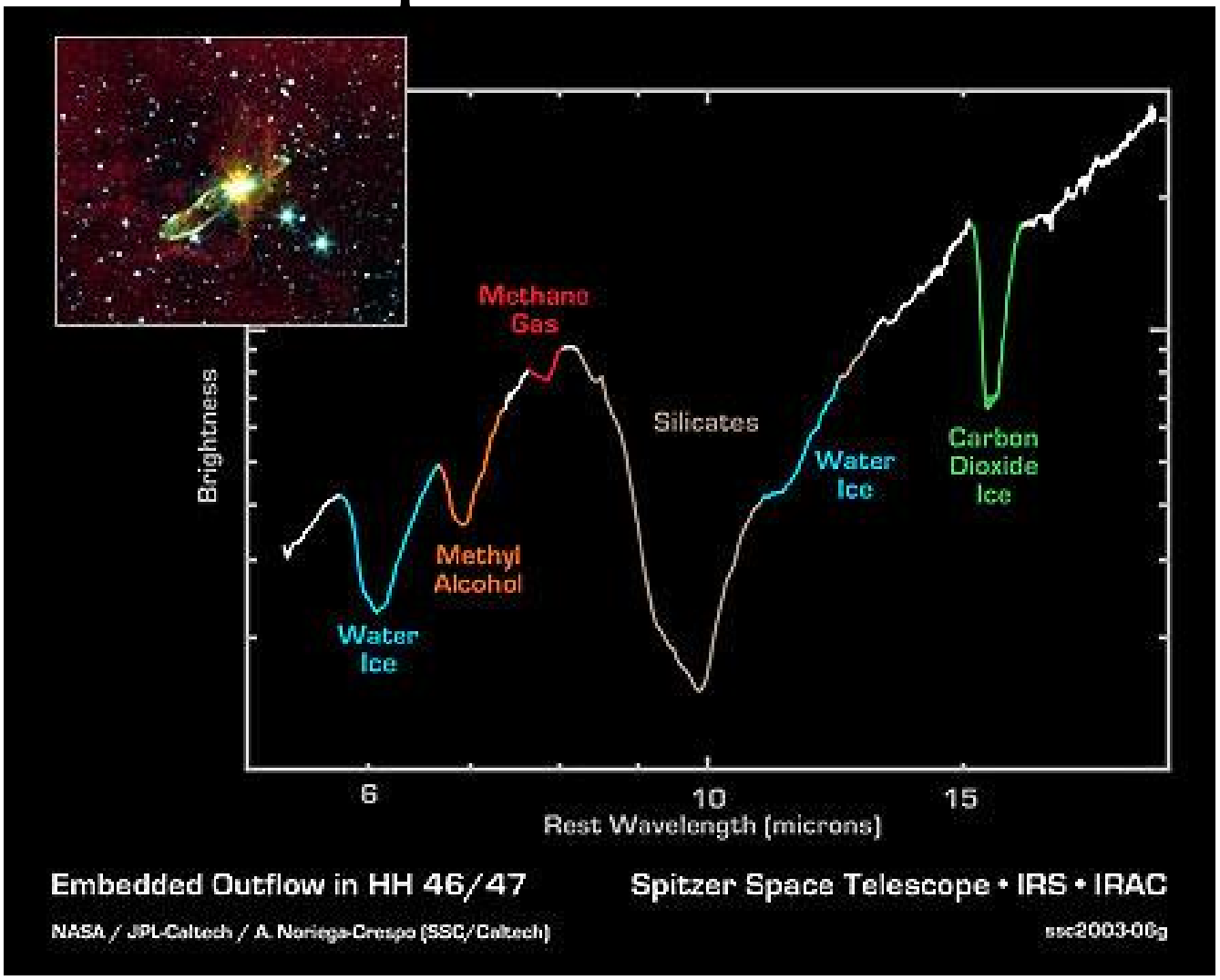
- dark globule inside emission nebula (ionizing star is to left of frame)

- pair of newly formed stars have created cavity



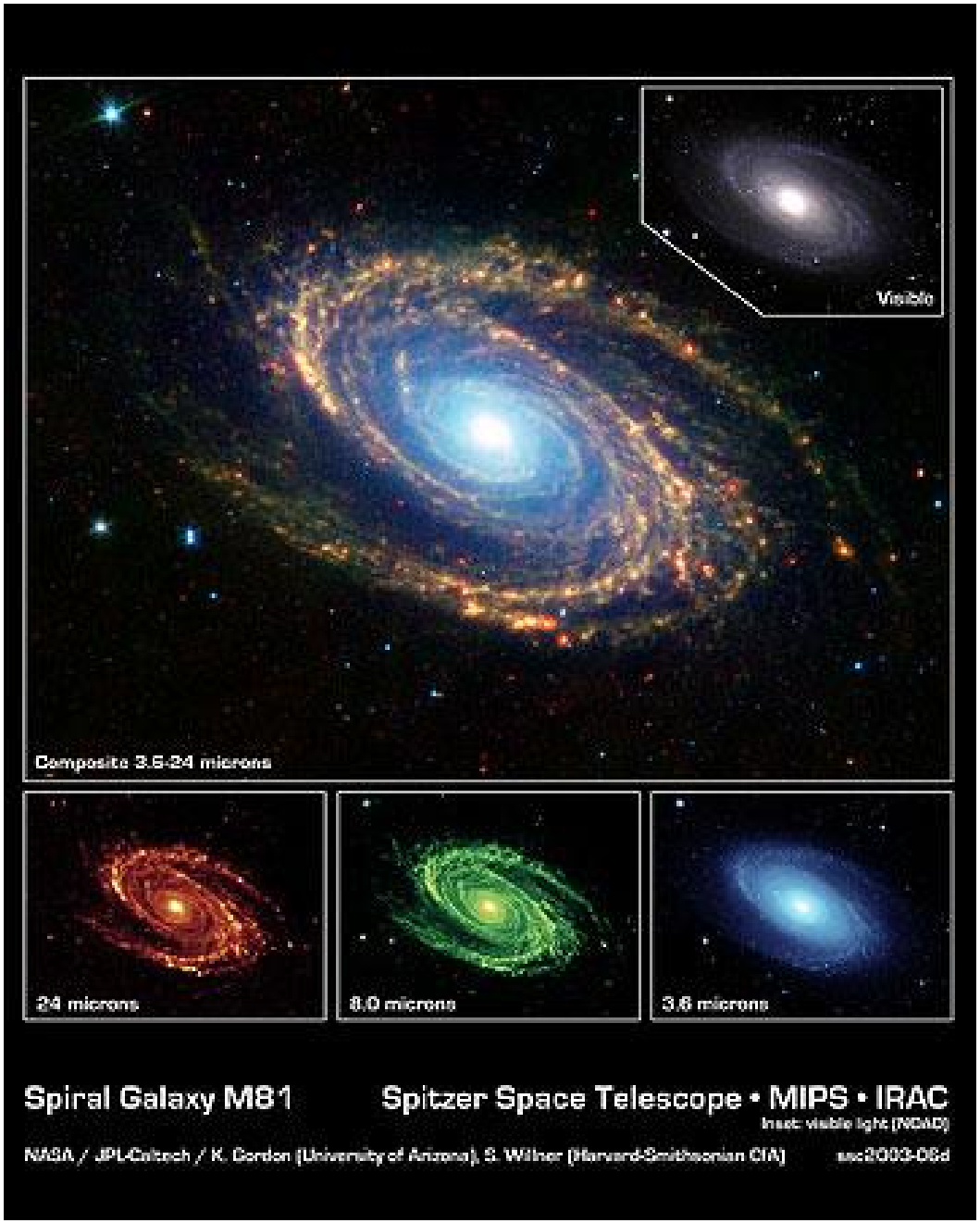
# HH46-47 spectrum

IRS 5-20 μm spectrum of the newly formed star HH46-47, showing features of water and $CO_2$ ices, methane and methyl alcohol, and silicates



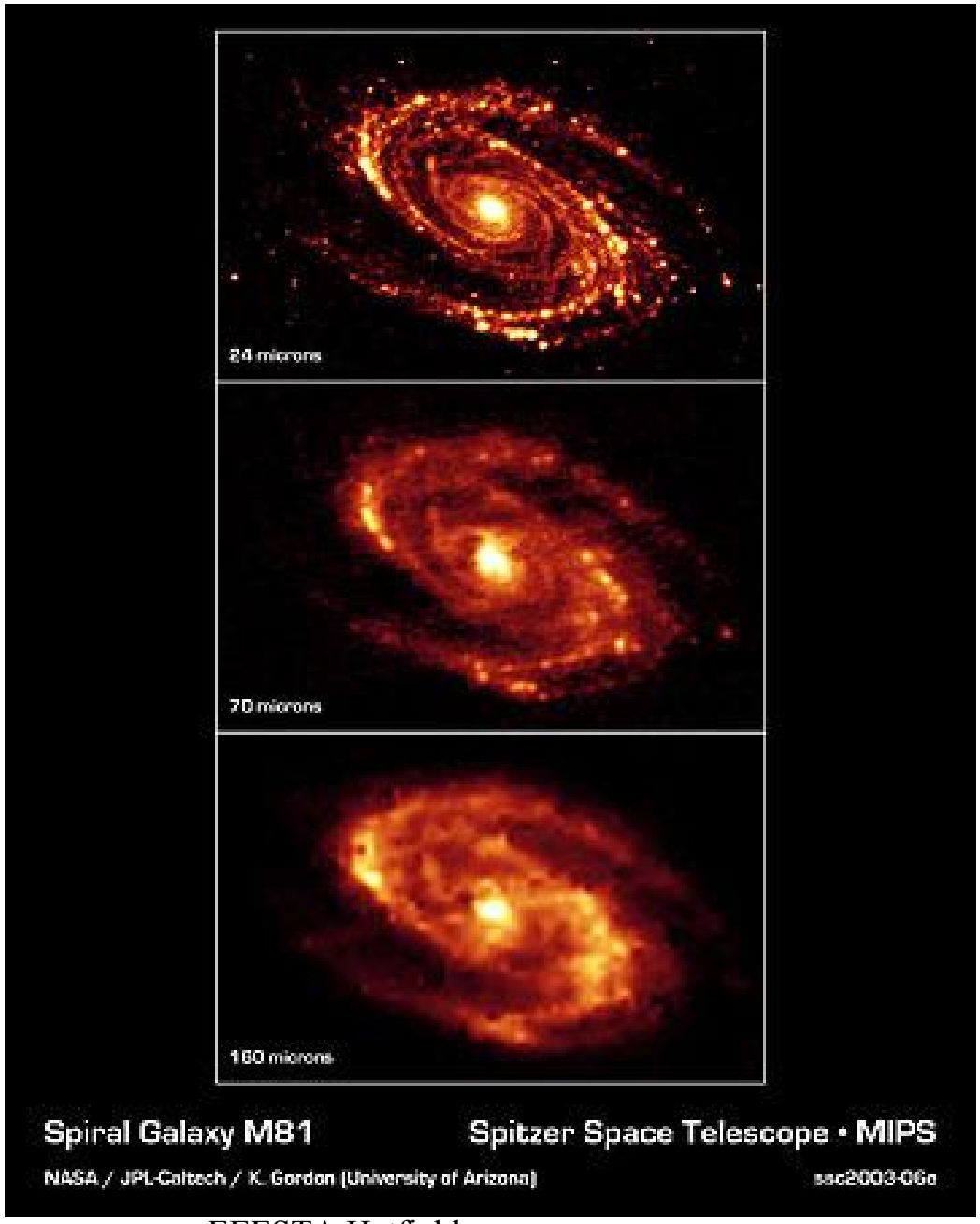
# Messier 81

images at 3.6, 8 and 24 μm, and a combined image



# M81

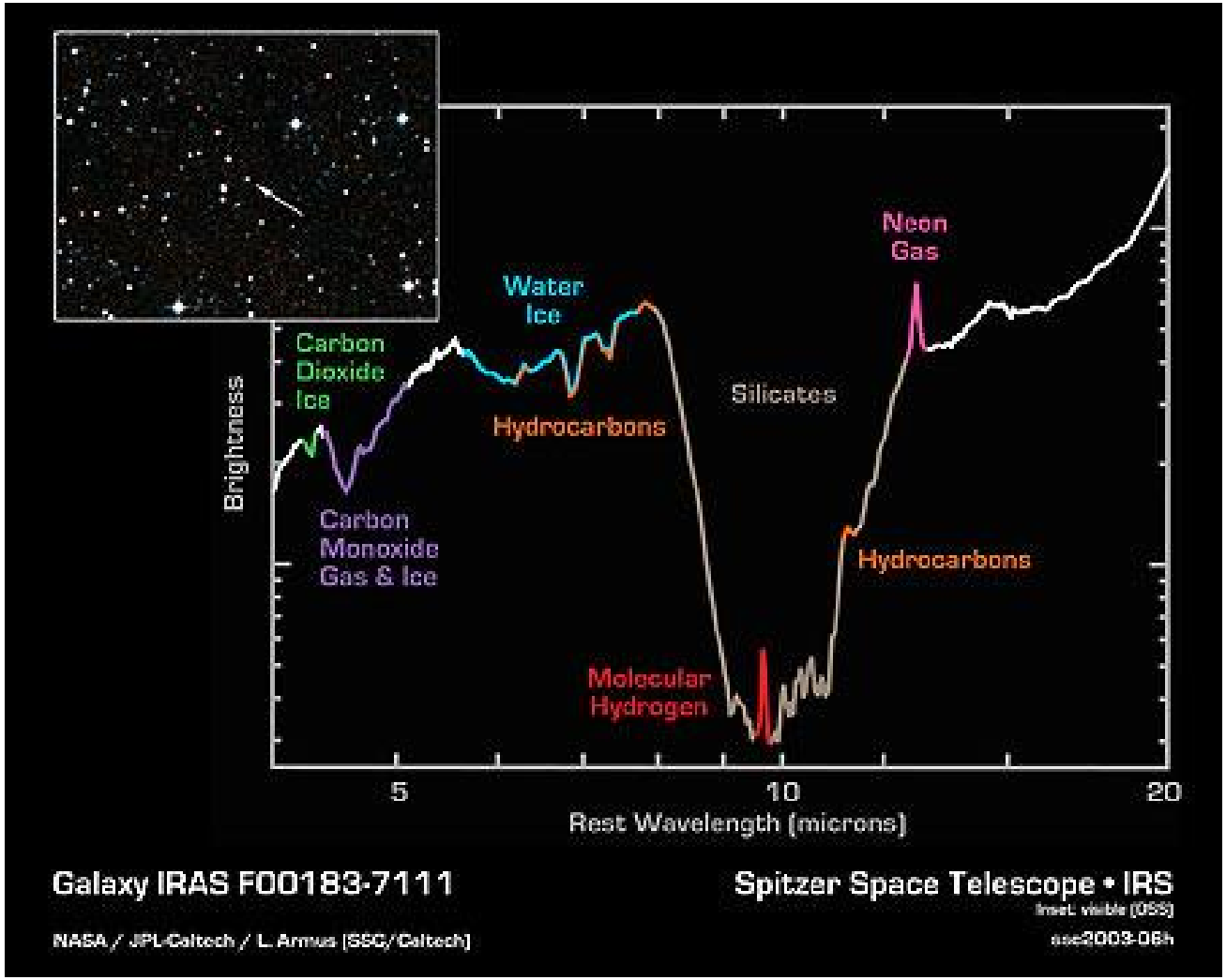
images at 24, 70 and 160 μm



# IRAS F00183-7111, hyperluminous infrared galaxy

- IRS spectrum of the hyperluminous ir galaxy F00183-7111 = IRAS P00182-7112 (Saunders et al 1996, Rowan-Robinson 2000)

- z = 0.327 (narrow line object), lg $L_{sb}$ = 13.25 (H=50,Ω=1)

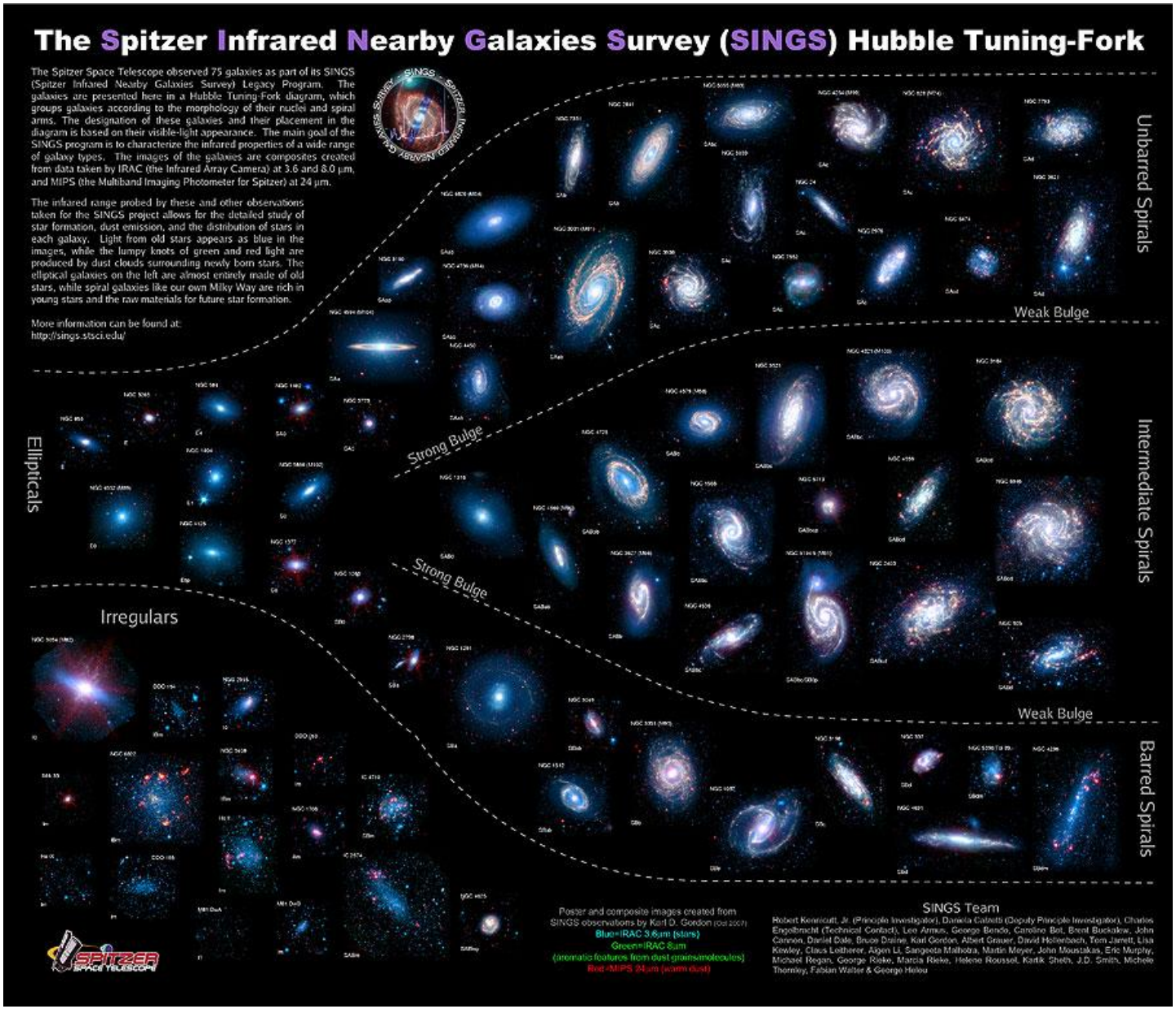


# SPITZER Legacy Programs

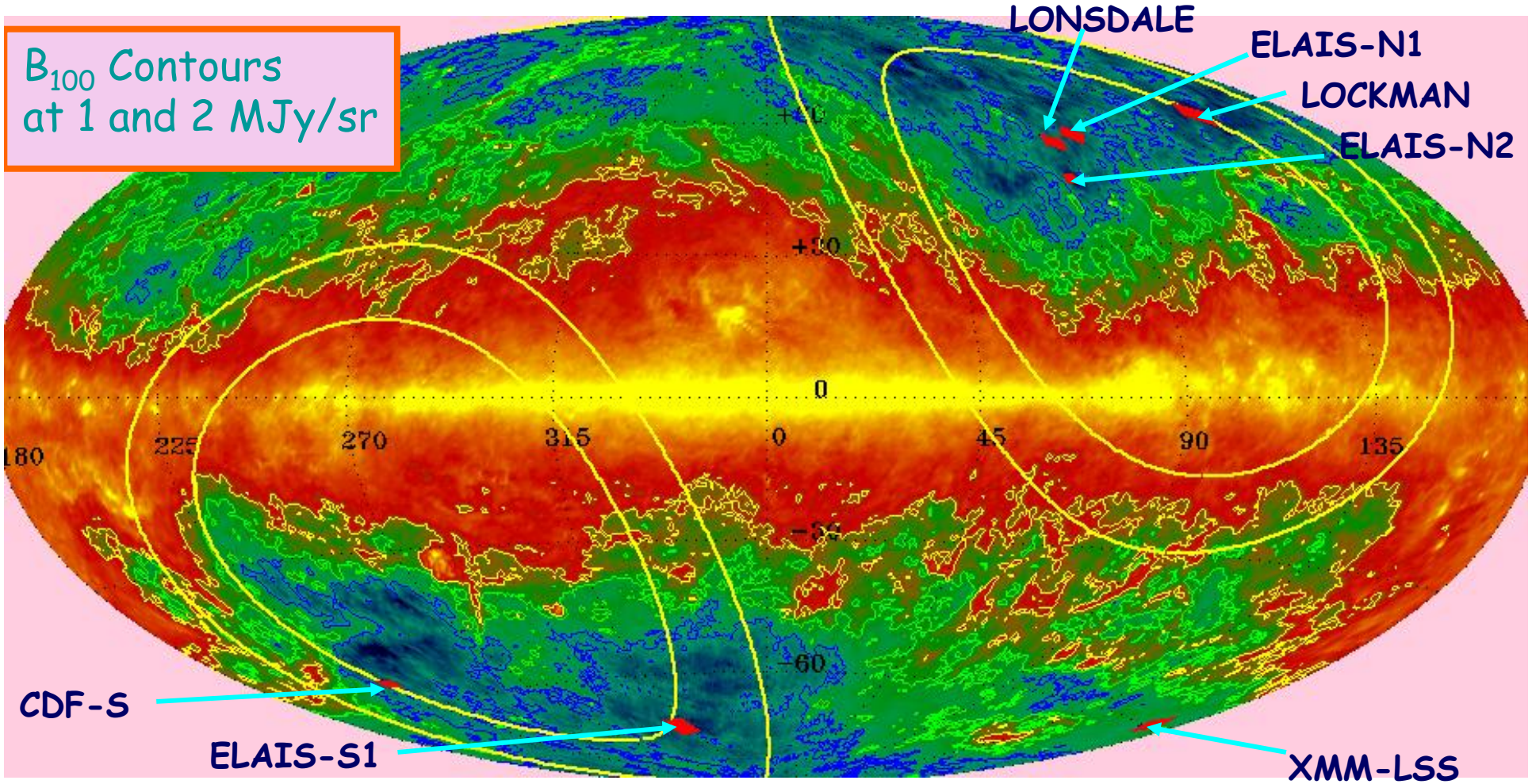
Spitzer placed great emphasis on ‘Legacy’ programmes

- SWIRE - large area survey
- GOODS - very deep survey in HDFN and CDFS
- SINGS - mapping of nearby galaxies
- COSMOS - combined HST and Spitzer survey
- SAGE - mapping LMC, star formation

# The SINGS nearby galaxy survey



# SWIRE & the New "Cosmic Windows"

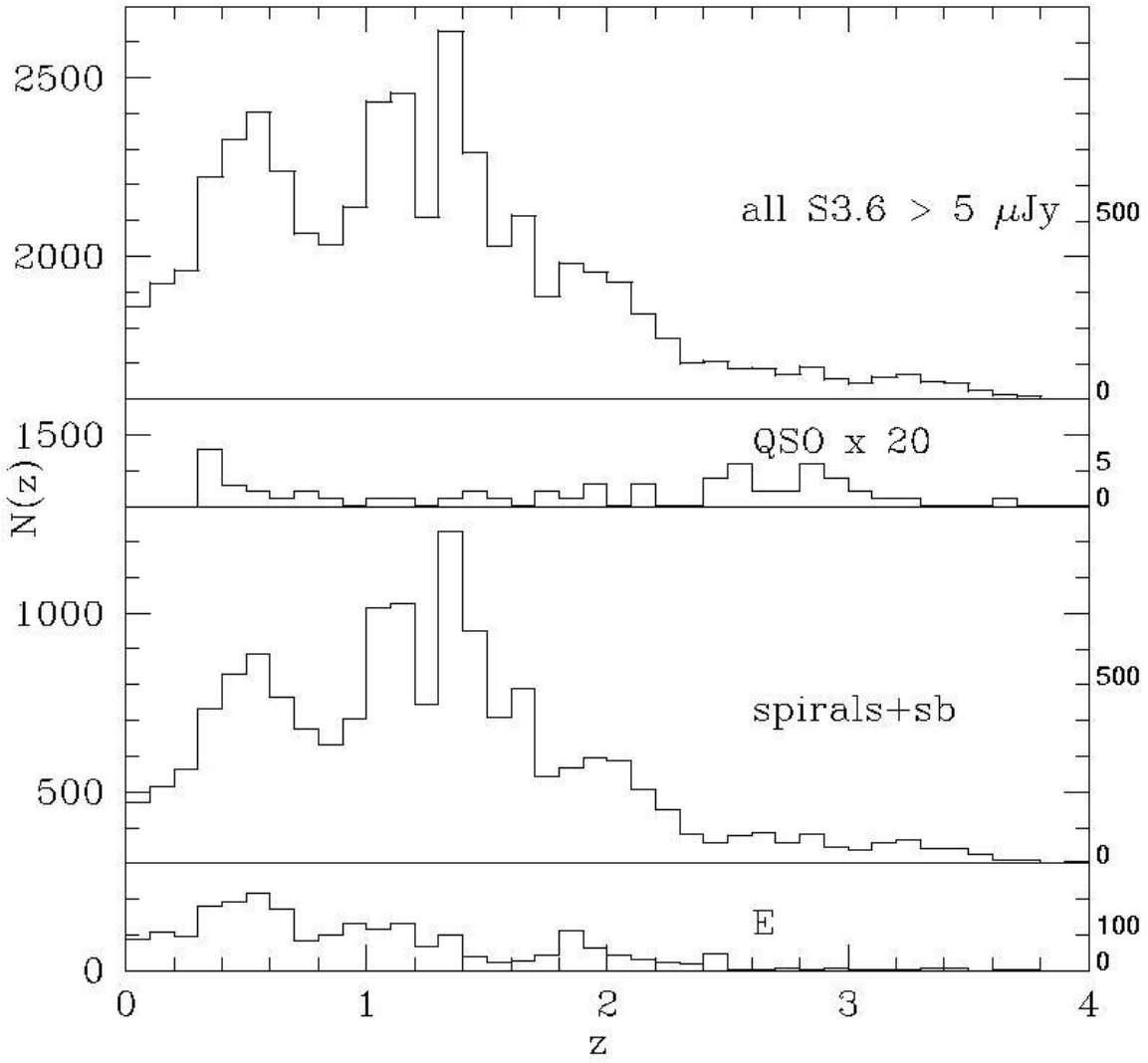



Schlegel et al. 1998 DIRBE-calibrated IRAS 100μm map



Fig: Seb Oliver.

# Redshift distributions for SWIRE survey

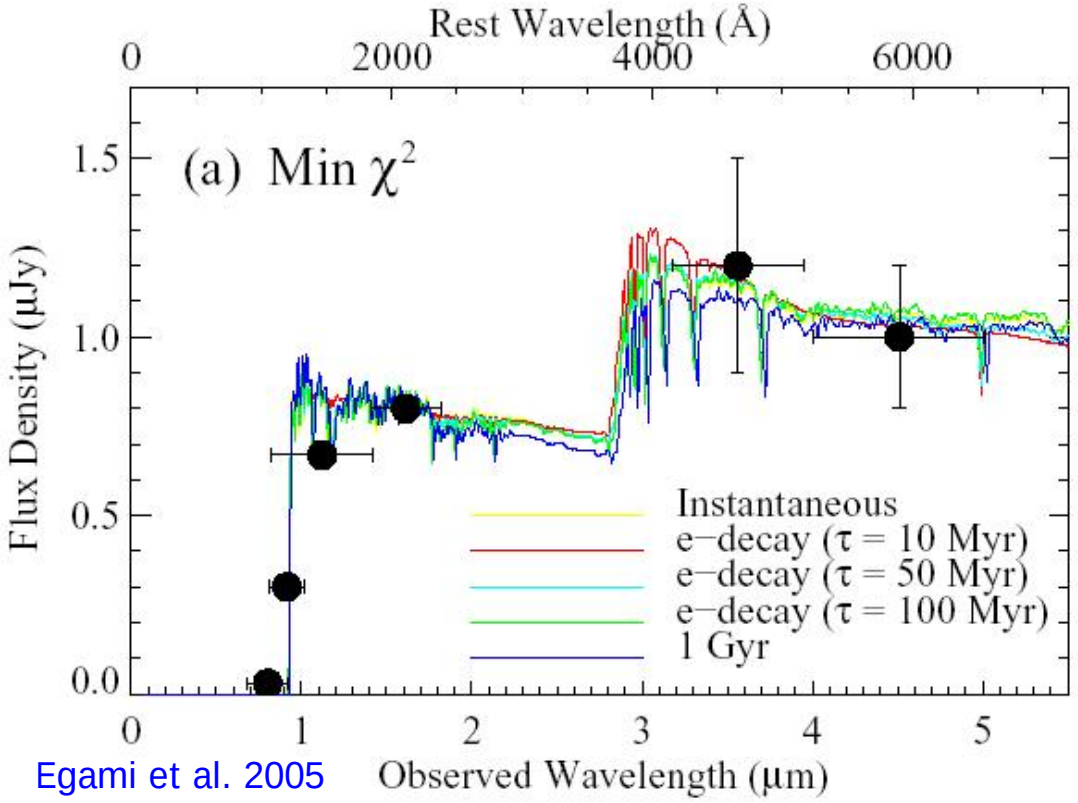



Photometric redshifts in Suburu XDS, R<27.5 (Rowan-Robinson et al 2008)

SWIRE survey gives redshift (and hence distance) estimates for over 1 million galaxies

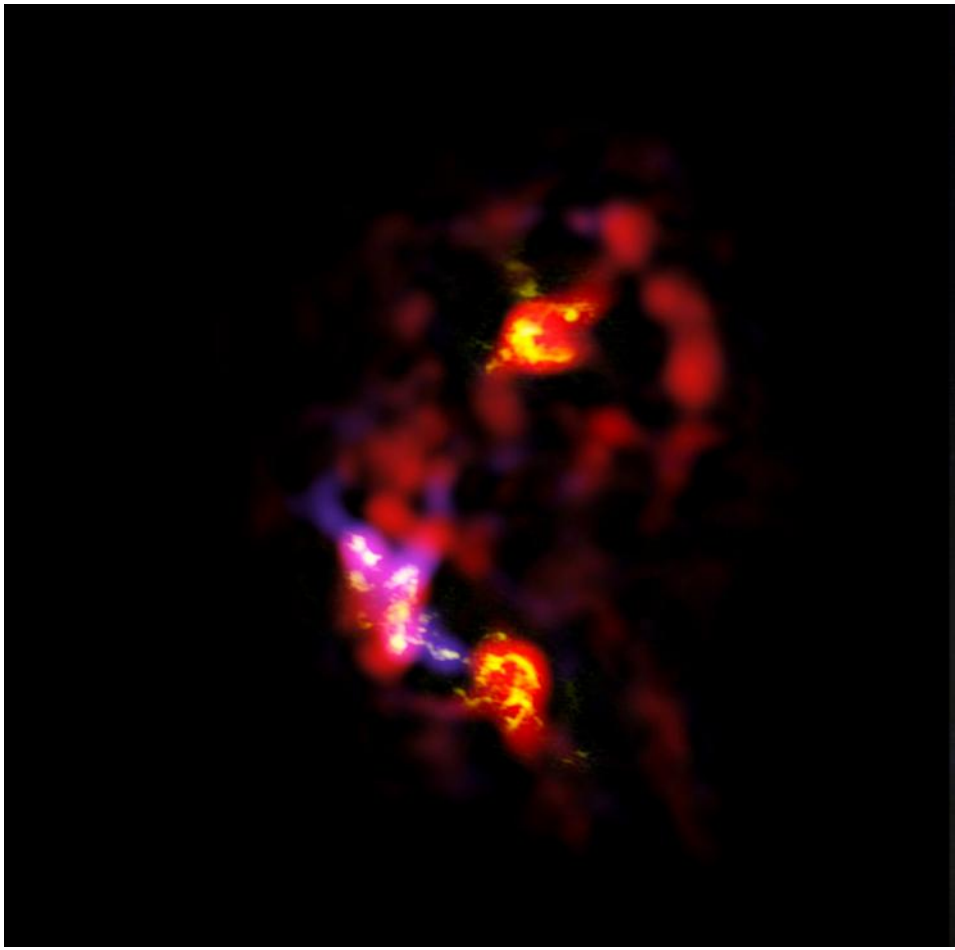
# Spitzer detection of z ~ 7 galaxy

- the Spitzer telescope, with a diameter of 70 cm, detected one of the most distant galaxies in the universe



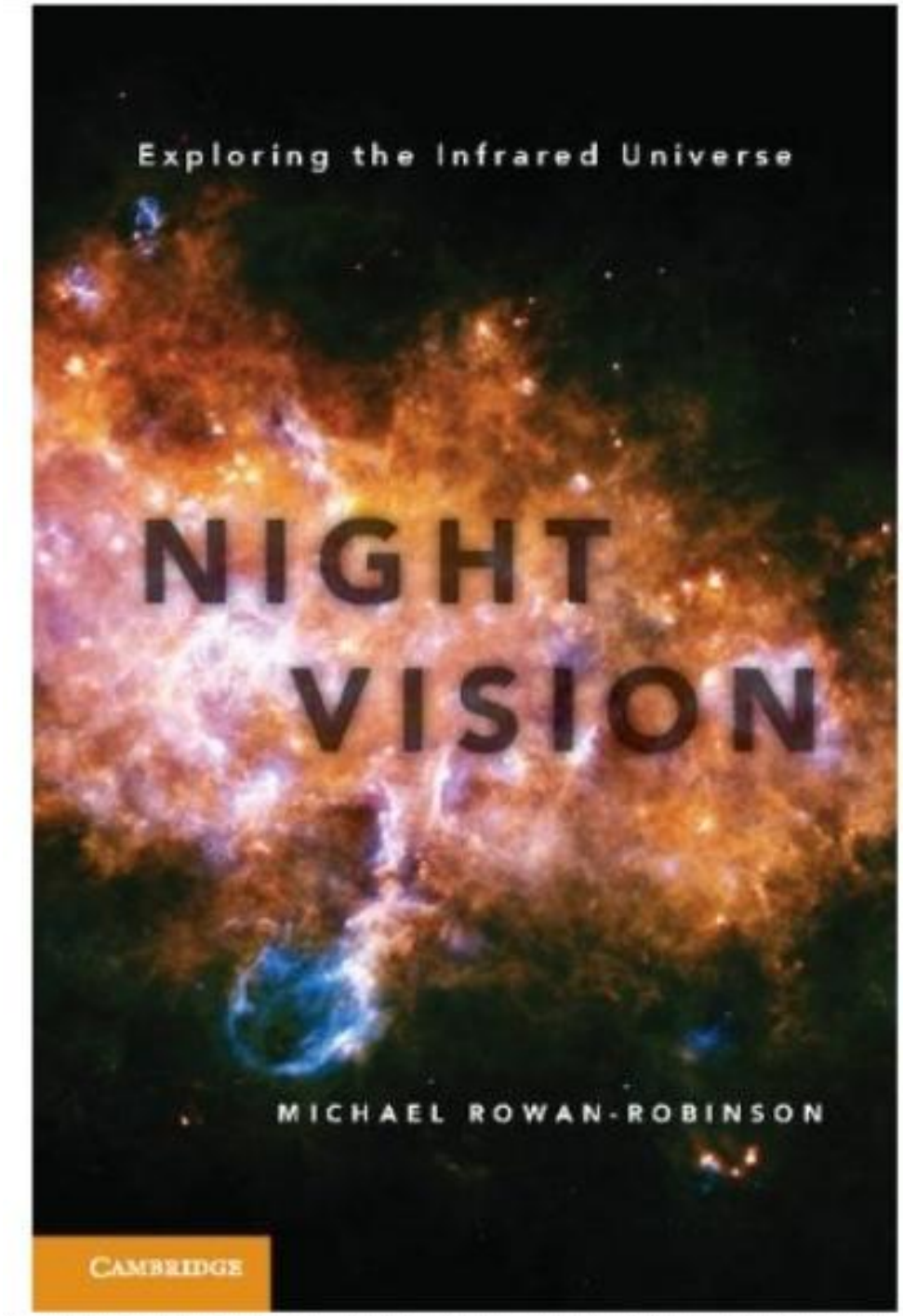

Egami et al. 2005

# The future: ALMA submillimetre image of the Antennae galaxies



ALMA submm image

HST optical image




# Night Vision

Exploring the infrared universe

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. Hatfield