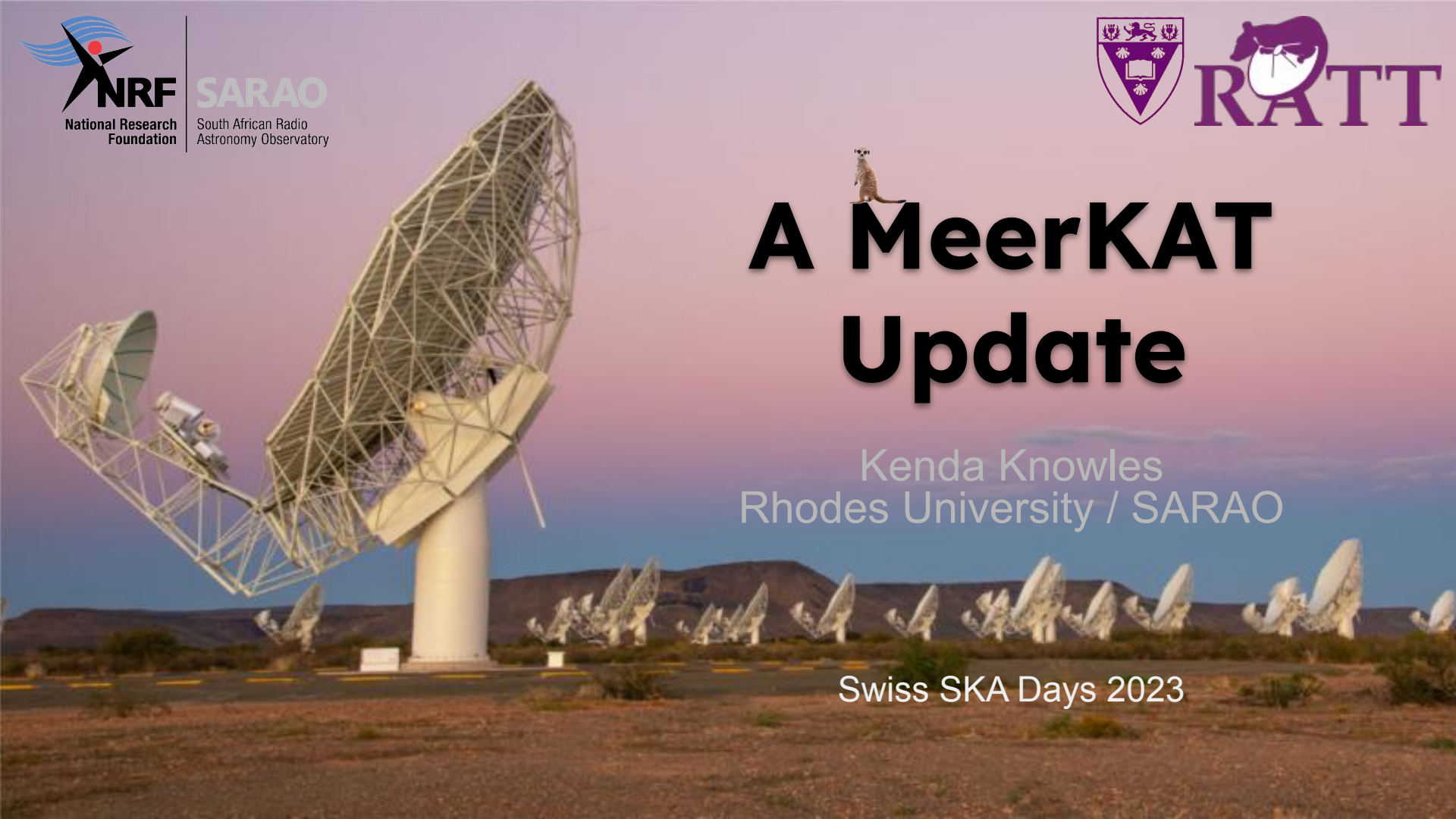


A MeerKAT Update

Kenda Knowles
Rhodes University / SARAO

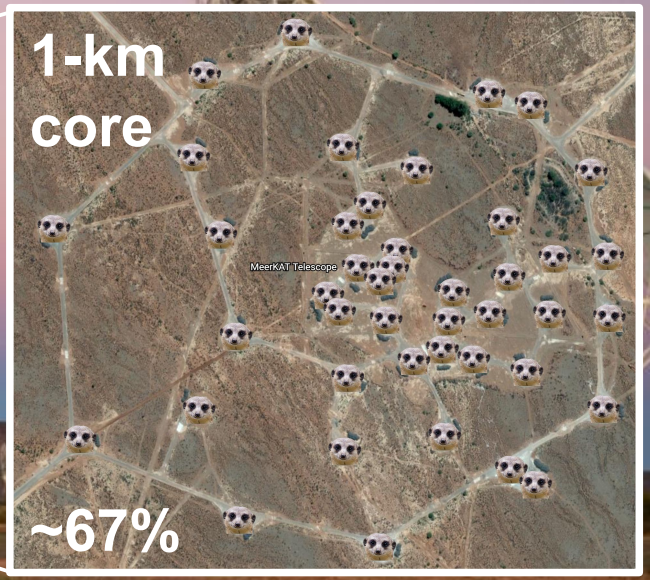
Swiss SKA Days 2023

The MeerKAT Array

64 x 13.5m antennas

Operating bands:

UHF	580 – 1015 MHz
L	900 – 1670 MHz
S	1.75 – 3.5 GHz



Dense core for sensitivity to large scale emission

Wide Science Impact

ADS Public Library

MeerKAT

My ADS library

Number of Papers:	Date Created:	Date Last Modified:
229	Sep 11 2020, 4:35pm	Aug 28 2023, 1:46pm

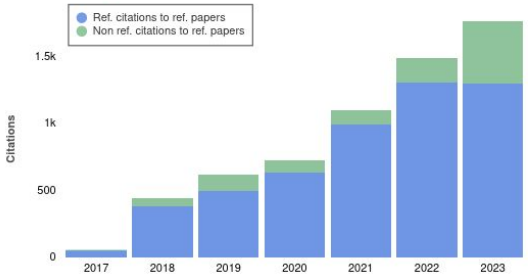
View Library | Export | Metrics | Explore | Citation Helper

Citations

	Totals	Refereed
Number of citing papers	4738	4738
Total citations	6174	6174
Number of self-citations	731	731
Average citations	27.1	27.4
Median citations	6	6
Normalized citations	199.3	199.3
Refereed citations	5142	5142
Average refereed citations	22.6	22.9
Median refereed citations	5	5
Normalized refereed citations	164.3	164.3

Total | Normalized

stacked ● grouped ○



2017ApJ...848L..12A 2017/10 cited: 2,861
Multi-messenger Observations of a Binary Neutron Star Merger
Abbott, B. P.; Abbott, R.; Abbott, T. D. *and 3674 more*

2020ApJ...888...61M 2020/01 cited: 85
The 1.28 GHz MeerKAT DEEP2 Image
Mauch, T.; Cotton, W. D.; Condon, J. J. *and 101 more*

2019Natur.573..235H 2019/09 cited: 83
Inflation of 430-parsec bipolar radio bubbles in the Galactic Centre by an energetic event
Heywood, I.; Camilo, F.; Cotton, W. D. *and 96 more*

2022A&A...657A..56K 2022/01 cited: 45
The MeerKAT Galaxy Cluster Legacy Survey. I. Survey Overview and Highlights
Knowles, K.; Cotton, W. D.; Rudnick, L. *and 148 more*

2021MNRAS.505.3698W 2021/08 cited: 45
H I intensity mapping with MeerKAT: calibration pipeline for multidish autocorrelation observations
Wang, Jingying; Santos, Mario G.; Bull, Philip *and 10 more*

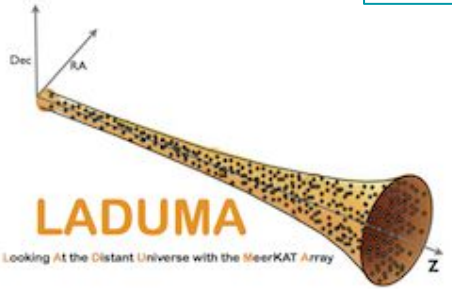
2021MNRAS.502.2970A 2021/04 cited: 44
Primary beam effects of radio astronomy antennas - II. Modelling MeerKAT L-band beams
Asad, K. M. B.; Girard, J. N.; de Villiers, M. *and 12 more*

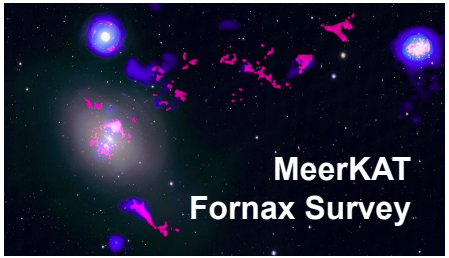
2020MNRAS.495.1271C 2020/06 cited: 44
Hydrodynamical backflow in X-shaped radio galaxy PKS 2014-55
Cotton, W. D.; Thorat, K.; Condon, J. J. *and 13 more*

2021MNRAS.504.1407R 2021/06 cited: 43
Eight new millisecond pulsars from the first MeerKAT globular cluster census
Ridolfi, A.; Gautam, T.; Freire, P. C. C. *and 25 more*

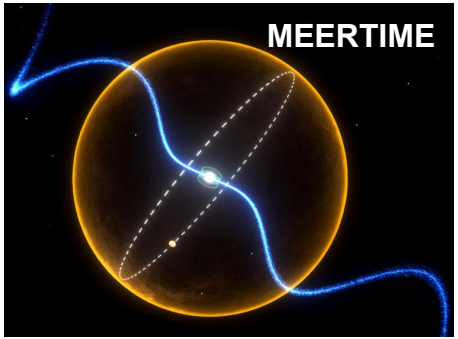
MeerKAT Large Survey Projects

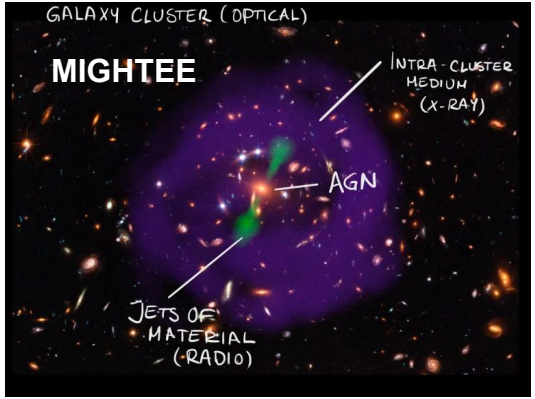
High-impact science programmes to help drive the design of MeerKAT



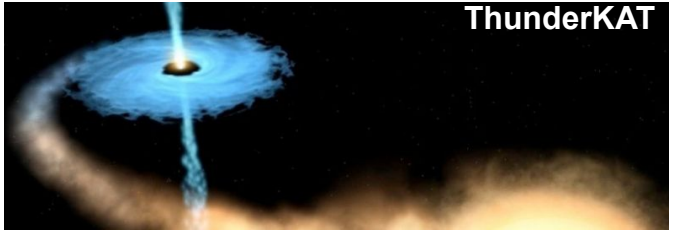


MALS
MeerKAT Absorption Line Survey



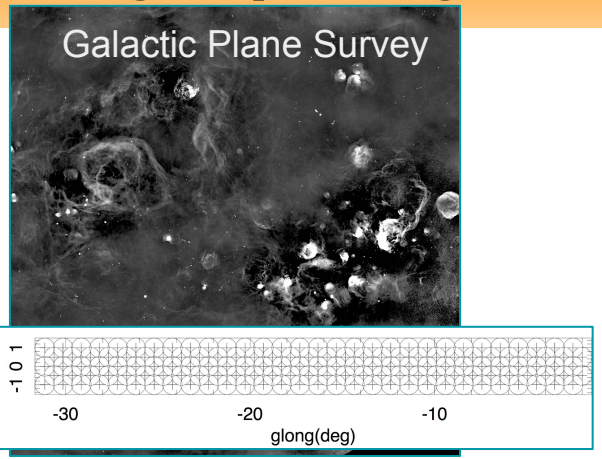


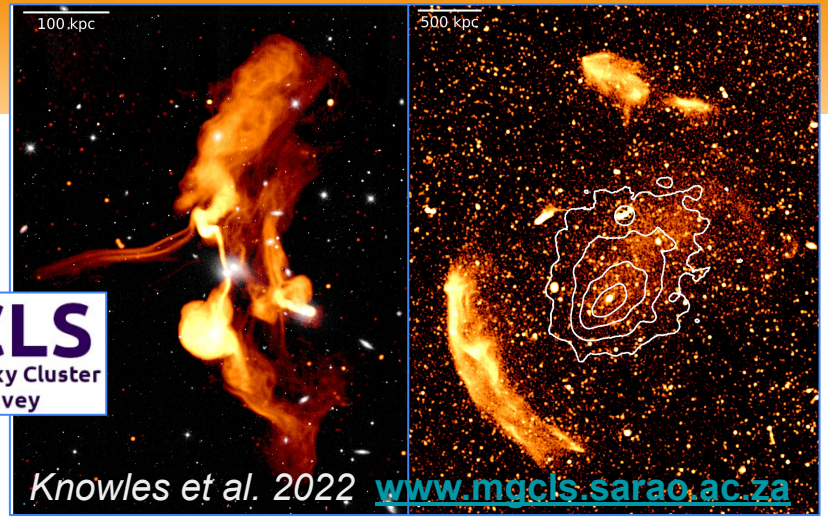
MHONGOOSE

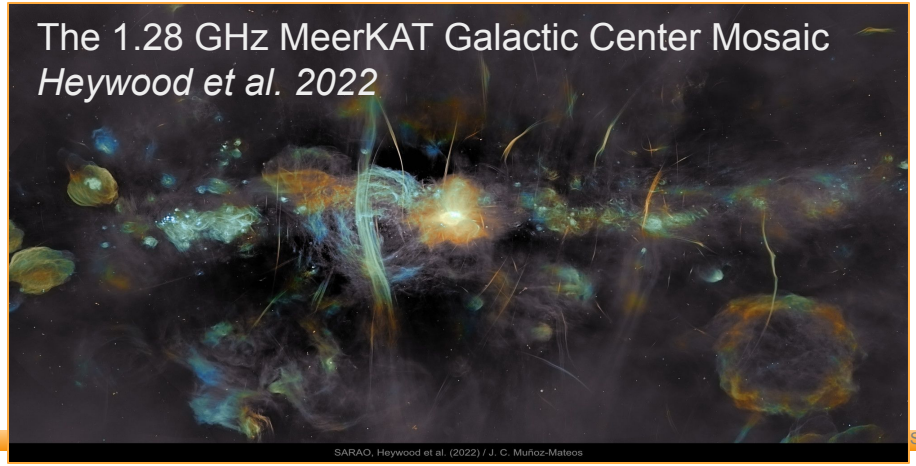


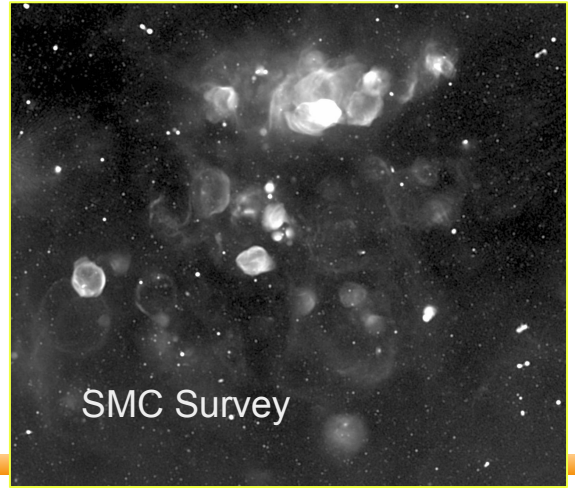
TRAPUM
Transients and Pulsars with MeerKAT

Legacy Programmes

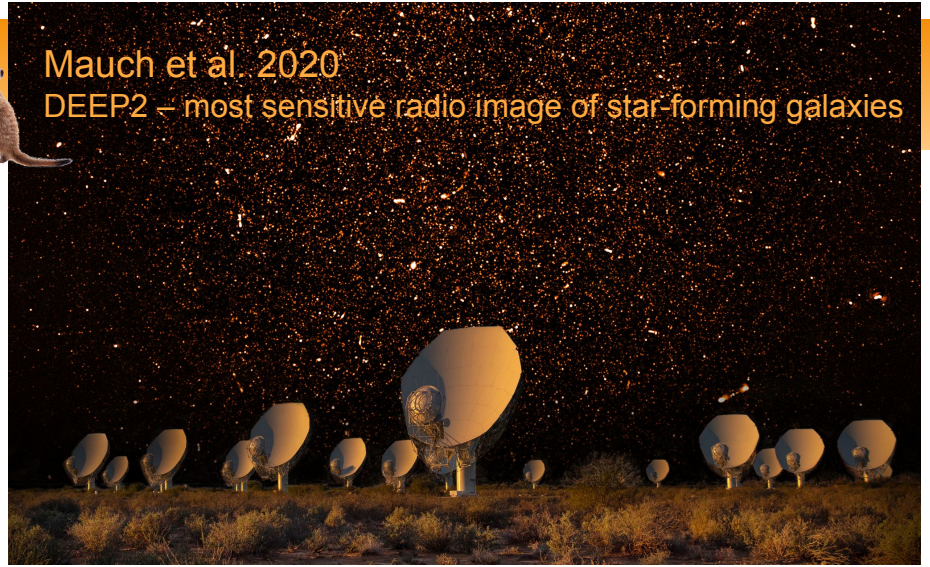


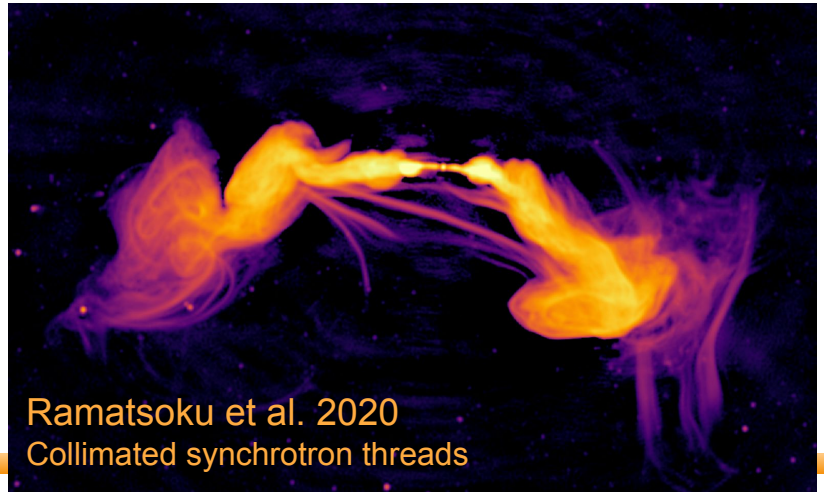


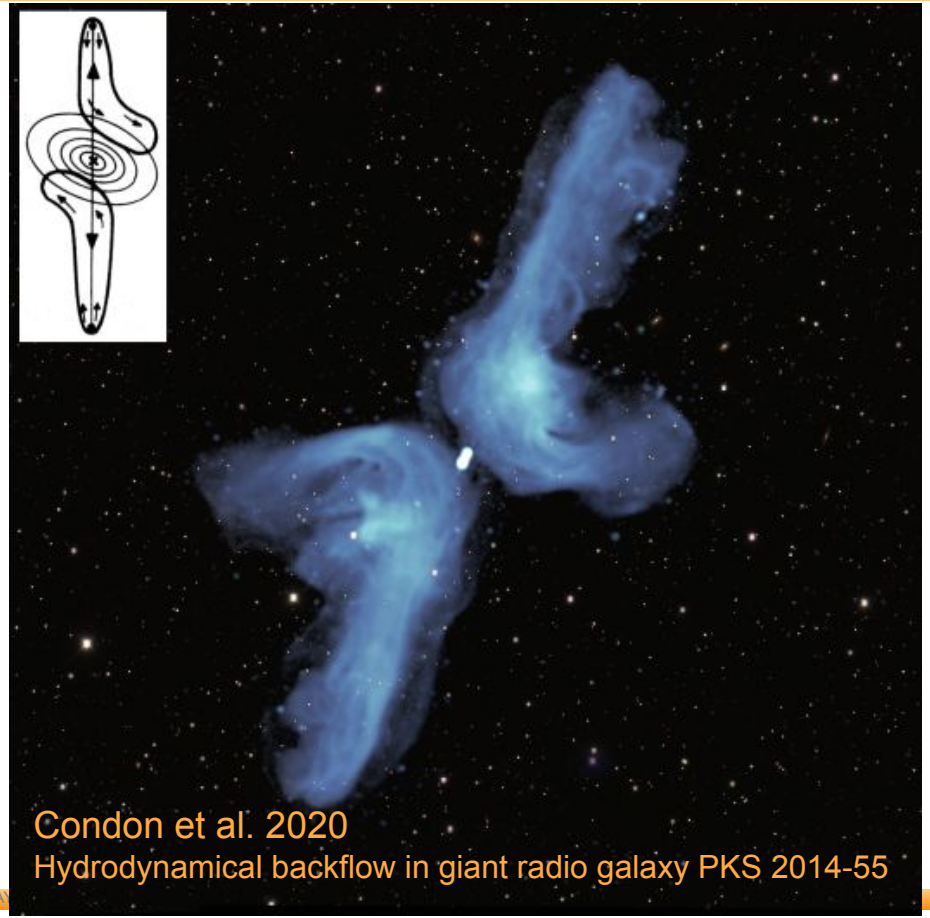




PI Projects


Mauch et al. 2020
DEEP2 – most sensitive radio image of star-forming galaxies


Ramatsoku et al. 2020
Collimated synchrotron threads


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

The MERGHERS Survey

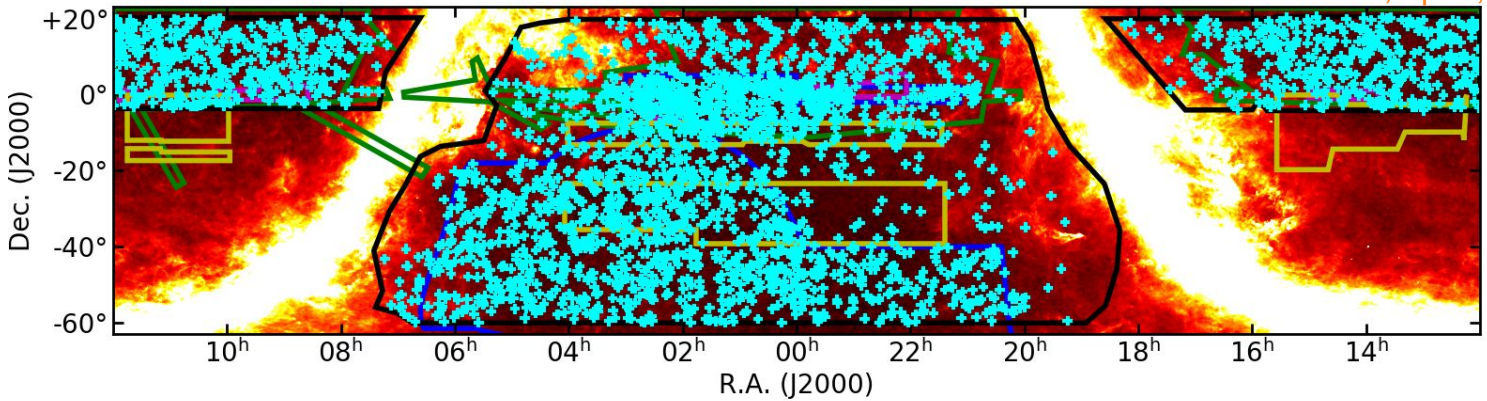
Knowles et al. 2016, POS, 30

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 cluster observations (~1–3 hr on source)

Hilton et al. 2021, ApJS, 253, 3



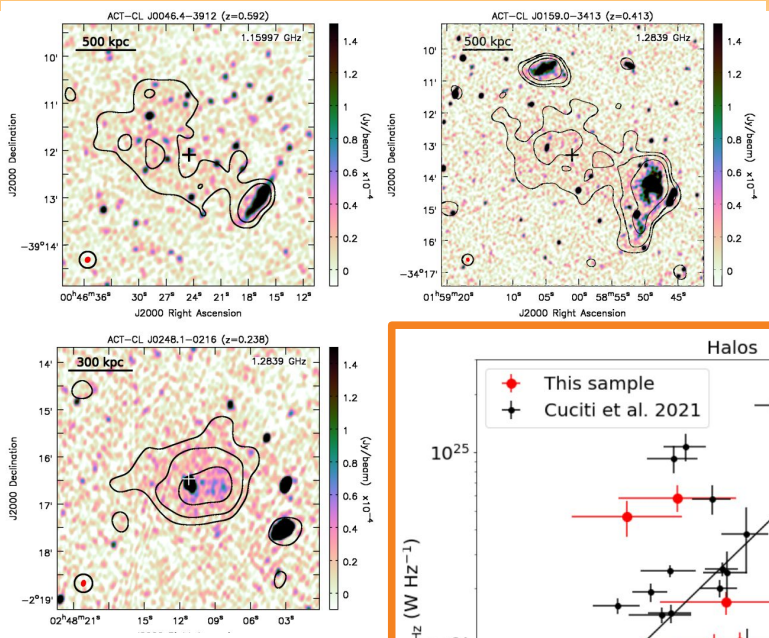
MERGHERS Pilot

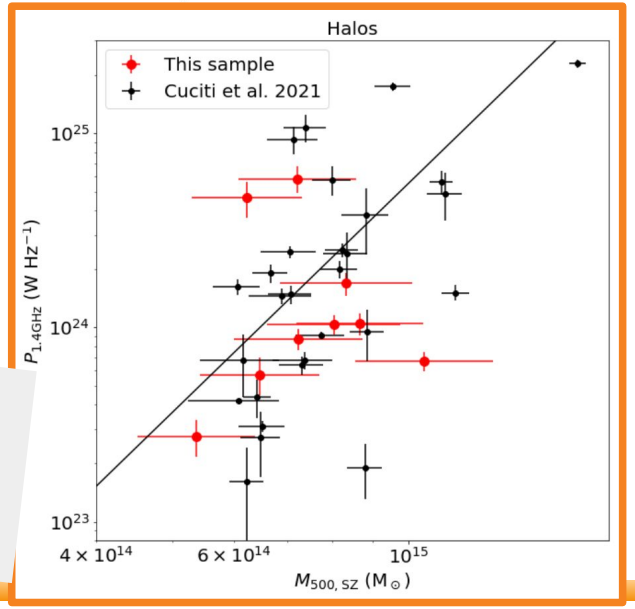
Knowles et al. 2021, *MNRAS*, 504, 1749

- ★ 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**

Still lots to do (student projects)

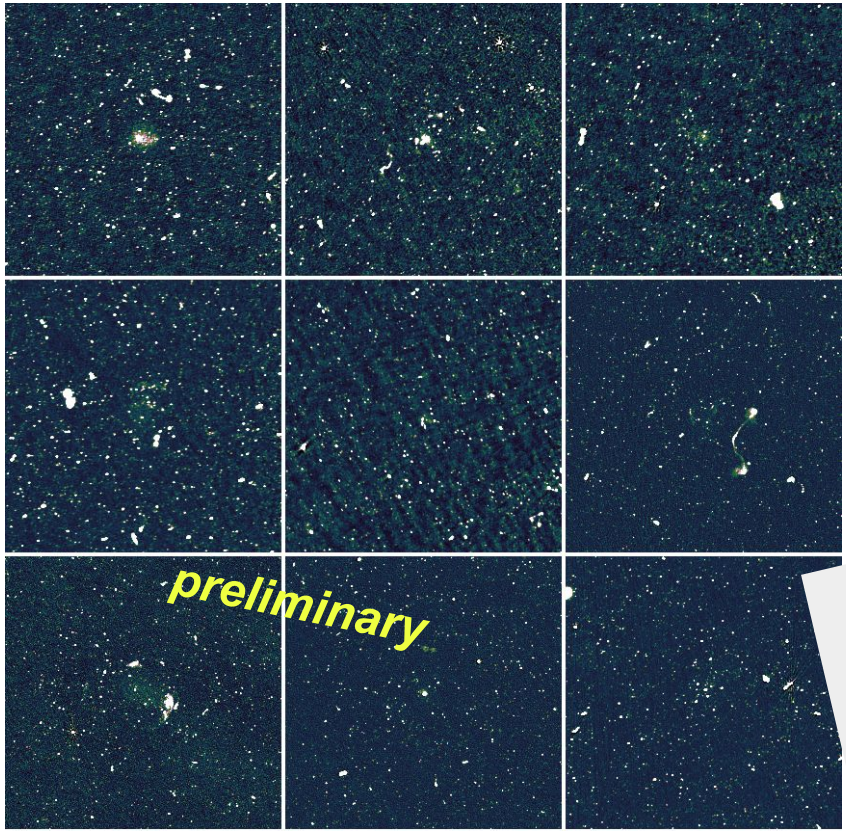
- ★ Spectral index studies
- ★ Dynamical state studies
  - e.g., Pillay et al. 2021, *Galaxies*, 9, 97
- ★ Source cataloguing and science



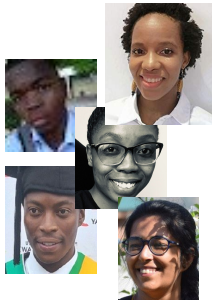


70% detection rate!
11 new diffuse emission detections

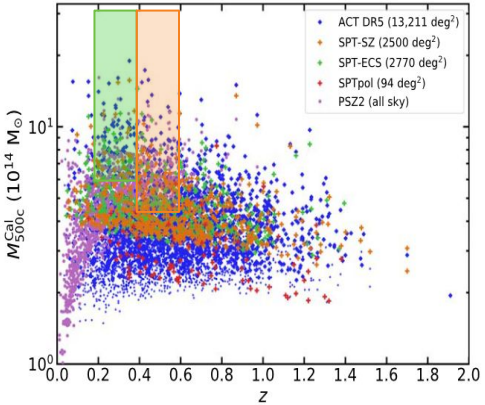
MERGHERS Tiers 1 and 2



- Focus on building a statistical sample in the mid- to high-redshift range
  - Published ACT DR5
  - DES region
  - $0.4 < z < 0.6$
  - $M_{500,SZ} > 4 \times 10^{14}\ M_{\odot}$



56 clusters
~40% detection rate for diffuse emission



RadioClusters Project

Interdisciplinary SKA Preparation with MeerKAT and Big Data

- ★ All-female PI team
  - Kenda Knowles (RU)
  - Michelle Lochner (UWC)
  - Emma Tolley (EPFL)

- ★ Goals:
  - Astrophysics
    - statistical studies of diffuse emission in clusters
  - Data science
    - image analysis techniques/source finding for faint extended emission
  - Knowledge exchange
    - Host skills-driven workshop for Swiss and South African students focusing on radio astronomy and machine learning

Postdoc position @ RU for RadioClusters

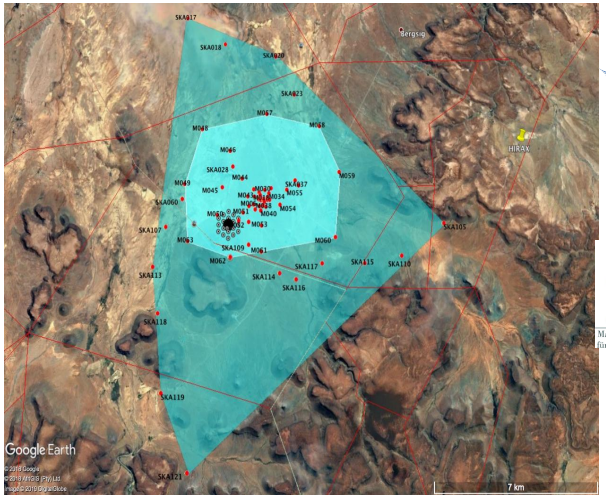
Job Ad!

- ★ 70% FTE on RadioClusters extragalactic + machine learning
- ★ 30% FTE on your own project(s)
- ★ 1-year post (renewable up to 3 years) based in Cape Town / Makhanda
- ★ Application deadline: 30 September 2023

For more info contact:
k.knowles@ru.ac.za

Next steps for MeerKAT

MeerKAT extension (MeerKAT+)



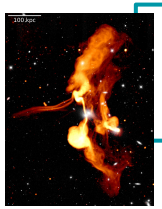
★ ~13 SKA dishes added to increase max baseline to ~17 km

★ MK+ Legacy Survey(s) being planned

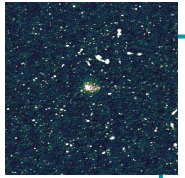
Construction of SKA-Mid and phasing in of MeerKAT

Summary

Superb engineering has created a premier radio telescope in Africa, with a broad science reach

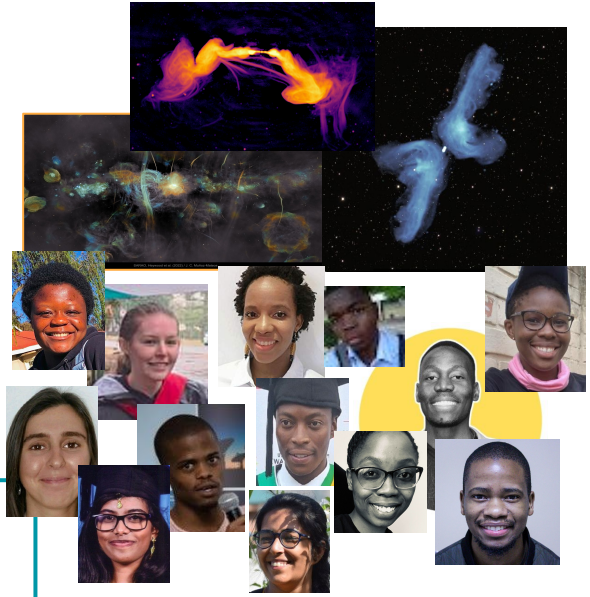


Lots of public data available from LSPs and Legacy Programmes



Cluster programmes like MERGHERS will help us prepare for the SKA era

…which we're working towards with joint SA / Swiss projects



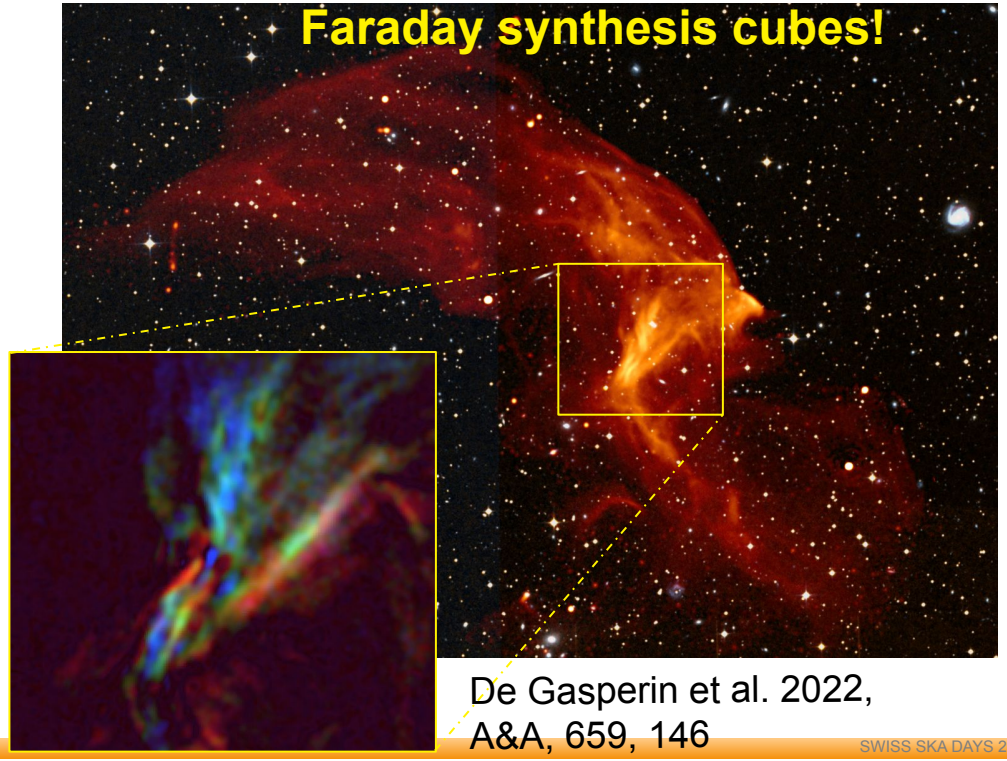
Job Ad!

Exciting times: all the science (and students!) still to come

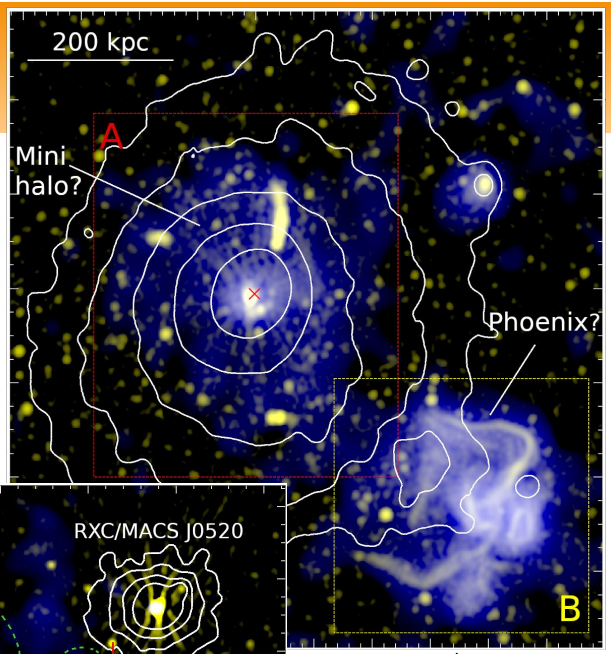
Extra slides on MGCLS

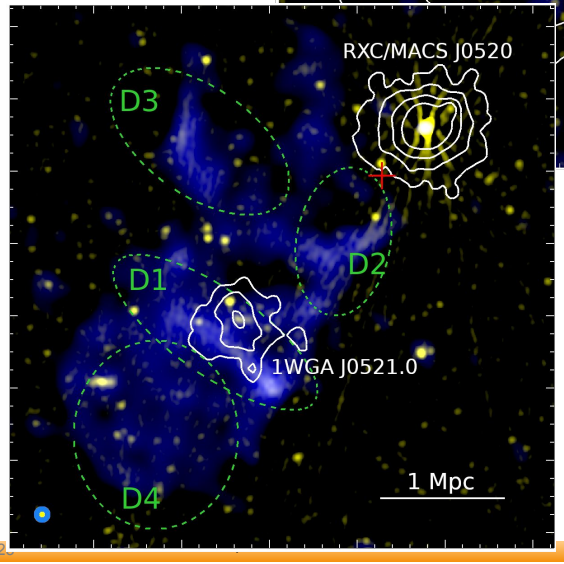
MGCLS: Diffuse Cluster Emission

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



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





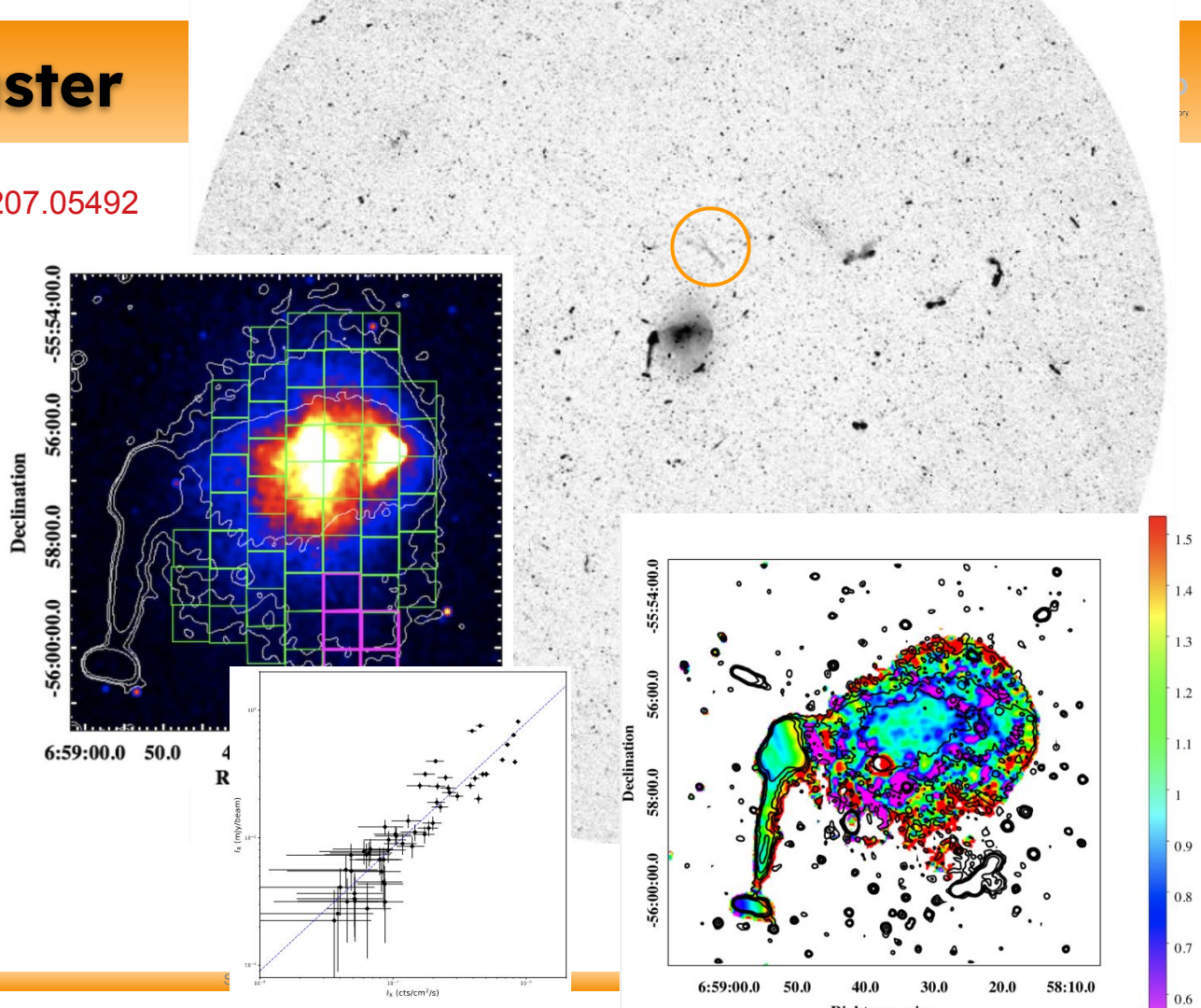
Knowles+2022

New views of known sources

MGCLS: Bullet Cluster

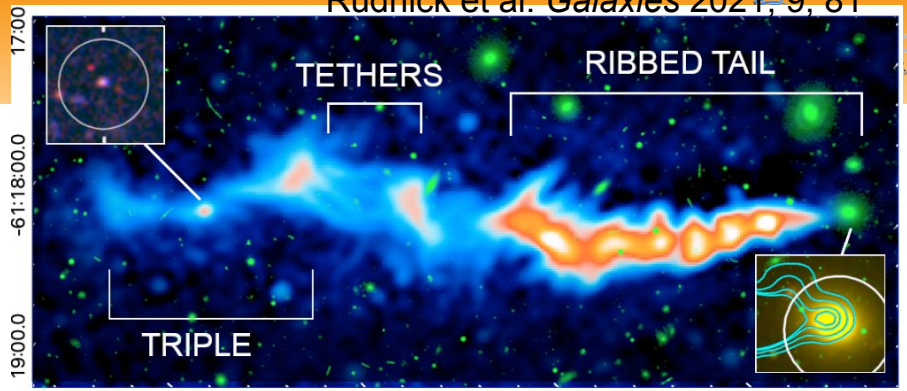
Sikhosana et al. MNRAS *sub*., arXiv:2207.05492

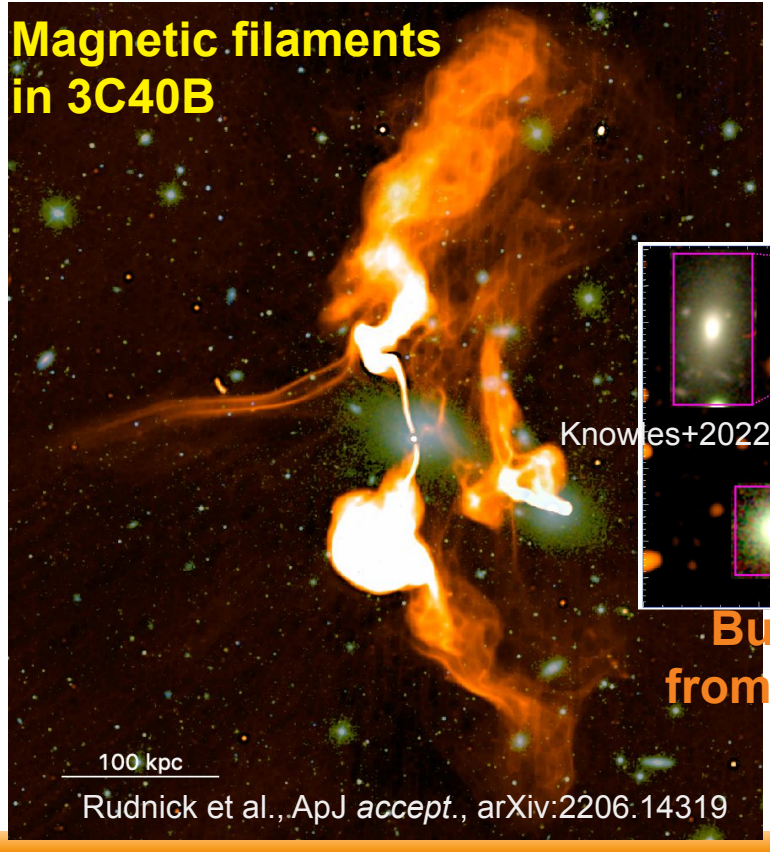
- ★ Detect much larger N/S extent to the halo
- ★ Detect new forked diffuse source
- ★ In-band spix map shows flat central region



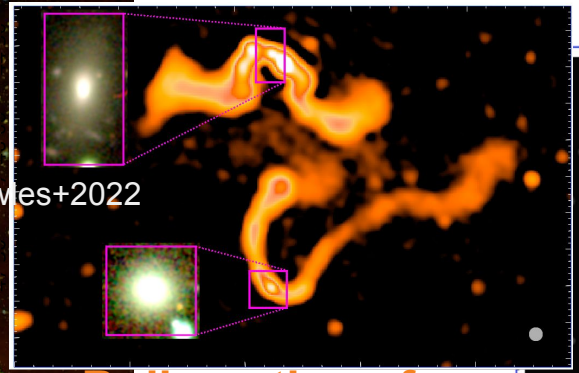
MGCLS: Radio galaxies

Rudnick et al. *Galaxies* 2021, 9, 81

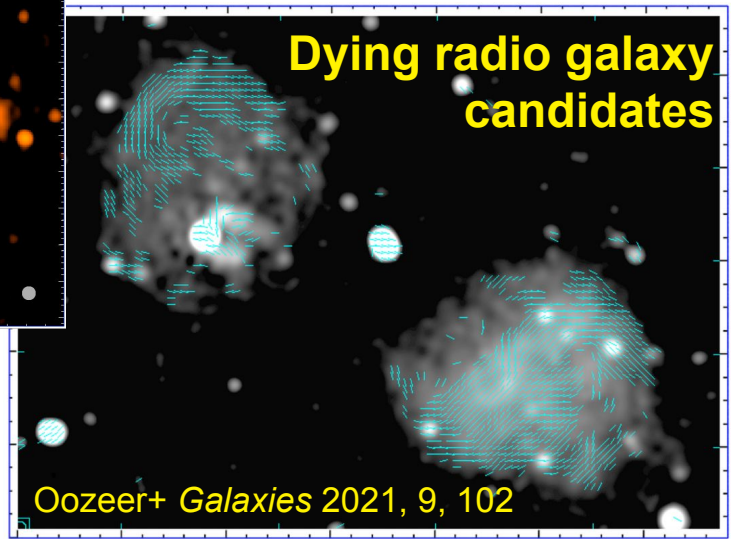




Rudnick et al., ApJ *accept.*, arXiv:2206.14319

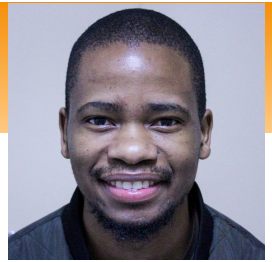


Bulk motions far from known clusters



Oozeer+ *Galaxies* 2021, 9, 102

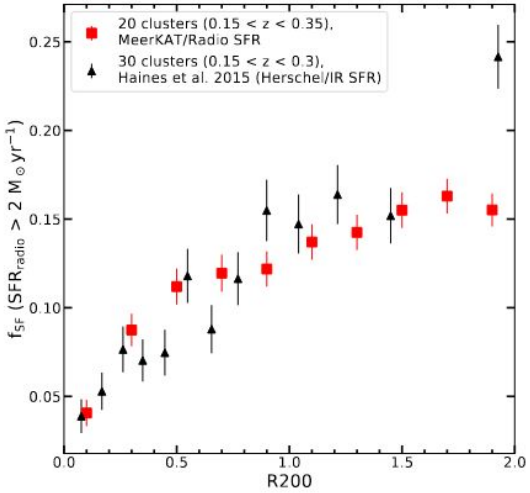
MGCLS: Star-forming galaxies

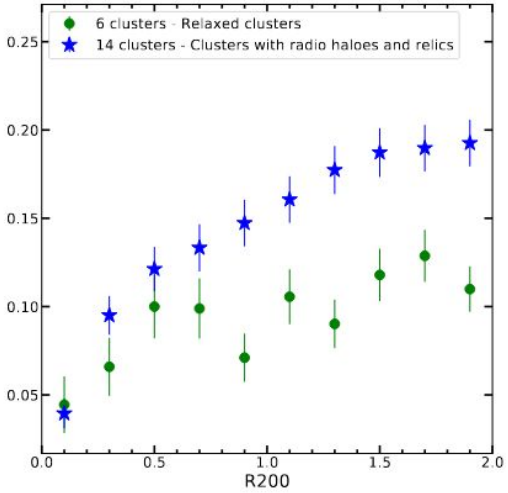


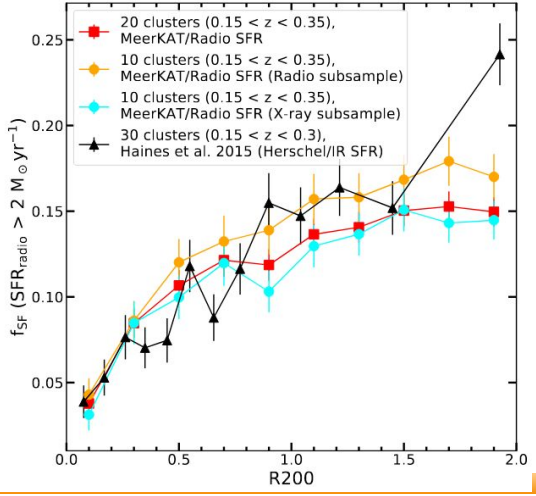
Kesebonye et al., MNRAS *sub*.

- 20 massive clusters (ACT DR5–MGCLS)
  - $M_{200} > 4 \times 10^{14}\ M_{\odot}$
  - $0.15 < z < 0.35$

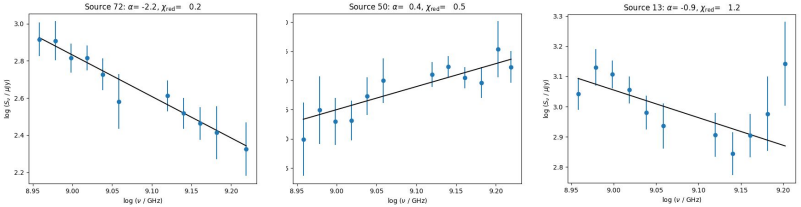
Different SFR trends in clusters with vs without diffuse cluster emission

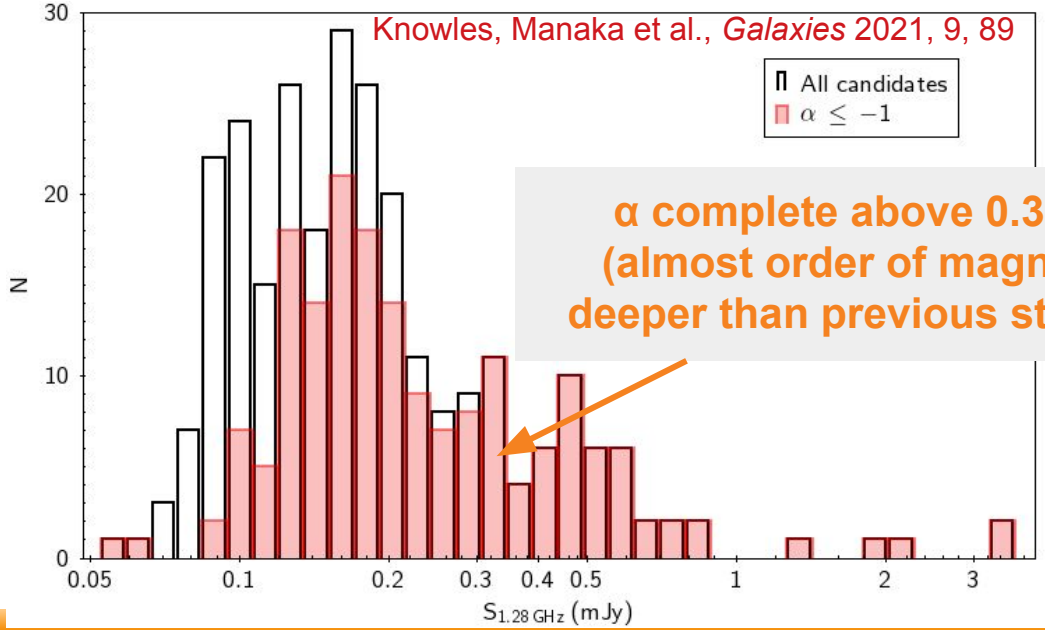






MGCLS: HzRG searches





α complete above 0.3 mJy (almost order of magnitude deeper than previous studies!)

★ MGCLS source catalogue for Abell 2751
- 3610 compact sources

★ Catalogue cuts:
- > 5σ flux density
- < 10″ angular size
- No match in DECaLS, AllWISE
- MeerKAT α < -1

179 (+95) new HzRG candidates!