Update on ASKAP Continuum Surveys

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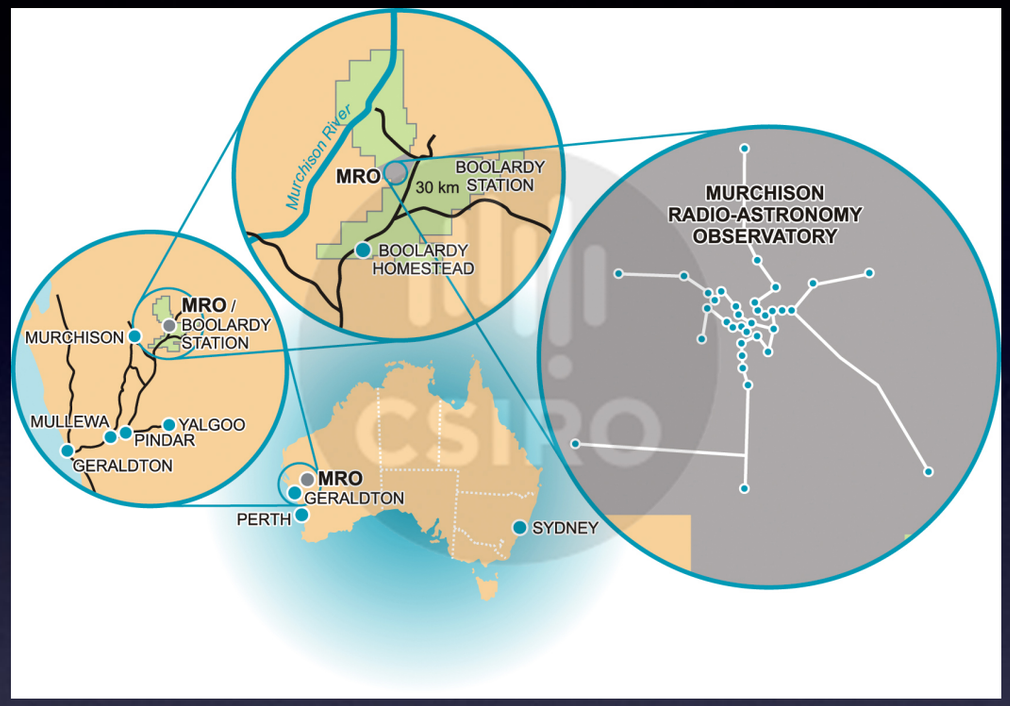
On behalf of the EMU Cosmology Project

ASKAP



- 36 12m dishes equipped with phased array feed at Inyarrimanha Ilgari Bundara, the CSIRO Murchison Radio-astronomy Observatory
- Baselines up to 6km
- High-speed processing at Pawsey Supercomputing Research Centre, Perth
- Rapid ASKAP Continuum Survey (RACS) commissioned in 2019 to test capability
- Fastest survey of Southern Sky: 3 million galaxies in 300 hours, one million never seen before

We acknowledge the Wajarri Yamatji people as the traditional owners of the Observatory site. New telescope name means 'sharing sky and stars' in the Wajarri language.

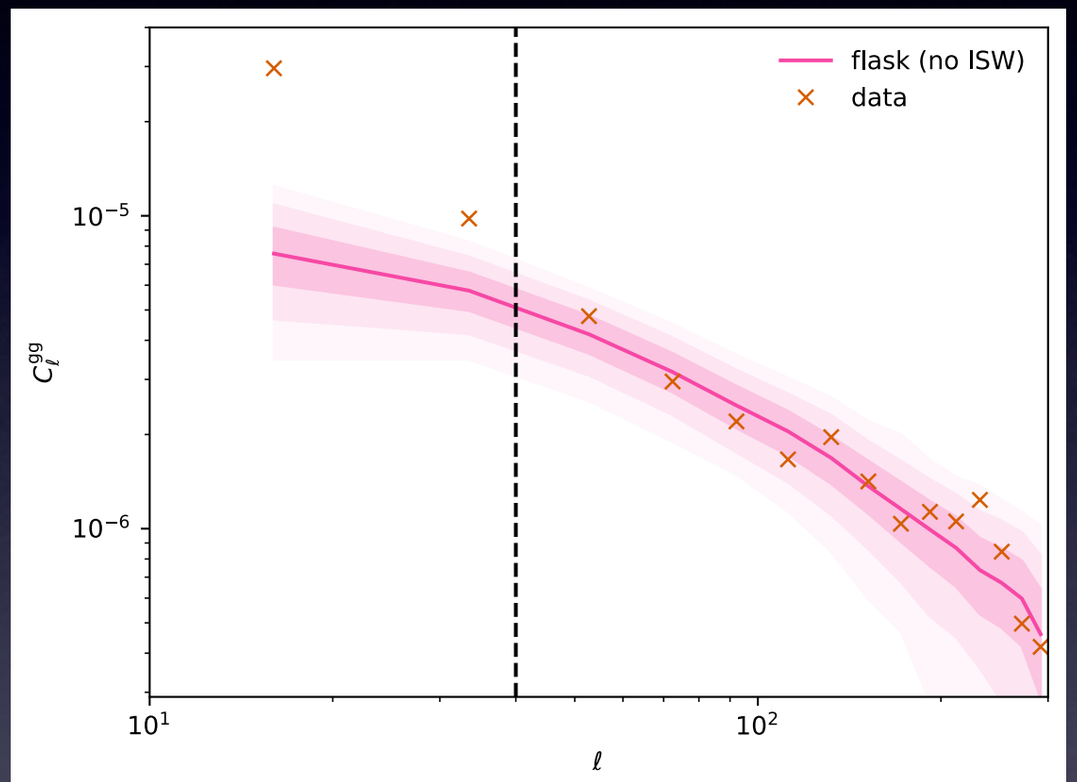
RACS specifications

Band	Frequency (MHz)	Name	Resolution (arcsec)	Median noise (μJy/beam)	Sources (M)	Released?
Band 1	887.5	RACS-low	>12	266	<3	Paper I: McConnell+ 2020 Paper II: Hale+ 2021
Band 2	1367.5	RACS-mid	>8	197	~3.1	Paper IV: Duchesne+ 2023 Paper V: in prep.
Band 3	1632.5	RACS-high	>6	198	>3	TBD
Band 1	887.5	RACS-low2	>12	211	~4?	TBD

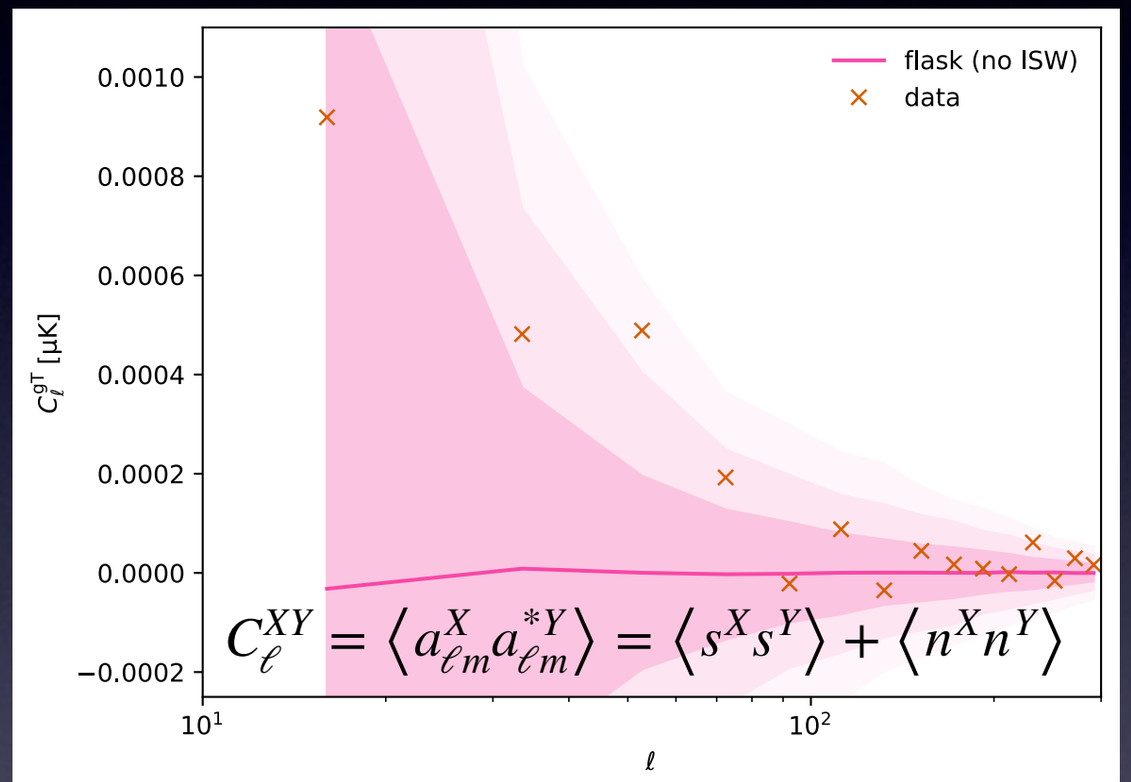
Slide credit: Stefan Duchesne (CSIRO)

RACS-low power spectra

gg

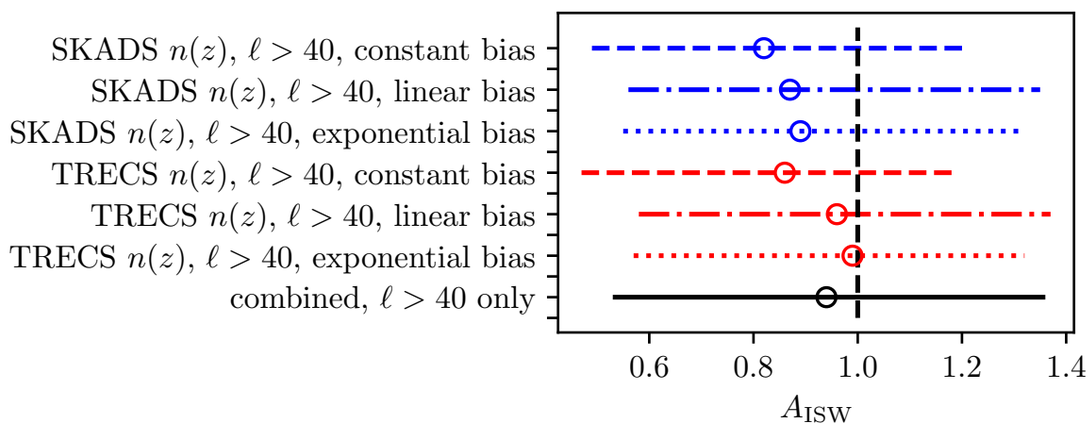


gT



Good agreement at small scales,
Large scale power offset

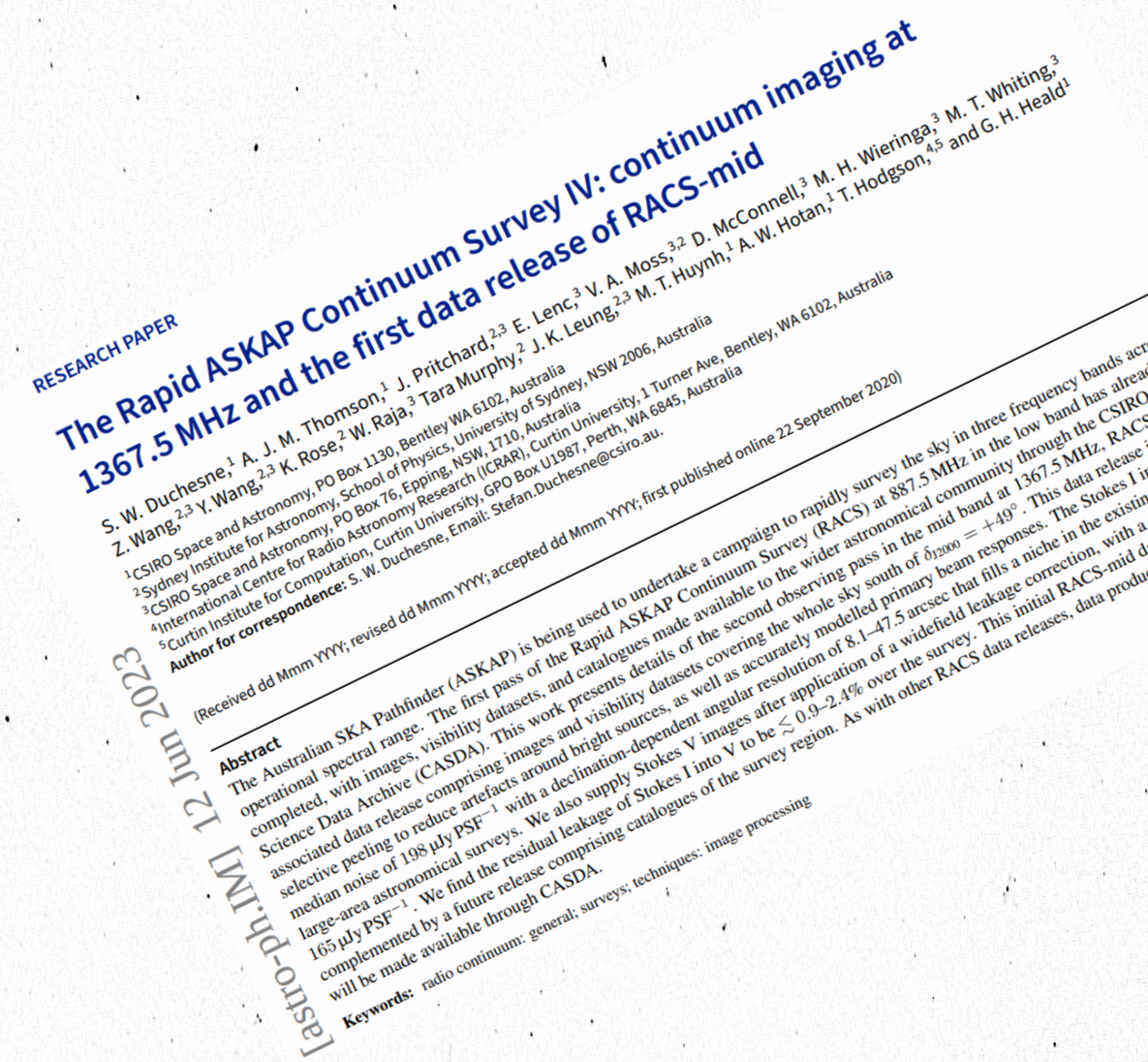
For gκ: Talk by Giulia Piccirilli at 12 o'clock



RACS-mid: data release 1

- **Images:**
  - Stokes I
  - Stokes V (with widefield leakage correction applied)
- **Per-beam visibilities**
  - Self-calibrated
  - On-axis leakage corrections
  - (Some peeled)
- + various metadata products

- See paper for plenty of detail about these data products -->

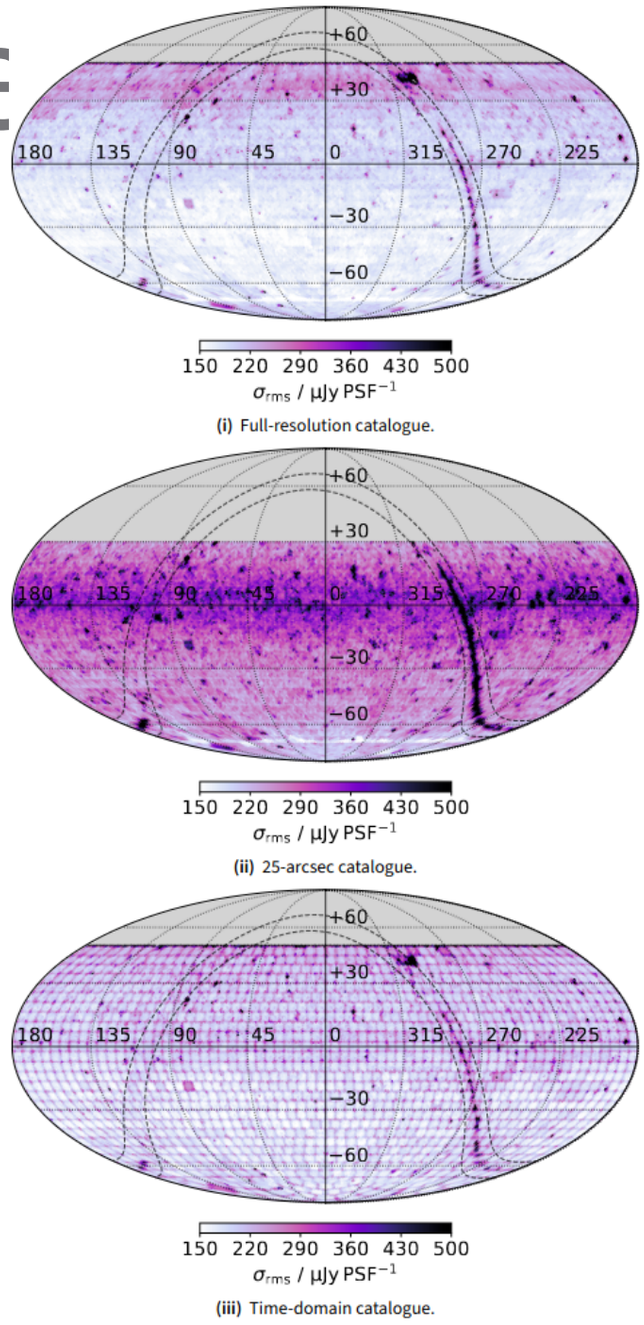


Slide credit: Stefan Duchesne (CSIRO)

RACS-mid: Catalogue

Published in Nov 2023!

- **"Primary" catalogue**
  - Neighbouring tiles merged and convolved to achieve a common resolution = variable resolution
  - Source-finding on Stokes I
  - ~3.1M sources > 5σ
- **"25-arcsec" catalogue**
  - Fixed resolution
  - Matches existing RACS-low catalogue
  - ~2.1M sources > 5σ
- **"Time-domain" catalogue**
  - No mosaicking + convolution (variable resolution)
  - Concatenated source lists
  - Includes duplicate sources in overlap regions and duplicate sources from repeat observations



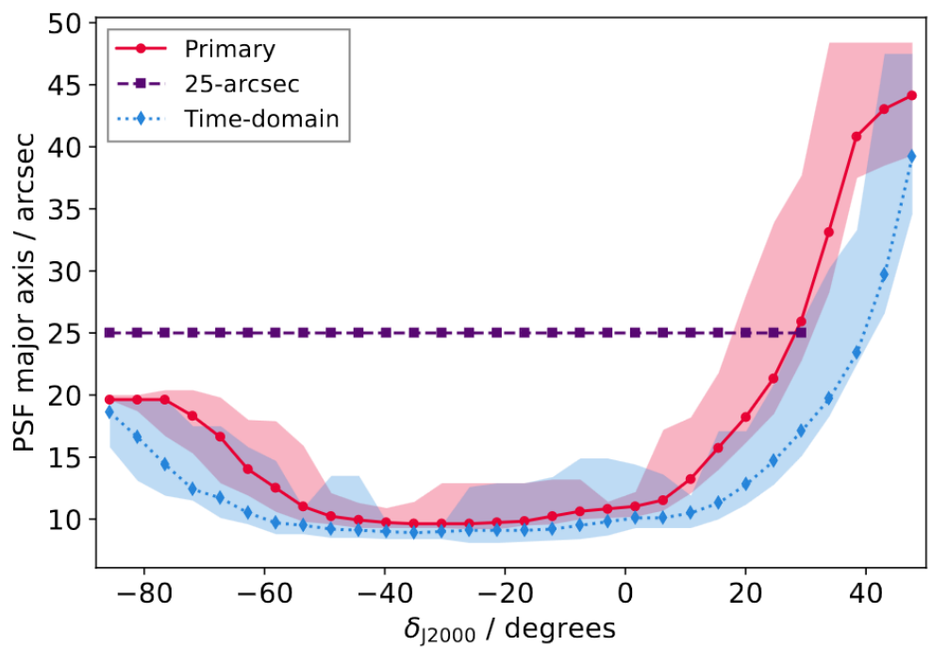
Slide credit: Stefan Duchesne (CSIRO)

RACS-mid: Stokes I catalogue properties

Table 1. RACS-mid all-sky catalogues and image properties.

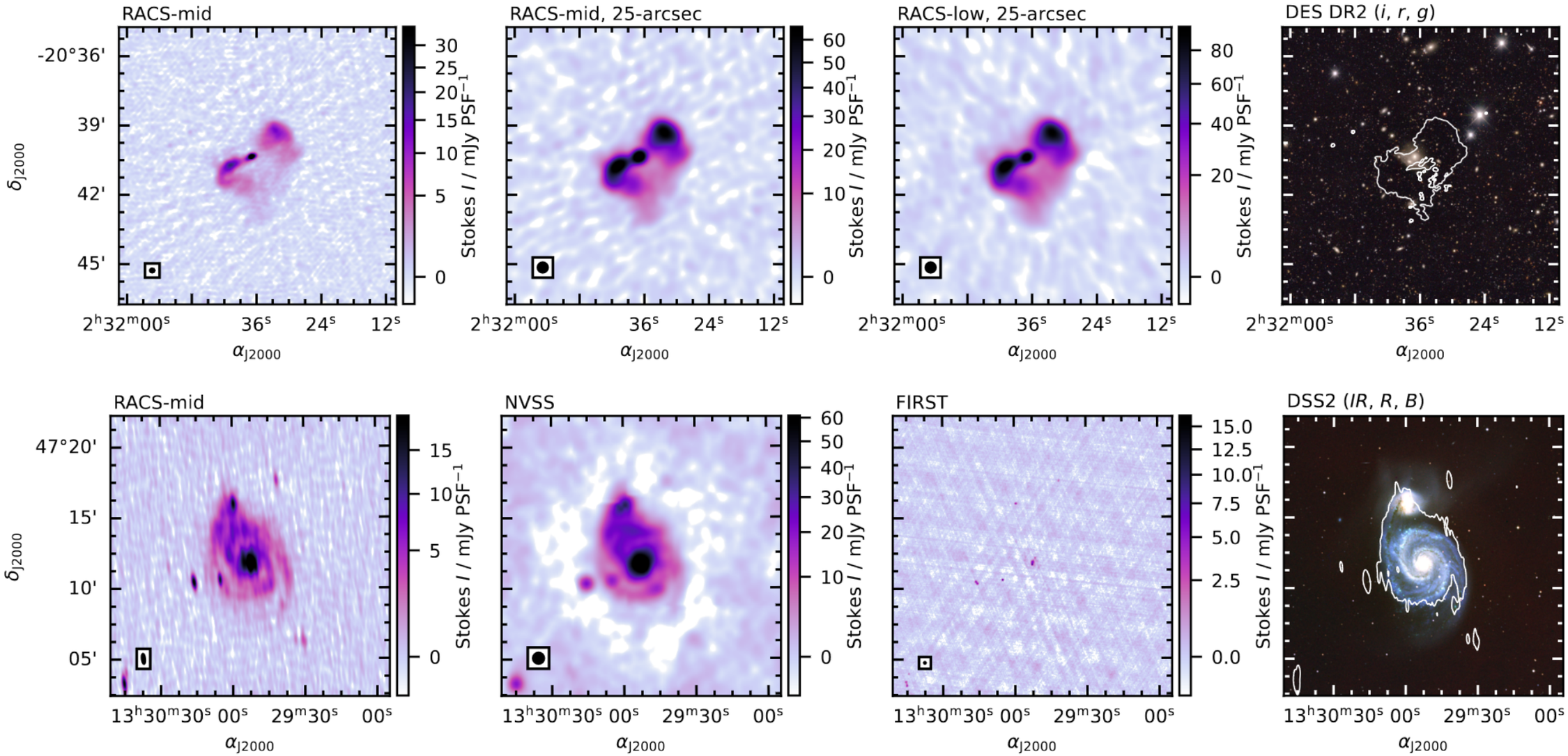
Label	δ_{J2000} limit ($^\circ$)	Median resolution ($'' \times ''$)	Pixel size ($'' \times ''$)	Area [b] (deg^2)	Median σ_{rms} [a] (μJy PSF^{-1})	$N_{sources}$ [b]	$N_{components}$ [b]
Primary	$\leq +49$	11.2×9.3	2×2	36 200 (33 242)	182^{+41}_{-23}	3 105 668 (2 861 923)	4 199 578 (3 869 149)
25 arcsec	$\leq +30$	25×25	4×4	30 900 (28 467)	278^{+68}_{-47}	2 154 585 (1 990 598)	2 521 038 (2 324 196)
Time-domain	$\lesssim +49$	10.0×8.1	2×2	$\sim$ 36 200 (33 242)	203^{+140}_{-33}	4 087 417 (3 766 945)	5 530 478 (5 094 689)

[a] Uncertainties are reported from the 16^{th} and 84^{th} percentiles.
[b] In parenthesis excluding the Galactic Plane ($b \pm 5^\circ$).



Slide credit: Stefan Duchesne (CSIRO)

RACS-mid: Full-sensitivity images



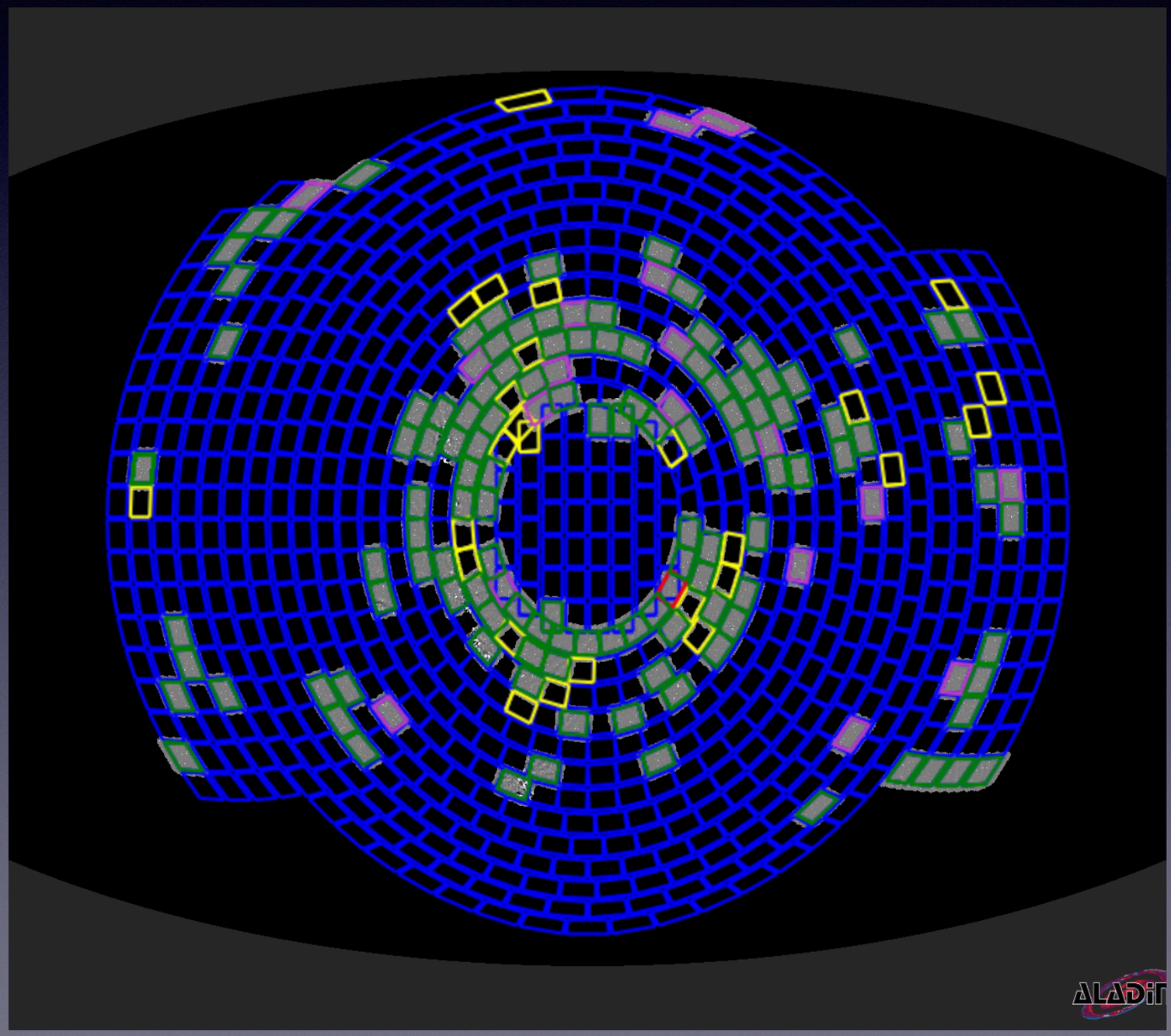
Slide credit: Stefan Duchesne (CSIRO)

EMU

- EMU started in November 2022 to observe half the sky within next 5 years
- Up to ~30,000 sq degs (3pi steradians, subject to funding)
- Integration time per tile: 10 hours instead of 15 minutes
- All-sky allow us to do tests of new physics, such as:
    - Cosmic dipole (Bengaly et al, MNRAS 2019)
    - Primordial non-Gaussianity (Bernal et al, JCAP 2019)
    - Modified gravity (Bernal et al, JCAP 2019)
- With machine learning methods, we should be able to split the sample by redshift, and cross-correlate the different redshift bins, to enhance the statistical power of the sample
- Cross-correlation with other data (e.g. CMB) will allow us to learn more about the galaxy bias

EMU

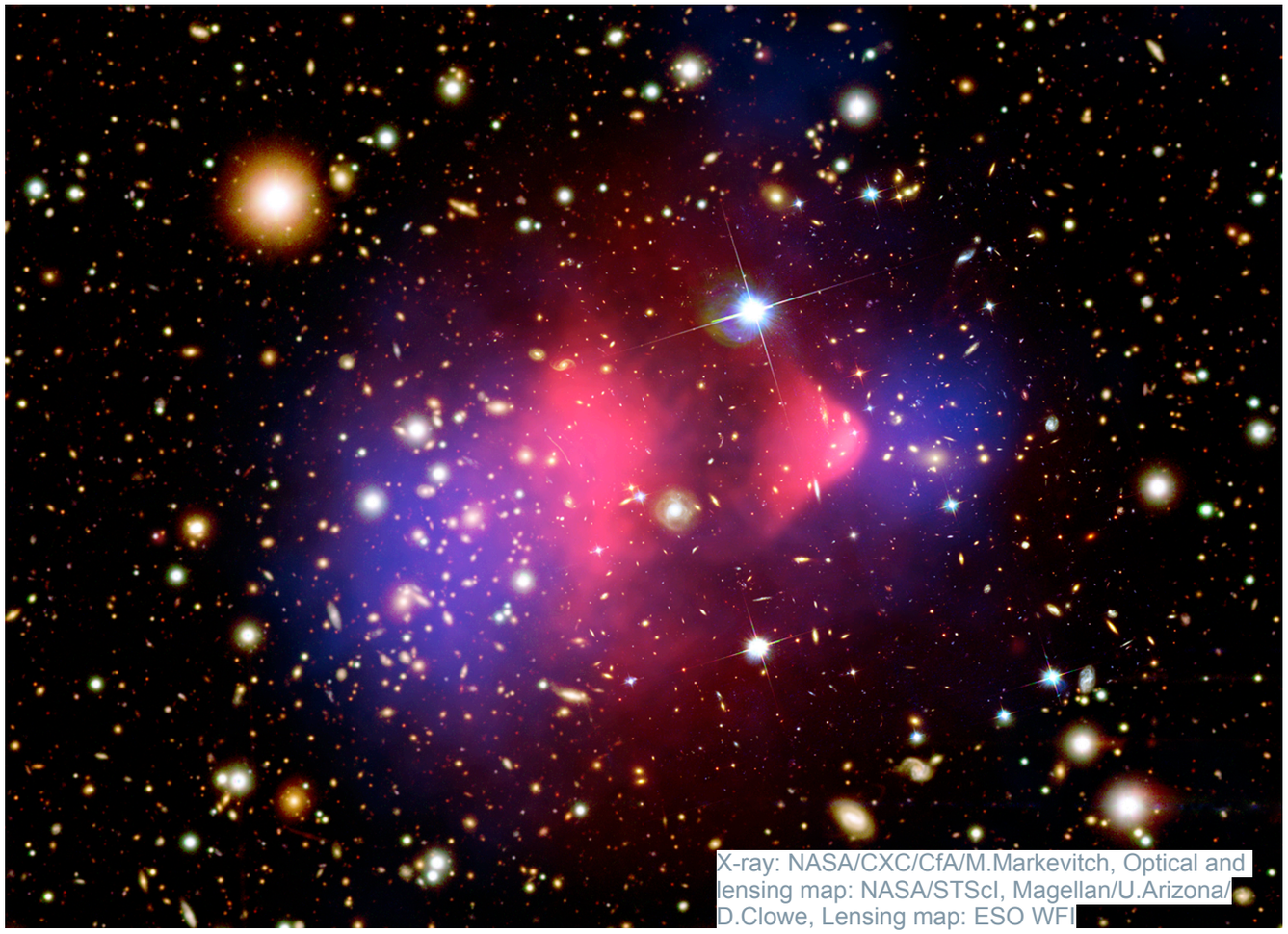
- Green: released
- Purple: validated
- Red: processed
- Yellow: observed

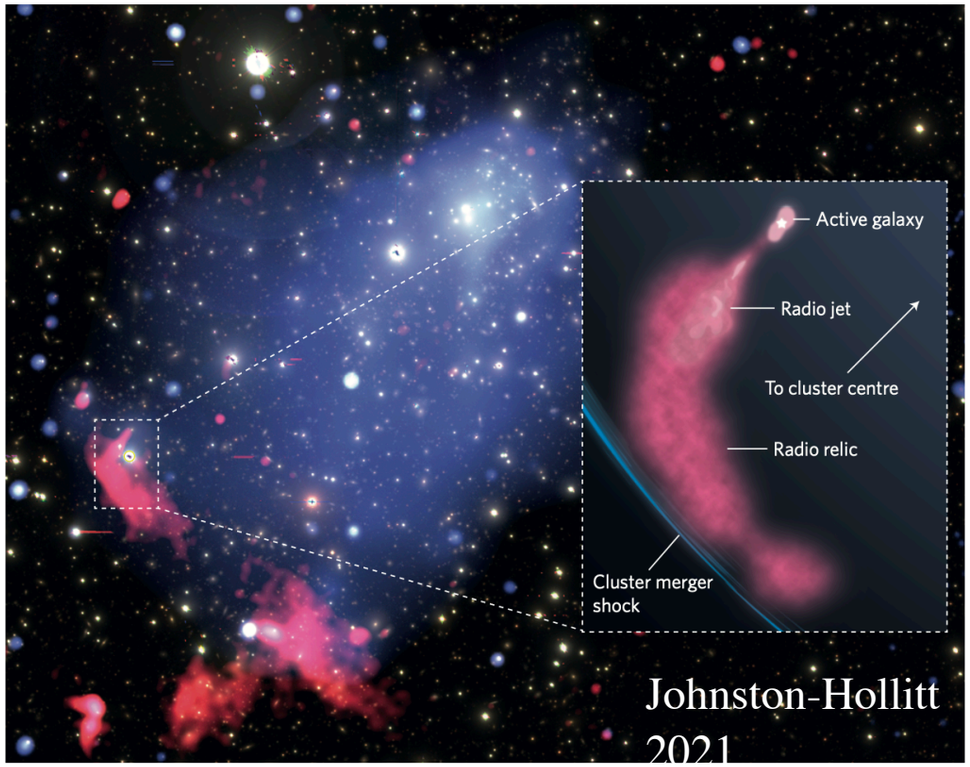


The EMU Collaboration

- 400 scientists in 28 countries
- Open collaboration: Anyone can ask to join, if intending to contribute, and agreeing to follow publication policy
- Contact the EMU Management Team (Andrew Hopkins, Josh Marvil, Tessa Vernstrom, Anna Kapinska): O365-Group-EMU_Management@mq.edu.au
- EMU website: www.emu-survey.org
- EMU team wiki: askap.pbworks.org
- EMU team Slack workspace: emunetwork.slack.com

Radio relics from merging cluster

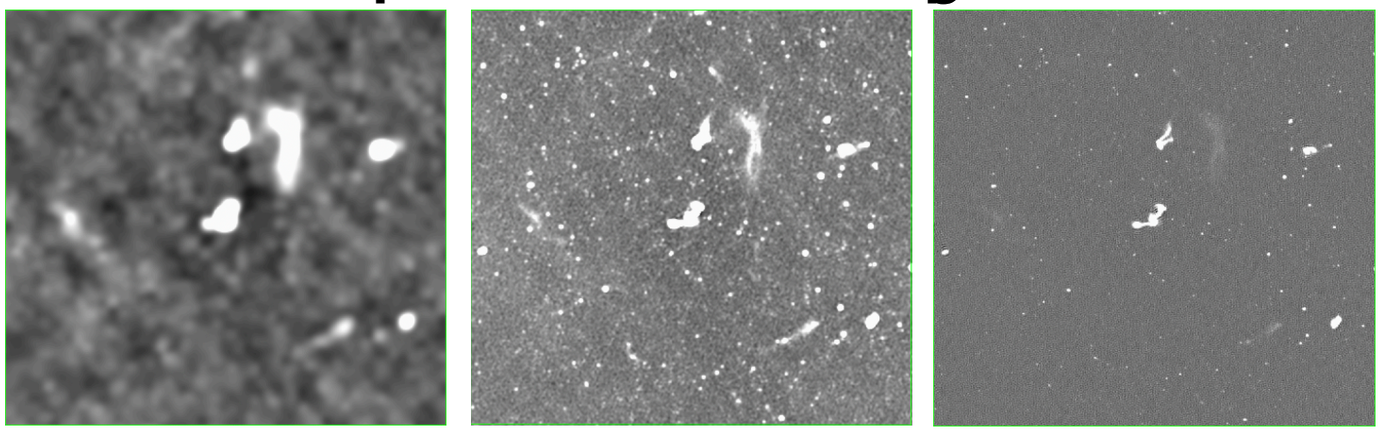




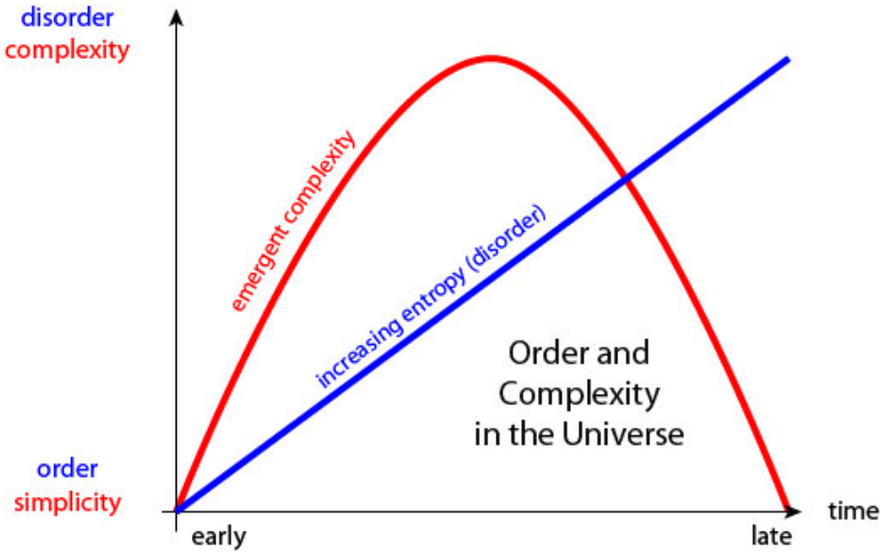
- Galaxy cluster merger produced the radio relic.
- Outskirt of the galaxy cluster, elongated feature

Diffuse map and Complexity

Diffuse map 15” resolution map **High resolution map**



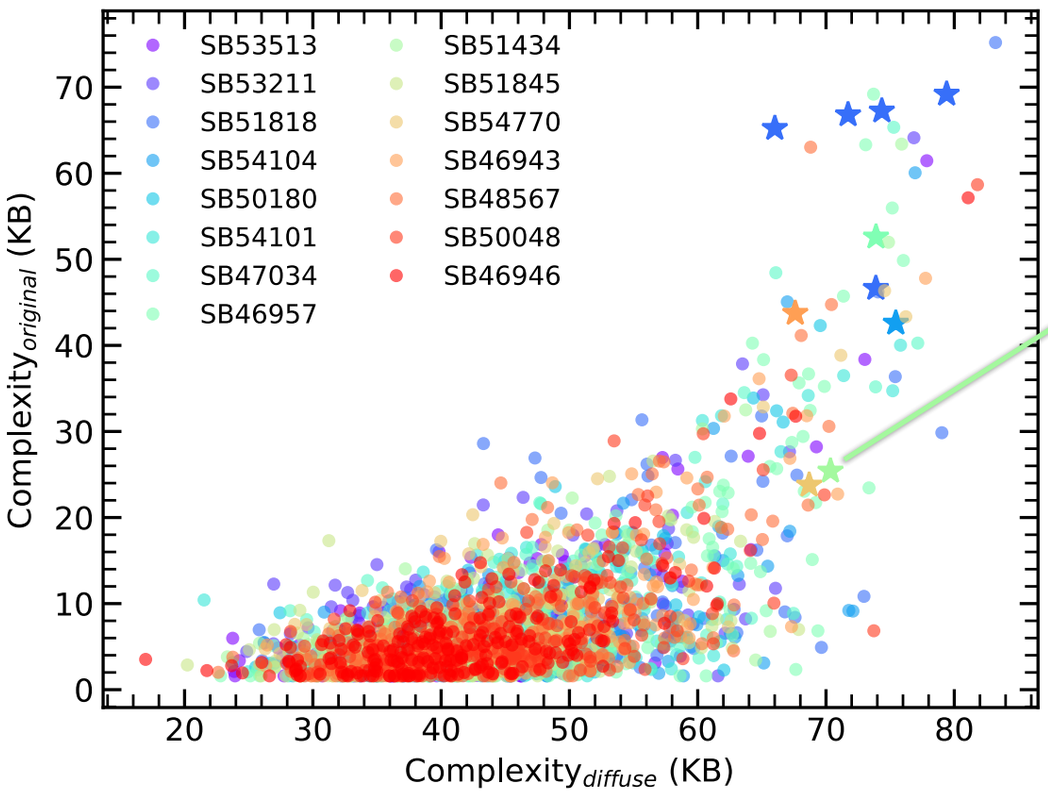
- **Diffuse map allows the identification of low brightness structures in the presence of brighter small scale emission**

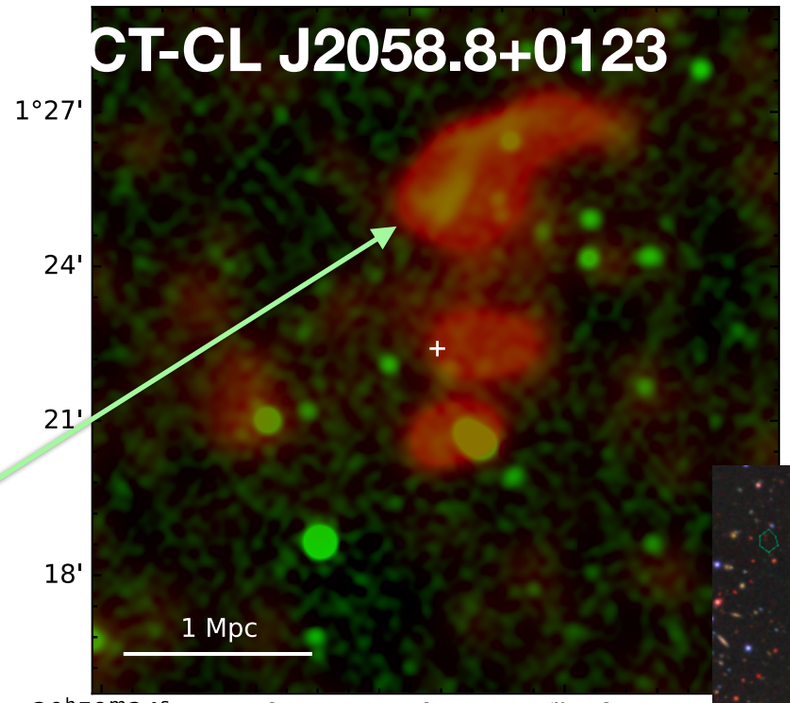


https://www.preposterousuniverse.com/podcast/2019/10/07/67-kate-jeffery-on-entropy-complexity-and-evolution/

- **We can easily calculate complexity by using compressed file size**

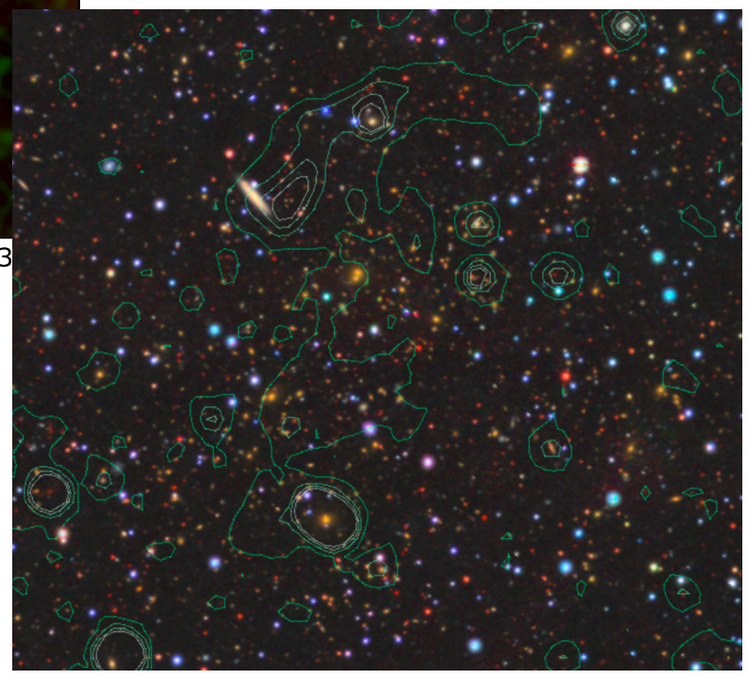
Relic candidate from EMU-MS





Diffuse map

Original EMU map



EMU contour

on DECam optical image