The GAMA Legacy ATCA Southern Survey (GLASS)

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The GAMA Legacy ATCA Southern Survey

A Legacy 4cm Survey of the GAMA G23 Field

In a nutshell:

- Deep and wide 5.5 and 9.5 GHz survey of the GAMA G23 field (centered on RA 23 hours, Dec -32.5 deg)
- Cover 50 sq deg to ~30 microJy rms at 5.5 GHz and ~50 microJy rms 9.5 GHz
- Understand radio galaxy populations and their role in galaxy evolution
- Trace Star Formation with Thermal Radio Emission

Legacy radio dataset in very well covered field

Evolution of Radio AGN

Study in detail the life-cycle of radio galaxies

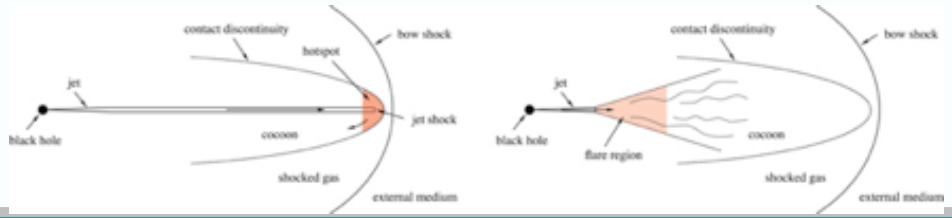
Key questions:

- How do CSS and GPS sources evolve to FRIs and FRIIs?
- Why don't all radio galaxies become giant radio galaxies (> Mpc)?
- How common is remnant and episodic activity?
- Is there are population of high redshift radio-loud galaxies and what are there properties (USSs)?
- How do the radio AGN populations change with host galaxy properties (e.g. stellar mass, SFR, etc), redshift and environment
- What is the kinetic energy luminosity function of AGN?

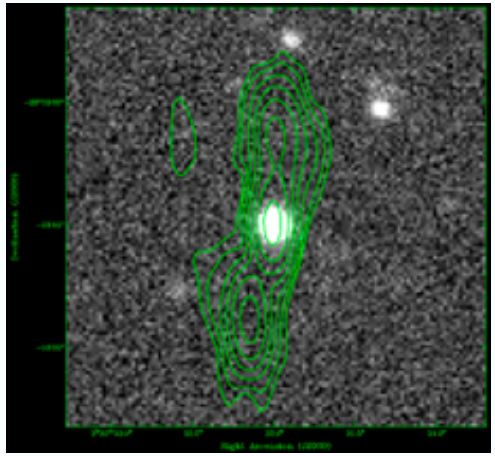
Constrain AGN jet models with:

- morphological information from arcsec resolution radio imaging
- broadband radio SEDs

Population source counts, N(z), and luminosity functions to investigate AGN duty cycles and evolution



FR-II (left) and FR-I models (Turner and Shabala 2015)



An FR-II in the ECDFS (Huynh et al. 2012)

Star Formation History with Thermal Radio Emission

A top SKA1 Priority Science Objective

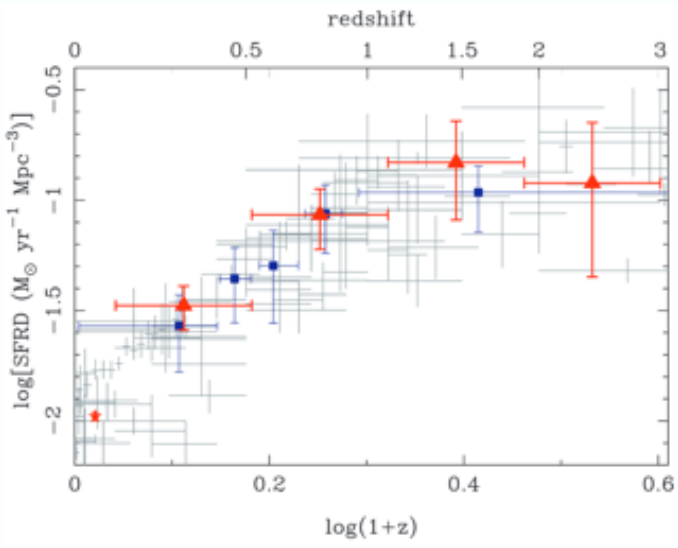
Radio SFR from 1.4 GHz monochromatic flux density
- Dominated by non-thermal synchrotron radiation from electrons accelerated by supernovae
- Non-instantaneous measure of SFR

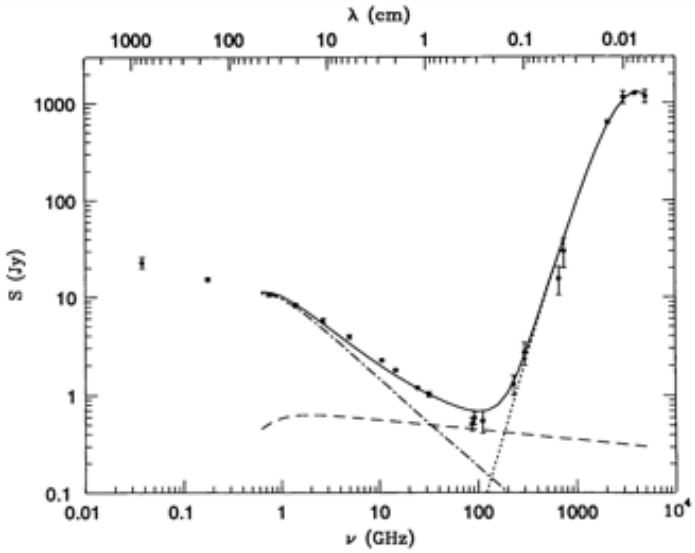
Thermal free-free emission from HII regions makes up 1/3 of radio at 10 GHz
- More direct tracer of star formation

Key Goals:
- Use 5.5 and 9.5 GHz observations to decompose radio continuum emission into thermal and non-thermal components
- Use all GAMA multiwavelength data to calibrate the radio SFRs

S9.5GHz 5σ limit of 250 μJy: thermal emission could be detected from ULIRGs to z ~ 0.5 and LIRGs to z ~ 0.2

Seymour et al. 2008





M82 radio SED (Condon 1992)

Legacy Value

GAMA G23 has outstanding multi-wavelength coverage (GALEX,VST,VISTA,Herschel) and ~60,000 optical spectra

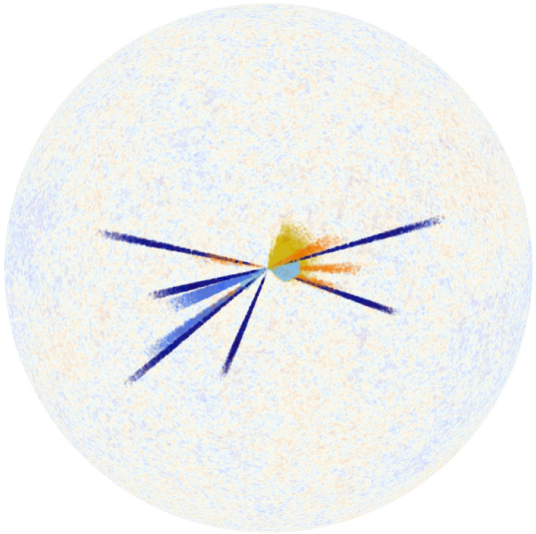
Radio coverage from MWA-GLEAM (70-230MHz), SUMSS (845 MHz), to EMU and DINGO in the future.
- Adding 5.5 and 9.5 GHz data provides 2 decades in radio frequency coverage

EMU Early Science has a large beam (~25 arcsec)

- this higher resolution dataset allows for more reliable counterpart identification and testing of matching algorithms used by the EMU team

Future WAVES survey plans to target G23:

- Go to fainter magnitudes and GAMA-like completeness to z ~ 0.8
- ~0.5M redshifts/spectra expected in G23



Credit: WAVES Collaboration

Observing Strategy

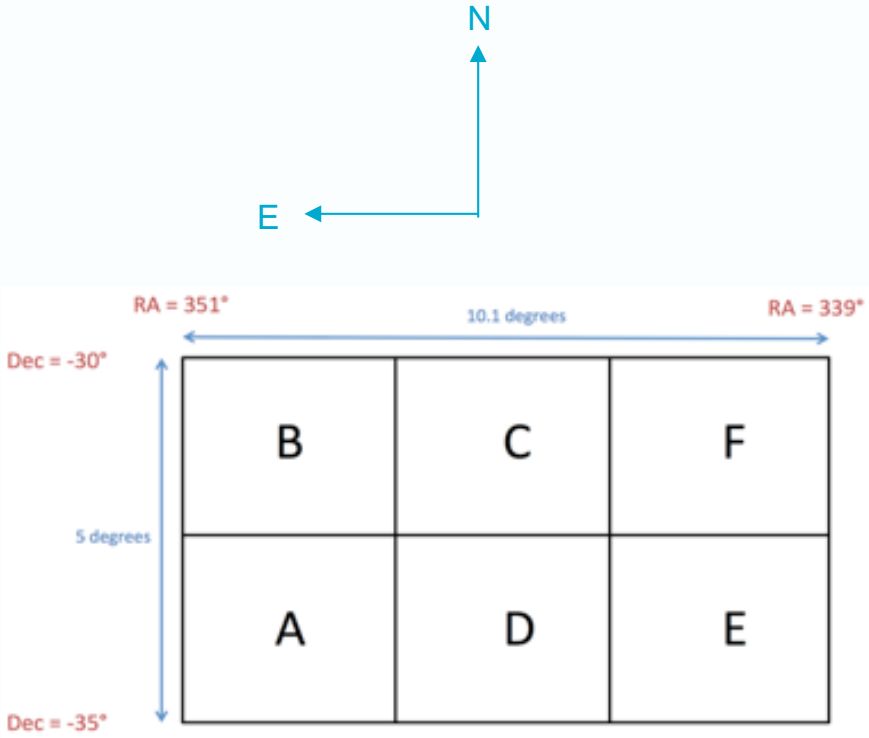
Use C2028 knowledge:
- 5.5 and 9.0 GHz observations of eCDFS (Huynh et al. 2012, 2015)

Point and shoot mosaicing.
- Hexagonal pattern, ~5 arcmin separation for 5.5 GHz
- Simultaneous 9.5 GHz observations
- 2 x 2 GHz bandwidth

Cover 1/6 of G23's 50 sq deg each semester.

Covered region D in first semester OCT2016 to iron out kinks. Then A and B.

A and B are highest priority (should get full coverage by WFIRST).



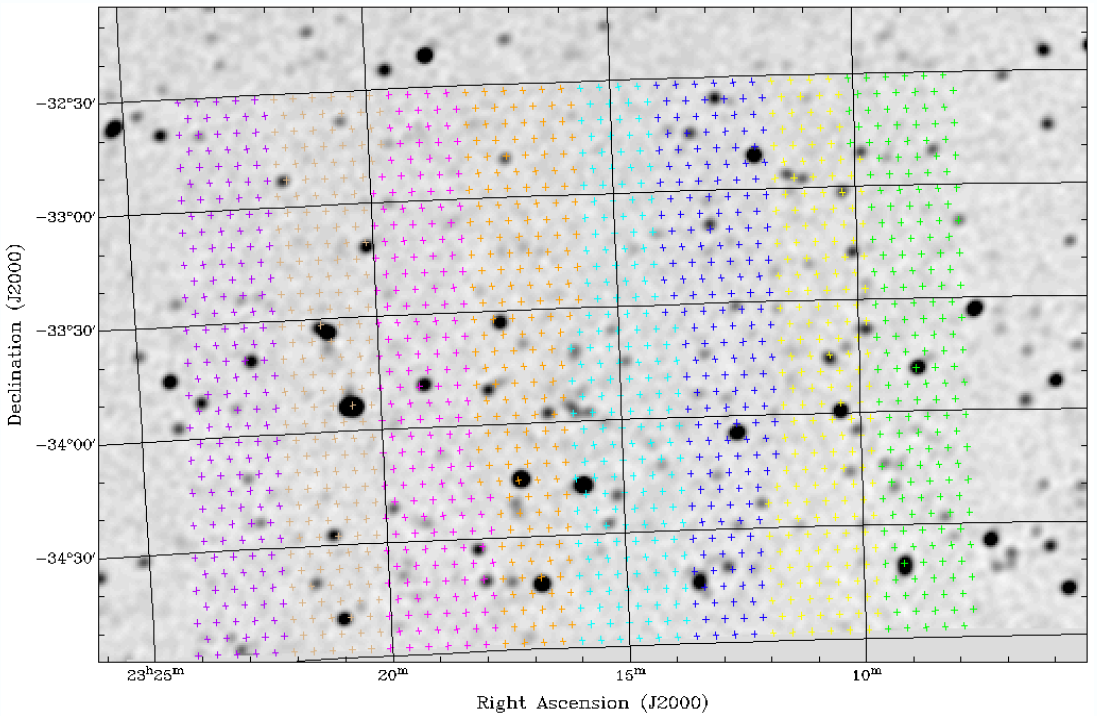
Observing Strategy

Each semester ~3.37 × 2.5 degrees is covered by 1435 pointings.

These are divided into 8 daily sets of 180.

40 sec scans - each set of pointings is covered 4 to 5 times in 12 hours.

- 24 to 30 x 40 sec scans per pointing in total, in semester one)



OCT 2016 Observing

48 days in OCT 2016 (555 hours)
- Mix of 6A and 1.5C (31%)

Observing issues:
- Storms. Lightning and windstows. Affects troposphere so 9.5 GHz data may have issues. Estimate 1/4 of 1/5 days affected, roughly (5%).
- Overheating of some receiver cryogenics (lost some antennas at times). Minor.
- Antenna 6 tracking errors while on 1934-638. Puzzling, went away once on source.

Data Reduction

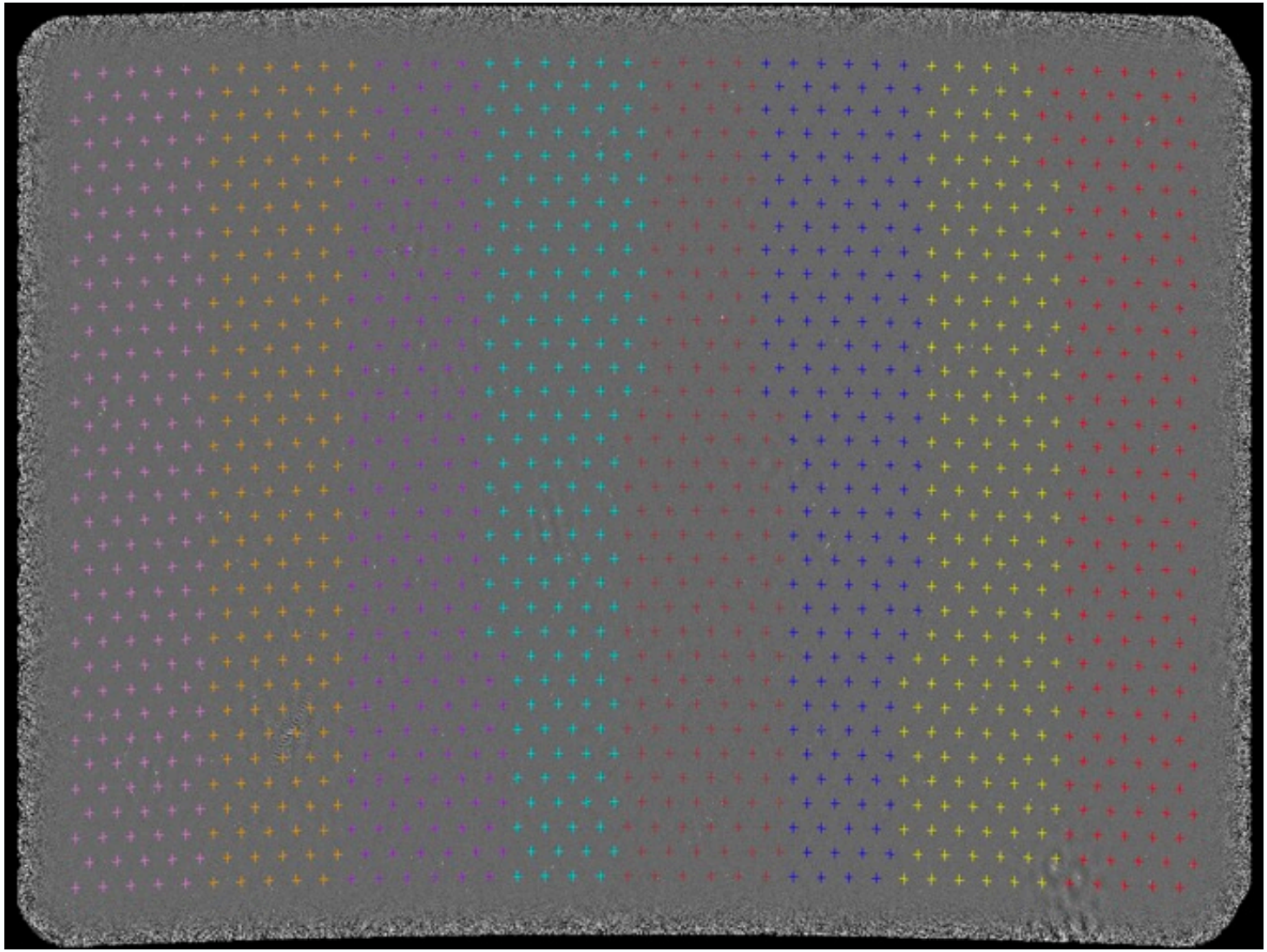
Huynh et al. 2015 scheme:

- Invert full 2GHz CABB band robust=1 (5.5 GHz) and 0.75 (9.5 GHz), mfclean, linmos (bw=2,10)
- 2 iterations of phase selfcal (with first model from 100 mfclean iterations, and second from cleaning to 4 sigma)

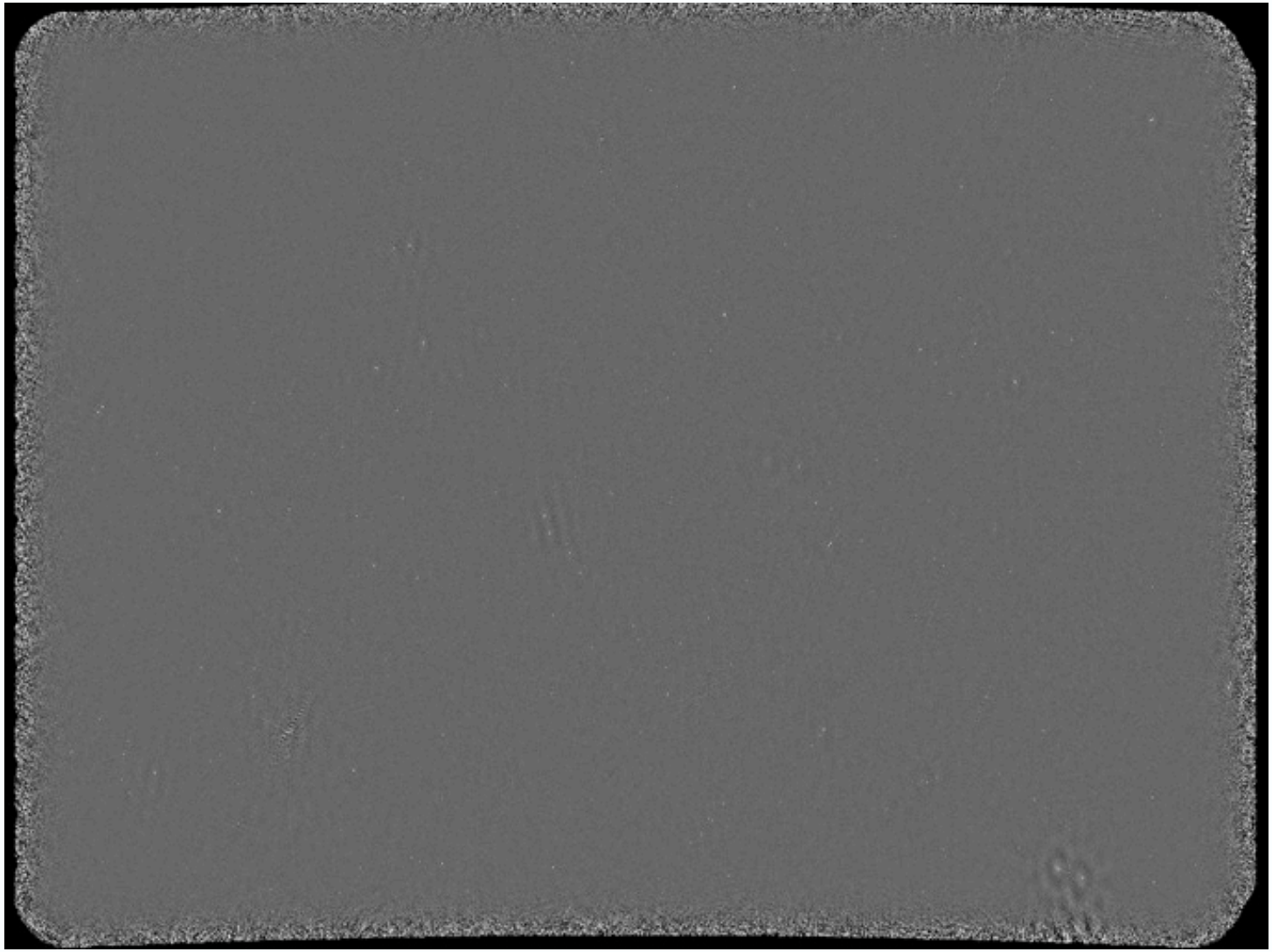
Results from Semester One

- 5.5 GHz: rms ~22 microJy /beam, ~5.7 x 2.0 arcsec beam
- 9.5 GHz: rms 35 – 40 microJy/beam, ~3.2 x 1.2 arcsec beam
- (worse in regions with artefacts/around bright sources)

GLASS Semester One 5.5 GHz image



GLASS Semester One 5.5 GHz image

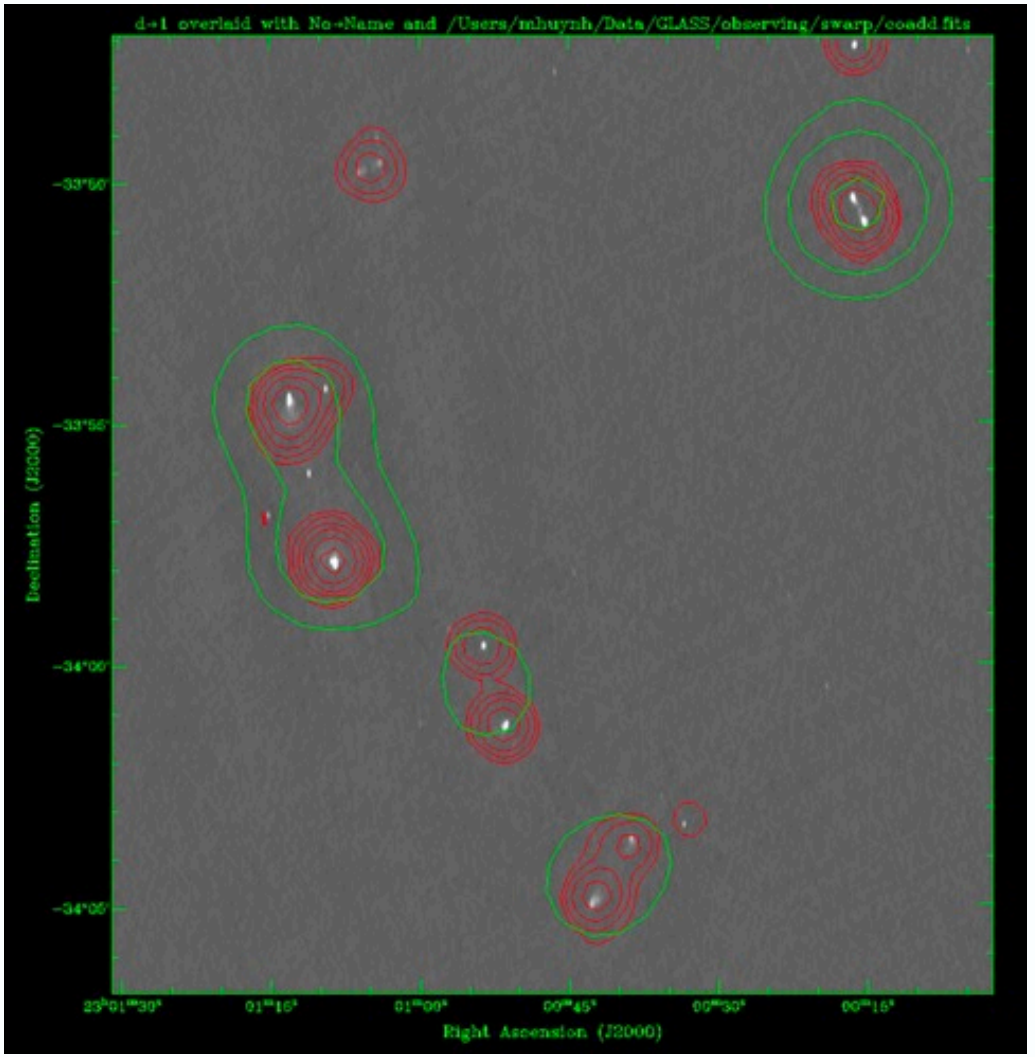


GLASS results at 5.5 GHz

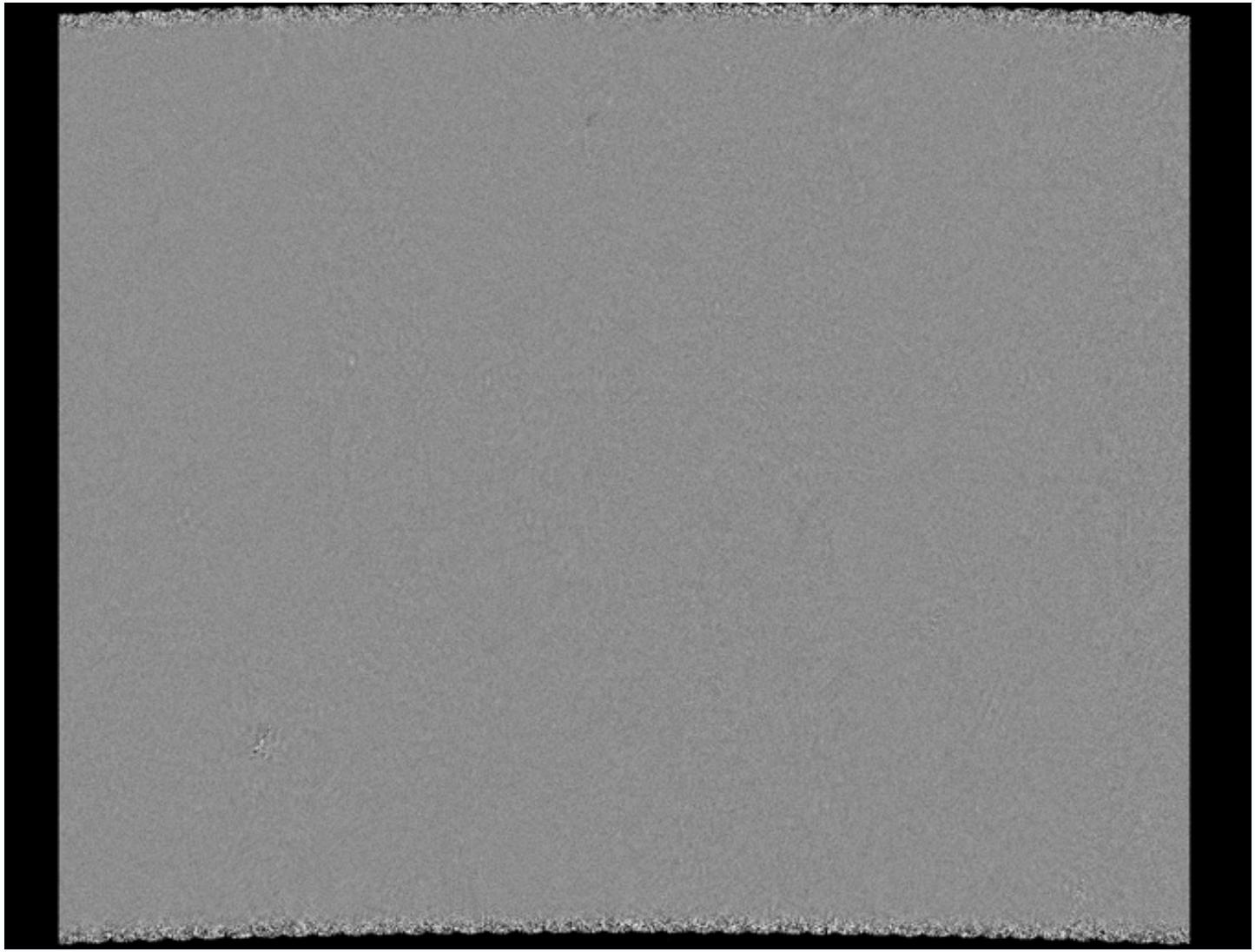
Grey scale is GLASS 5.5 GHz

Green contours: GLEAM MWA 139 – 170 MHZ

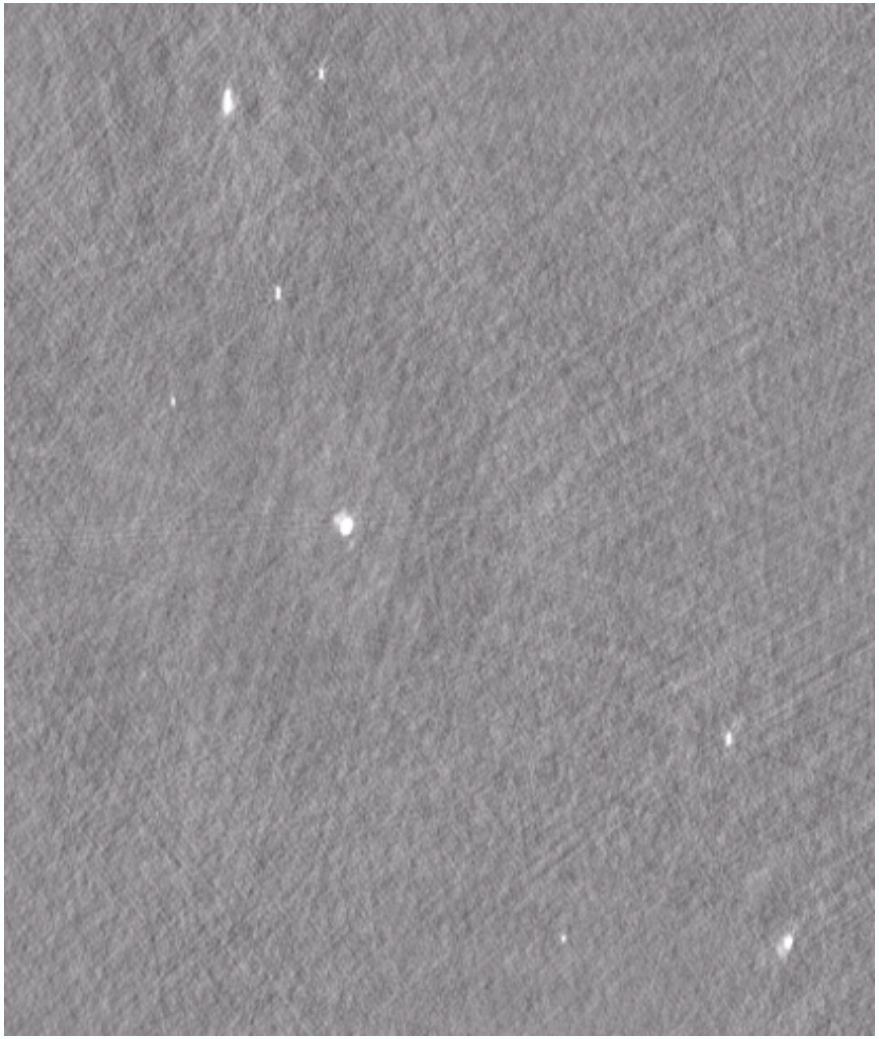
Red contours: NVSS 1.4 GHz



GLASS Semester One 9.5 GHz image



GLASS Semester One 9.5 GHz image



GLASS results at 5.5 GHz: PKS 2250-351

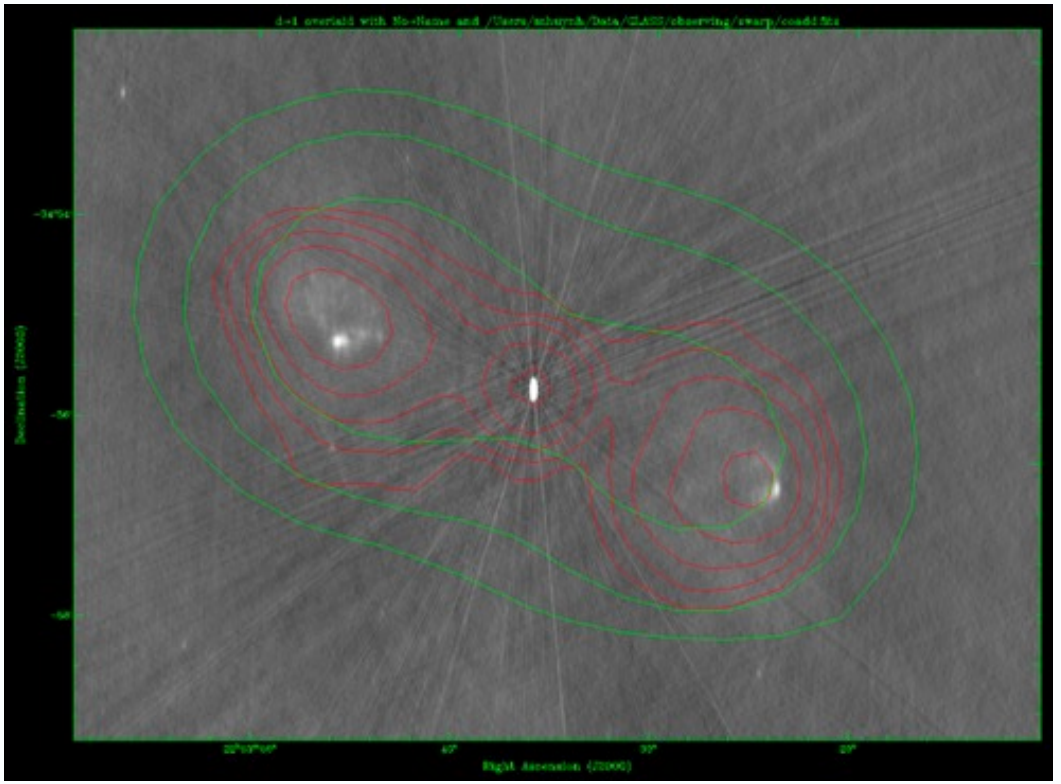
Grey scale is GLASS 5.5 GHz

Green contours: GLEAM MWA
139 – 170 MHZ

Red contours: NVSS 1.4 GHz

Lobes separated by ~5 arcmin or
1 Mpc at z = 0.211
-> Giant radio galaxy!

GAMA group catalogues:
- investigate environments of faint radio galaxies



Source Extraction on Semester One Data

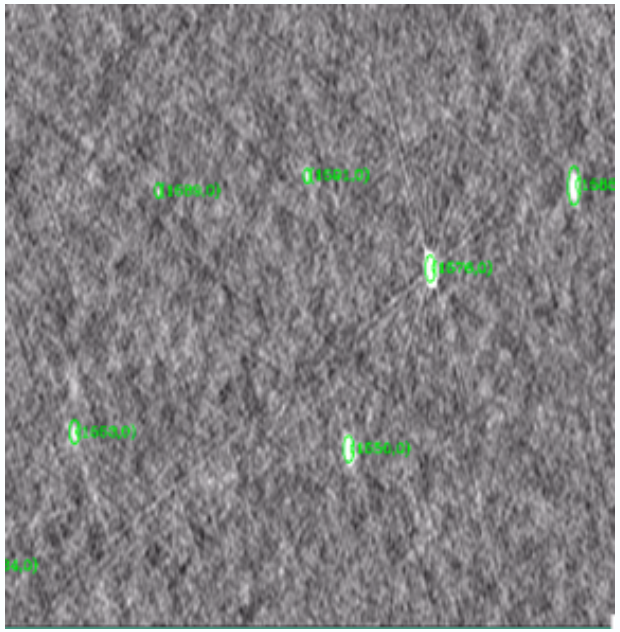
An Updated Aegean and BANE run on 5.5 GHz image:

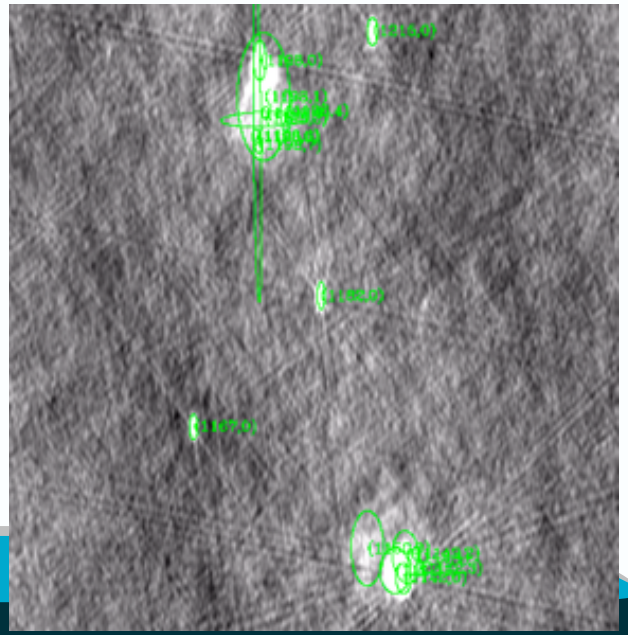
- ~2900 sources to 5 sigma

Implies ~18,000 5.5 GHz sources in full GLASS

In general worked well, but issues with:

- artefacts (spurious sources) around bright sources, and
- multi-component sources and resolved lobes





Work to be done

Data reduction and imaging

- Refine and optimise MIRIAD reduction
- Perform CASA reduction and compare

Source Extraction and catalogues

- Run, test and compare AEGEAN, BLOBCAT, PyBDSM etc.
- Need to do multi-component source identification/characterisation, determine host galaxies.
  - Eyeball? (>10,000 sources) – need machine learning (new CASS postdoc)

SCIENCE !

Future Observations

300 hours in winter semester, 500 hours in summer semester

Average to 400 hours per region (c.f. 500 in semester 1)
- Cover winter semester regions for 100 hours in summer

Expect to reach 25 microJy/beam at 5.5 GHz, and 40 to 50 microJy/beam rms at 9.5 GHz

uGMRT observations of G23 at Band 3 (~375 MHz) scheduled for July/August 2017

- 33 hours, expect to reach 0.1 – 0.15 mJy/beam rms, with ~7 arcsec beam

5.5 GHz Integrated source counts

Quick source extraction over 137.5 x 62.5 arcmin region:
- detects 682 sources with S > 0.094 mJy,, or a source density of ~284/sq deg.

384 sources with S > 0.3 mJy, or ~160/sq deg.

In eCDFS, there's 48 sources with S > 0.3 mJy in 0.34 sq deg, or ~141/sq deg.

5.5 GHz source counts consistent with eCDFS (within ~ 15%)