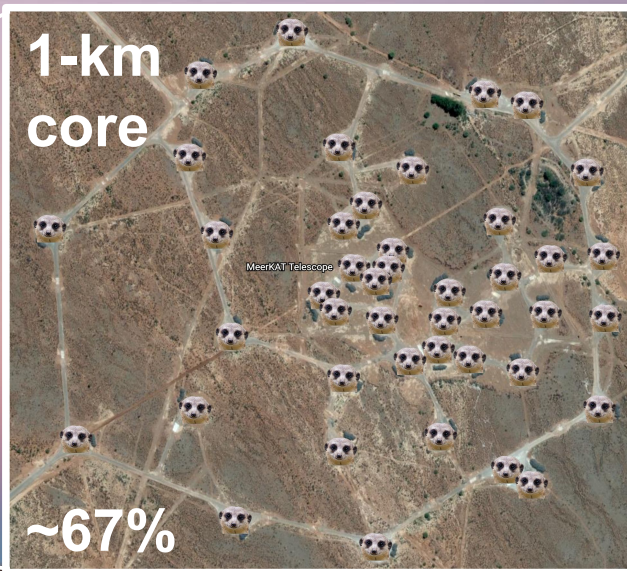
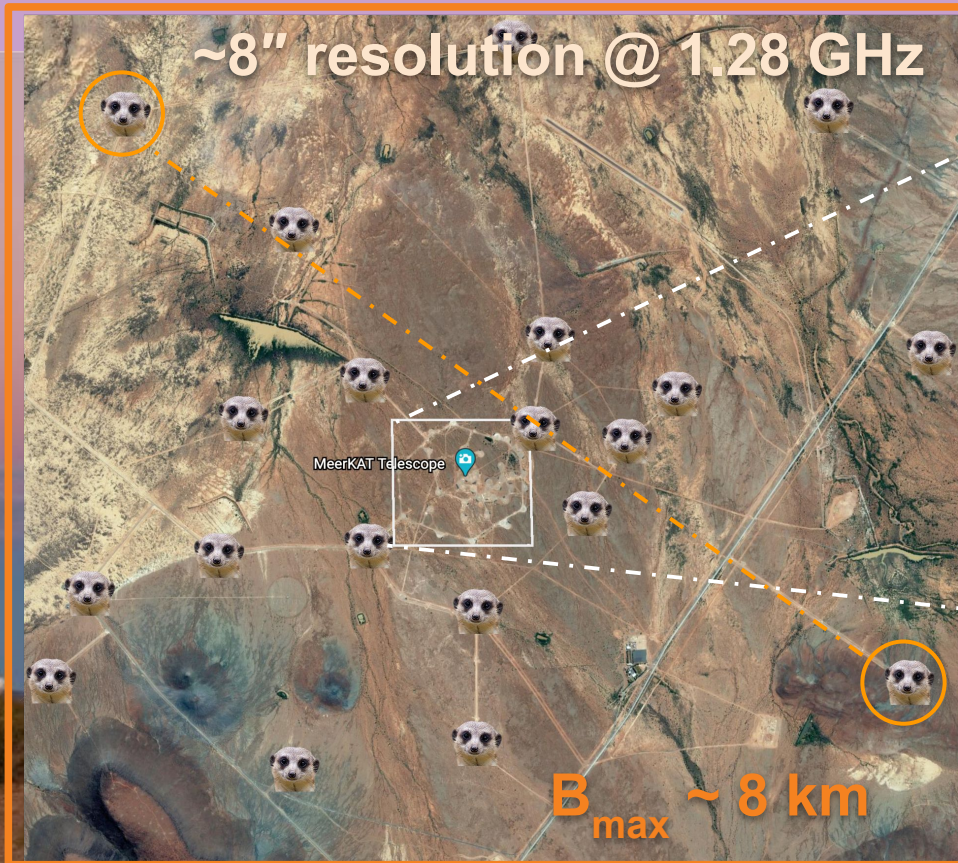


# Science with MeerKAT

Kenda Knowles  
Rhodes University / SARAO

Swiss SKA Days 2022

# The MeerKAT



Dense core for sensitivity to large scale emission

# Science Impact

ADS Public Library

## MeerKAT

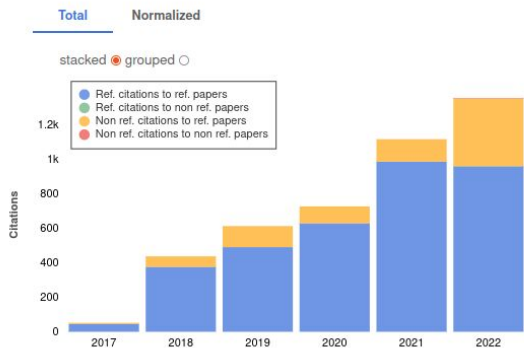
My ADS library

Number of Papers: 152  
 Date Created: Sep 11 2020, 4:35pm  
 Date Last Modified: Sep 22 2022, 10:17pm

View Library Export Metrics Explore Citation Helper

## Citations

	Totals	Refereed
Number of citing papers	3556	3555
Total citations	4296	4291
Number of self-citations	393	393
Average citations	28.3	29.6
Median citations	5	6
Normalized citations	98.6	98.3
Refereed citations	3483	3481
Average refereed citations	22.9	24.0
Median refereed citations	4	4
Normalized refereed citations	77.6	77.5



Monthly Notices of the ROYAL ASTRONOMICAL SOCIETY  
 MNRAS **505**, 6003–6016 (2021)  
 Advance Access publication 2021 May 31  
<https://doi.org/10.1093/mnras/stab1540>

## A new look at old friends – I. Imaging classical radio galaxies with uGMRT and MeerKAT

Bernie Fanaroff,<sup>1</sup> Dharam V. Lal,<sup>2\*</sup> Kshiti Thorat,<sup>5,6</sup> Landman H. Best,<sup>7</sup> Sphehile Makhathini<sup>9</sup> and Sarah V.<sup>1</sup>  
<sup>1</sup>South African Radio Astronomy Observatory, 2 Fir...

Monthly Notices of the ROYAL ASTRONOMICAL SOCIETY  
 MNRAS **502**, 2970–2983 (2021)  
 Advance Access publication 2021 January 15  
[doi:10.1093/mnras/stab104](https://doi.org/10.1093/mnras/stab104)

## Primary beam effects of radio astronomy antennas – II. Modelling MeerKAT L-band beams

K. M. B. Asad,<sup>1,2,3,4\*</sup> J. N. Girard,<sup>5</sup> M. de Villiers,<sup>4</sup> T. Ansah-Narh,<sup>2</sup> K. Iheanetu,<sup>2</sup> O. Smirnov,<sup>2,4</sup> M. S. ...  
<sup>1</sup>South African Radio Astronomy Observatory, 2 Fir...

Monthly Notices of the ROYAL ASTRONOMICAL SOCIETY  
 MNRAS **506**, 2753–2765 (2021)  
<https://doi.org/10.1093/mnras/stab1817>  
 ka, 1229, Bangladesh  
 rica  
 outh Africa  
 r 7405, South Africa

## MIGHTEE-HI: discovery of an H I-rich galaxy group at z = 0.044 with MeerKAT

Shilpa Ranchod,<sup>1,2\*</sup> Roger P. Dean,<sup>3</sup> Bradley S. Frank,<sup>5,6,7</sup> Matt J. Jarvis,<sup>8</sup> Kelley M. Hess,<sup>11,12</sup> Madalina Tudor,<sup>13</sup> Rebecca A. A. Bowler,<sup>9,3</sup> Jordan D. ...  
<sup>1</sup>Department of Physics, University of Pretoria, Private  
<sup>2</sup>Wis Centre for Astrophysics, School of Physics, Unive

Monthly Notices of the ROYAL ASTRONOMICAL SOCIETY  
 MNRAS **505**, 3698–3721 (2021)  
 Advance Access publication 2021 May 17  
<https://doi.org/10.1093/mnras/stab1365>

## H I intensity mapping with MeerKAT: calibration pipeline for multidish autocorrelation observations

Jingying Wang,<sup>1\*</sup> Mario G. Santos,<sup>1,2</sup> Philip Bull,<sup>3,1</sup> Keith Grainge,<sup>4</sup> Steven Cunnington,<sup>3</sup> José Fonseca,<sup>5,6,3,1</sup> Melis O. Irfan,<sup>1,3</sup> Yichao Li,<sup>1</sup> Alkistis Poursidou,<sup>3,1</sup> Paula S. Soares,<sup>3</sup>

Monthly Notices of the ROYAL ASTRONOMICAL SOCIETY  
 MNRAS **506**, 4621–4631 (2021)  
 Advance Access publication 2021 July 1  
<https://doi.org/10.1093/mnras/stab1791>

## Spectropolarimetry and photometry of the early afterglow of the gamma-ray burst GRB 191221B

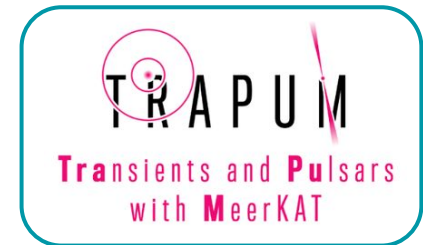
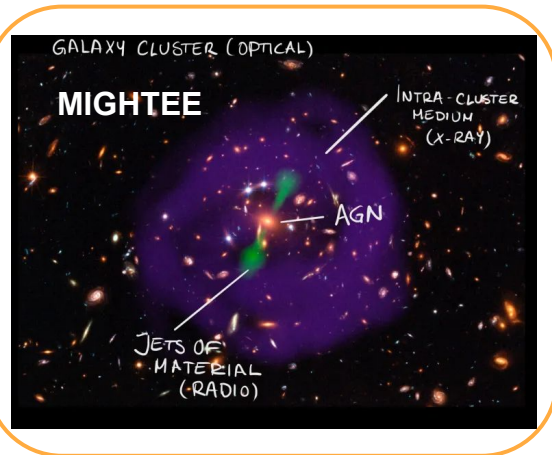
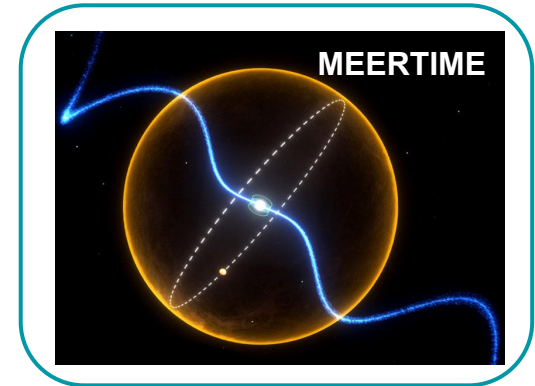
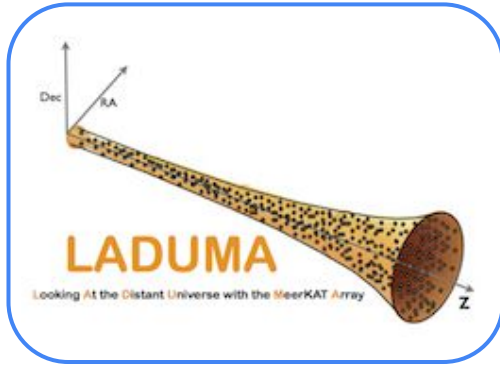
D. A. H. Buckley,<sup>1,2\*</sup> S. Bagnulo,<sup>3</sup> D. M. Hewitt,<sup>1,2</sup> S. Razaque,<sup>11</sup> N. P. A. J. van der Horst,<sup>15,16</sup> K. Wiersema,<sup>9</sup> I. Gorbunov,<sup>9</sup> D. N. Groenewald,<sup>9,1,2</sup> R. Podesta,<sup>25,26</sup> J. K. Thomas,<sup>1</sup> N. Ty

Monthly Notices of the ROYAL ASTRONOMICAL SOCIETY  
 MNRAS **502**, 407–422 (2021)  
 Advance Access publication 2021 January 8  
[doi:10.1093/mnras/stab037](https://doi.org/10.1093/mnras/stab037)

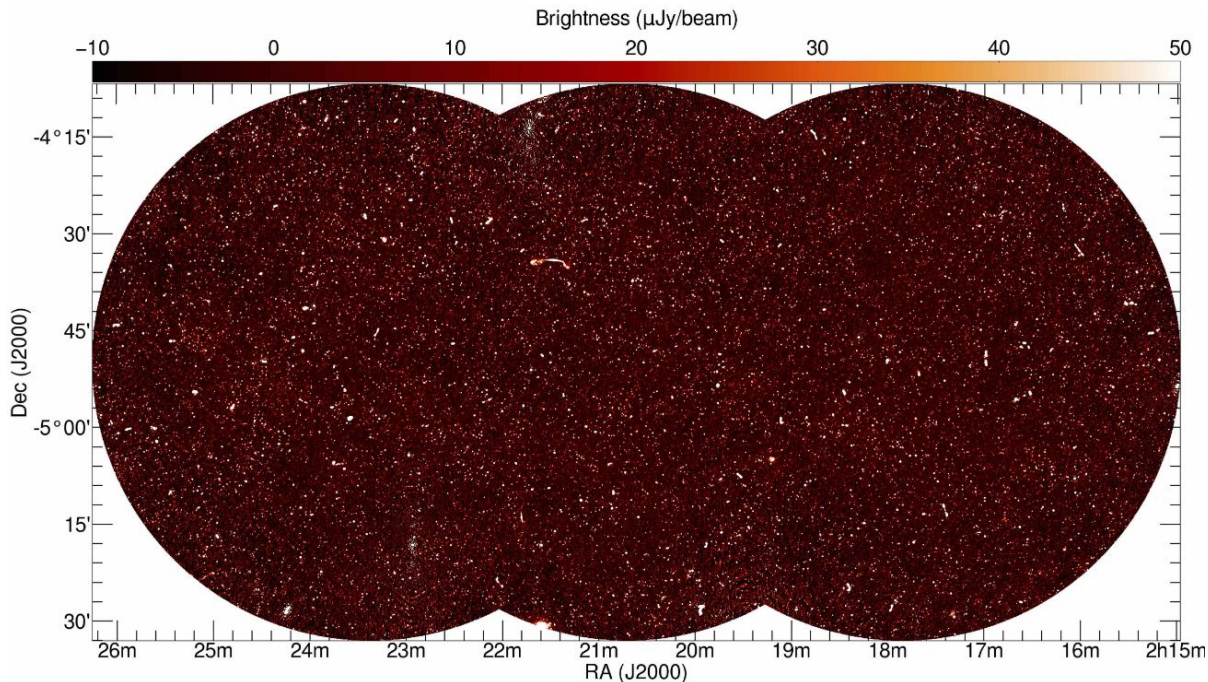
## Measurements of pulse jitter and single-pulse variability in millisecond pulsars using MeerKAT

A. Parthasarathy,<sup>1,2,3\*</sup> M. Bailes,<sup>1,3\*</sup> R. M. Shannon,<sup>1,3\*</sup> W. van Straten,<sup>4</sup> S. Osłowski,<sup>1,5</sup> S. Johnston,<sup>6</sup> R. Spiewak,<sup>1,3,7</sup> D. J. Reardon,<sup>1,5</sup> M. Kramer,<sup>2</sup> V. Venkatraman Krishnan,<sup>2</sup> T. T. Pennucci,<sup>8,9</sup> F. Abbate,<sup>2</sup> S. Buchner,<sup>10</sup> F. Camilo,<sup>10</sup> D. J. Champion,<sup>2</sup> M. Geyer,<sup>10</sup> B. Hugo,<sup>10,11</sup> A. Jameson,<sup>1,3</sup> A. Karastergiou,<sup>12</sup> M. J. Keith<sup>7</sup> and M. Serylak<sup>10</sup>

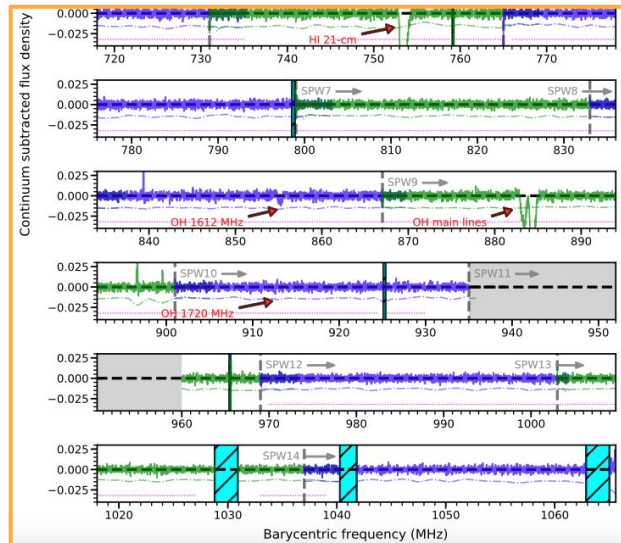
# MeerKAT Large Survey Projects (LSPs)



# MeerKAT Large Survey Projects (LSPs)

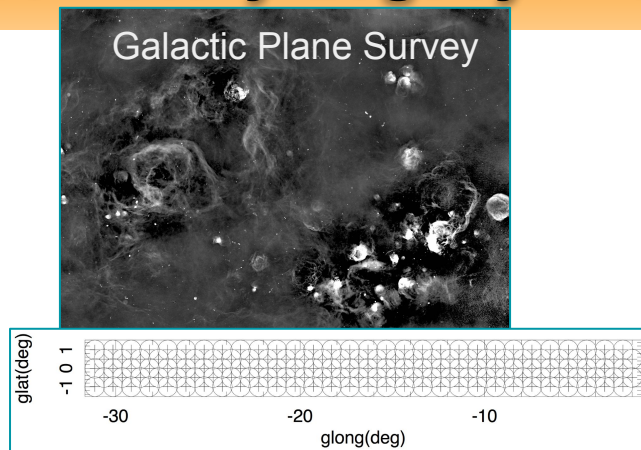


Heywood et al. 2021  
MIGHTEE Early Science:  $3.5 \text{ deg}^2$  in XMM-LSS  
and  $1.6 \text{ deg}^2$  of COSMOS

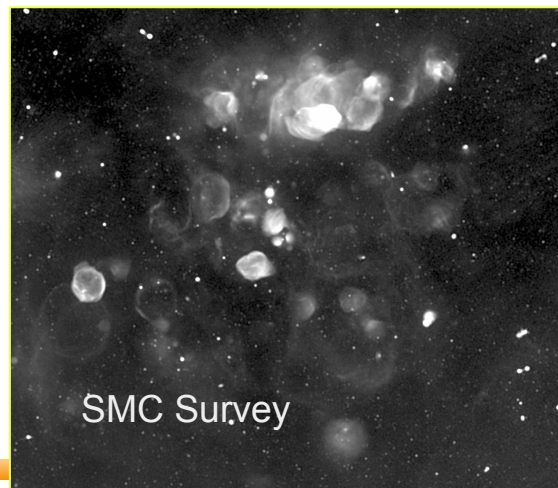
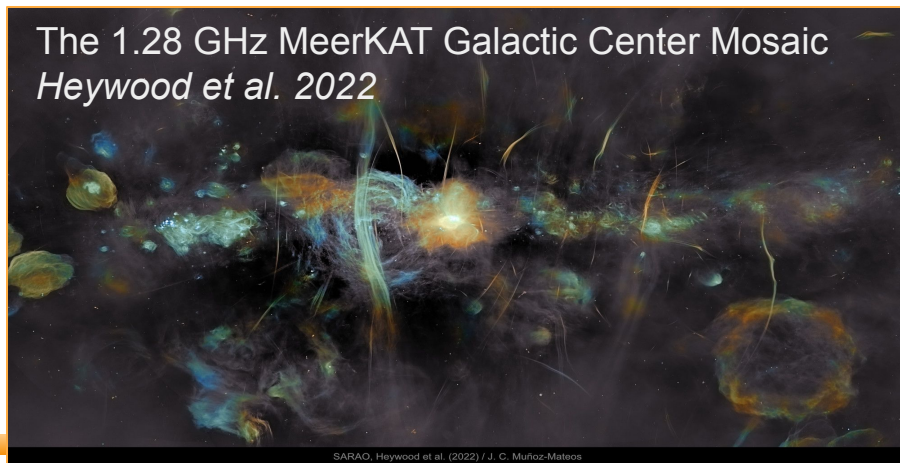
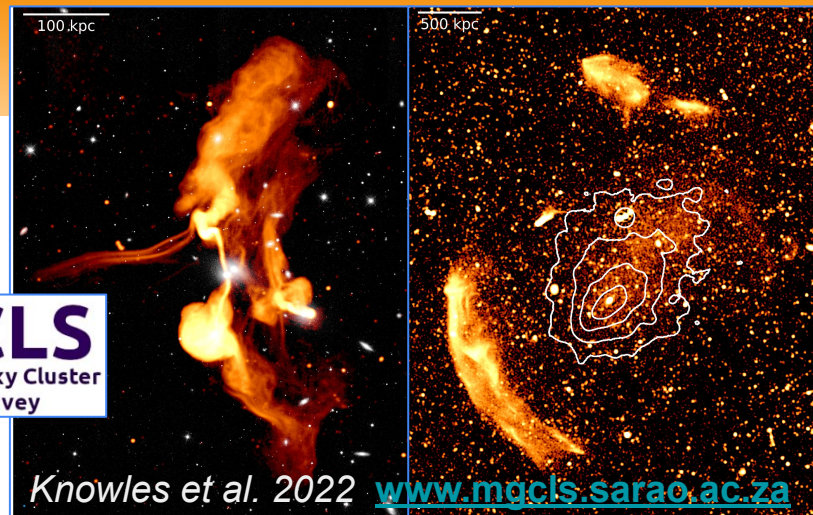


Gupta et al. 2021  
MALS Early Science: First  
MeerKAT UHF spectrum  
 $\sim 4000$  SNR in 90min!

# Observatory Legacy Programmes

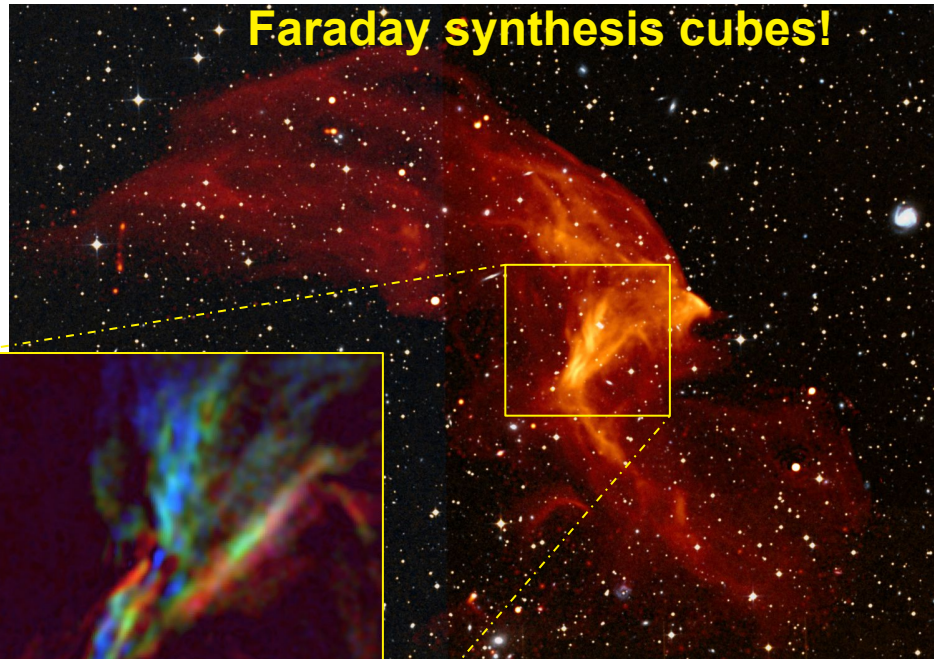


**MGCLS**  
MeerKAT Galaxy Cluster  
Legacy Survey

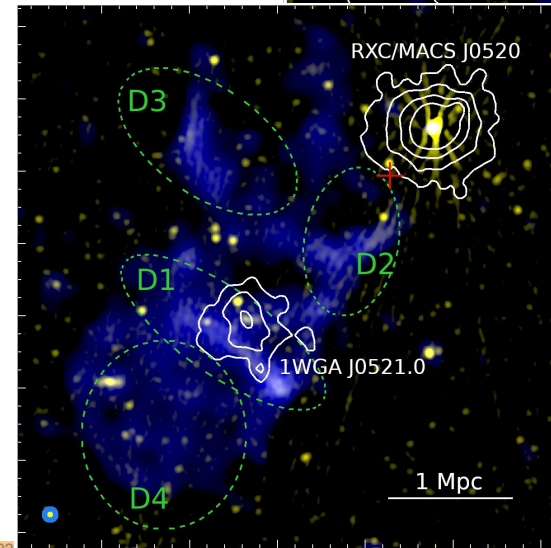
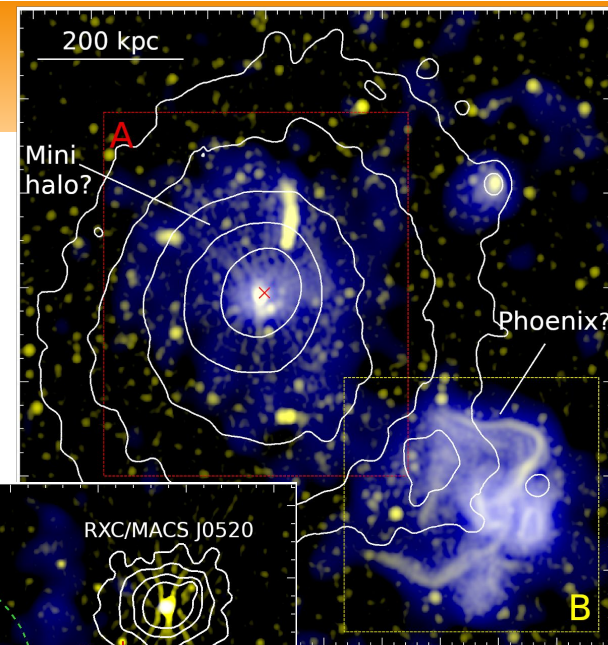


# MGCLS: Diffuse Cluster Emission

★ 62/115 clusters (54%) with 99 individual detections



De Gasperin et al. 2022,  
A&A, 659, 146



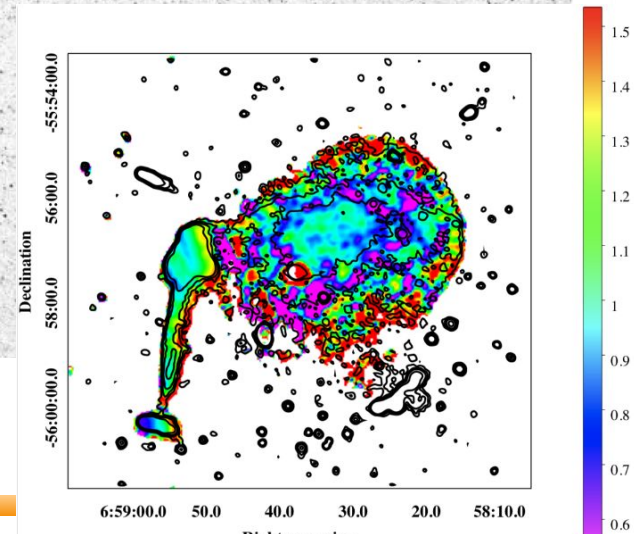
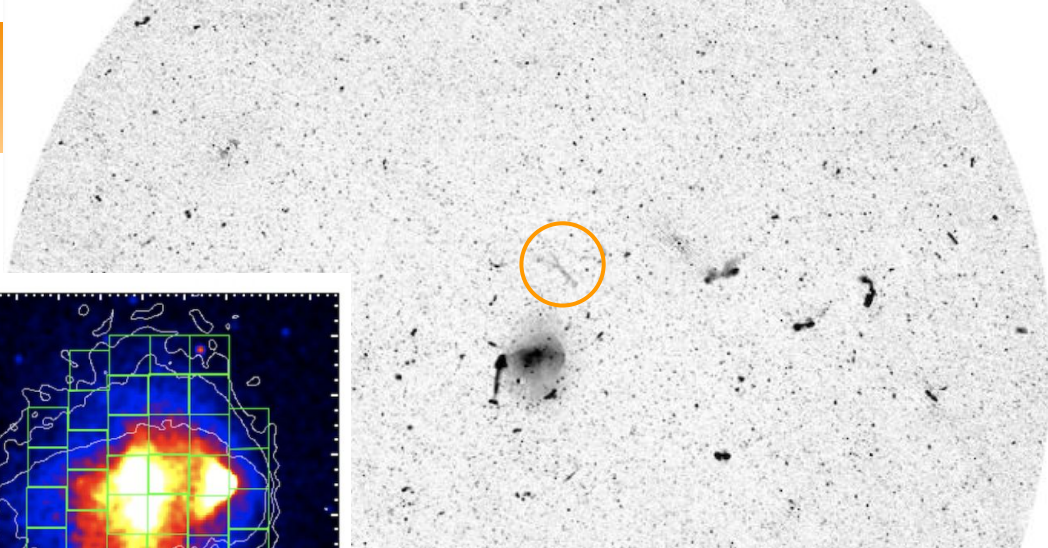
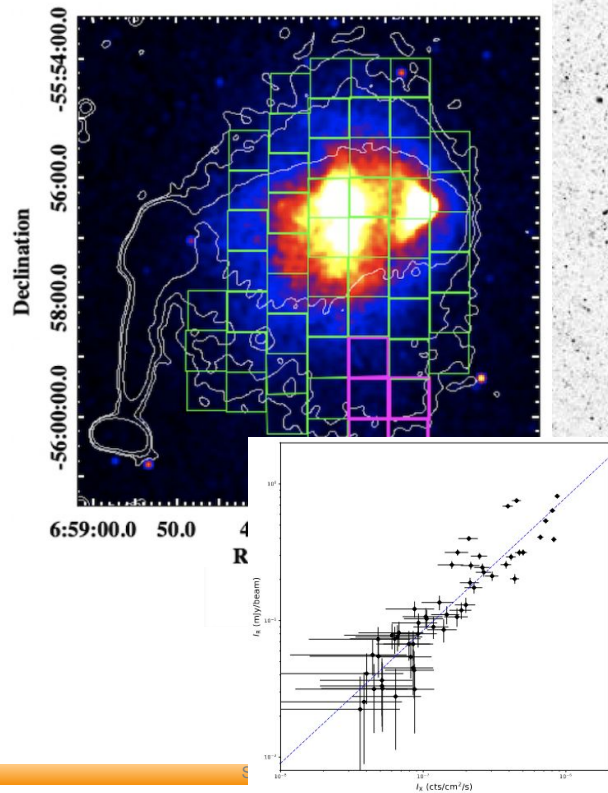
Knowles+2022

New views  
of known  
sources

# MGCLS: Bullet Cluster

Sikhosana et al. MNRAS *sub.*, arXiv:2207.05492

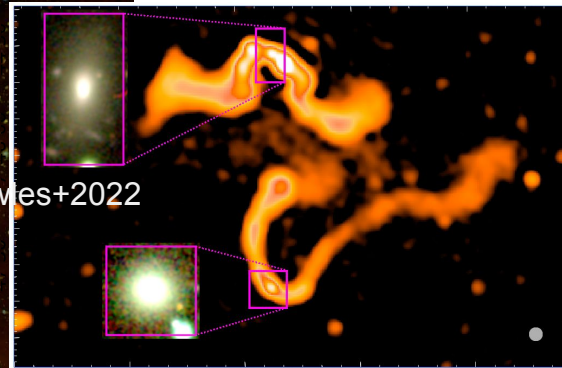
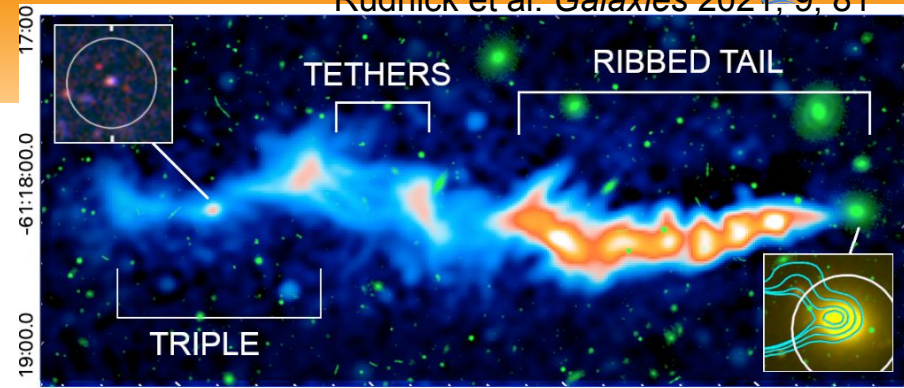
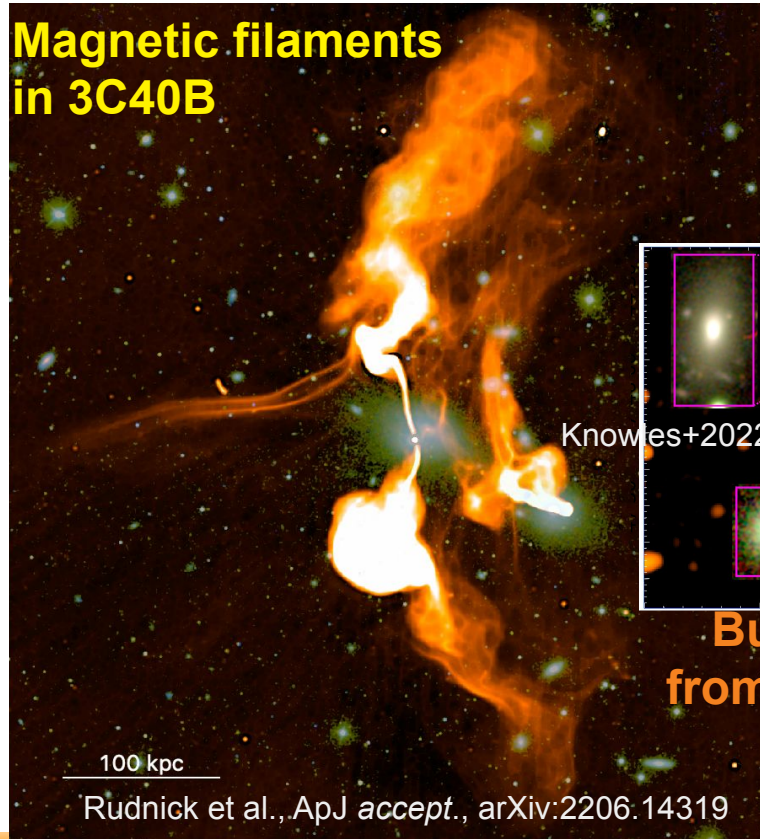
- ★ Detect much larger N/S extent to the halo
- ★ Detect new forked diffuse source
- ★ In-band spix map shows flat central region



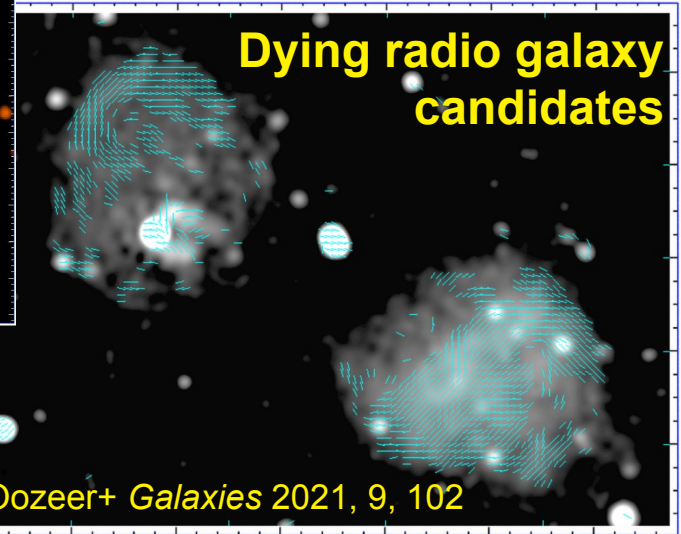


# MGCLS: Radio galaxies

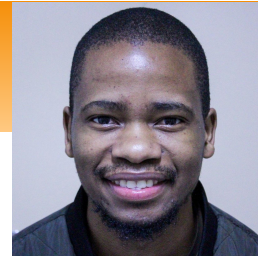
## Magnetic filaments in 3C40B



Bulk motions far from known clusters



# MGCLS: Star-forming galaxies

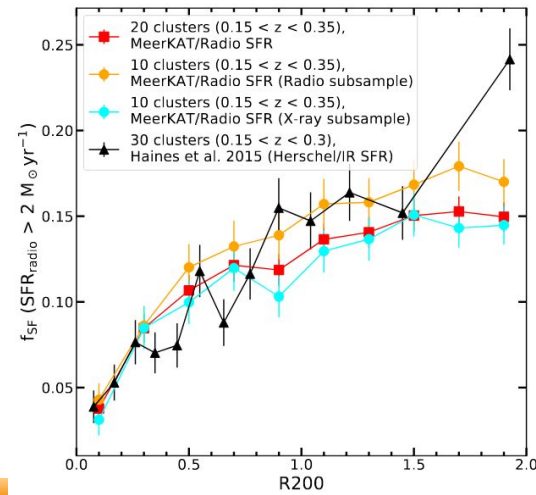
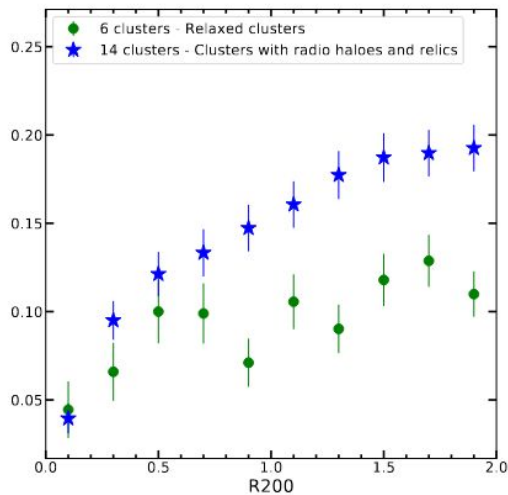
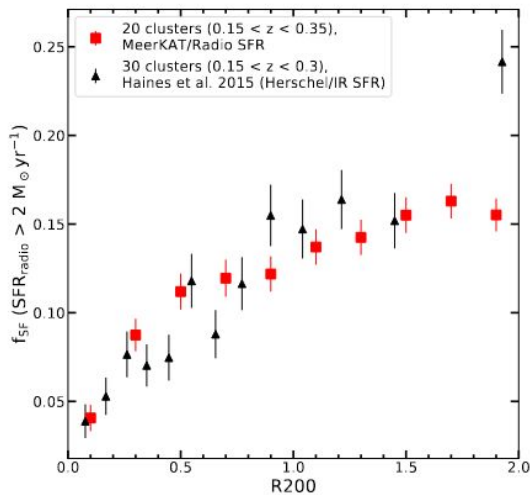


Kesebonye et al., MNRAS *sub.*

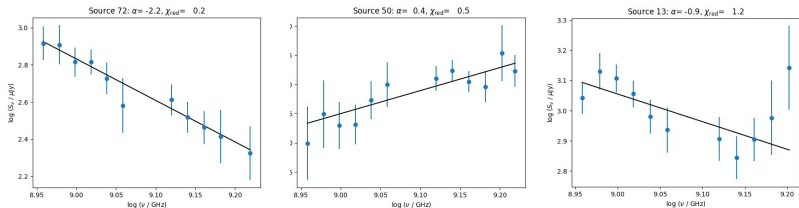
## ★ 20 massive clusters (ACT DR5–MGCLS)

- $M_{200} > 4 \times 10^{14} M_{\odot}$
- $0.15 < z < 0.35$

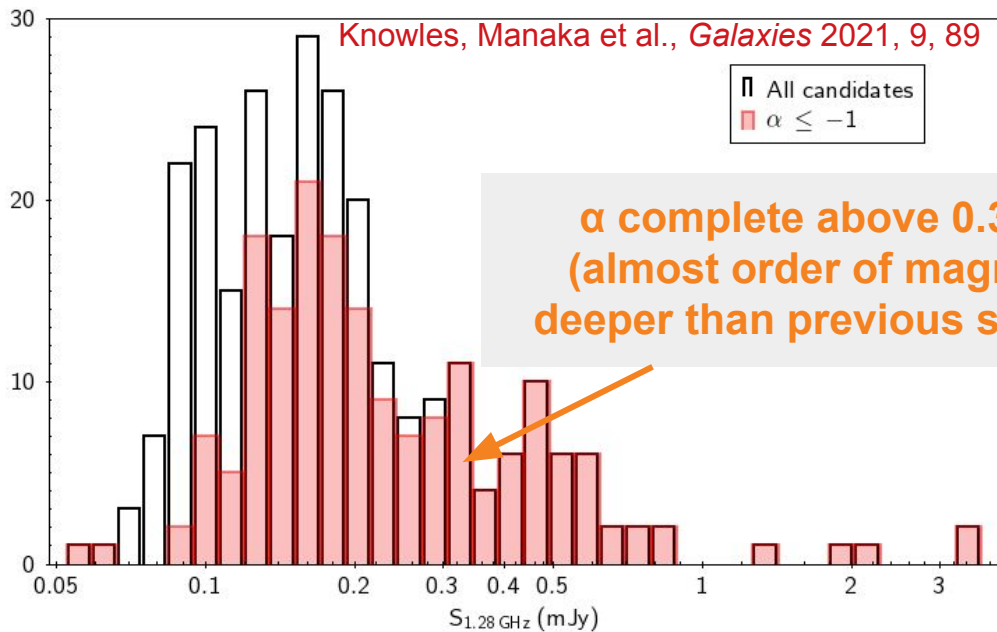
**Different SFR trends in clusters with vs without diffuse cluster emission**



# MGCLS: HzRG searches



- ★ MGCLS source catalogue for Abell 2751
  - 3610 compact sources

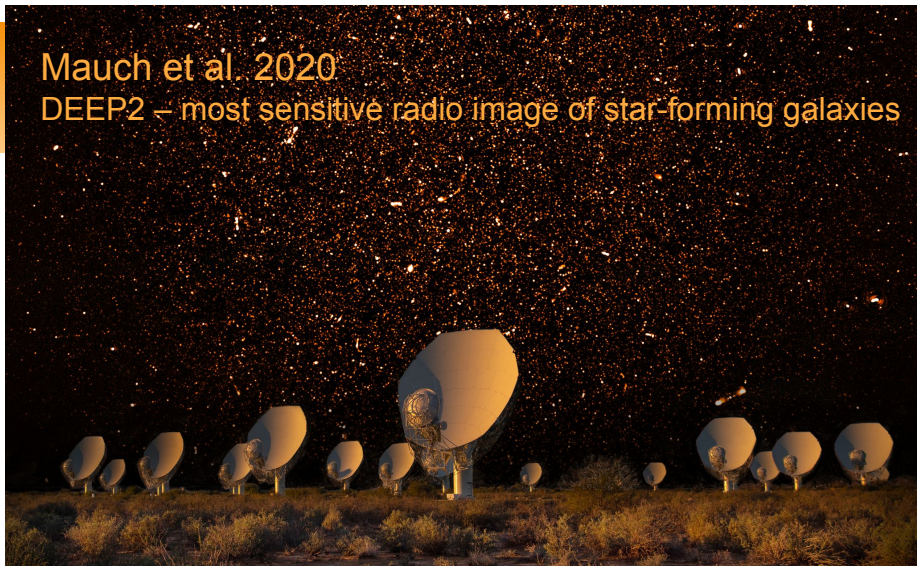


- ★ Catalogue cuts:
  - $> 5\sigma$  flux density
  - $< 10''$  angular size
  - No match in DECaLS, AllWISE
  - MeerKAT  $\alpha < -1$

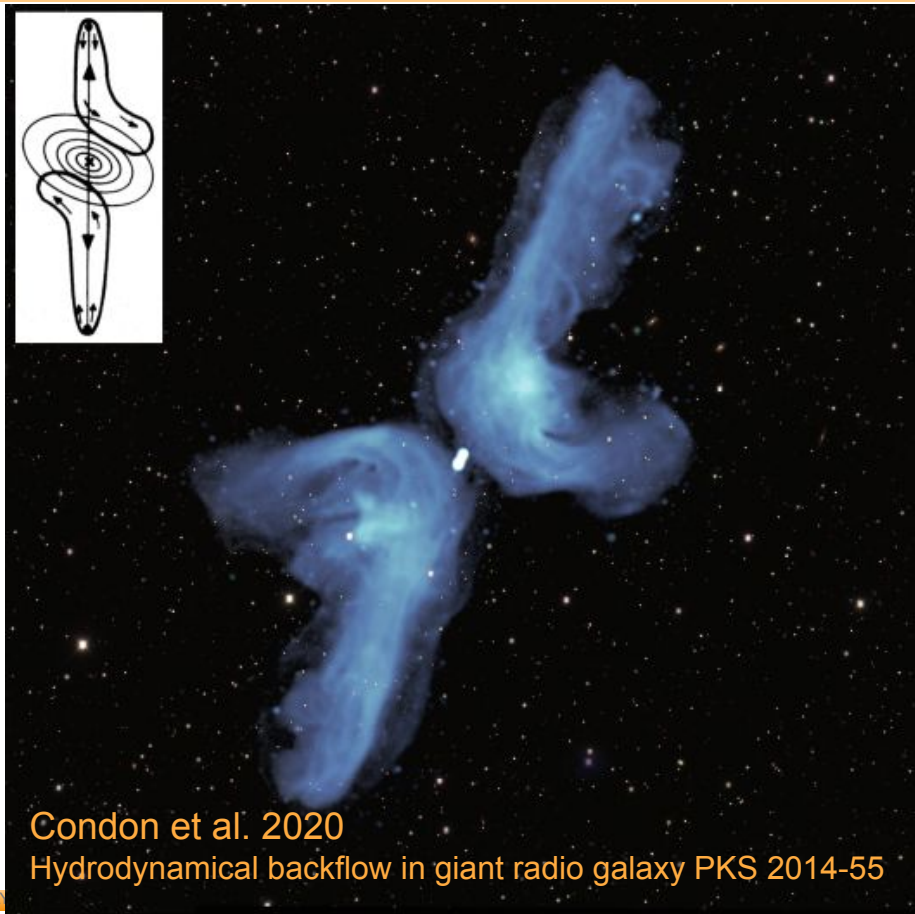
**179 (+95) new HzRG candidates!**

Mauch et al. 2020

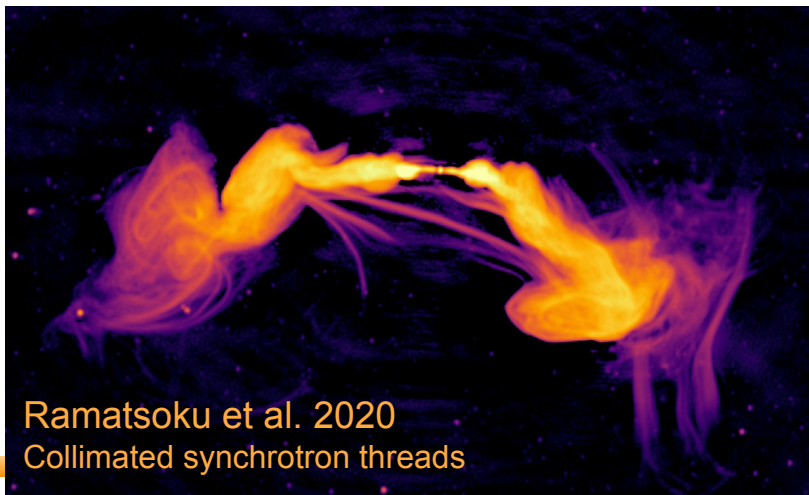
DEEP2 – most sensitive radio image of star-forming galaxies



# Continuum studies



Ramatsoku et al. 2020  
Collimated synchrotron threads



Condon et al. 2020  
Hydrodynamical backflow in giant radio galaxy PKS 2014-55

# The MERGHERS survey

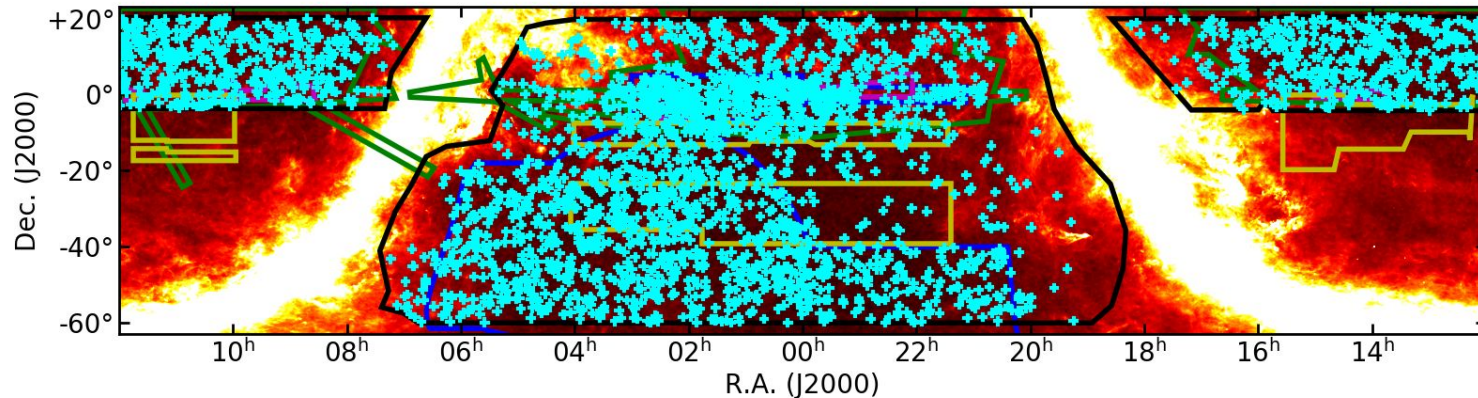
Knowles et al. 2016, POS, 30

## MeerKAT Exploration of Relics, Giant Halos, and Extragalactic Radio Sources

- ★ Statistical studies over wide  $z$ ,  $M$  ranges
  - Diffuse cluster emission
  - Cluster magnetic fields
- ★ Well-selected cluster sample: ACT-DR5
  - 4000+ confirmed SZ clusters

**Short track  
(~1–3 hr on source)**

Hilton et al. 2021, ApJS, 253, 3

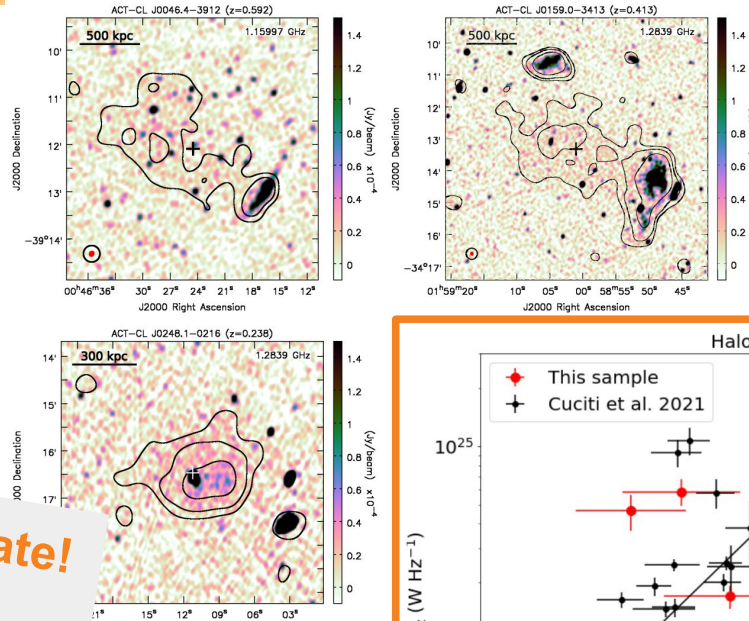


# MERGHERS Pilot

Knowles et al. 2021, *MNRAS*, 504, 1749

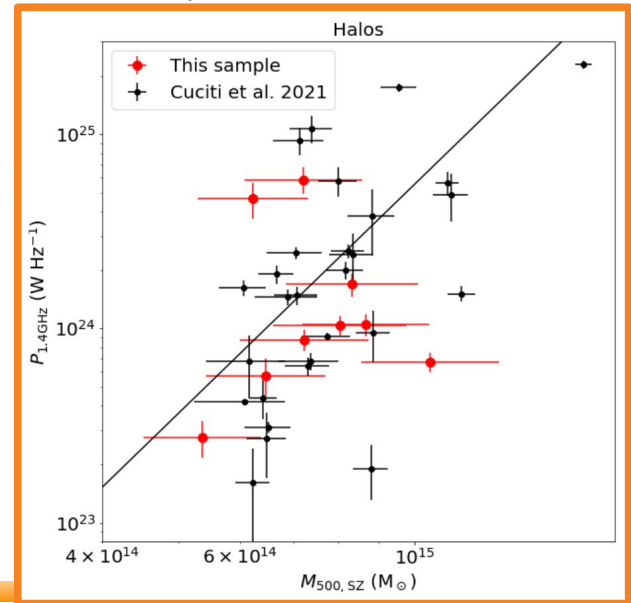
- ★ 13 cluster targets @ L-band
  - Preliminary ACT DR5
  - ACT SNR > 10
  - $z < 0.6$
  - $M_{500,SZ} > 6 \times 10^{14} M_{\odot}$
  - **Candidate mergers**

**70% detection rate!**  
11 new diffuse  
emission detections



Still to do:

- ★ spectral index studies
- ★ Dynamical state studies  
e.g., Pillay et al. 2021, *Galaxies*, 9, 97



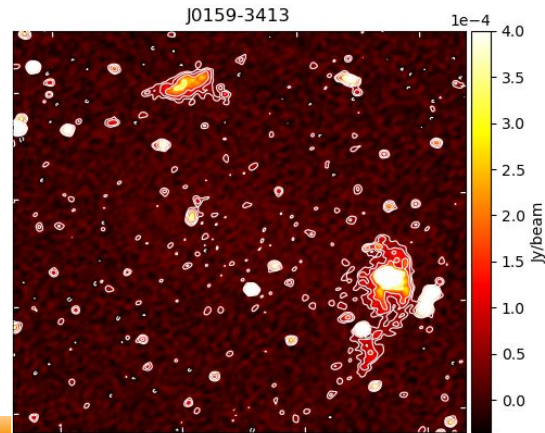
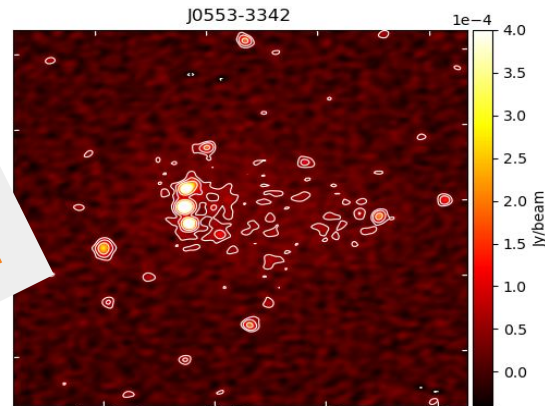
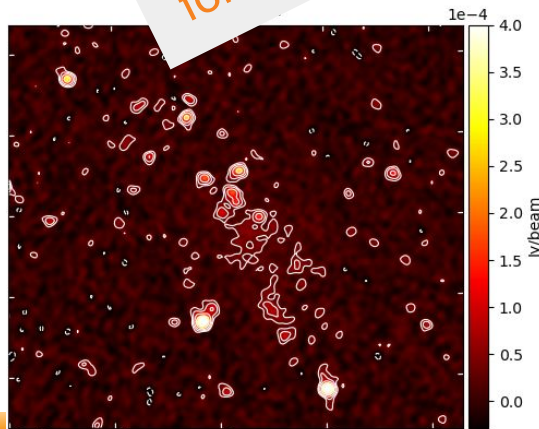
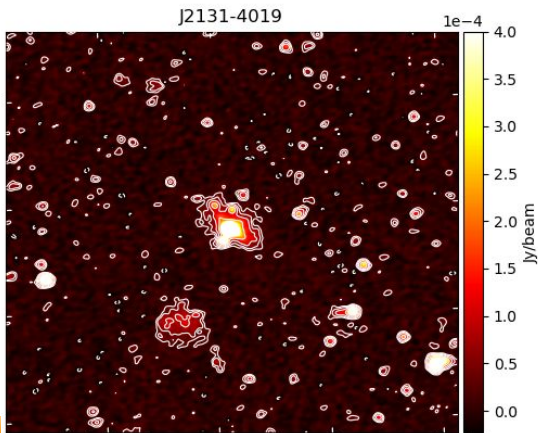
# MERGHERS Tier 1

Mngqibisa et al., *in prep*

★ Focus on building a statistical sample in the mid- to high-redshift range

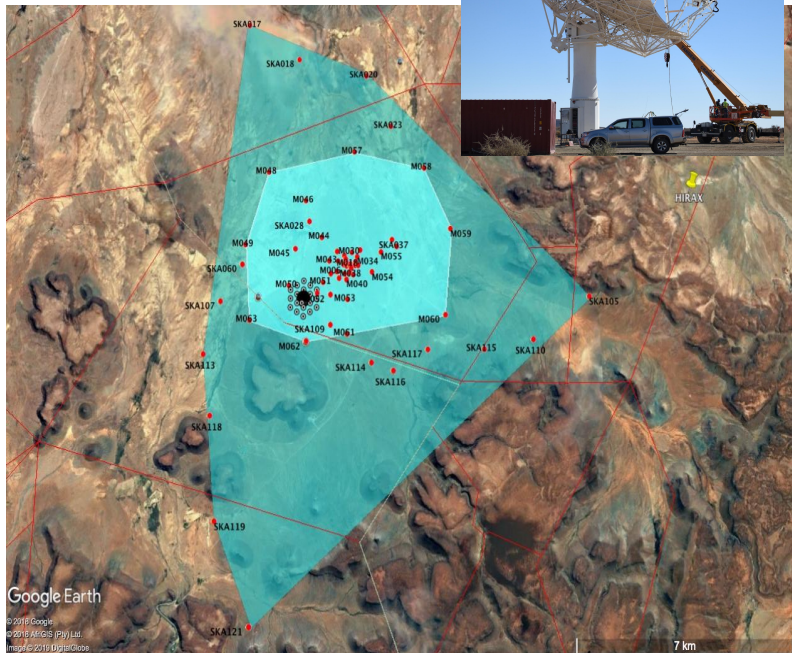
- Published ACT DR5
- $0.4 < z < 0.6$
- $M_{500,SZ} > 7 \times 10^{14} M_{\odot}$

21 clusters  
~40% detection rate  
for diffuse emission



# What's Next...

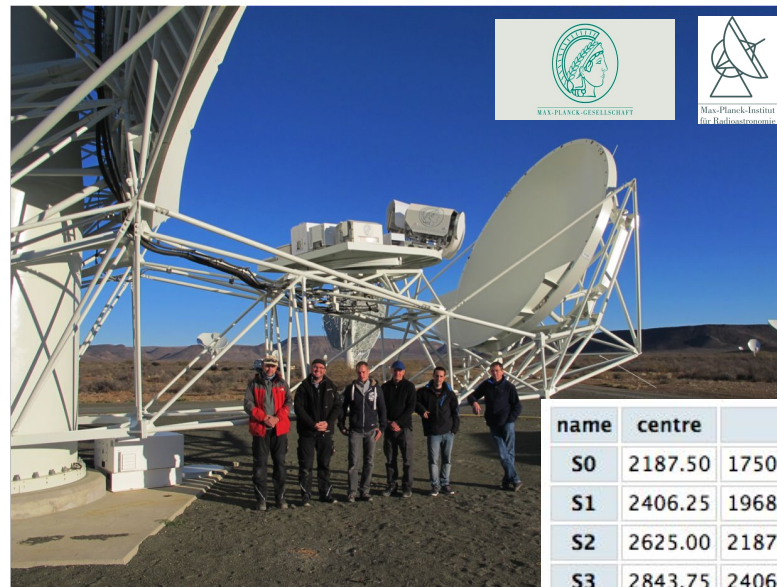
## MeerKAT extension



13 SKA dishes at SKA-mid positions, increasing  $B_{\max}$  to 17-km



## S-band commissioning



name	centre	range
S0	2187.50	1750.00 – 2625.00
S1	2406.25	1968.75 – 2843.75
S2	2625.00	2187.50 – 3062.50
S3	2843.75	2406.25 – 3281.25
S4	3062.50	2625.00 – 3500.00

- Installed on all 64 dishes
- Array-level commissioning underway (SARAO + MPfIR)



# Summary

- Superb engineering has created a premier radio telescope in Africa
- MeerKAT's science scope is very broad, already revealing new structures and helping to solve long-held puzzles
- Variety of publicly available data from LSPs and other programmes, e.g. MGCLS
- Lots still to do before the first phase of the SKA comes online, so watch this space!



# Postdoc position @ RU for MGCLS DR2

- ★ Advanced calibration of all fields (DDEs and polarization)
- ★ Your choice of science exploitation of DR2
- ★ 3-year post based in Cape Town / Makhanda

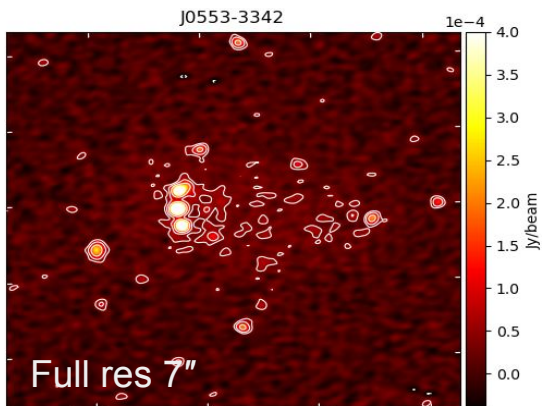
For more info contact myself or Oleg Smirnov  
[k.knowles@ru.ac.za](mailto:k.knowles@ru.ac.za) / [o.smirnov@ru.ac.za](mailto:o.smirnov@ru.ac.za)

Job Ad!

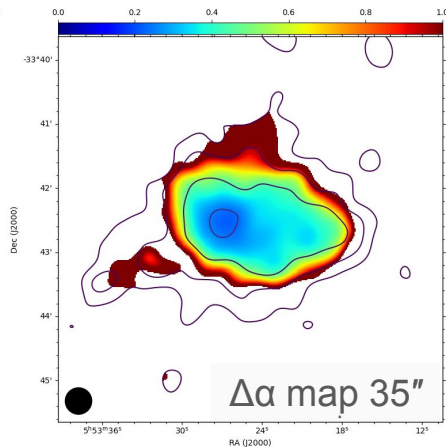
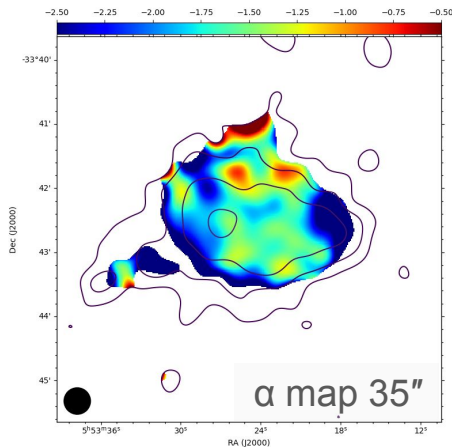
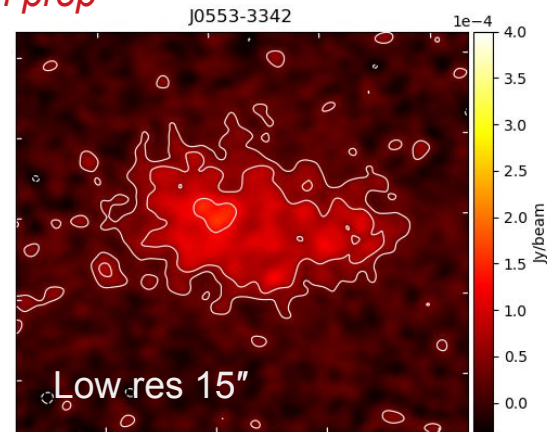


# MERGHERS Tier 1

Mngqibisa et al., *in prep*



Source subtraction  
+  
LR imaging



In-band spectral index maps

- ★ Split BW into two
- ★ Match  $uv$ -range
- ★ Convolve to 35"

# MERGHERS: next steps

- ★ Radio analysis of T1 clusters
  - Complete intensity + spix analysis
  - Calibrate + image in Stokes Q & U
- ★ Dynamical state analysis of T1 clusters
  - eRosita IEC
  - DES data
  - SALT spectroscopy
- ★ 2022 MeerKAT Open Time proposal (UHF)
  - Expand T1 sample to lower mass
  - **55 clusters** with  $M_{500,SZ} > 4 \times 10^{14} M_{\odot}$
- ★ Cycle 43 GMRT proposal for spectral studies

