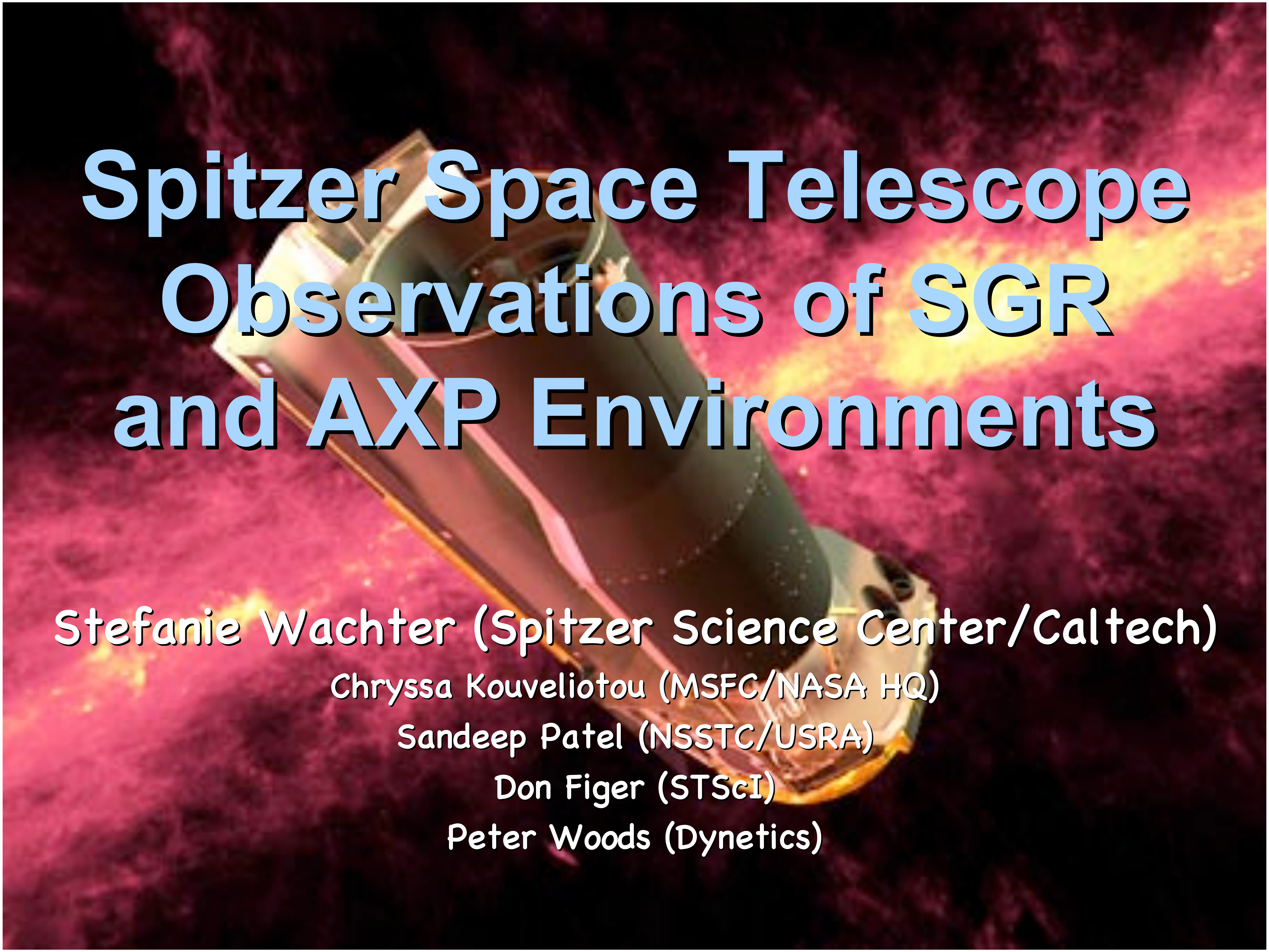


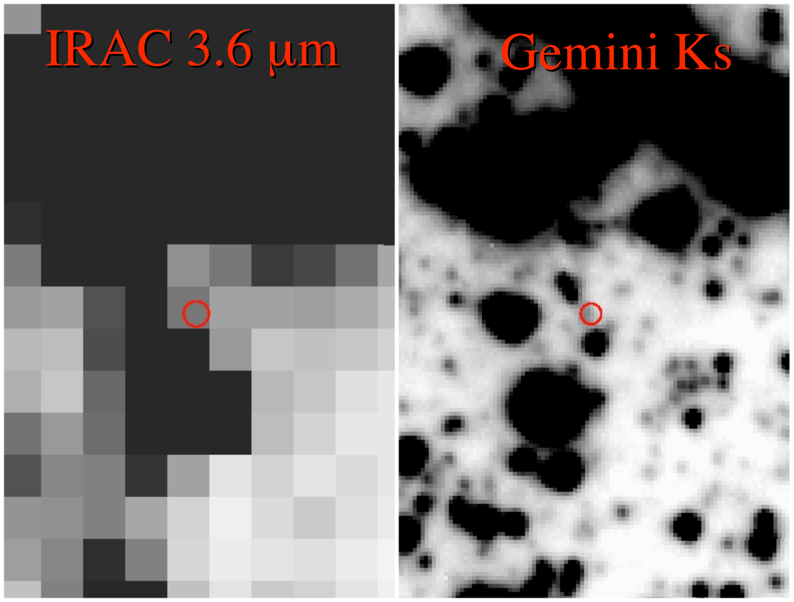
Spitzer Space Telescope Observations of SGR and AXP Environments

Stefanie Wachter (Spitzer Science Center/Caltech)
Chryssa Kouveliotou (MSFC/NASA HQ)
Sandeep Patel (NSSTC/USRA)
Don Figer (STScI)
Peter Woods (Dynetics)

Spitzer Instruments Overview

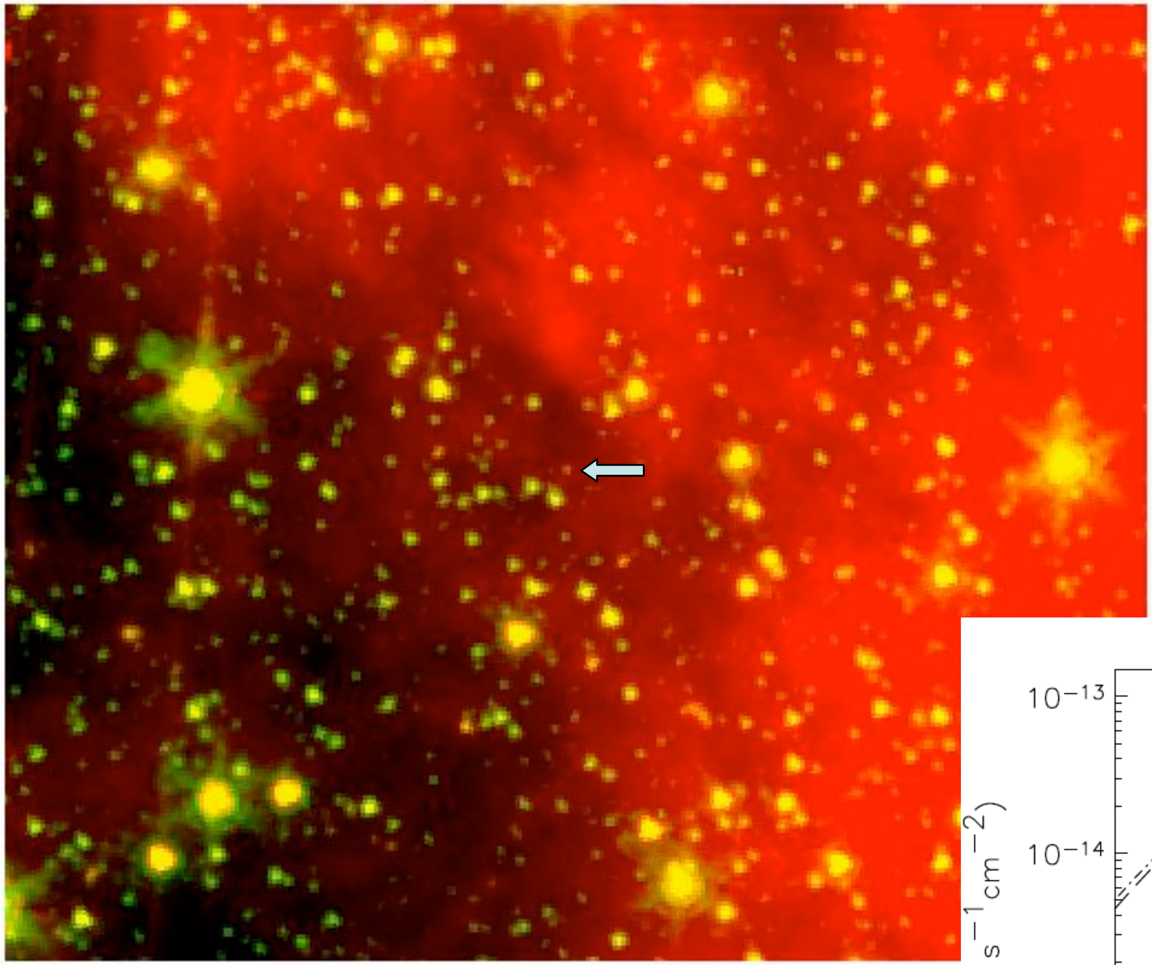
IRAC (Infrared Array Camera)
FOV: ~ 5' x 5'
Imaging: 3.6, 4.5, 5.8, 8.0 μm
Resolution: 1.2" pixels

SGR 1806-20



IRS (Infrared Spectrograph)
Spectroscopy: 5-38 μm
Imaging: centered at 16 and 22μm

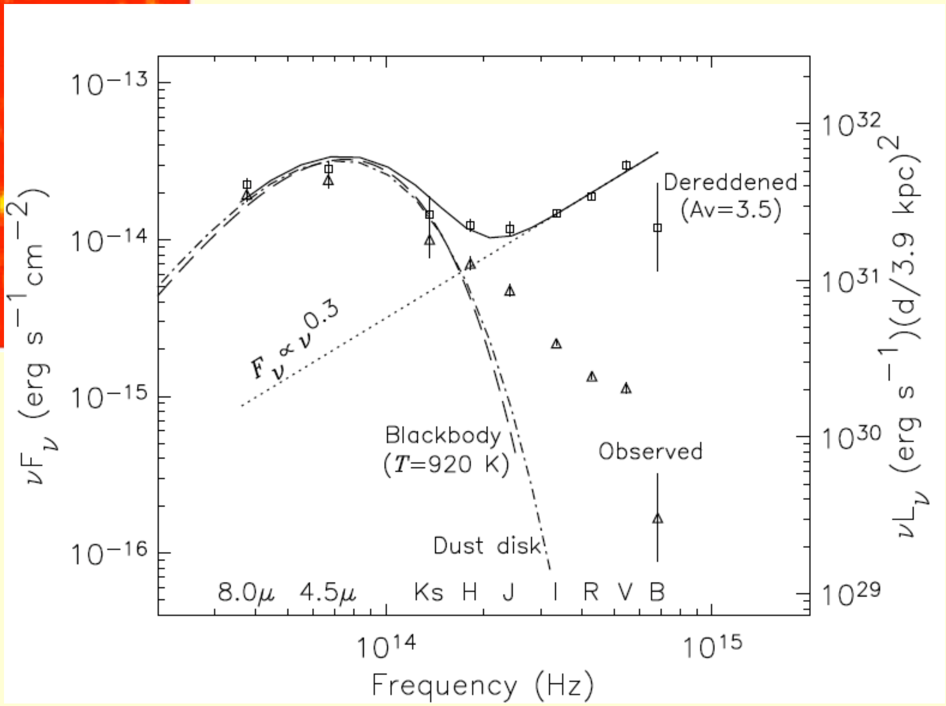
MIPS (Multiband Imaging Photometer)
FOV depends on array, ~5' x 5' (24 μm), scans of up to 6^o
3 Arrays: 24μm (2.5"), 70μm (5"/9.8"), 160 μm (16")



Spitzer Detection of a debris disk around AXP 0142+61

Wang, Chakrabarty & Kaplan
2006, Nature 440, 772

IRAC 4.5 (green) + 8.0 μm (red)
FOV ~ 5' x 5'



Does the IR environment of magnetars offer clues to their progenitors and formation? Are there differences in these environments between AXPs and SGRs?

IR advantageous in the presence of large amount of extinction

Search for

- clusters (deeply embedded, not detected in near-IR)
- SNRs (not detected at other λ)
- wind blown bubbles (prominent in IR)

Suggested magnetar progenitor properties:

- very massive and/or
- fast rotators

Clusters:

- expect more massive stars in higher density clusters
- no difference in fraction of fast rotators between clusters and field, clusters may be missing slow rotators

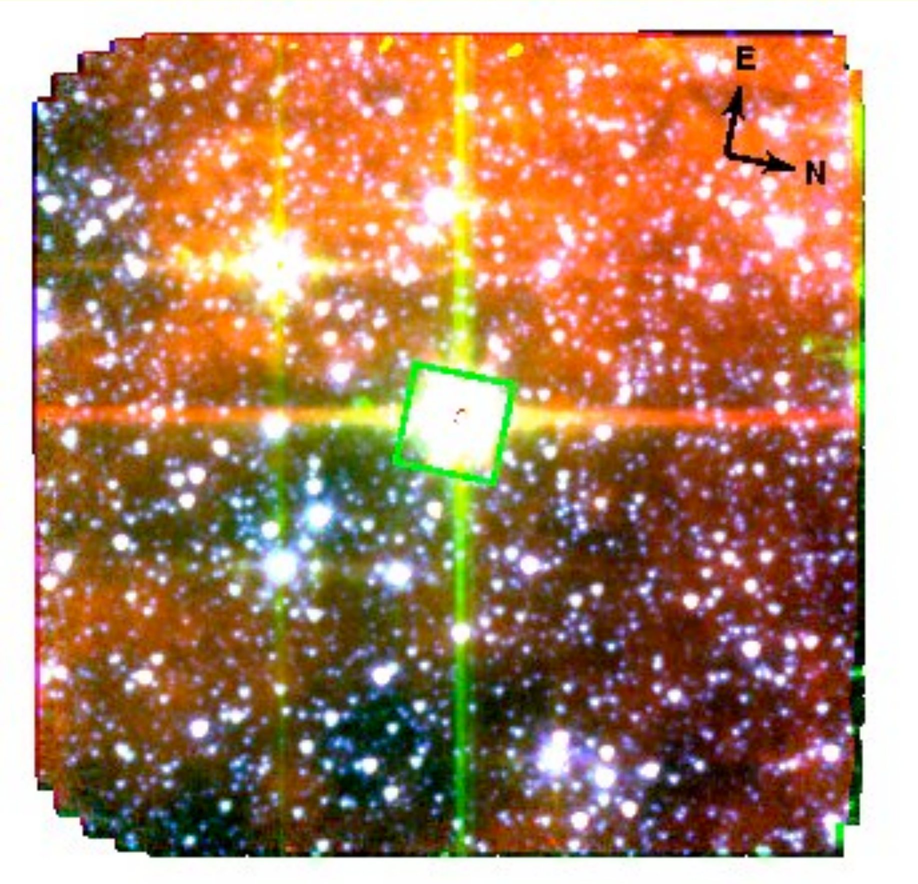
(Strom et al. 2005, AJ, 129, 809)

SNRs and Bubbles:

- clues to the nature of the progenitor

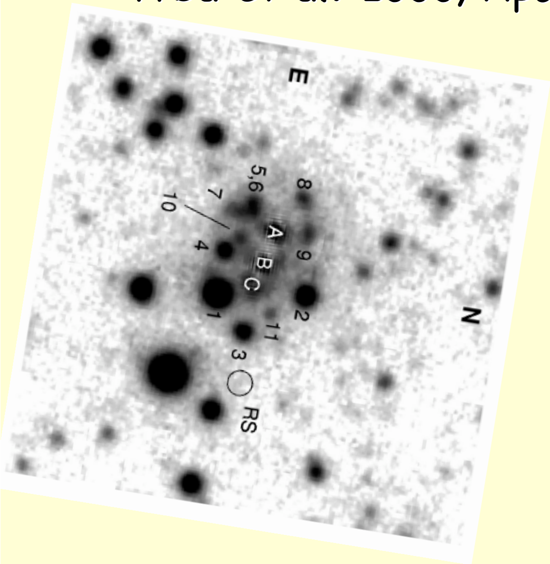
Clusters can be tricky to find !

SGR 1900+14



IRAC 4.5(blue) + 5.8(green) + 8.0(red) µm

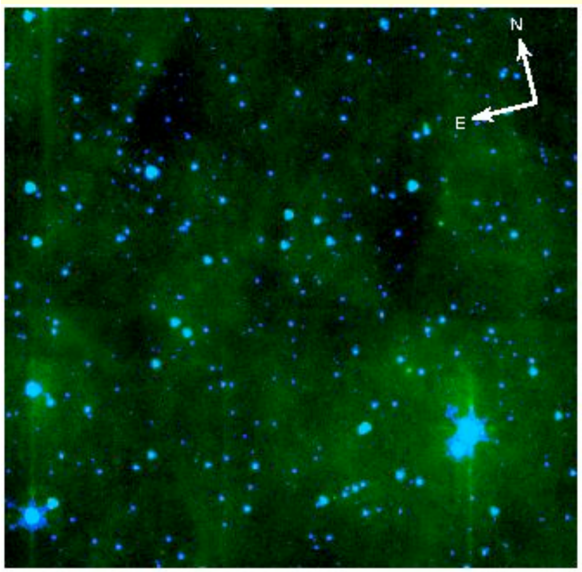
Vrba et al. 2000, ApJ, 533, L17



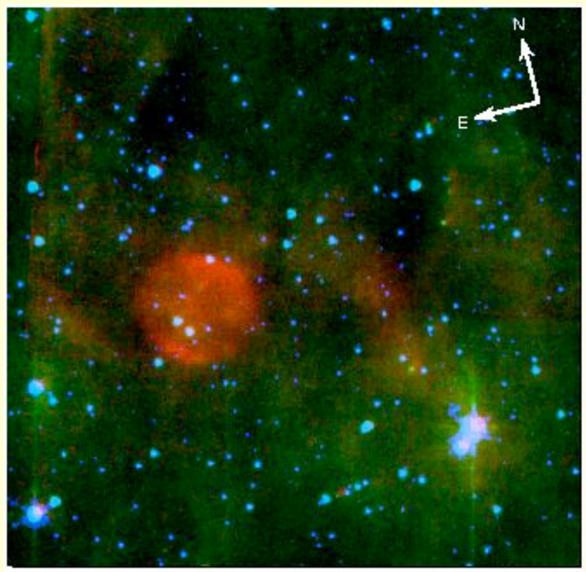
Supernova Remnants at Spitzer Wavelengths

- poorly studied up to now (e.g. Saken, Fesen & Shull 1992, ApJS, 81, 715; Reach et al. 2006, AJ, 131, 1479)
- Continuum/line emission of dust with different grain sizes, shock- or radiatively heated at 8 μm (e.g. PAH - polycyclic aromatic hydrocarbons), warm (very small grain) dust at 24 μm, cold dust at 70 and 160 μm
- Interaction with dense gas => shock cooling occurs through molecular/ionic lines in mid-IR
- might expect dust emission (slower/older remnants) even if no radio emission

IRAC 4.5(blue) + 8.0(green)

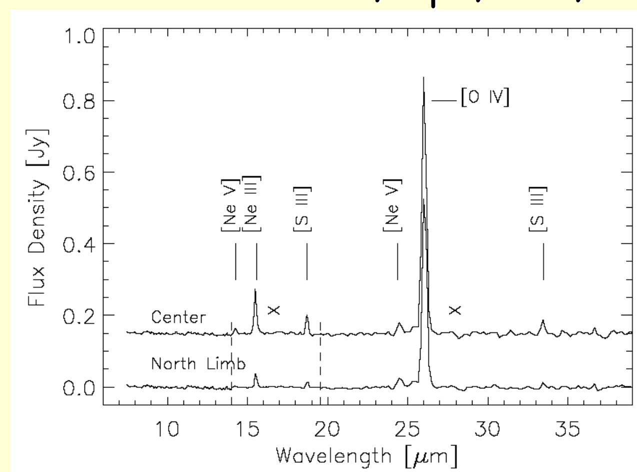


+ MIPS 24μm (red)



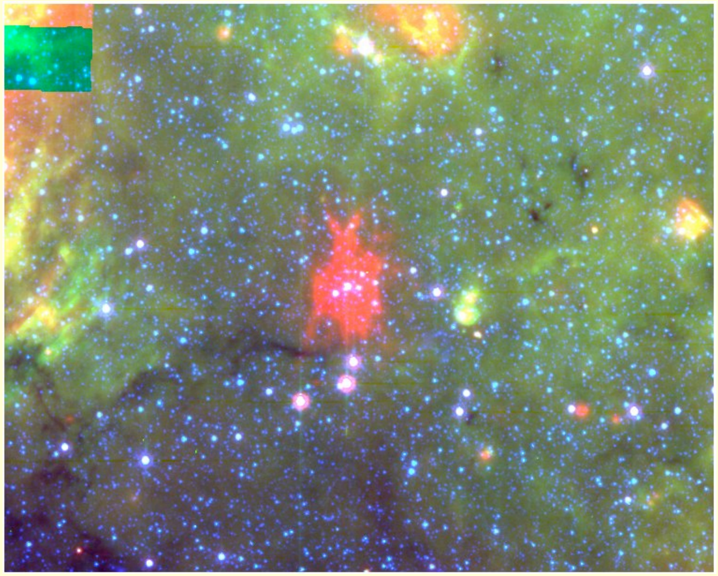
Radius ~40"

Morris et al. 2006, ApJ, 640, L179



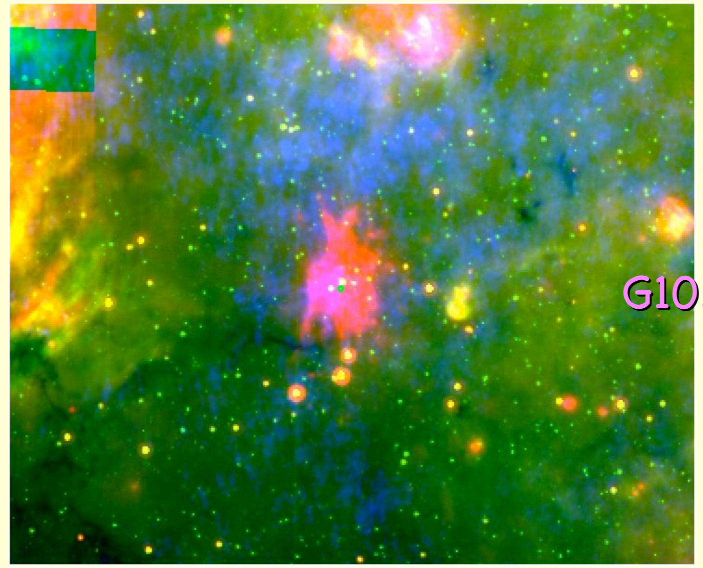
Young SNR 1E 0102.2-7219 in SMC might be similar (Stanimirovic et al. 2005, ApJ, 632, L103)

SGR 1806-20



IRAC 4.5(blue), 8.0(green) + MIPS 24μm(red)

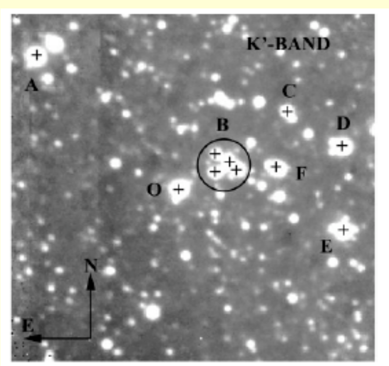
IRAC 8.0(green), MIPS 24μm(red), radio 20cm(blue)

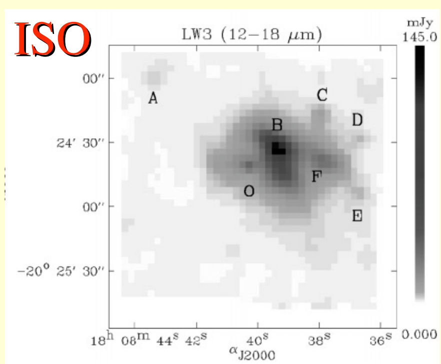


FOV
12′ x 15′

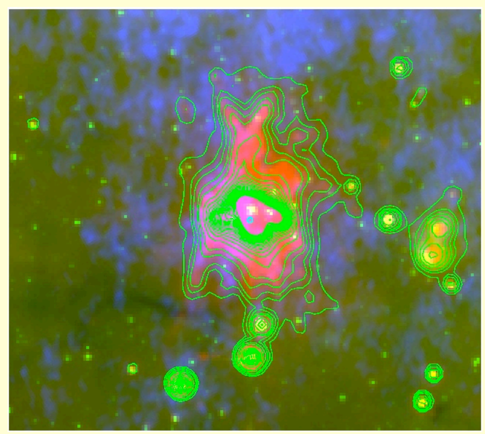
G10.0-00.3

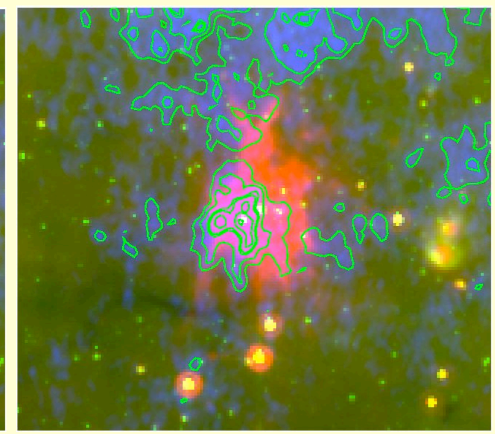
Radio data from MAGPIS
(Helfand et al. astro-ph/0510468)





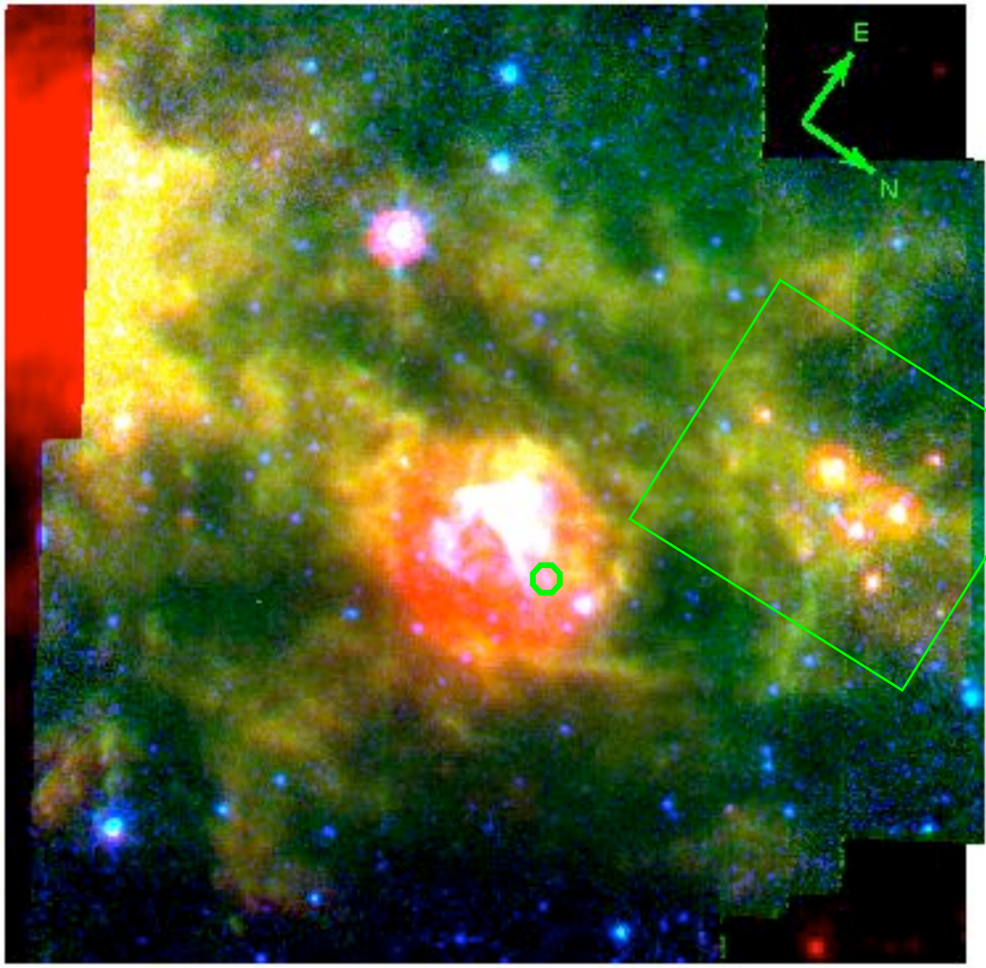
Fuchs et al. 1999, A&A, 350, 891





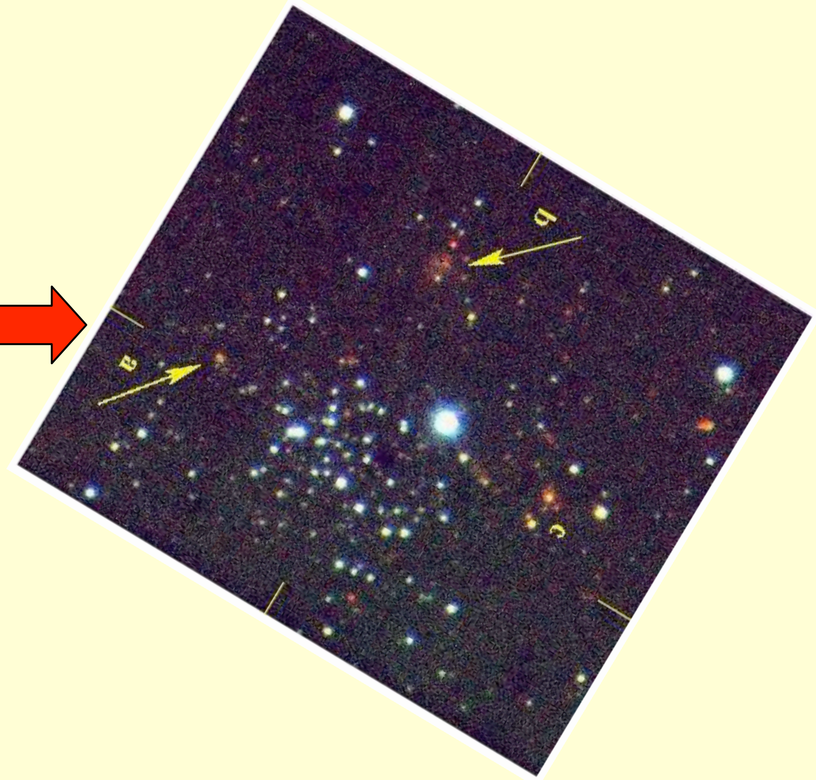
SGR 0526-66

FOV 7′ x 8′



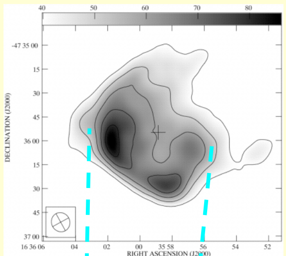
SNR N49

Klose et al. 2004, ApJ, 609, L13

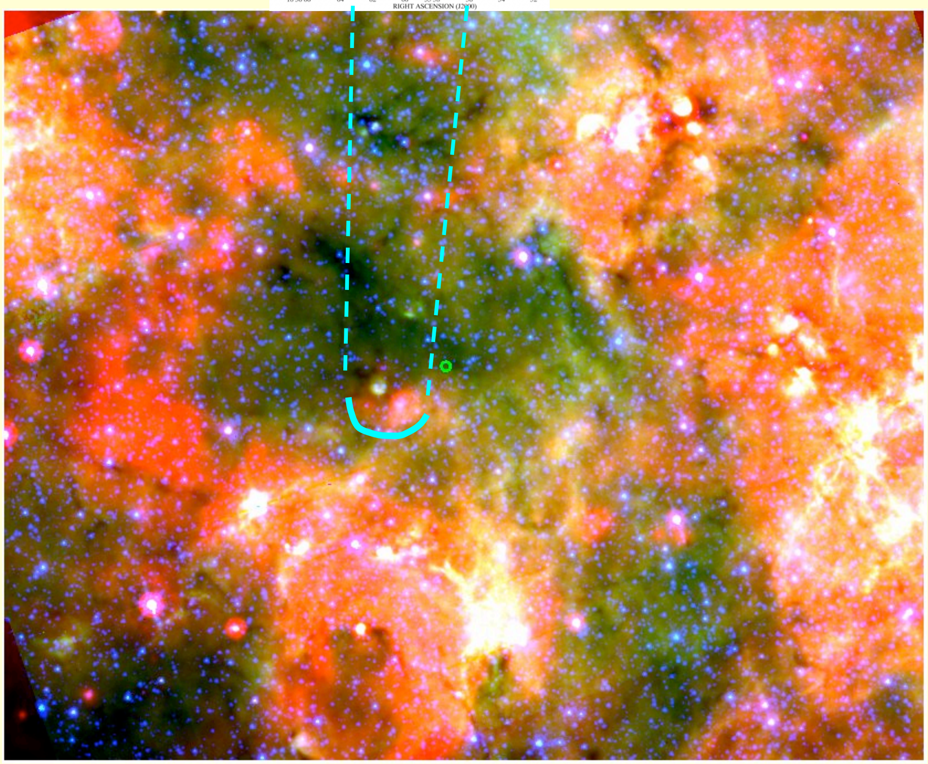


IRAC 4.5 (blue), 8.0 μm (green) + MIPS 24 μm (red)

SGR 1627-41

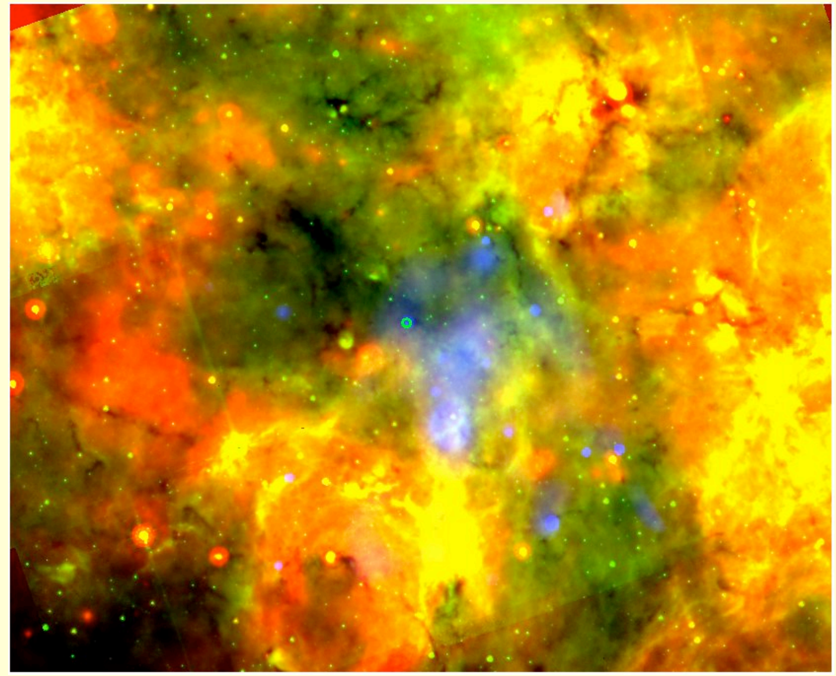


SNR G337.0-0.1
Sarma et al. 1997, ApJ, 483, 335



IRAC 4.5(blue), 8.0(green), MIPS 24μm(red)

IRAC 8.0(green), MIPS 24μm(red) + Chandra (blue)

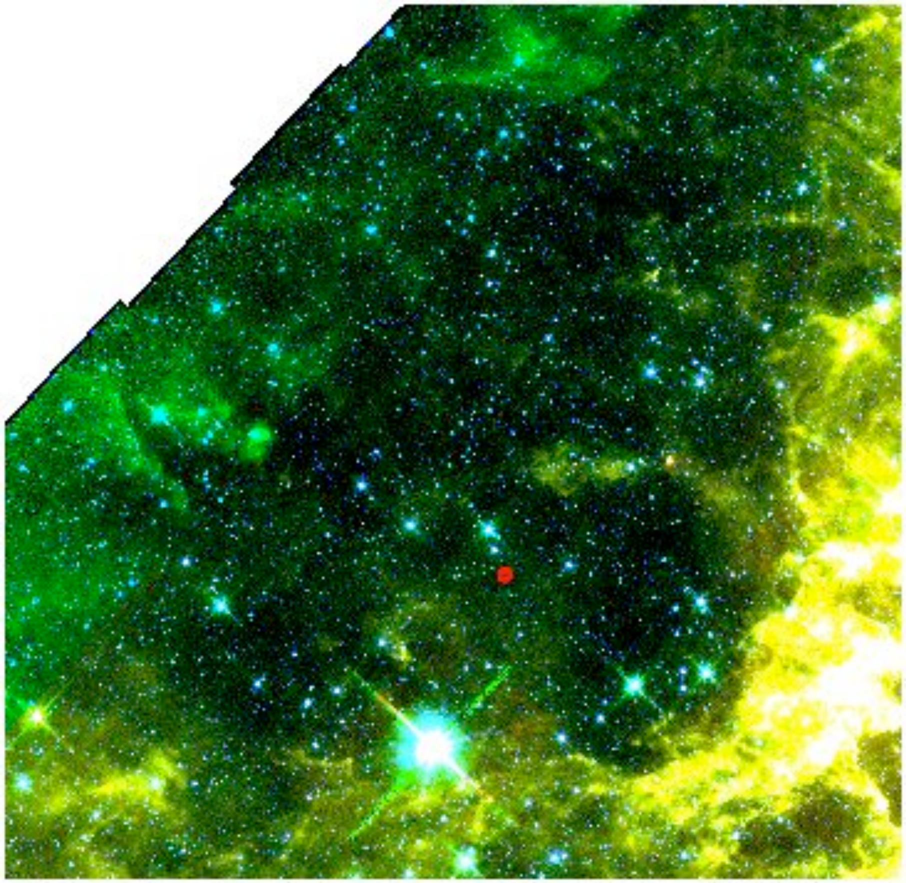


FOV 17′ x 15′

Extremely complicated region, faint diffuse X-ray emission in Chandra 0.7-8.0 keV image

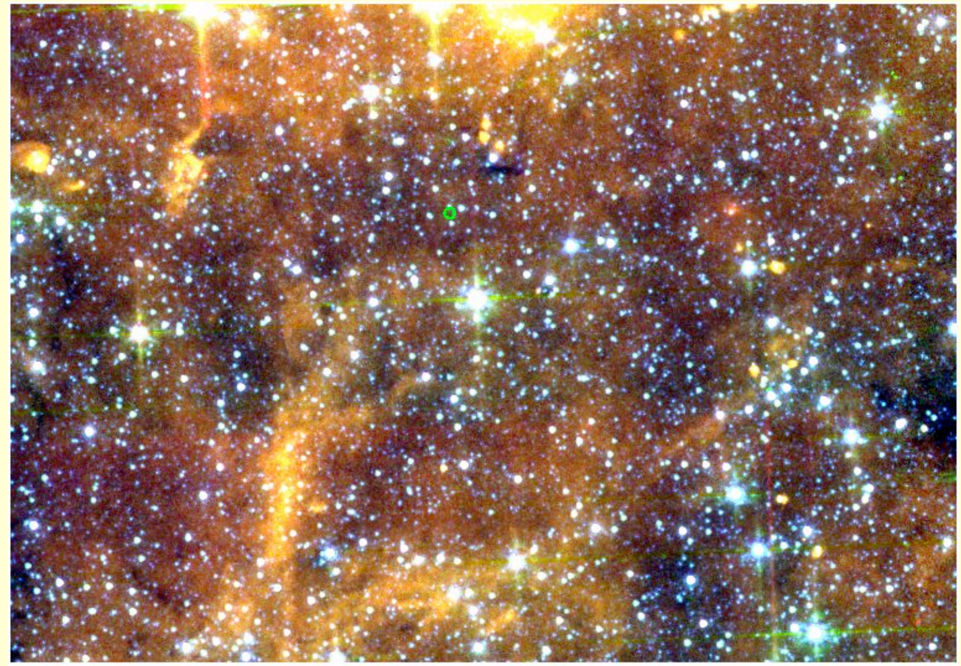
Bubbles?

AXP 1E 1048.1-5937



IRAC 4.5(blue), 5.8(green), 8.0μm (red)

AXP 170849.0-4009



IRAC 4.5(blue), 5.8(green), 8.0μm (red)

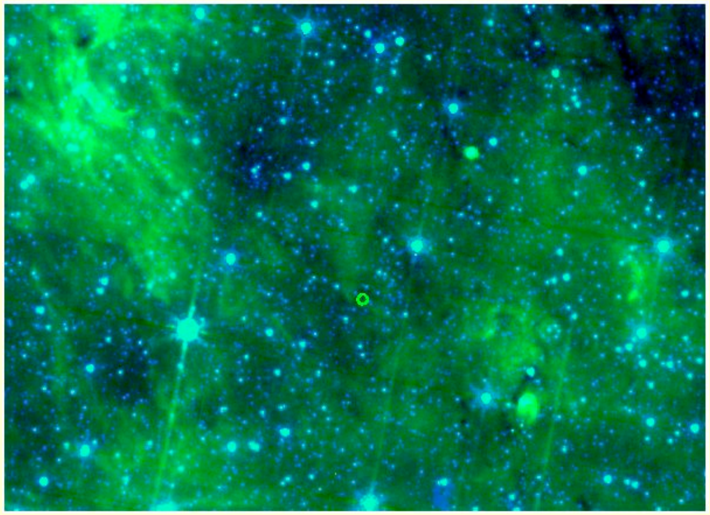
FOV ~15′ x 12′, bubble radius ~ 5′ x 3.8′
assuming d=10kpc r~14.5 pc x 11 pc

FOV ~25′ x 25′, bubble radius ~10.6′
assuming d=2.7kpc r~8 pc
HI 21 cm bubble: 17.5 x 11.5 pc (radius) - Gaensler et al. 2005, ApJ, 620, L95

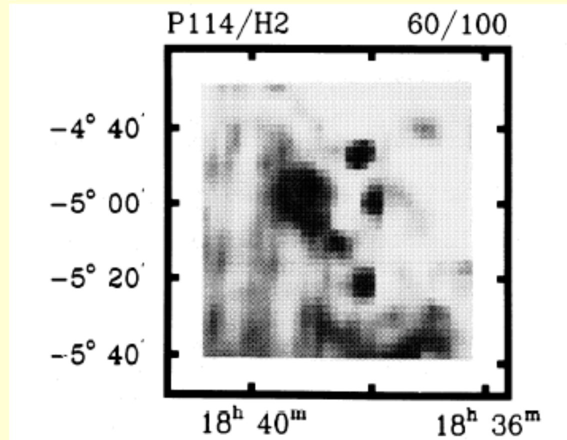
AXP 1841-045

SNR G27.4+0.0

IRAC 4.5(blue), 8.0 μm (green)

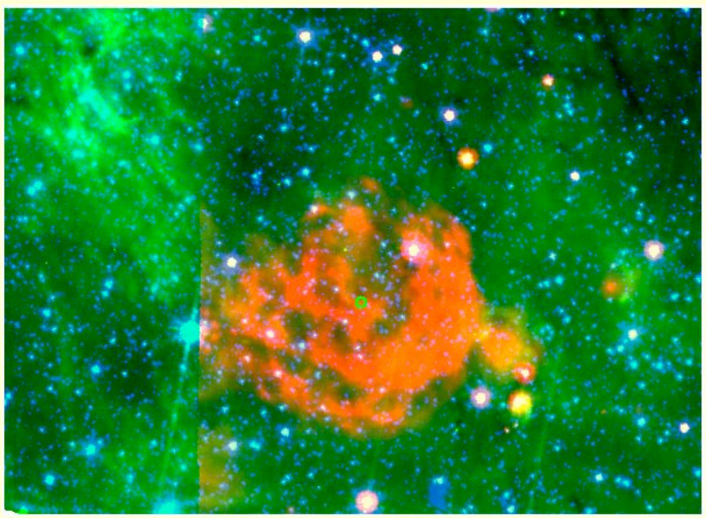


FOV ~ 10′ x 8′



IRAS 60/100 μm

Shull et al. 1989, ApJ, 346, 860



IRAC 4.5(blue), 8.0(green) + MIPS 24μm (red)

Radius ~ 2.2′

IRAC 4.5(blue), 8.0 μm (green) + MAGPIS 20 cm (red)

Conclusions

- No new clusters so far (follow-up of AXP 1841-045?)
- Several SNRs detected with 24μm (70μm ?)
- Evidence for bubbles, but difficult to confirm association with AXP/SGR
- lots more work to be done!