# Compact Radio Source Population Towards the Galactic Centre

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- Ian Heywood

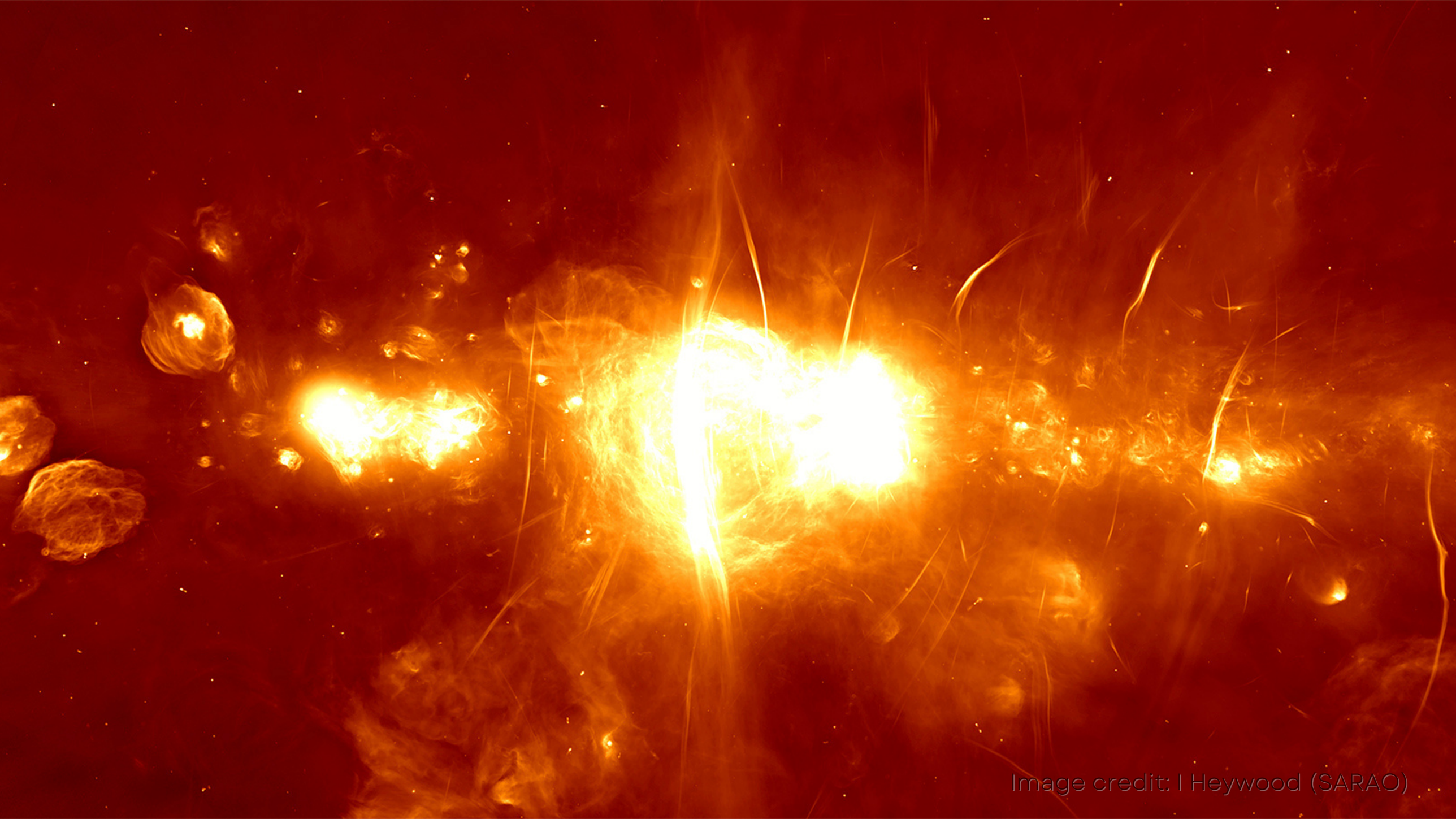
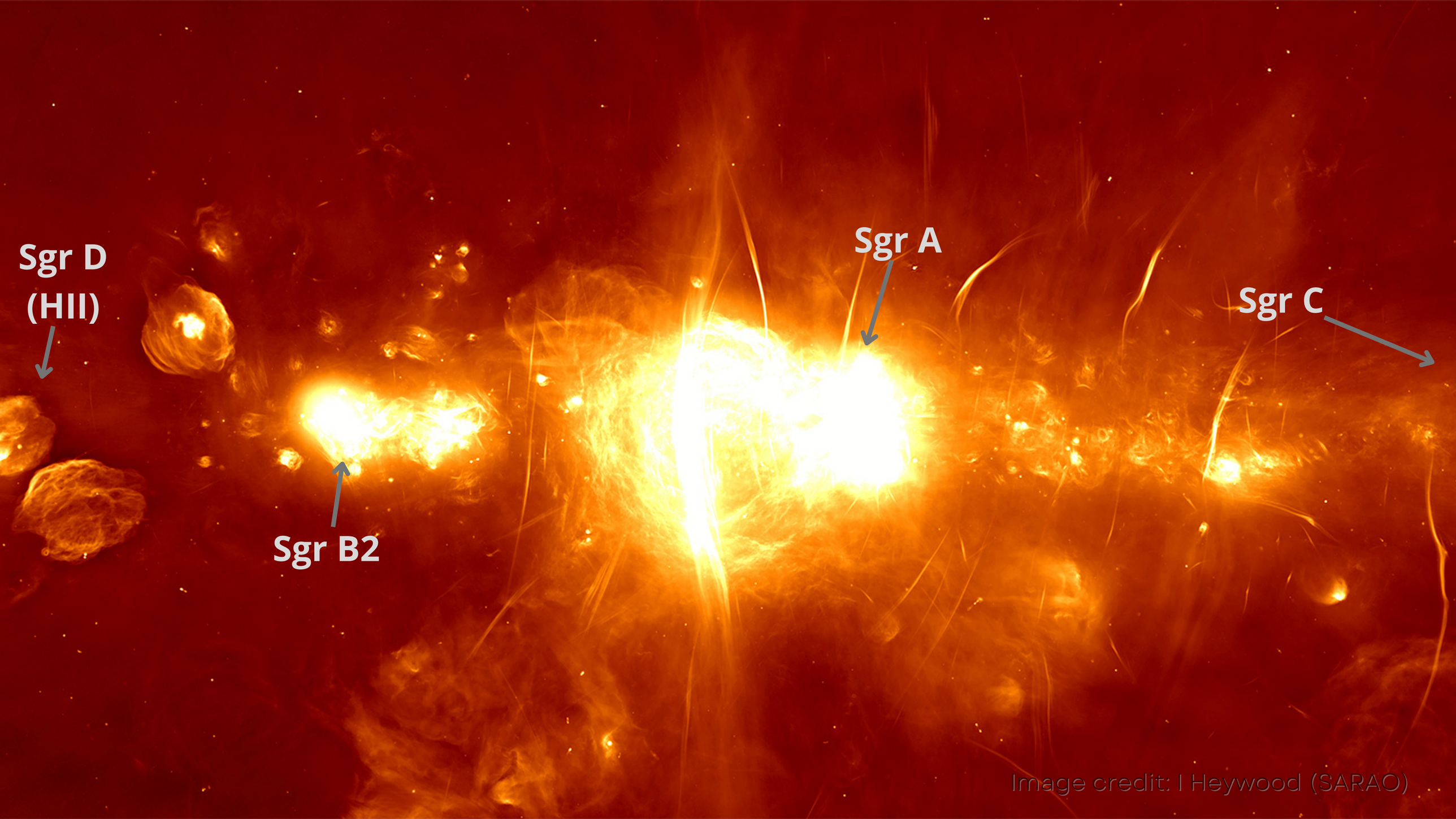
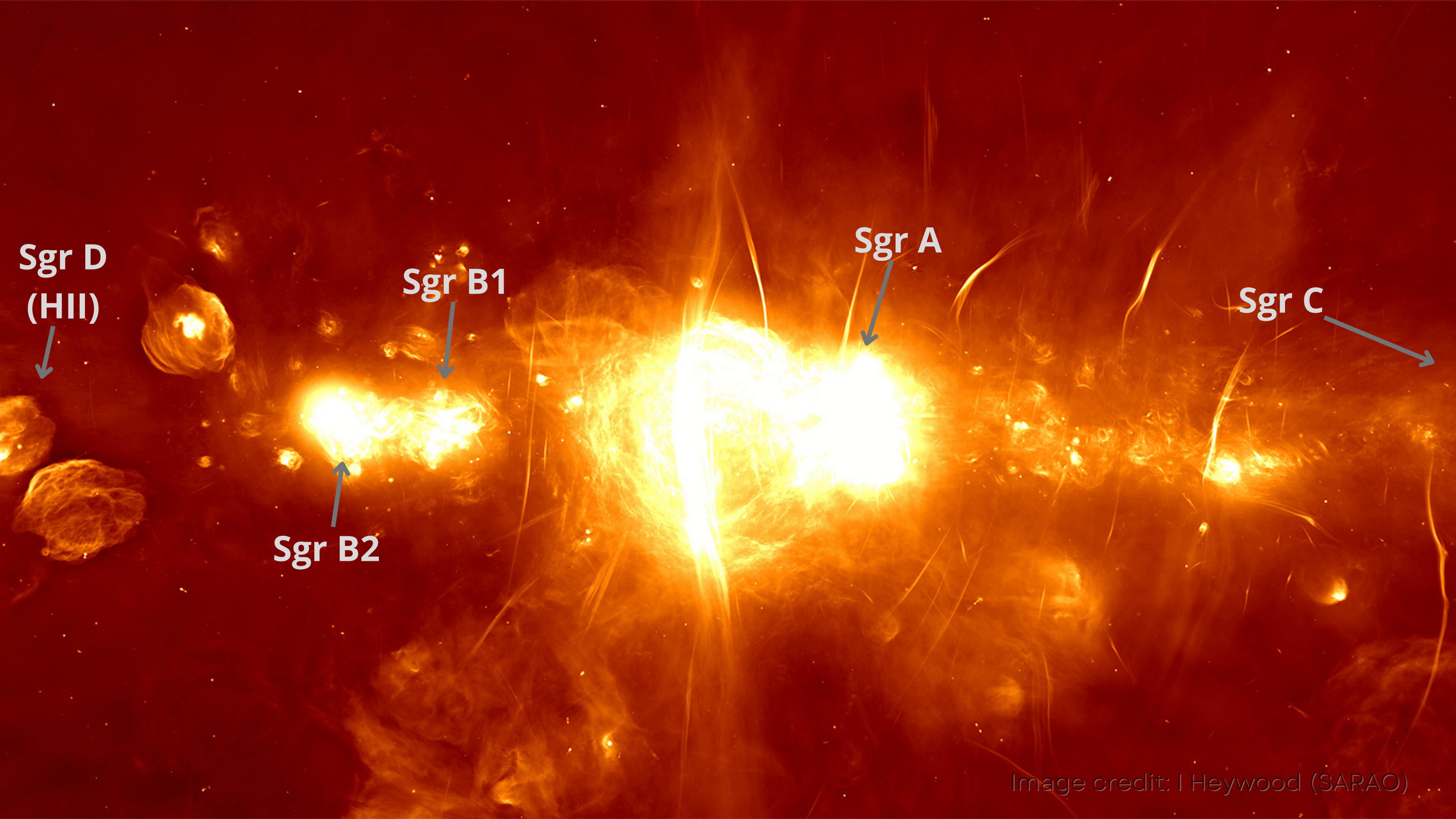
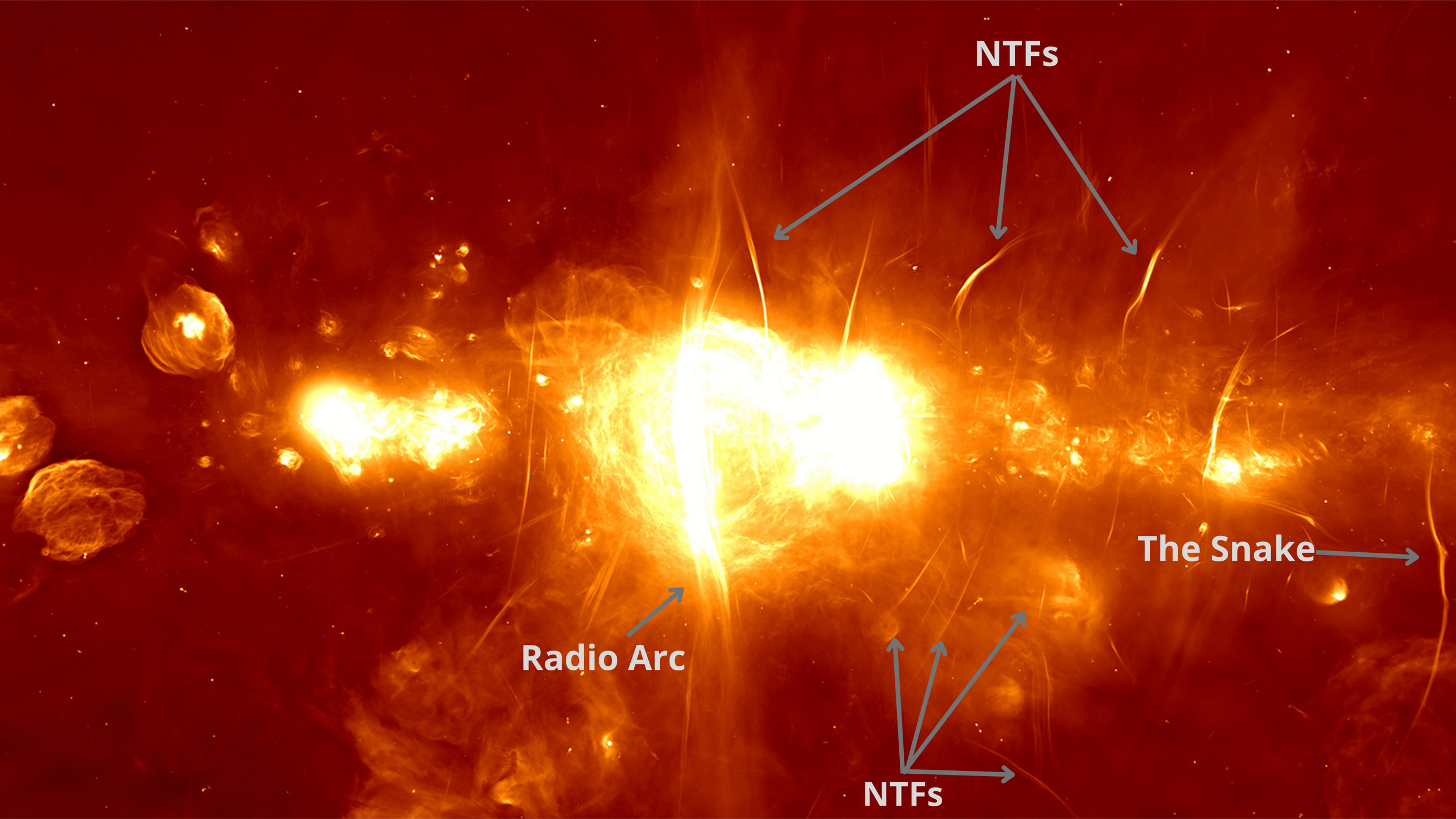


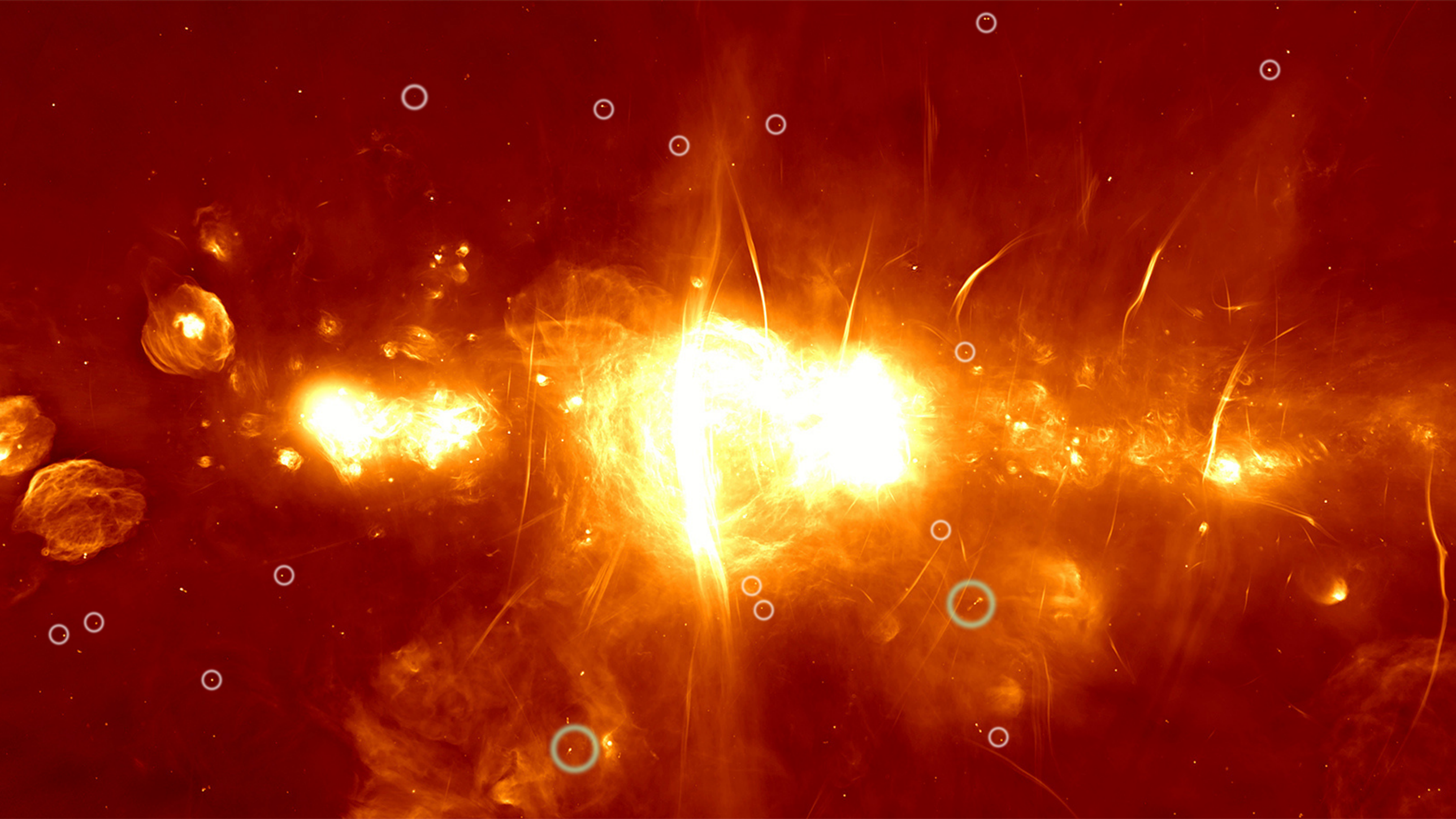
Image credit: I Heywood (SARAO)


Sgr D
(HII)
Sgr B2
Sgr A
Sgr C
Image credit: I Heywood (SARAO)


Sgr D
(HII)
Sgr B1
Sgr A
Sgr C
Sgr B2
Image credit: I Heywood (SARAO)

SNR
G0.9+0.1
Sgr D
(SNR)
SNR
G359.1-0.5

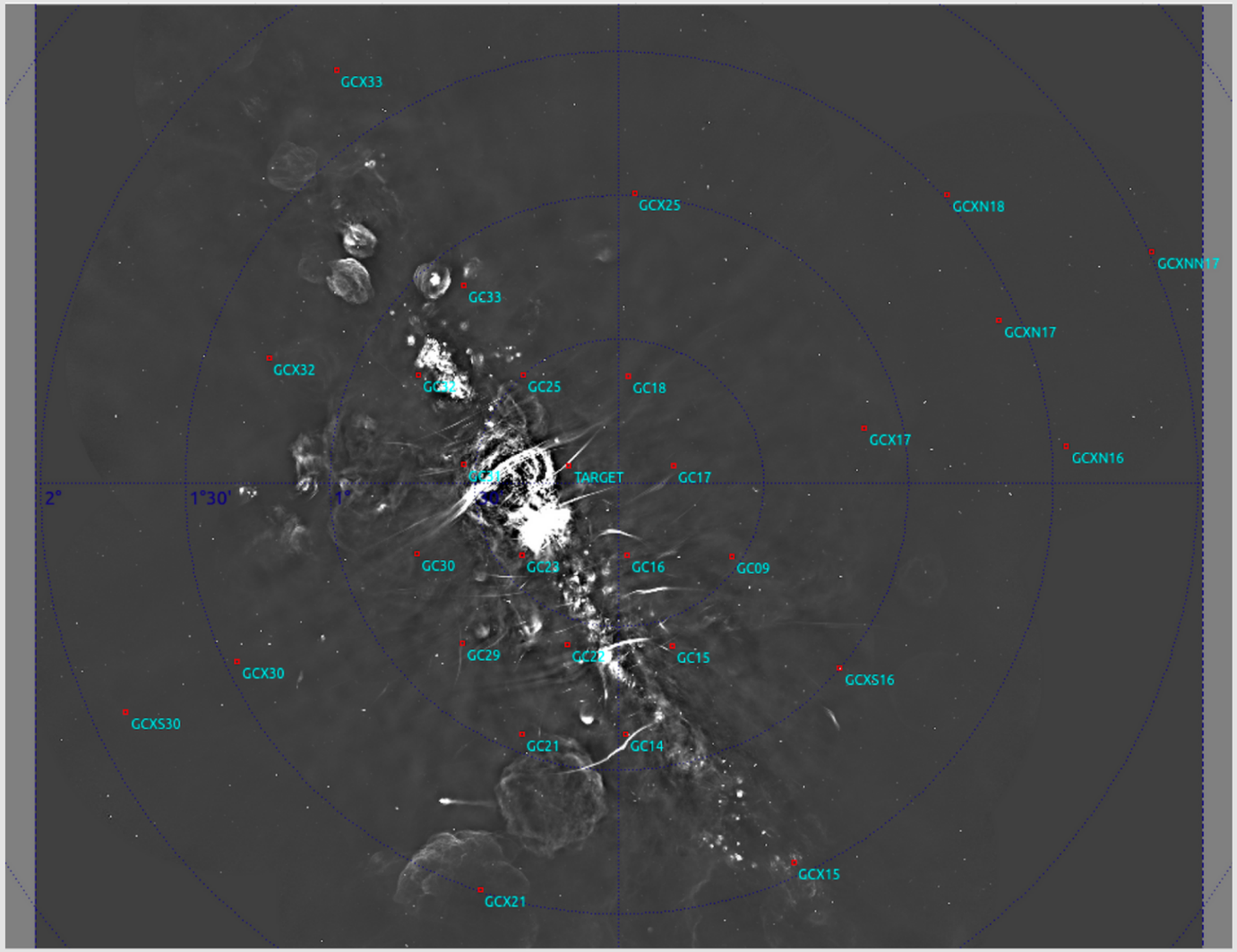

NTFs
The Snake
Radio Arc
NTFs



# Aim:

- How many are new sources?
- What types are they?
  - Morphology & spectral properties
- Which are pulsar candidates?

# The DATA




- MeerKAT GC survey
- 1.2 GHz
- 30 Pointing
- Full polarisation data

# The DATA

- MeerKAT GC survey
- 1.2 GHz
- 30 Pointing
- Full polarisation data

# Procedure:

- Produce high resolution images
  - Full intensity and spectral images
- Spectral index fitting
  - $S_\nu \propto \nu^\alpha$

# The Results

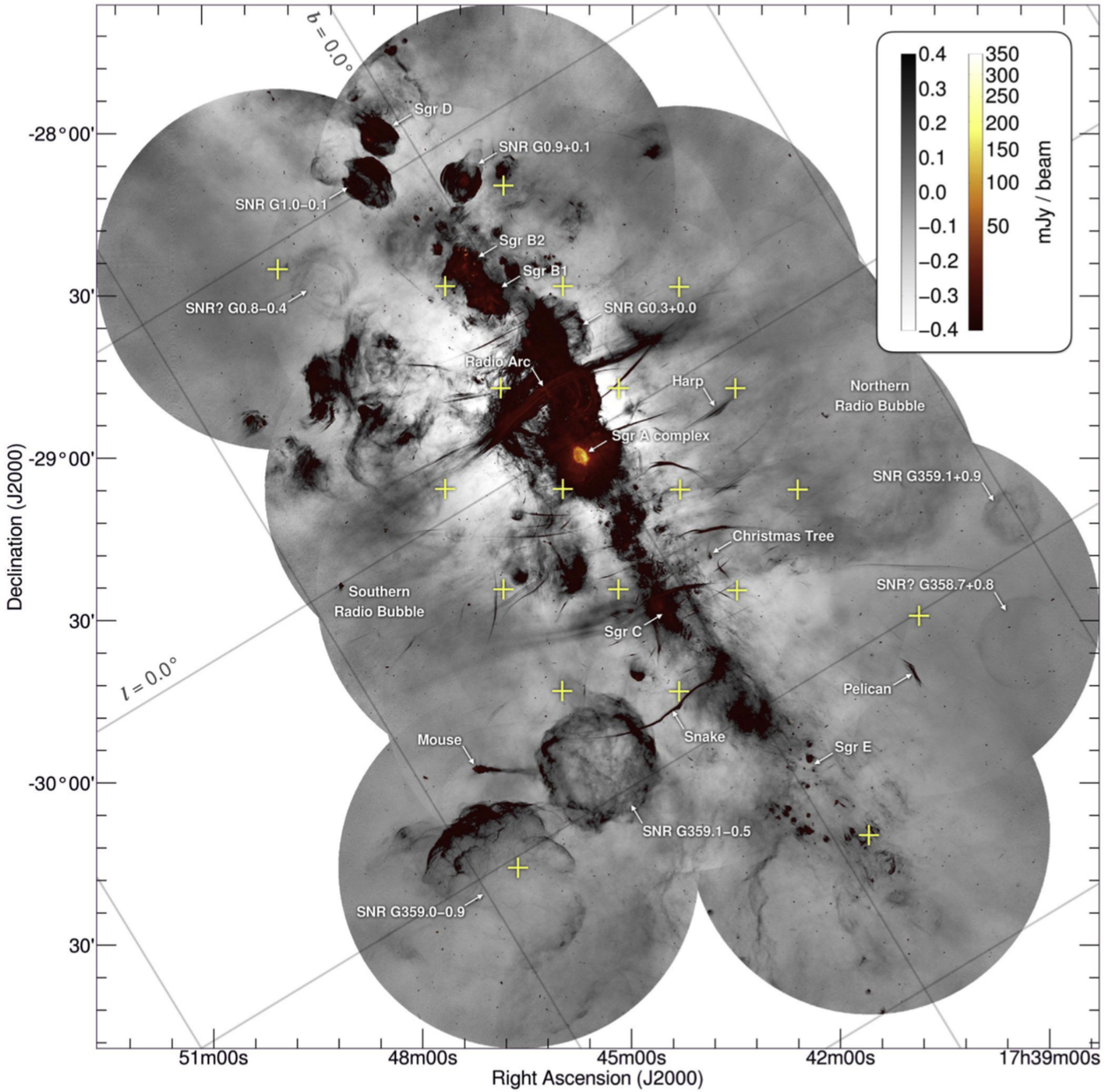
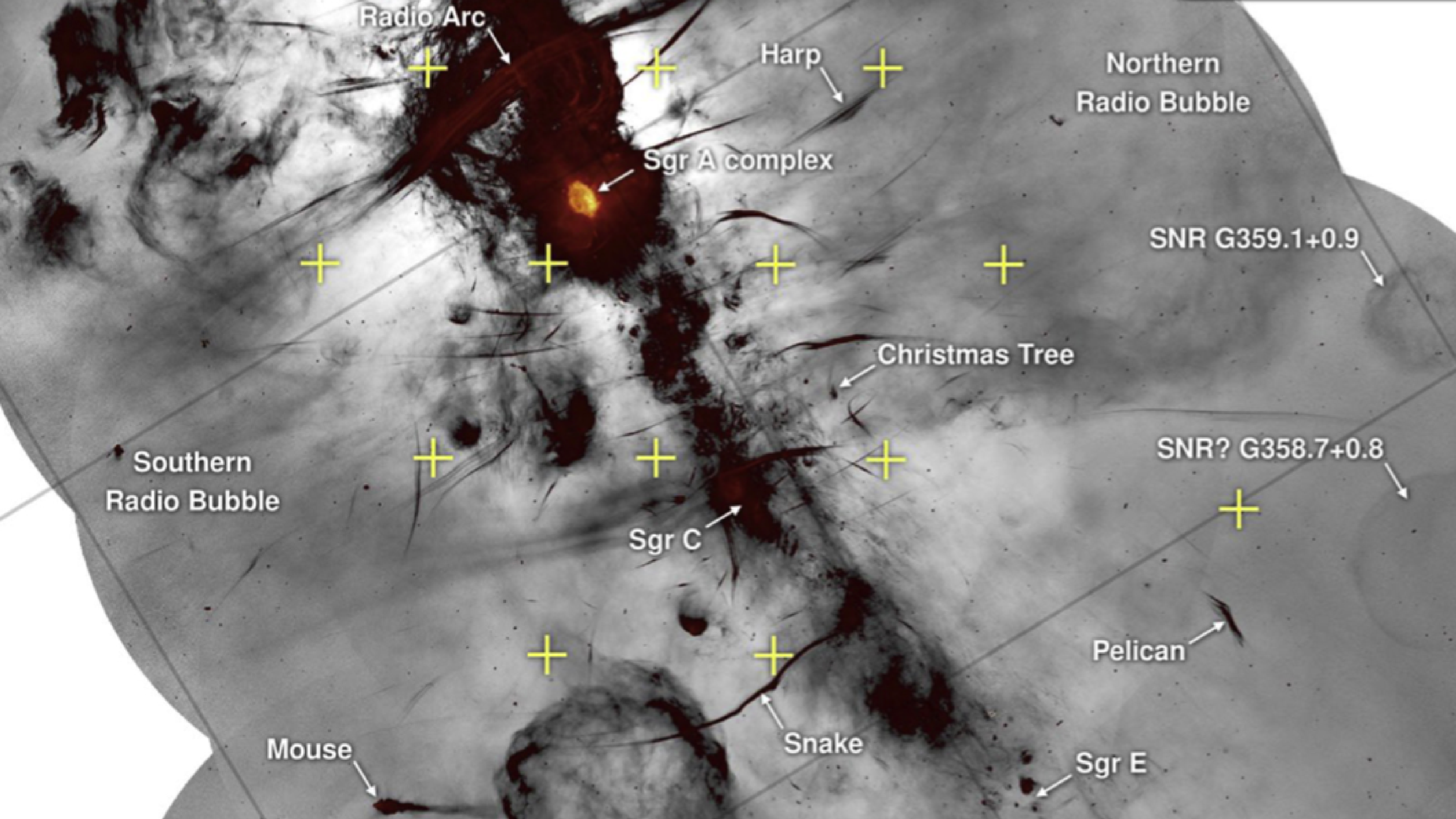
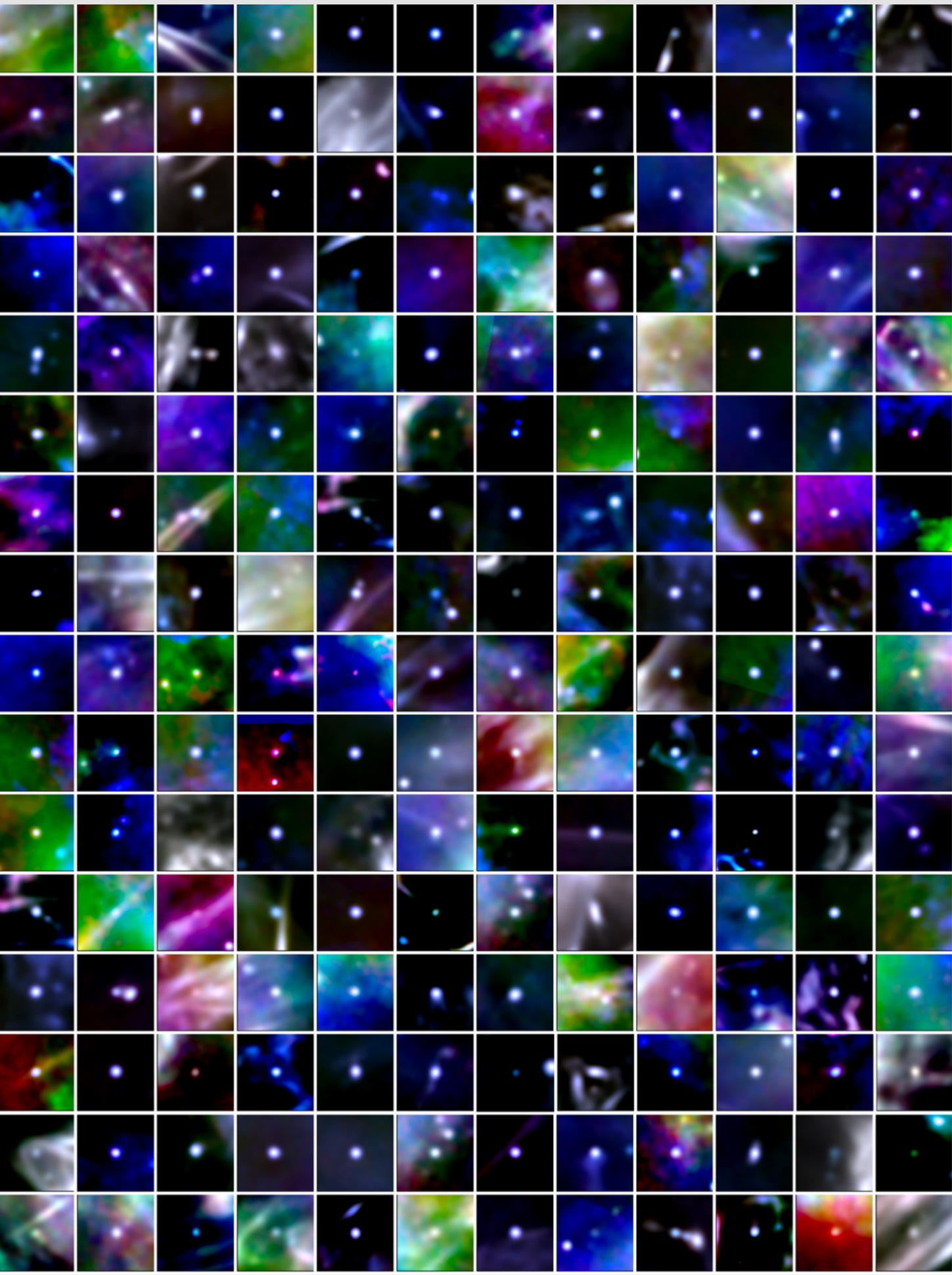



**Figure 3.2:** The total intensity linear mosaic of the 20 MFS images (also in Heywood et al. [2022]). The full mosaic covers 6.5 square degrees of the GC, with 4″ angular resolution. A dual colour scheme was used to capture the high dynamic range of the image with the linear grey-scale covering the faint end while the square-root stretched heat map covers the bright end. Known sources are labelled, including Sagittarius complex, molecular clouds, some Supernova Remnants (SNR), several non-thermal radio filaments, and part of the radio bubble whose full extend is captured in Heywood et al. [2019].


Radio Arc
Harp
Northern
Radio Bubble
Sgr A complex
SNR G359.1+0.9
Christmas Tree
Southern
Radio Bubble
SNR? G358.7+0.8
Sgr C
Pelican
Snake
Mouse
Sgr E

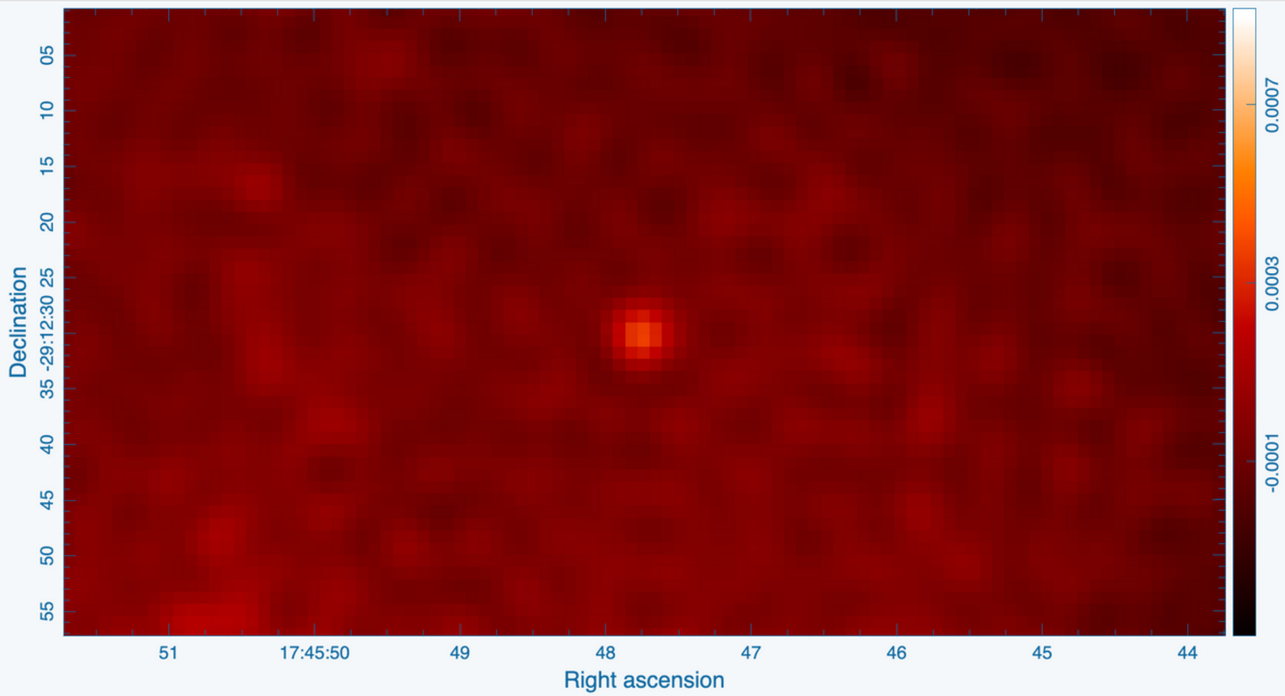
# New Sources (1523)

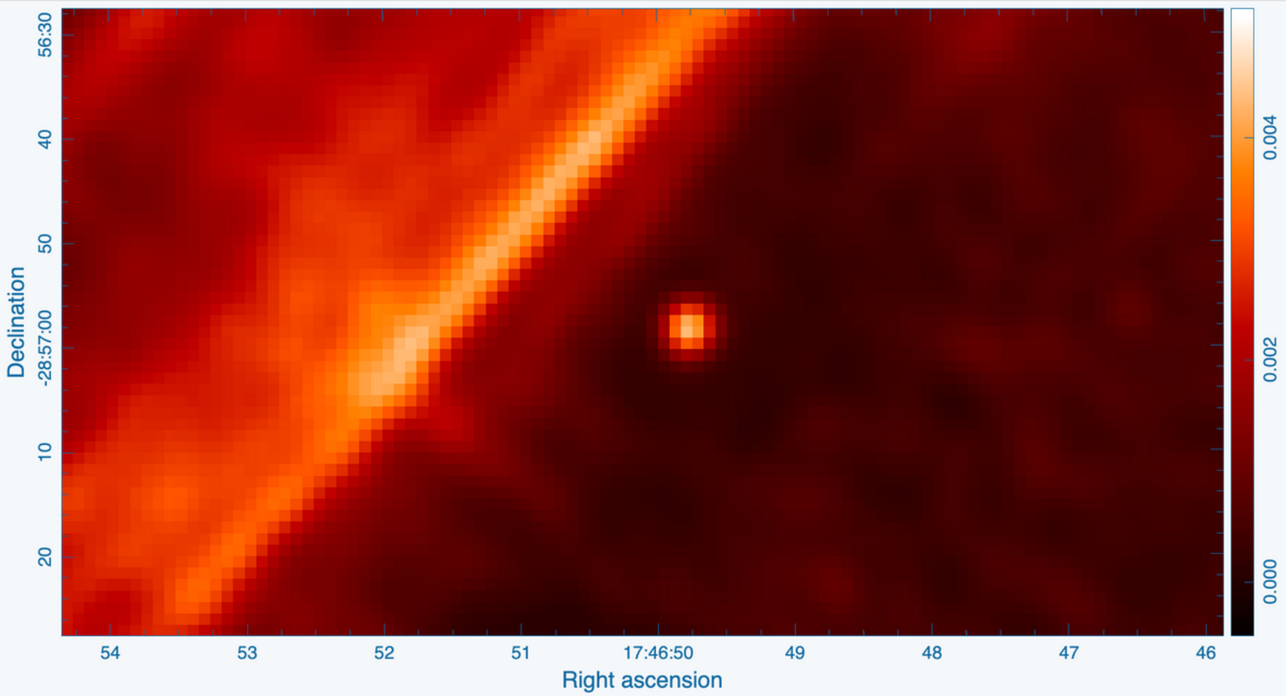


Examples of new sources in false colour (RGB)!

# Classification: COMPACT

- Mean Flux $1.96 \pm 0.11 \ \mathrm{mJy}$ , Mean spectral index $-0.56 \pm 0.28$

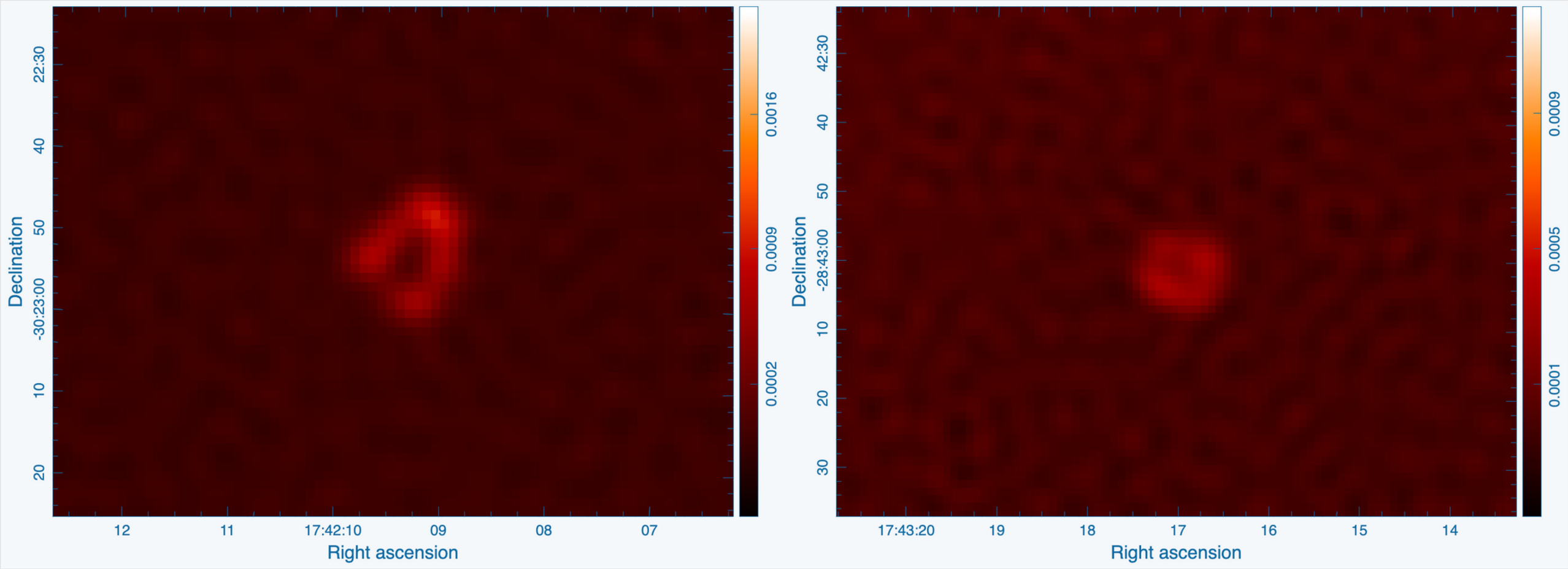



PSR J1745-2912 (left) & PSR J1746-2856 (right). Both pulsars are see as compact sources in the continuum data (Rammala et al, 2023: in prep).

# Classification: SHELL (29)

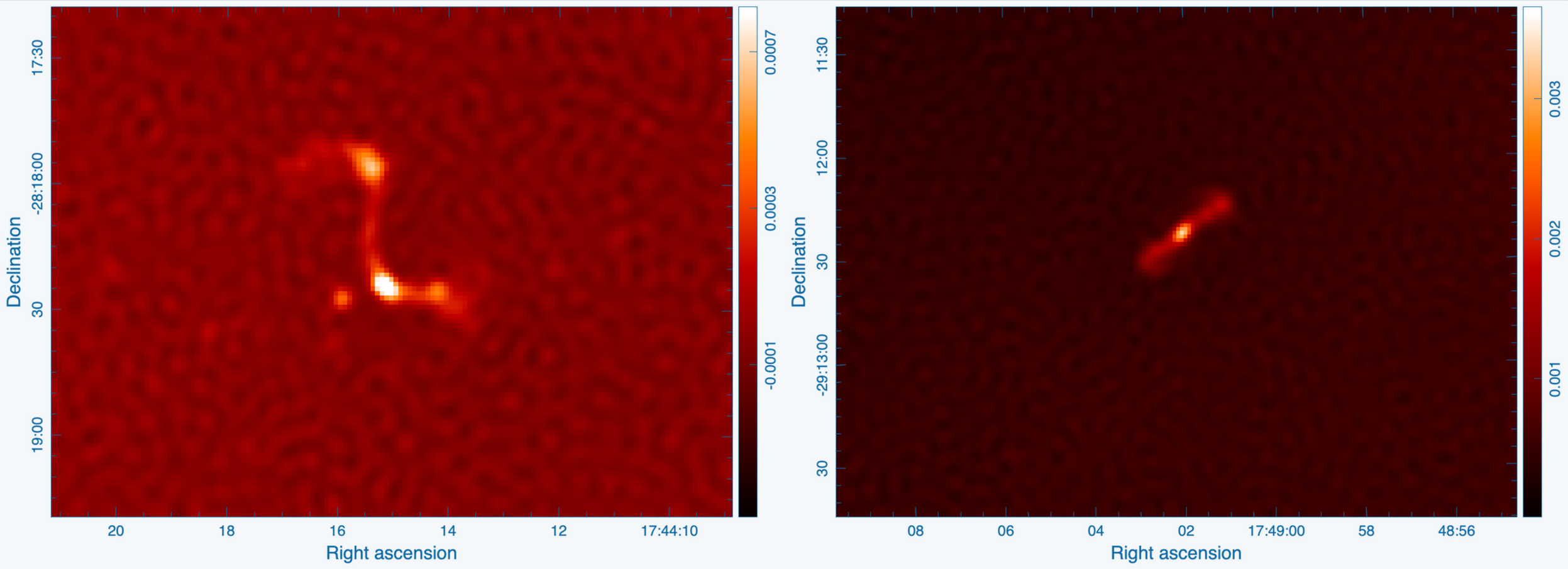
- Mean Flux $3.24 \pm 0.0.28\ \mathrm{mJy}$ , Mean spectral index $-0.10 \pm 0.18$




Examples of shell-type sources in the catalogue (Rammala et al, 2023: in prep)

# Classification: AGN (30)

- Mean spectral index $-0.8 \pm 0.1$




Examples of AGN-type sources in the catalogue (Rammala et al, 2023: in prep)

# Galactic or Extra-Galactic?

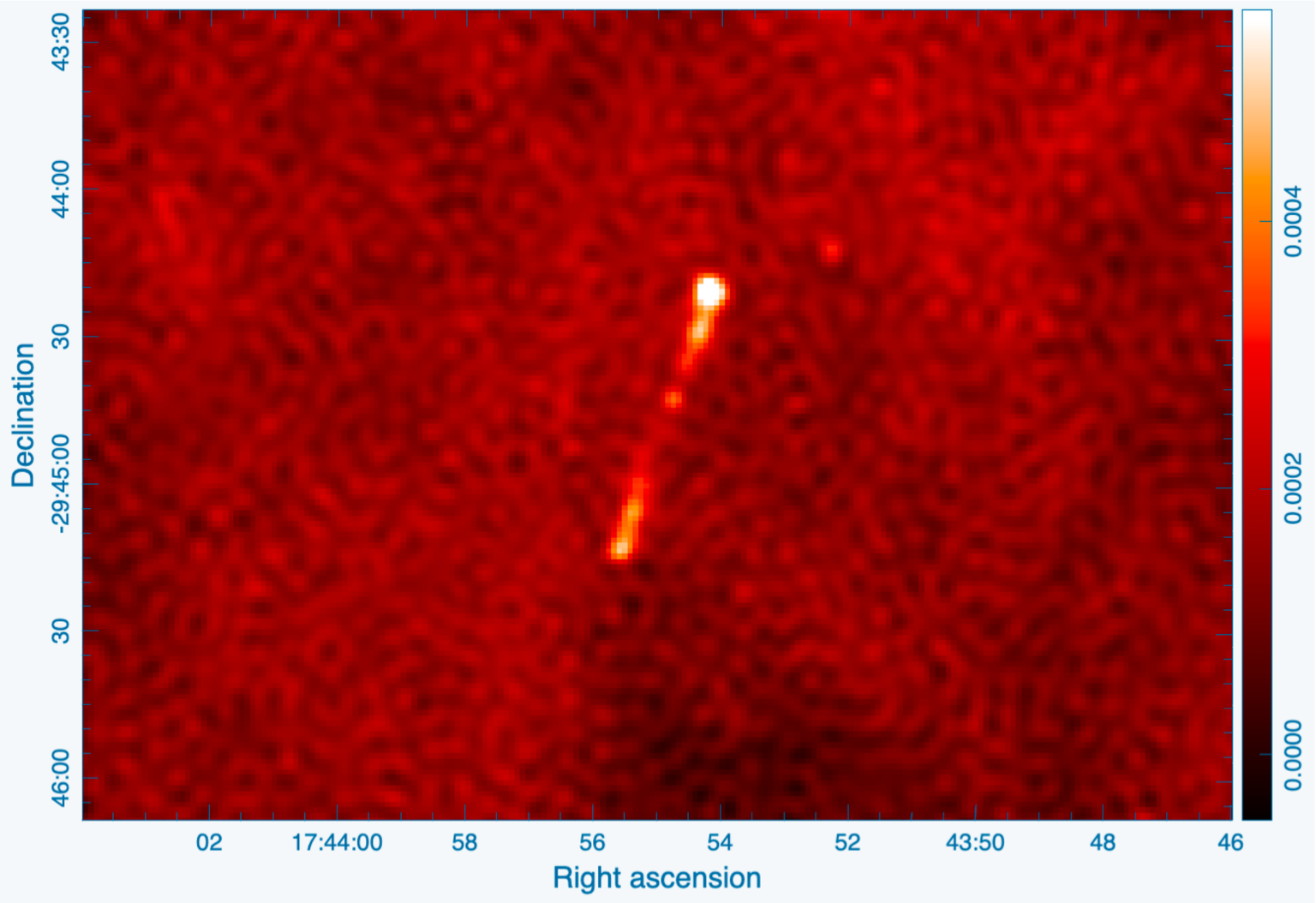
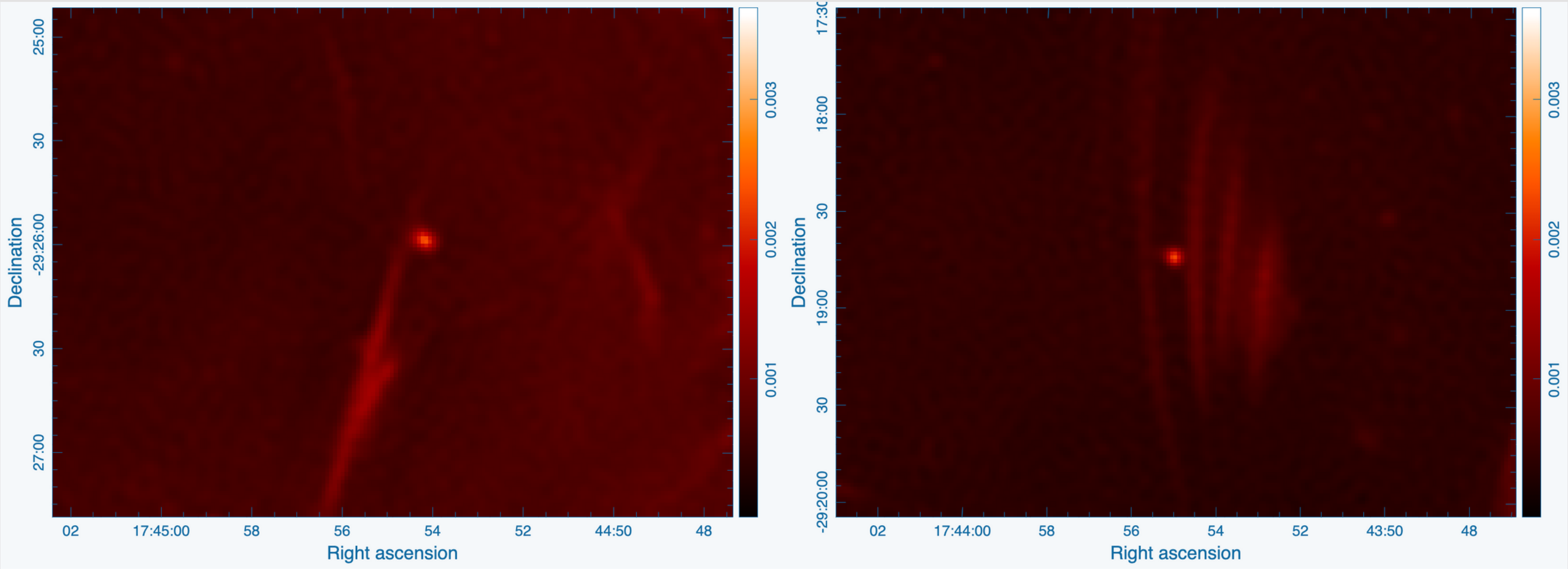



**Figure 5.6:** Radio image of the great annihilator, 1E1740.7-2942, as seen in the GC mosaic. The source is an X-ray binary of a stellar mass blackhole with a companion. When observed in radio, the source exhibits double-lobe jets that resemble those of an extra-galactic AGN source. The image shows the flux in mJy.

# Classification: FILAMENTS (19)

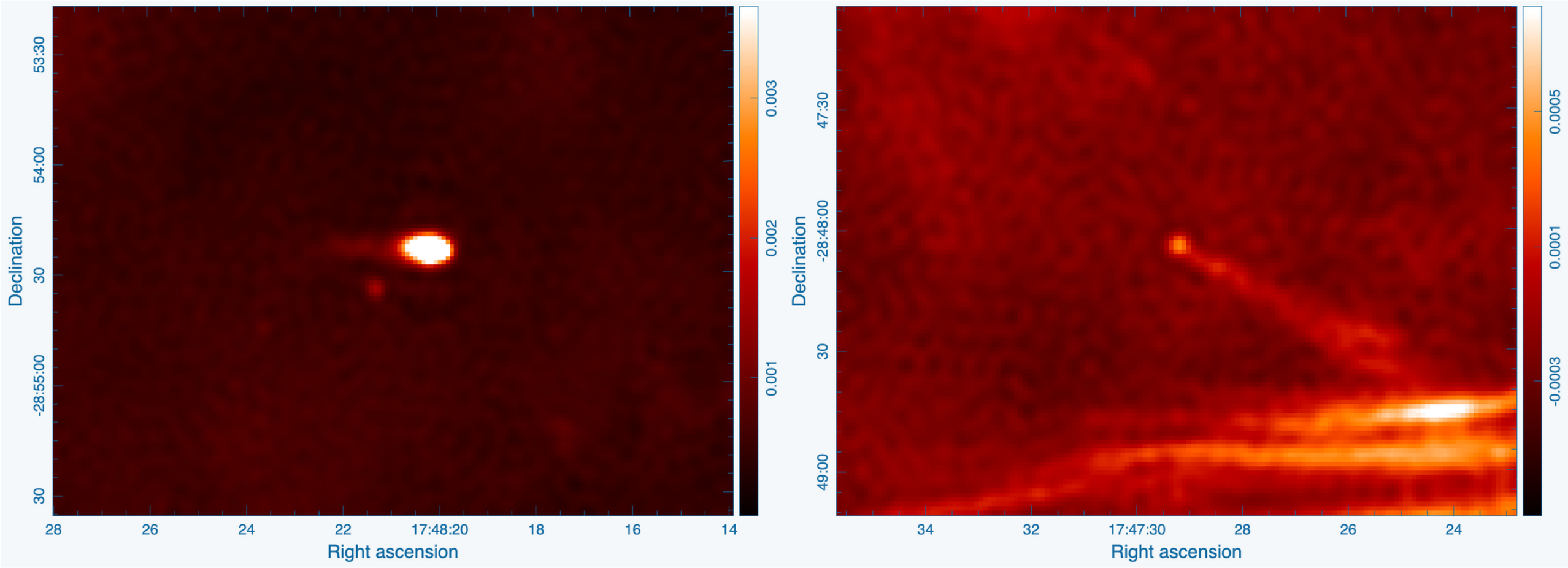
- Mean flux $3.99 \pm 0.5\ \mathrm{mJy}$ Mean spectral index $-0.37 \pm 0.28$




Examples of point sources associated with filaments in the catalogue (Rammala et al, 2023: in prep

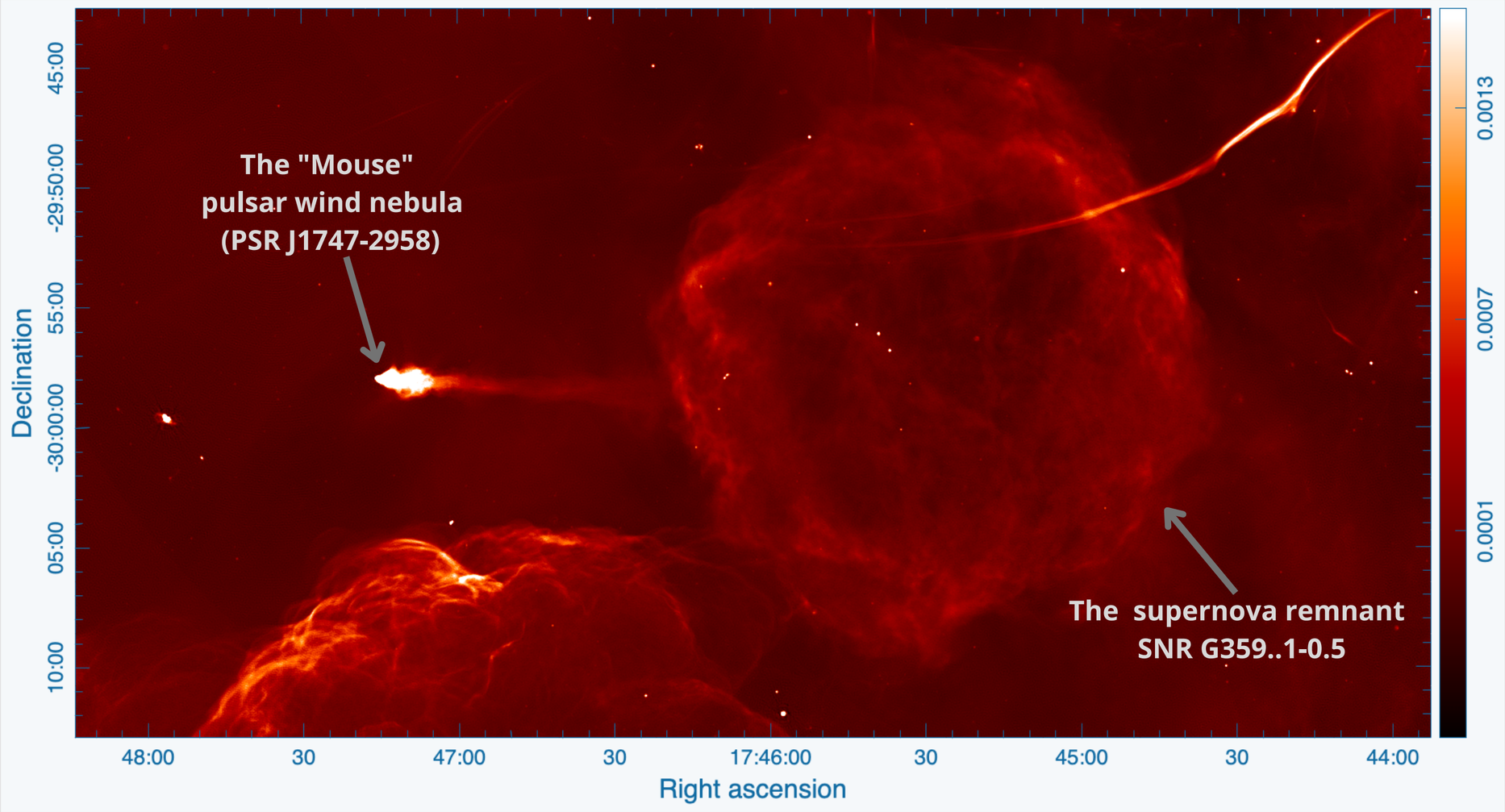
# Classification: TAIL (17)

- Mean Flux $4.12 \pm 0.14$ mJy , Mean spectral index $-0.6 \pm 0.22$



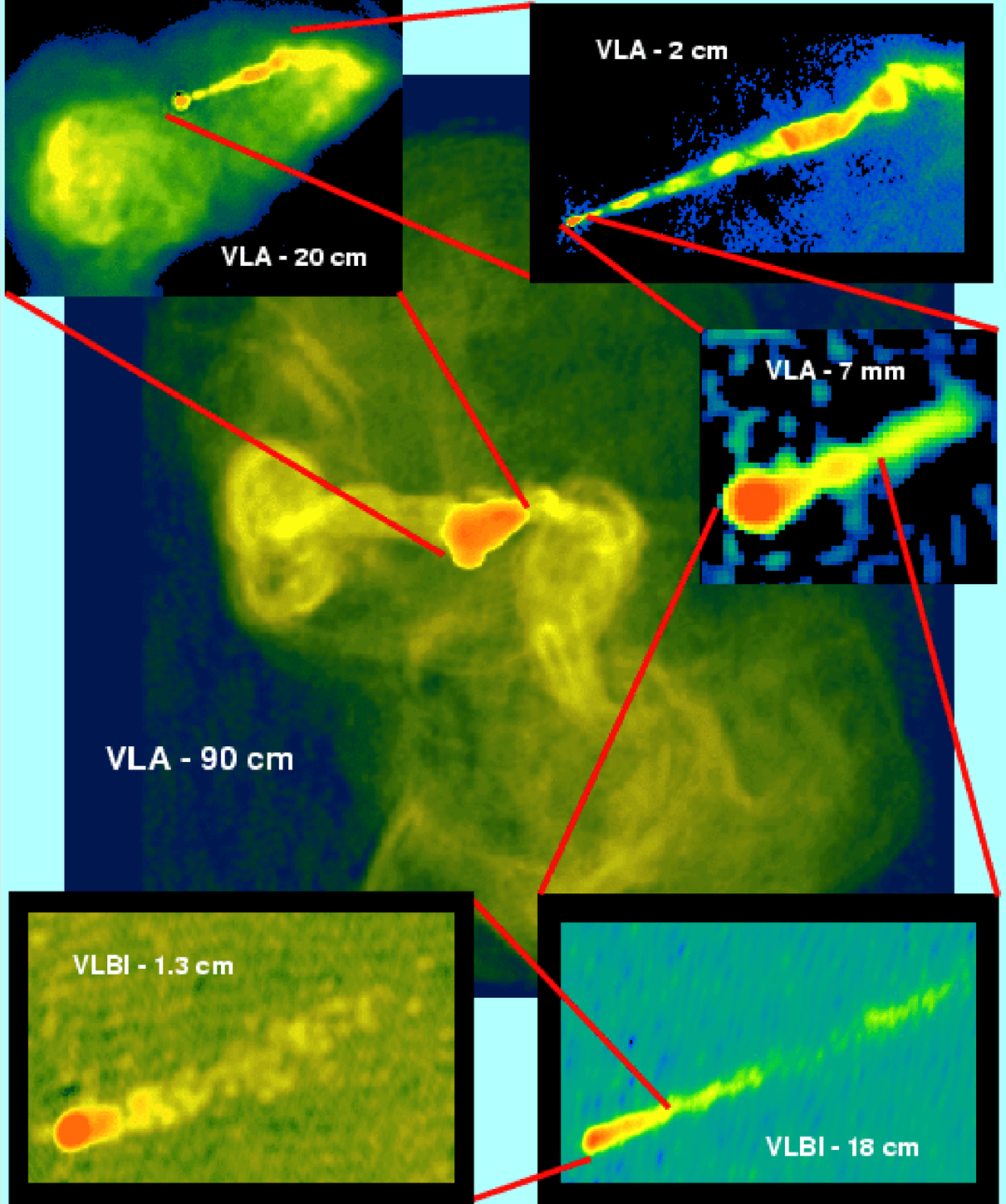

Examples of tail sources in the catalogue (Rammala et al, 2023: in prep)

# Tail of a PWNe? Example (Mouse Pulsar)




The "mouse" pulsar (Camillo et al 20) wind nebula "kicked-out" of the supernova remnant at birth

# Tail of an AGN?
# Example: M87




Radio Image of the Giant elliptical galaxy M87 showing the galaxy's radio structures at varied scale, observed at different frequencies. (image credit: NRAO)

# Pulsar Candidates?

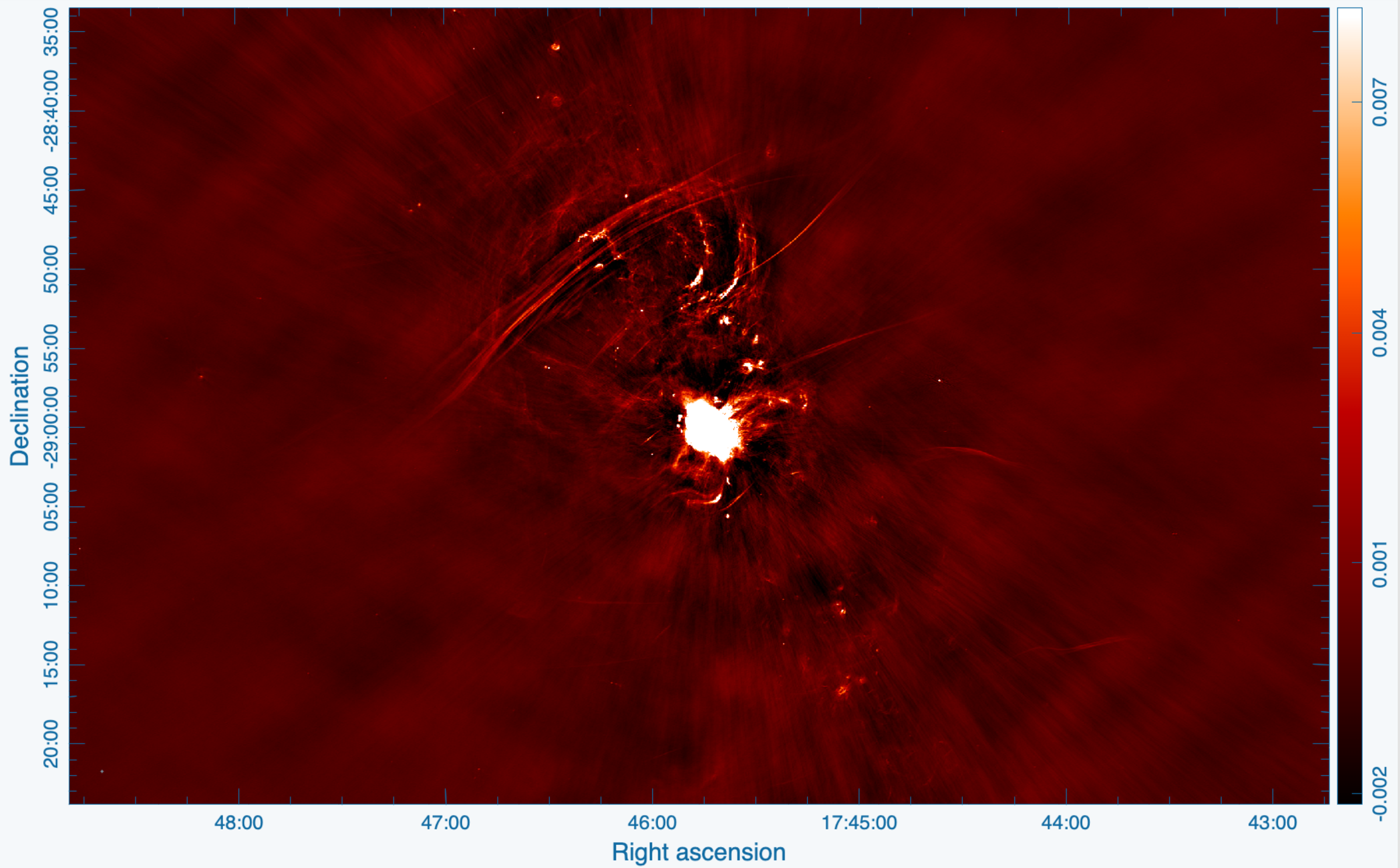
- Known radio pulsars - steep negative spectra.
- Identify sources with spectral index < −1.8
- Morphological nature or environment

# Pulsar Candidates?

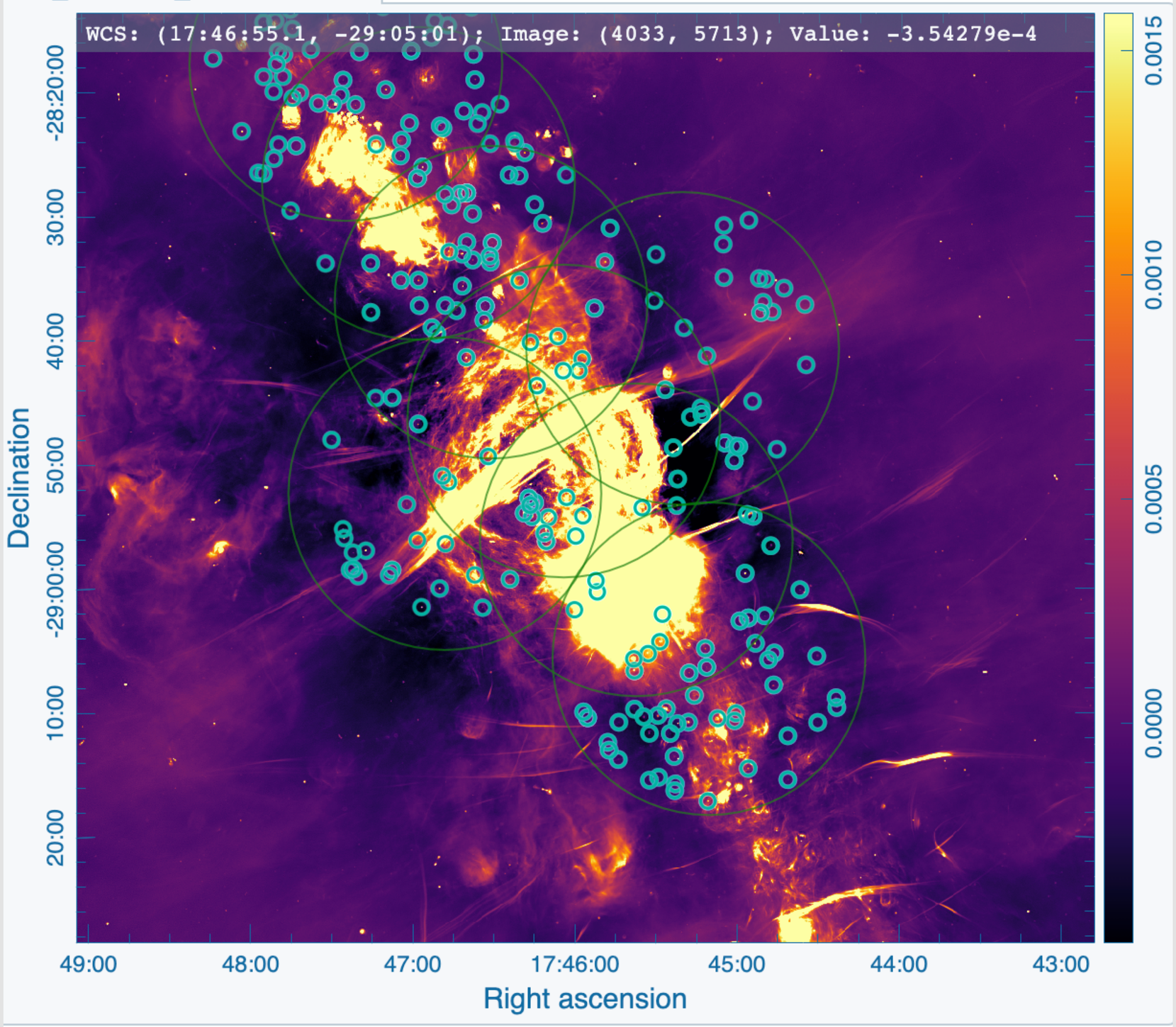
- 18 Candidates identified
- Based of on morphology & spectral properties
- Biased for only bright sources with steep spectra
- Periodicity searches in time domain required!

# Future work

- MeerKAT S-Band survey
- 200 hrs
- Simultaneous continuum and time-domain data collection!




1 hour MeerKAT S-Band commissioning observation at S0 (1.7 - 2.6 GHz). Image credit: Sarrvesh Saidhar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20:00
Right ascension
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48:00
47:00
17:46:00
45:00
44:00
43:00
0.0015
0.0010
0.0005
0.0000

# SUMMARY

- 1523 new GC compact radio source.
- 5 types of sources.
- Morphology and spectral index alone are not enough discriminators.
- 18 Steep negative spectra sources identified as pulsar candidates.
- Commensal time-domain & continuum searches at S-Band promising.

NRF National Research Foundation | SARAO South African Radio Astronomy Observatory

RHODES UNIVERSITY Where leaders learn

https://ratt.center RATT Centre For Radio Astronomy Techniques & Technologies • Rhodes University

# Thank you!

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# Any Question?

MAX-PLANCK-INSTITUT FÜR RADIOASTRONOMIE

IDIA Inter-University Institute for Data Intensive Astronomy

nicis CHPC