

Discovery of a Pulsar-powered Bow Shock Nebula in the Small Magellanic Cloud SNR DEM S5

**M. D. Filipović & Rami Alsaberri,
N. Maxted, + #PGstudents
(Western Sydney University)**

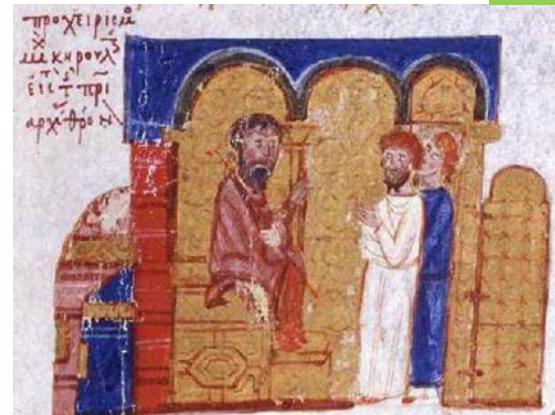
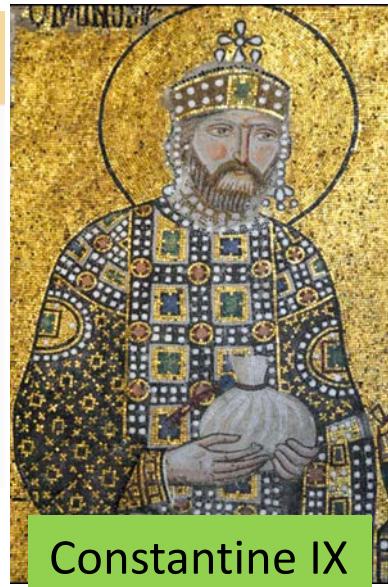
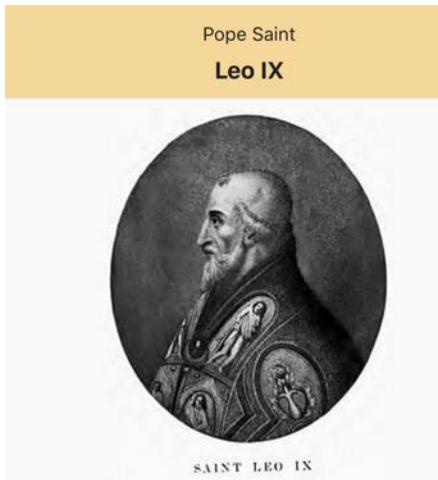
**C. Maitra, F. Haberl, P. Kavanagh, M. Sasaki, P. Maggi
N. Hurley-Walker, D. Urosević & B. Onić
H. Sano, F. Yasuo
G. Rowell, R. Kothes, T. Jarrett...**



The Cold Case of SN1054.

Was it the First Cover-up in the History of Astronomy?

The Scene of the Crime

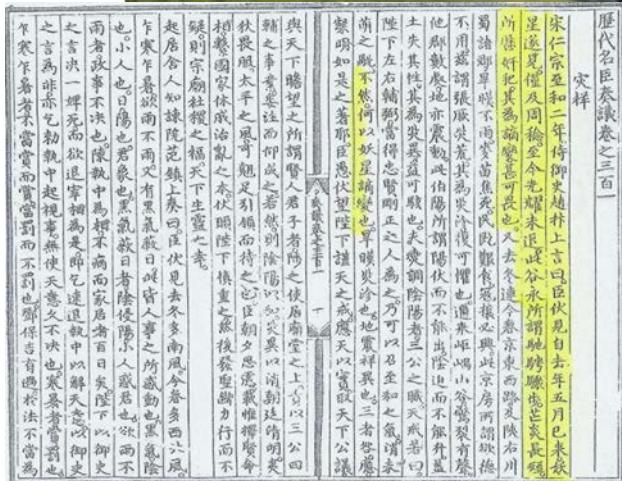
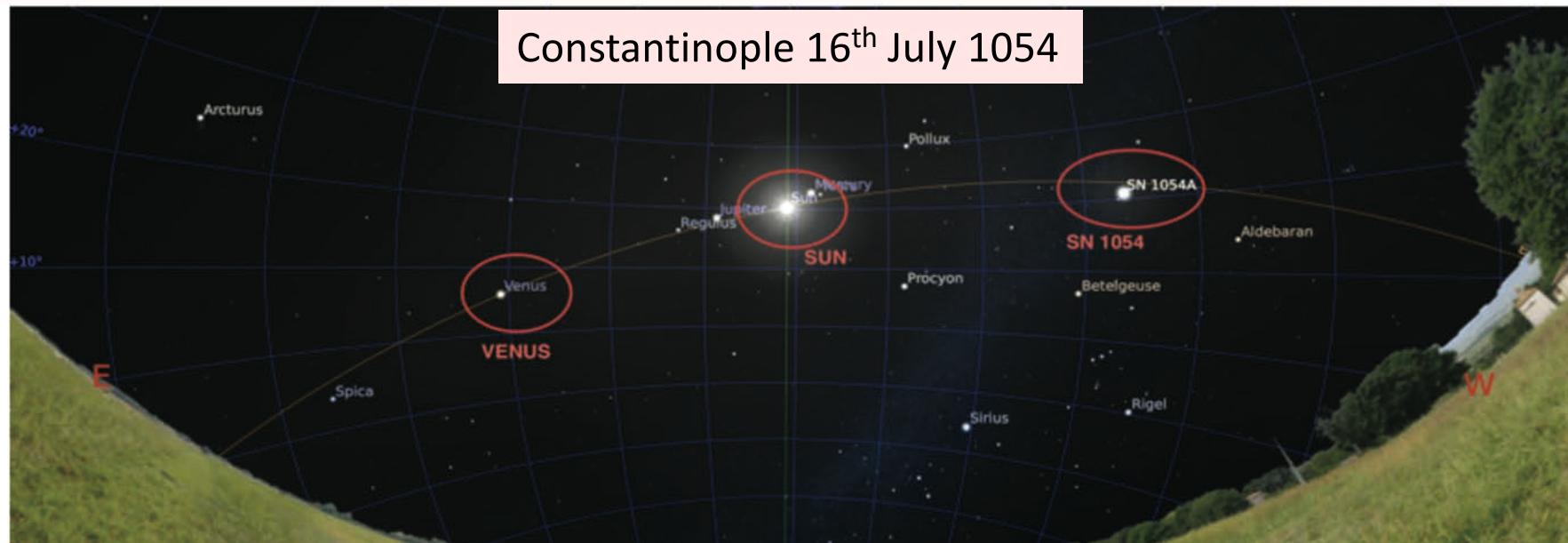


The Cold Case of SN1054.

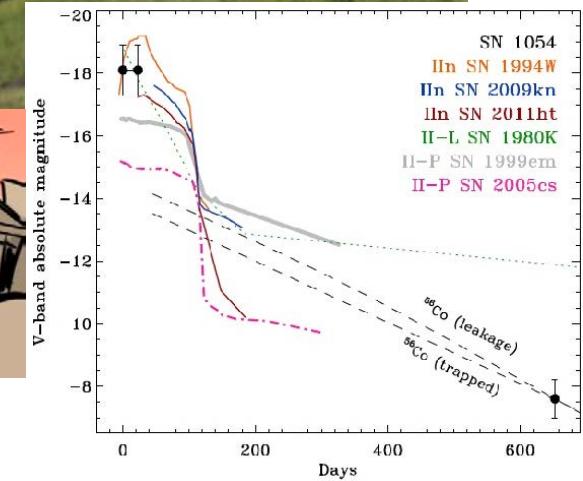
Was it the First Cover-up in the History of Astronomy?

The VICTIM

Constantinople 16th July 1054



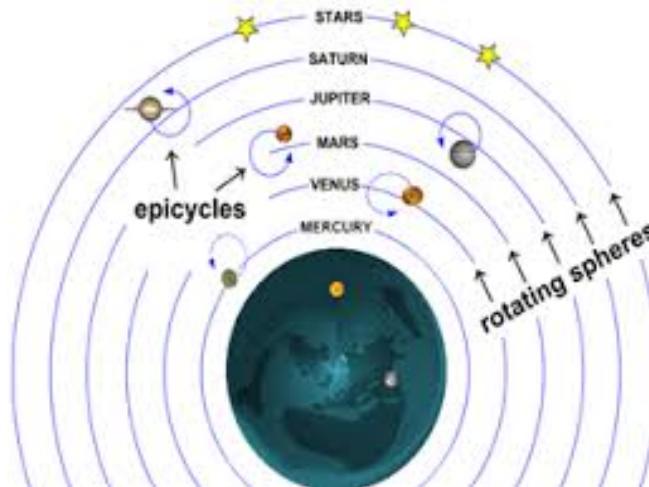
SNR II, Crete 2019



The Cold Case of SN1054.

Was it the First Cover-up in the History of Astronomy?

The Motive for cover up



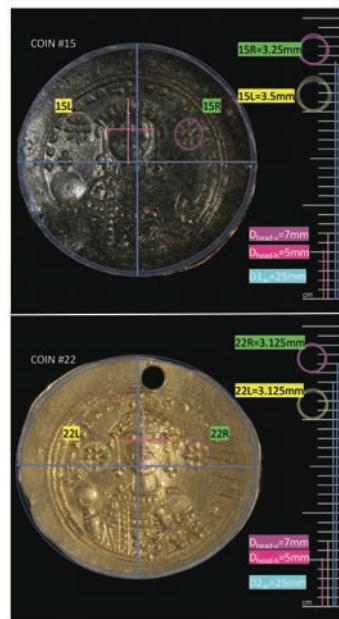
- Afraid?
- Doctrine at the time
- Weather
- Apocalypse?!
- Second Comings



The Cold Case of SN1054.

Was it the First Cover-up in the History of Astronomy?

The Cover-up or Cipher



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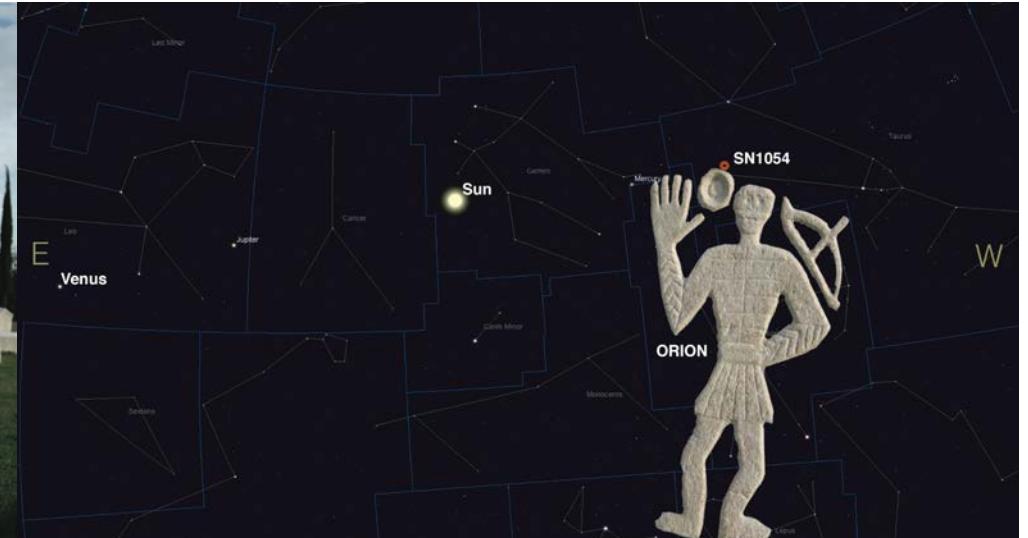
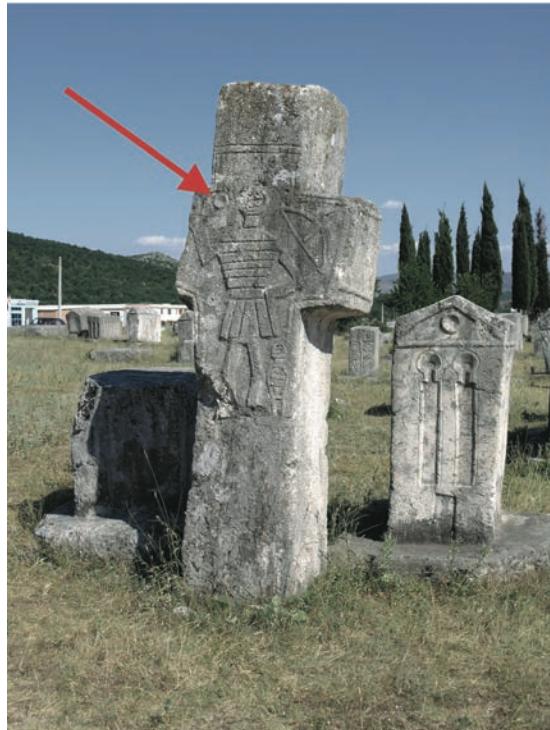
Time-domain astronomy?



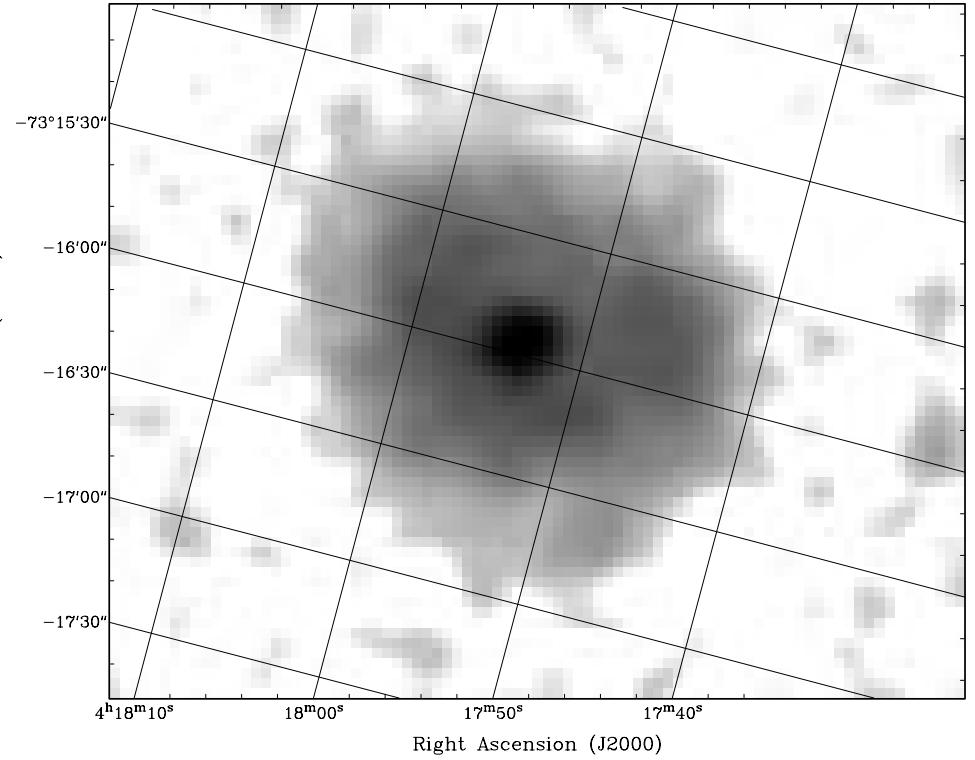
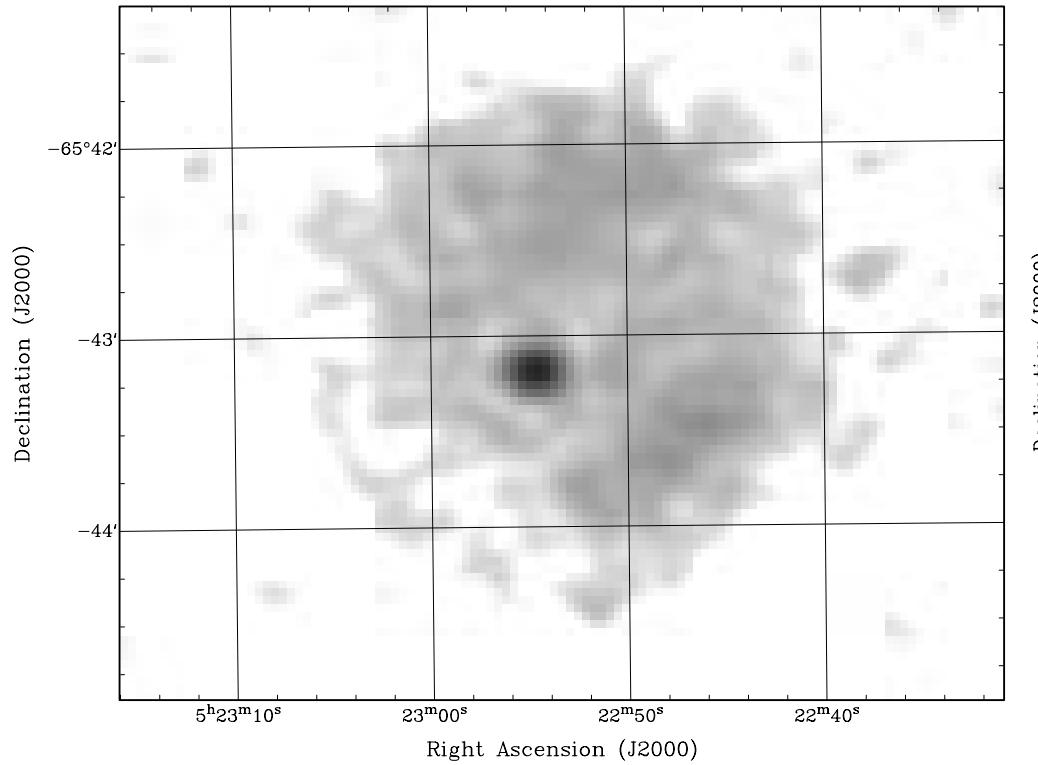
The Cold Case of SN1054.

Was it the First Cover-up in the History of Astronomy?

Even to the Grave

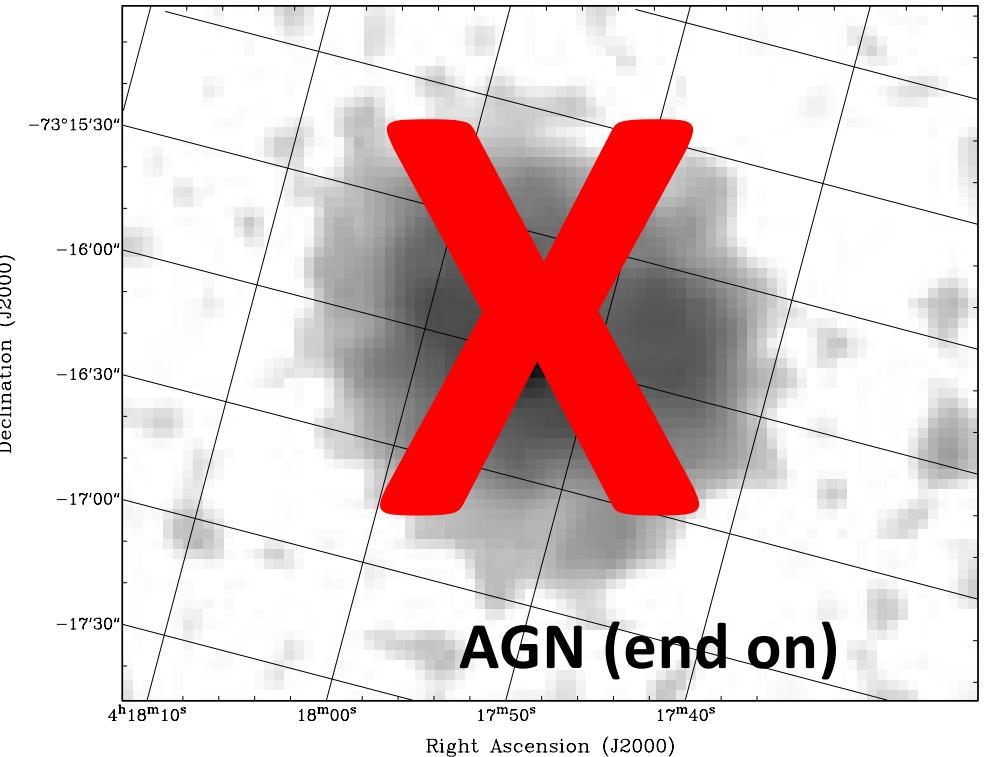
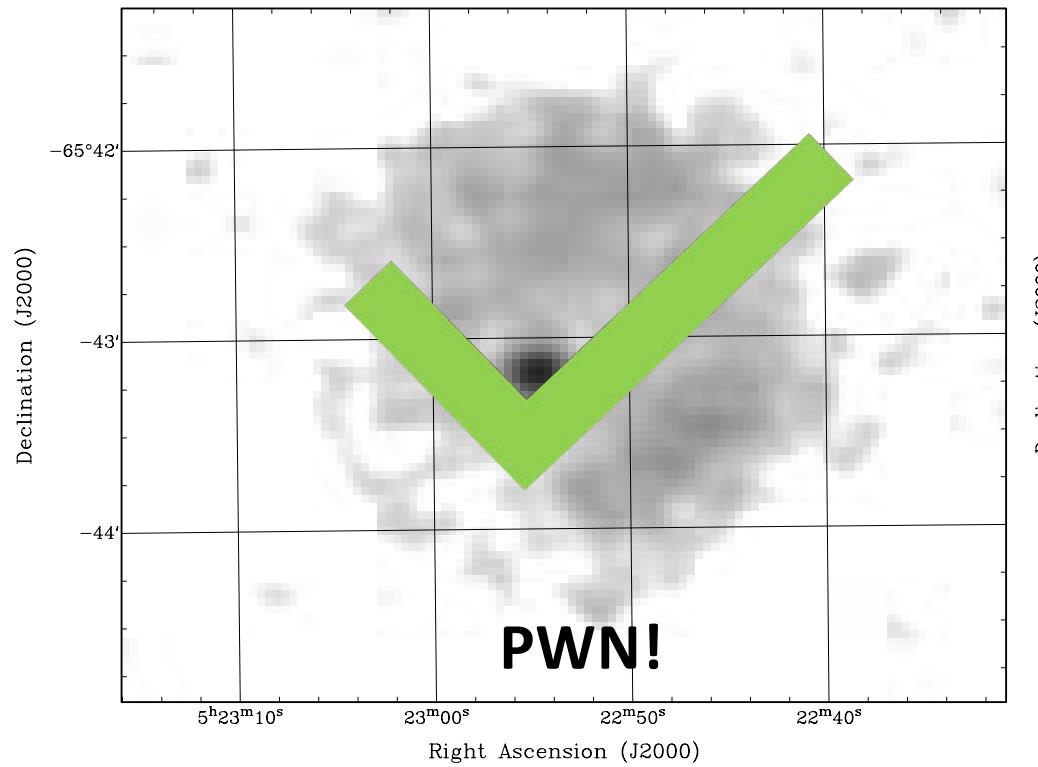


To be PWN or not?



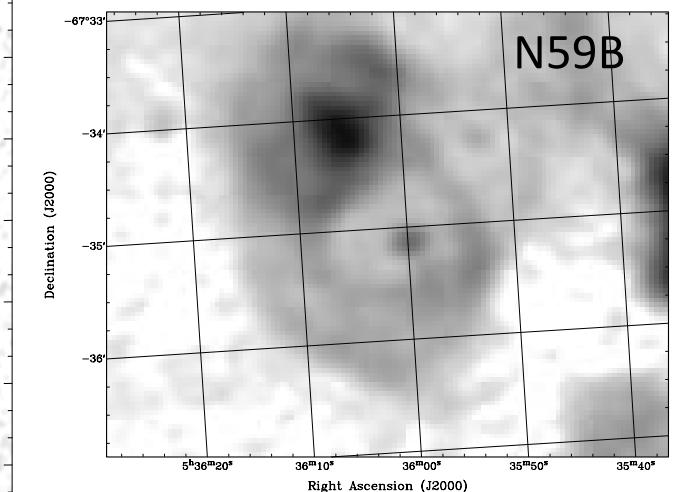
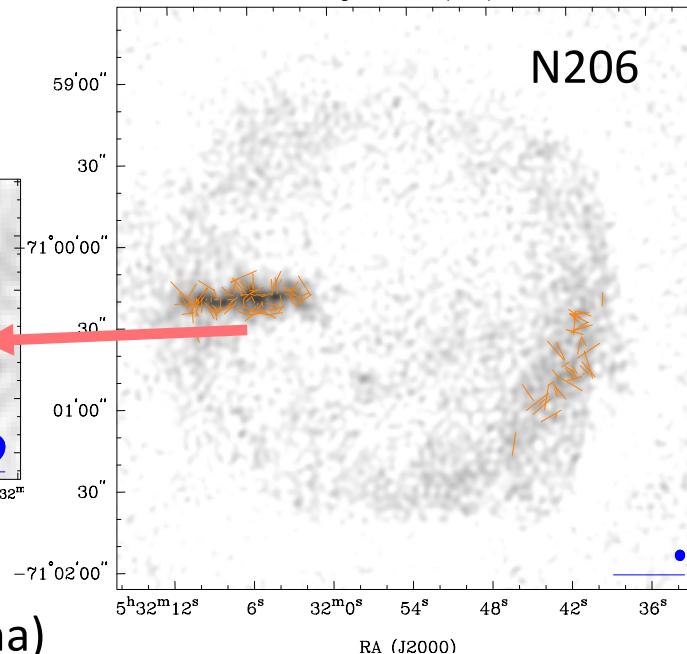
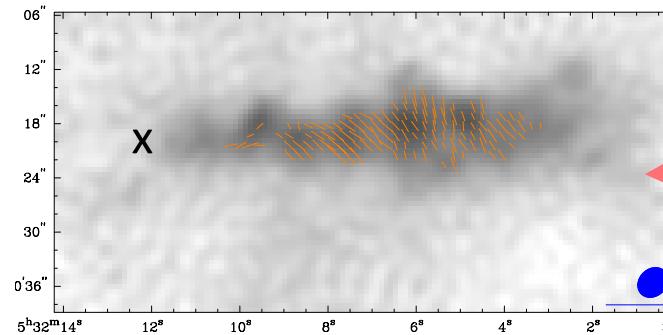
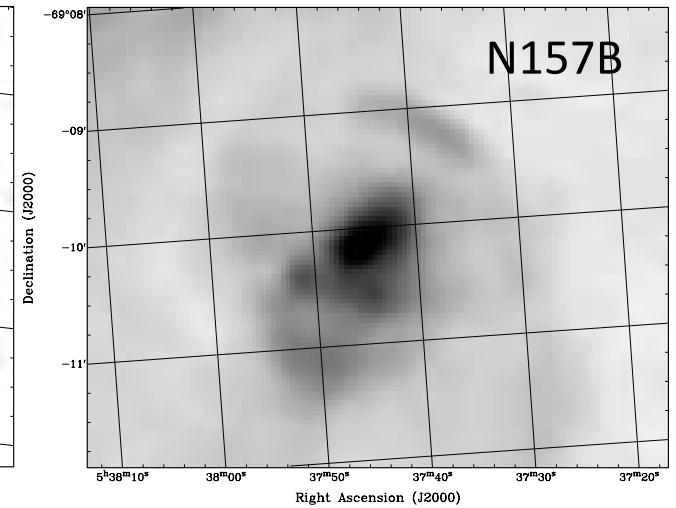
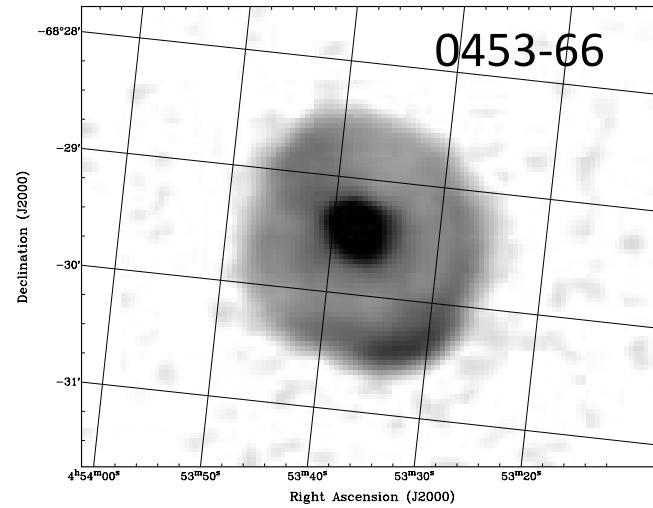
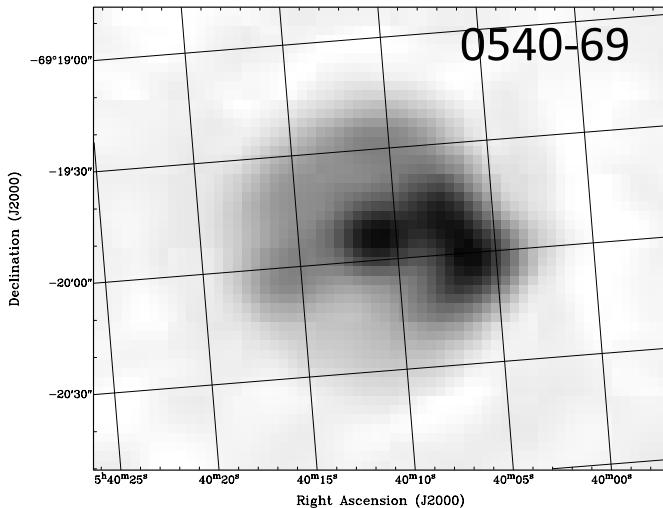
To be PWN or not?

Multi messenger approach is MUST!



known PWN in the LMC

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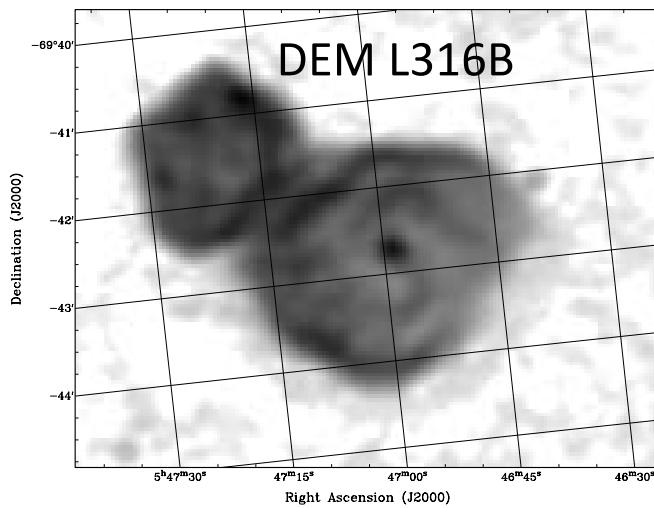
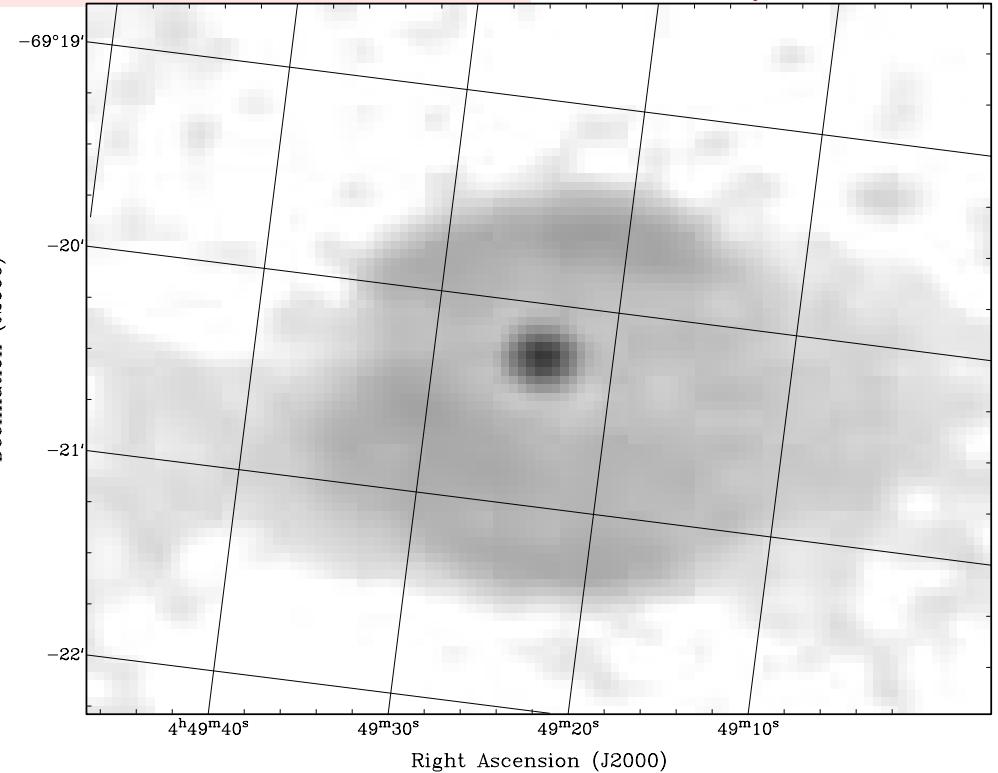
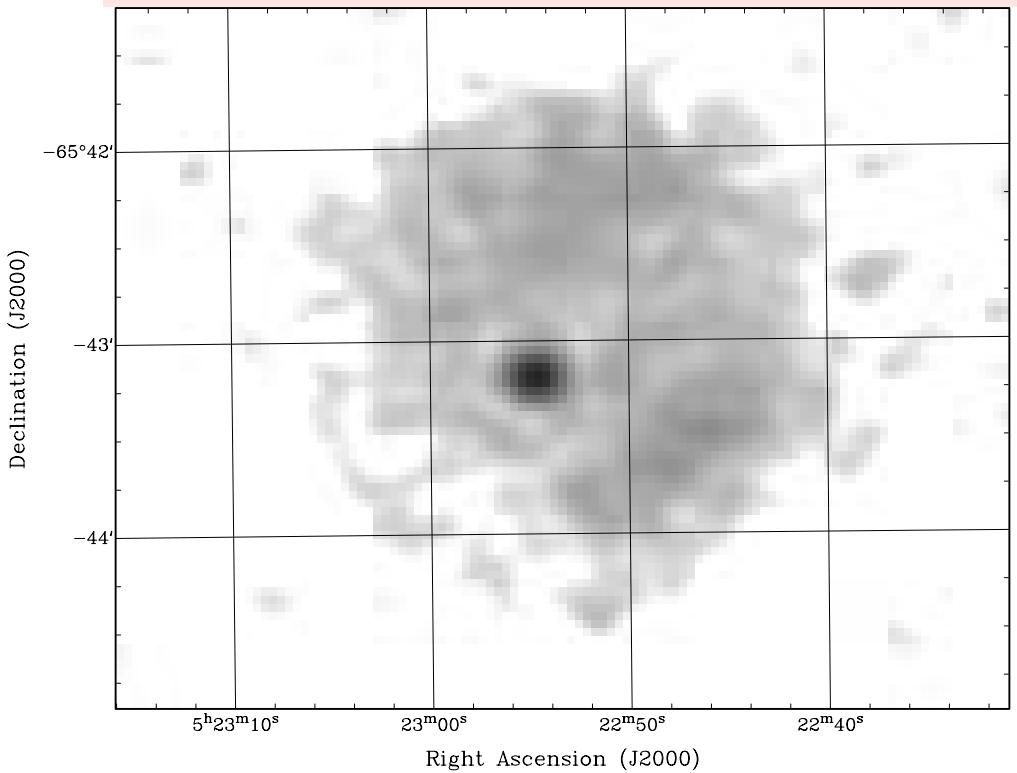



ATCA 6/3cm (credit: D. Shobana)

ASKAP_36_LMC; credit: E. Lenc

...and new? PWN in the LMC

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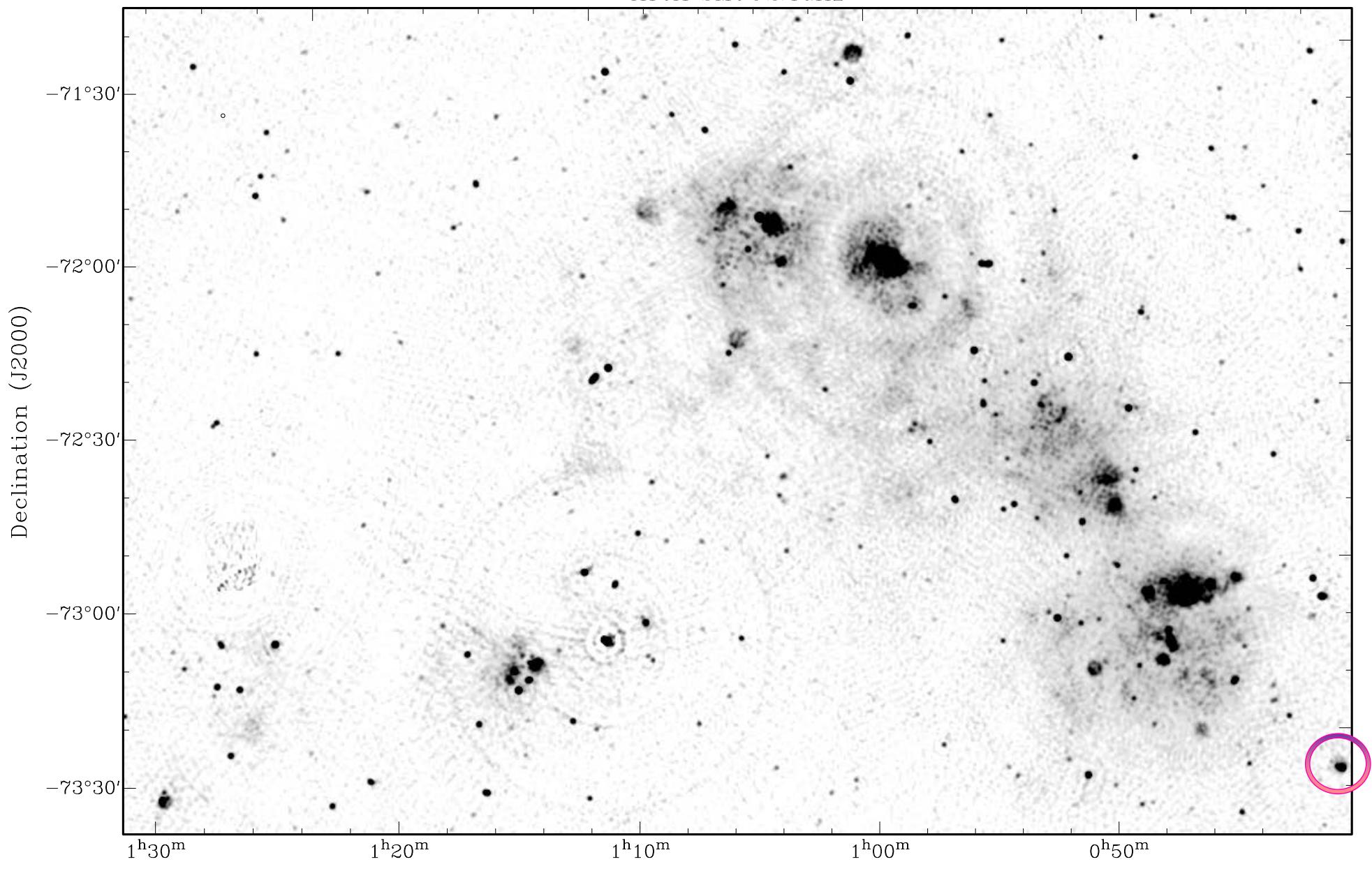
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ASKAP_36_LMC; credit: E. Lenc

ATCA SMC at 13cm
B.S.=40" rms=1.1 mJy

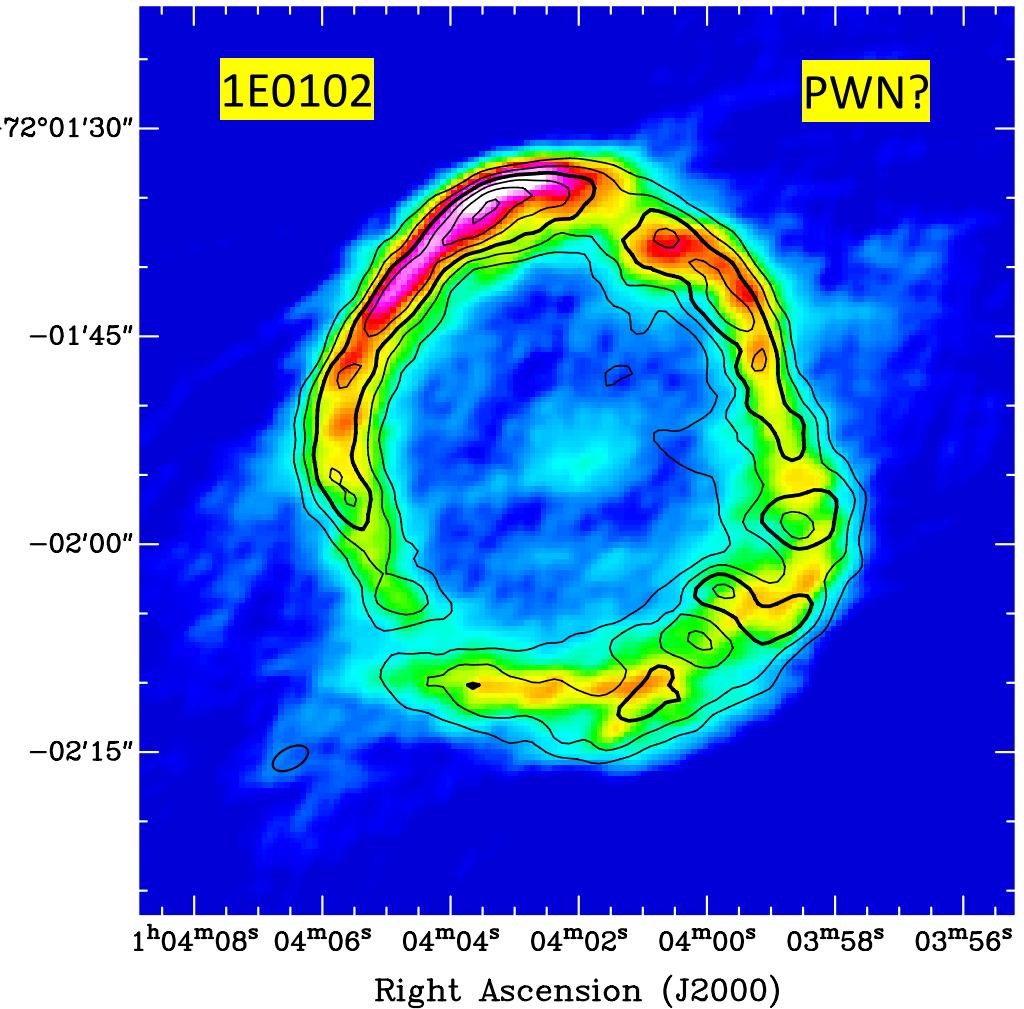
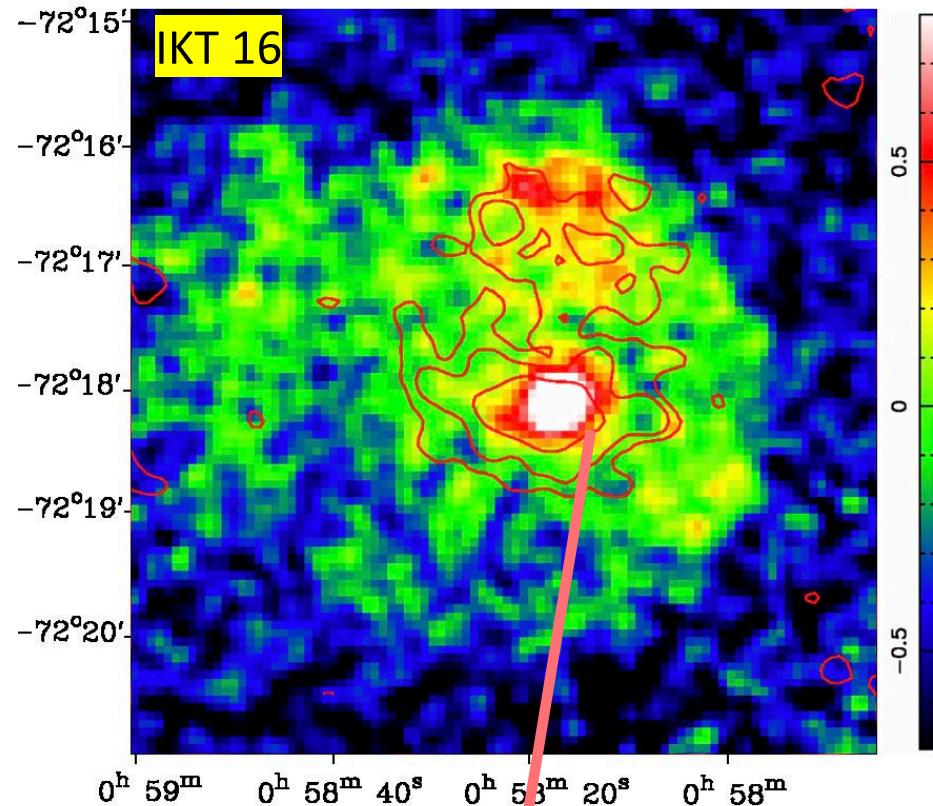
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ATCA SMC@2.4GHz



known PWN in the SMC

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Owen+11, Maitra+15

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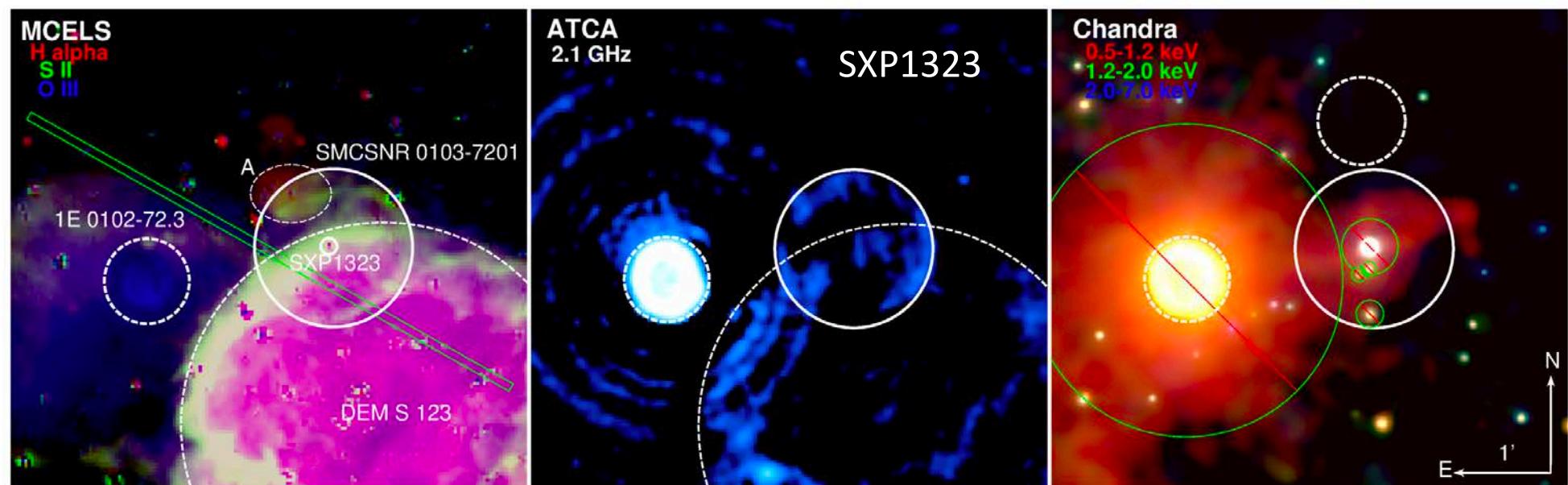
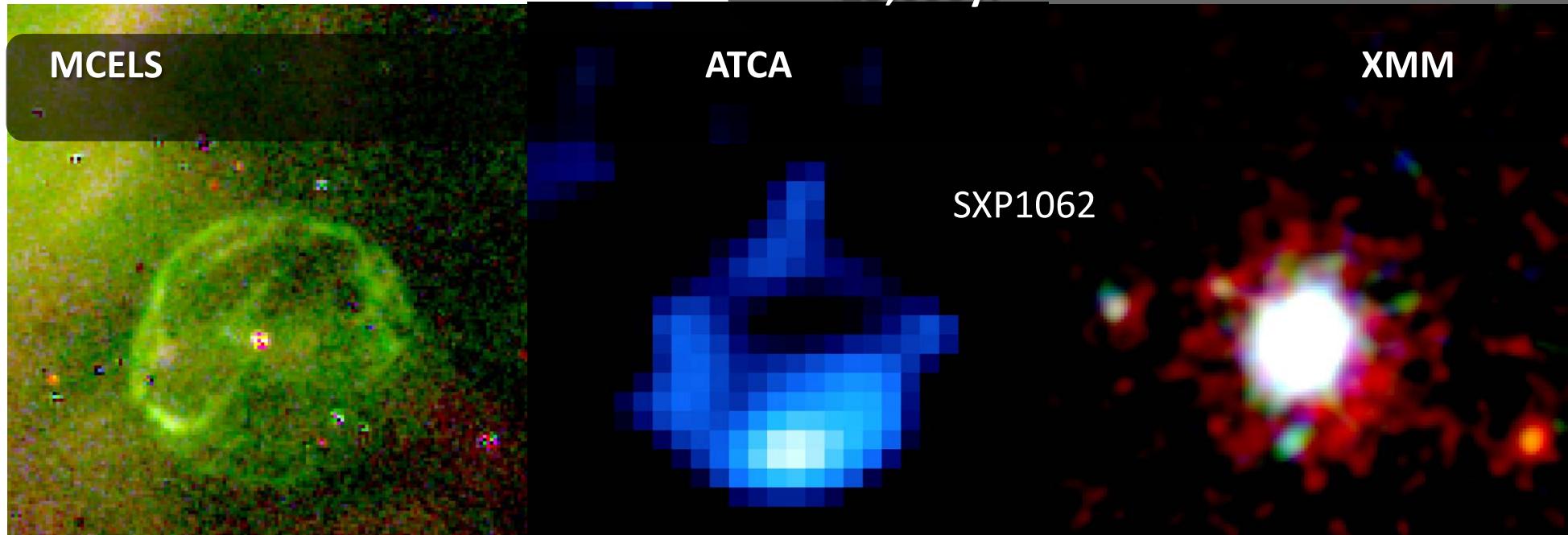
ATCA; credit: R. Alsaberi

SMC SNR SXP 1062 & SXP1323

Haberl et al. 2012, A&A
Sturm et al. 2019 submit.

- SNR around Be/X-ray binary,
- Oxygen-rich → Type Ib?
- Neutron start with a spin of 1062sec
- <25,000yr

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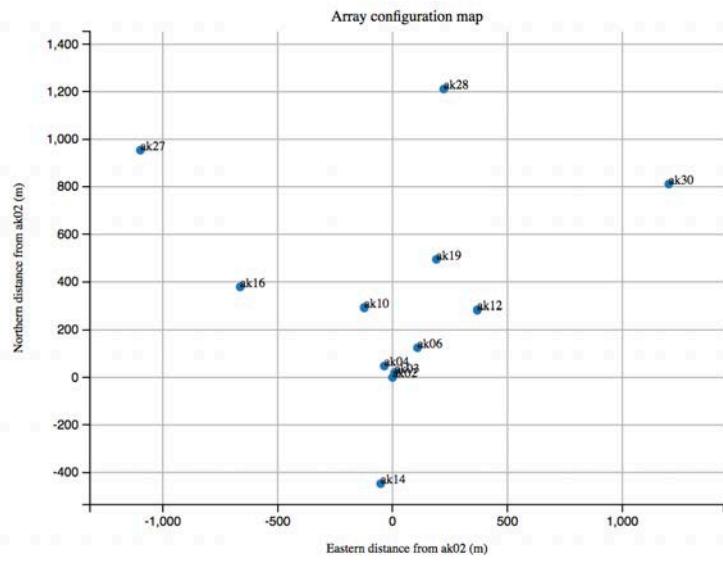
The future is here?

NEW ASKAP/MWA
SMC & LMC & GC
Radio Continuum Study

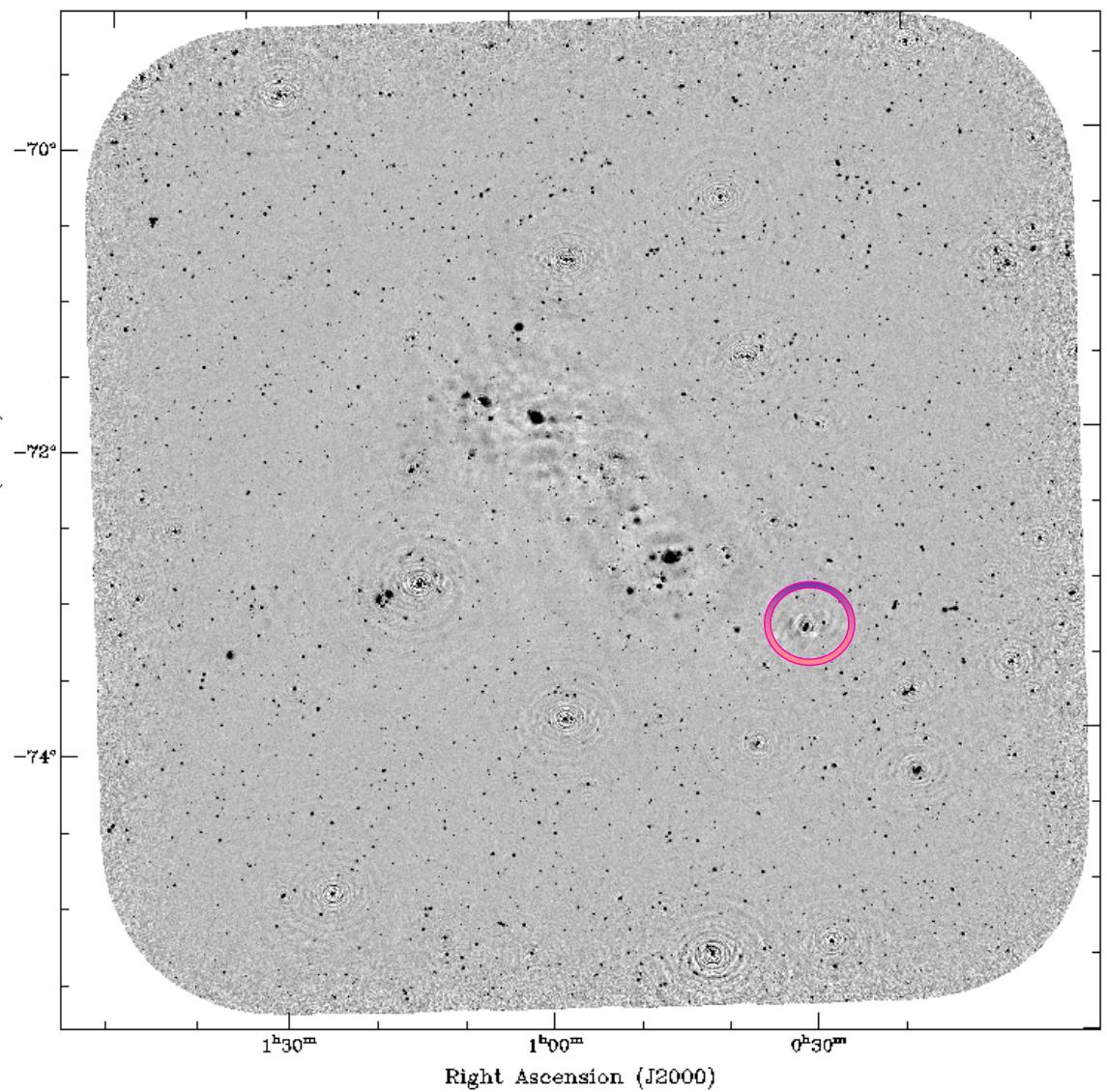
- EMU Key Science project 15 – The Magellanic Clouds

Observing configuration

- Bandwidth: 192 MHz
- Antennas: 12
- Footprint: square 6 x 6deg
- Duration: 10, 11, 11.5 hours per field
- 960 and 1320.5 MHz
- RMS=130-190uJy
- Catalogue with 4737 point sources



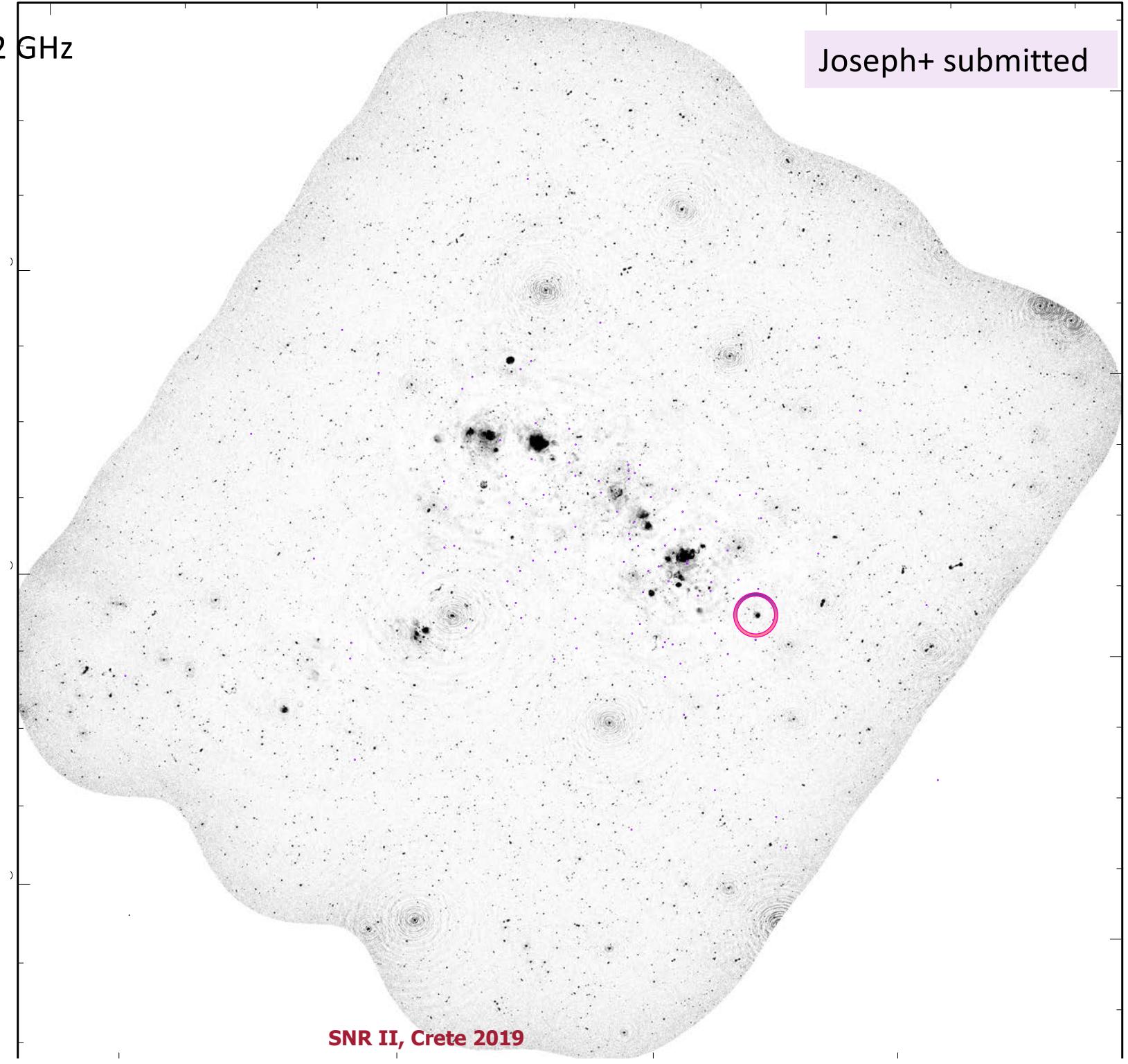
SNR II, Crete 2019



960 MHz image

SMC ASKAP at 1.32 GHz
RMS>55uJy
B.S.=18"

Joseph+ submitted

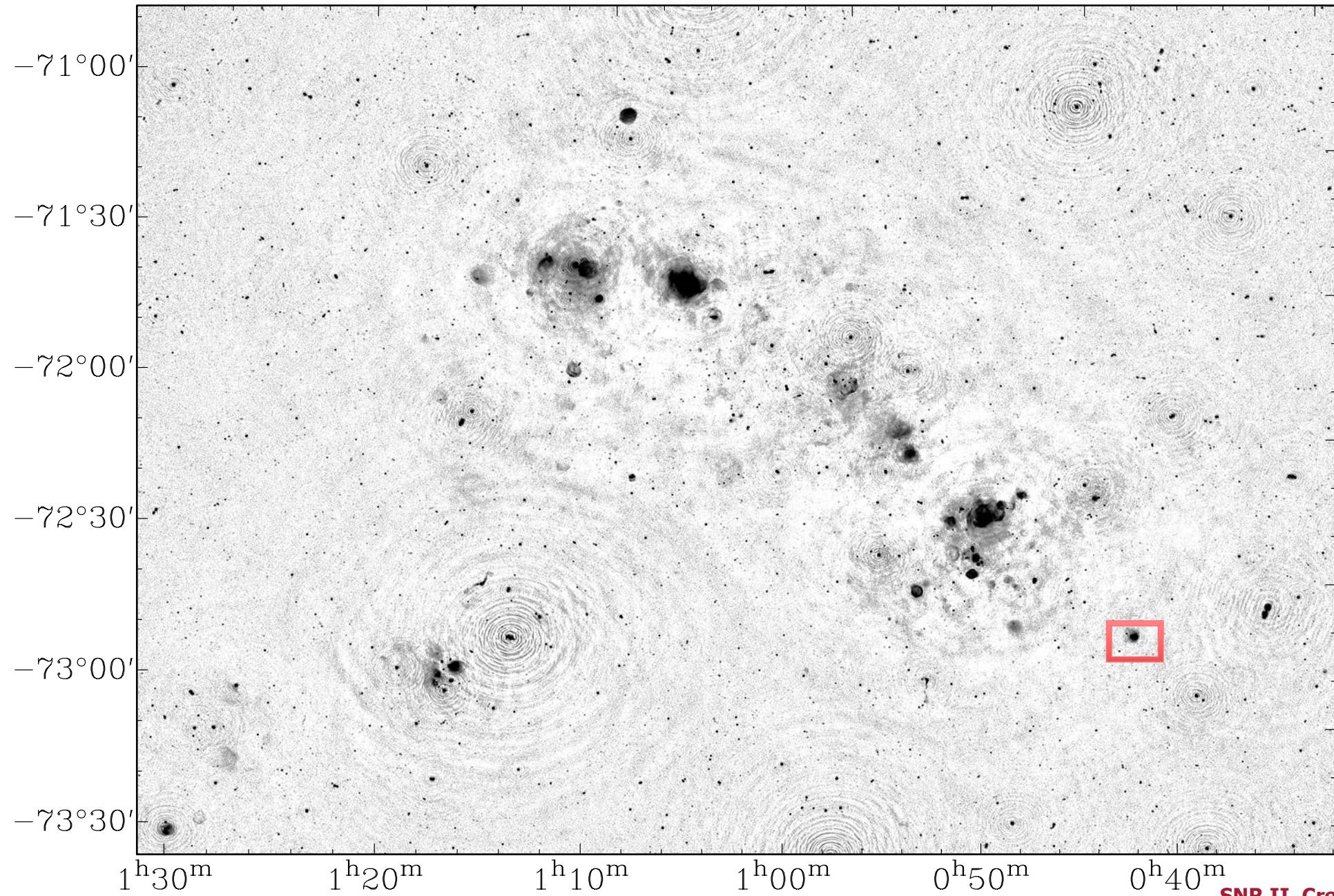


SMC ASKAP at 1.32 GHz

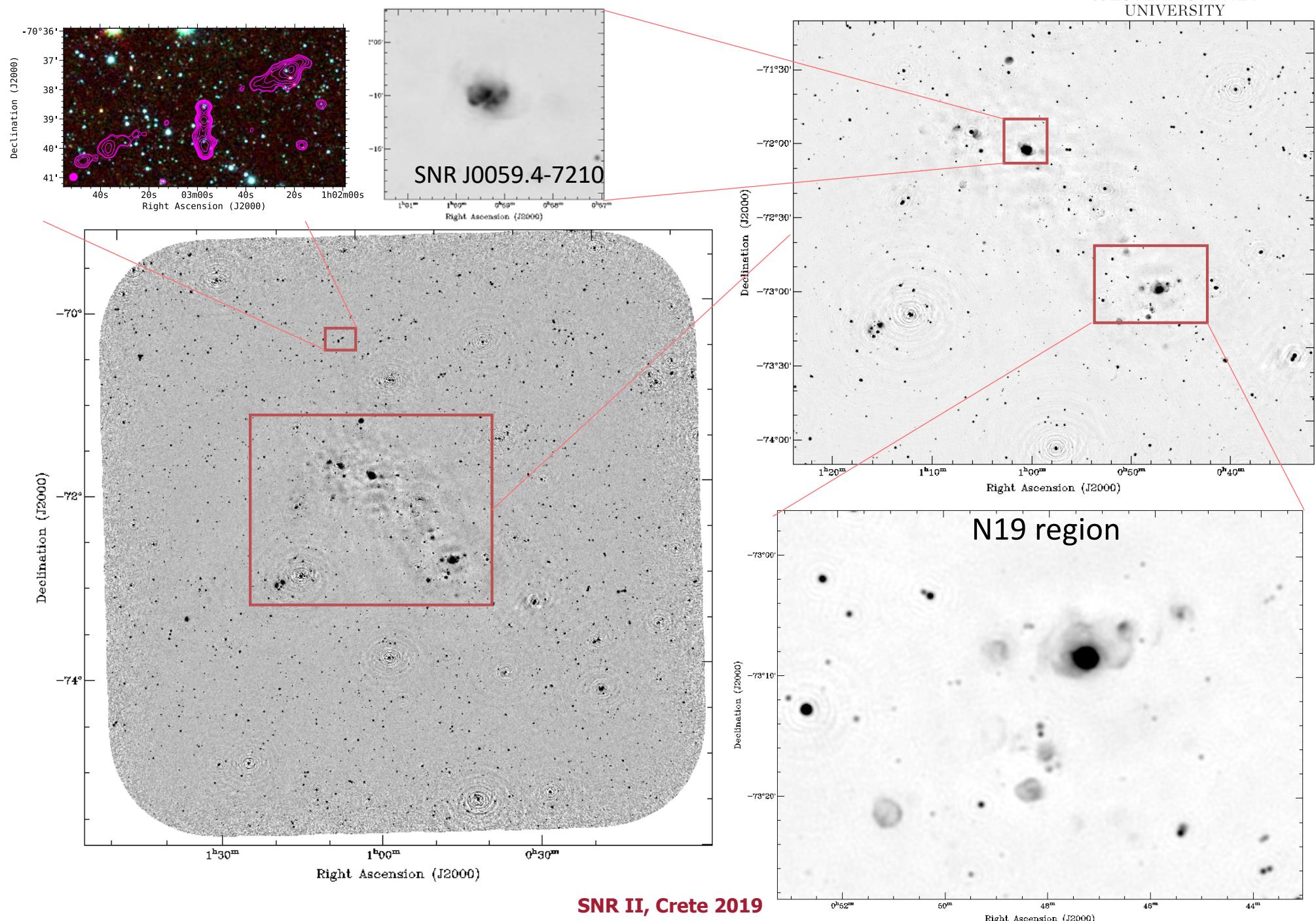
RMS>55uJy

B.S.=18"

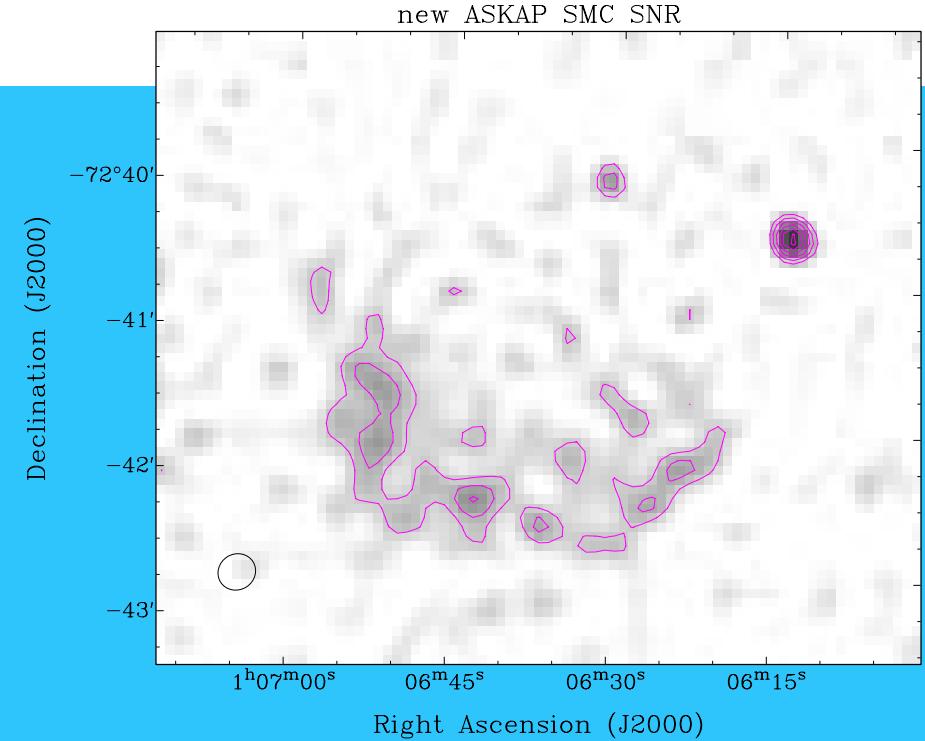
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- New images at 960 and 1320 MHz
- 2 new SNR candidates
- 12 new radio PNe
(on top of 10 previously known)
- 1 new PWN
- 15 new YSO
- Over 8300 point sources



Joseph et al., submitted



Credit: CSIRO

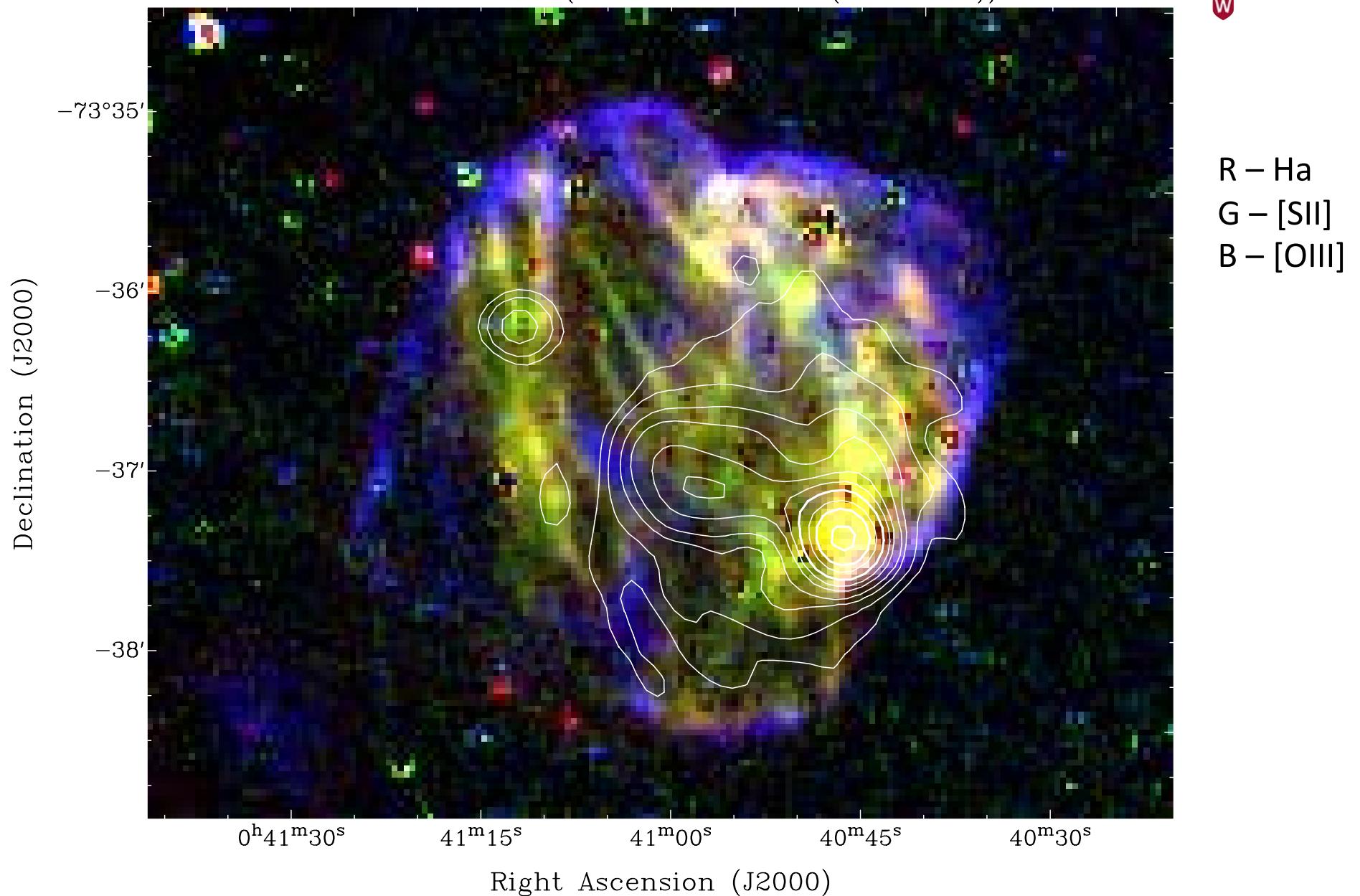
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Mix-morphology?

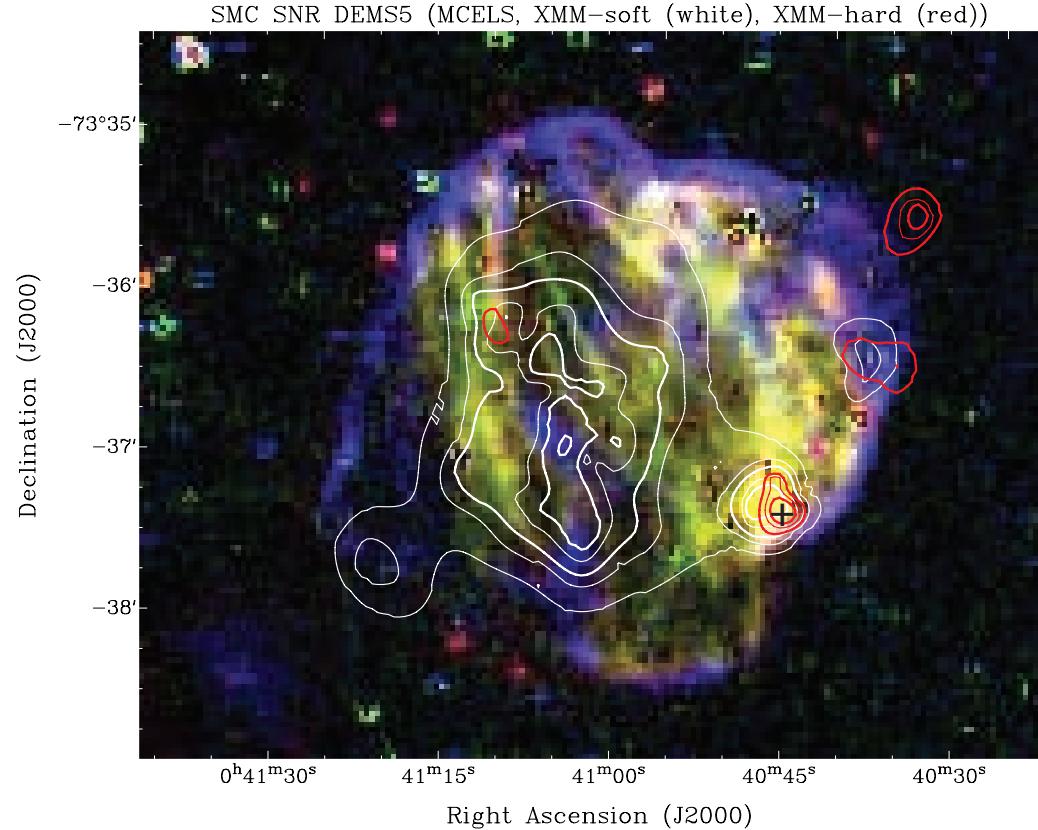
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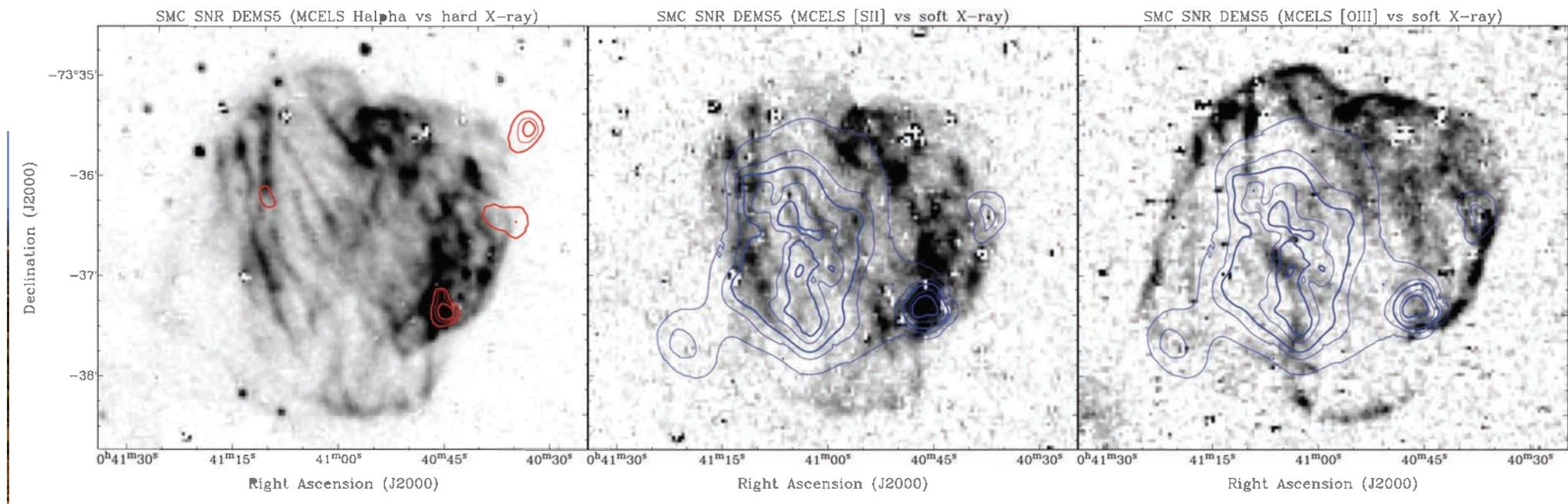

SMC SNR DEMS5 (MCELS vs. ASKAP (1320 MHz))



MCELS
71.4pc x 63.9pc



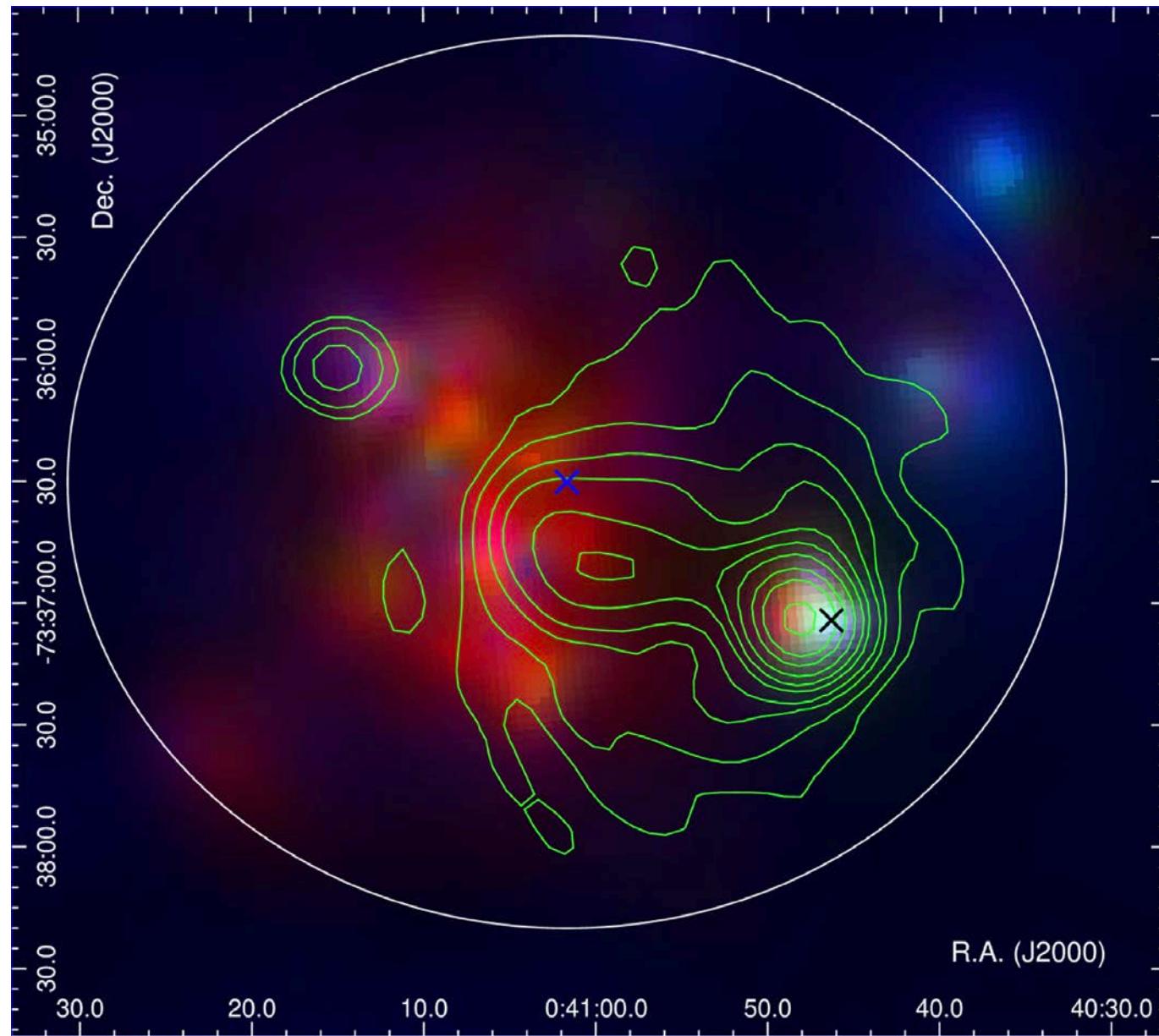
DEM S5



Mix-morphology?

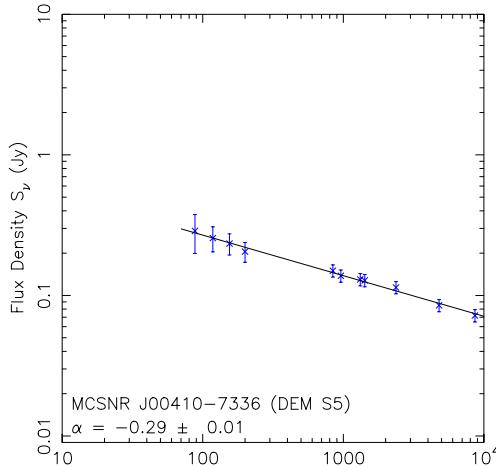
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XMM-Newton
R – 0.4-1 keV
G – 1-2 keV
B – 2-4.5 keV

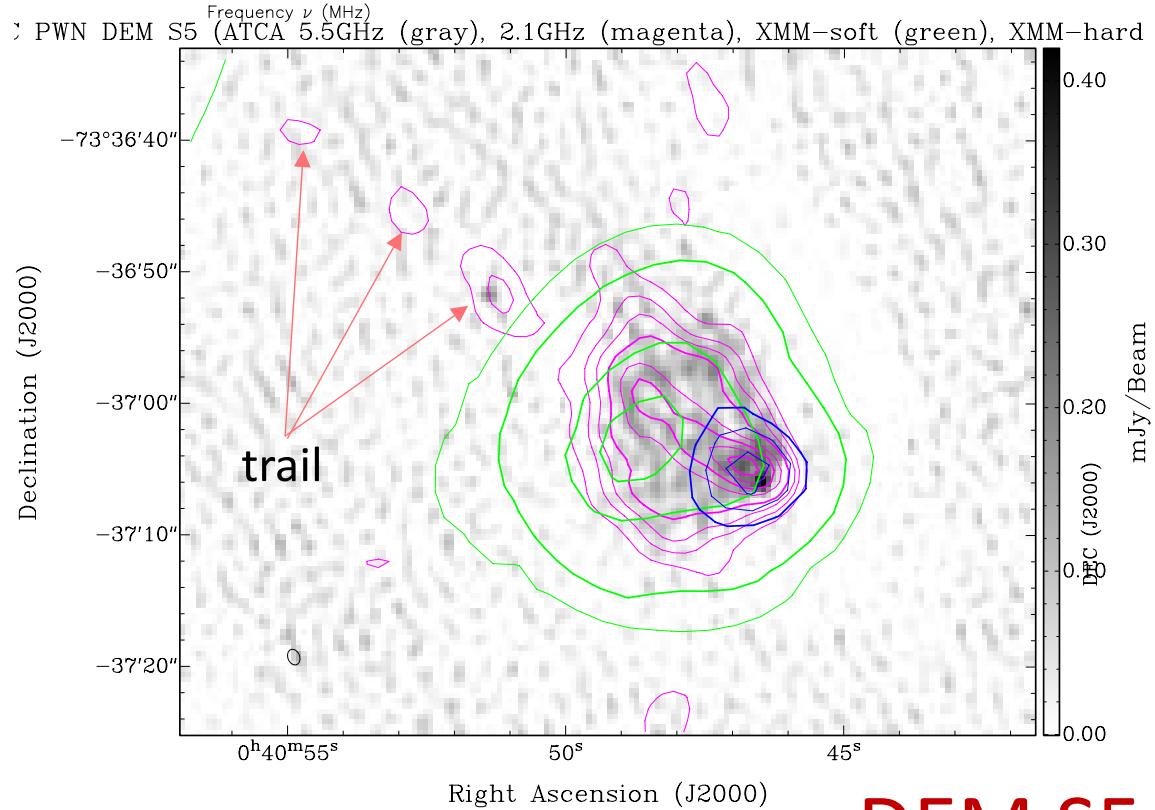
Contours:
ASKAP 1320MHz



28 known Pulsars with supersonic motion: all in MW (Kargaltsev+17)

X-ray power-law spectrum ($\Gamma \sim 2$) is indicative of non-thermal synchrotron emission as is expected from PWN–pulsar system.

α for this SNR–PWN–pulsar system is flat (-0.29 ± 0.01) (typical!)
The putative pulsar has a radio spectral index of -1.8 (typical!)

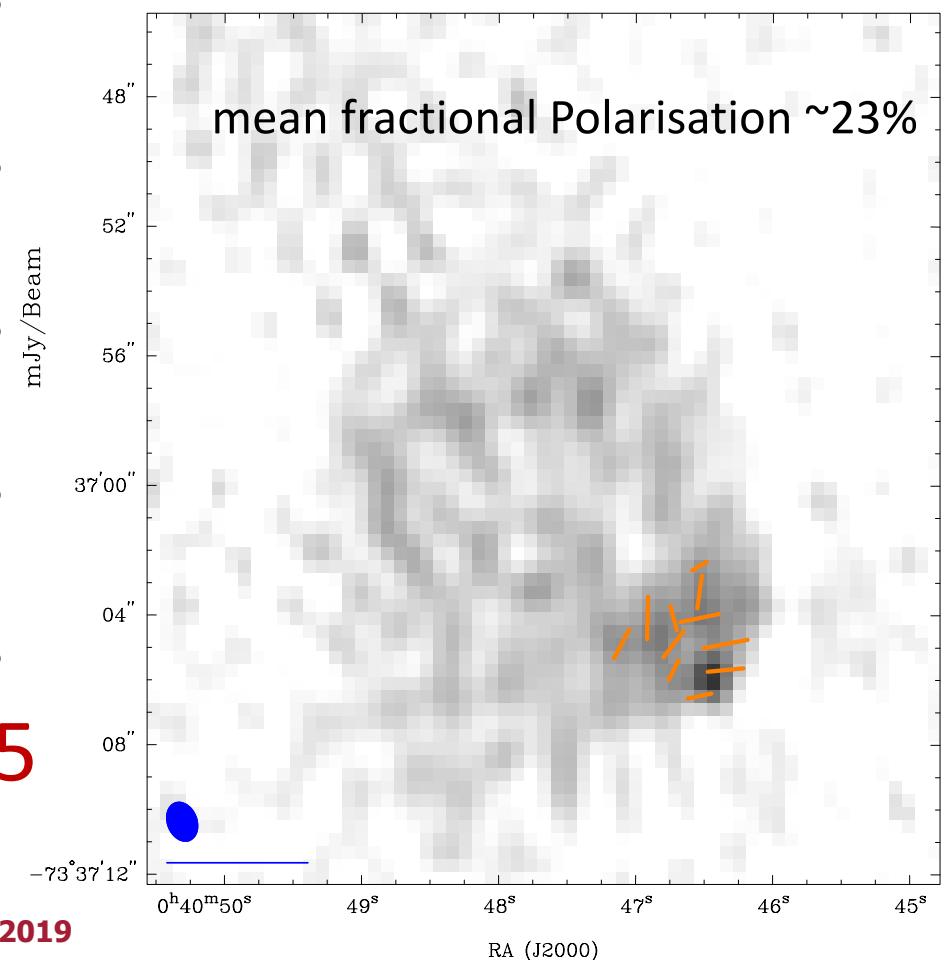


$V \sim 700\text{--}2000 \text{ km/s}$ at age od 10 kyr

Pulsar ~ 21.2 pc from SNR centre

DEM S5

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DEM S5

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SMC SNR DEMS5 (IRAC 421-bands vs ASKAP (magenta) vs [SII] (white))

Declination (J2000)

-73°37'00"

-37'30"

-38'00"

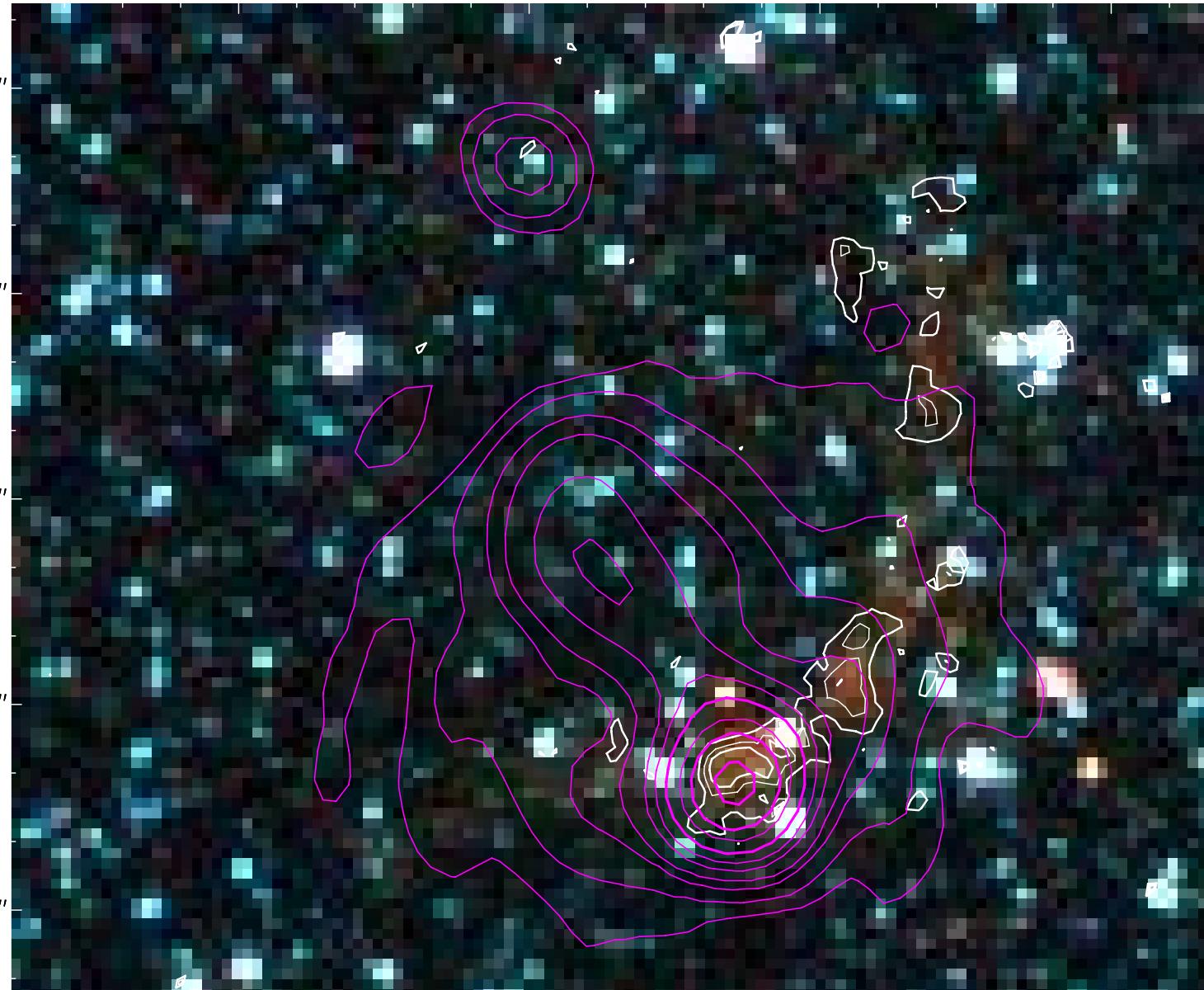
-38'30"

-39'00"

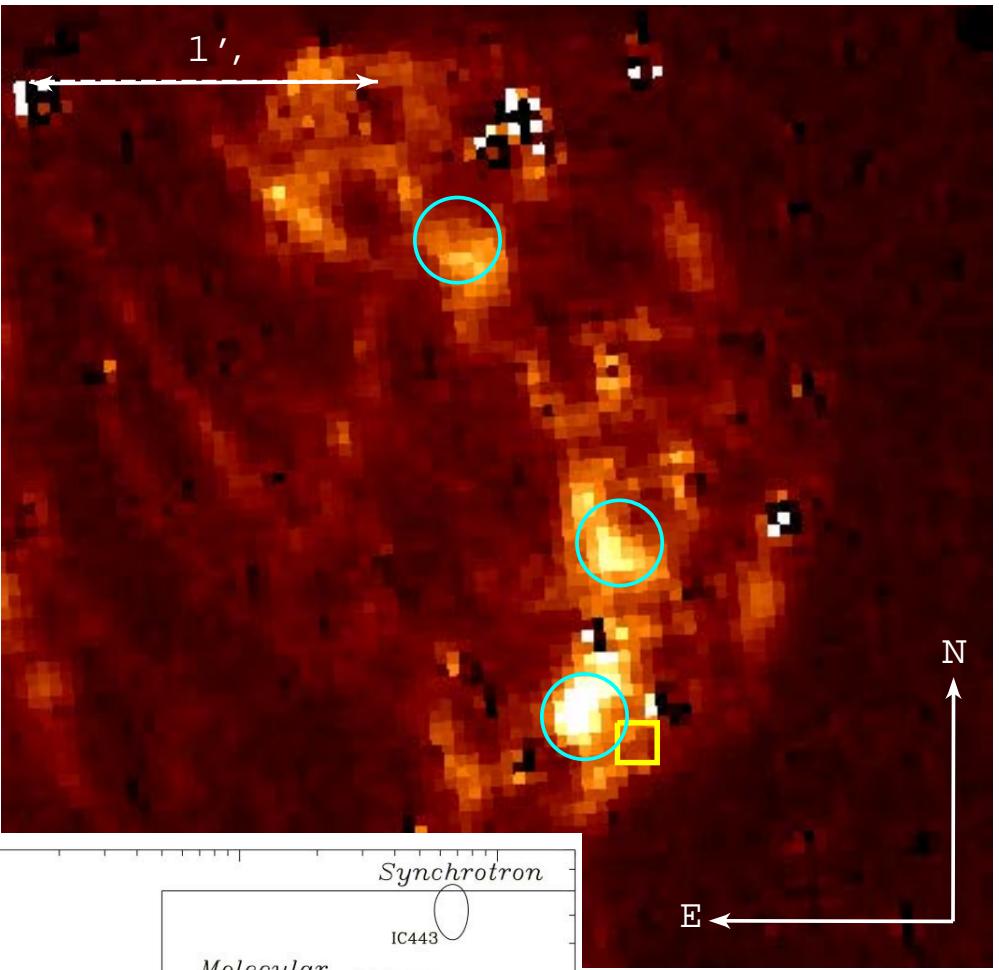
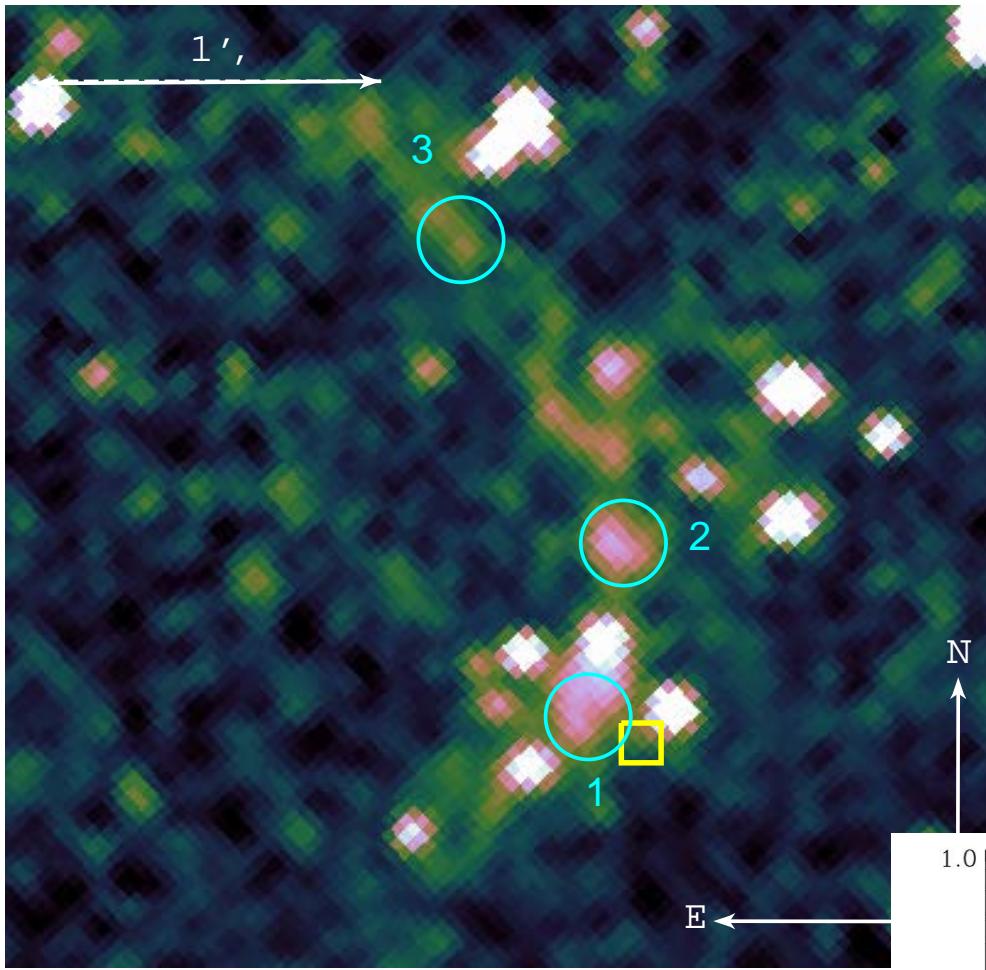
0^h41^m00^s

Right Ascension (J2000)

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Bands:
band-1 (3.6 μ m),
band-2 (4.5 μ m),
band-3 (5.8 μ m),
and
band-4 (8.0 μ m)

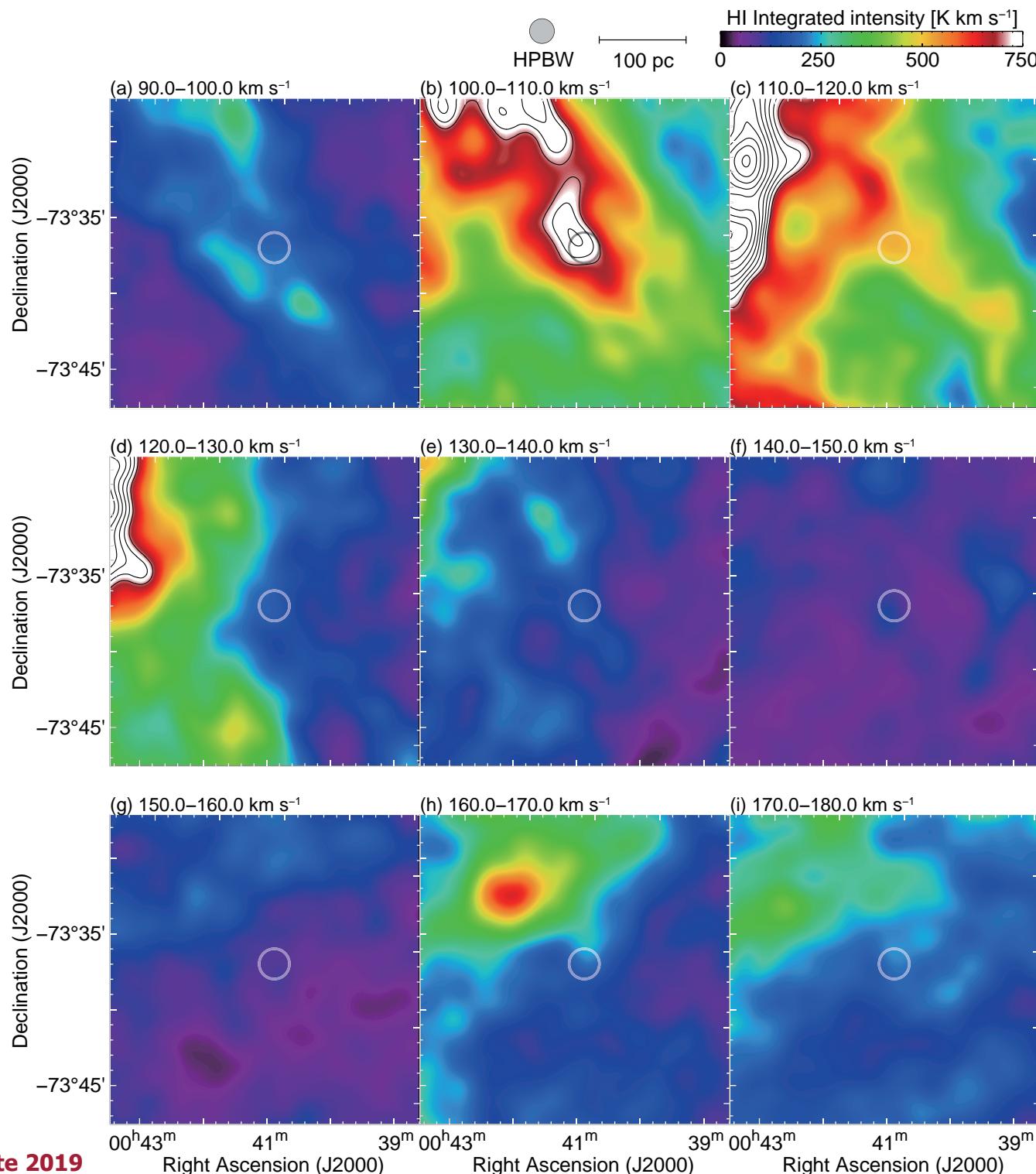


Molecular hydrogen emission is dominating the broad-band imaging.

Presence of shocked gas that is expected for SNRs.

Is it unusual to detect such IR emission in an SNR with a supersonic bow shock PWN.

Spitzer CC diagram
(Reich+2006)

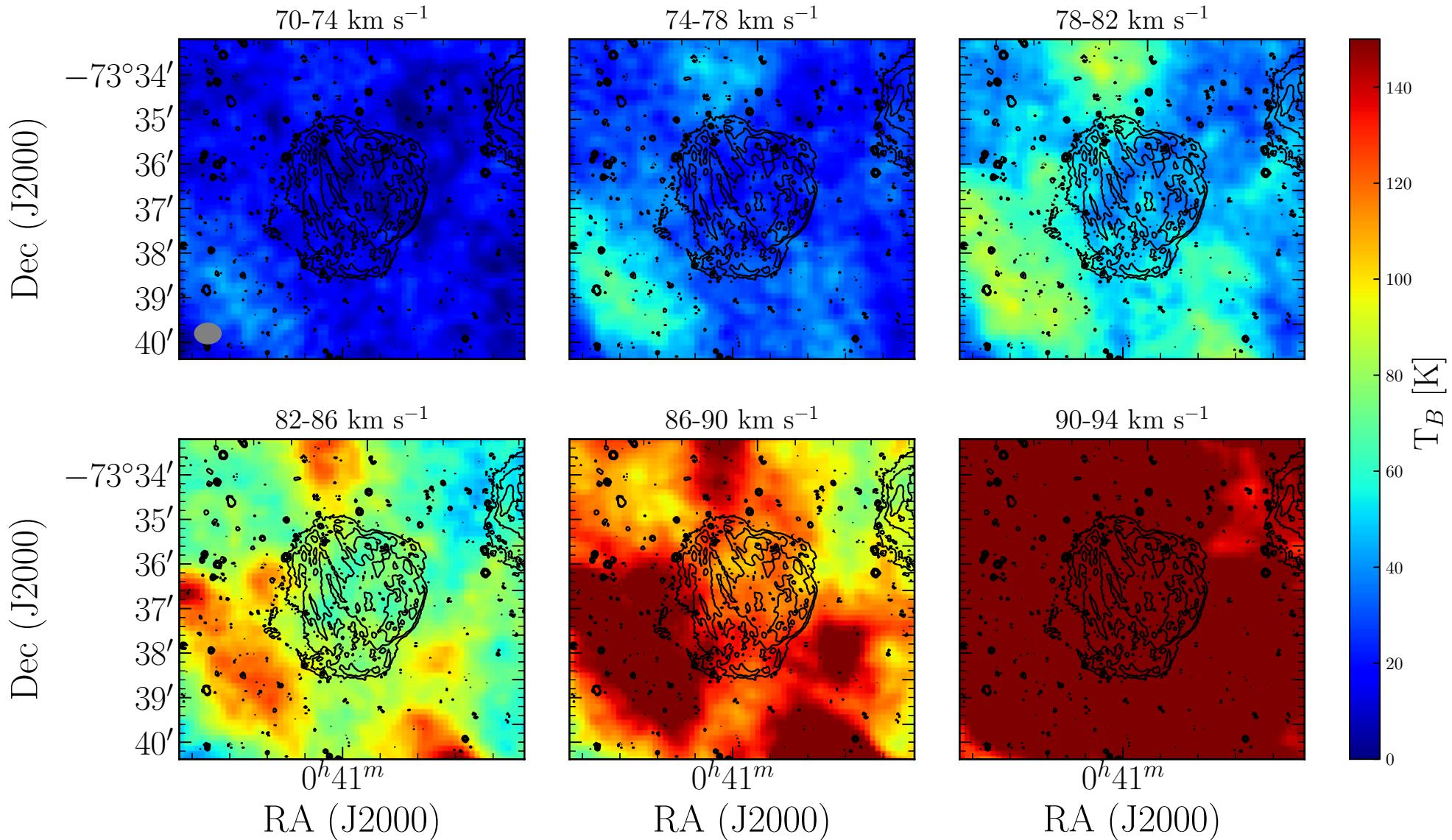


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ATCA HI

ASKAP HI SMC DEM S5



Instead of
Conclusion





We're All Different!

Just Accept It.





We are all different!



Just accept it!



There are a lot of things/characteristics
(but NOT all) that we see in Galactic SNRs

....

and ...

the Magellanic Clouds SNR would have
them as well!