A DECADE OF MWA MAGNETISM:
WHERE DID WE COME FROM AND WHERE ARE WE GOING?

Chris Riseley

Research Fellow | MWA Principal Scientist

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[2] INAF -- Istituto di Radioastronomia, Bologna
[3] CSIRO Space & Astronomy, Perth

@cjriseley

Ten years of MWA Science | 25th July 2023

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Credit: Bryan Gaensler

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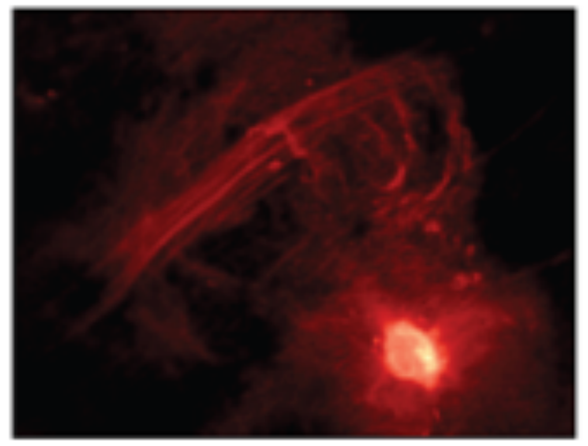

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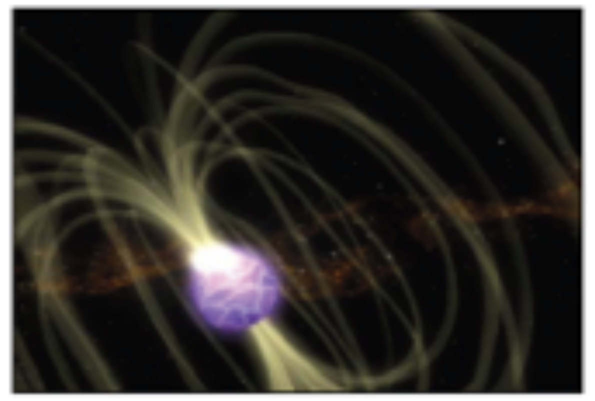

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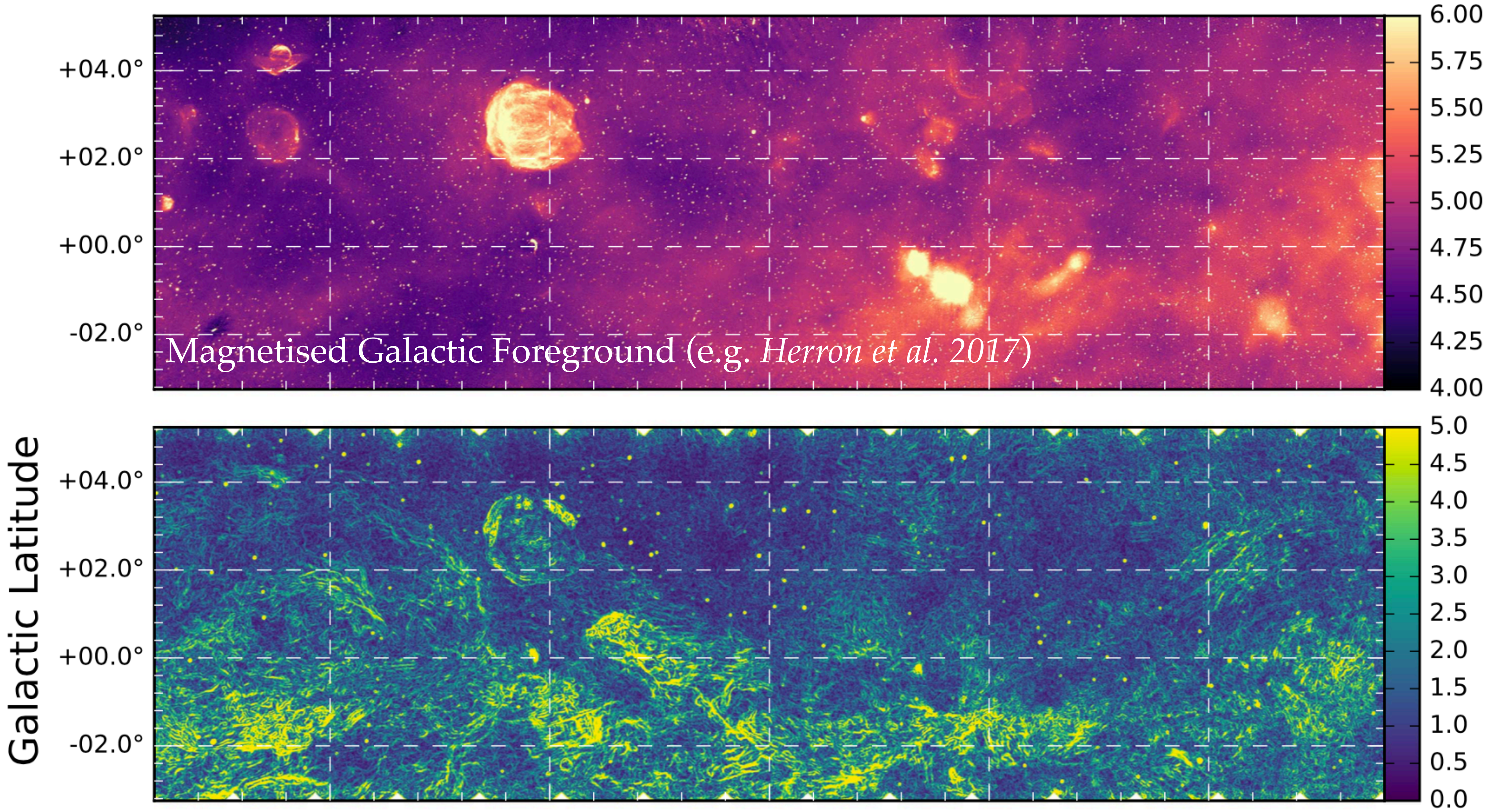

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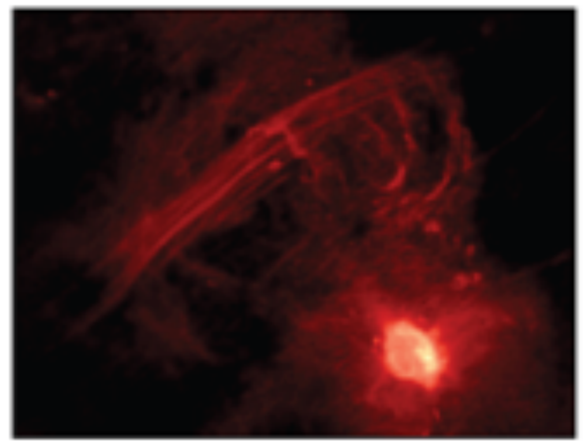

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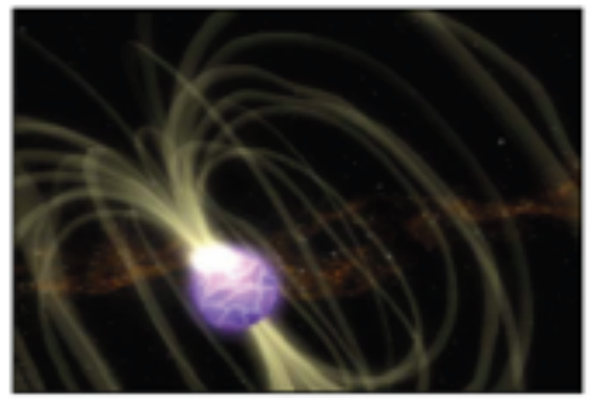

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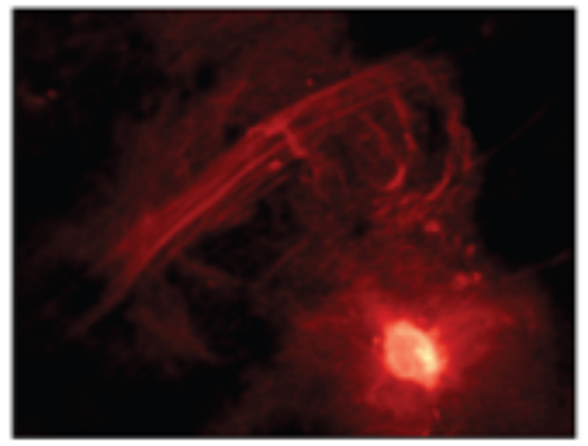
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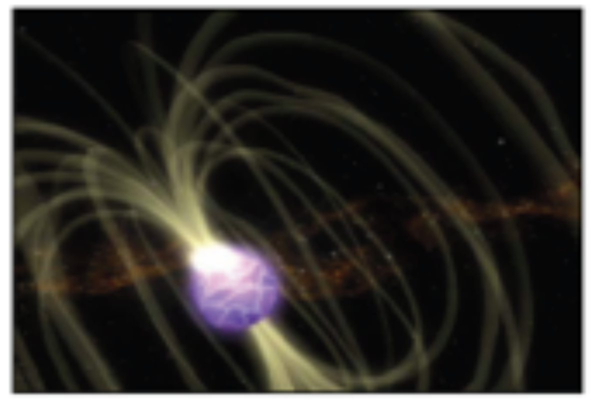
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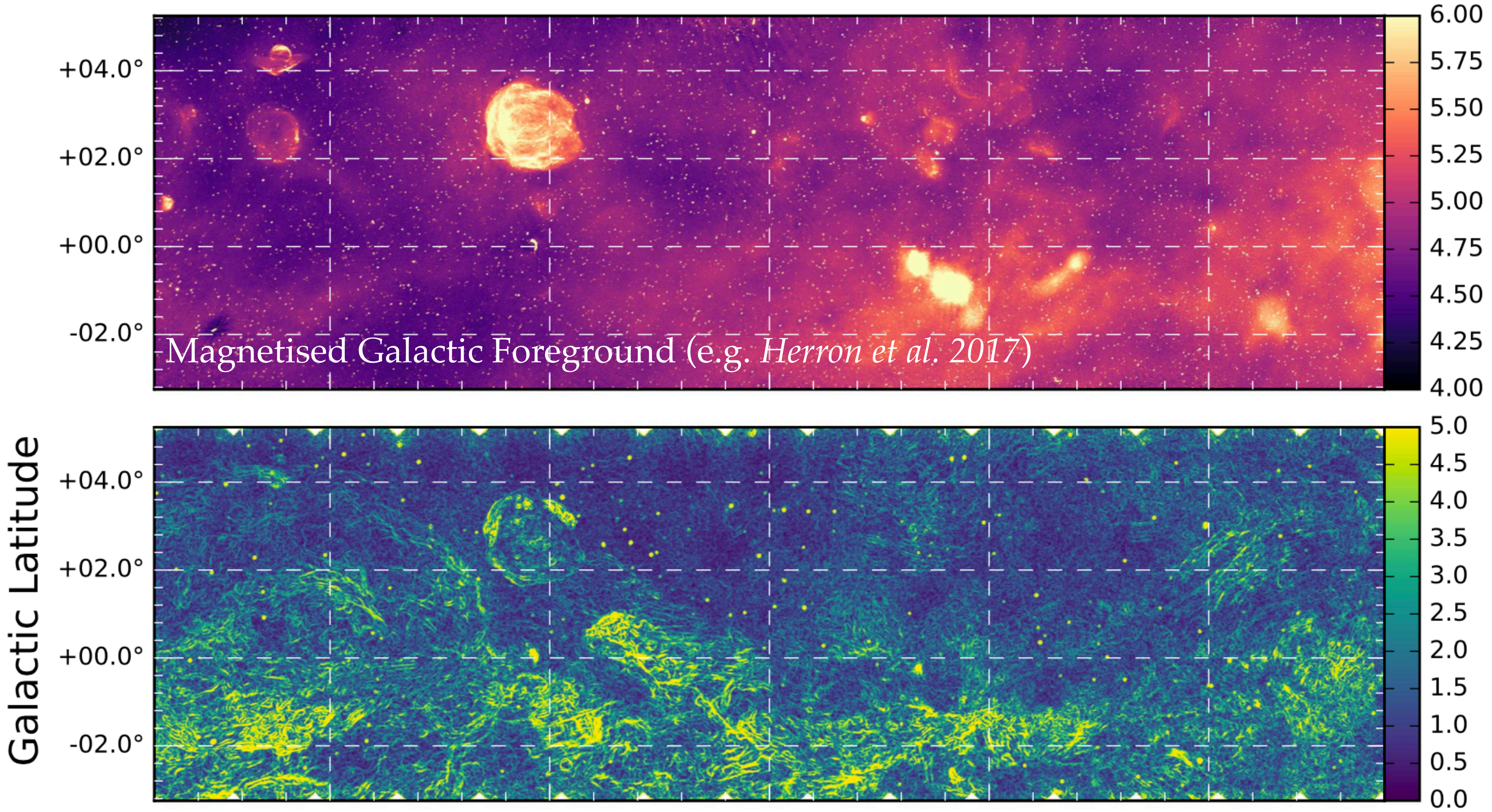
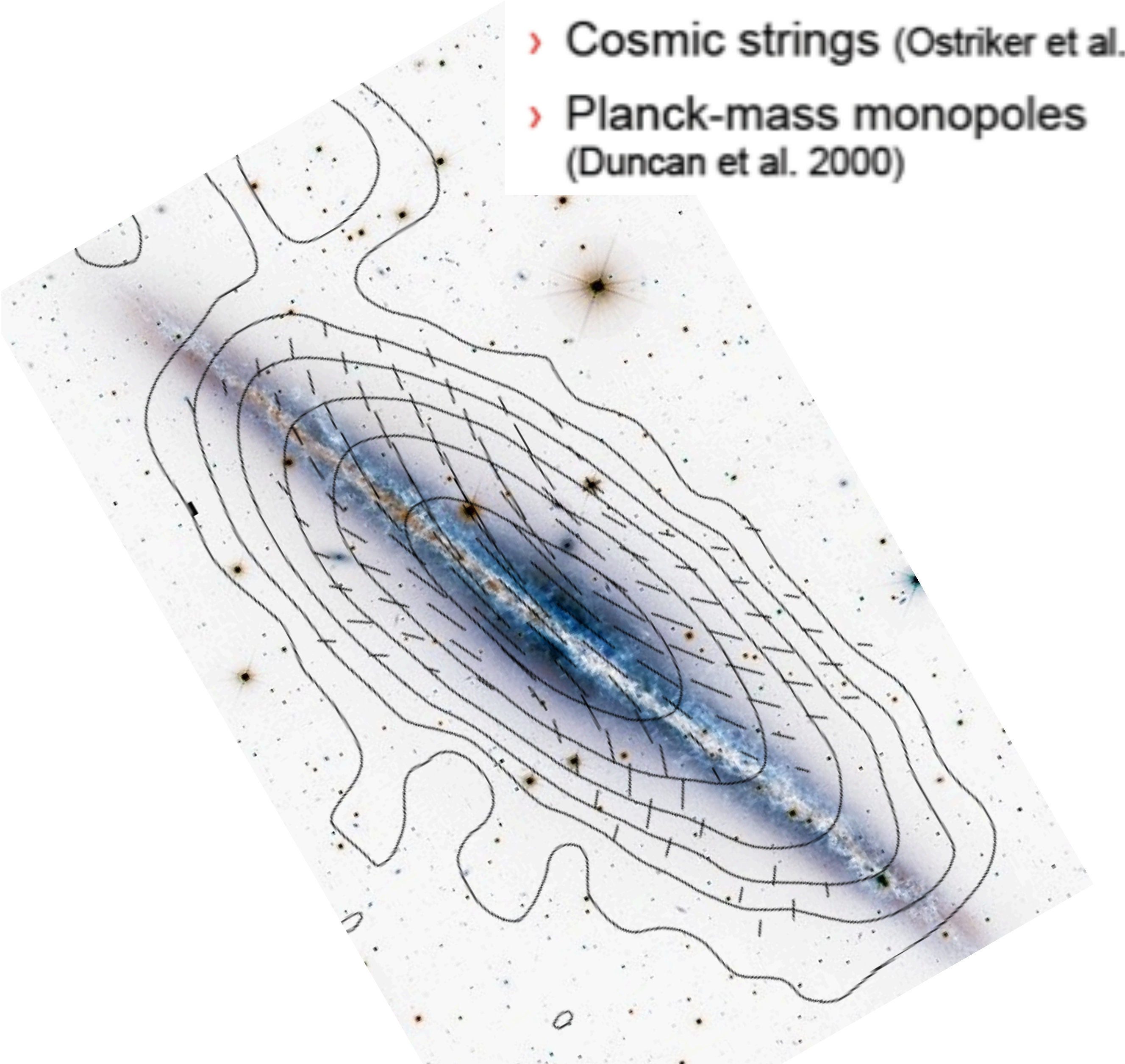


Magnetised Galactic Foreground (e.g. *Herron et al. 2017*)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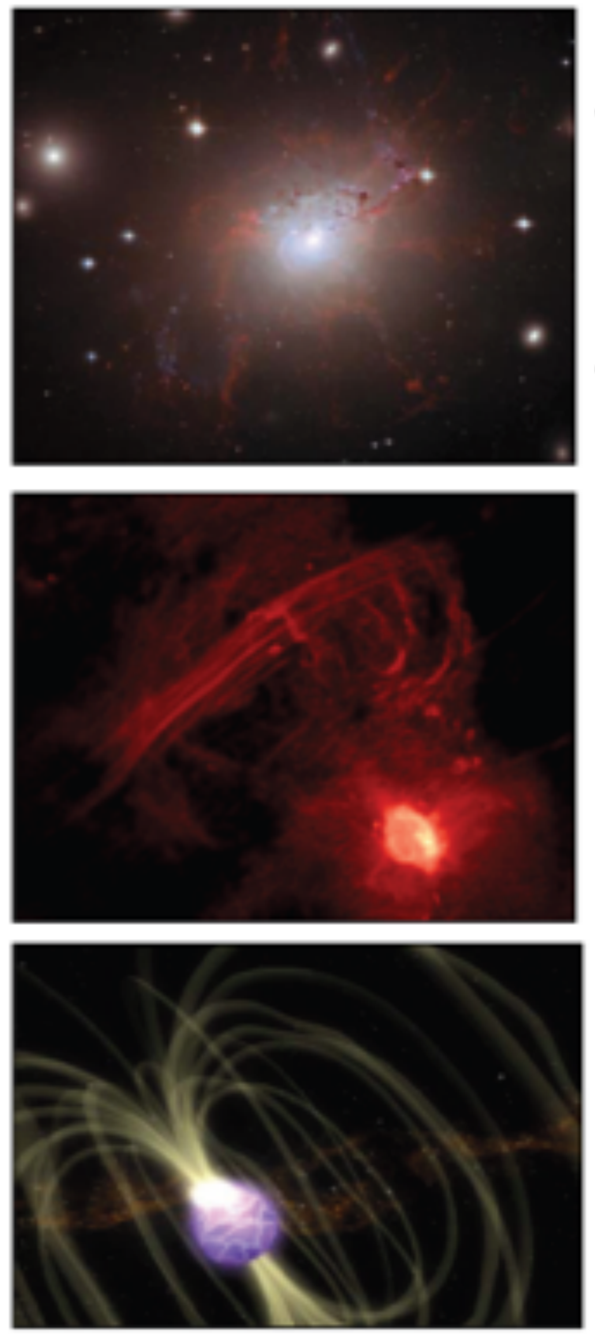

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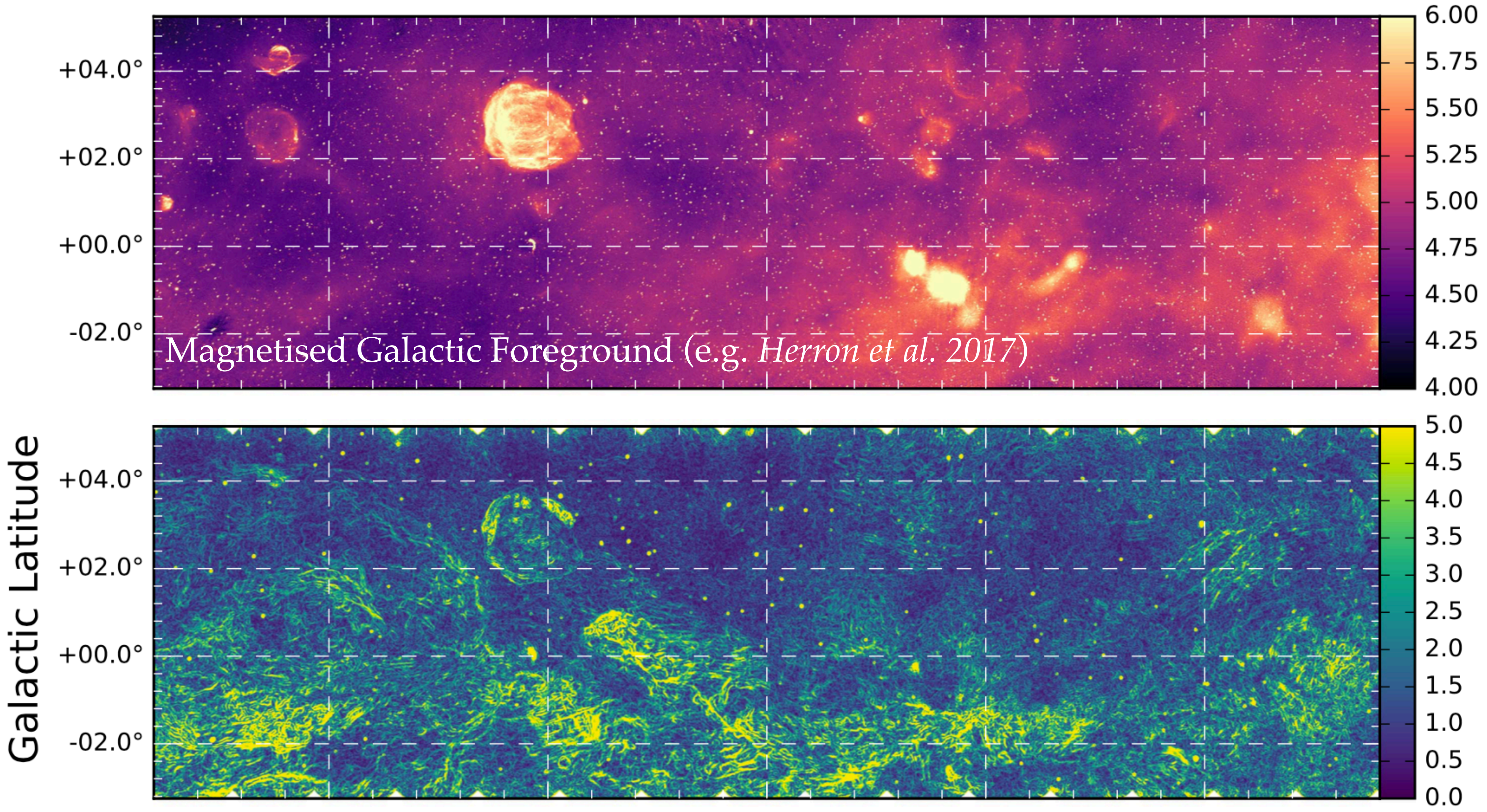

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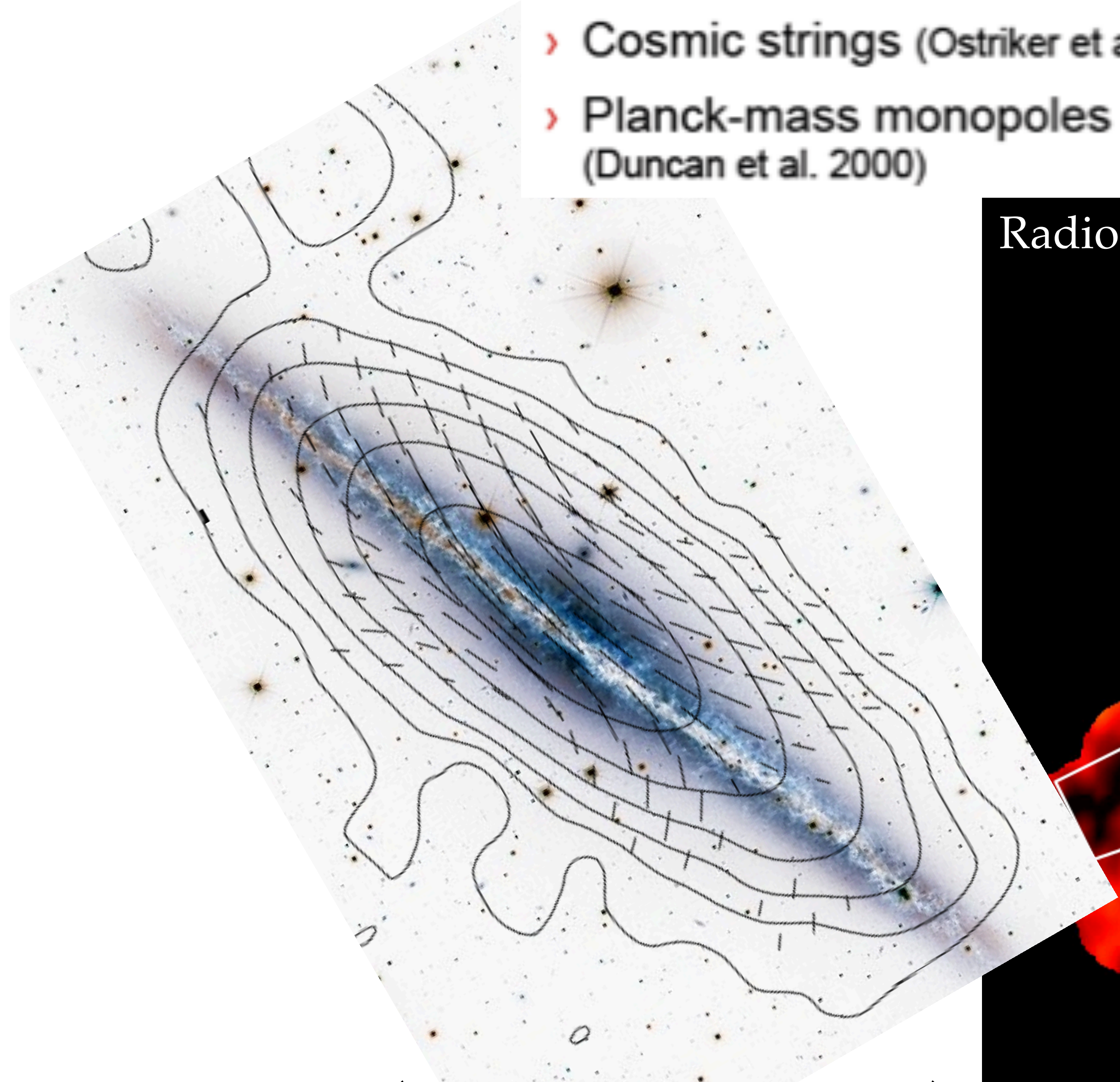

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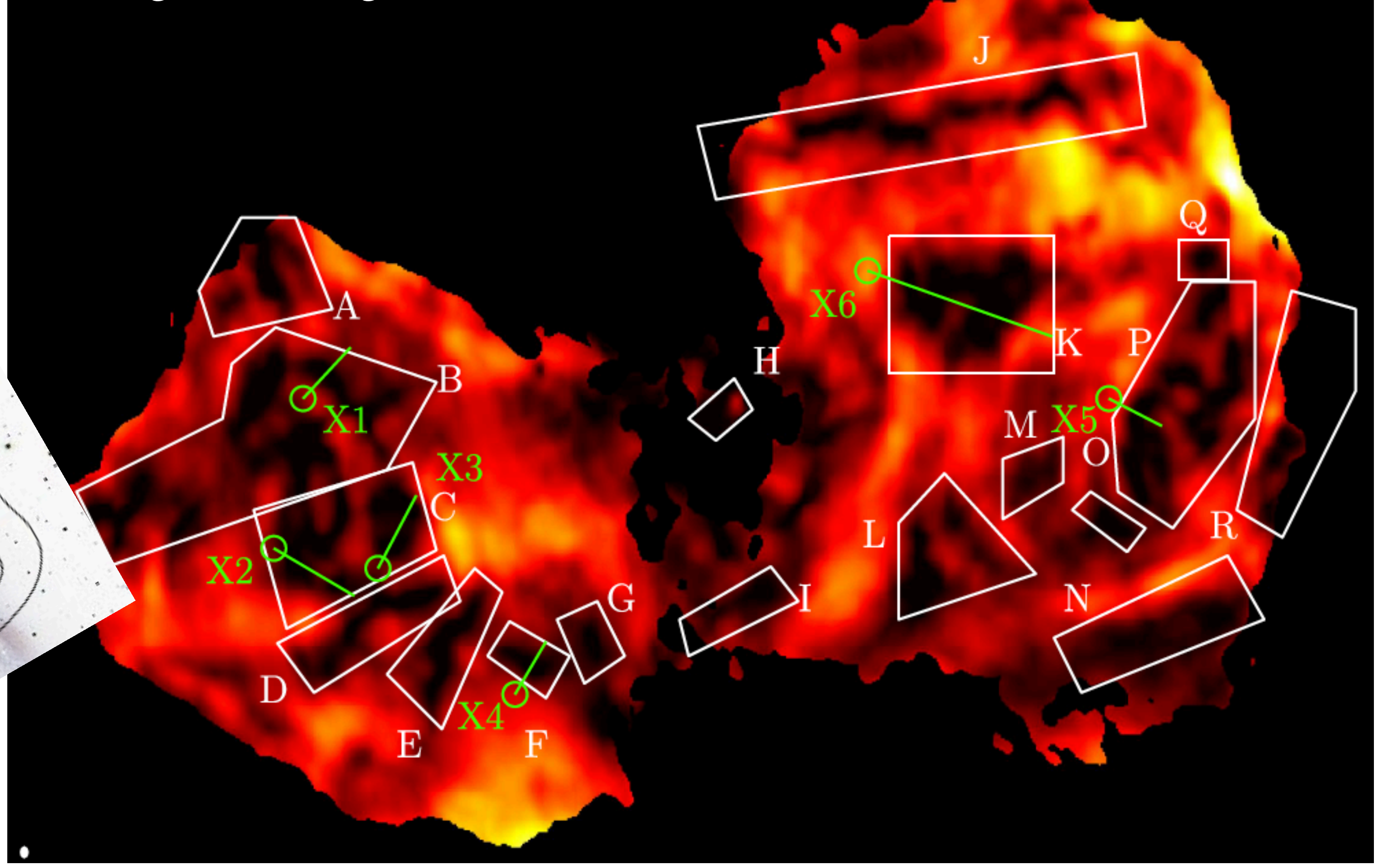

Radio galaxies (e.g. Fornax A; *Anderson et al. 2018*)

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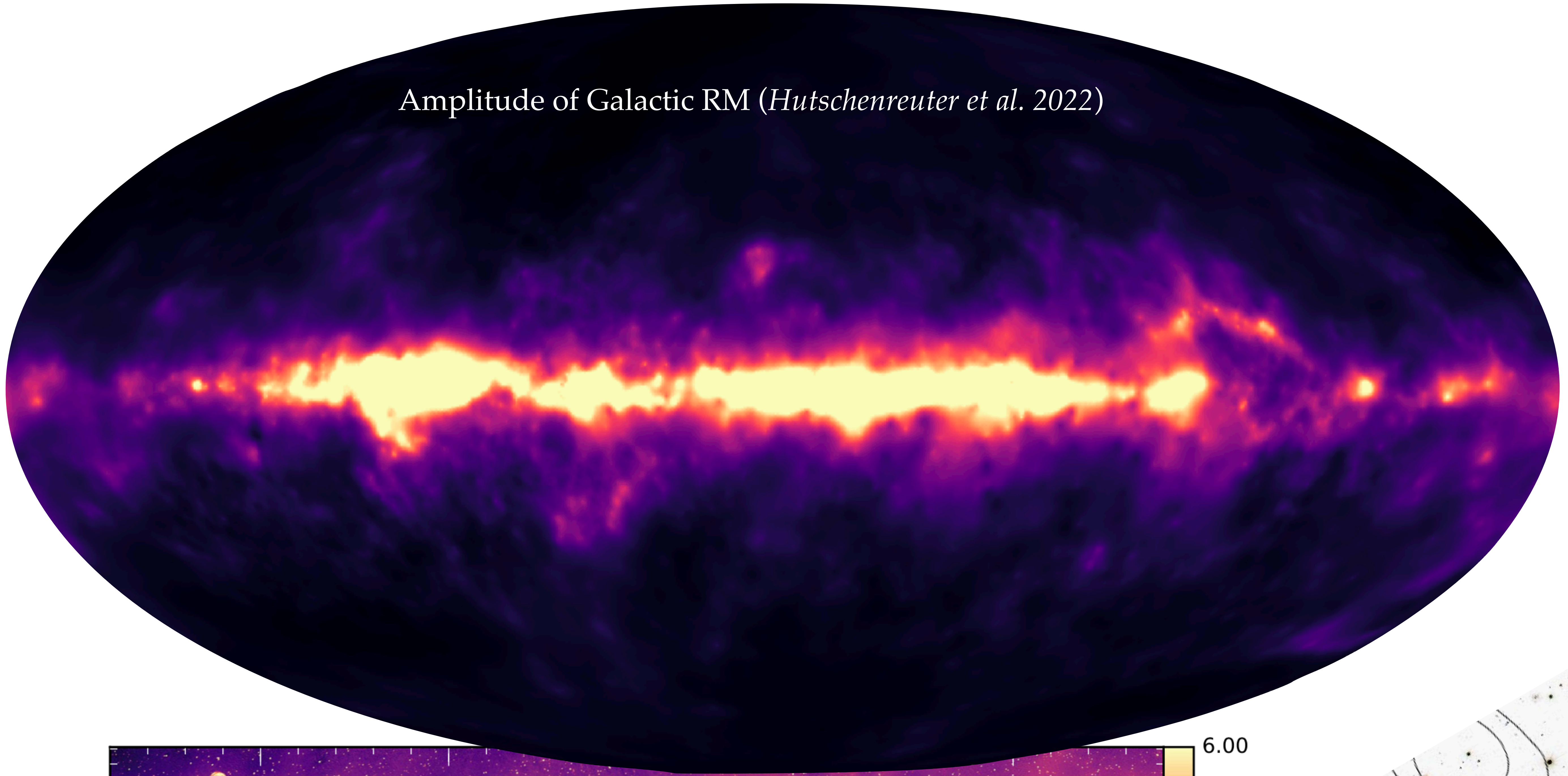
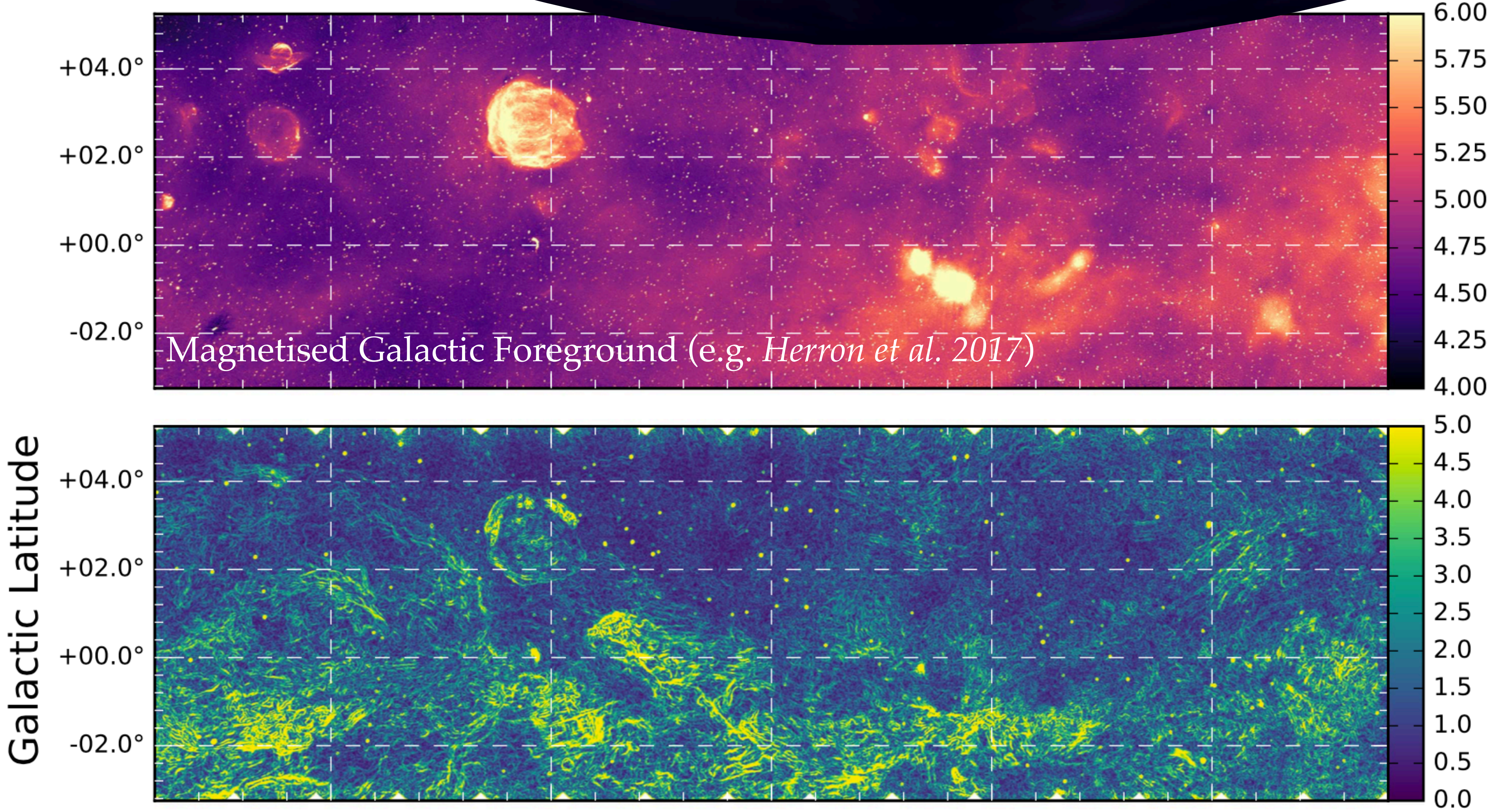

Amplitude of Galactic RM (*Hutschenreuter et al. 2022*)



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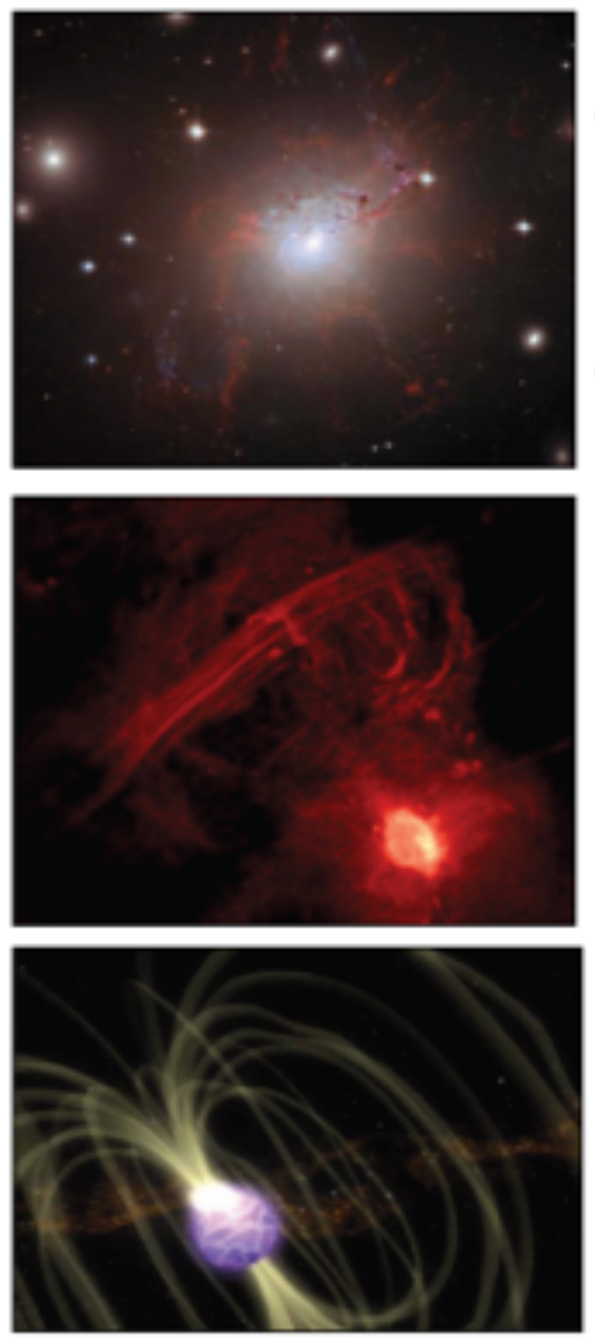
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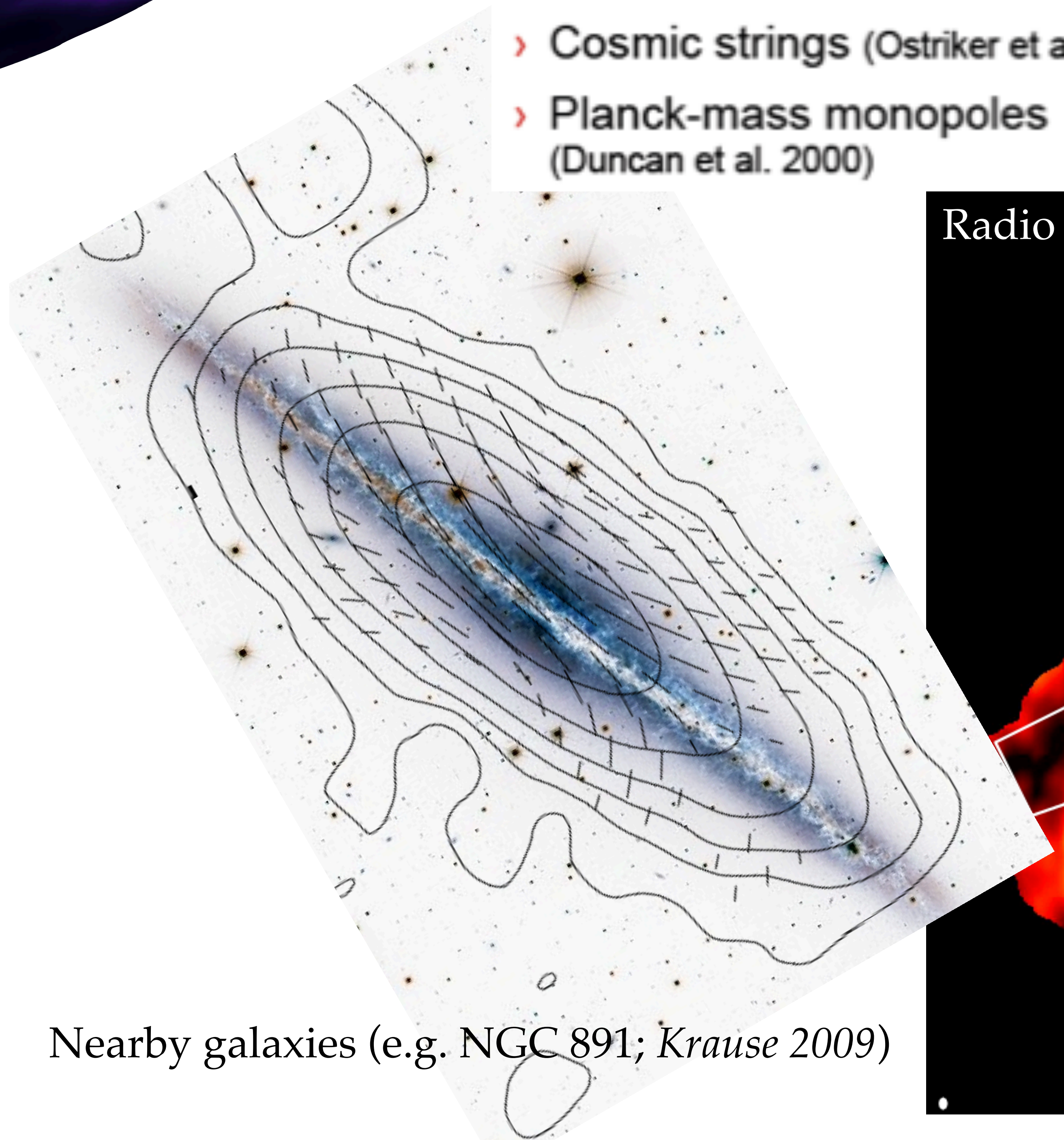
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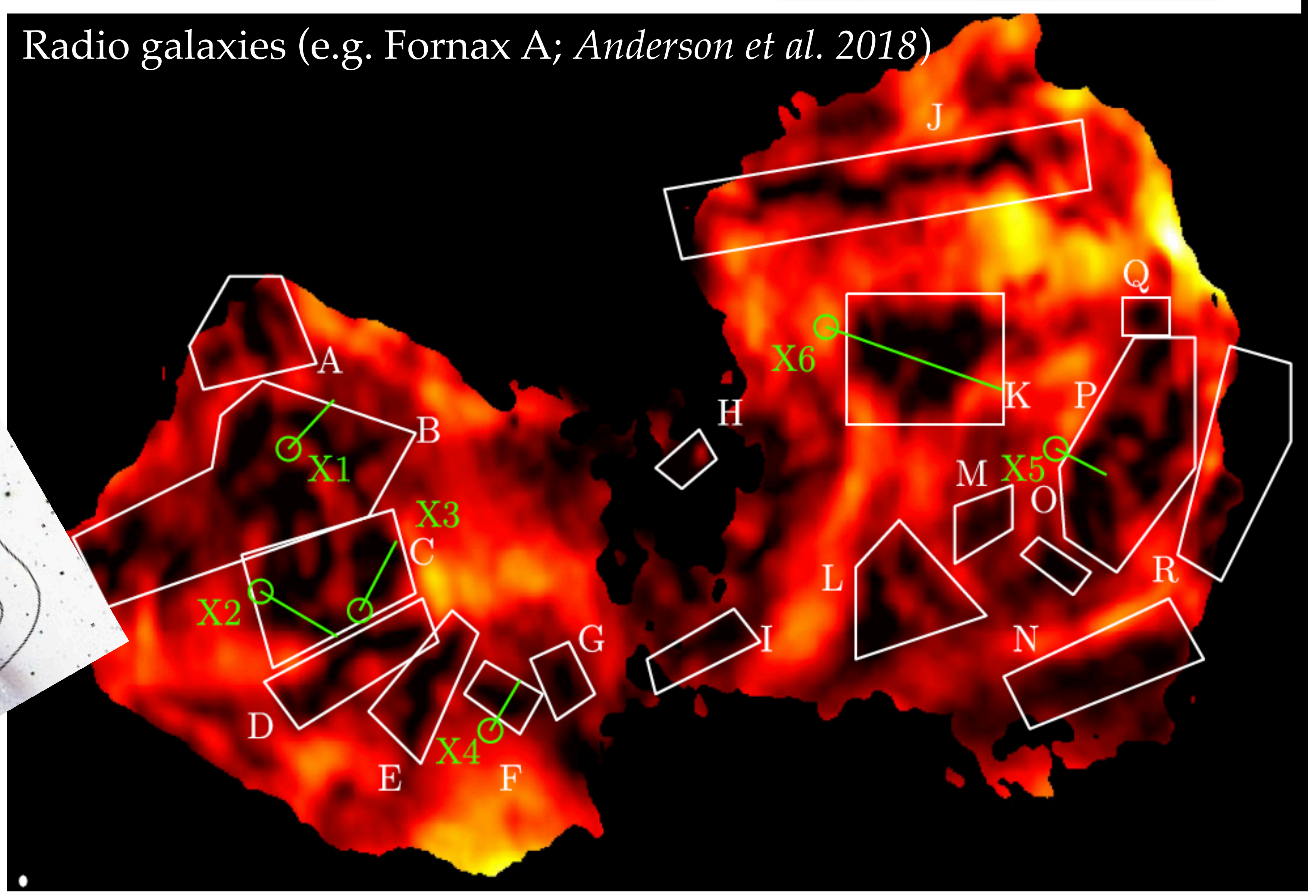

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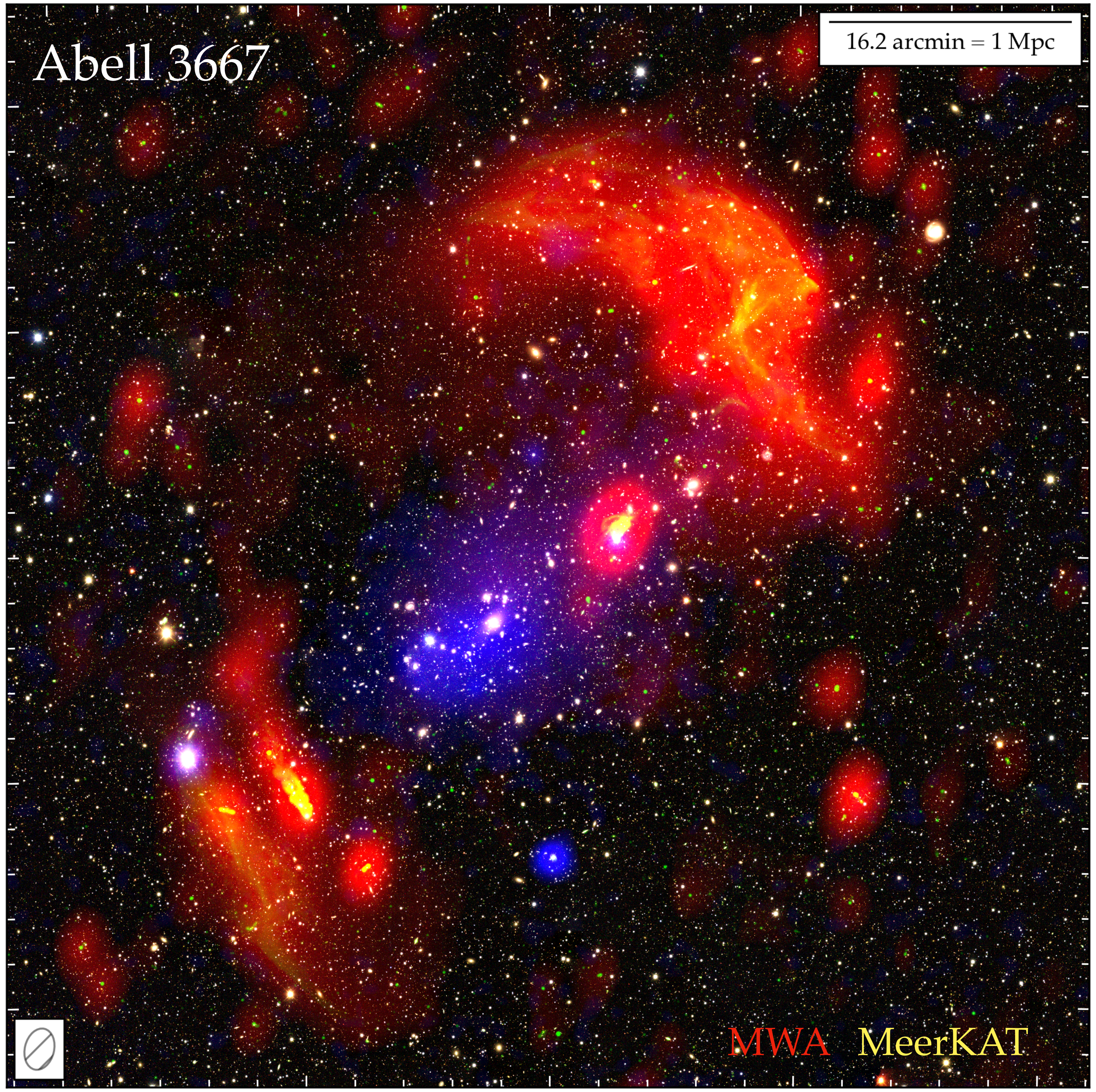

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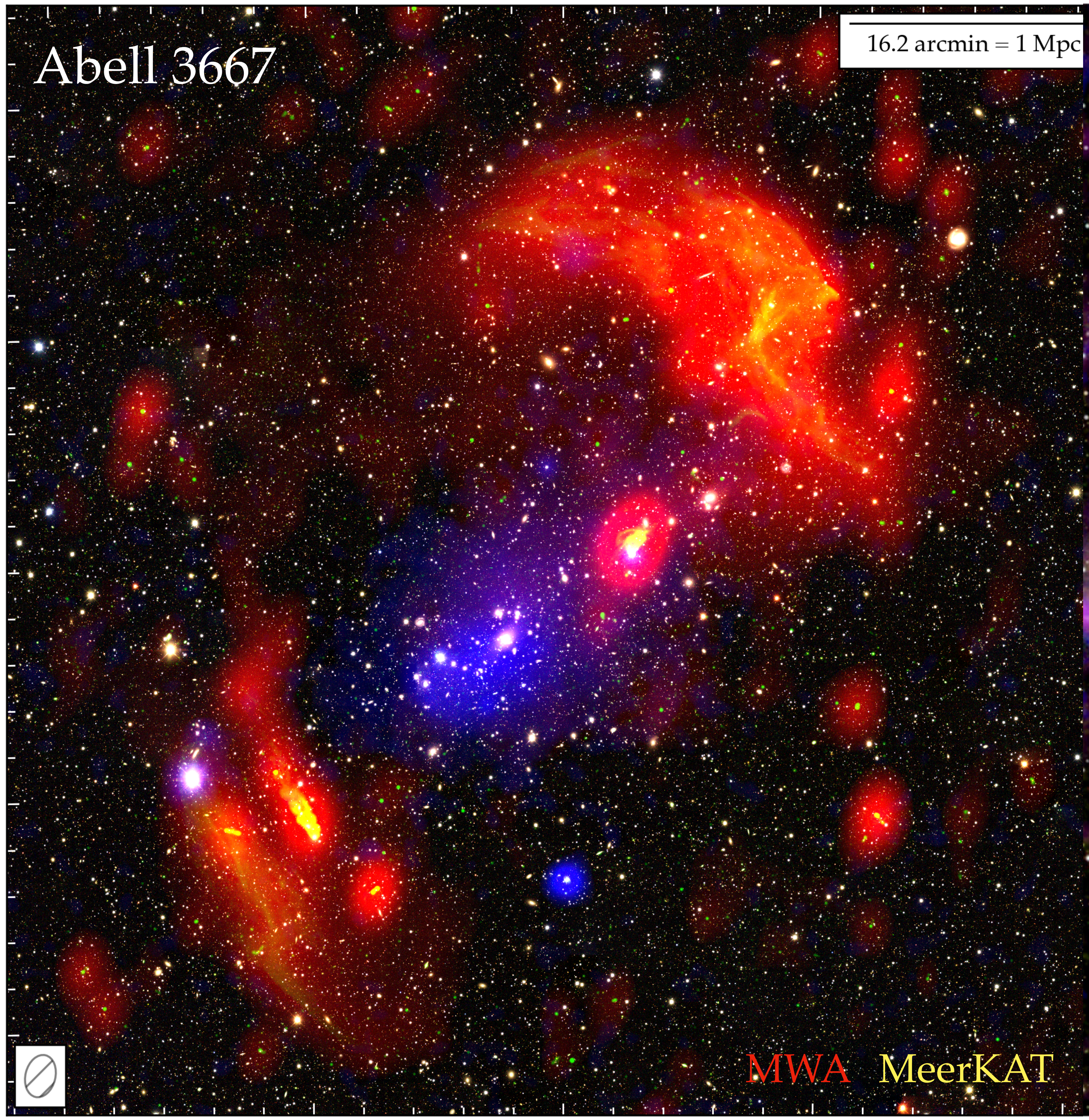

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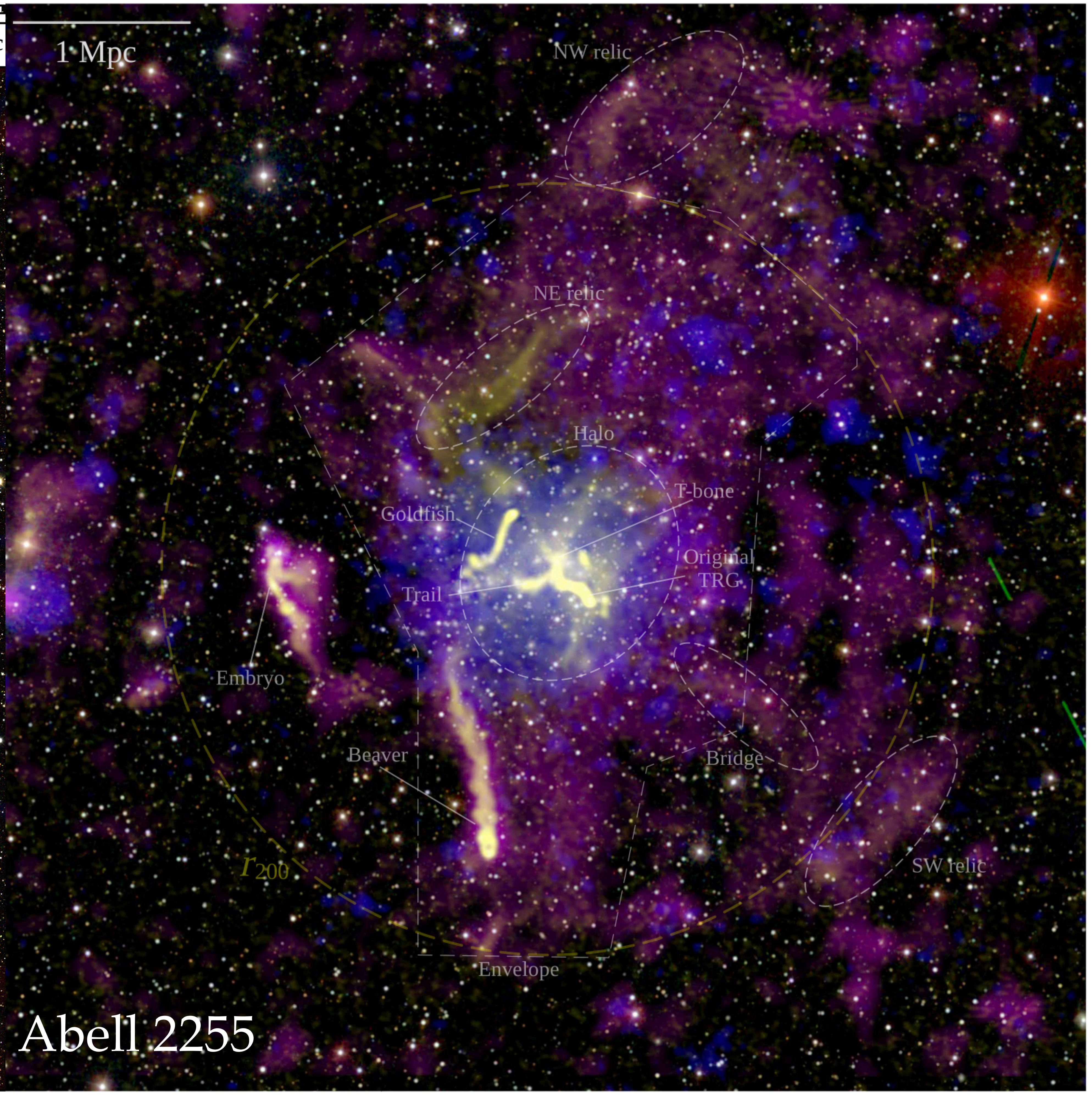

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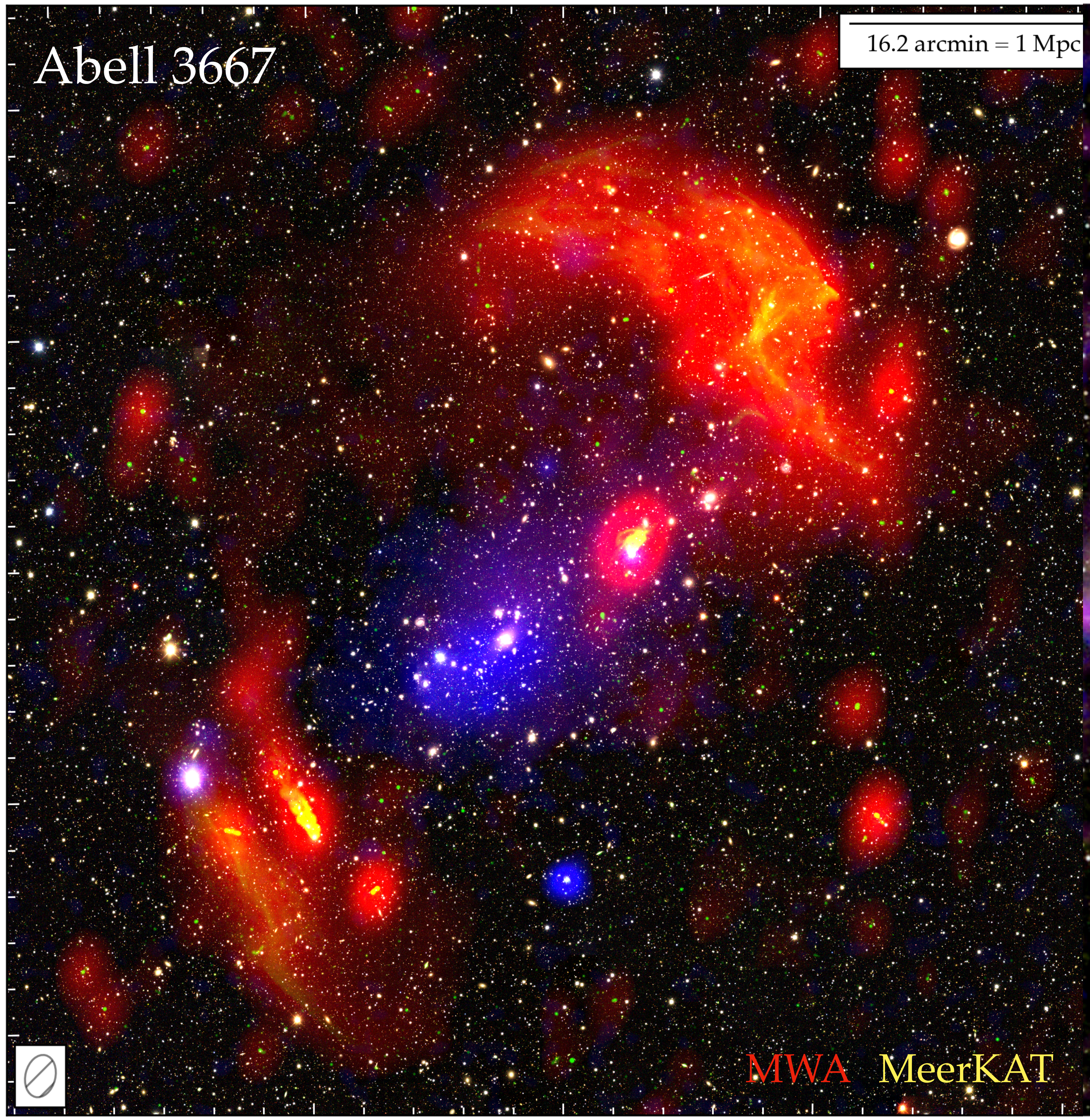

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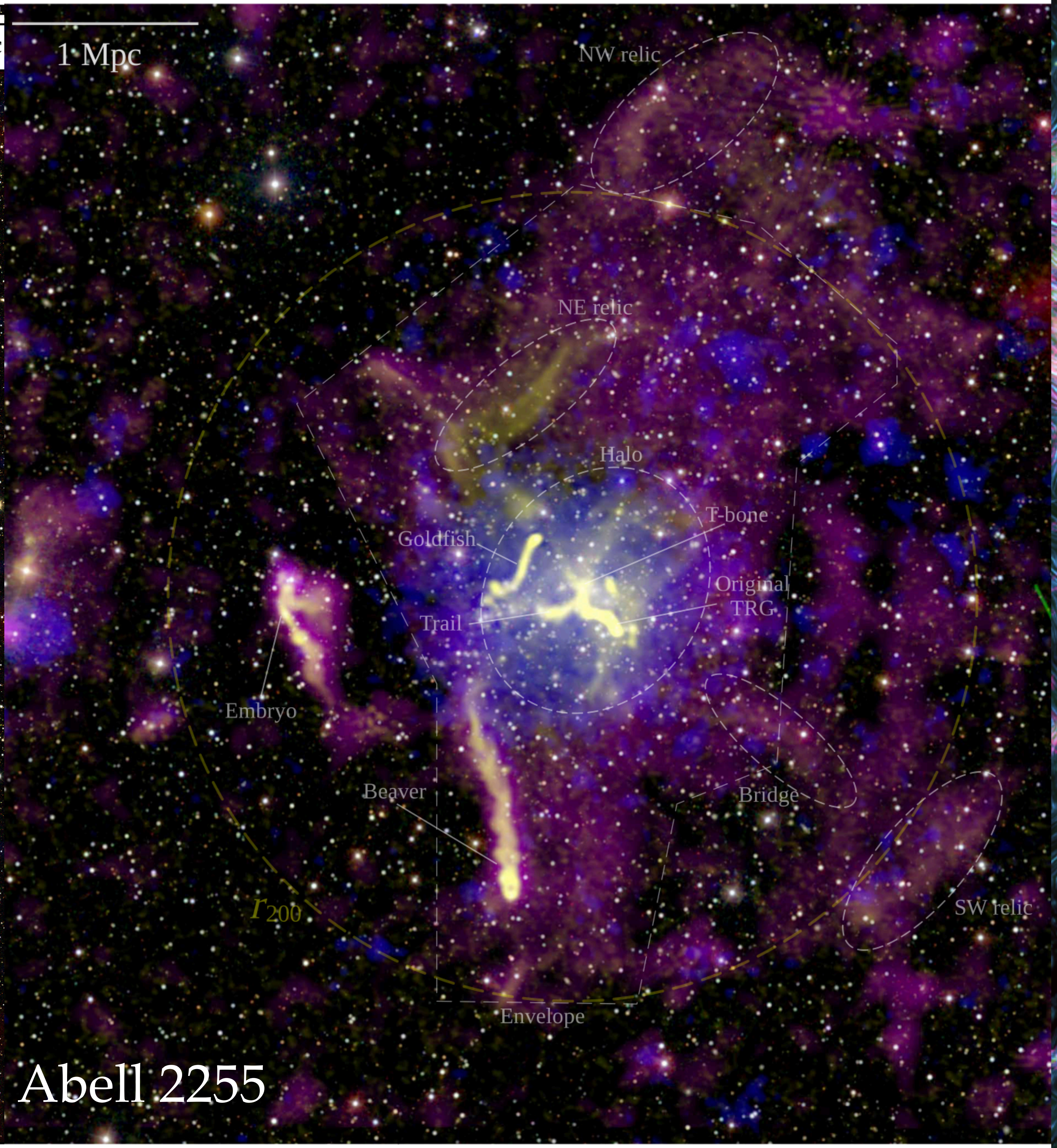

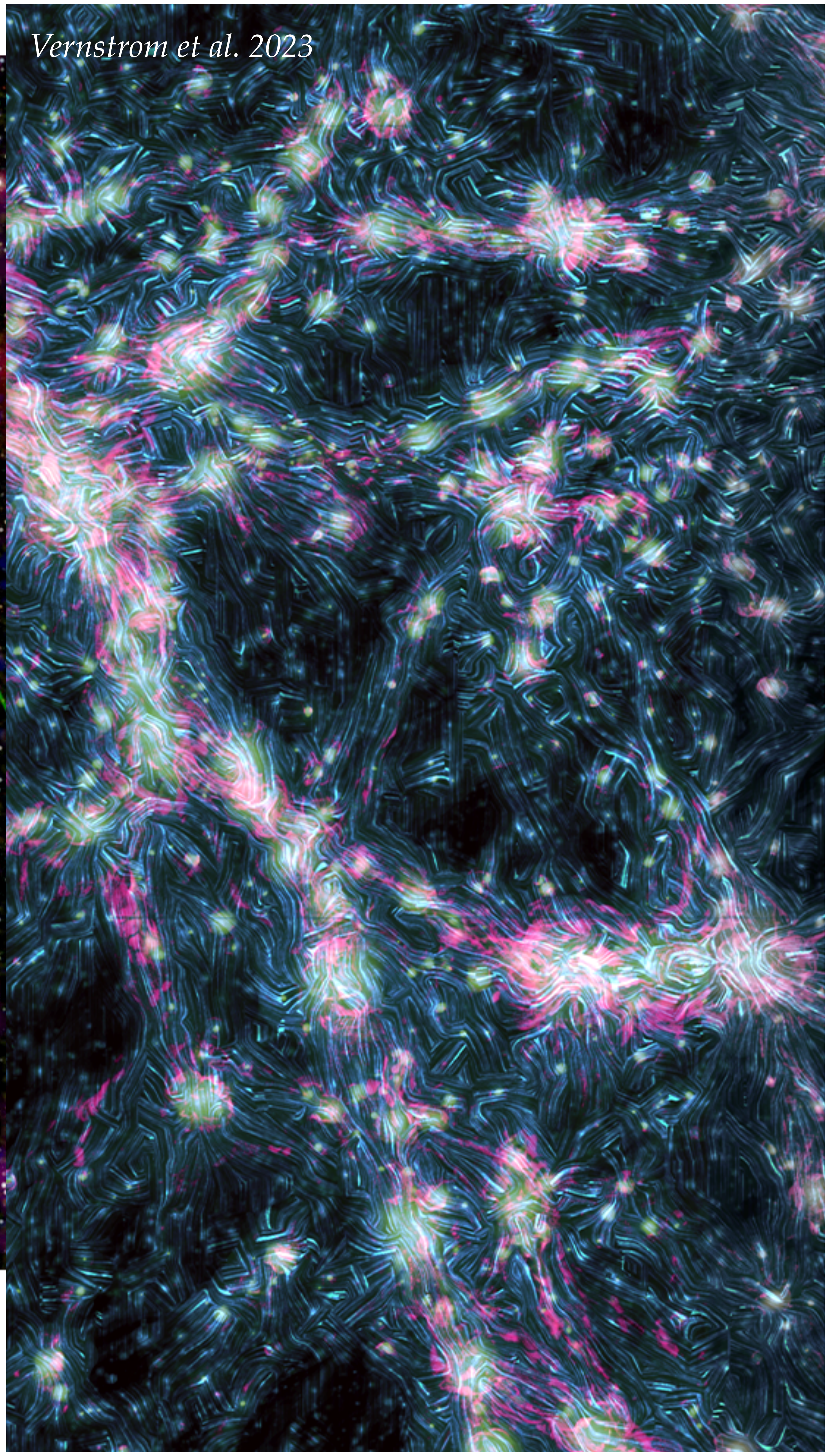

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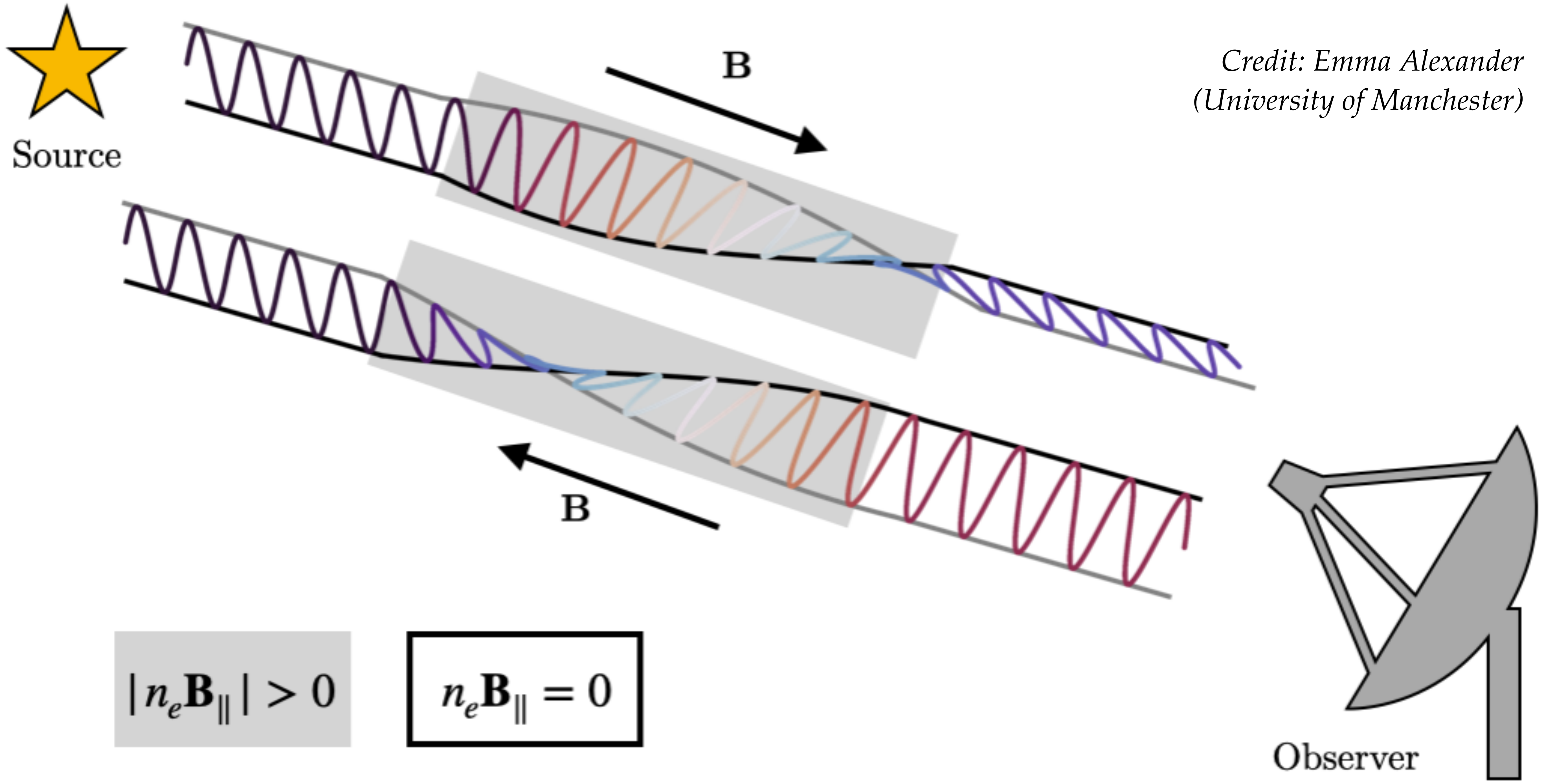
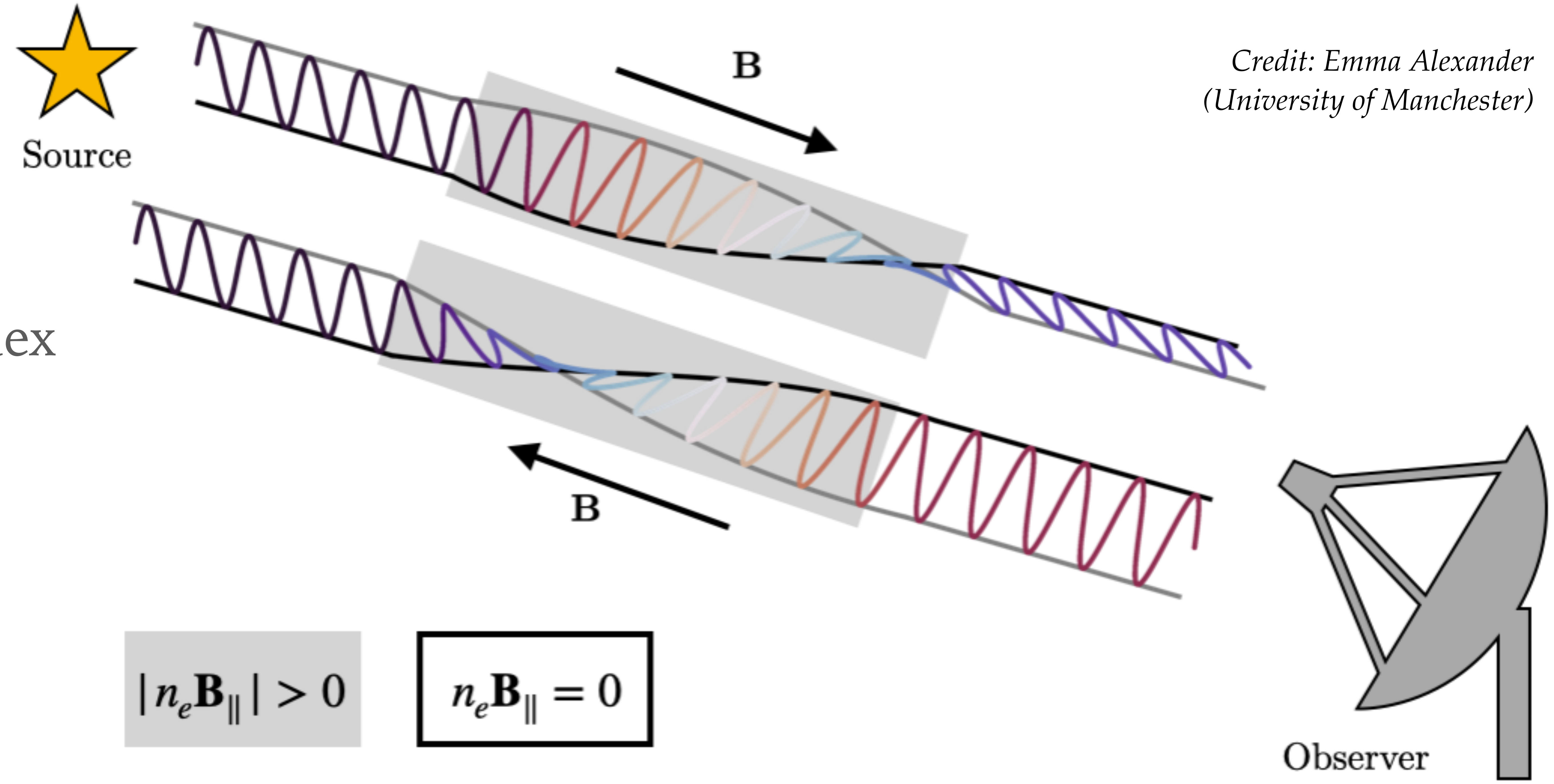


Credit: Emma Alexander (University of Manchester)

SEARCH FOR POLARISED SOURCES

- Rotation Measure (RM) synthesis:
  - Astrophysical plasma is birefringent
  - Each handedness “sees” different refractive index
  - Plane of polarisation rotates
- How much rotation?
  - Quantified by the rotation measure (RM)



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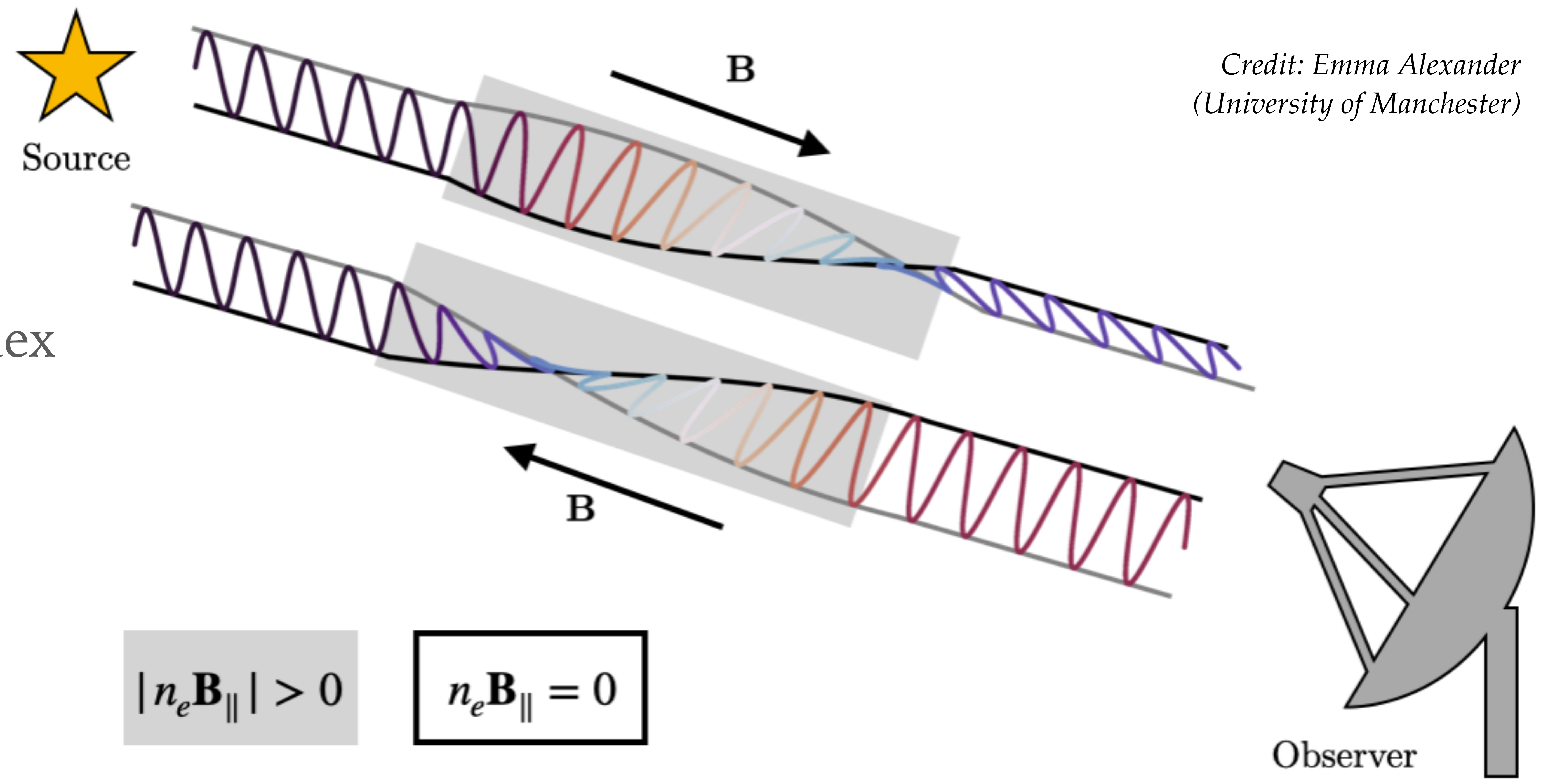

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$$\boxed{\chi(\lambda^2)} = \boxed{\chi_0} + \mathrm{RM} \cdot \lambda^2$$

Polarisation angle (frequency-dependent)

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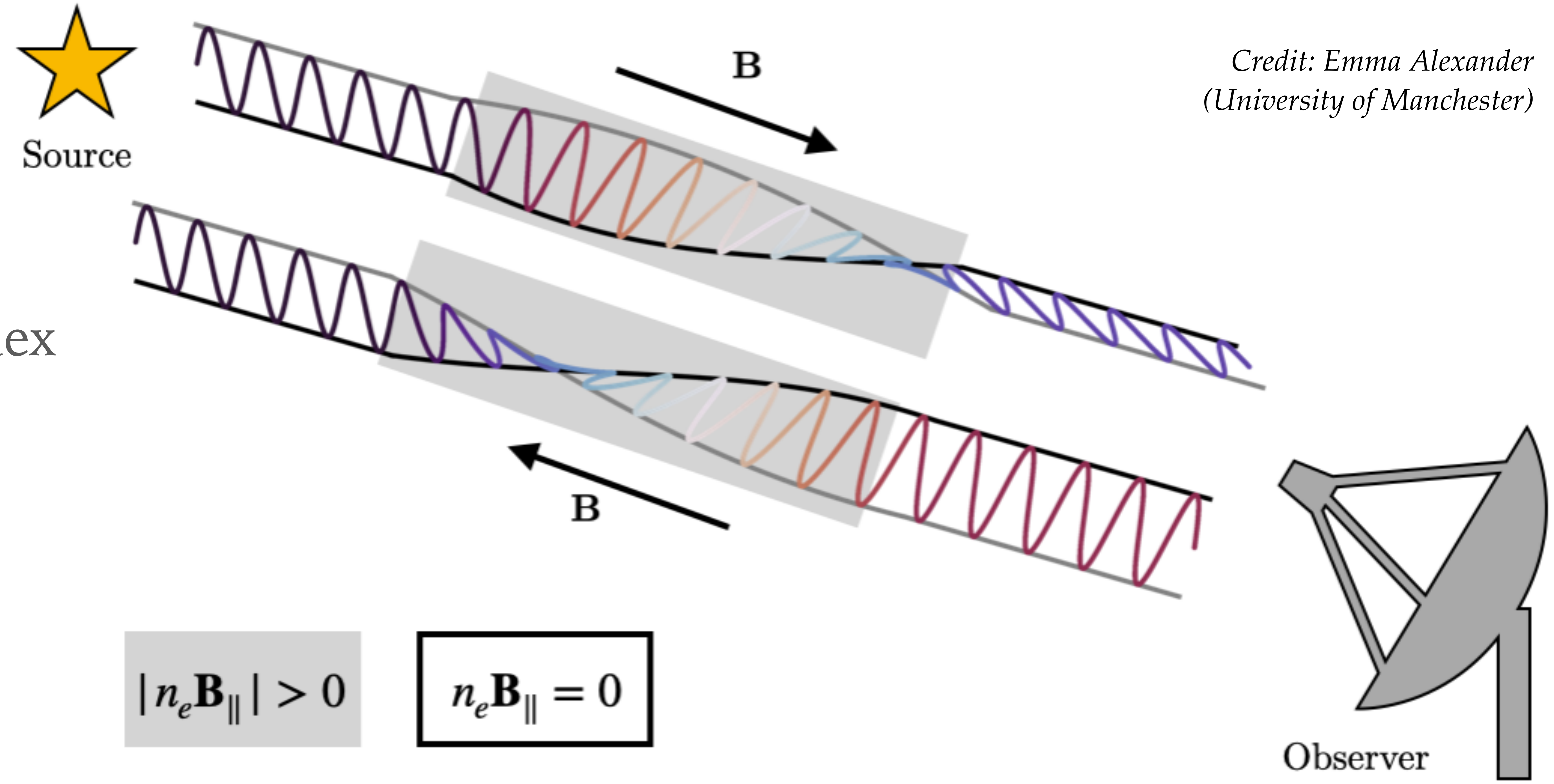

Intrinsic polarisation angle

LOS magnetic field strength

$$\boxed{\chi(\lambda^2)} = \boxed{\chi_0} + \mathrm{RM} \cdot \lambda^2 \qquad \mathrm{RM} = 0.81 \int_{\ell}^{0} \boxed{n_e} \boxed{B_\parallel} \cdot d\ell$$

Polarisation angle (frequency-dependent)

where

Free electron density

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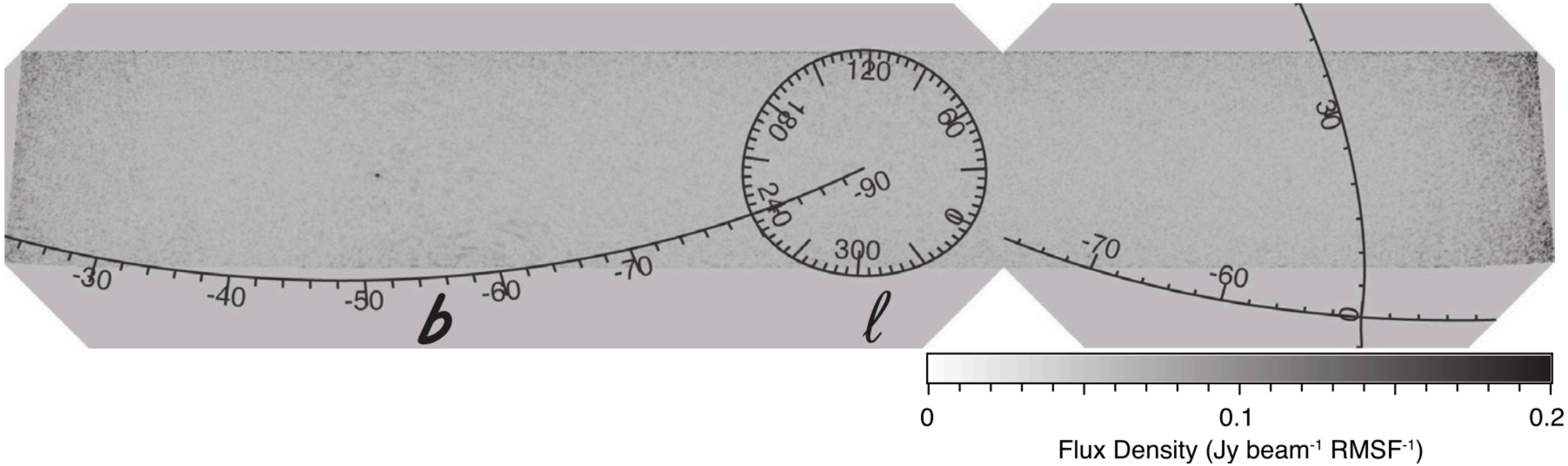

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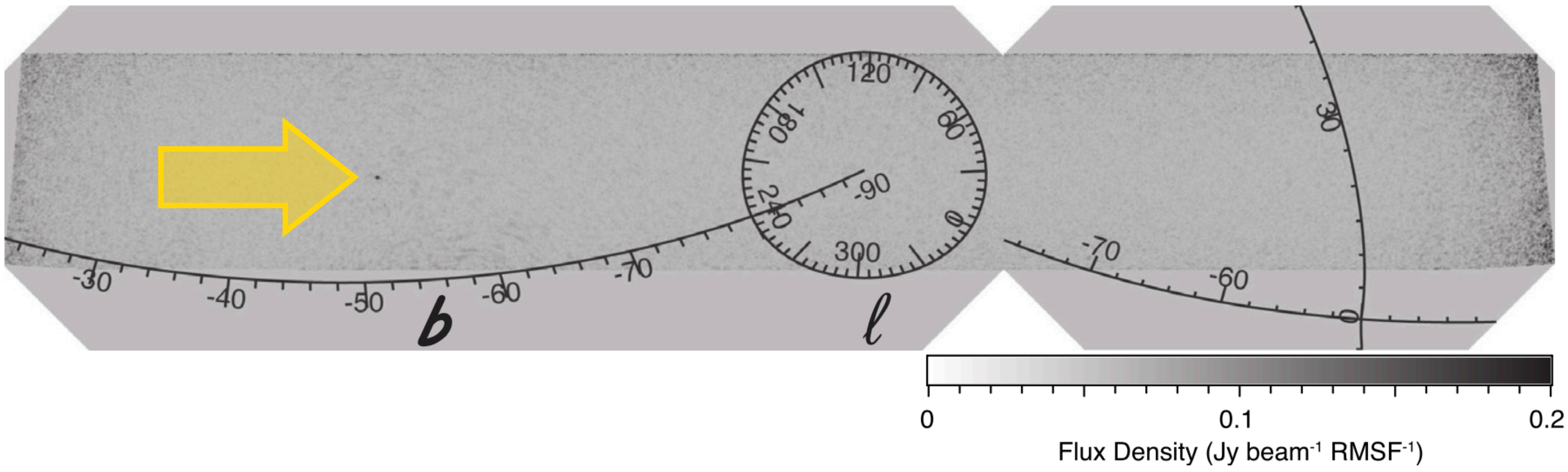

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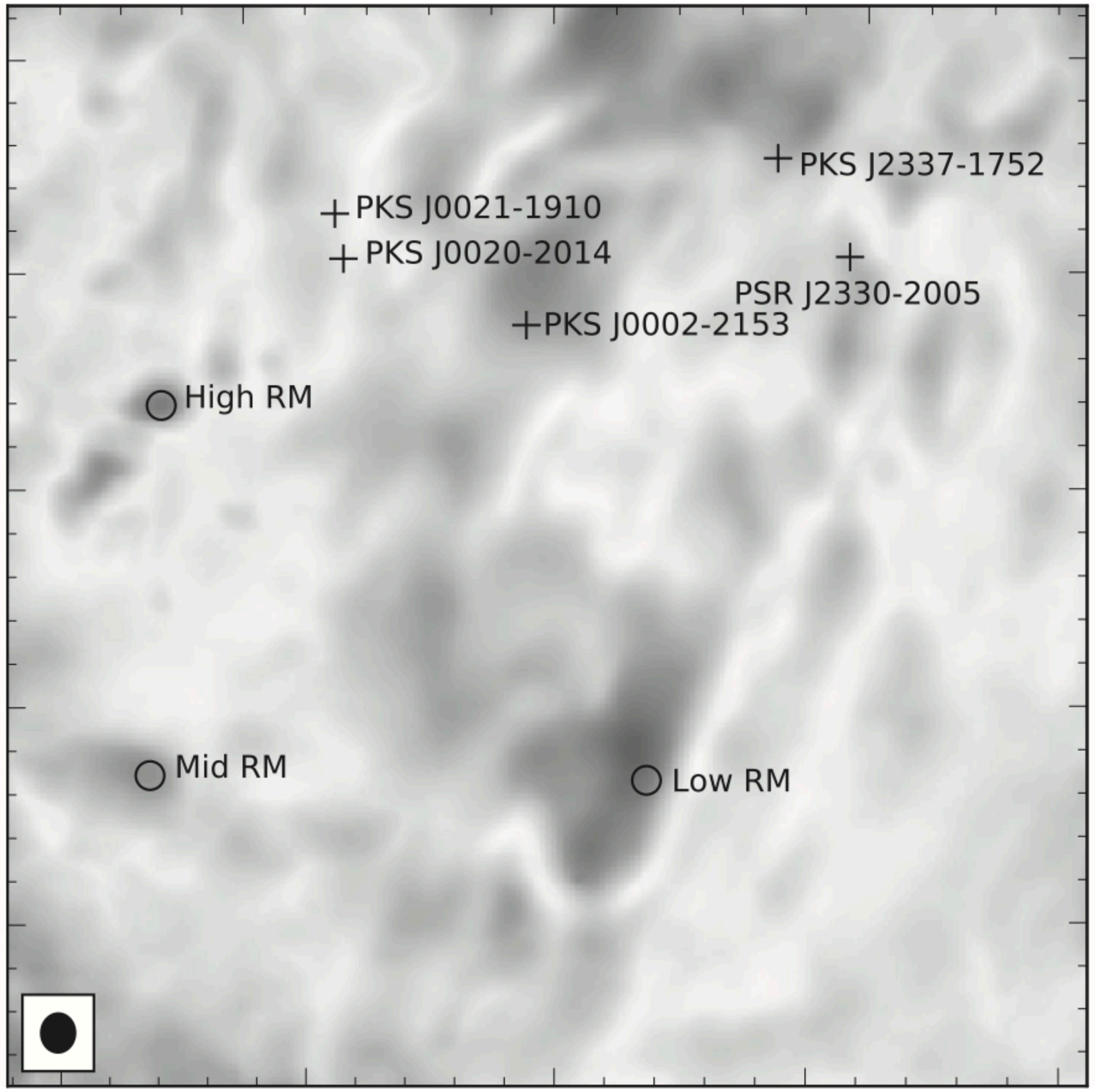

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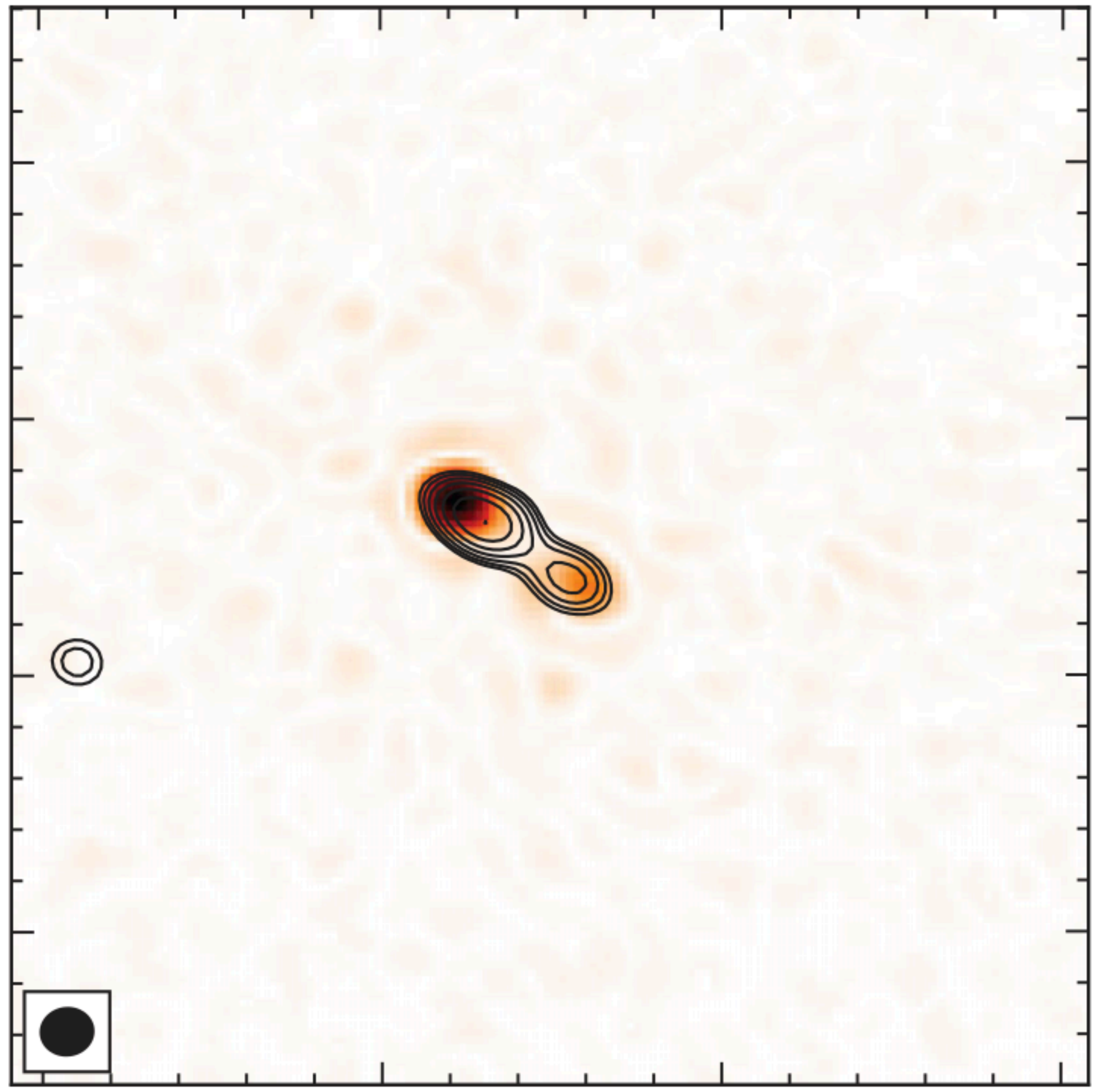

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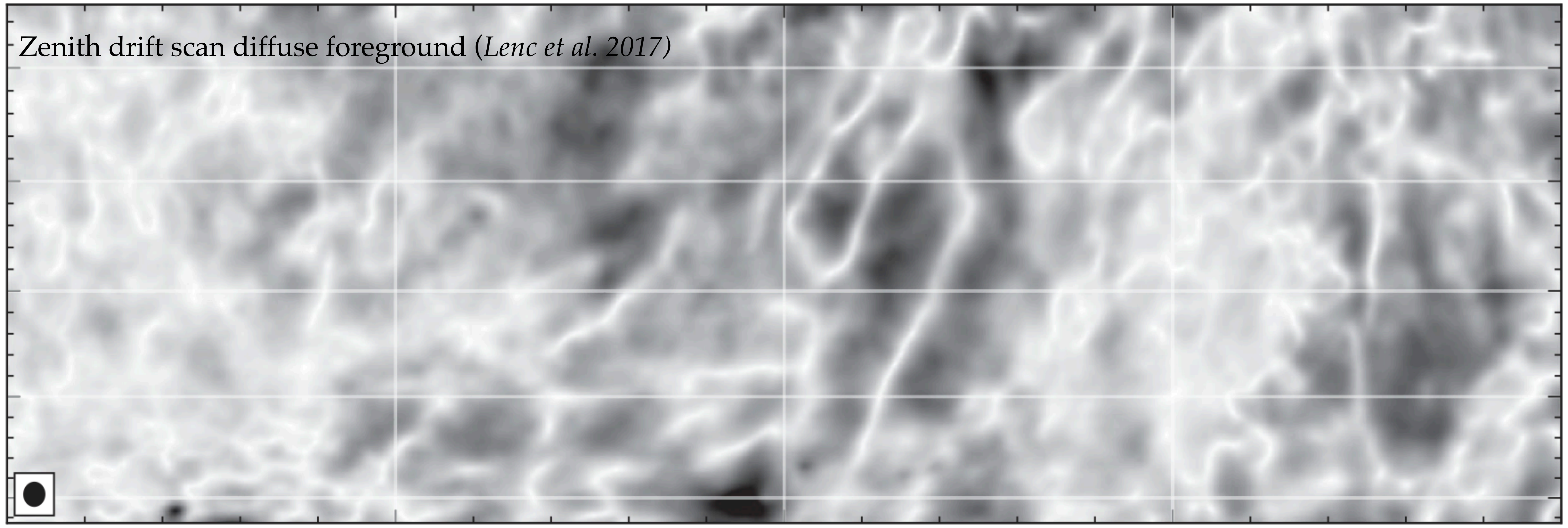

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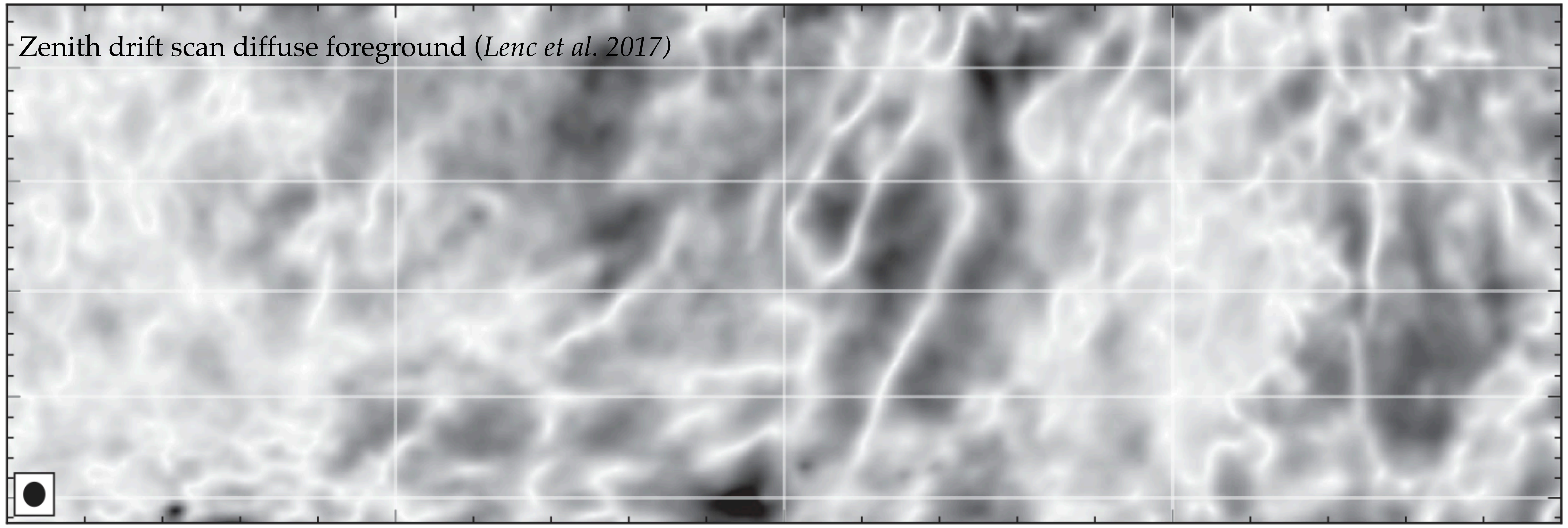

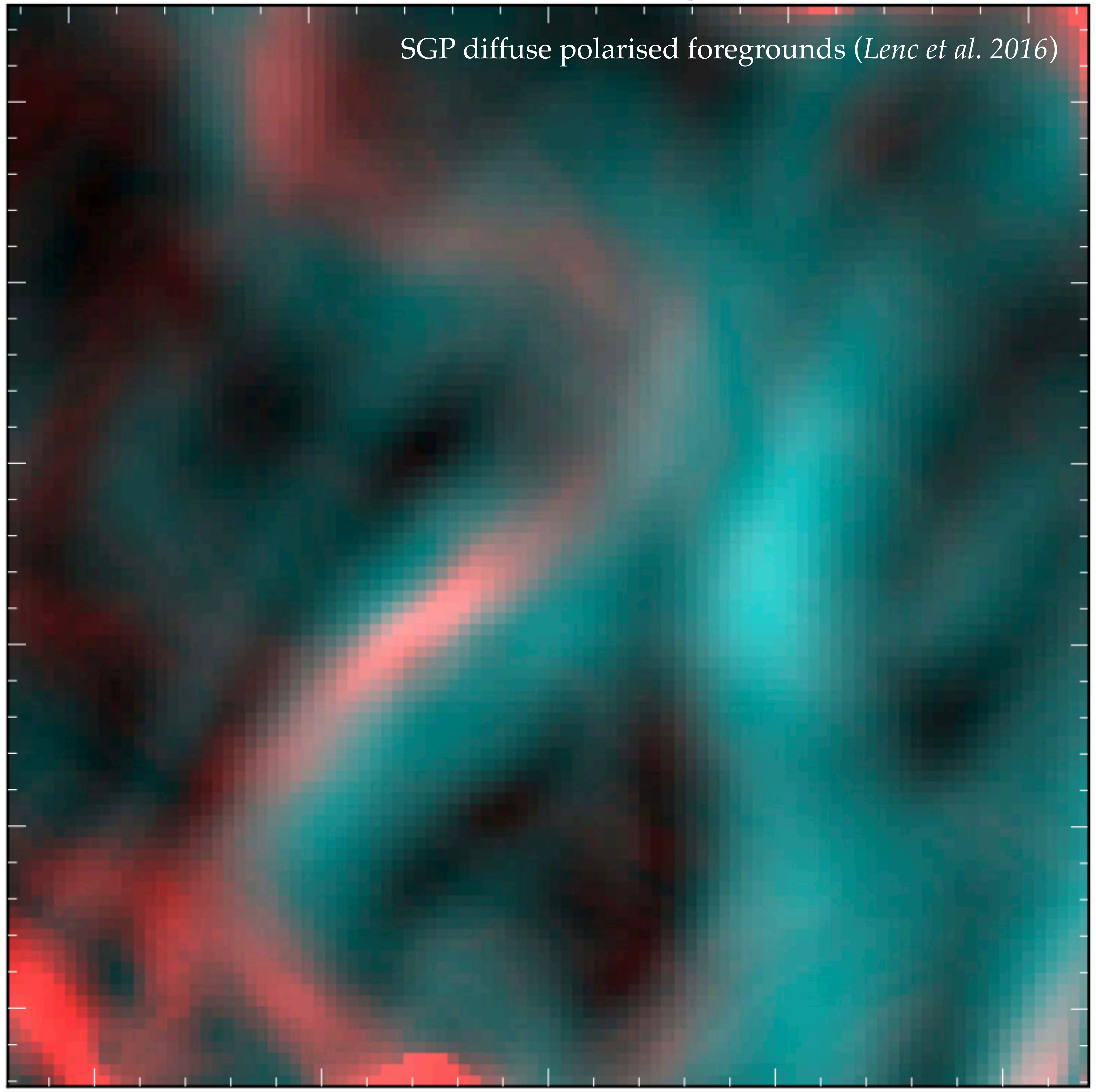

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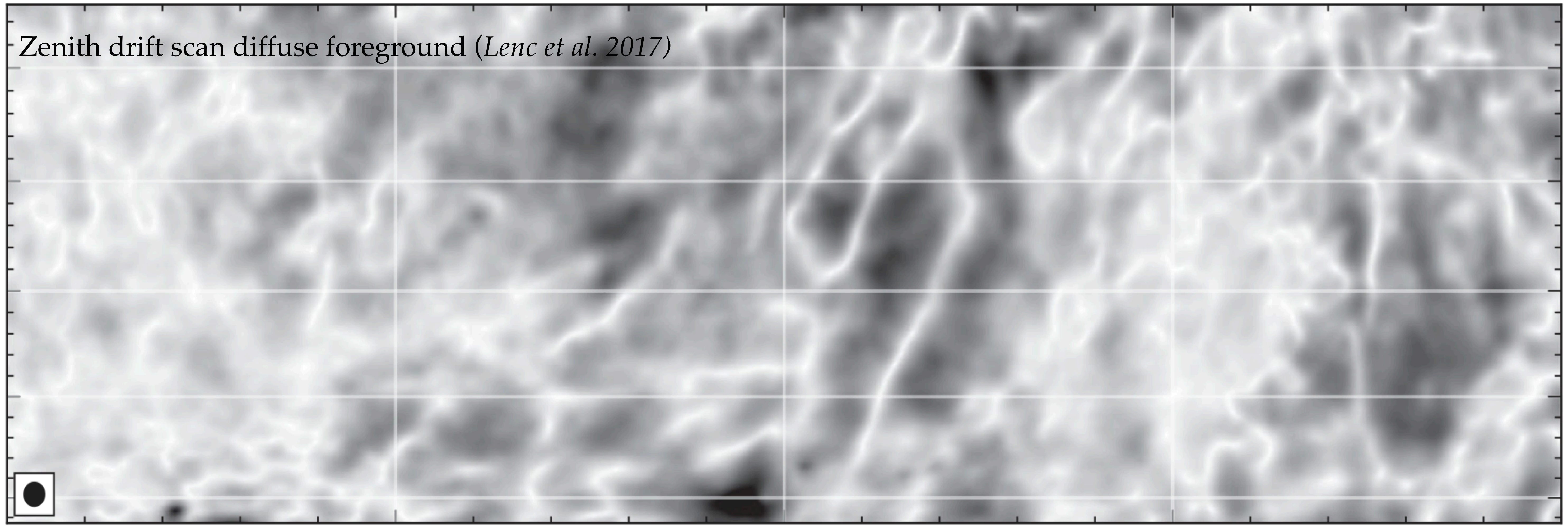

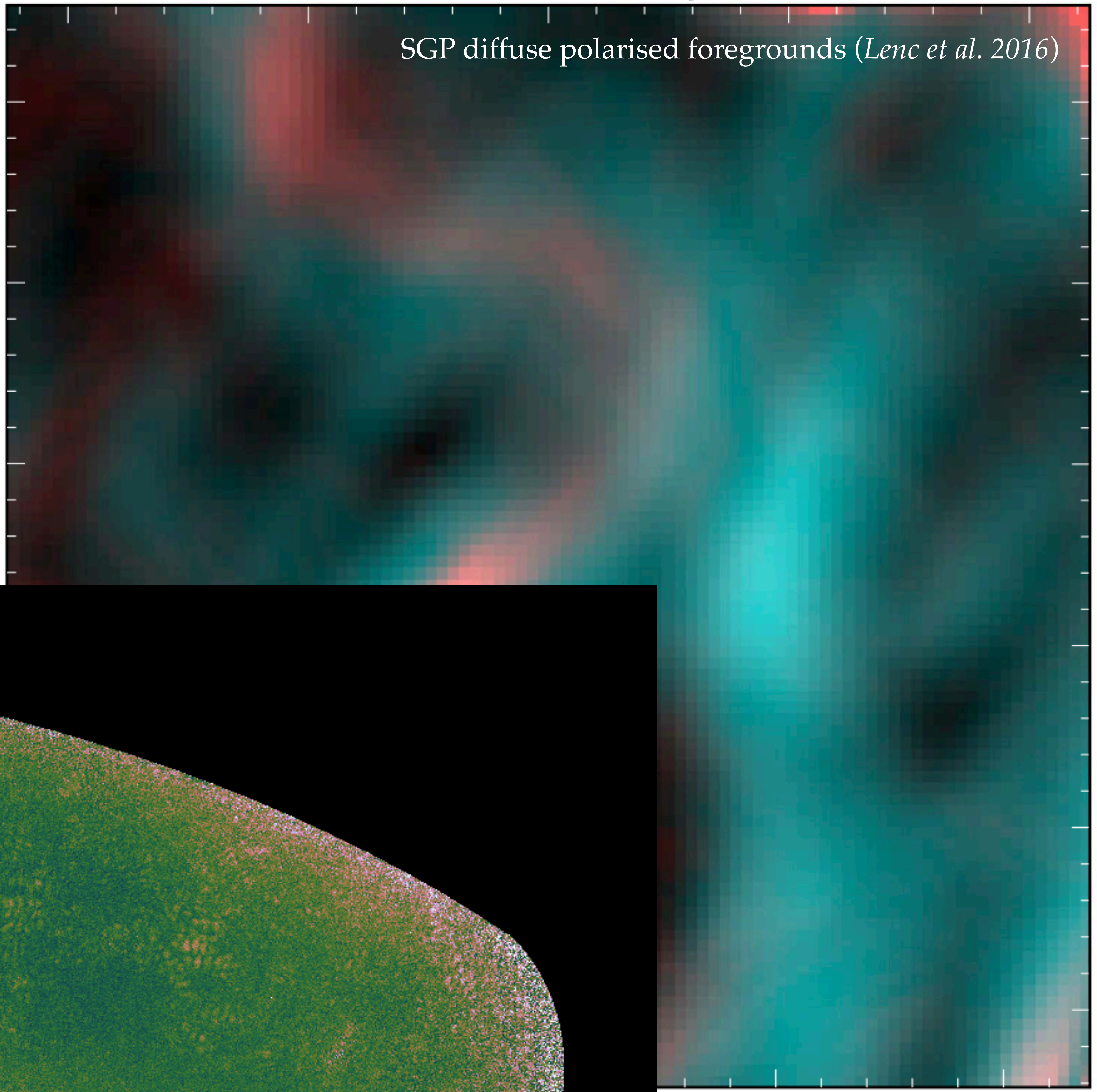

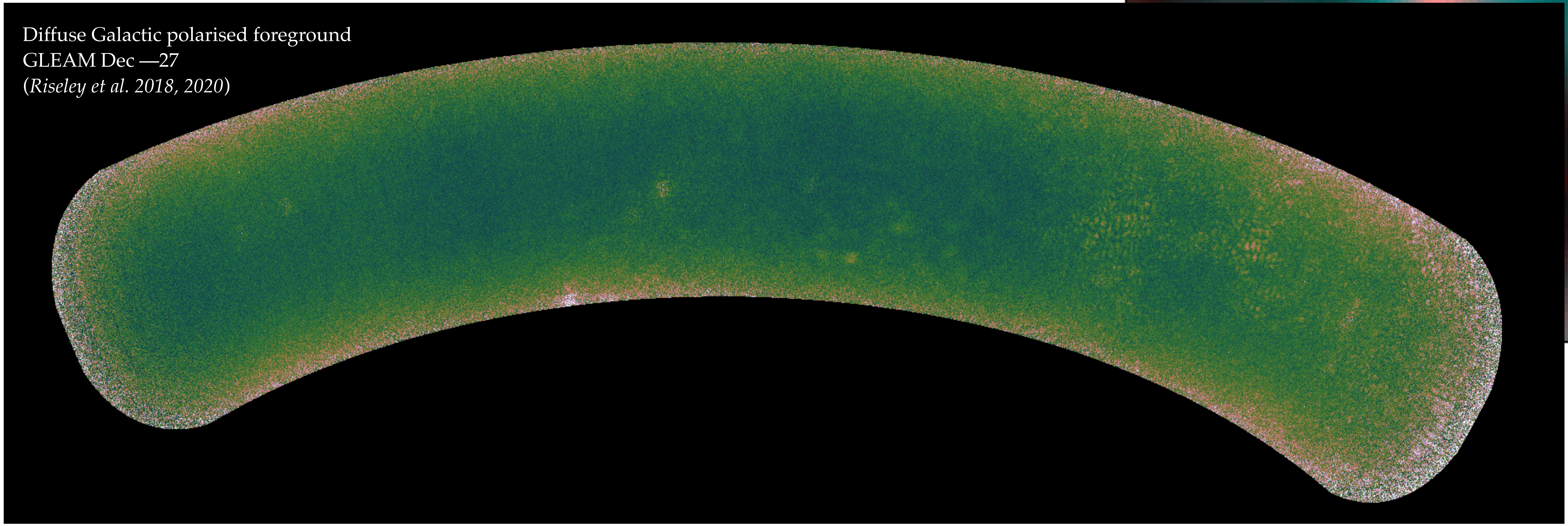

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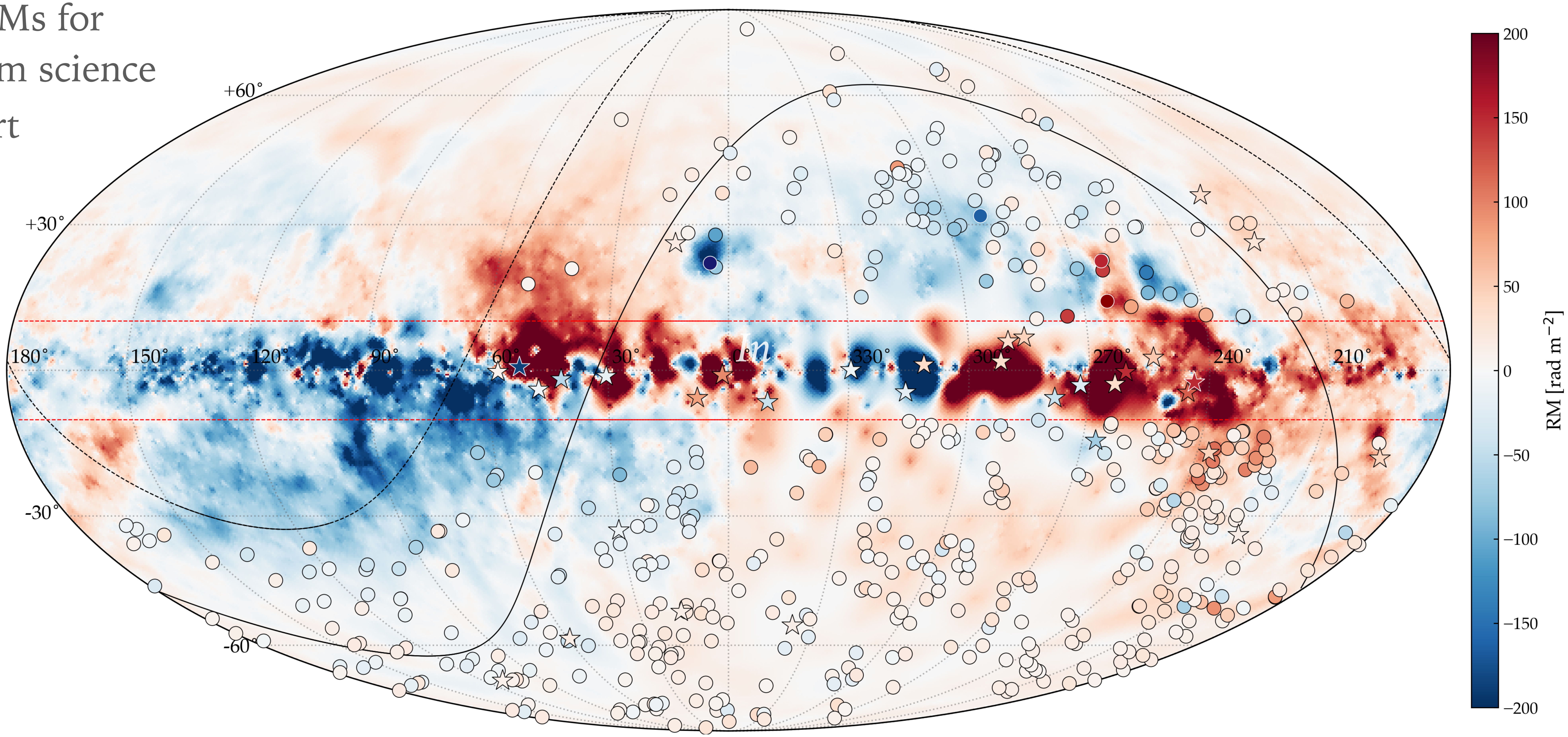

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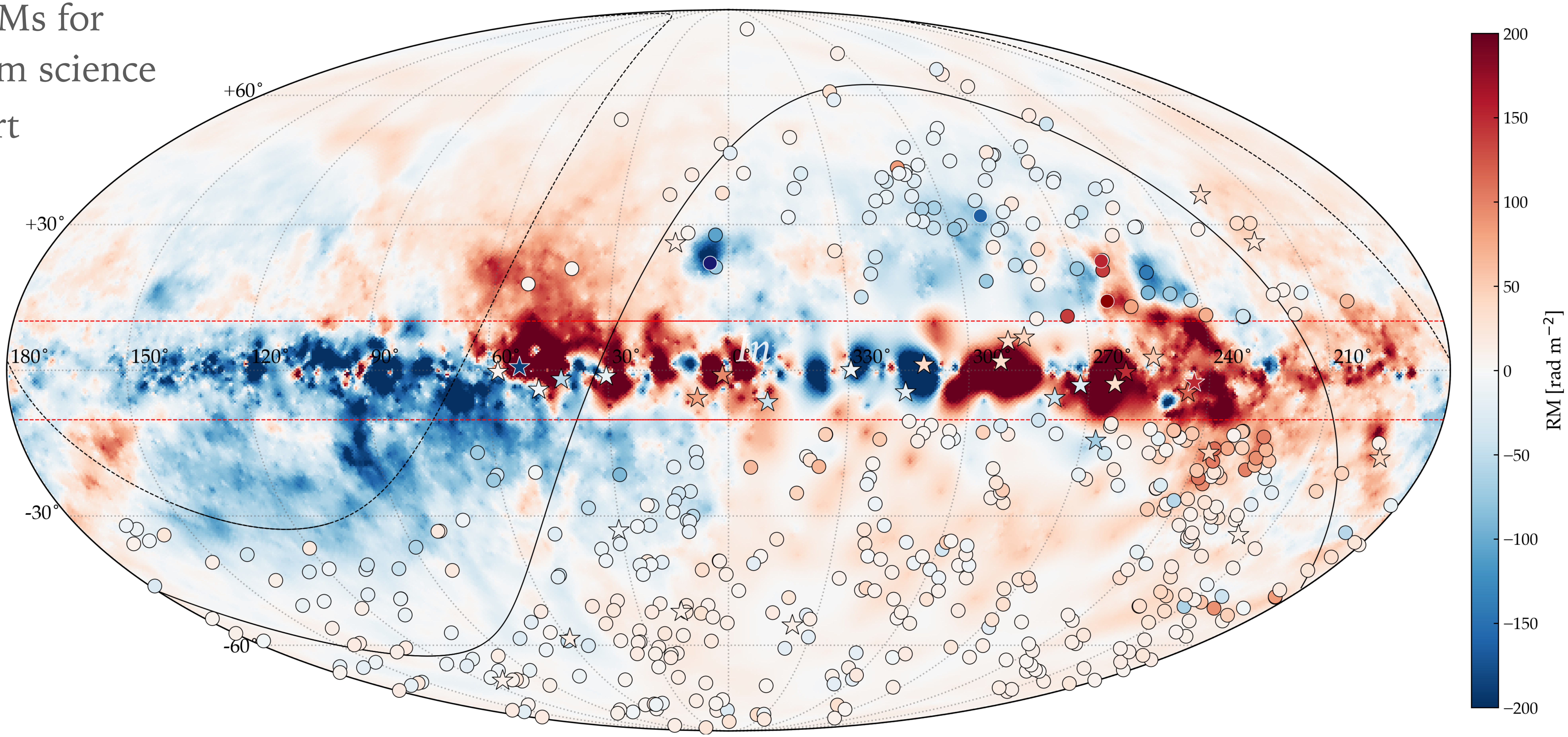

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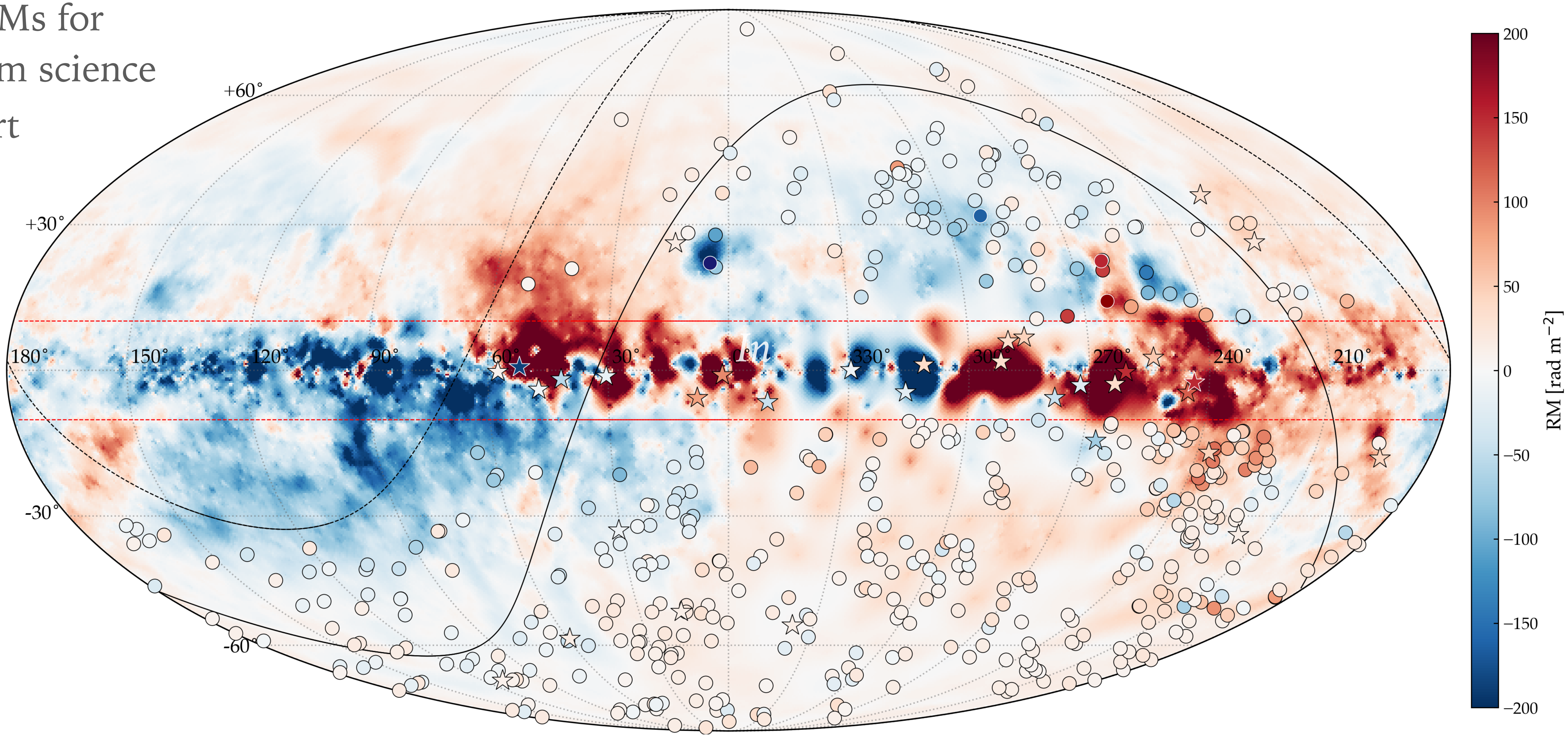

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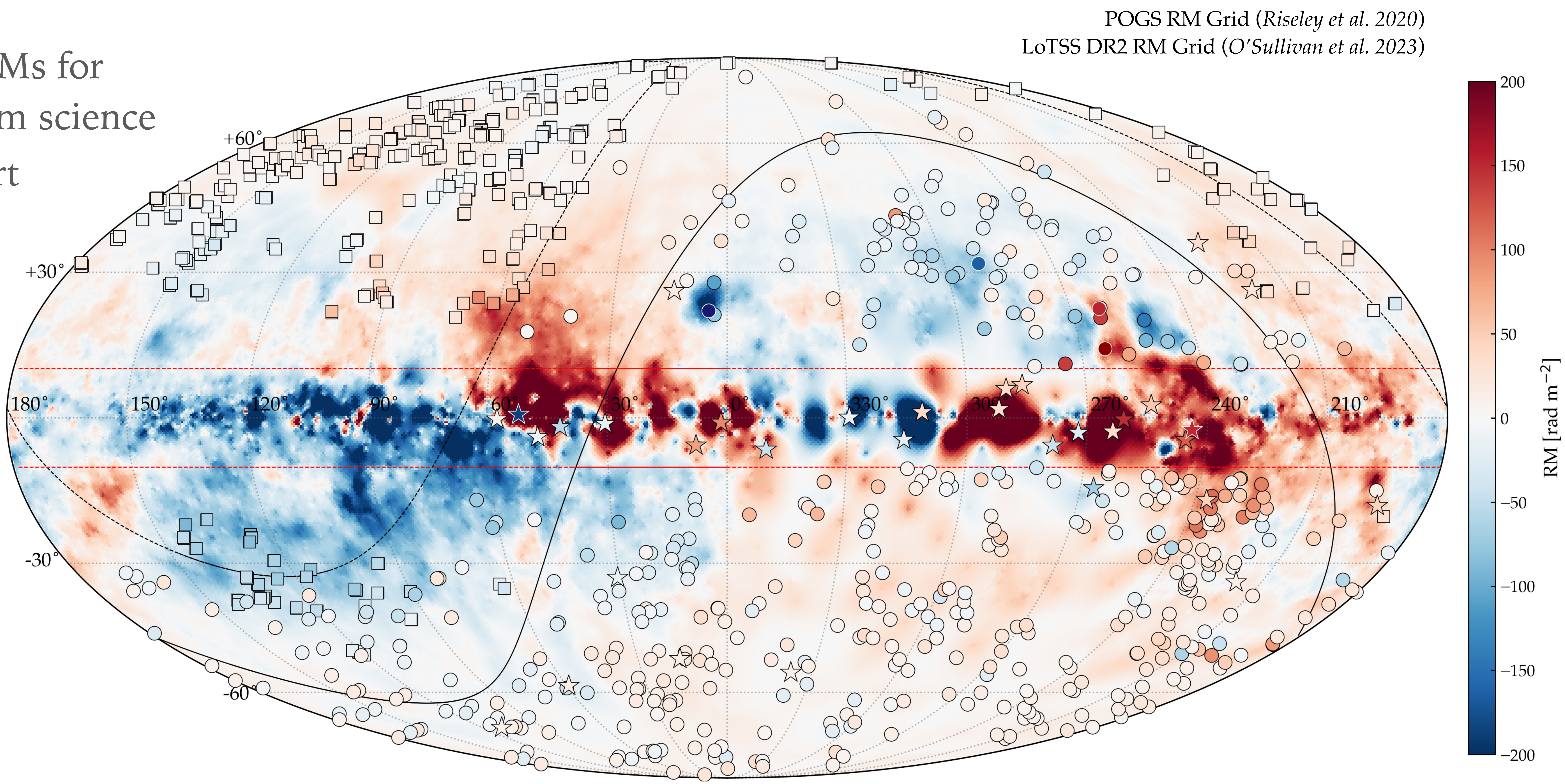

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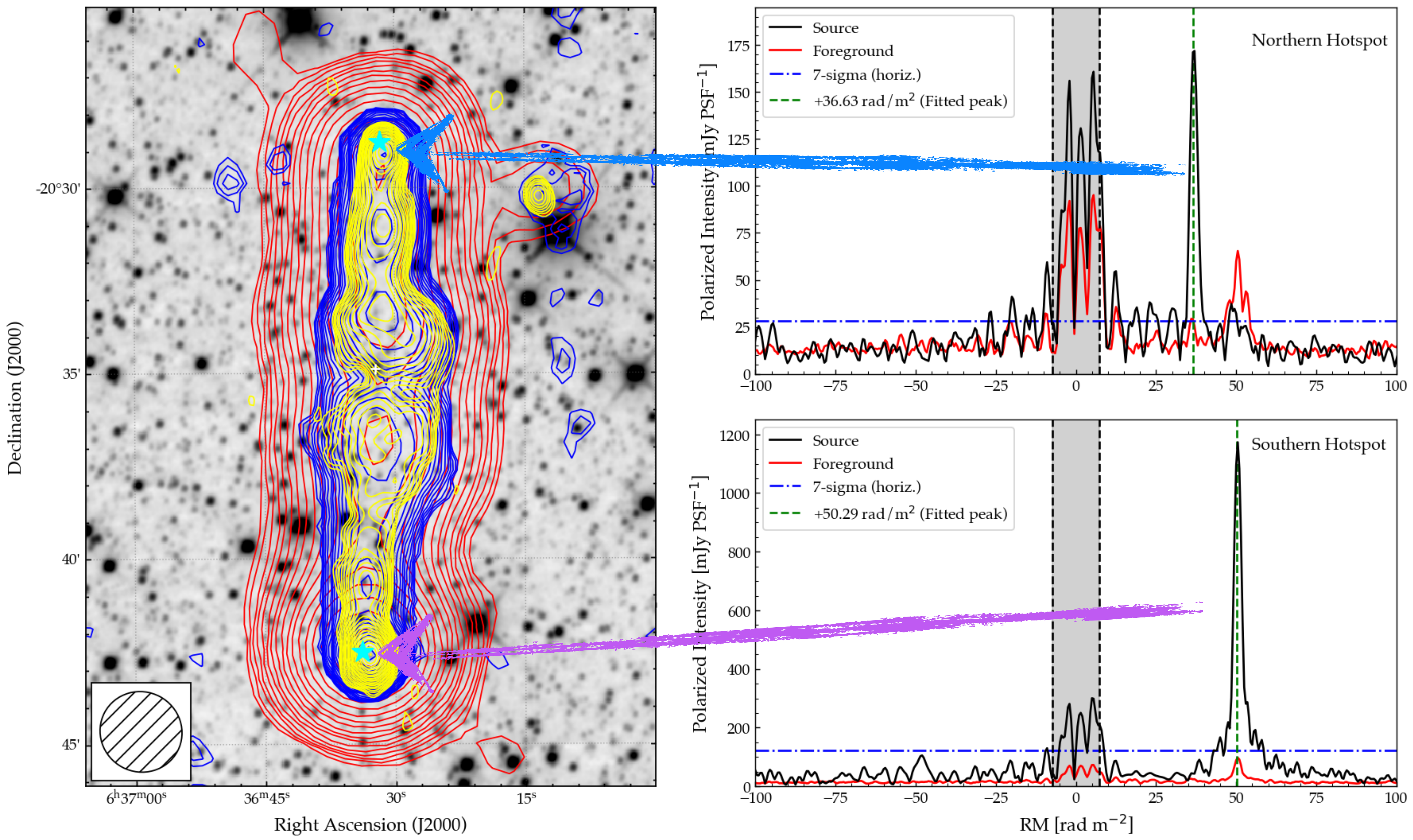

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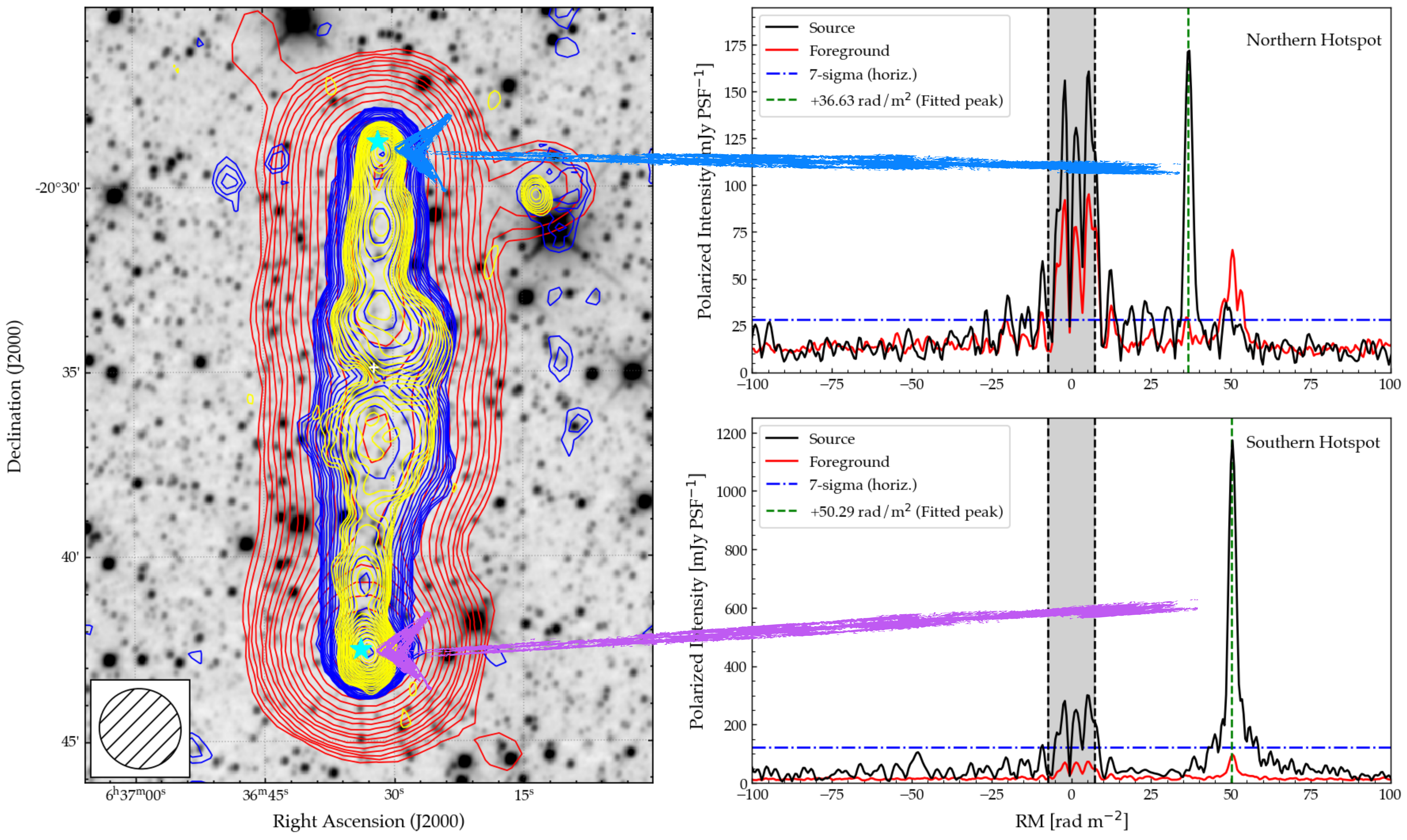

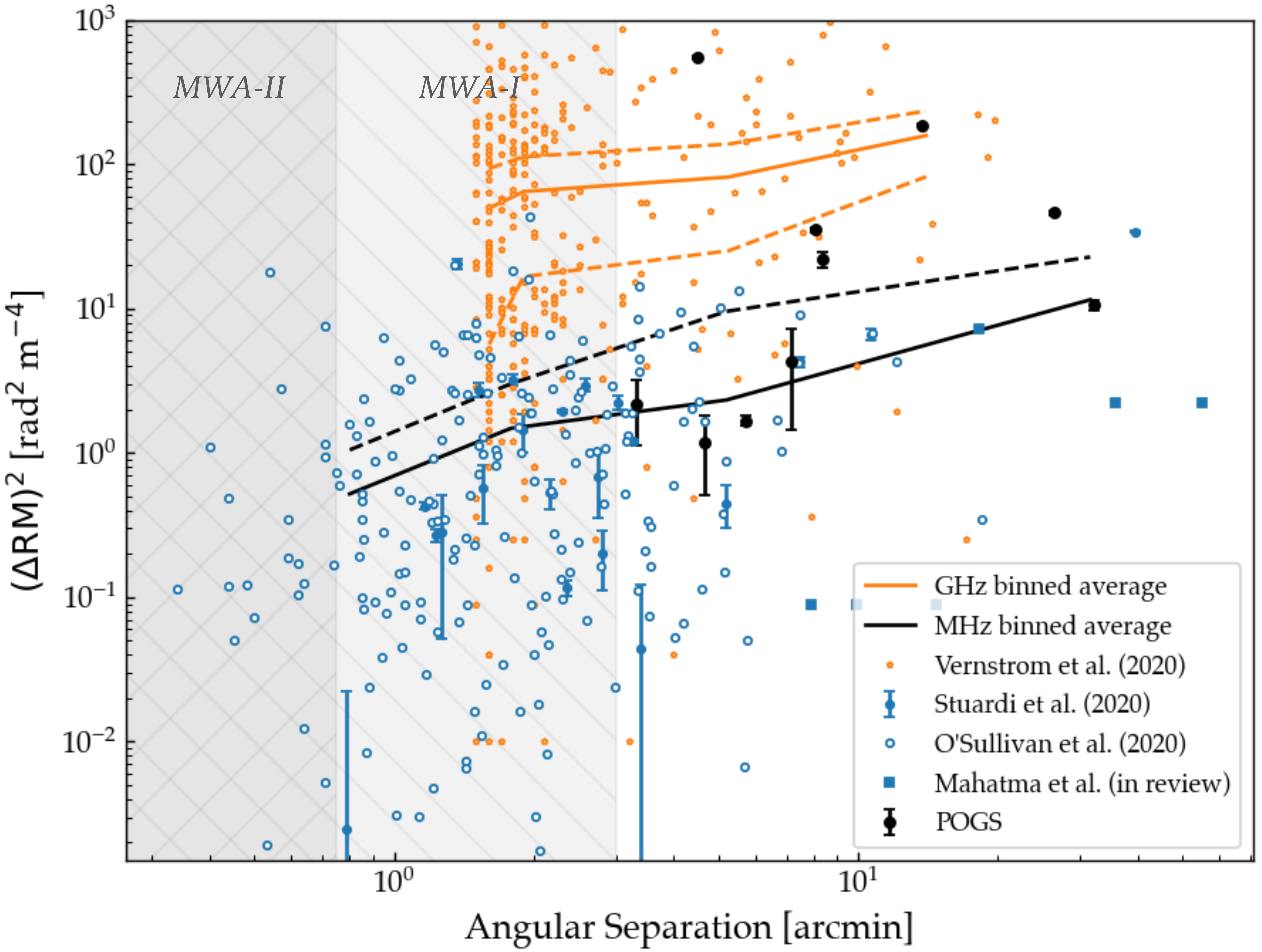

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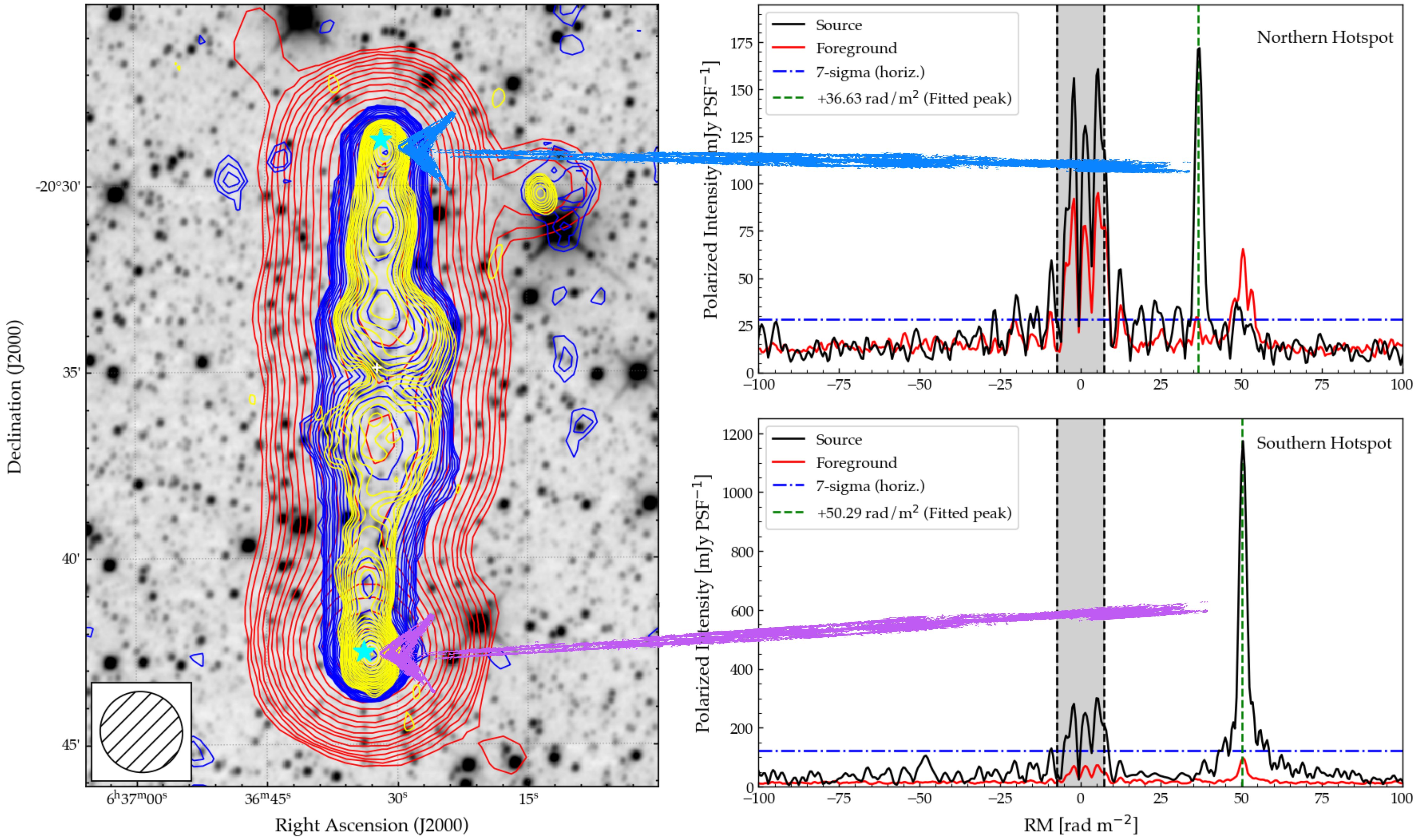

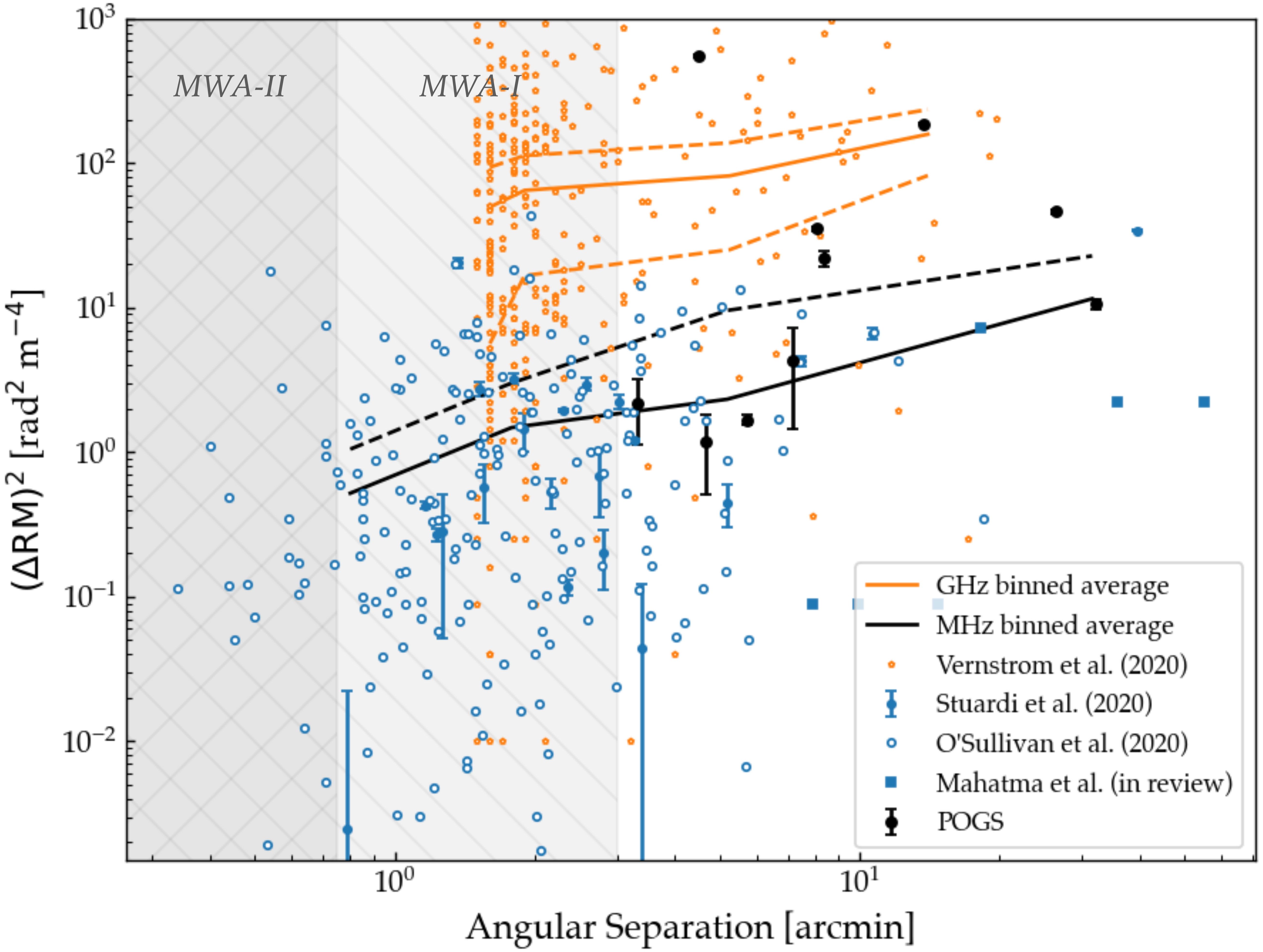

- Using pairs of polarised sources:
  - Physical pairs vs. random pairs (e.g. *Vernstrom+ 2019*) => statistical detection of cosmic magnetic fields.
  - Structure function different for random pairs at 150 MHz (*O'Sullivan+ 2020*).

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- 33 known pulsars detected.
- RMs consistent with previous studies:
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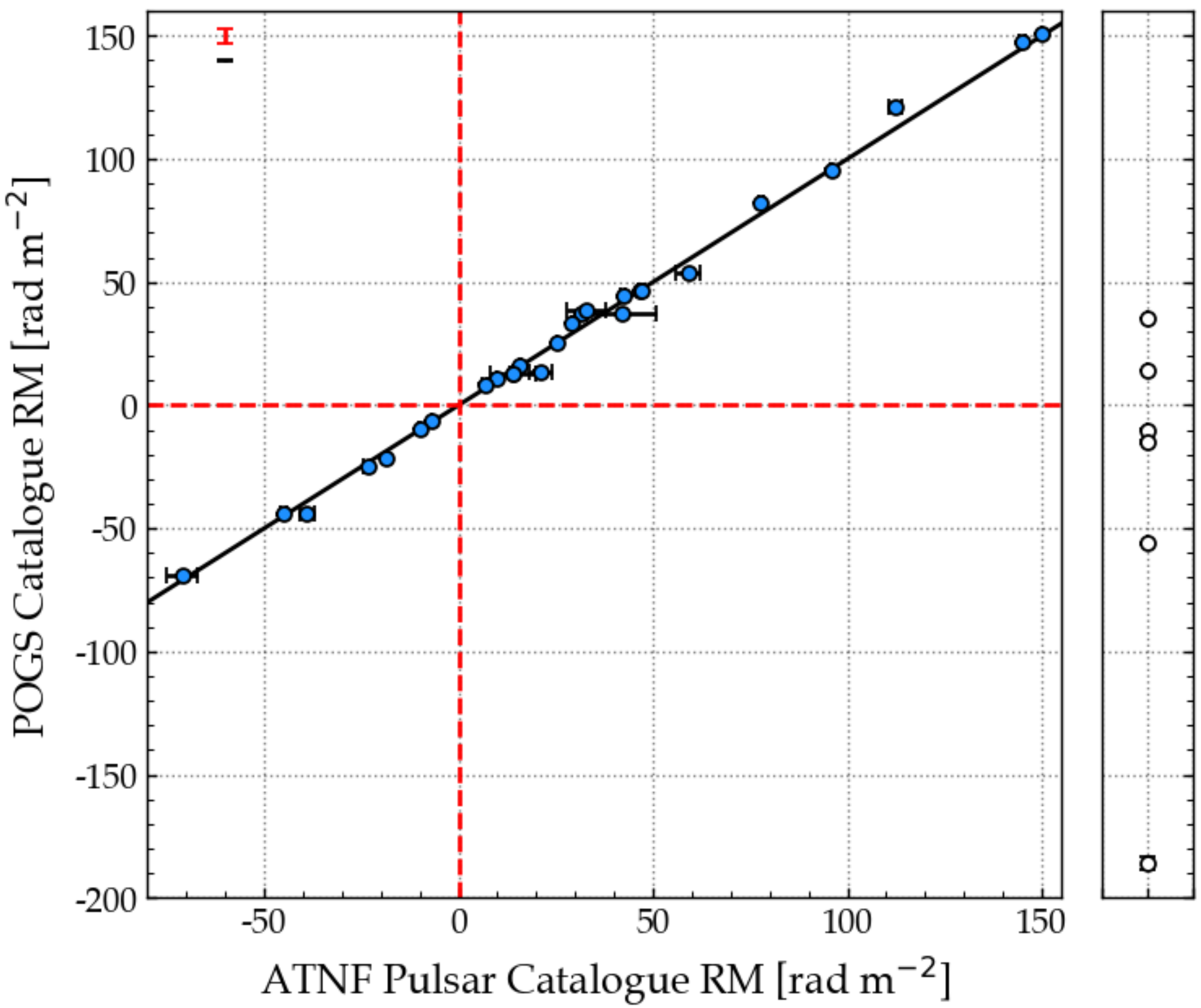

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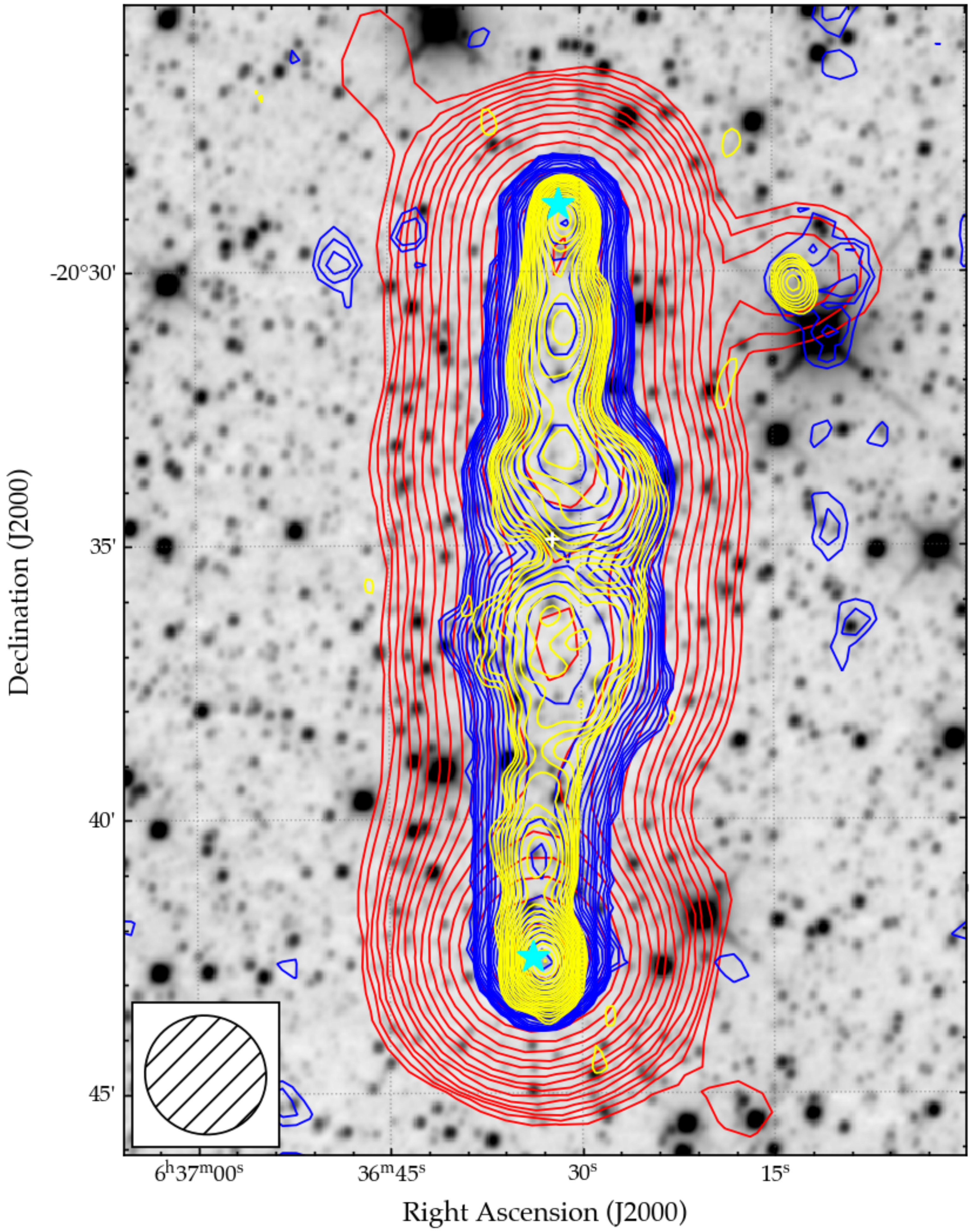

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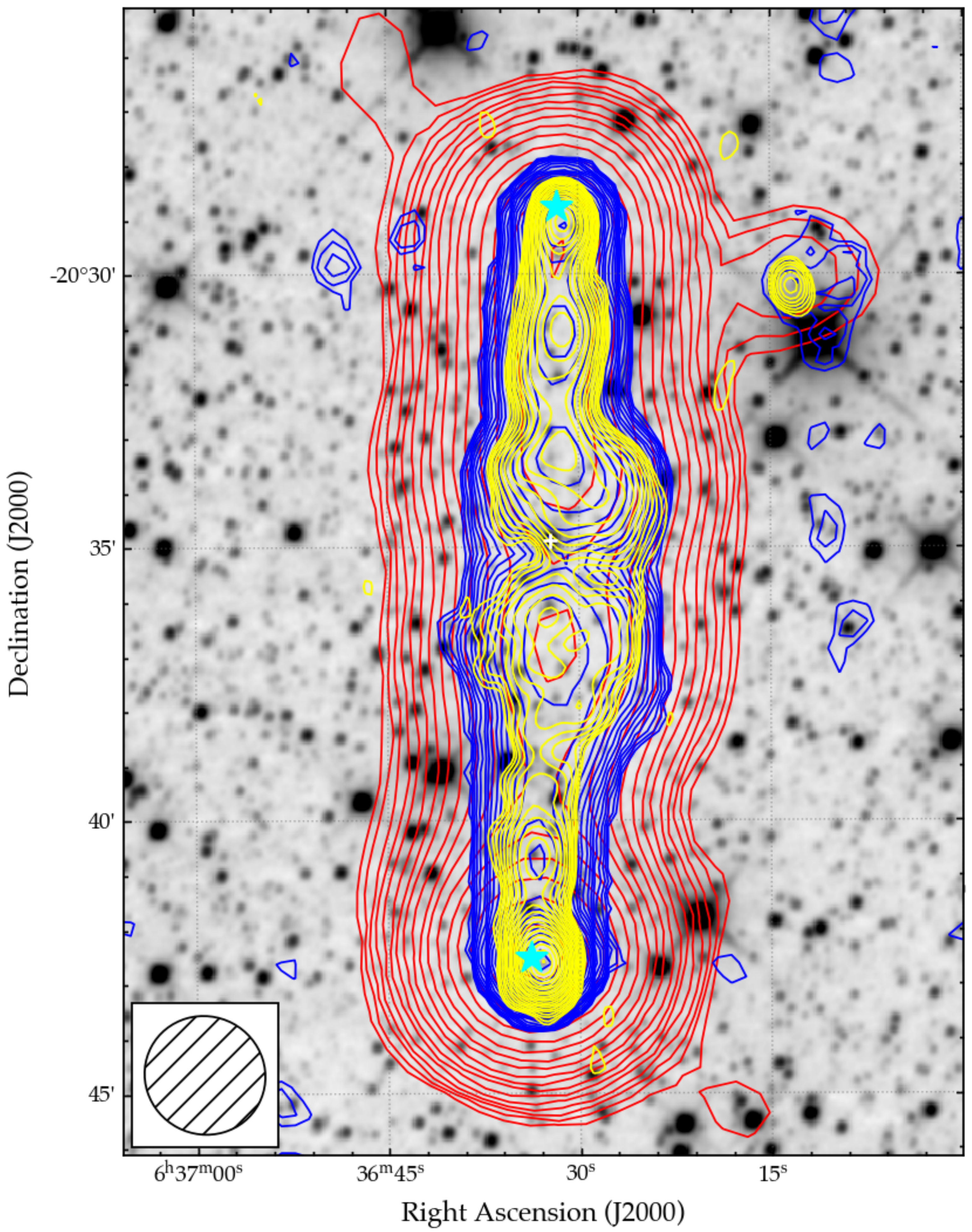

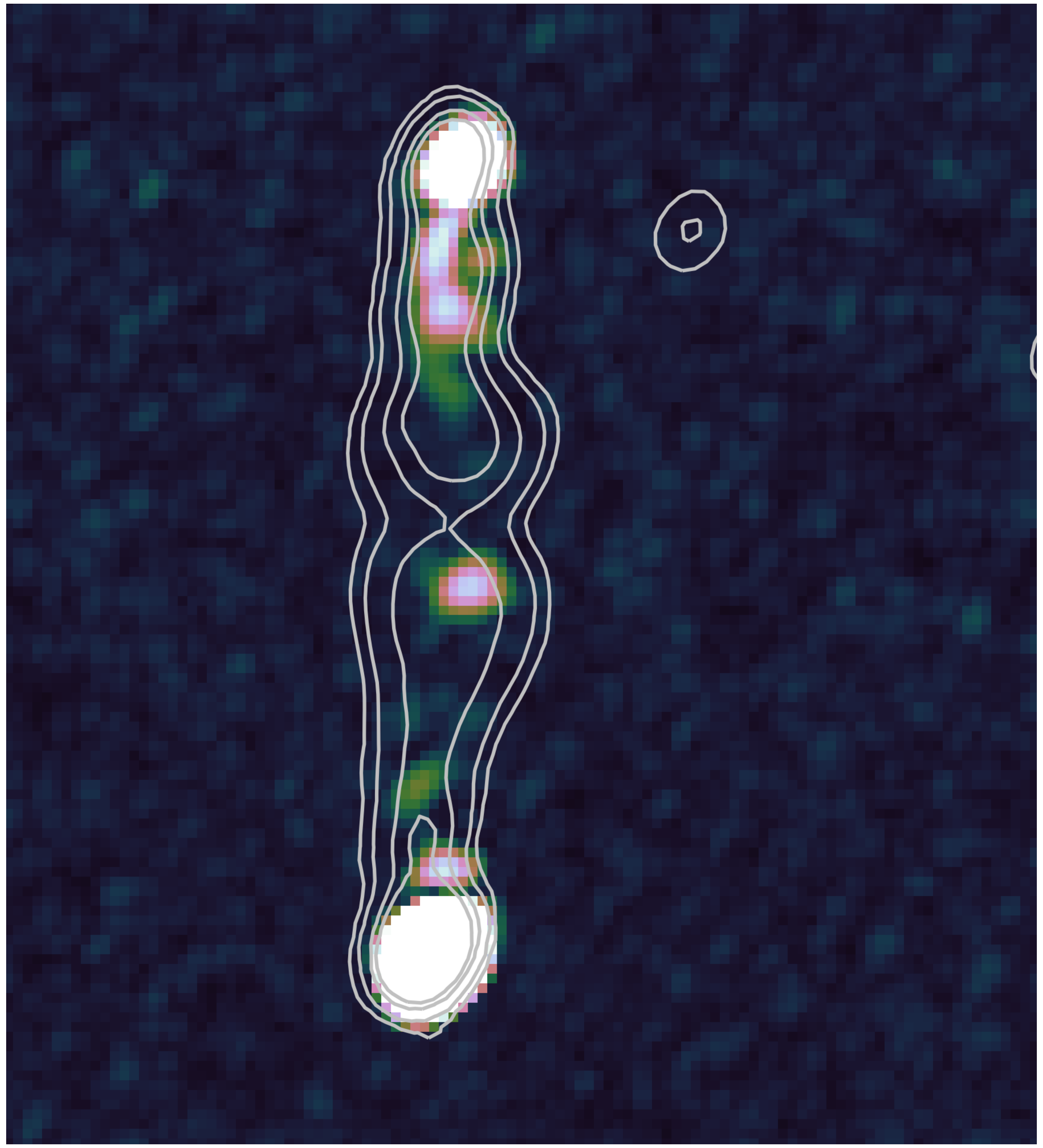

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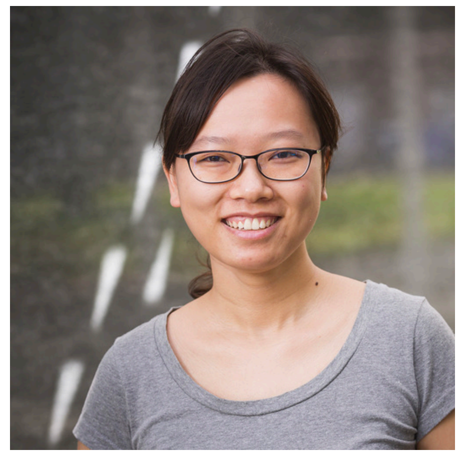

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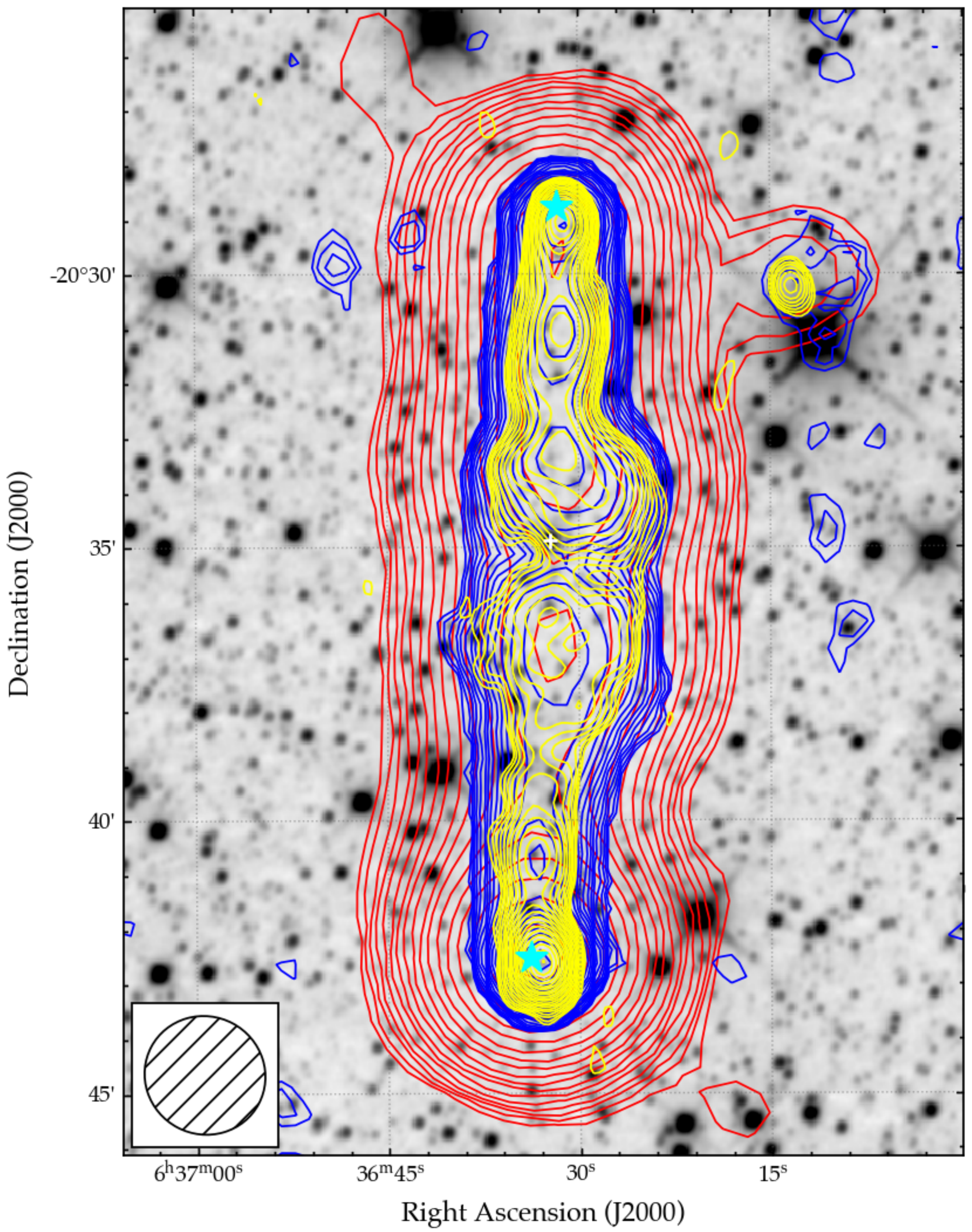

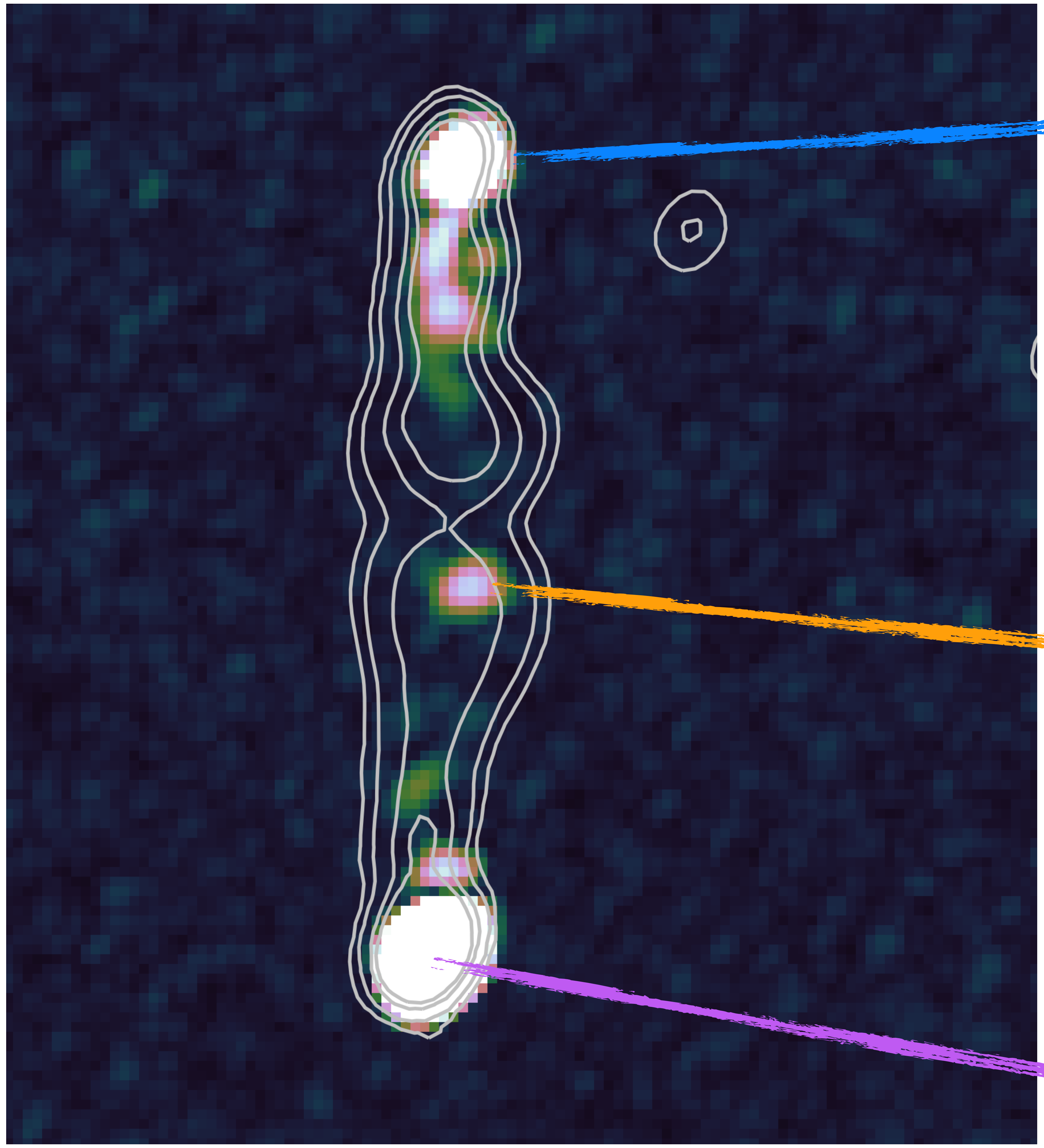

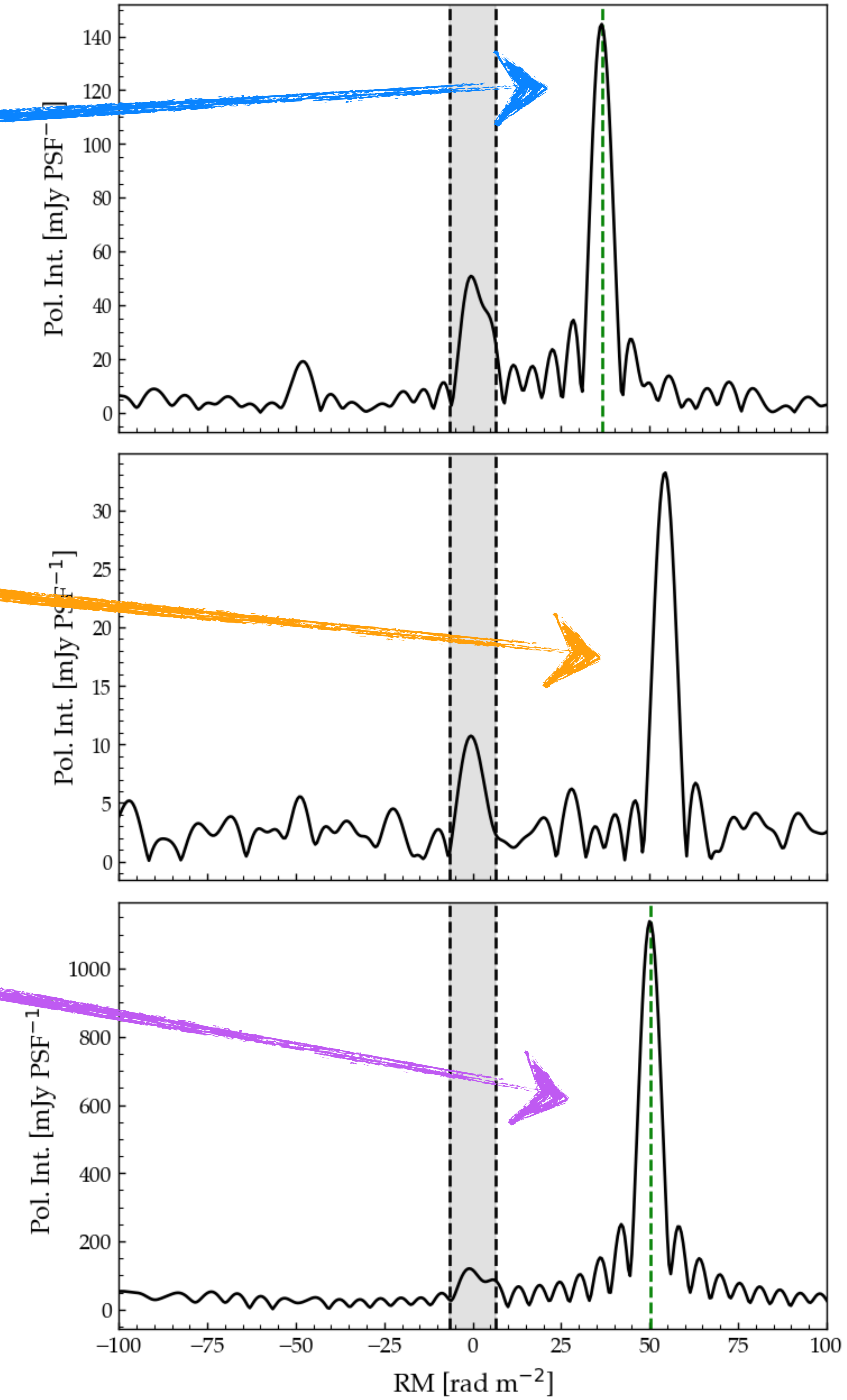

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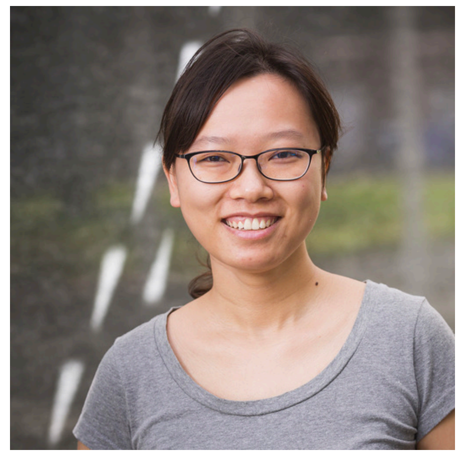

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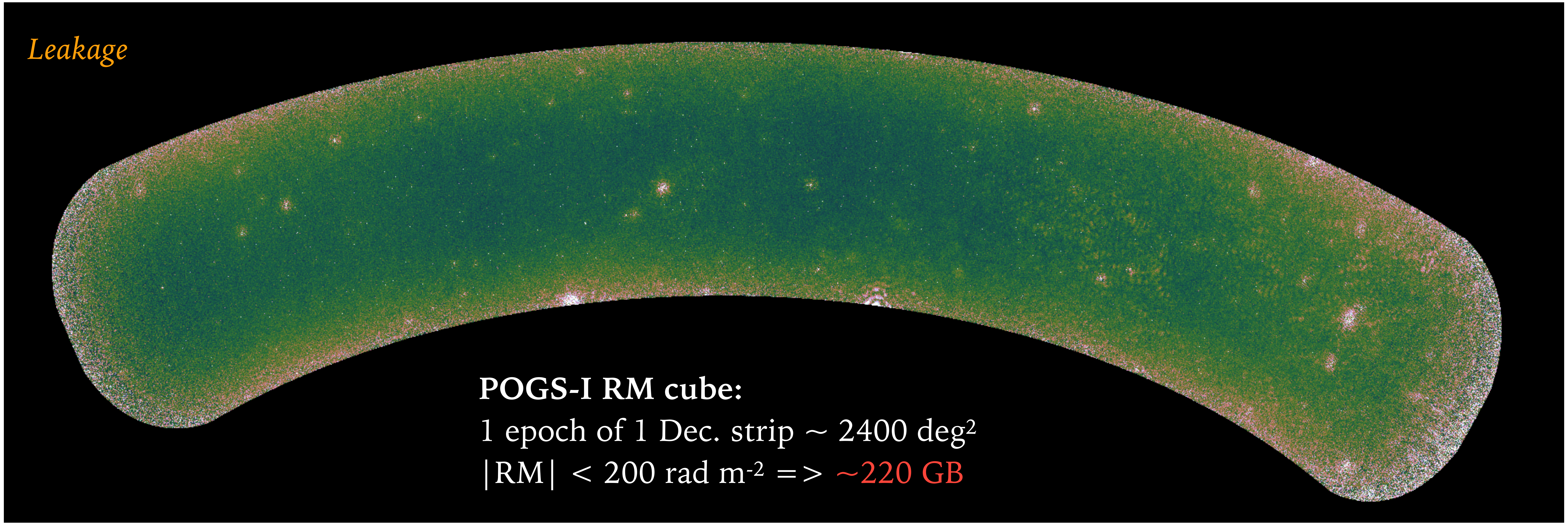

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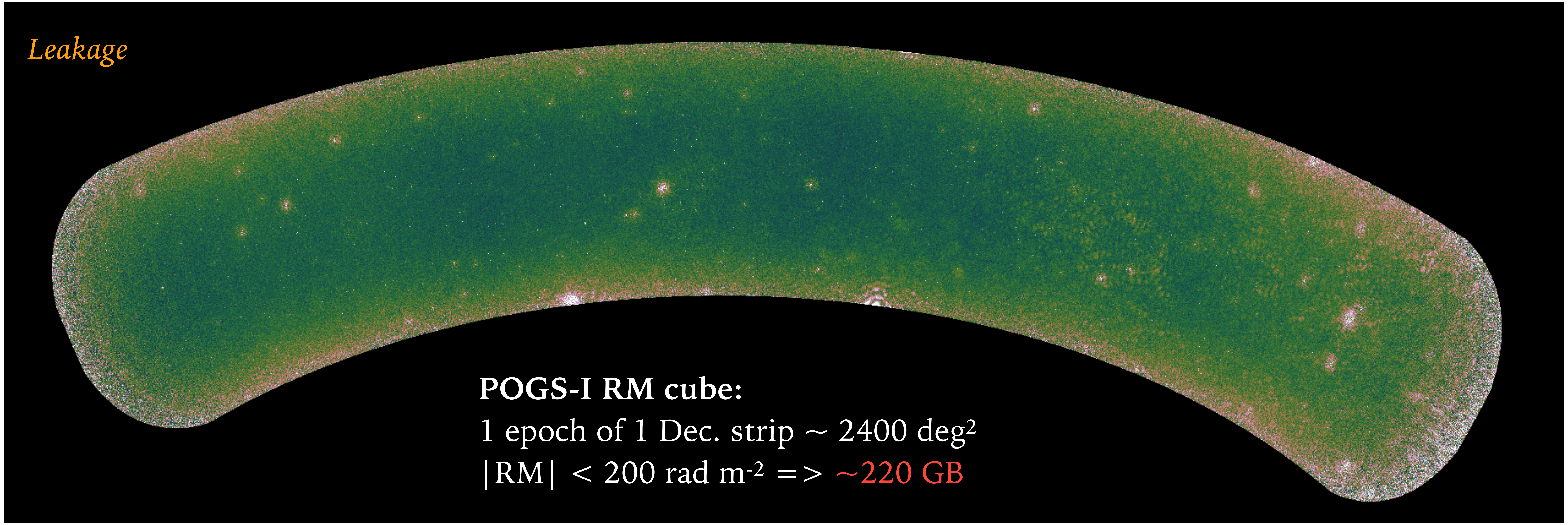

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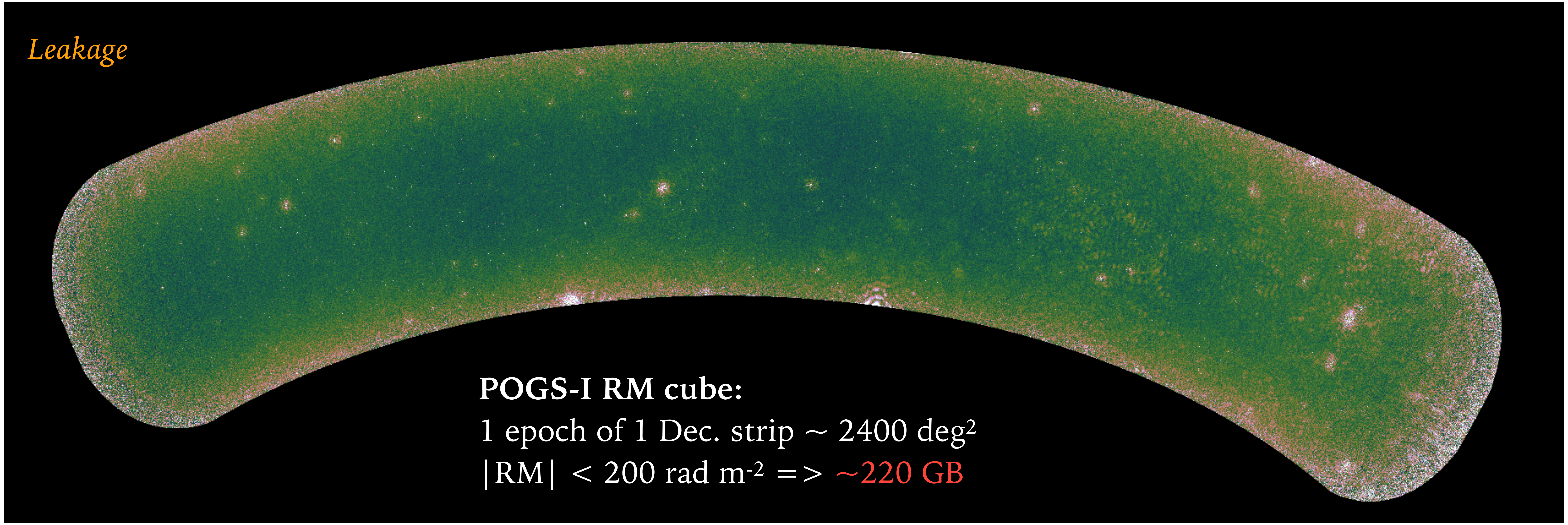

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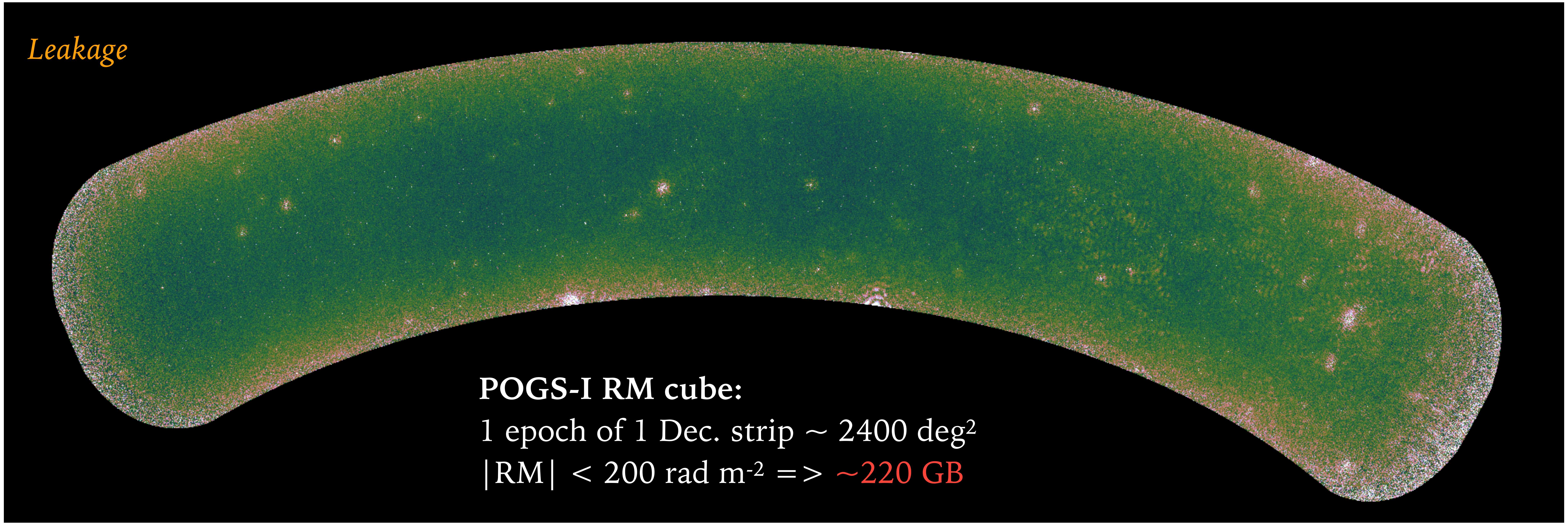

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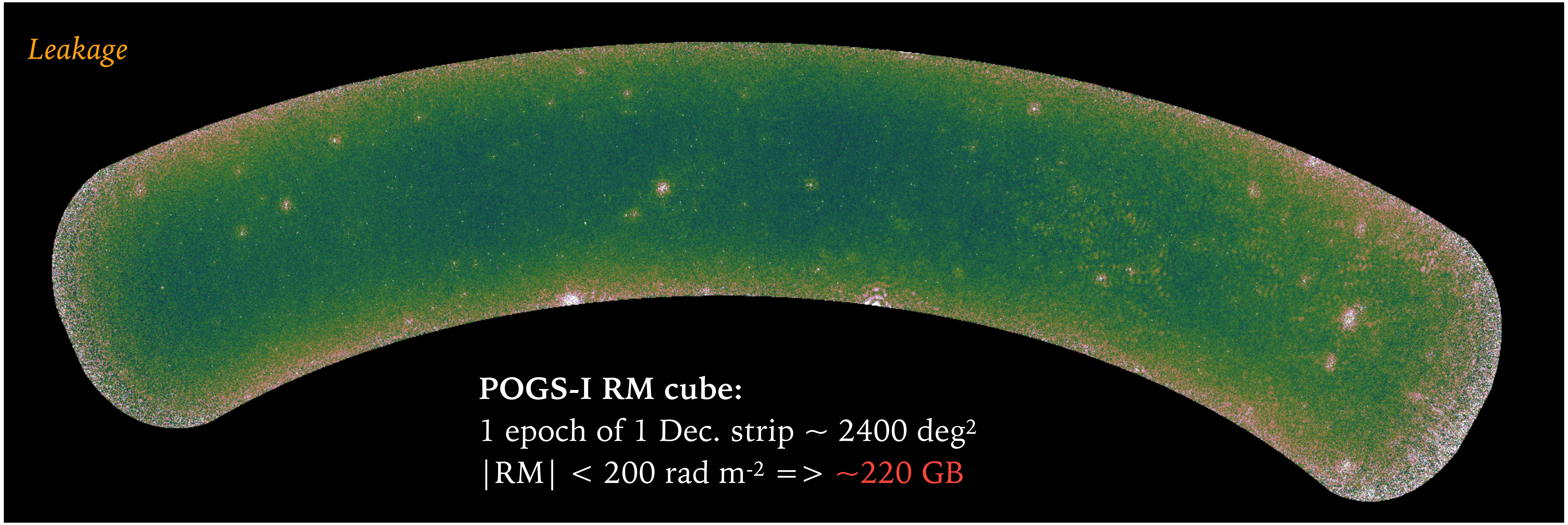

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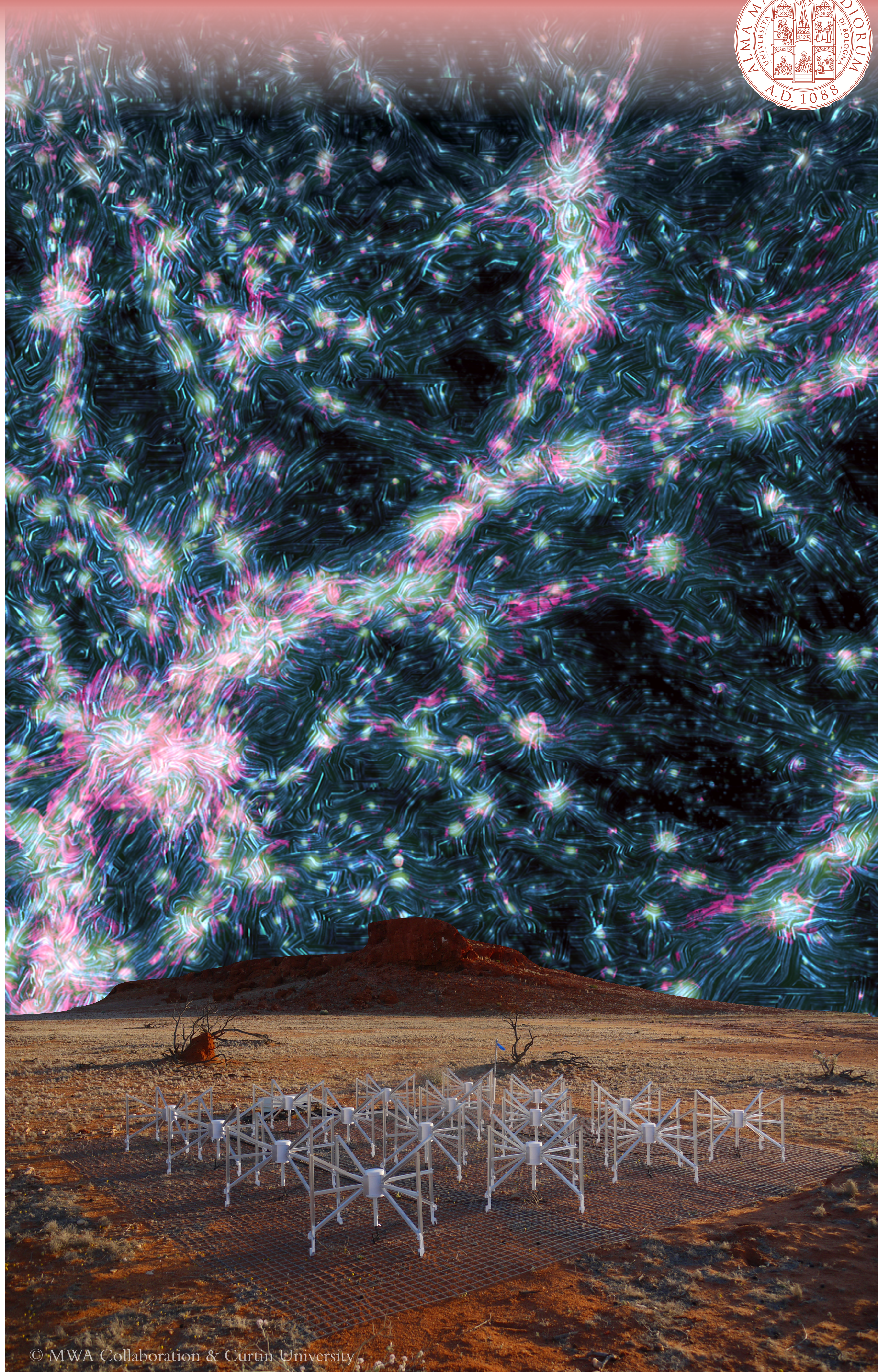

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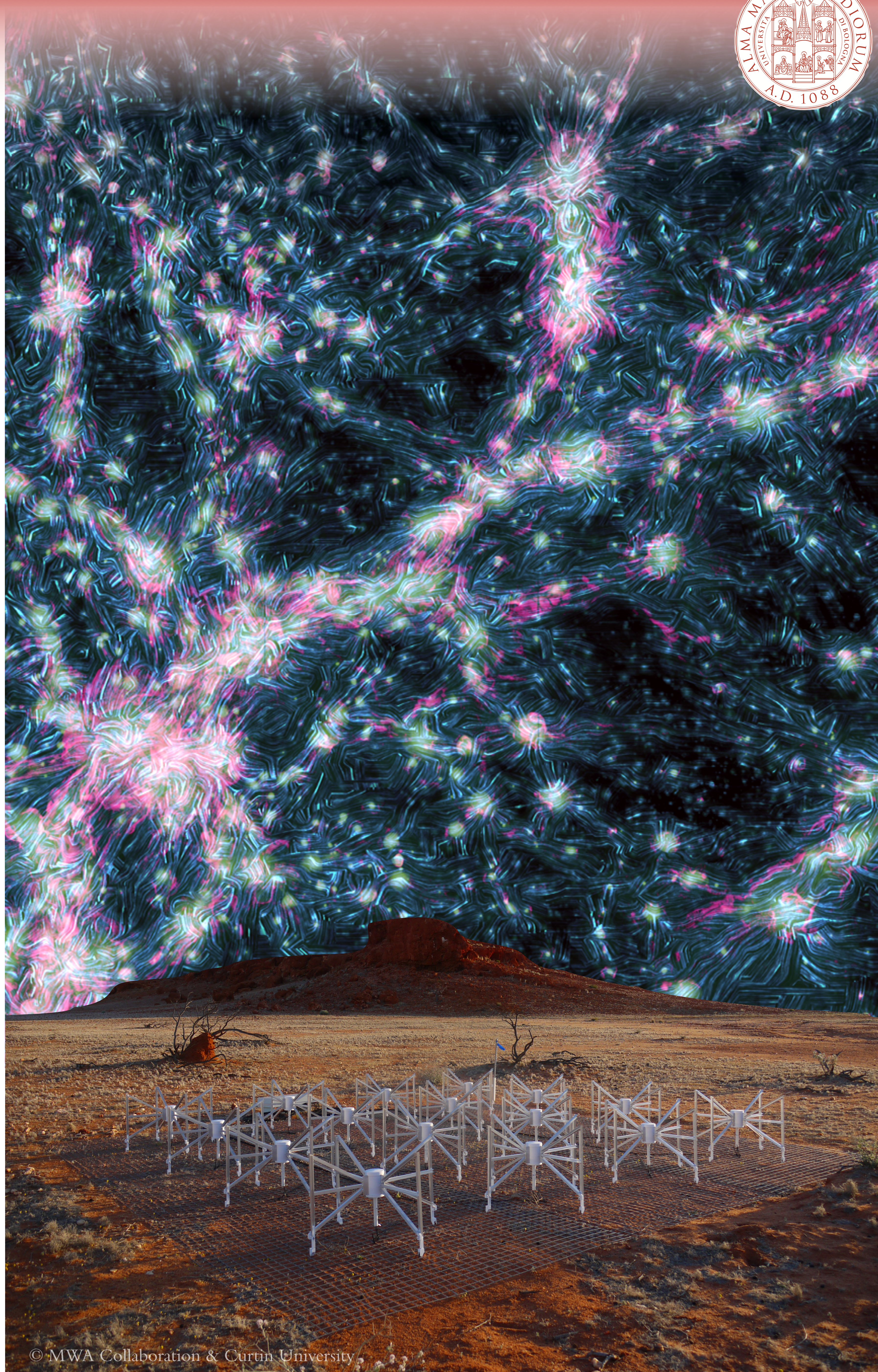

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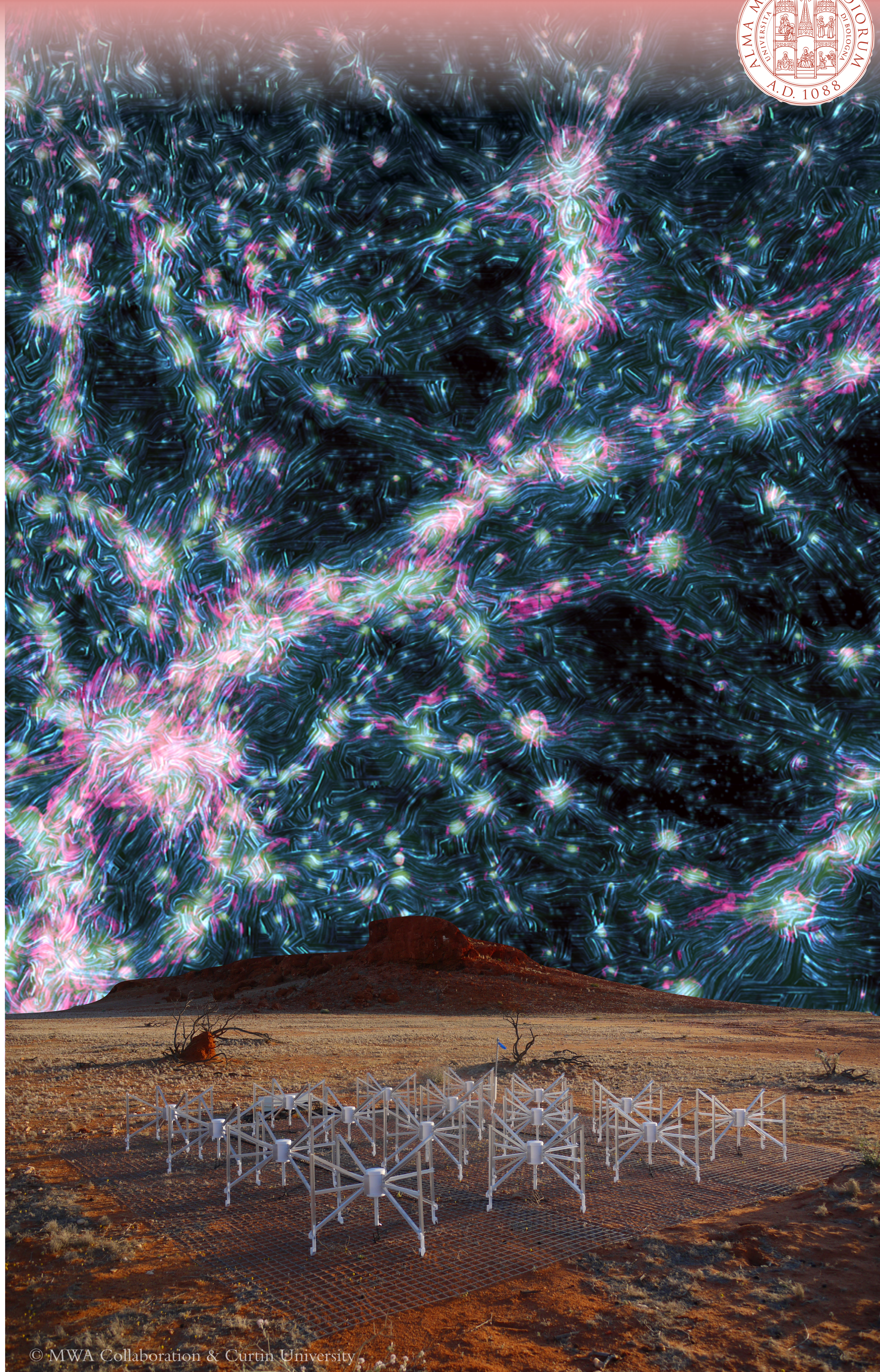

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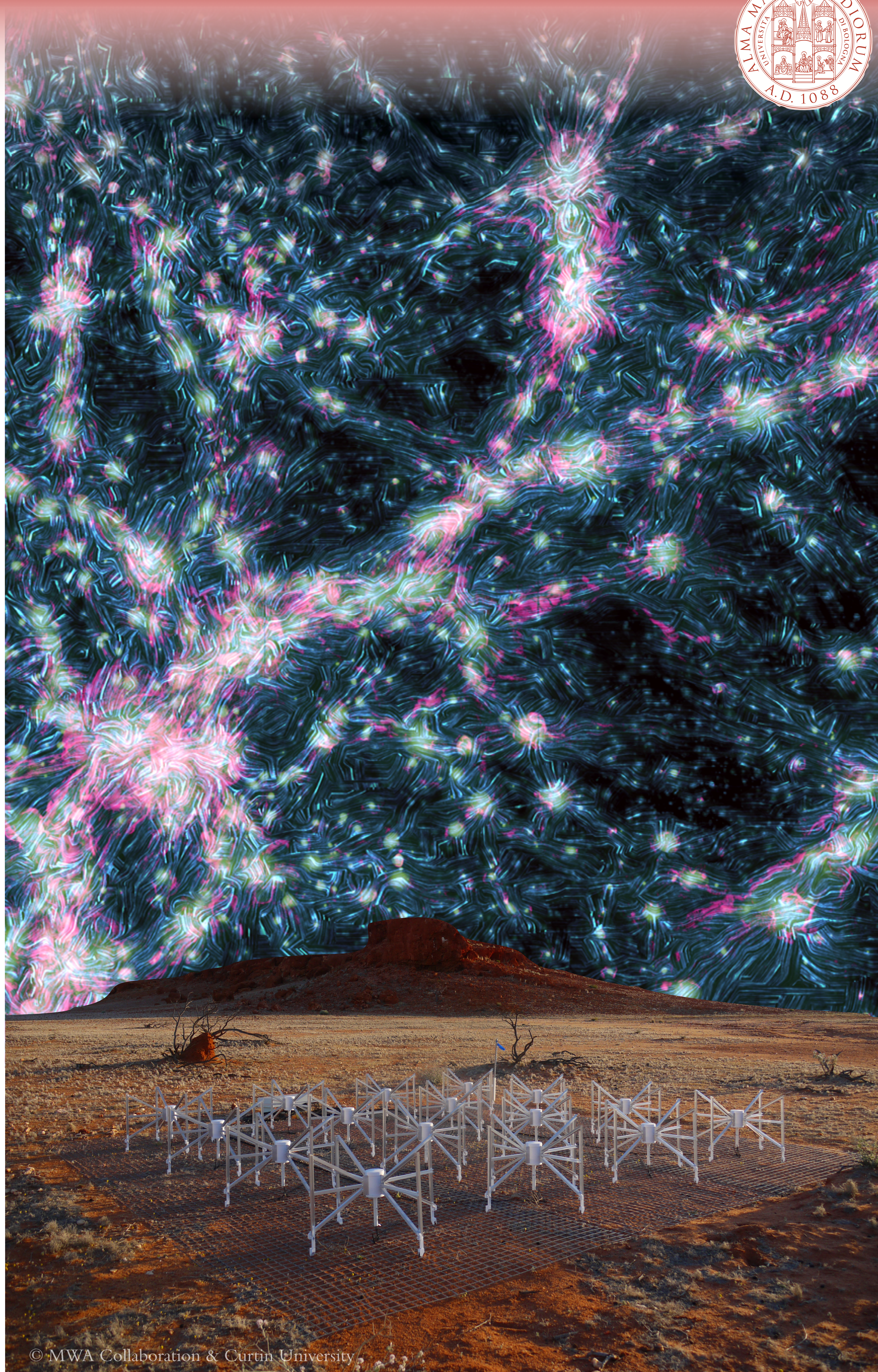

CONCLUSIONS...

- POGS-II:
  - Represents the current MWA gold standard.
  - *We're not done yet…*
- Influence beyond just MWA science:
  - SKA-Low antenna design & specs
  - Galactic foreground modelling (Hutschenreuter)
  - Pulsar follow-up (Sobey, McSweeney, Bhat)
  - Stacking ? (Vernstrom)
  - …
  - ${YOUR_SCIENCE_HERE} !!

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Thanks for listening.
Questions?