



International
Centre for
Radio
Astronomy
Research



GLEAM and Beyond: Radio Surveys with the Murchison Widefield Array

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Curtin University



THE UNIVERSITY OF
WESTERN
AUSTRALIA



Government of Western Australia
Department of the Premier and Cabinet
Office of Science

<https://gleamoscope.icrar.org>





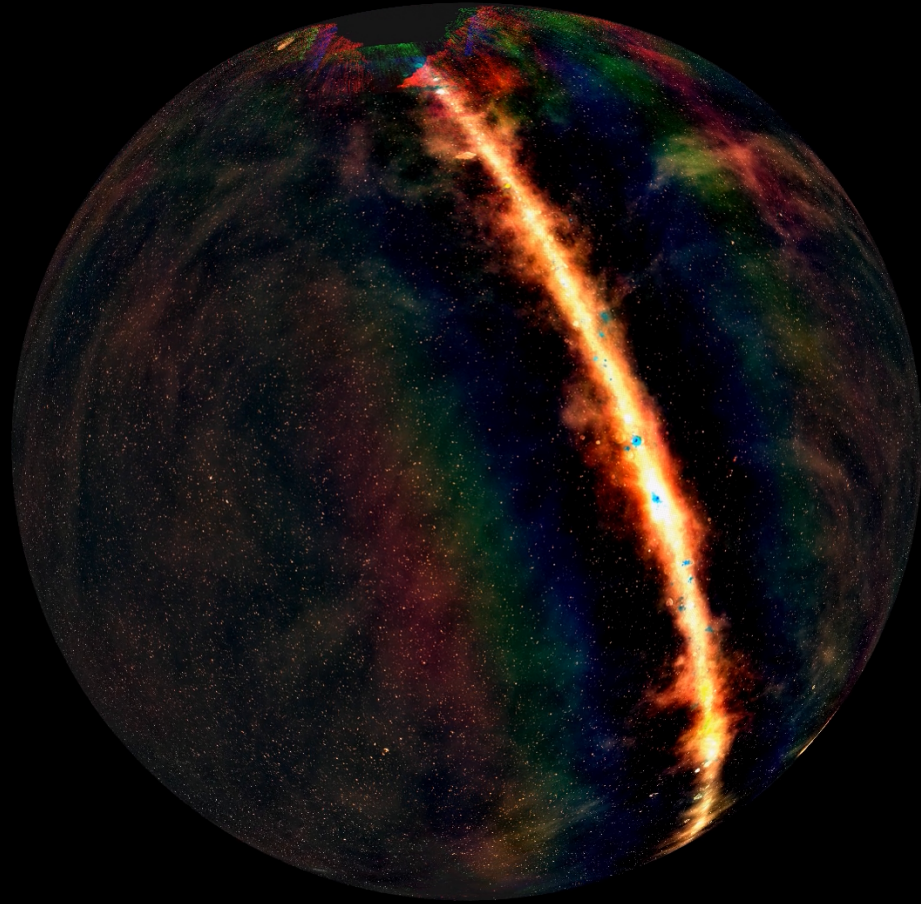
GaLactic and Extragalactic All-sky MWA survey



Accepted Publications

- Riseley et al. 2018: The POLarised GLEAM Survey (POGS) I: First Results from a Low-Frequency Radio Linear Polarisation Survey of the Southern Sky
- For et al. 2018: A multifrequency radio continuum study of the Magellanic Clouds - I. Overall structure and star formation rates
- Su et al. 2018: Galactic synchrotron distribution derived from 152 H II region absorption features in the full GLEAM survey
- Galvin et al. 2018: The spectral energy distribution of powerful starburst galaxies - I. Modelling the radio continuum
- Callingham et al 2017: Extragalactic Peaked-spectrum Radio Sources at Low Frequencies
- George et al. 2017: A study of halo and relic radio emission in merging clusters using the Murchison Widefield Array
- Kapinska et al. 2017: Spectral Energy Distribution and Radio Halo of NGC 253 at Low Radio Frequencies
- Murphy et al. 2017: Low-Frequency Spectral Energy Distributions of Radio Pulsars Detected with the Murchison Widefield Array
- Murphy et al. 2017: A search for long-time-scale, low-frequency radio transients
- Su et al. 2017: Galactic synchrotron emissivity measurements between $250^\circ < l < 355^\circ$ from the GLEAM survey with the MWA
- Hurley-Walker et al. 2017: GaLactic and Extragalactic All-sky Murchison Widefield Array (GLEAM) survey - I. A low-frequency extragalactic catalogue
- Callingham et al. 2016: Low radio frequency observations and spectral modelling of the remnant of Supernova 1987A
- Lenc et al. 2016: Low-frequency Observations of Linearly Polarized Structures in the Interstellar Medium near the South Galactic Pole
- Hindson et al 2016: A Large-Scale, Low-Frequency Murchison Widefield Array Survey of Galactic H ii Regions between $260 < l < 340$
- Wayth et al. 2015: GLEAM: The GaLactic and Extragalactic All-Sky MWA Survey

GLEAM Data



- Images
 - gleam-vo.icrar.org or SkyView
 - 8-MHz sub-bands from 72 – 231 MHz
 - Wideband 30 – 60 MHz images
- Catalogue
 - 307,455 sources
 - ~25mJy/beam flux limit
 - 20 flux densities
 - Spectral indices for ~80% of sources
- For the public
 - GLEAM on Google Play
 - gleamoscope.icrar.org

Red = 72 – 103 MHz
Green = 103 – 134 MHz
Blue = 139 – 170 MHz



GLEAM Extragalactic Catalogue

307,455 sources

21 frequency measurements
(1 master, 20 sub-bands)

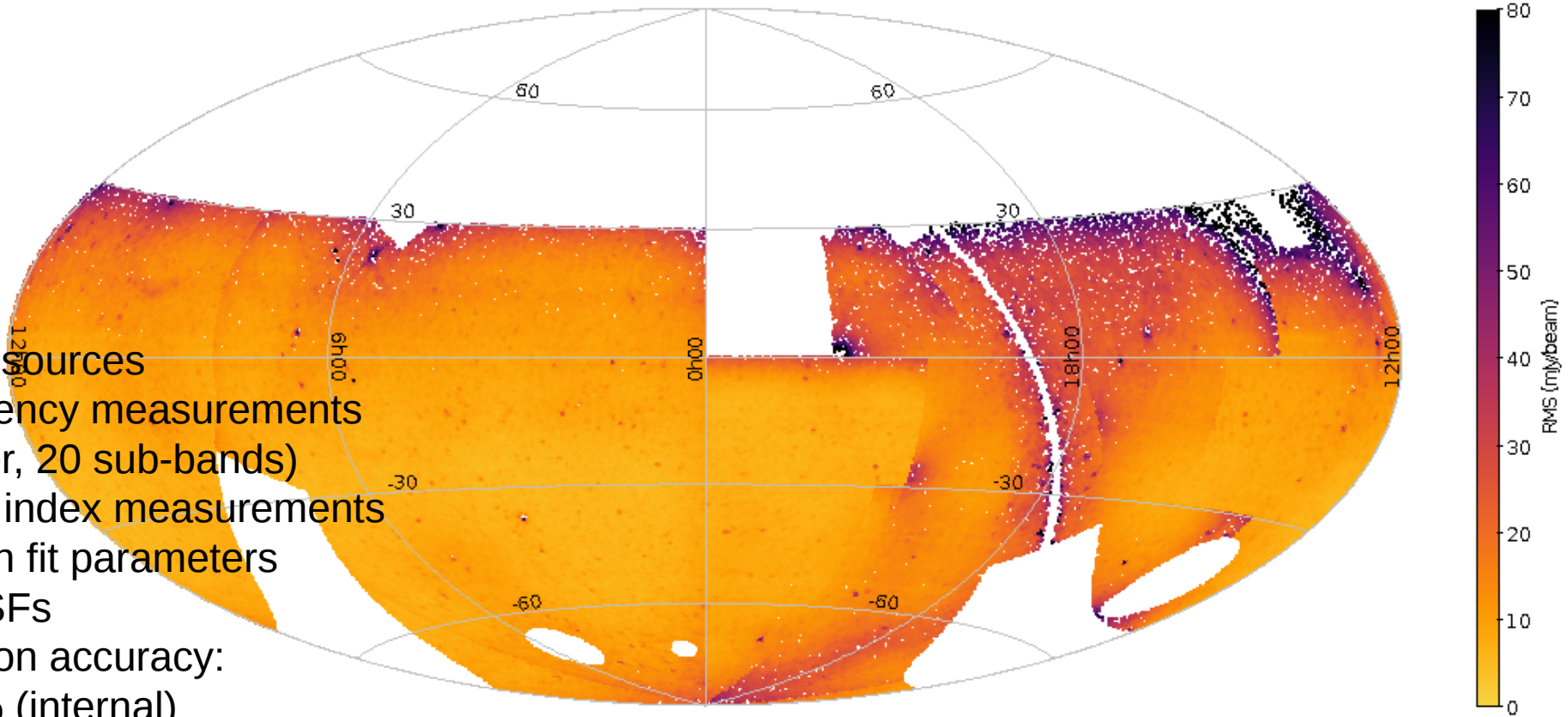
Spectral index measurements

Gaussian fit parameters

Local PSFs

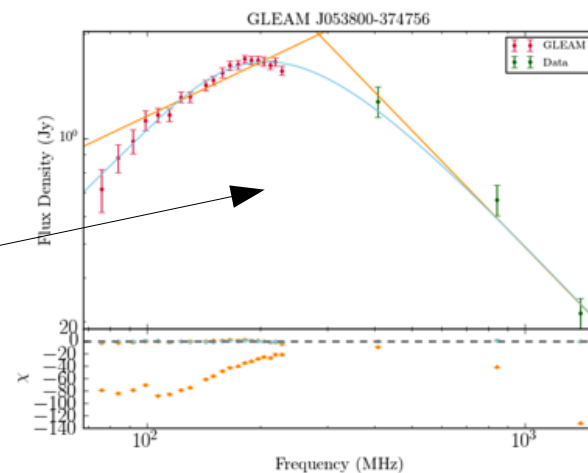
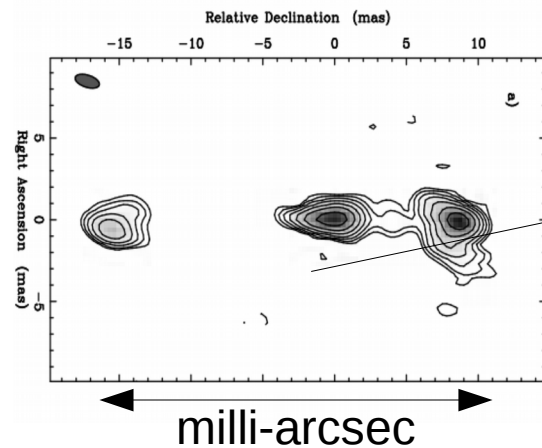
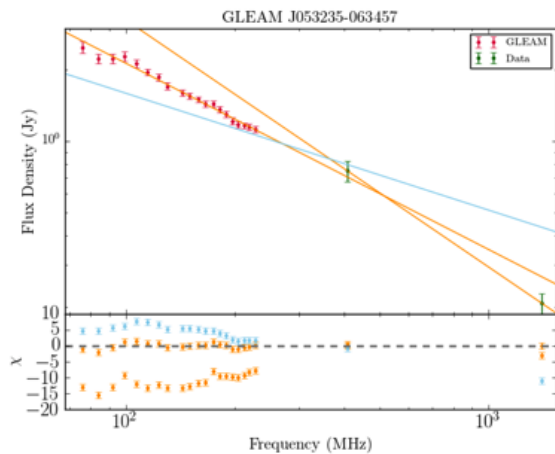
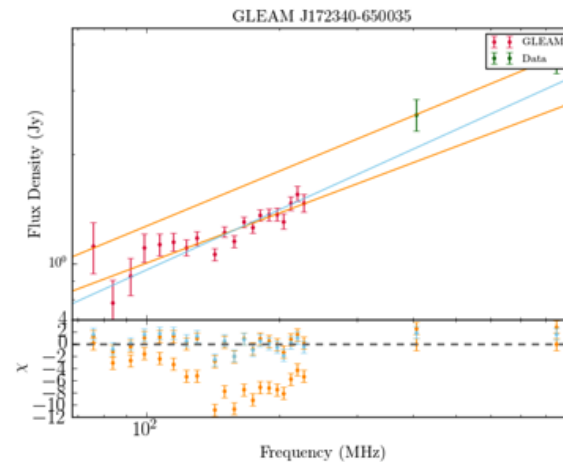
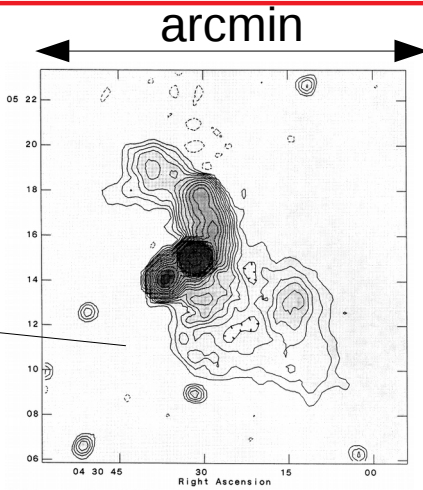
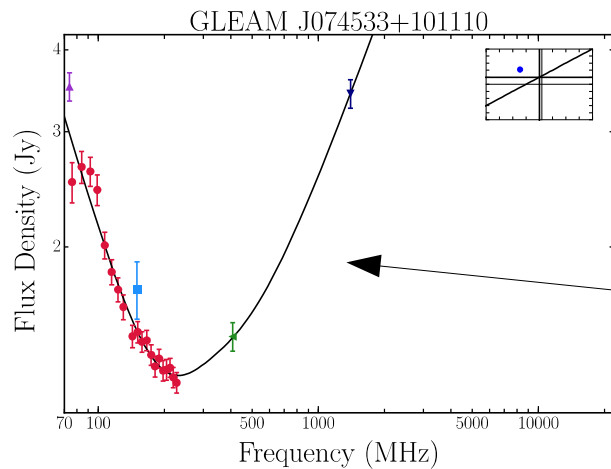
Calibration accuracy:

- 2—3% (internal)
- 8—13 % (external)



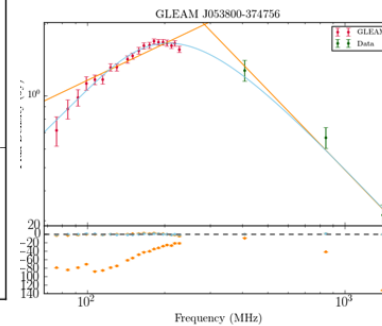
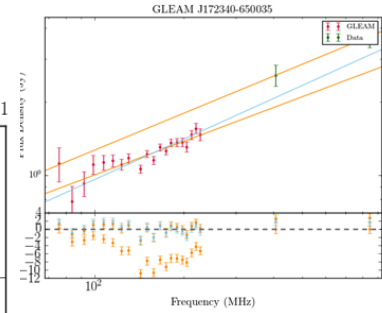
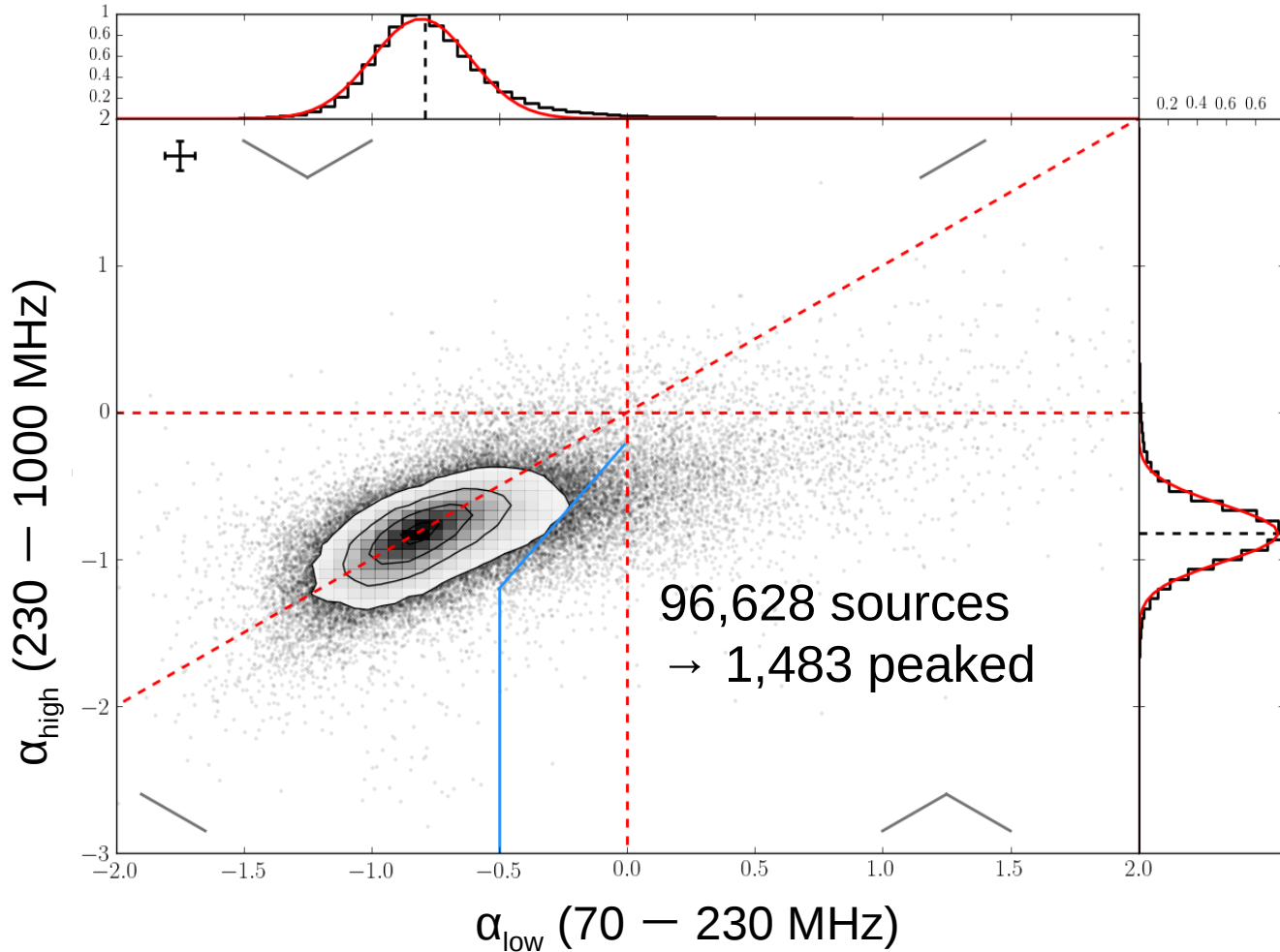
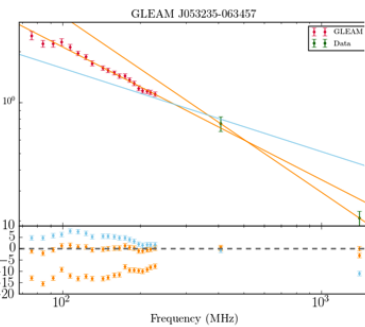
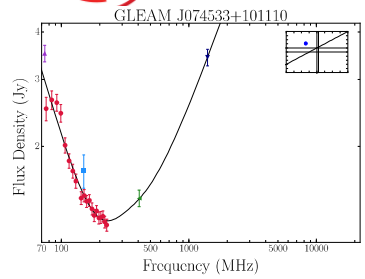
Hurley-Walker et al. 2017, 2019

Different sources, different spectra





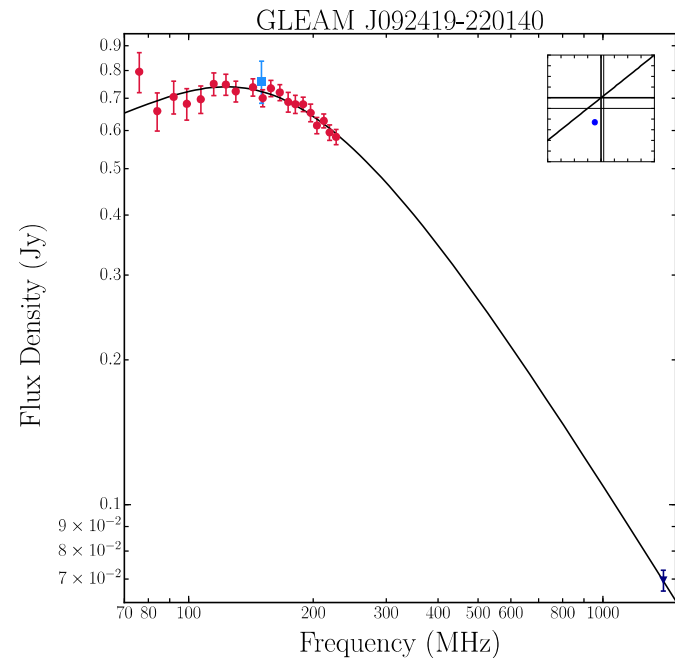
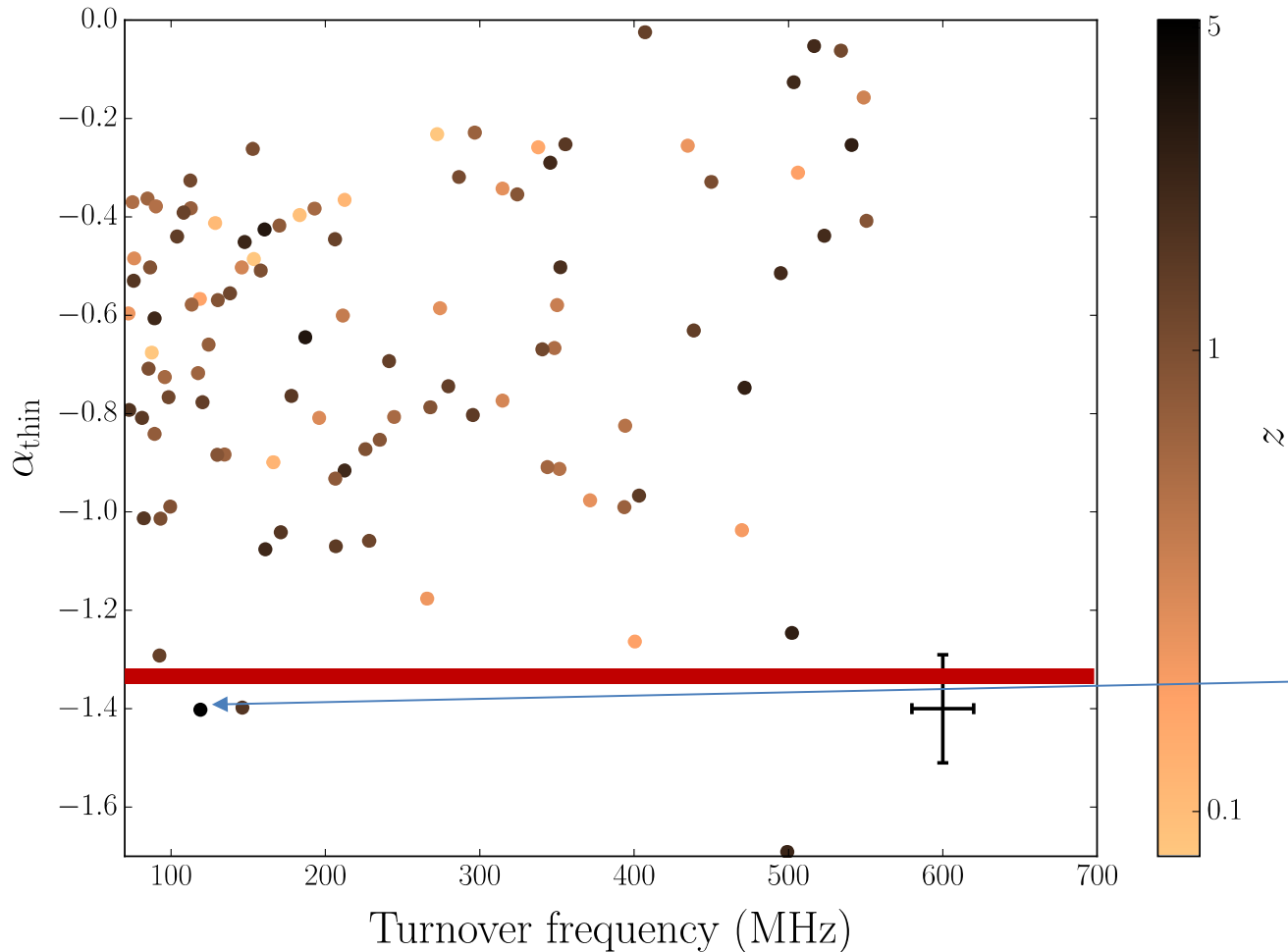
Colour-colour diagram



Callingham et al. (2017)



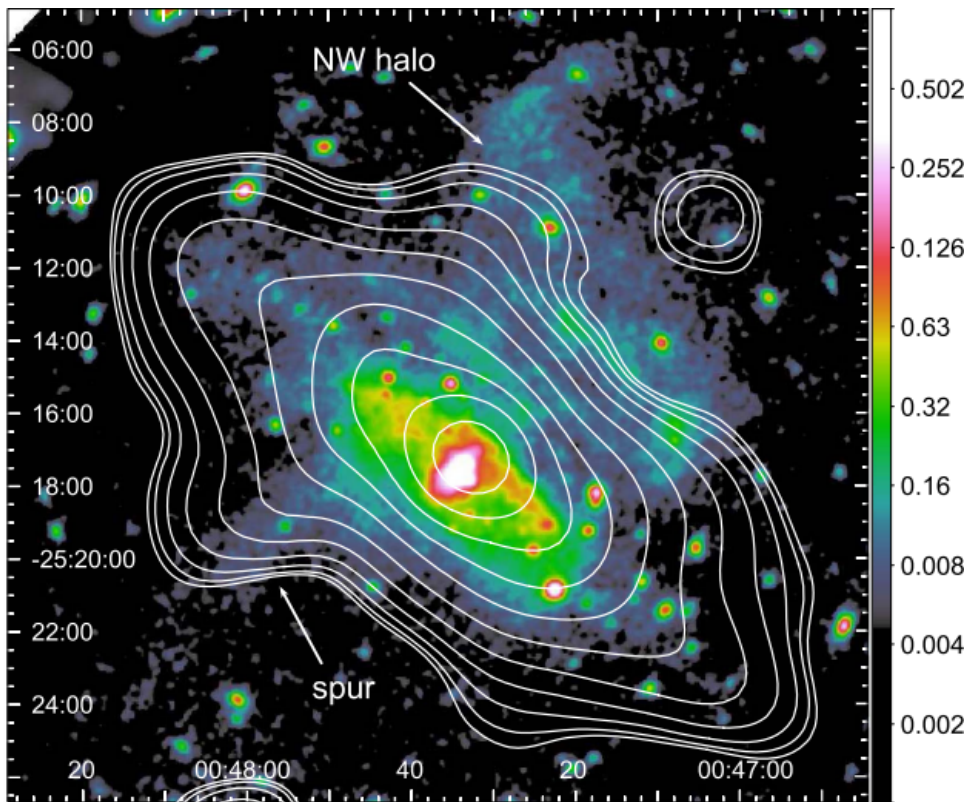
High-Redshift Universe



TN J0924-2201
 $z = 5$

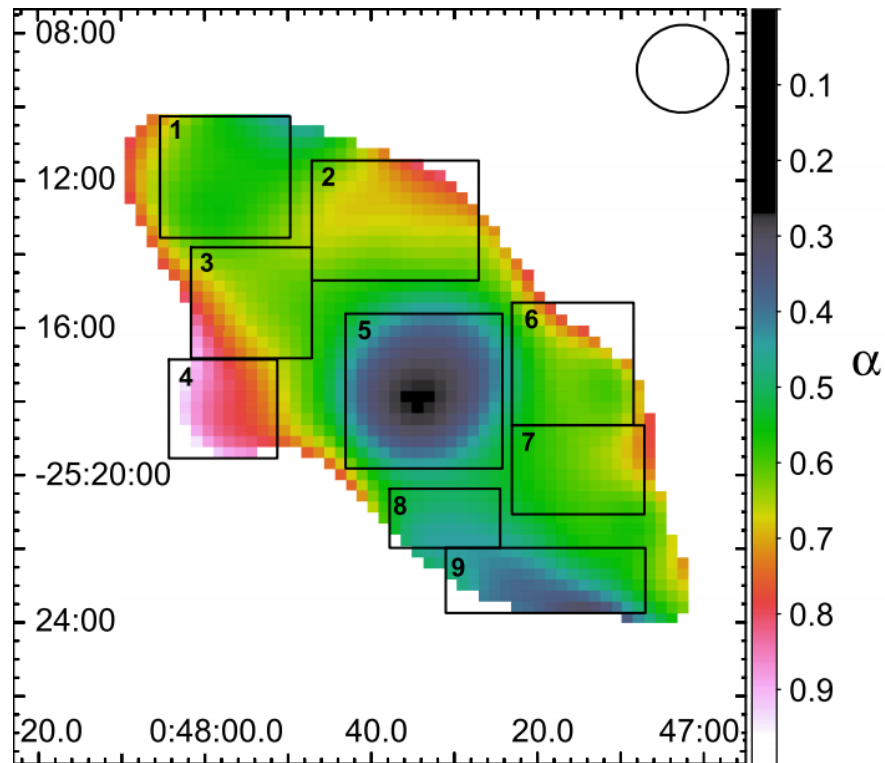
Callingham et al. (2017)

Local starforming galaxies



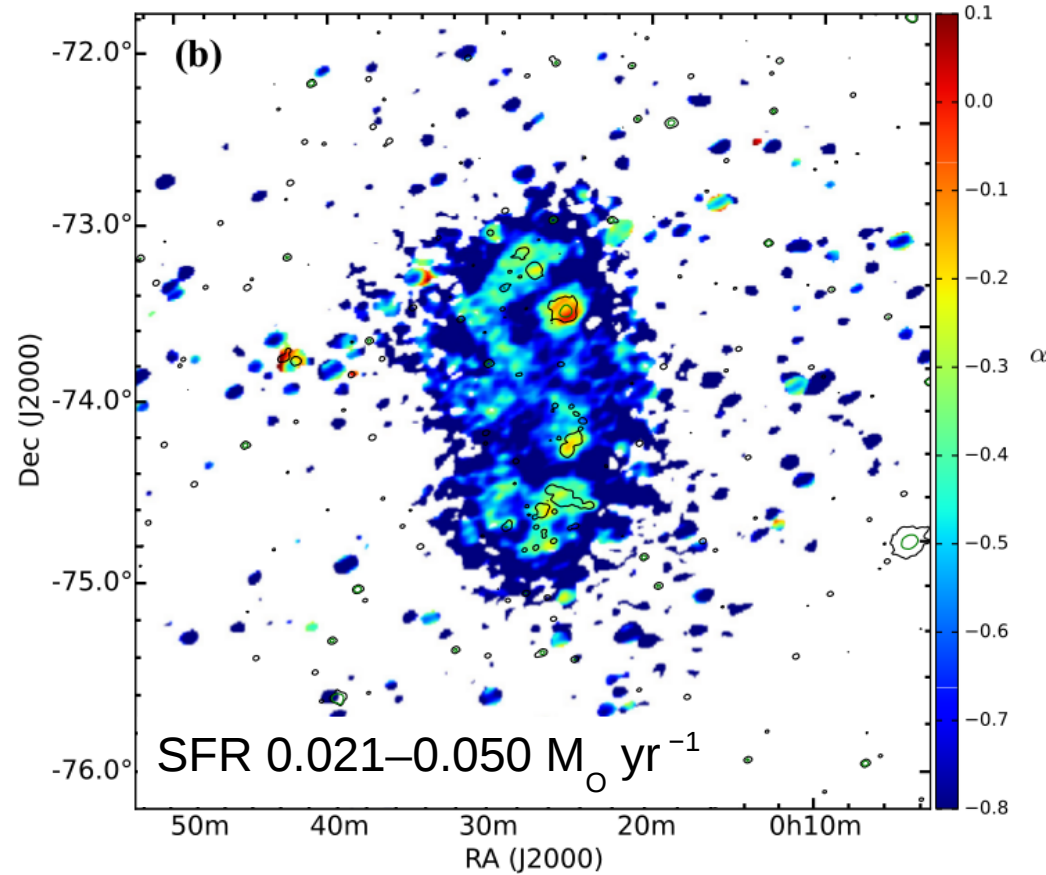
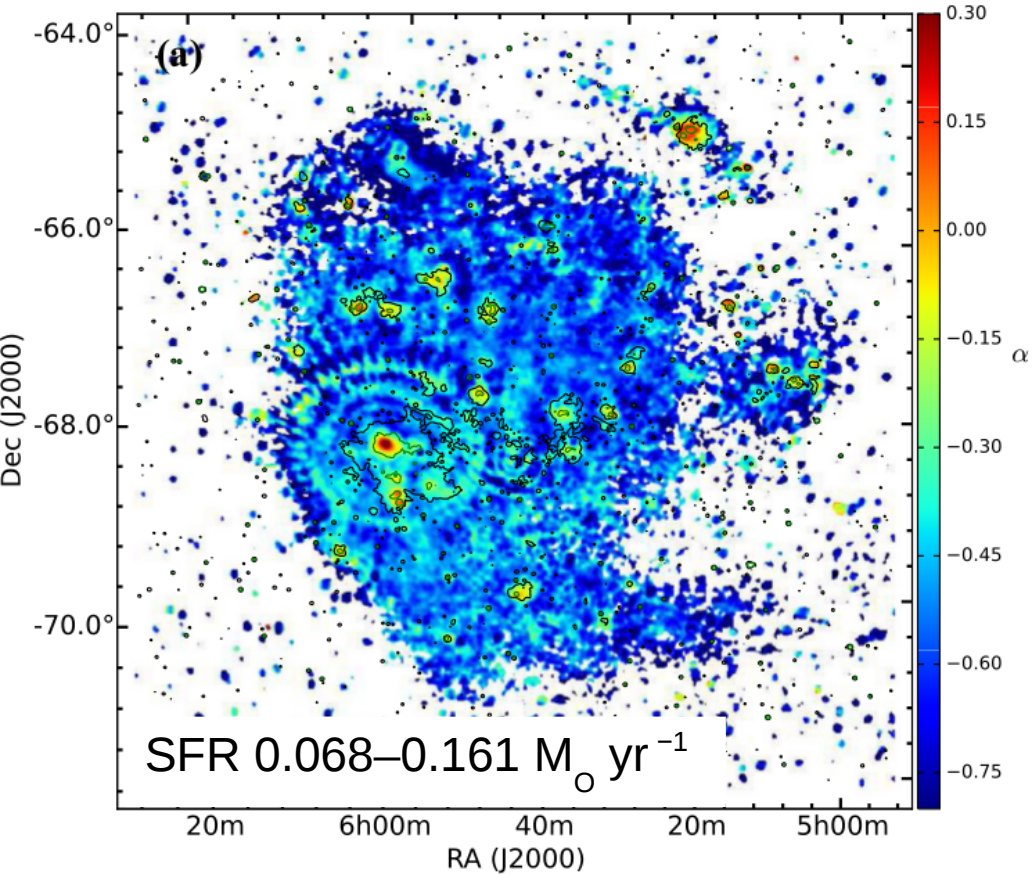
Right ascension (J2000)

GLEAM contours over X-ray emission



Kapinska et al. (2017): SED and radio halo of NGC 253

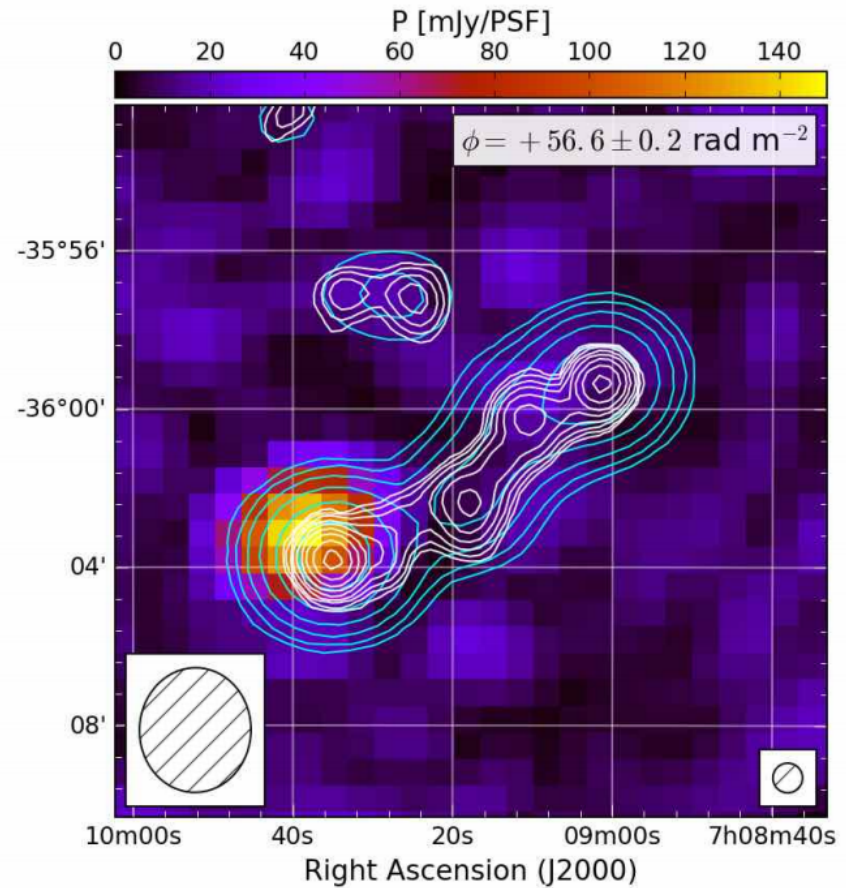
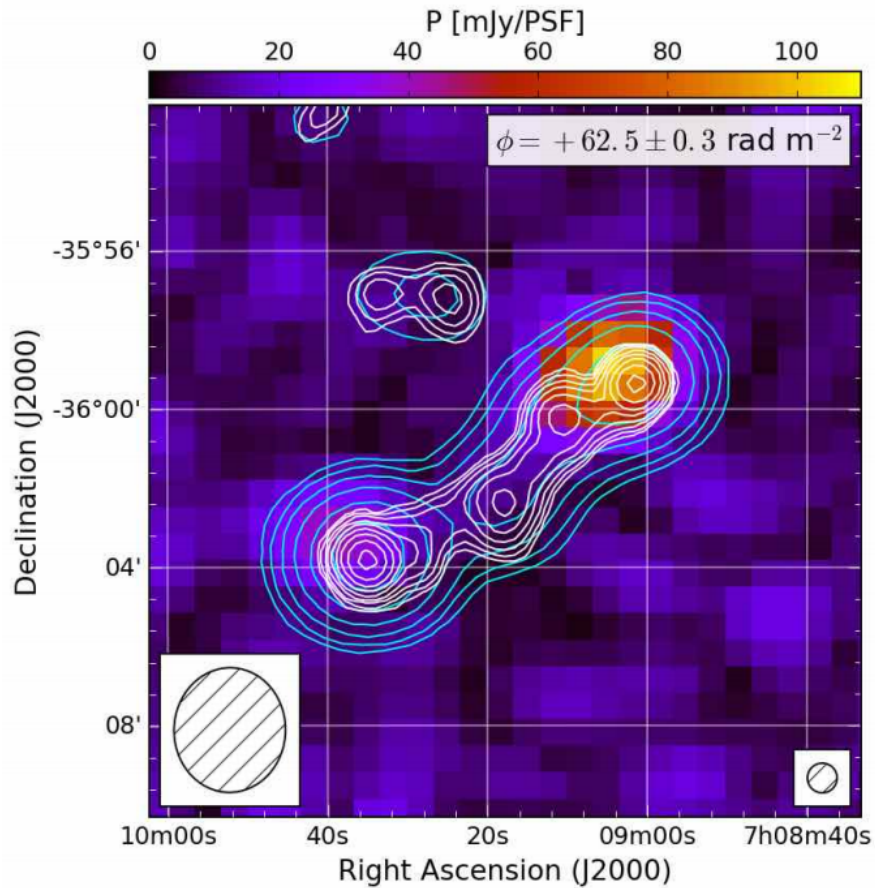
Magellanic Clouds



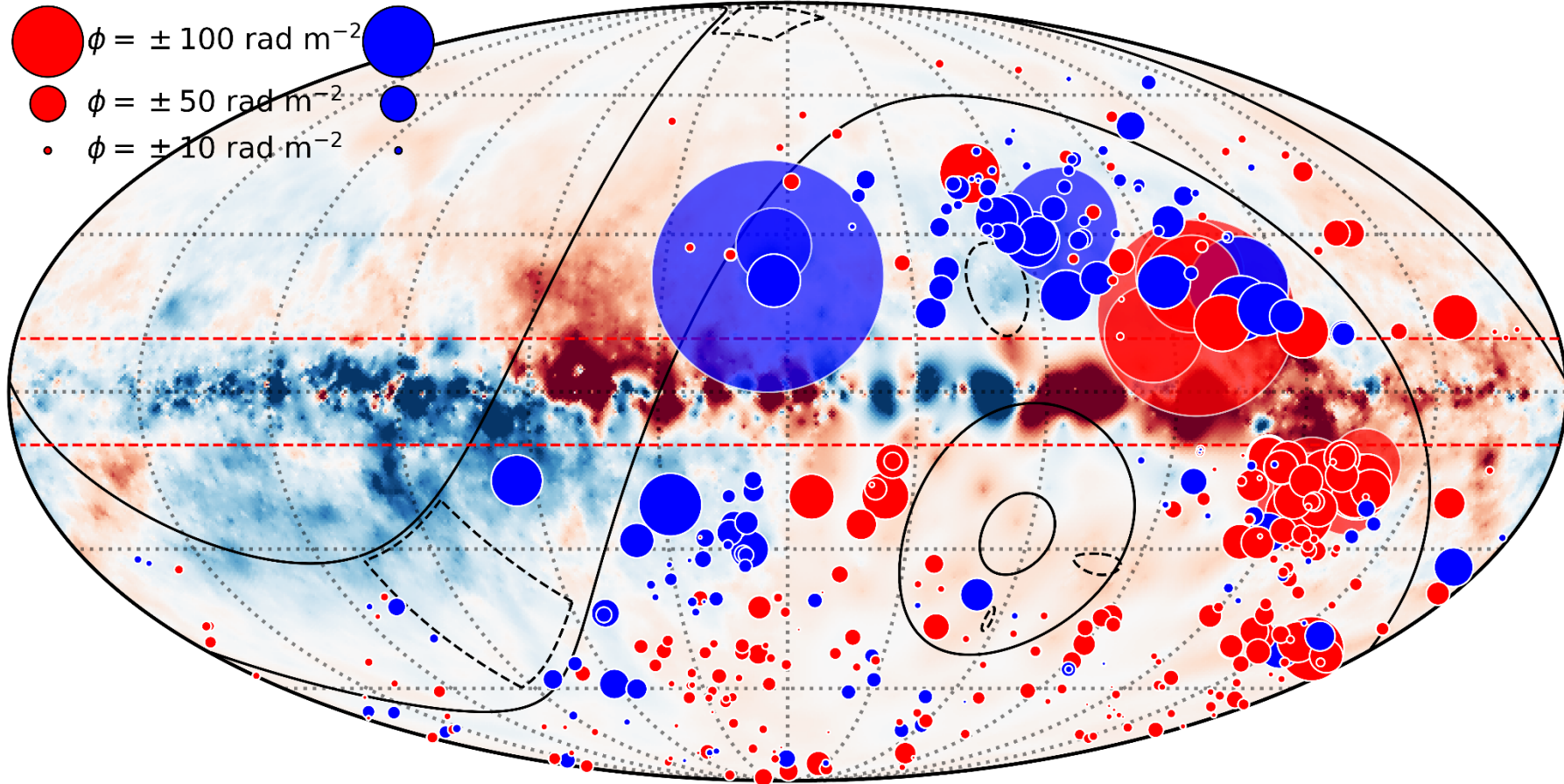
Star formation rate from 150 MHz–H α relation (Brown et al. 2017)

For et al. (2018): A radio continuum study of the MCs

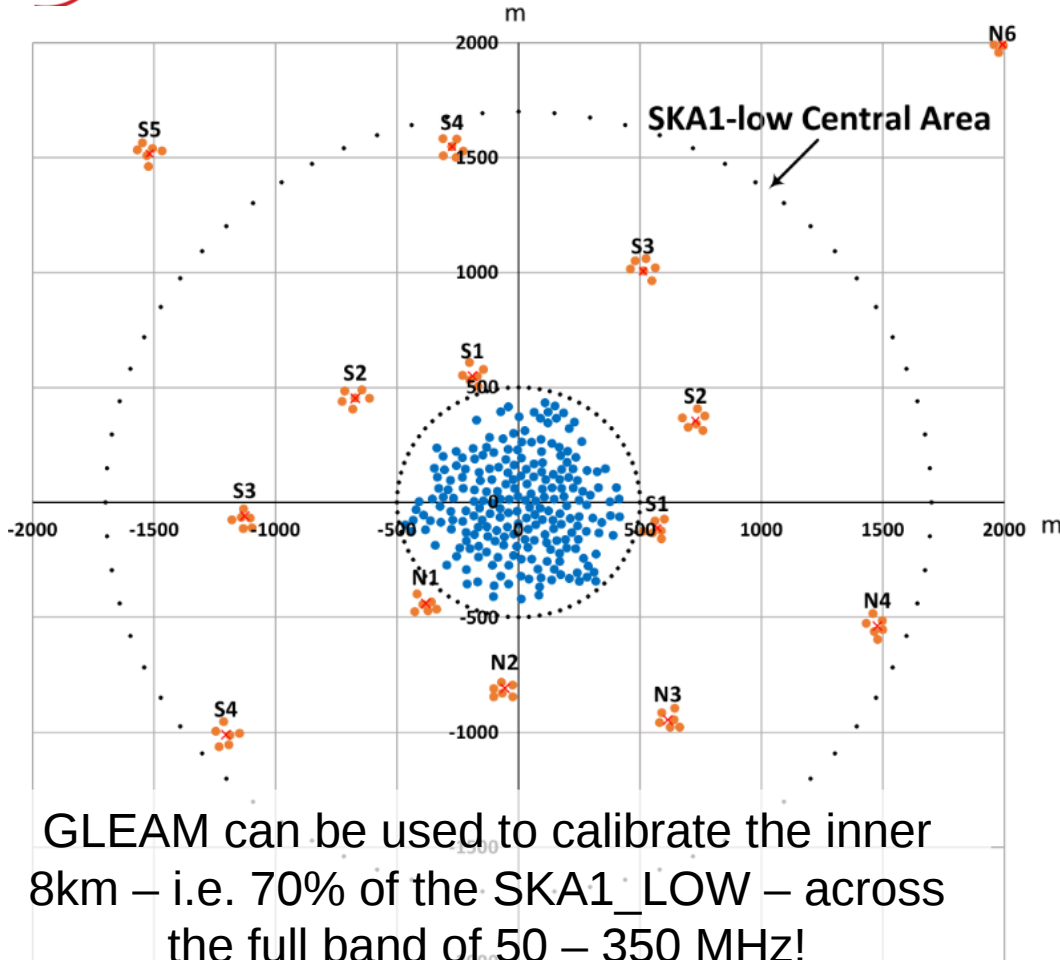
Polarised GLEAM Survey (POGS)



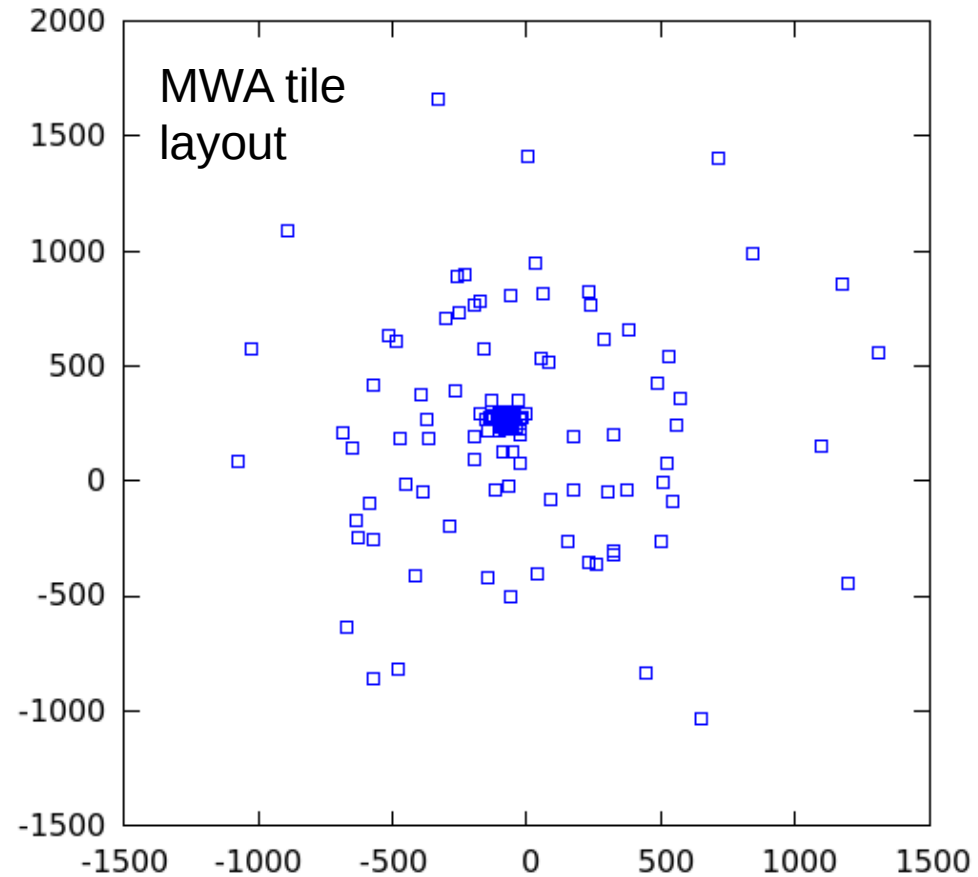
Polarised GLEAM Survey (POGS)



SKA_Low-ready sky model



GLEAM can be used to calibrate the inner 8km – i.e. 70% of the SKA1_LOW – across the full band of 50 – 350 MHz!



GLEAM: Galactic Plane Imaging

BEFORE

Access to wider areas via improved peeling

Better deconvolution of large-scale structure (Multiscale WSClean)

Removed image artefacts

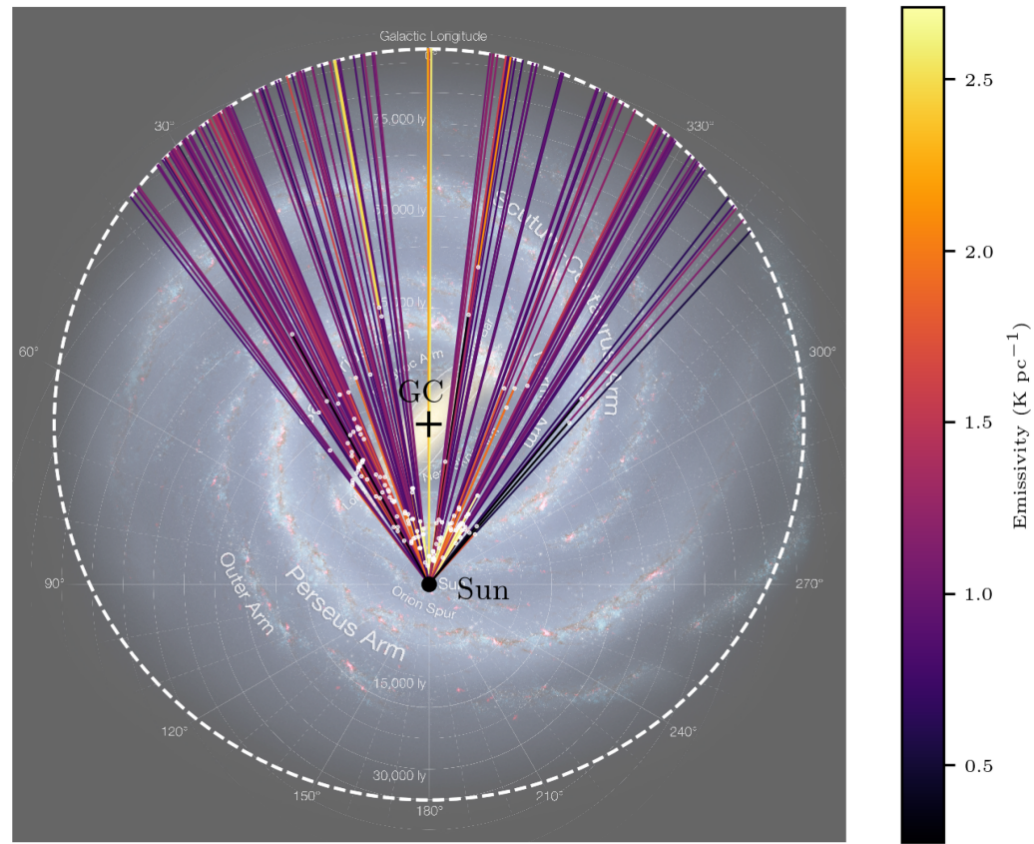
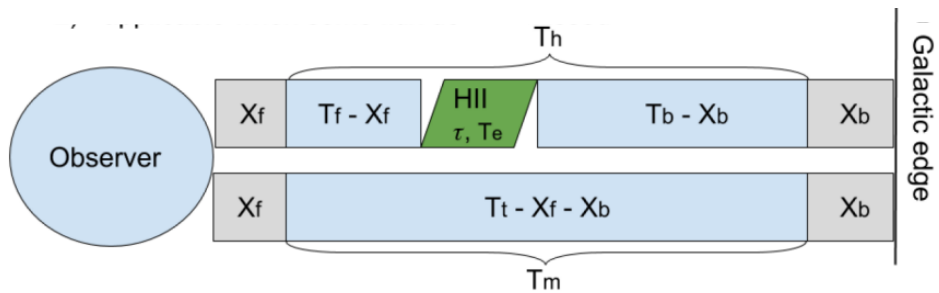
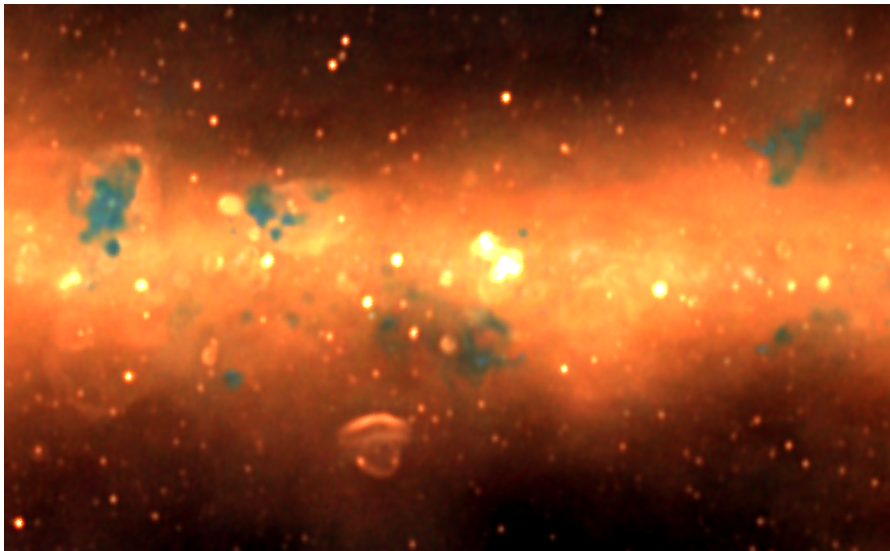
Accurate flux calibration

AFTER

RMS 10 – 20
mJy/beam @ 200MHz

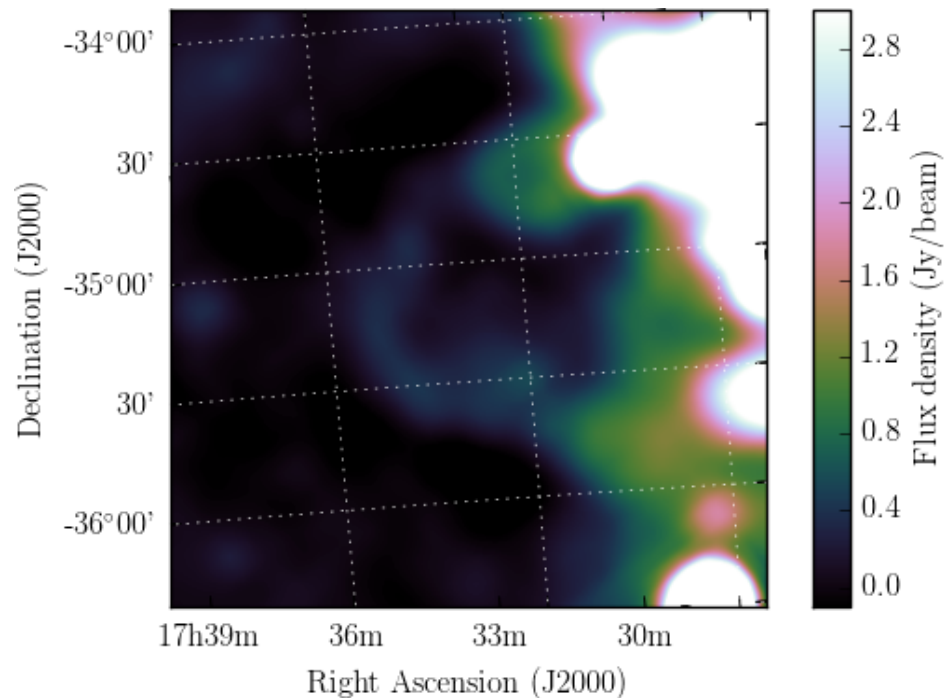
Hurley-Walker et al. (submitted): GLEAM GP across $345^\circ < l < 60^\circ$, $180^\circ < l < 240^\circ$

Cosmic Ray Tomography



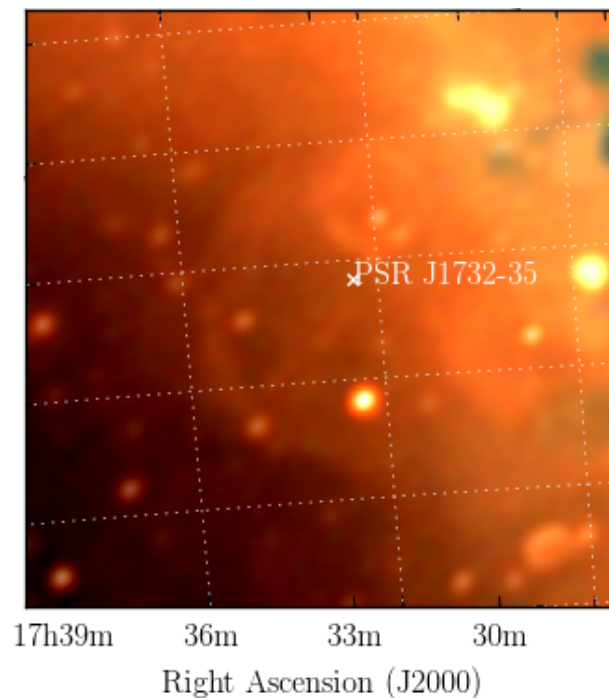
Su et al. 2018: Galactic synchrotron distribution derived from 152 H II region absorption features in the full GLEAM survey

Known SNR candidates: G353.3-1.1



Parke, 2.4 GHz (Duncan+95)

$\alpha = -0.85$, $S_{200\text{MHz}} \sim 100\text{Jy}$

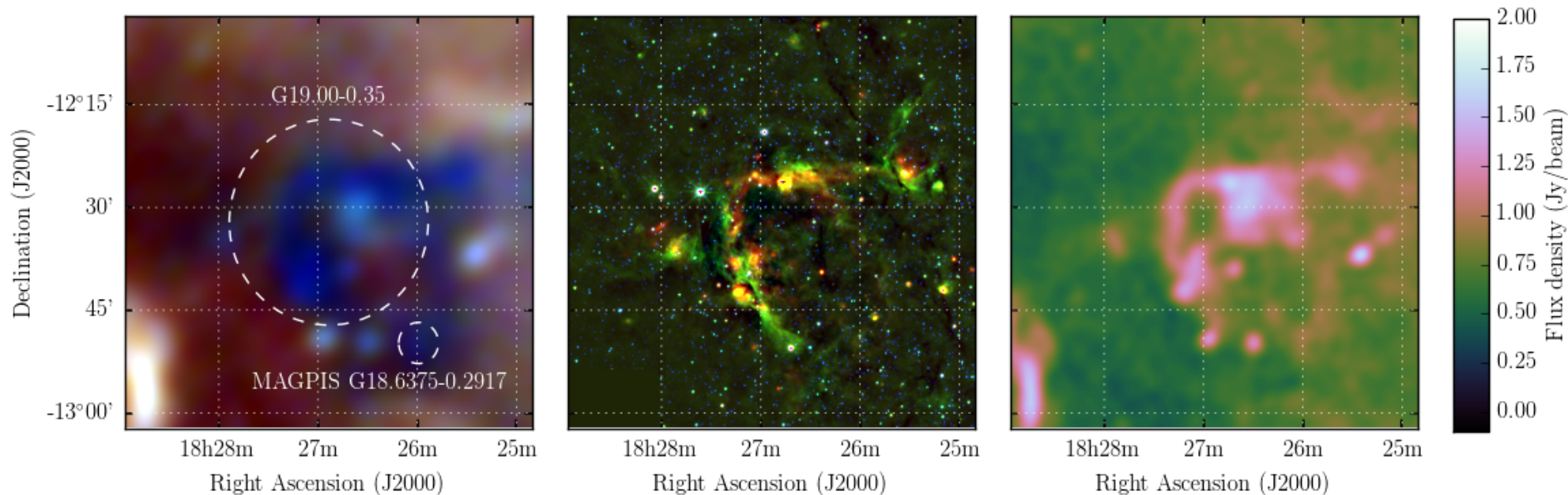


GLEAM GP RGB

PSR \rightarrow SNR diameter = 71pc
 \rightarrow SNR age > 130,000 yr

Hurley-Walker et al. (submitted): Follow-up of SNR candidates with GLEAM

Known SNR candidates: G19.00-0.35



GLEAM RGB (88/118/154)MHz

WISE RGB (8/12/22) μ m

GLEAM 200MHz

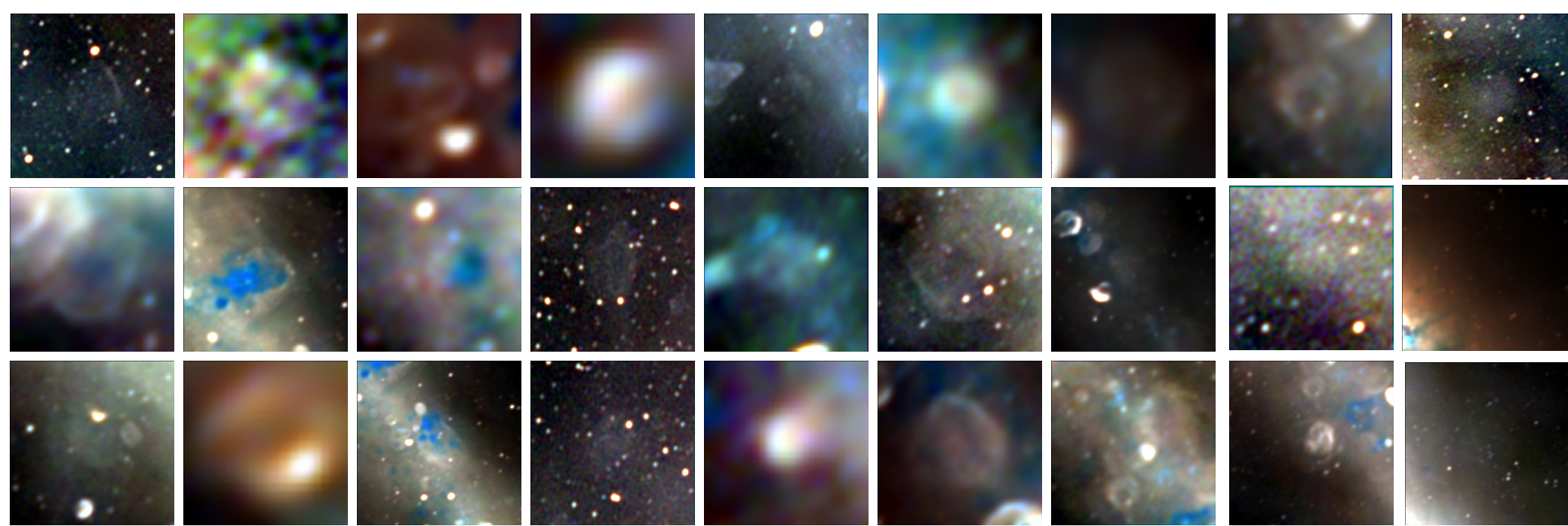
Proposed by Gosachinski 1985

Clearly a (complex of) Hii region(s)!

Hurley-Walker et al. (submitted): Follow-up of SNR candidates with GLEAM



27 new radio supernova remnants

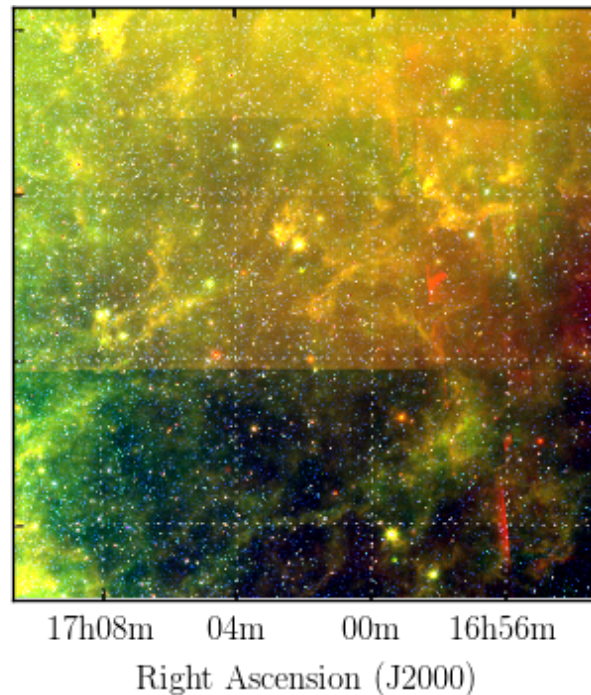
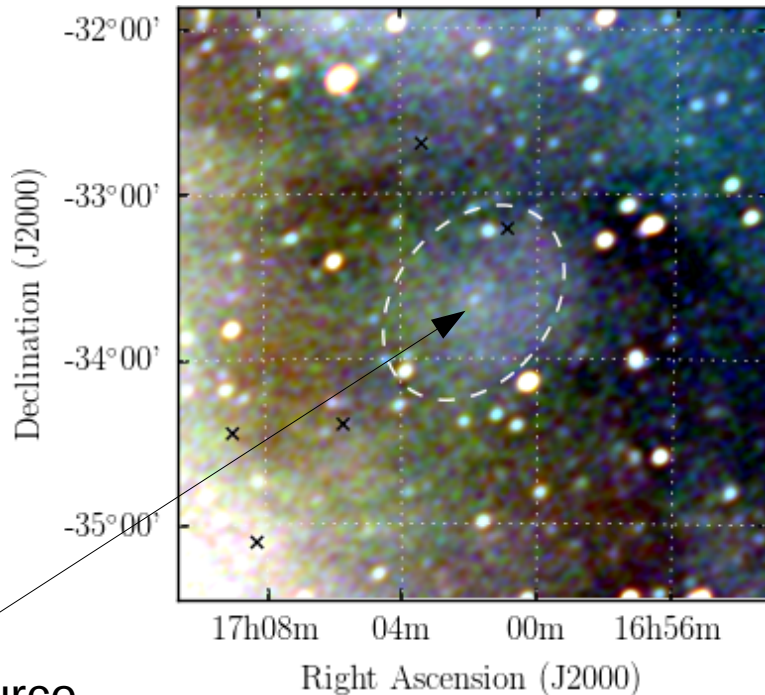


Hurley-Walker et al. (submitted): New candidate SNRs from GLEAM



New pulsars?

G 350.8+5.1

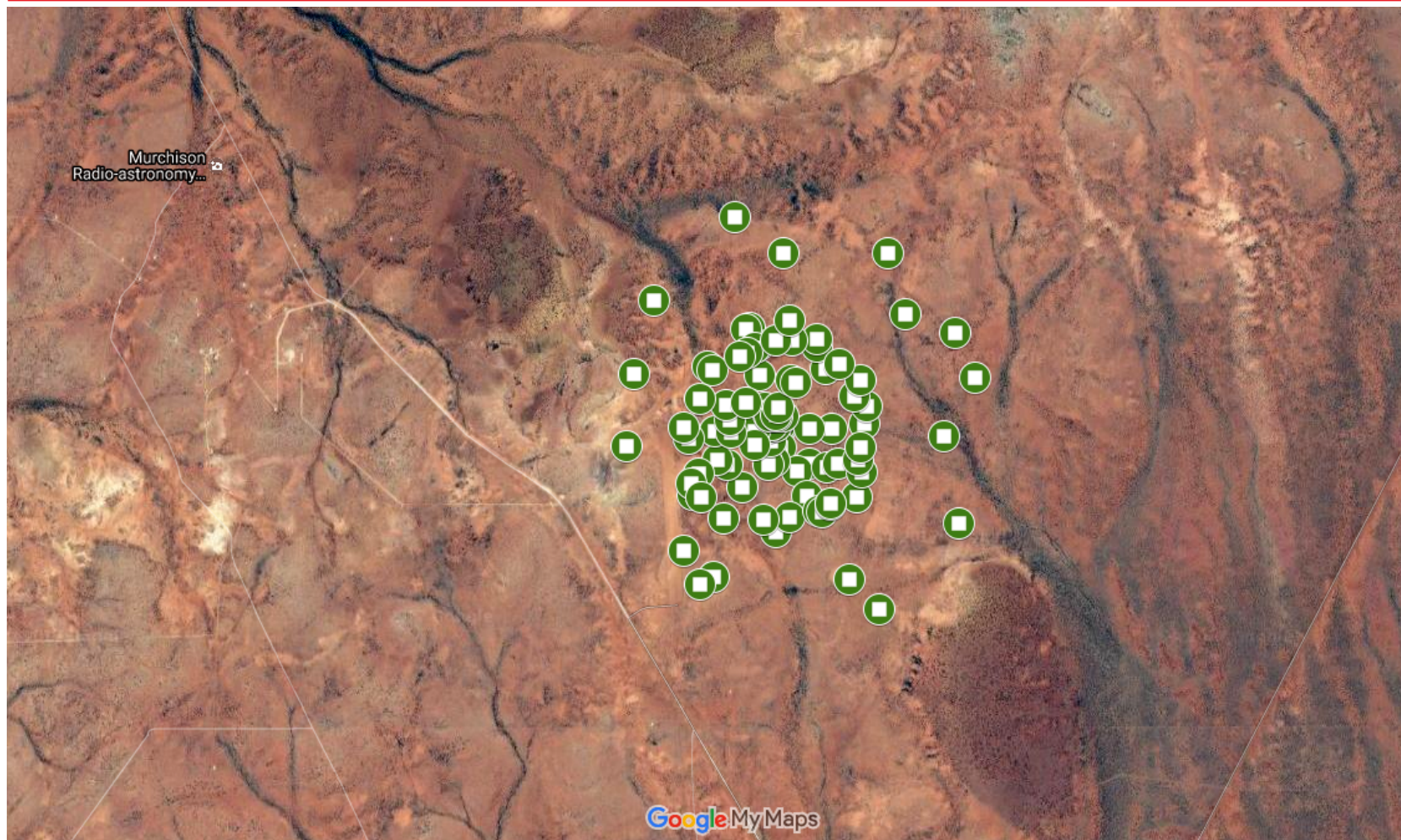


Compact source
 $\alpha = -1.4$
Pulsar?

GLEAM RGB (88/118/154)MHz WISE RGB (8/12/22)um

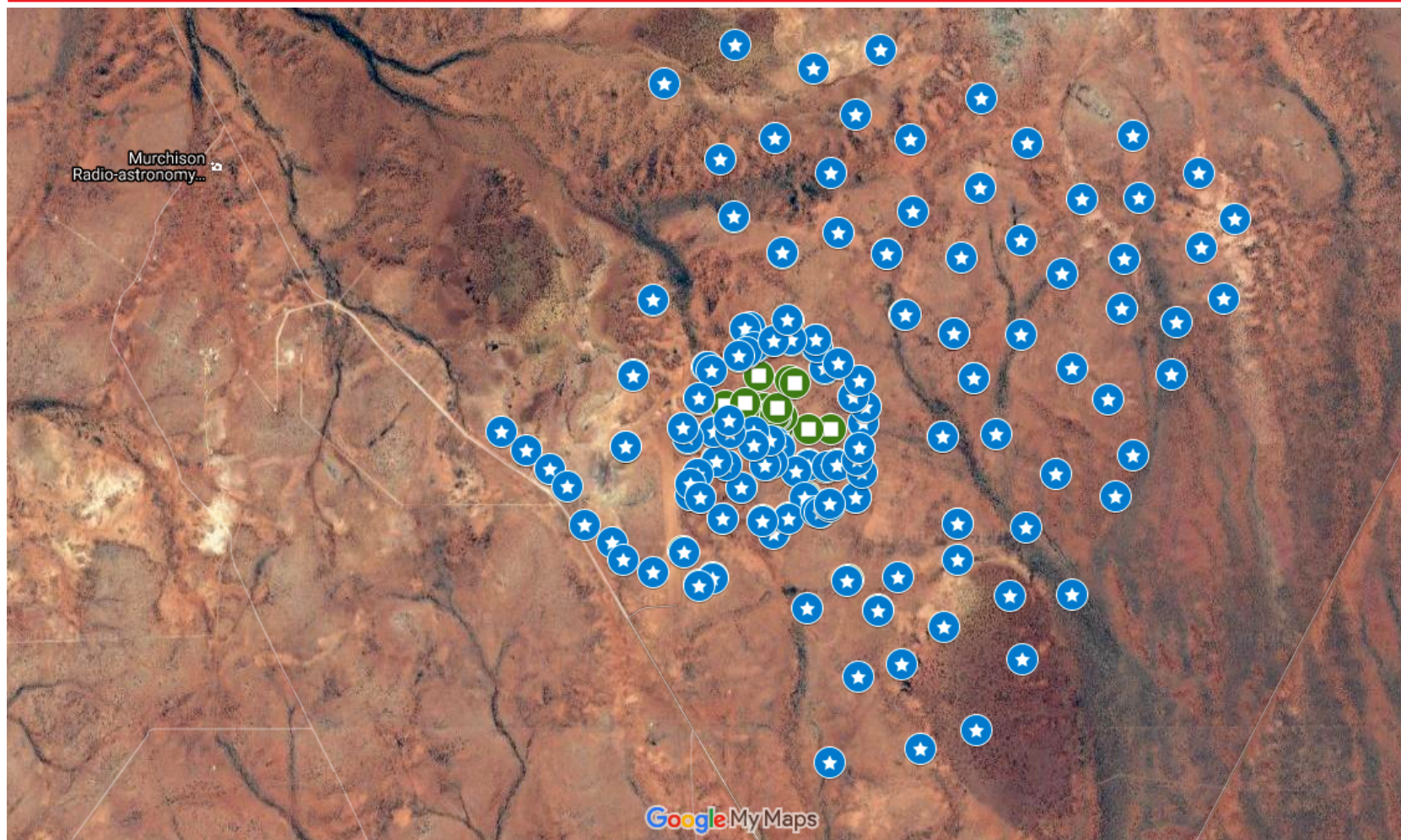


Surveys with the extended MWA



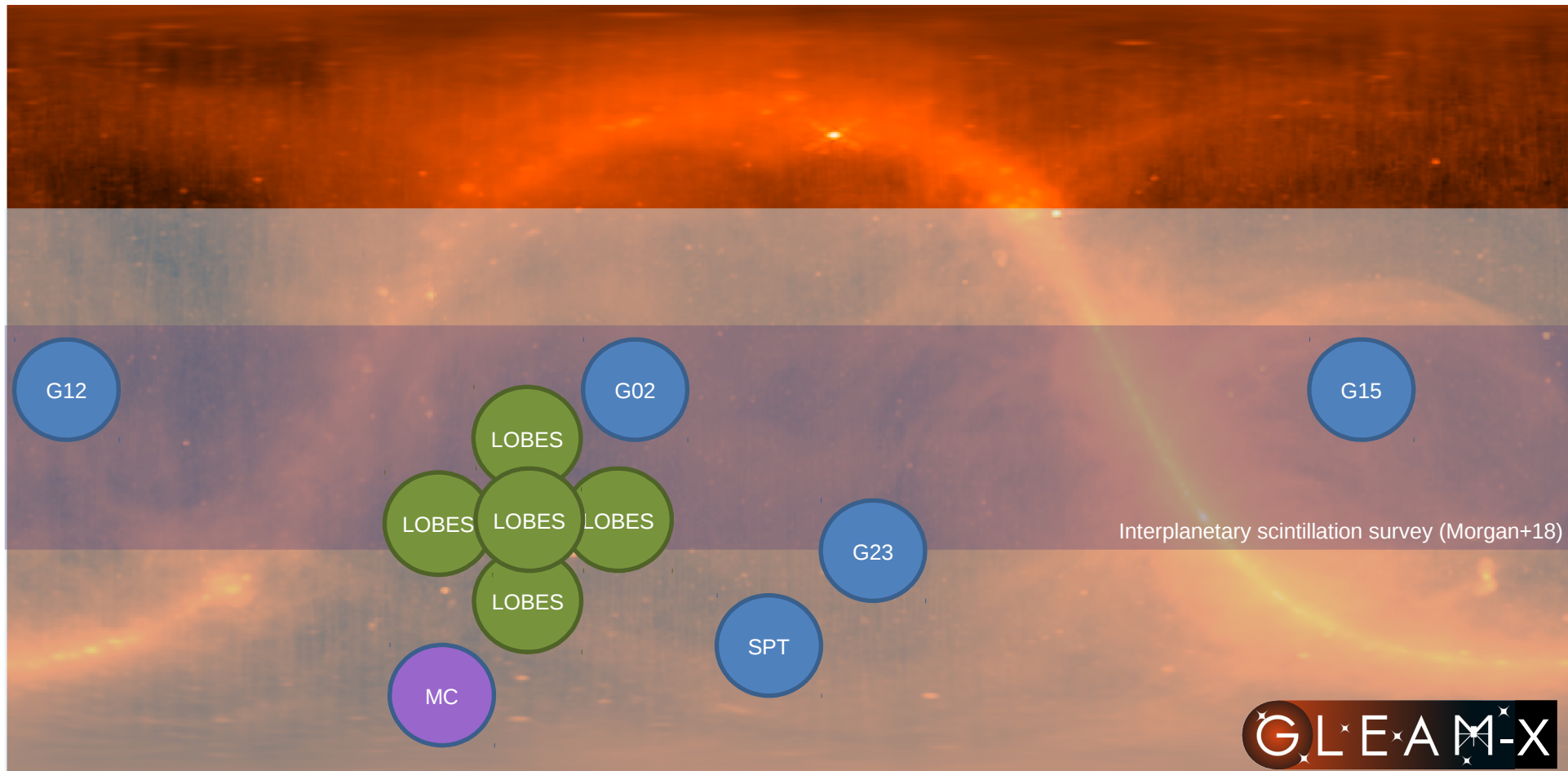


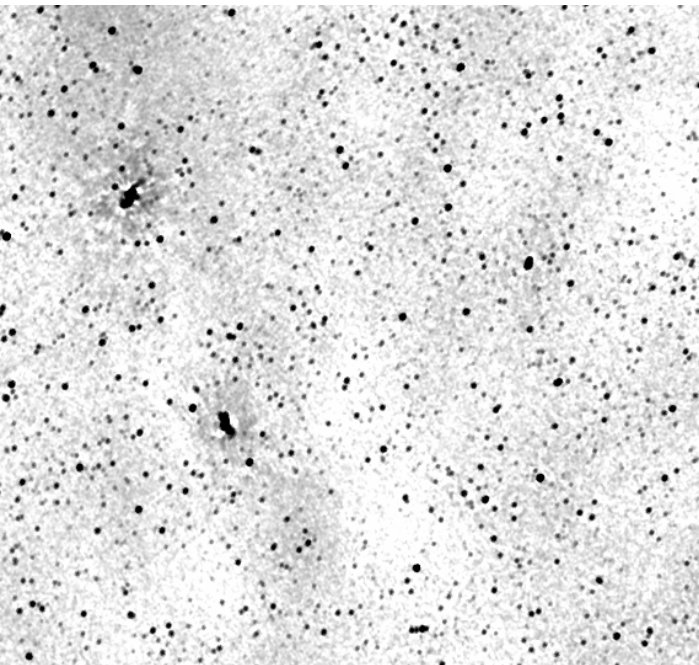
Surveys with the extended MWA



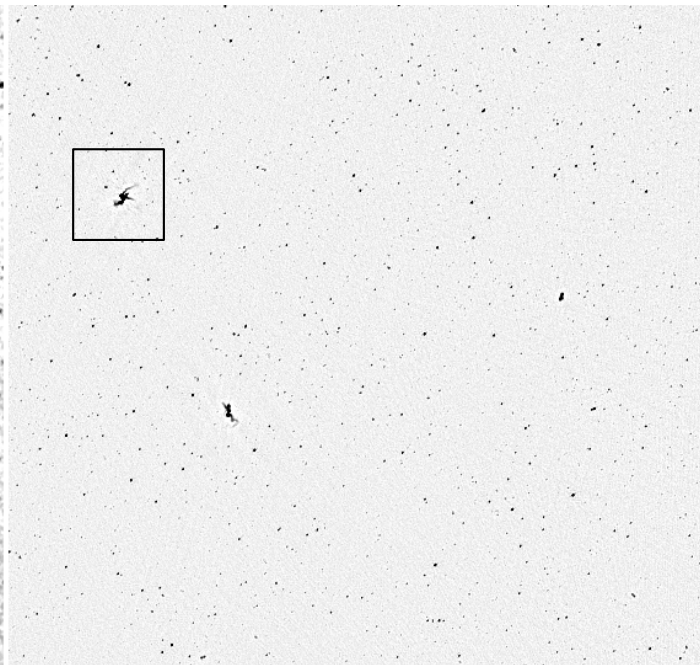


Surveys with the extended MWA





GLEAM 170 – 231 MHz
RMS: ~ 7 mJy/beam
Resolution: $2'$



GLEAM-X 170 – 231 MHz
RMS: ~ 2 mJy/beam
Resolution: $1'$

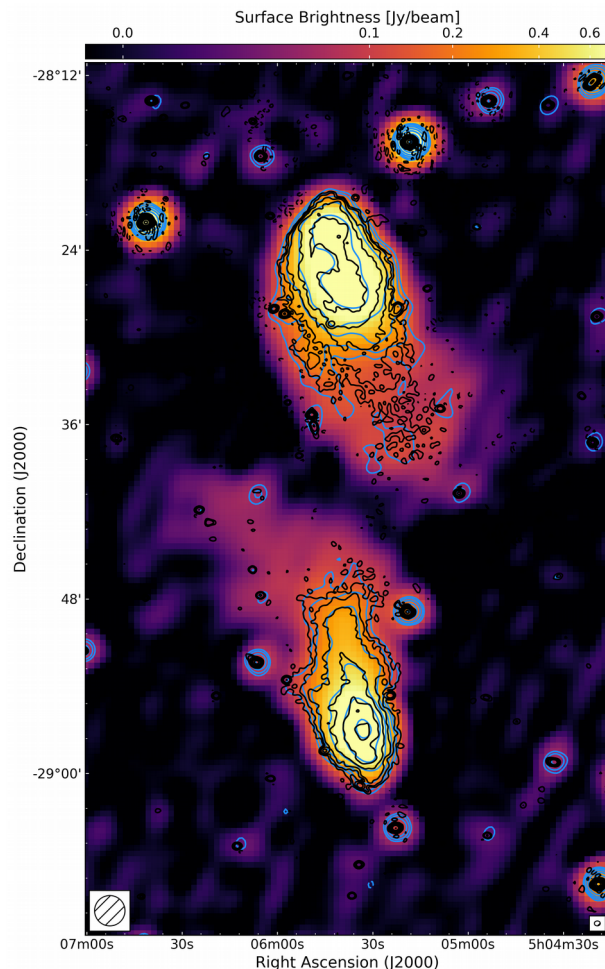


GLEAM-X
Red = 72 – 103 MHz
Green = 103 – 134 MHz
Blue = 139 – 170 MHz



Complementarity with Rapid ASKAP Continuum Survey

- Combine GLEAM-X and RACS for:
 - Cluster & radio galaxy morphologies including diffuse emission
 - Wideband SEDs for >1M radio sources from 72MHz – 1.4GHz
 - Precision RM measurements of radio galaxy lobes
 - Galactic astrophysics
 - ... and more!
- RACS observations in progress
- Overlap and collaboration between teams



ESO 422

- Colourscale: GLEAM-X 88MHz
- Black contours: ASKAP RACS

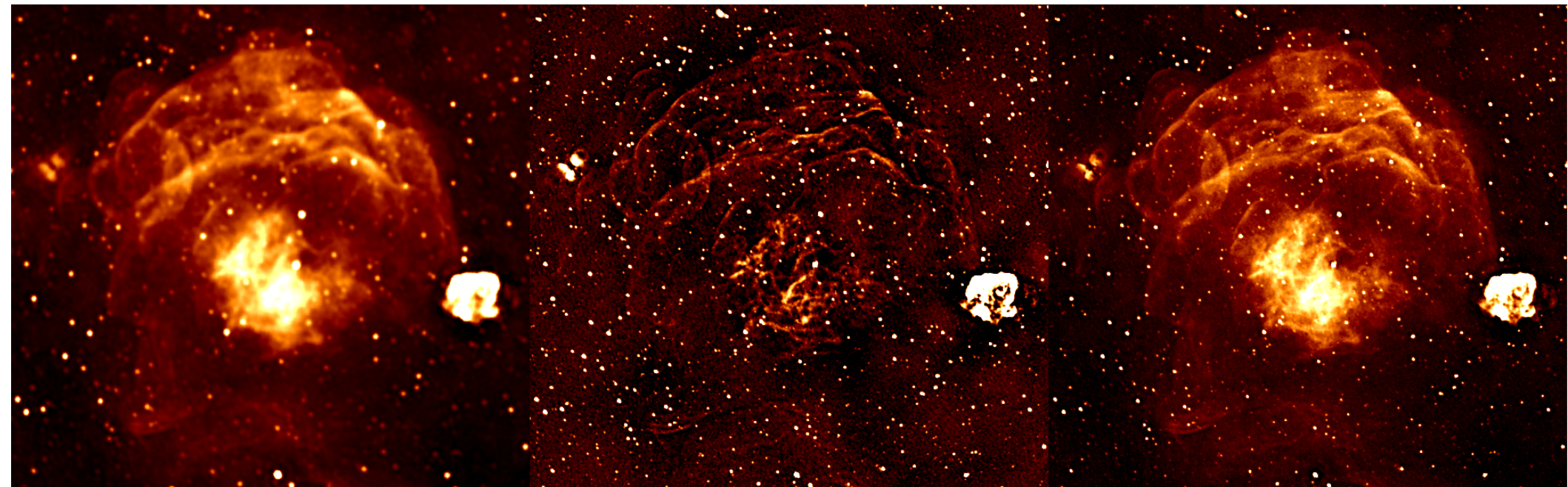
Image credit:
Stefan Duschene (ICRAR)
Susannah Keel (CSIRO)
Chris Riseley (CSIRO)

ASKAP, MRO





Combining GLEAM and GLEAM-X



GLEAM 72 – 103 MHz
Resolution: 2'

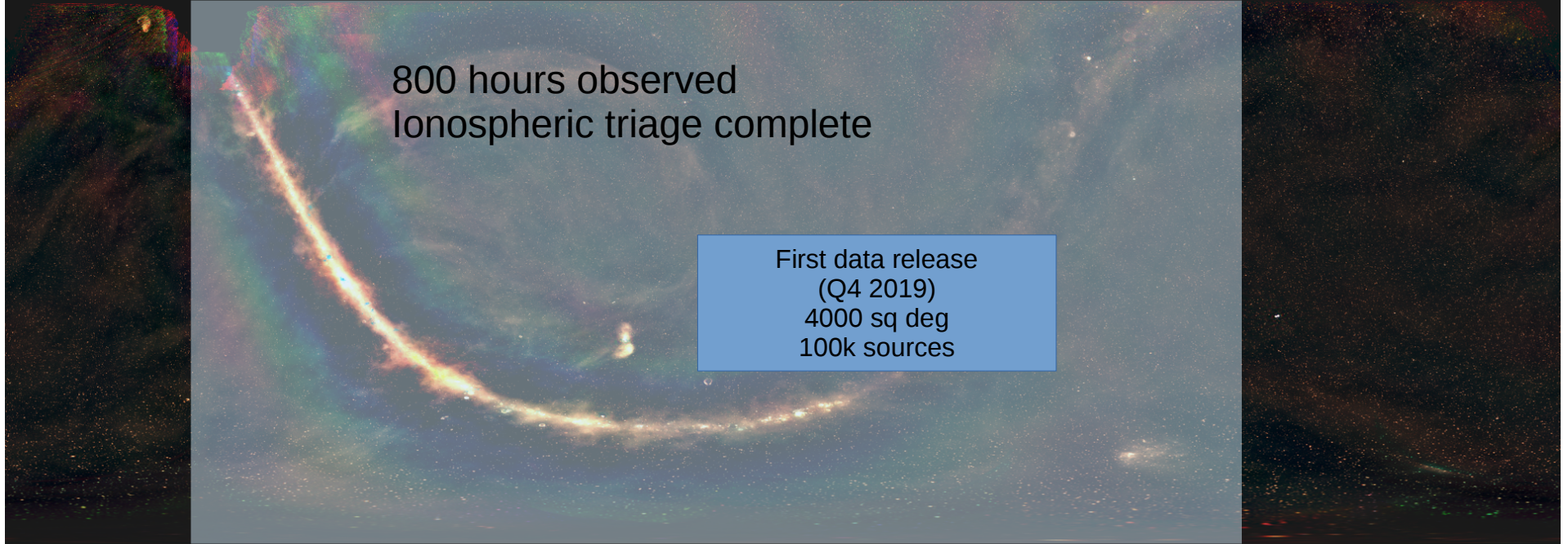
MWA Phase II 72 – 103 MHz
Resolution: 1'
Credit: Chenoa Tremblay (CSIRO)

Feathered combination

Vital for studies of the Galactic Plane and other types of extended emission!



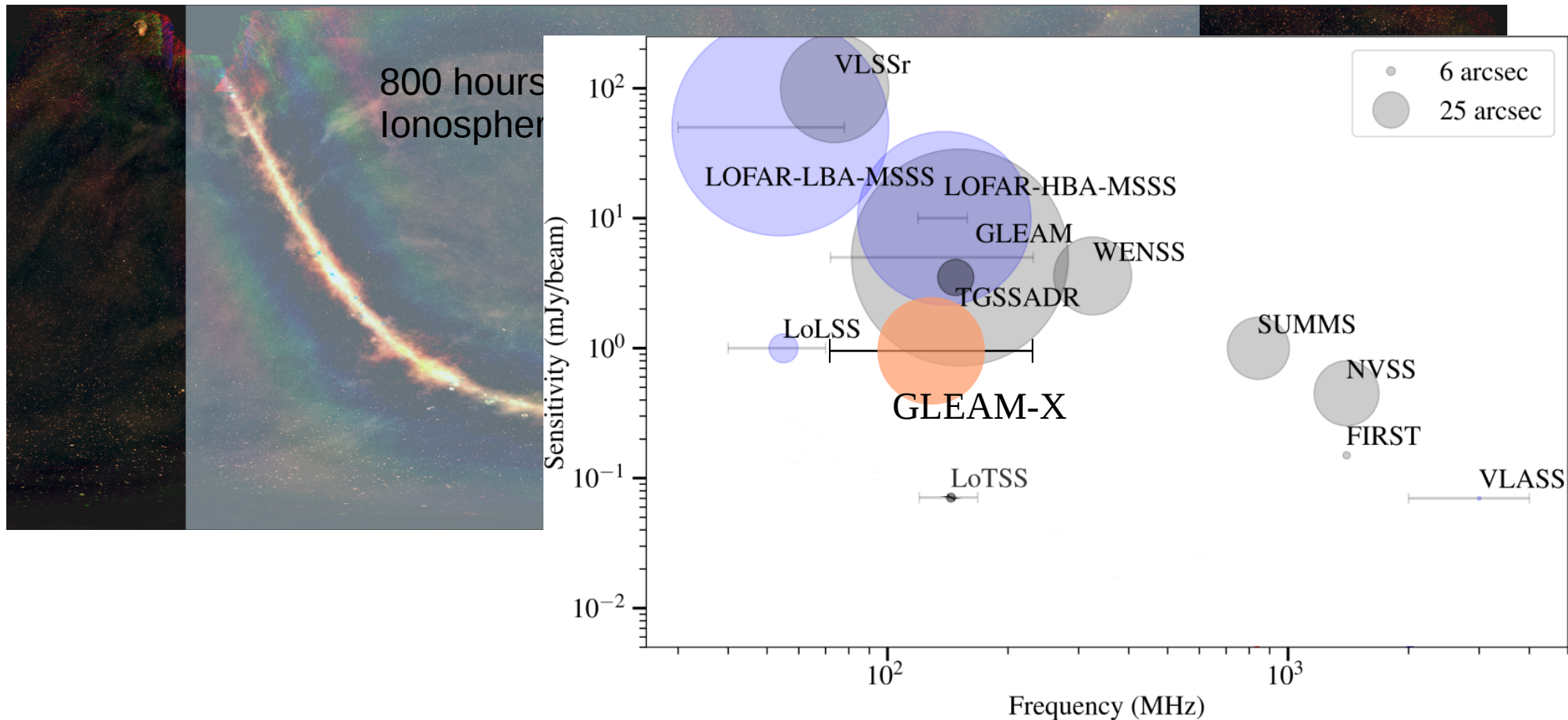
GLEAM-X Survey status



800 hours observed
Ionospheric triage complete

First data release
(Q4 2019)
4000 sq deg
100k sources

GLEAM-X Survey status





19th March 2019