MWA PROJECT MEETING JULY 2023

10 Years of Galactic & Extragalactic Astronomy

CHENOA TREMBLAY, PHD

BERKELEY SETI RESEARCH CENTER

SETI INSTITUTE

NRAO

Current GeG

How to interact with GeG:

- Quarterly telecons on the 4th Friday of the Month at +1:00 UTC.
- Slack Channel
- GeG Wiki
- “Celebration of Science” every 12-months

GeG Busy Day Dec 2014

Image Credit: Emil Lenc

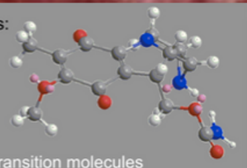
GeG Busy Day Dec 2014

COMPLEX MOLECULES AT LOW FREQUENCY

Chenoa Trembay & Andrew Walsh

Curtin University

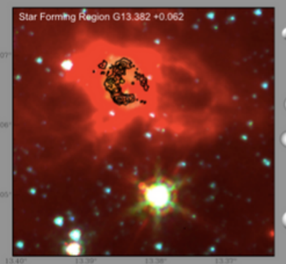
Rotation, Collisions & Vibrations: Oh My!

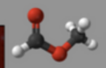


Low Frequency Science Drivers:

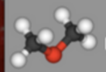
- Probe star formation to find transition molecules
- Low frequency molecules are not dust limited so probe deeper in molecular clouds
- Find simpler and low concentration molecules to map dense regions
- Find long chain molecules that have primary transitions at low frequencies

Hot Core Tracers: Elements that can be found at high and low frequencies.

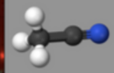




Methyl Formate



Dimethyl Ether



Acetonitrile

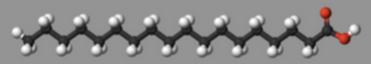
How do these form? The answers may be in these or simpler molecules at low frequencies (<300MHz)

Mercapto Radical (SH)

- Being able to see simpler molecules that only reside in lower frequencies may help us in our understanding of Star Formation.
- First discovered in 2000 in a s-type star and again in 2012 by SOFIA in a molecular cloud W49A.
- Analogous lines to OH so may be seen as a maser
- Could be used to map regions where OH is too dense to define areas

Could these two be used in conjunction?

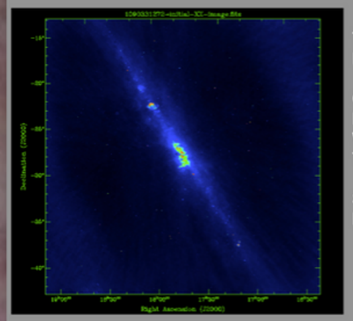
Cyanopolyynes (HC_xN)



- HC11N is the longest chain molecule found in astrophysical conditions
- HC13N was found to have a J=1-0 transition at 213MHz.*
- Found in
  - cold filamentary areas where stars are yet to form**
  - protoplanetary nebulae

*Travers et. al. ApJ 472:L61–L62, 1996
**Fiesen et. al. 2013MNRAS.436.1513F

Current Work: Centre of the Galaxy



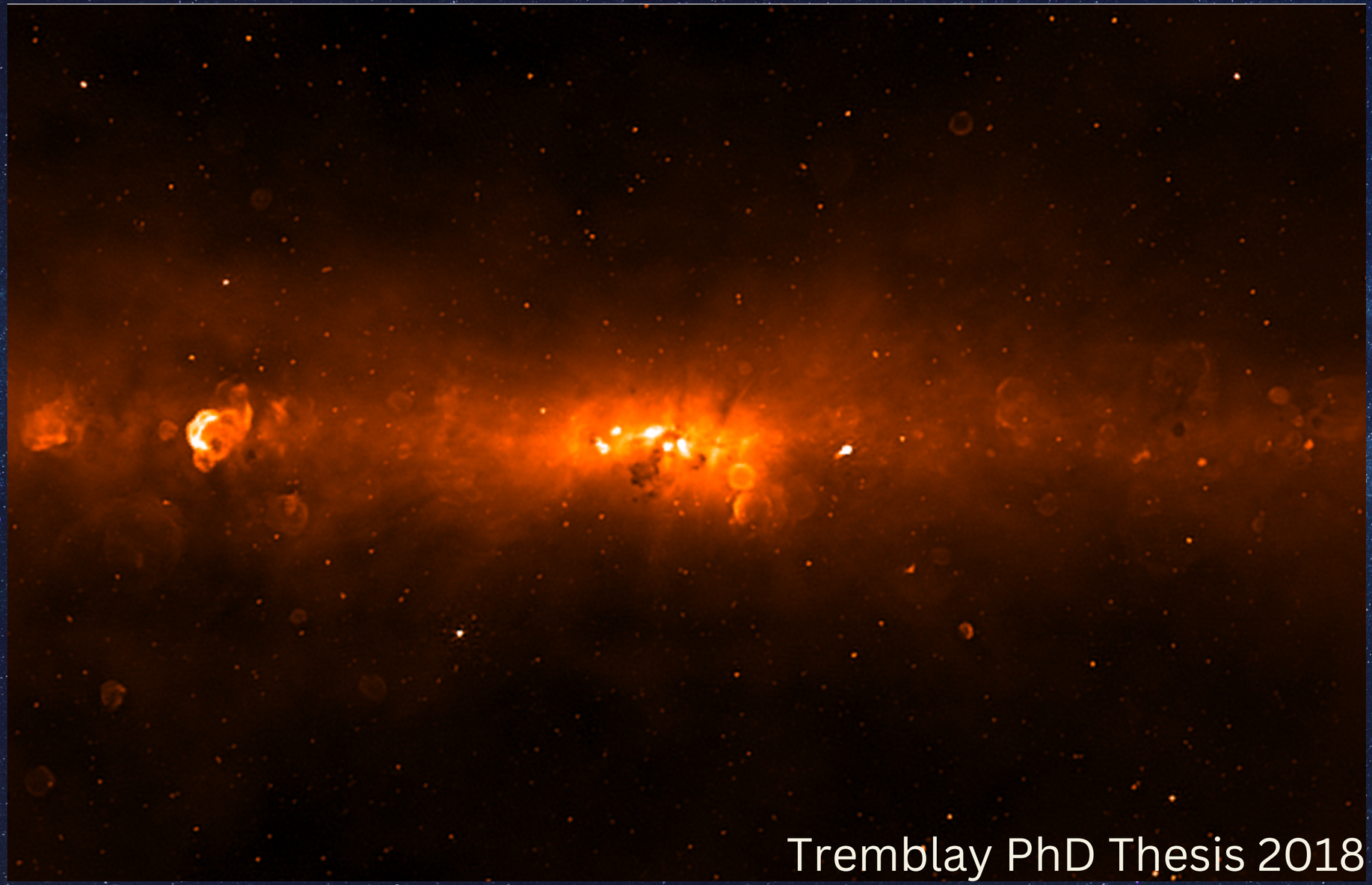
Telescope: MWA
Frequency:
103-133MHz
Continuum Image
Processed:
WSClean
Time: 5 minutes

Survey of Molecular Lines

The Way Forward

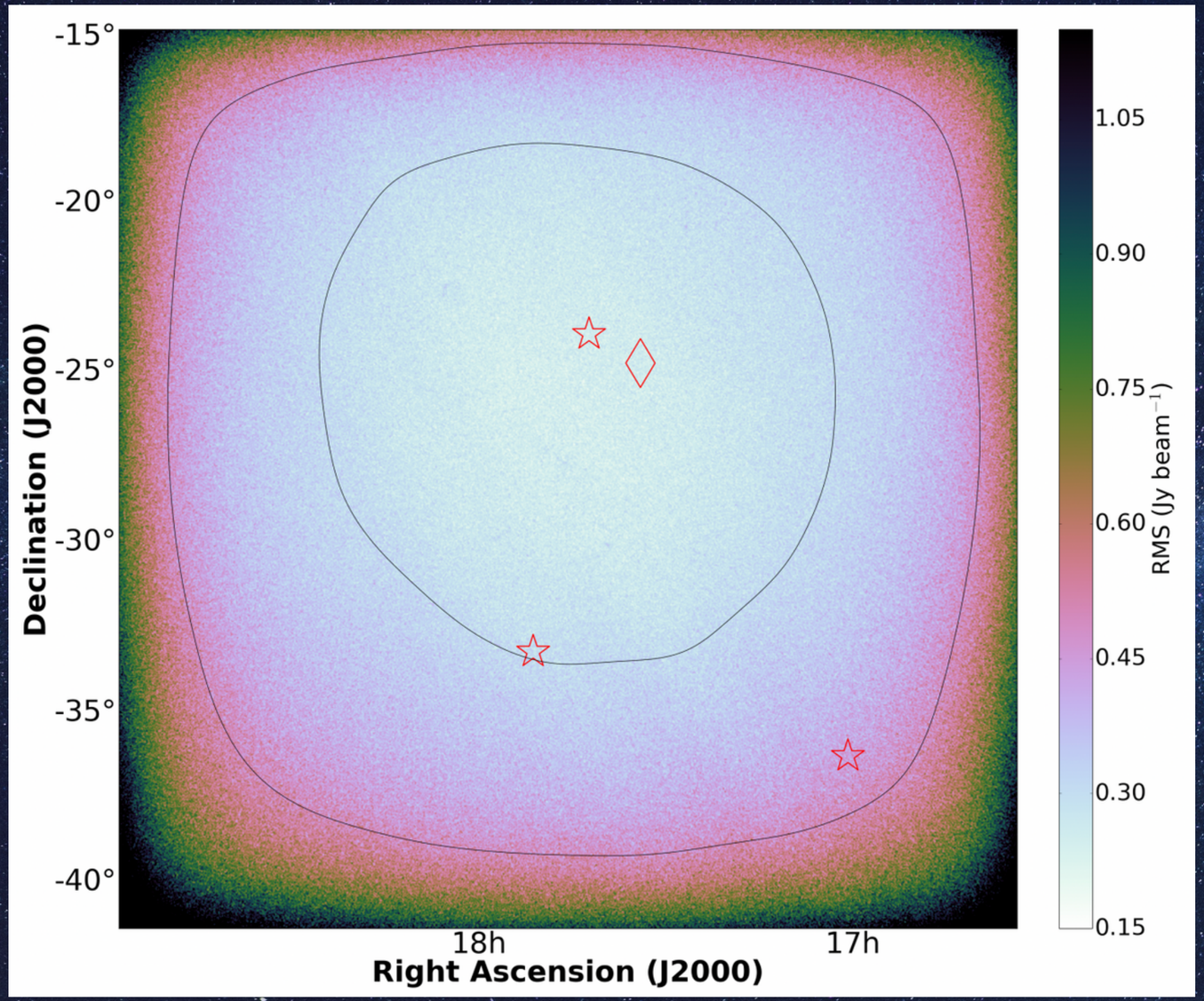
- Complete a Molecular Line Survey between 100-300MHz of the Orion Nebula
- Look for SH in both Orion and Sagittarius A.
  - Lines at 100.29, 111.49, 111.55 and 122.74MHz
  - Map centre of the galaxy with SH and OH.

My First GeG Image



Tremblay PhD Thesis 2018

My First GeG Image



Tremblay+2017

GeG Perception 2013

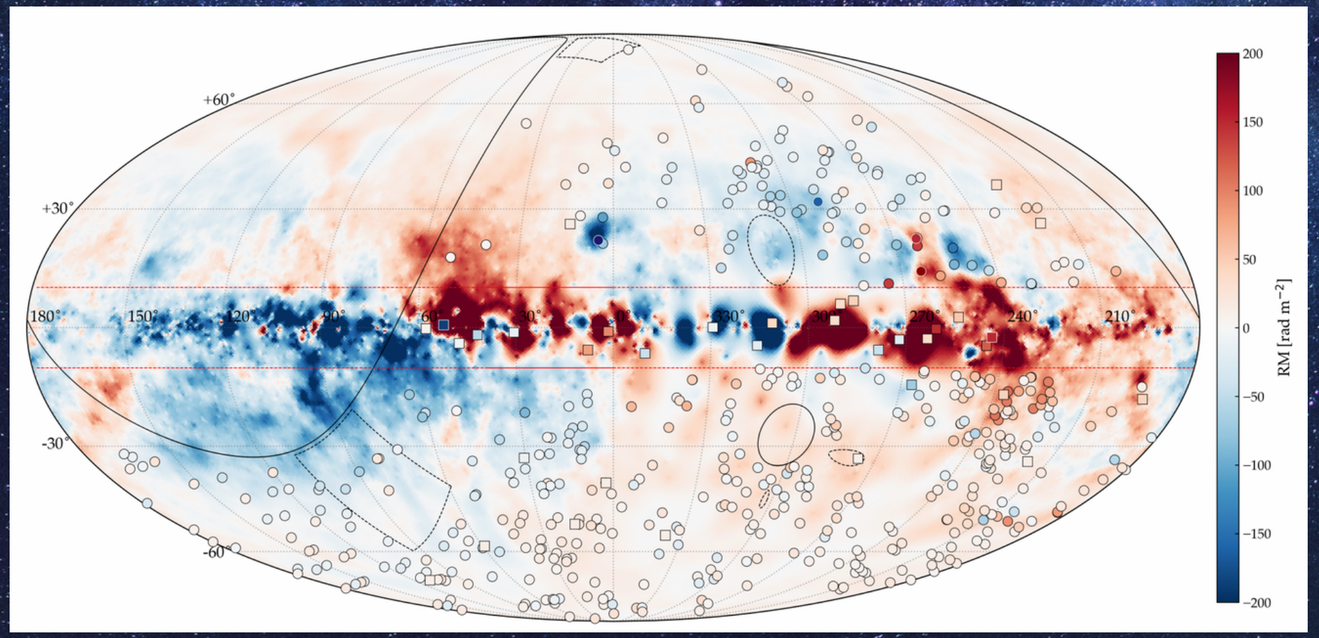
"The major input into this science will come from a deep all-sky southern hemisphere survey over the MWA frequency range with full polarimetry and spectral resolution." - Bowmen et al 2013

GeG Success - Surveys

GLEAM

The Galactic and Extra-Galactic All-Sky MWA Survey.

https://www.mwatelescope.org/science/galactic-science/gleam/



The POlarised GLEAM Survey (POGS)

GeG Success - Surveys

Coming up in this Session

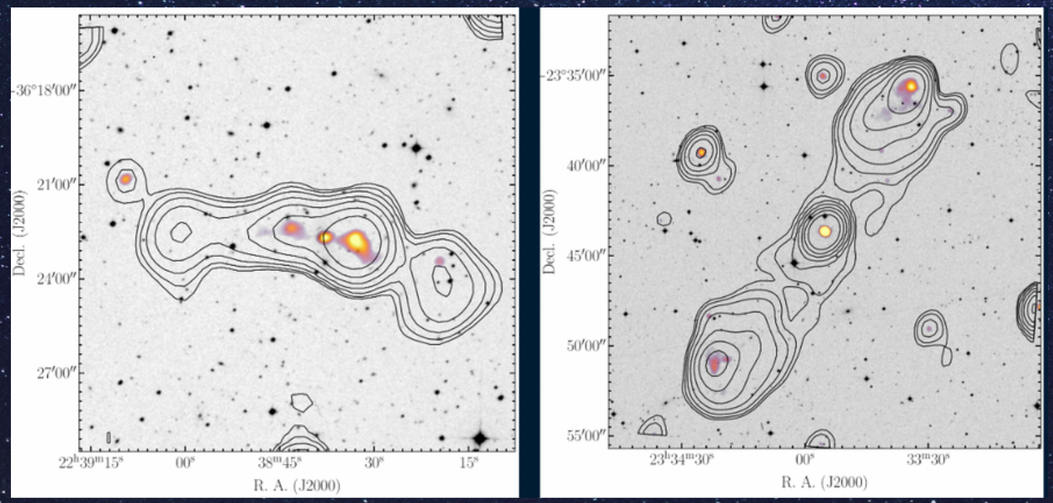
Kathryn Ross "GLEAM-X IDRII: What's available and what's next!"

Christopher Riseley "A decade of MWA magnetism: where did we come from and where are we going?"

GeG Success - Surveys

MIDAS - MWA Interestingly Deep Astrophysical Survey

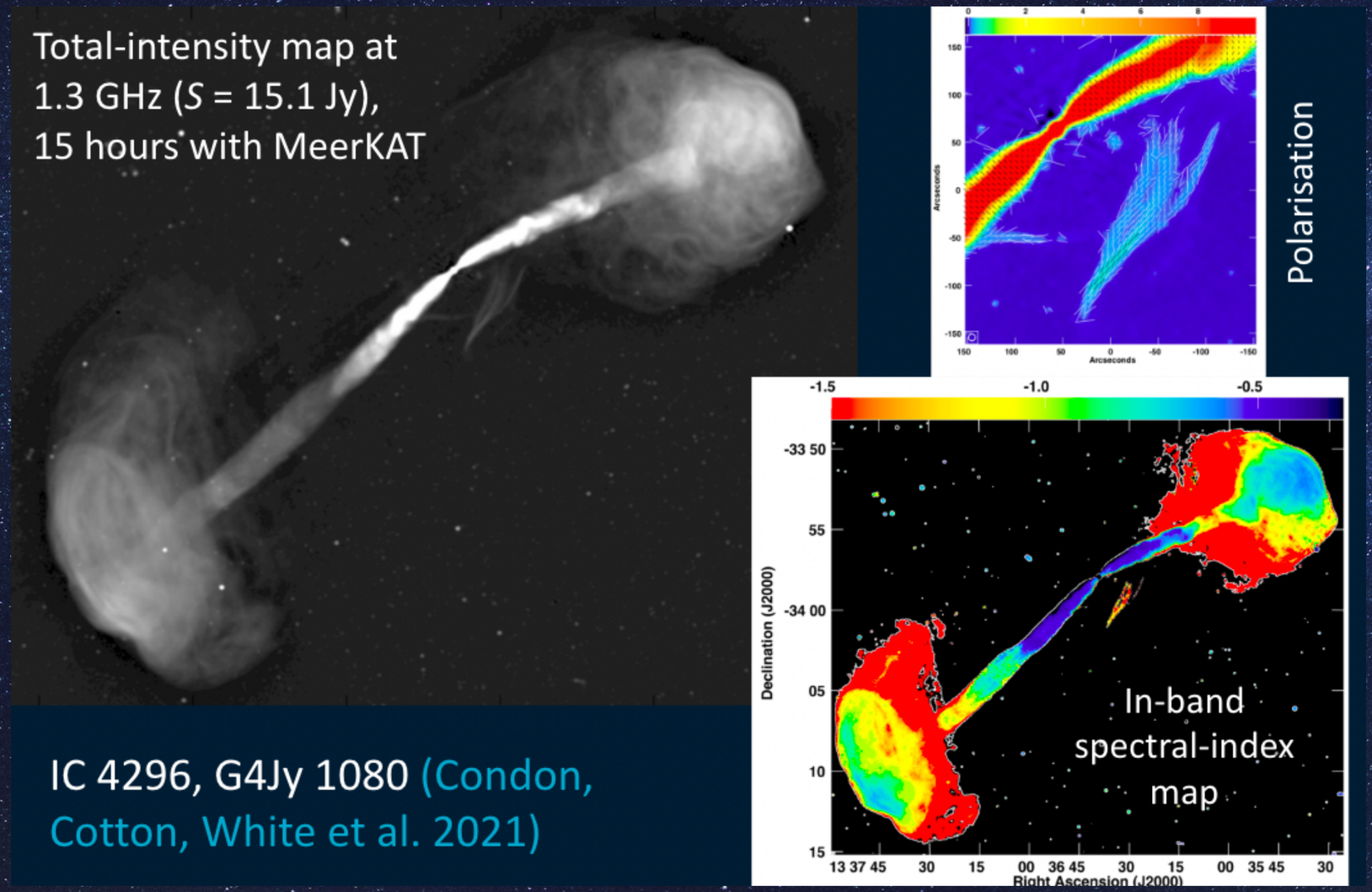
- MIDAS aims to provide deep (~1mJy) imaging of six well studying extra-galactic fields for numerous science goals
- First data release on GAMA 23 (internal only) 25th June, 2021
- Reaches ≤ 1 mJy across 100-230 MHz
- Planned papers:
  - Description paper (Quici, MIDAS+MWA builders et al.)
  - Z~6.4 QSO non-detection: GPS source (Ighina MIDAS+MWA et al.)



Background: DSS Red
Colored radio emission: RACS (887 MHz)
Black contours: MIDAS (216 MHz)

GeG Success - Surveys

GLEAM 4Jy Sample

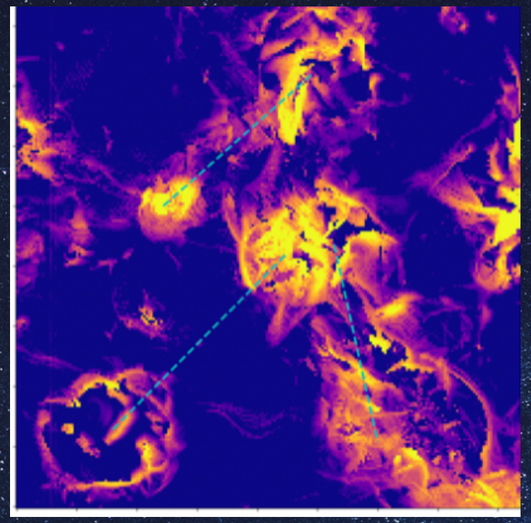


IC 4296, G4Jy 1080 (Condon, Cotton, White et al. 2021)

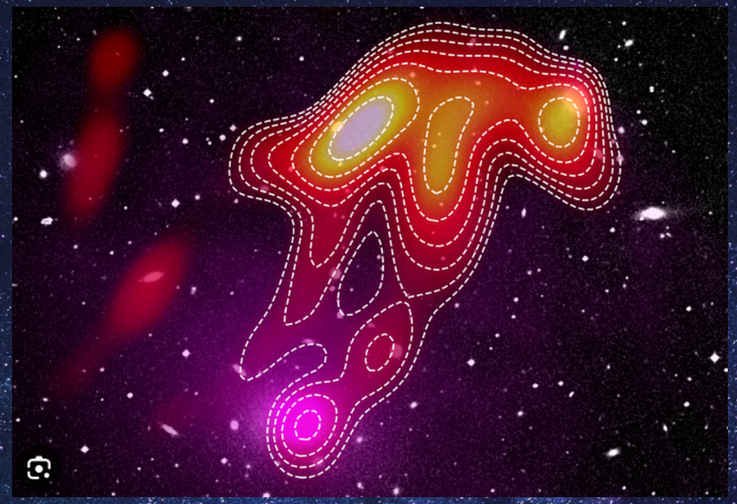
Sarah White has been leading the follow-up of 140 G4Jy sources with MeerKAT

In GLEAM 1,863 sources were detected and studied with S151MHz> 4 Jy

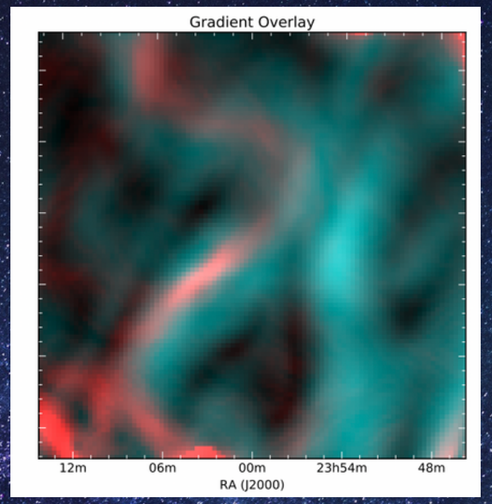
GeG Perception 2013



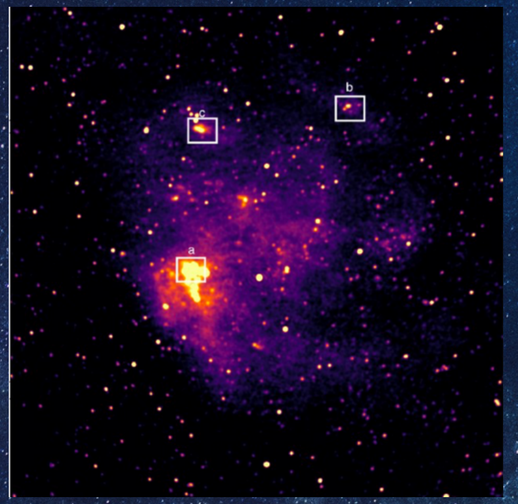
Cosmic Web



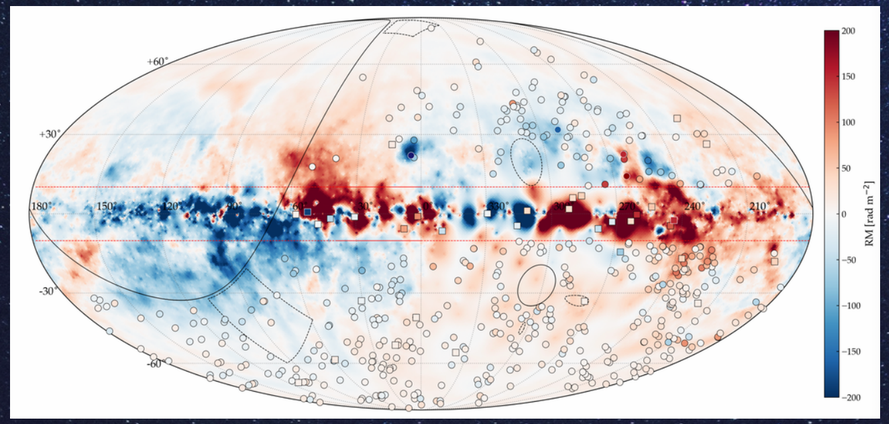
Relics & Clusters



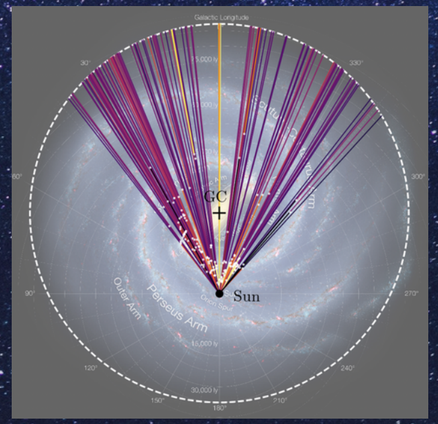
Faraday Tomography



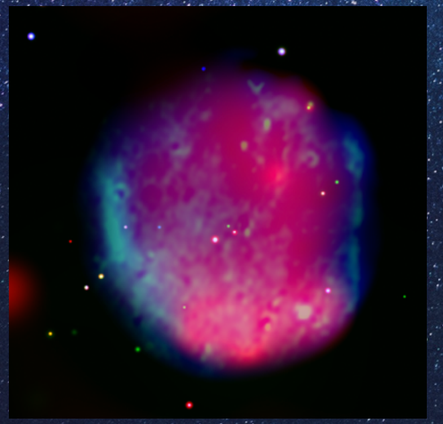
SMC & LMC



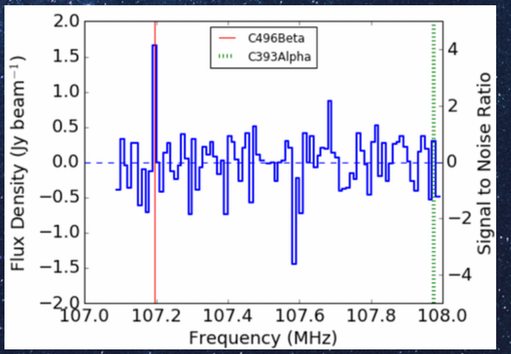
Magnetic Fields



Cosmic-ray mapping

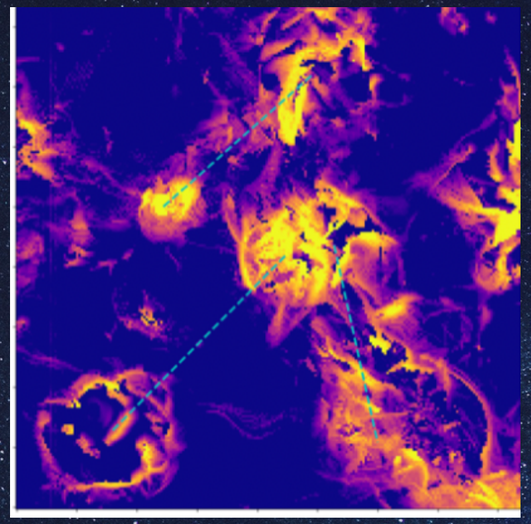


SNR

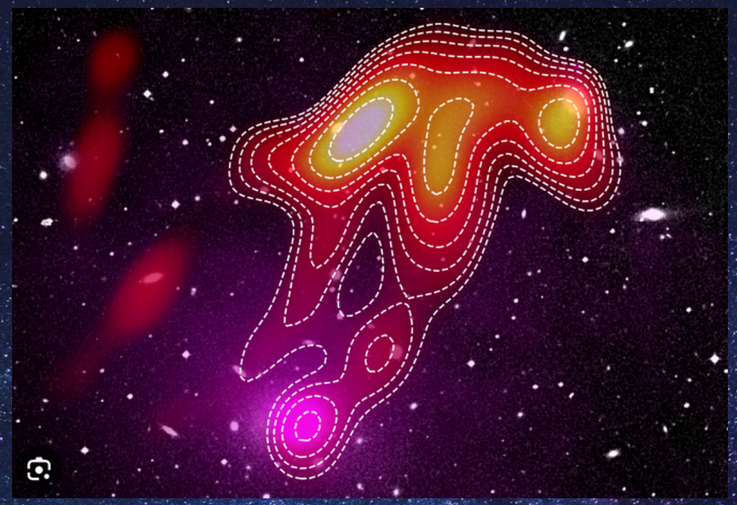


RRL

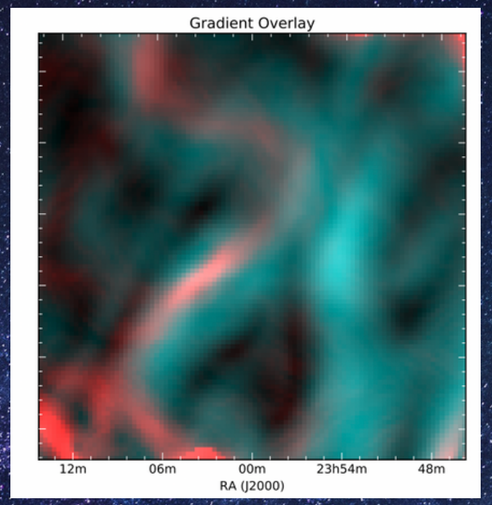
GeG Success



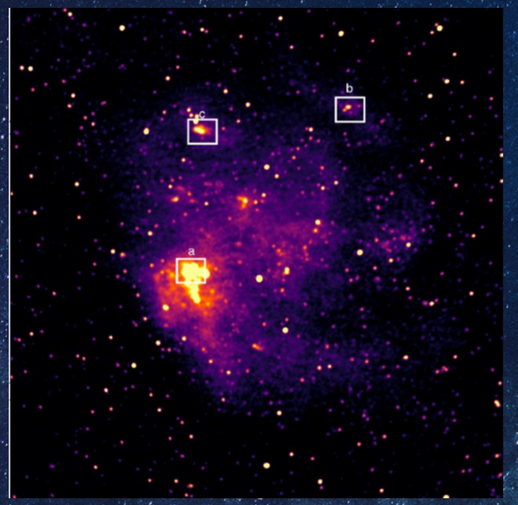
Vernstrom+ 2021



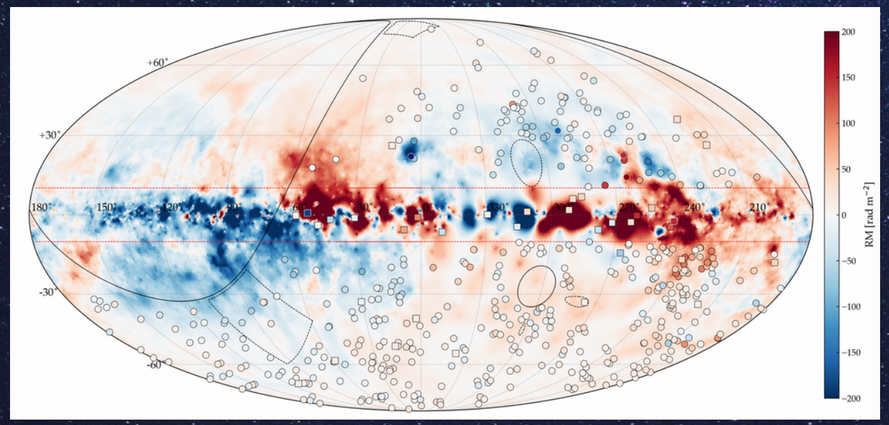
Hodgson+ 2021



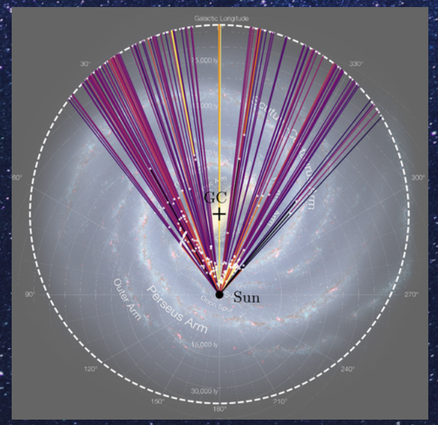
Lenc+ 2016



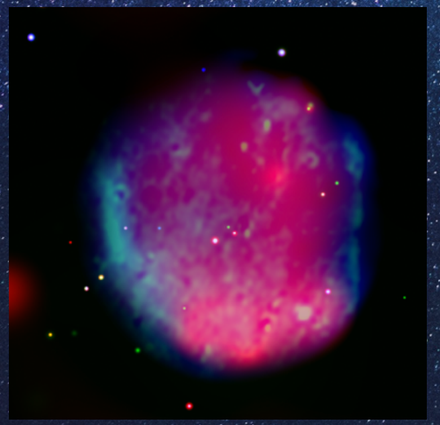
Patterson+ 2020



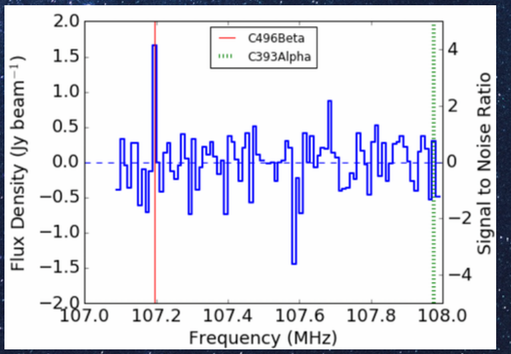
Riseley+ 2020



Su+ 2018



Becker+ 2020



Tremblay+ 2018

Current GeG

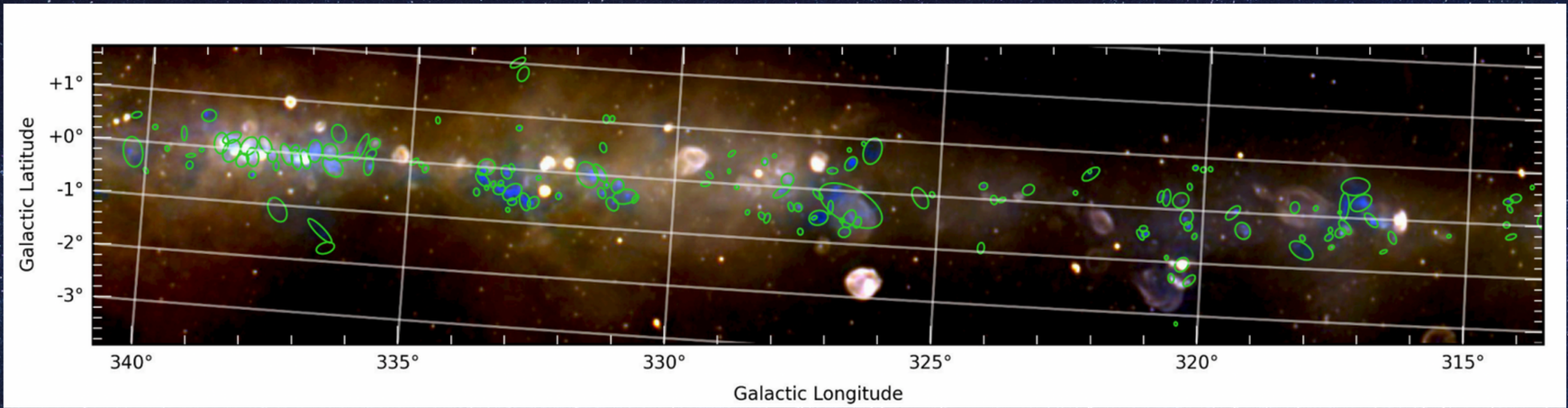
Science Teams:

- Galactic & Extragalactic Spectral Lines
- Radio Galaxies
- Galactic Continuum
- Polarimetry
- Clusters & Cosmic Web
- Magellanic Clouds & Nearby Galaxies
- Surveys

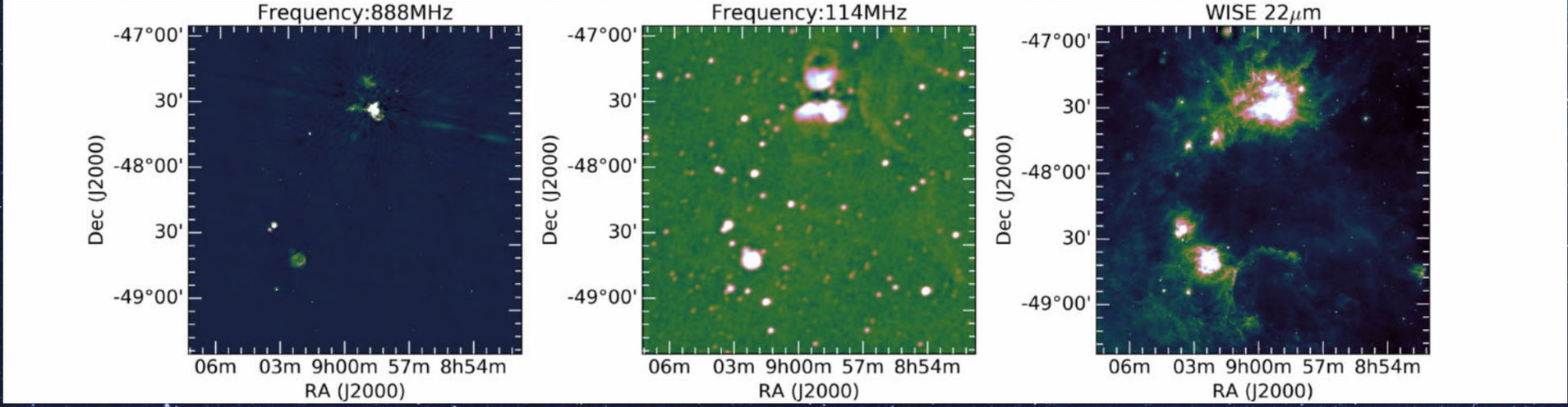
Science we didn't expect
or
Hoped to detect and did

GeG Success

HII Regions



Hindson+ 2016 -- 302 HII Regions Observed & Catalogued



Tremblay+ 2022 -- Deep dive on 10 HII Regions with MWA & ASKAP

GeG Success

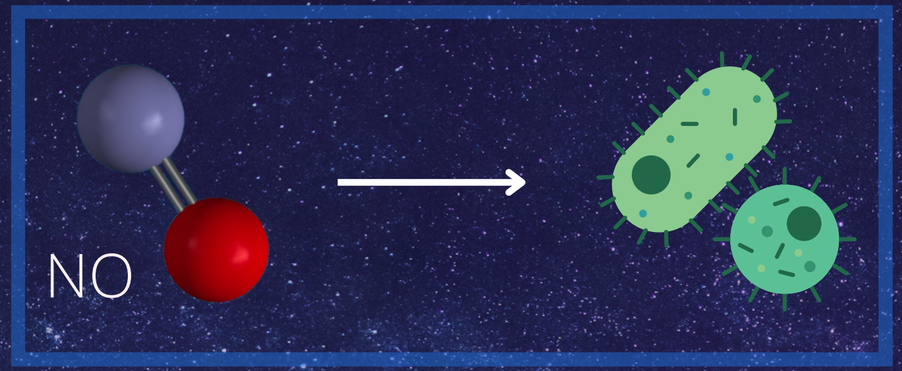
Search for Extraterrestrial Intelligence (SETI)

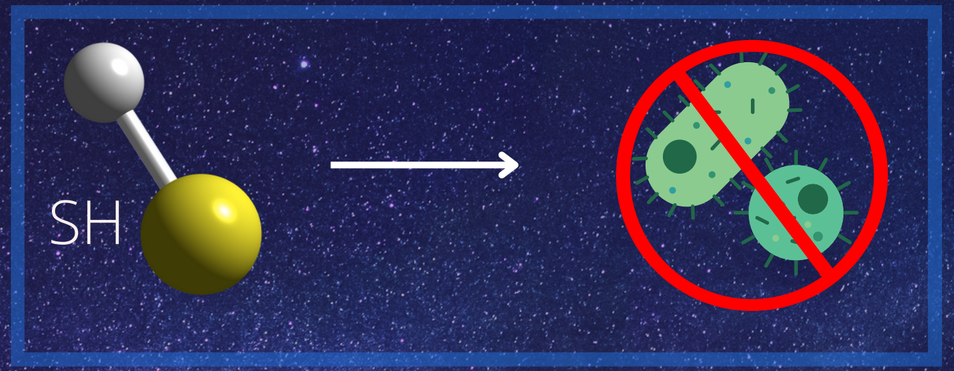
	Phase centre (J2000)	Phase centre l,b (deg)	Freq. (MHz)	FoV (deg^2)	RMS_{min} ($Jy\ beam^{-1}$)	$EIRP_{min}$ 10^{13}(W)	Exoplanets known
Galactic Centre	Phase I MWA						
Tingay et al. (2016)	17h45m40s −29d00m28s	0, 0	103–133	400	0.45	<4	38
Orion	Phase I MWA						
Tingay et al. (2018)	05h35m17s −05d23m28s	196, −15	99–122	625	0.28	<1	22
Vela	Phase I MWA						
Tremblay & Tingay (2020)	08h35m27s −45d12m19s	264, −5	98–128	400	0.034	<0.6	6
Galactic Centre	Phase II MWA						
This work	17h45m40s −29d00m28s	0, 0	139–169	200	0.14	< 27	144

Tremblay+ 2022

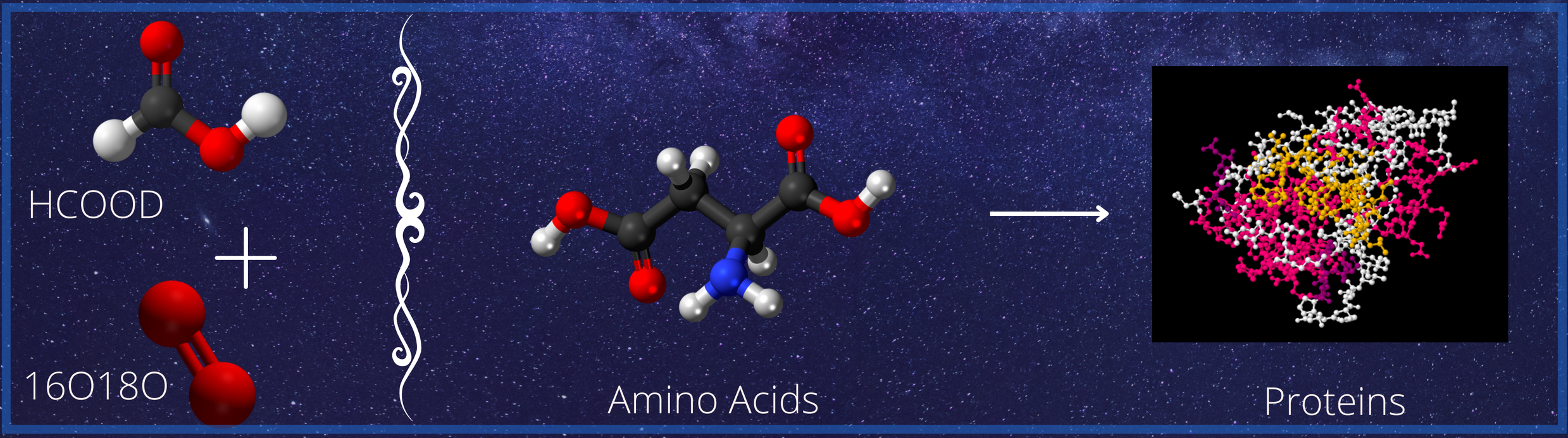
GeG Success

Molecules





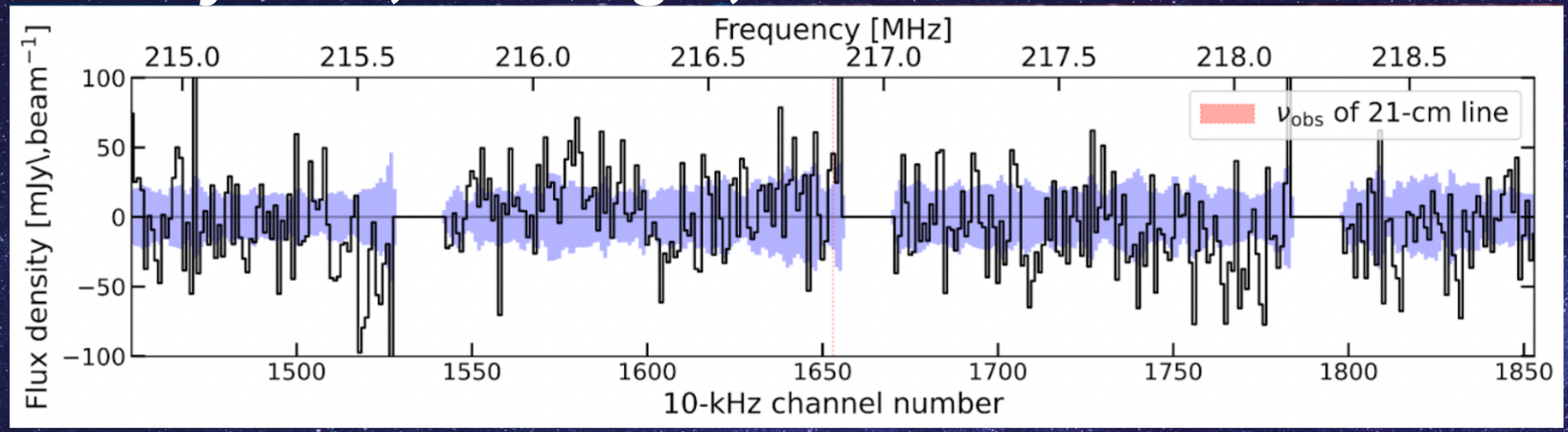
Tremblay+ 2017, 2018, 2020



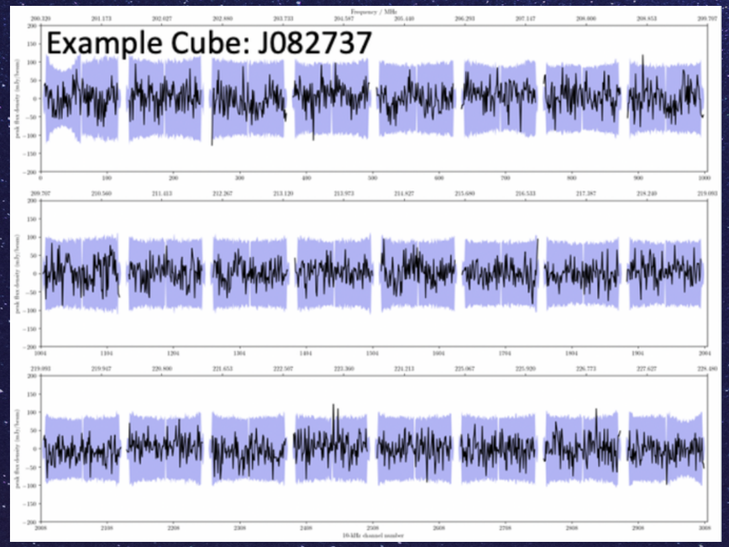
GeG Success

HI Observations of GLEAM J0856 (z=5.55)

Nick Seymour, AJ Hedge*, Jess Broderick et al.



Kris Walker (Summer Student), J Allison, N Hurley-Walker, C. Tremblay

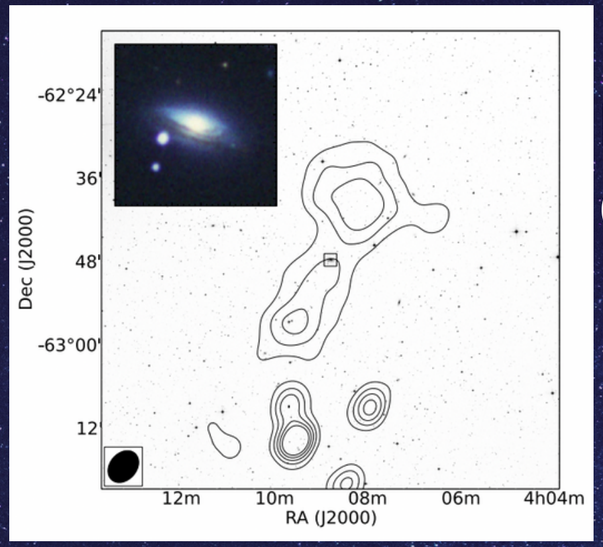


GLEAM Name	RA (J2000)	Dec. (J2000)	S_{215} (Jy)	t_{int} (hh:mm)
J161536-025543*	16:15:36.27	-02:55:43.06	3.0	00:30
J154110+154400	15:41:10.41	+15:44:00.93	2.1	01:00
J152146-192028	15:21:46.23	-19:20:28.97	1.6	02:00
J092012+215109*	09:20:12.42	+21:51:09.52	1.2	03:10
J082737-170020	08:27:37.81	-17:00:20.42	1.2	03:10
J051347+005514*	05:13:47.54	+00:55:14.18	0.71	09:05
J054829-203216	05:48:29.61	-20:32:16.30	0.67	10:05
J150254-323228	15:02:54.58	-32:32:28.94	0.67	10:10

GeG Success - The Big & The Old

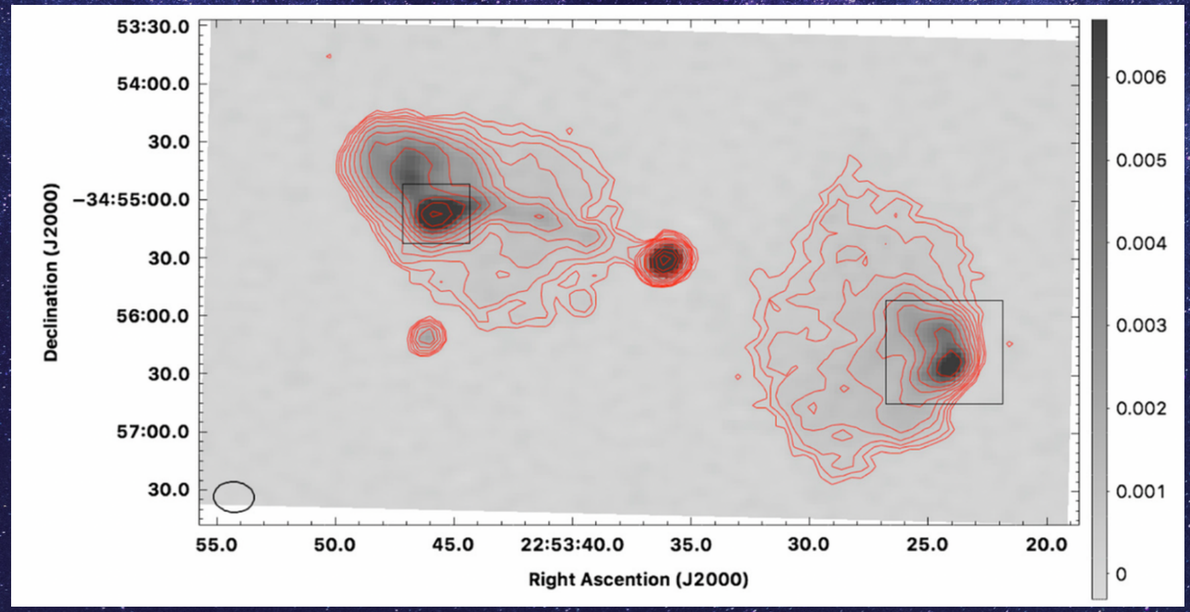
GeG Success

Giant Radio Galaxies



Discovery of a Giant Radio Galaxy in NGC 1534

Hurley-Walker+2015

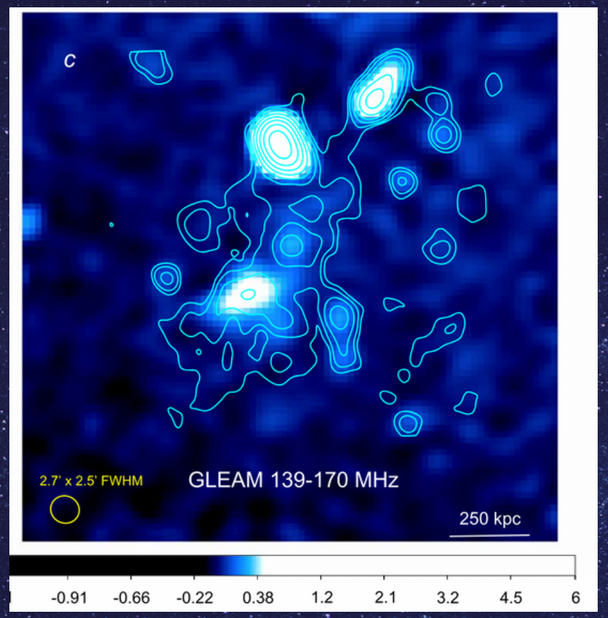


Discovery of a Giant Radio Galaxy in Abell 3936

Seymour+2020

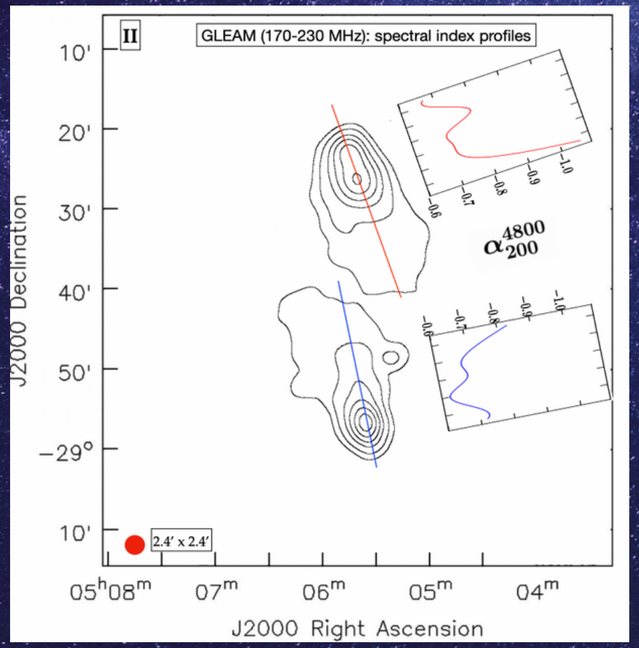
GeG Success

Giant Radio Galaxies



Giacintucci+2020

Giant Radio Fossil in the Ophiuchus Galaxy Cluster

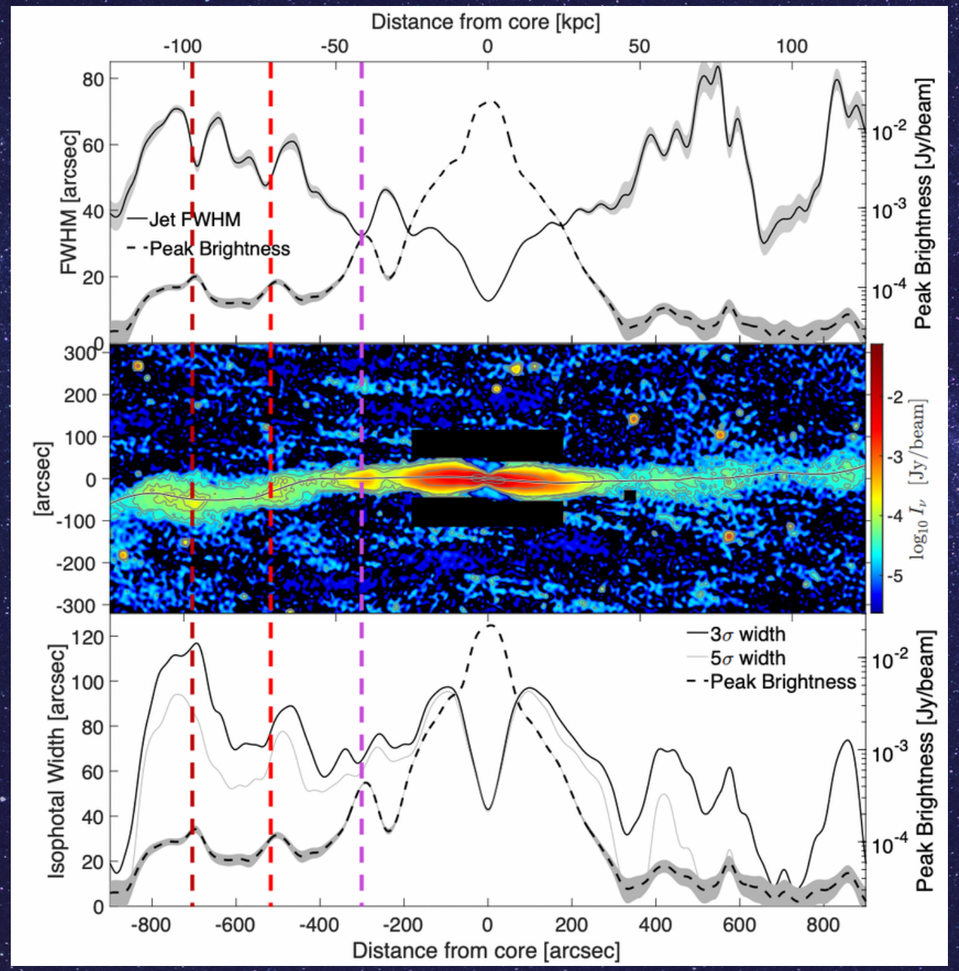


Dabhade+ 2022

X-shaped morphology of the giant radio galaxy 0503-286

GeG Success

Giant Radio Galaxies

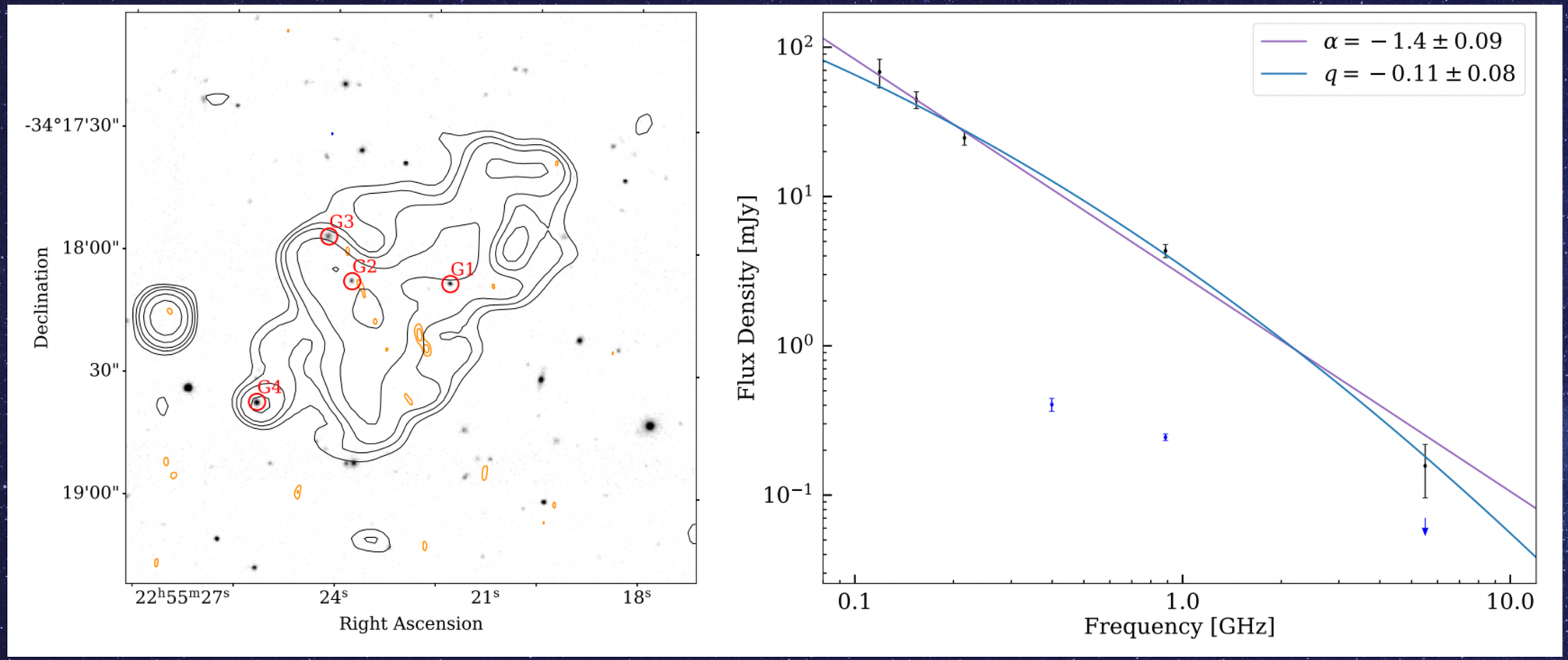


Velović+2022

NGC 2663 A nearby giant radio galaxy with recolimating jets.

GeG Success

Old Galaxies & Relics



Quici+2021

104 radio galaxies studied in the GAMA23 field

10 did not see to have active cores

Conclusion

- The last 10 years have lead to discovery but that discovery took time.
- Along the way the techniques we use have improved and the process has become smoother.

Looking forward to what's next!!


Thank you

@Chenoachem

astrochenoa@gmail.com