

610 MHz - LR

325 MHz - FR

325 MHz - LR

Diffuse Radio Emission in ACTPol Clusters

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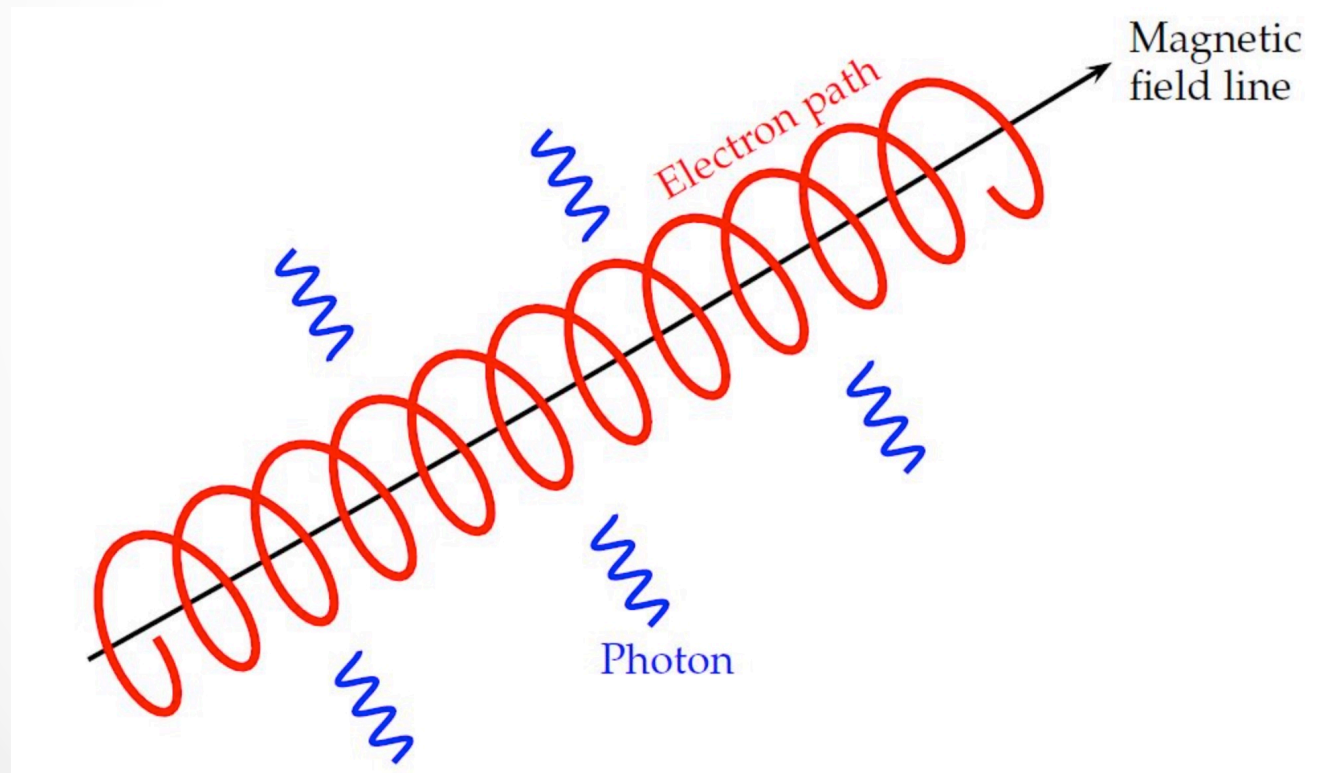


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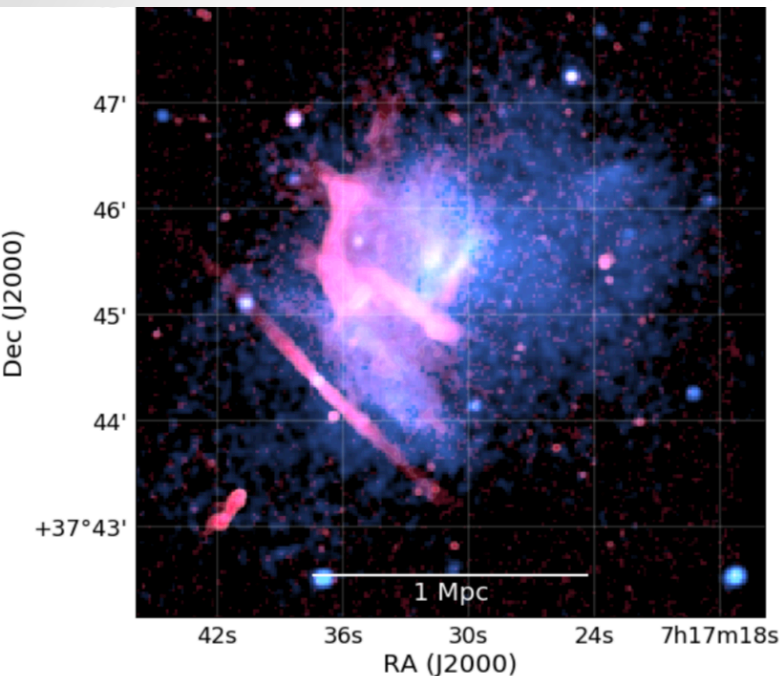
Diffuse Radio Emission in Clusters

- Magnetic fields across the ICM
- Cosmic Rays
- Diffuse radio emission



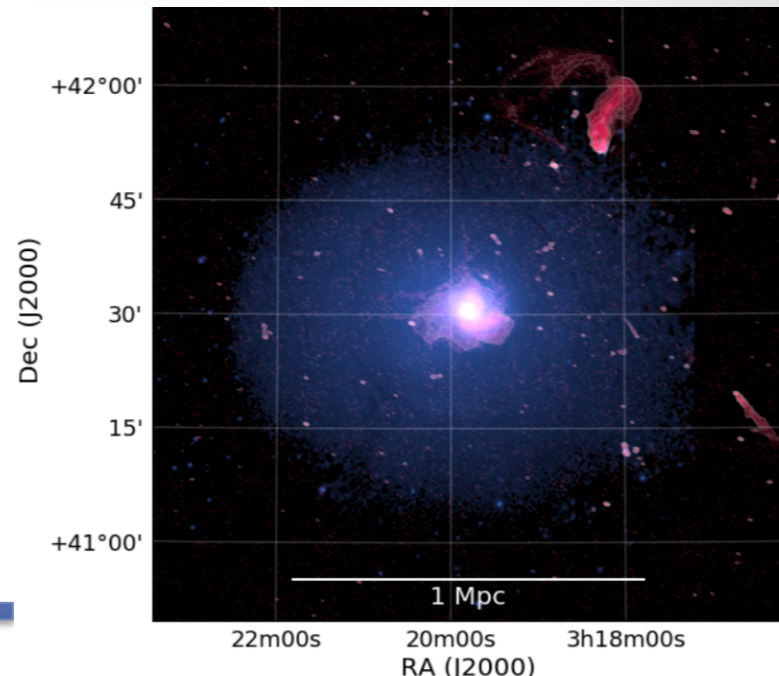
Source: <http://spiff.rit.edu>

Diffuse Radio Emission in Clusters



GRH

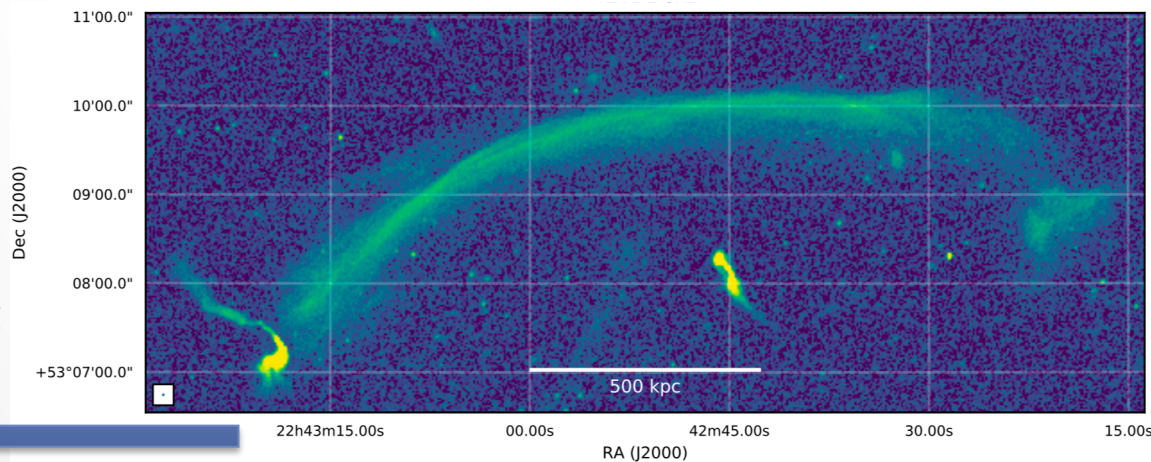
MRH



van Weeren et al.
2017a

Gendron-
Marsolais
et al. 2017

Radio Relic



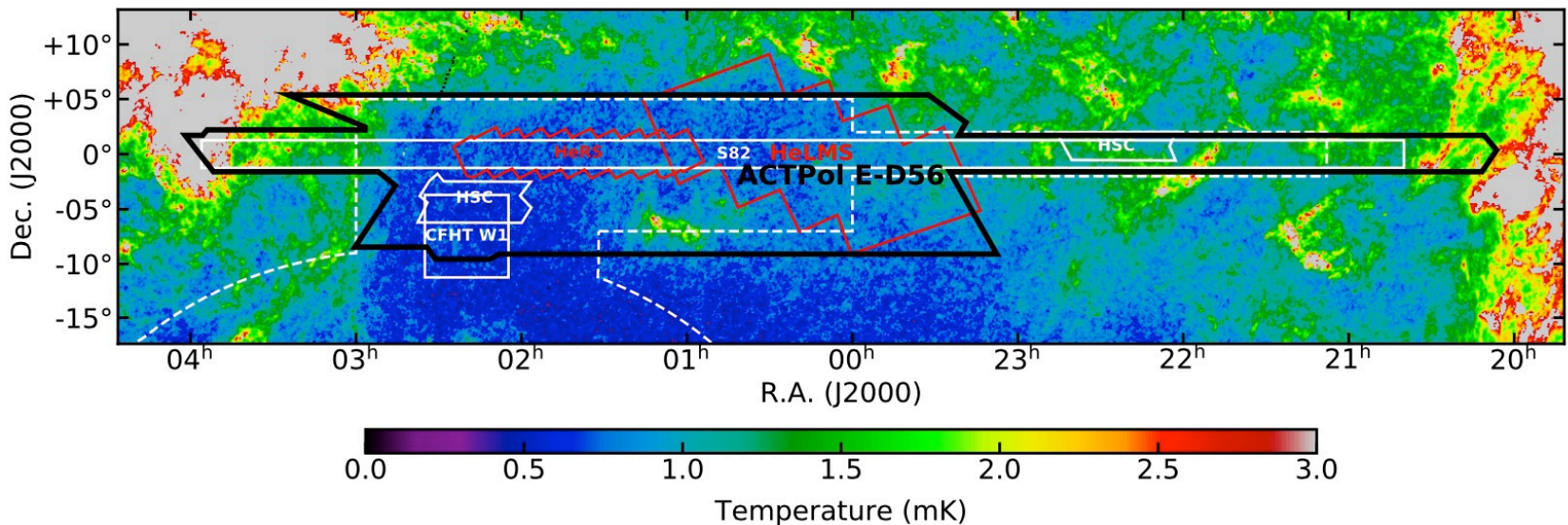
Di Gennaro et al. 2018

Current Questions

- Cosmological evolution
- Formation impact of cluster mass/merger properties
- Cosmic ray transport & (re)energizing mechanisms

ACTPol Sample: uGMRT Study

- Mass and redshift cut : $M_{500} > 4 \times 10^{14} M_{\text{sol}}$ & $0.1 < z \leq 0.8$
- **40 clusters:**
 - 13 with archival 610/325 MHz GMRT data
 - Only 10 overlap with Planck
- uGMRT Band 3 (250-500 MHz)

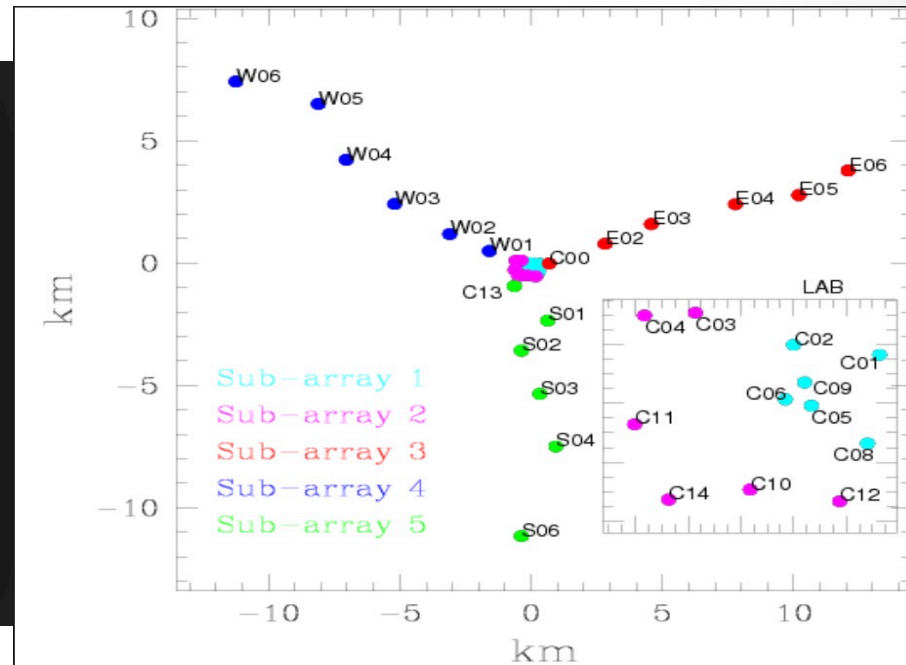


uGMRT Observations

- 375 MHz continuum, ~250 MHz bandwidth
- RR, LL, RL & LR polarization
- ~5-7.5 hours per cluster. Currently observed 14 clusters.



GMRT

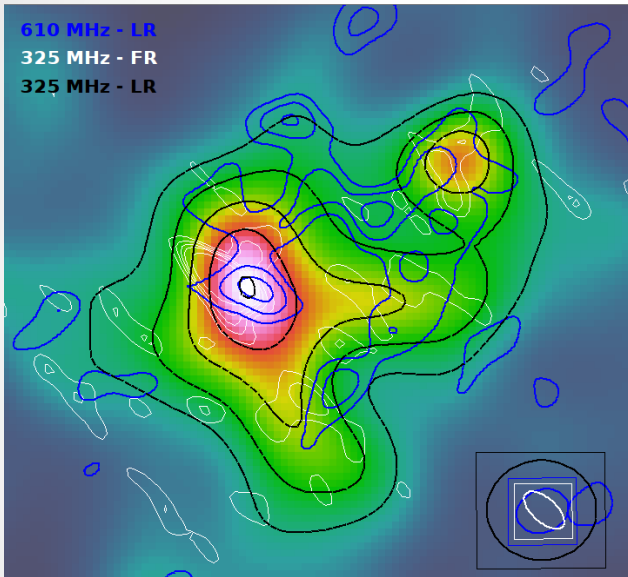


Data Reduction Techniques

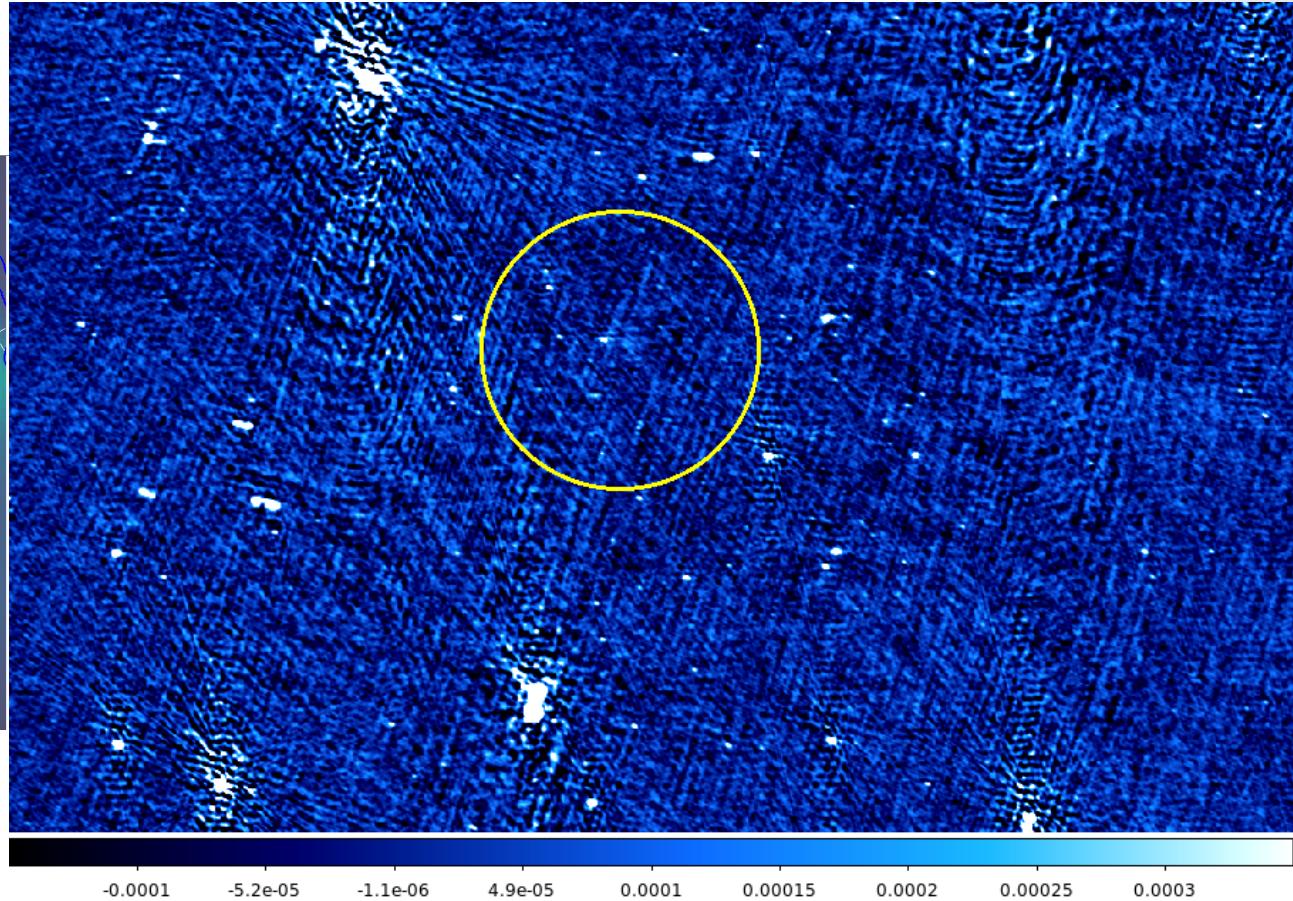
- IDIA (Inter-University Institute for Data Intensive Astronomy) pipeline:
 - Automated Flagging
 - Main calibration (primary & secondary calibrator)
 - Self-calibration (phase & amplitude)
- Directional Dependent Effects (DDEs) calibration
- Low-resolution imaging
- Stimela

(<https://github.com/SpheMakh/Stimela>)

Preliminary Results (ACTPol Sample)

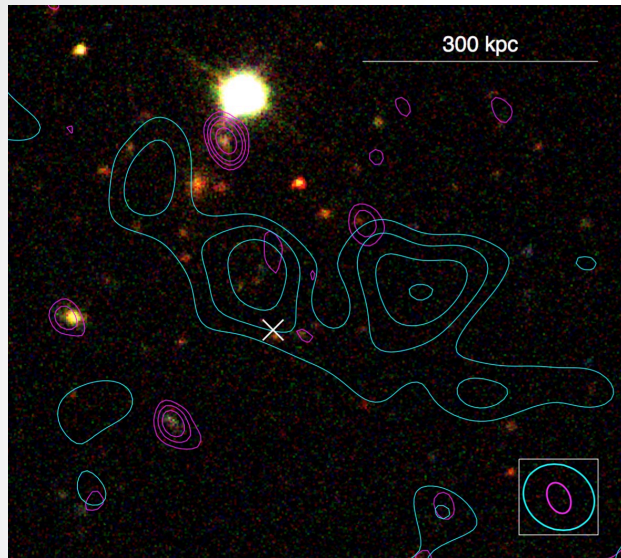


J0034.4+0225

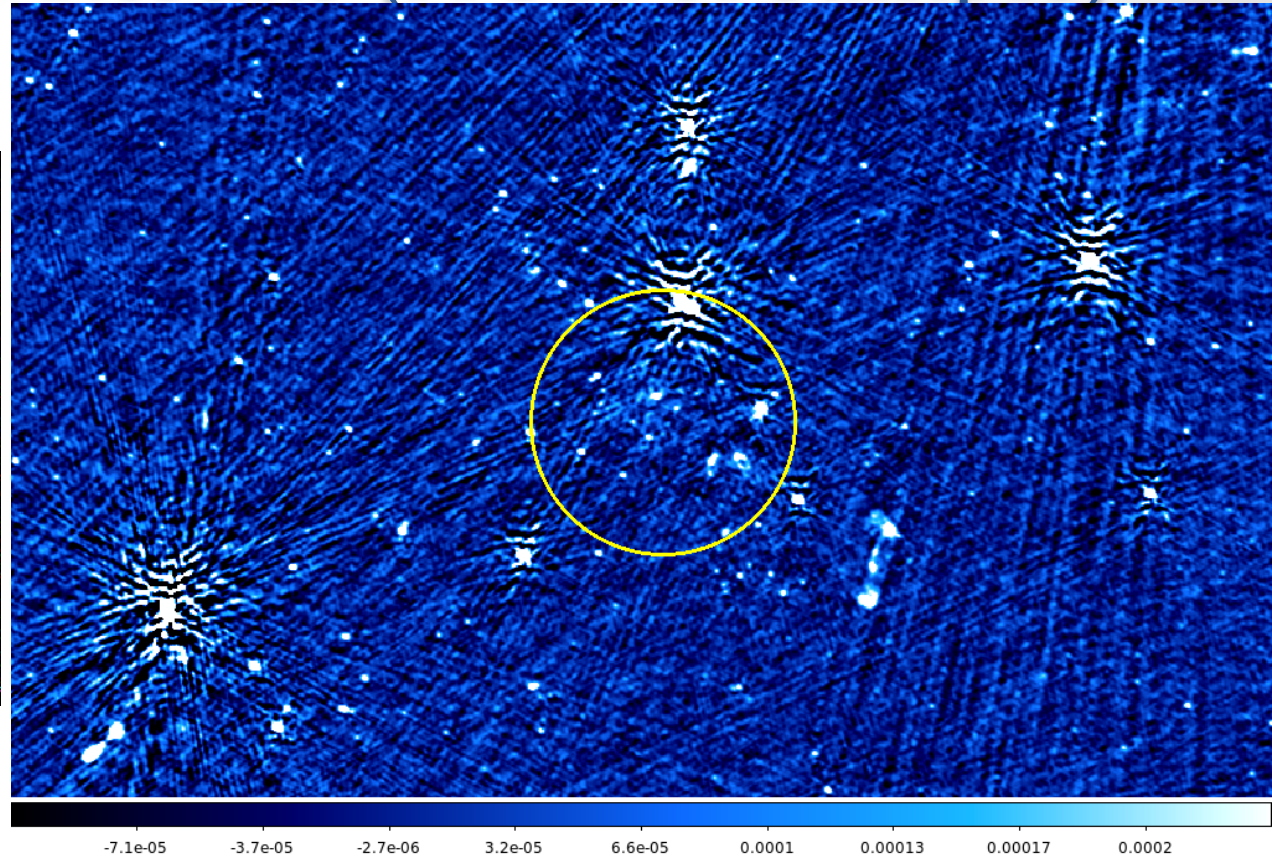


rms of full-resolution image:
36.8 $\mu\text{Jy}/\text{b}$
rms in cluster region (R_{500}):
82.3 $\mu\text{Jy}/\text{b}$

Preliminary Results (ACTPol Sample)



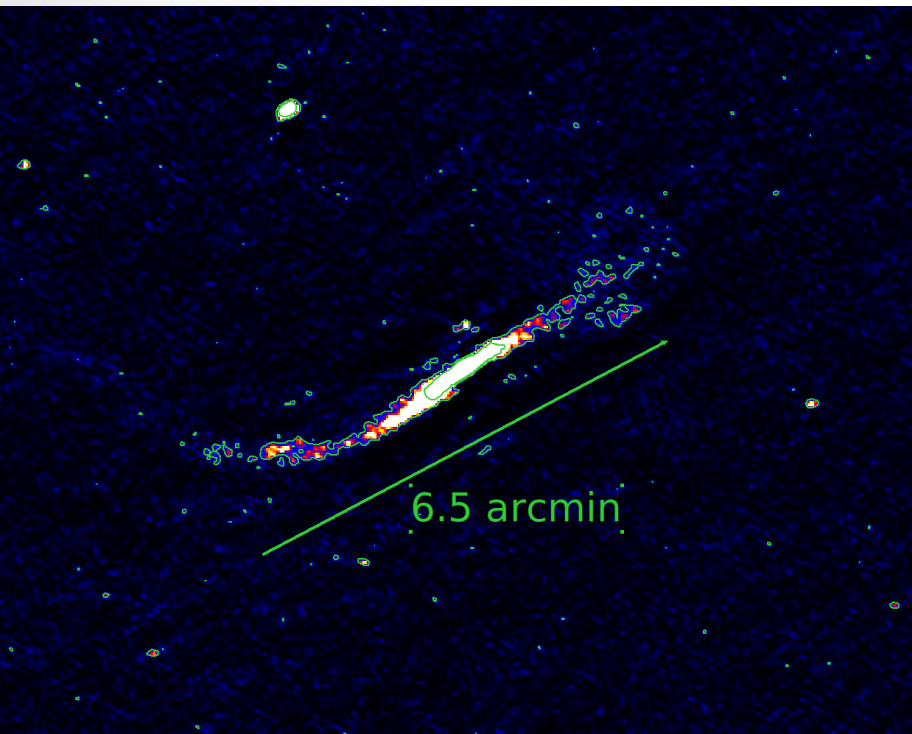
J0137.4-0827
 $1\sigma_{\text{rms}}$ is $40 \mu\text{Jy/b}$
Contours: $(3,4,6,8)\times\sigma$



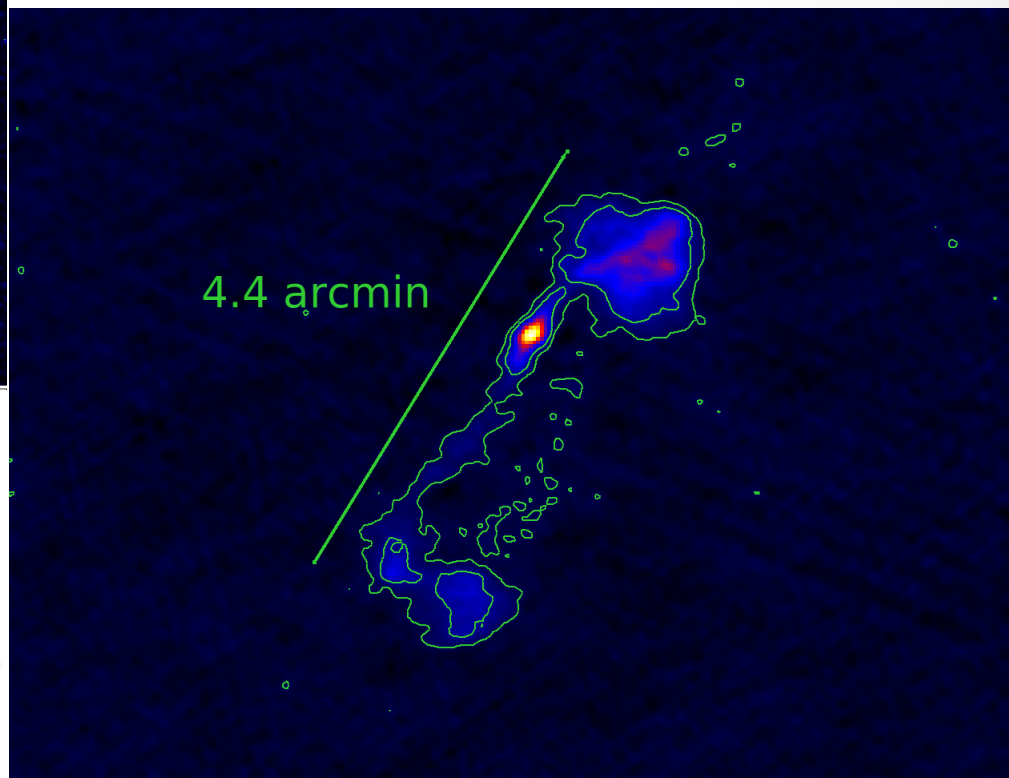
rms of full-resolution image:
 $22.5 \mu\text{Jy/b}$
rms in cluster region (R_{500}):
 $42.0 \mu\text{Jy/b}$



Extended Diffuse Sources



J0240.1+0116, 1σ rms: $24.2\mu\text{Jy}/\text{b}$
Contours: $(3,10) \times \sigma$



J0137.4-0827, 1σ rms: $22.5\mu\text{Jy}/\text{b}$
Contours: $(3,10) \times \sigma$

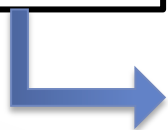


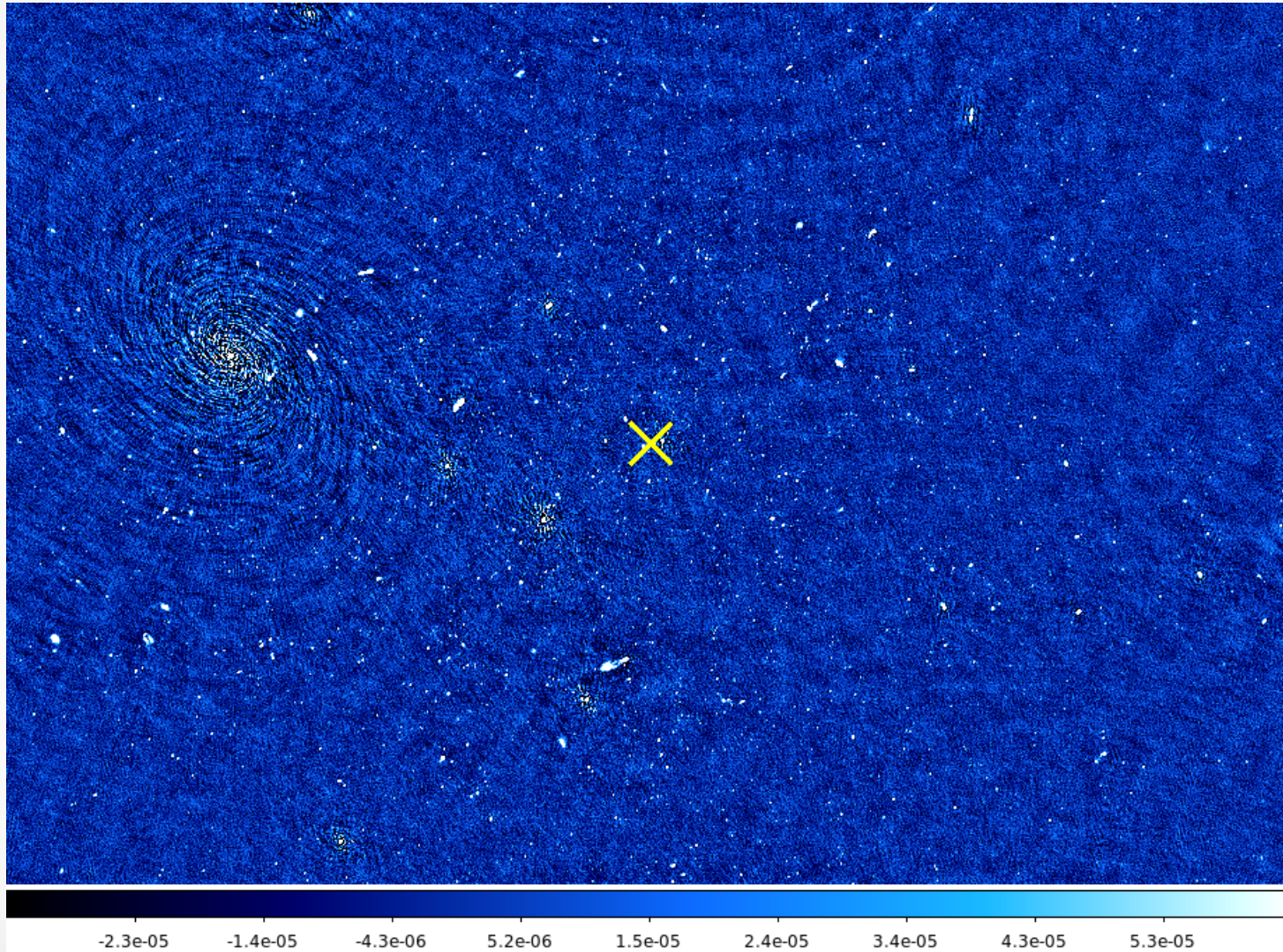
Table 1: uGMRT Analysis Statistics Summary

ACTPol cluster name	RMS in Final Image $\mu\text{Jy}/\text{beam}$	Beam ($'' \times ''$, $P.A^\circ$)	Flagged %
ACT-CL J0027.2–0456	53.8	$19.8 \times 6.2, -87.1$	77.7
ACT-CL J0034.4+0225	36.8	$7.9 \times 5.0, 60.3$	61.1
ACT-CL J0130.1–0305	66.5	$6.8 \times 5.4, 43.8$	55.1
ACT-CL J0137.4–0827	22.5	$6.6 \times 5.7, 47.8$	46.8
ACT-CL J0146.1–0316	60.3	$9.4 \times 7.2, -31.8$	68.5
ACT-CL J0154.0–0316	40.4	$6.8 \times 6.0, 76.3$	55.4
ACT-CL J0154.3–0736	29.5	$6.5 \times 6.1, -43.9$	54.2
ACT-CL J0240.1+0238	24.2	$6.8 \times 5.0, 61.8$	56.8
ACT-CL J0248.1+0238	17.2	$6.5 \times 5.4, 66.6$	40.3

MeerKAT Commissioning Data

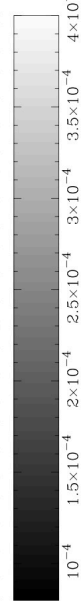
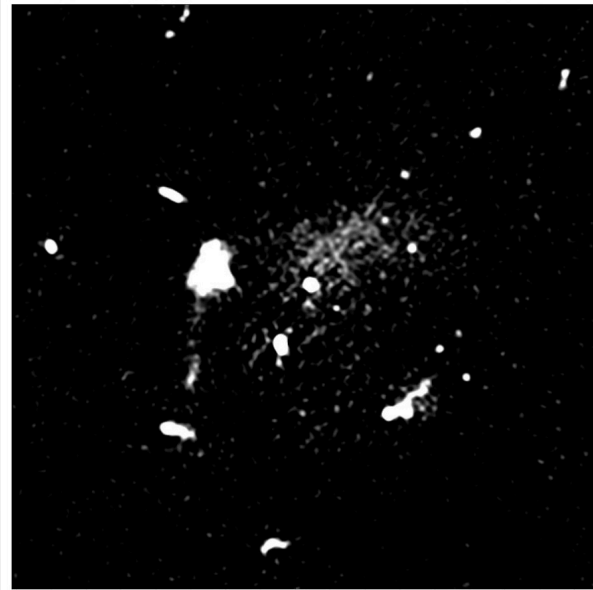
- NOT part of the ACTPol Sample
- Four Clusters:
 - **Abell3558**
 - J131-333 (AC03562)
 - RXCJ1314 (PKS1308-220)
 - **1E 0657-55.8 (Bullet Cluster)**
- 2-12 hours per cluster

Preliminary Results (Abell 3558)



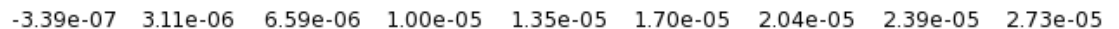
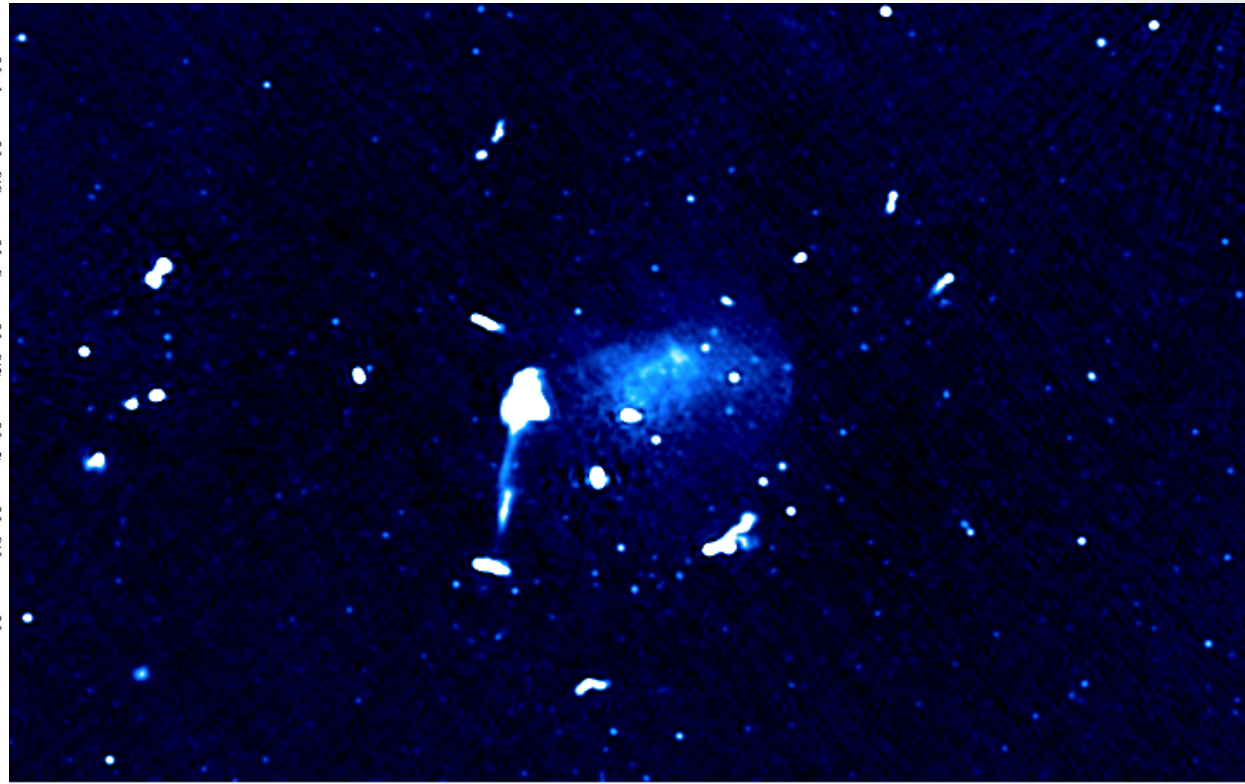
rms: 12.2 $\mu\text{Jy}/\text{b}$

Preliminary Results (Bullet Cluster)



ATCA, 1.3 GHz, rms: 44 μ Jy/b.

Source: Liang et al. 2000



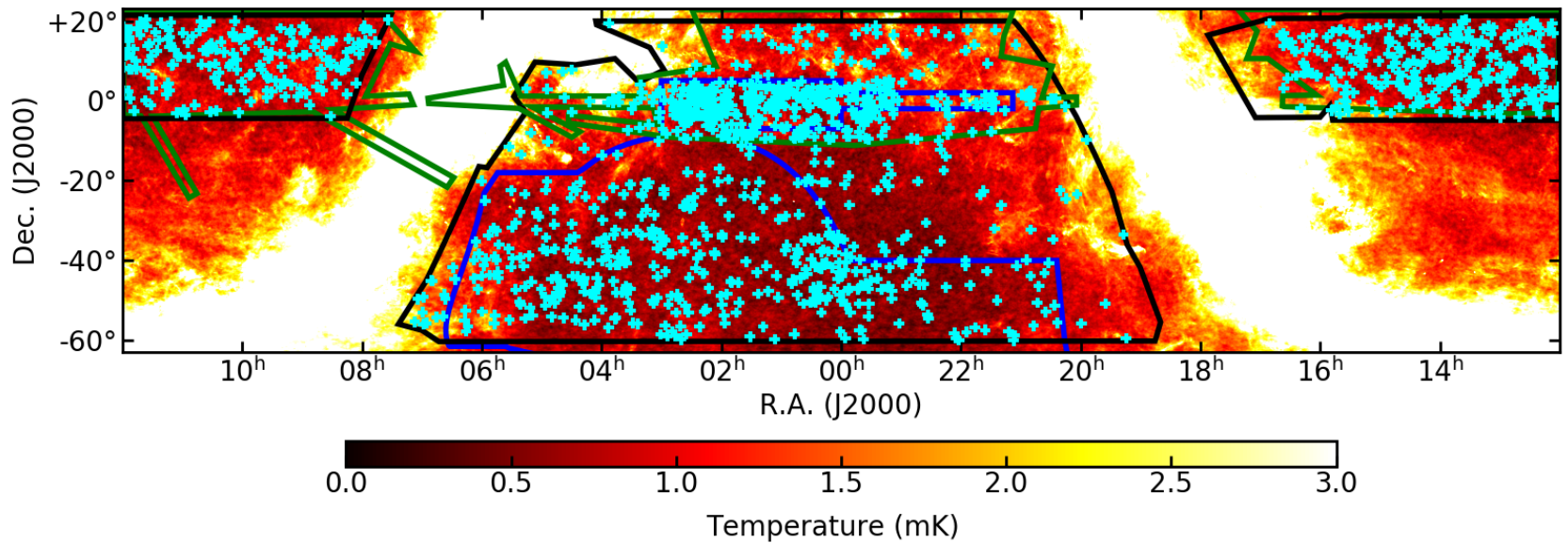
MeerKAT, 0.9-1.67 GHz,
rms: 7.3 μ Jy/b

Ongoing Work

- ACTPol Sample:
 - DDEs calibration using CubiCal/DDfacet
 - Multi-wavelength study of clusters with diffuse emission:
 - X-ray follow-up using Chandra
 - Optical spectroscopy using SALT
 - Scaling relations
- MeerKAT data Analysis

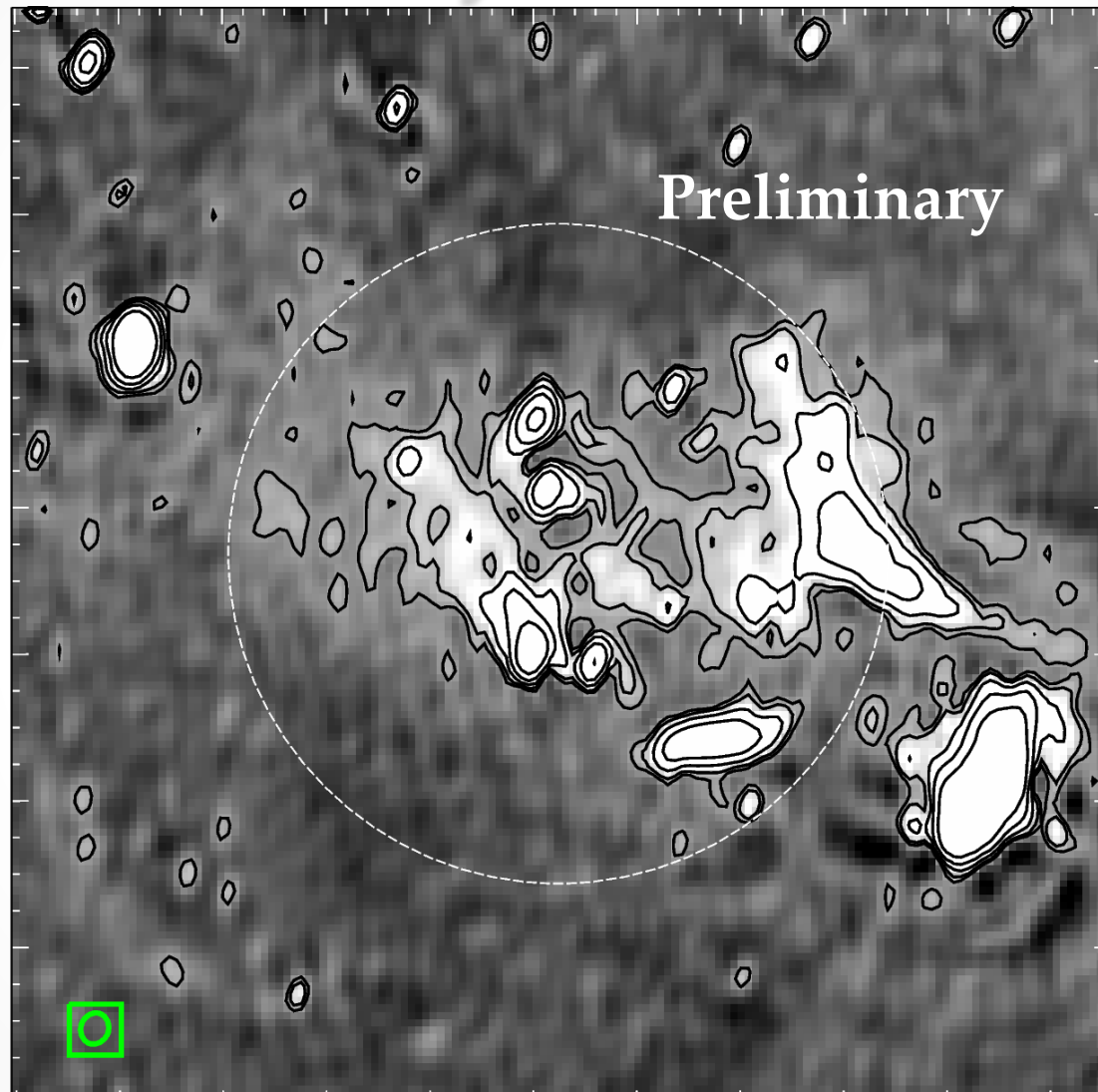
Future Work

- uGMRT project serves as precursor study for a larger program with MeerKAT
 - MERGHERS (MeerKAT Exploration of Relics, Giant Halos, and Extragalactic Radio Sources): targeted cluster survey
 - MALS & MIGHTEE: blind cluster survey



Preliminary positions of AdvACT clusters on the sky, overlaid on the Planck 353 GHz dust map. Source: Matt Hilton.

MeerKAT Early Science Detection



1 sigma central rms of $20 \mu\text{Jy}/\text{beam}$ and black contours show the 3, 5, 10, 20, 50 sigma levels. Source: Kenda Knowles.

NGIYABONGA!

THANK YOU!