

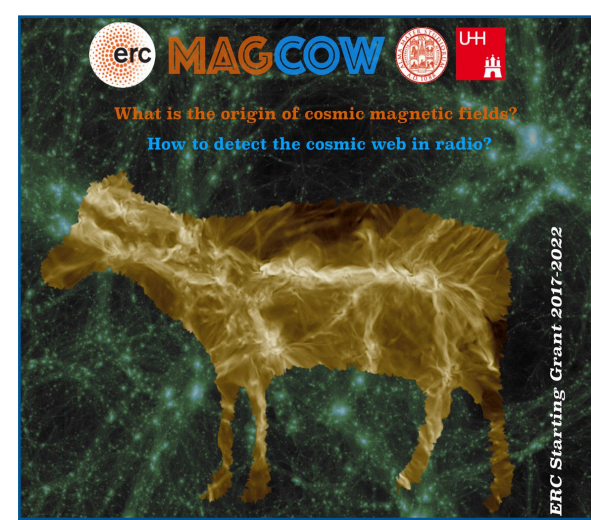
Insight into intracluster magnetic fields by wideband polarimetry of radio relics

Kamlesh Laxmi Rajpurohit

University of Bologna, Italy

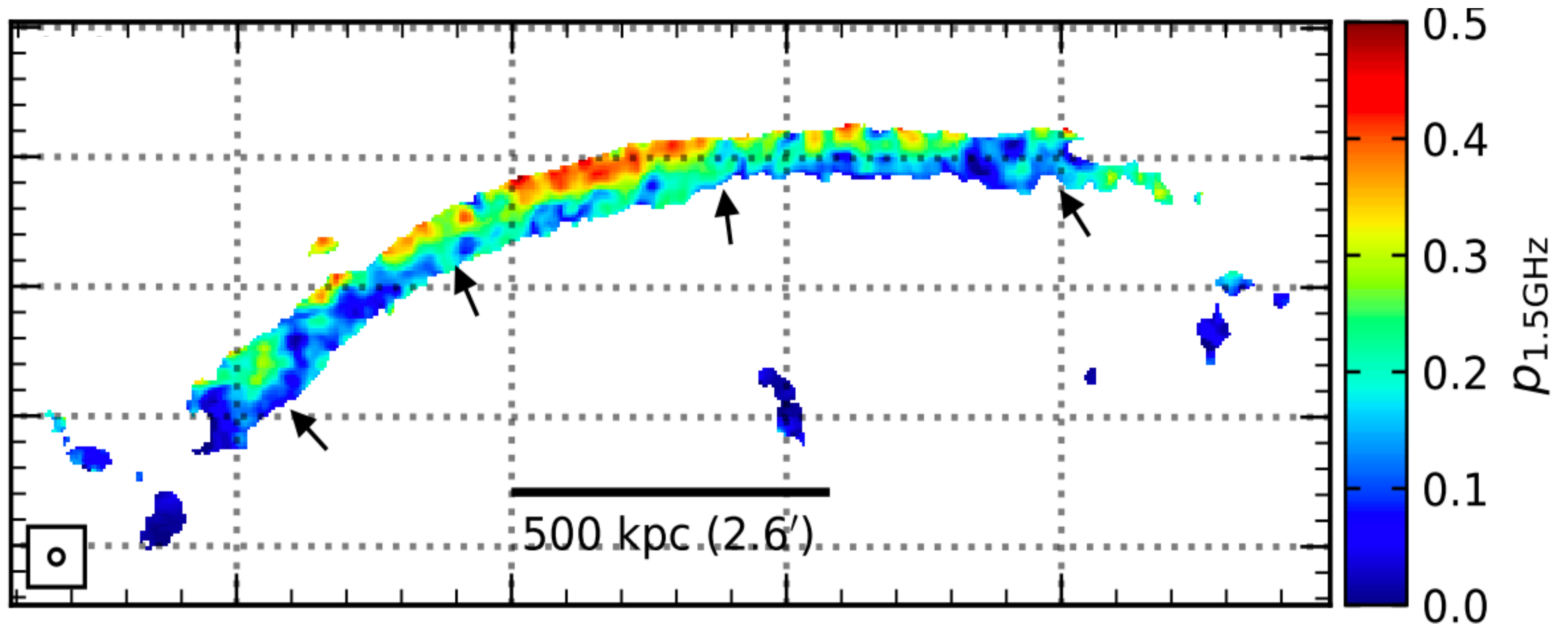
in collaboration with

F. Vazza, M. Hoeft, D. Wittor, R. J. van Weeren, M. Brienza, A. Bonafede,
C. R. Riseley, E. Bonnassieux et al.



Unique polarization properties of relics

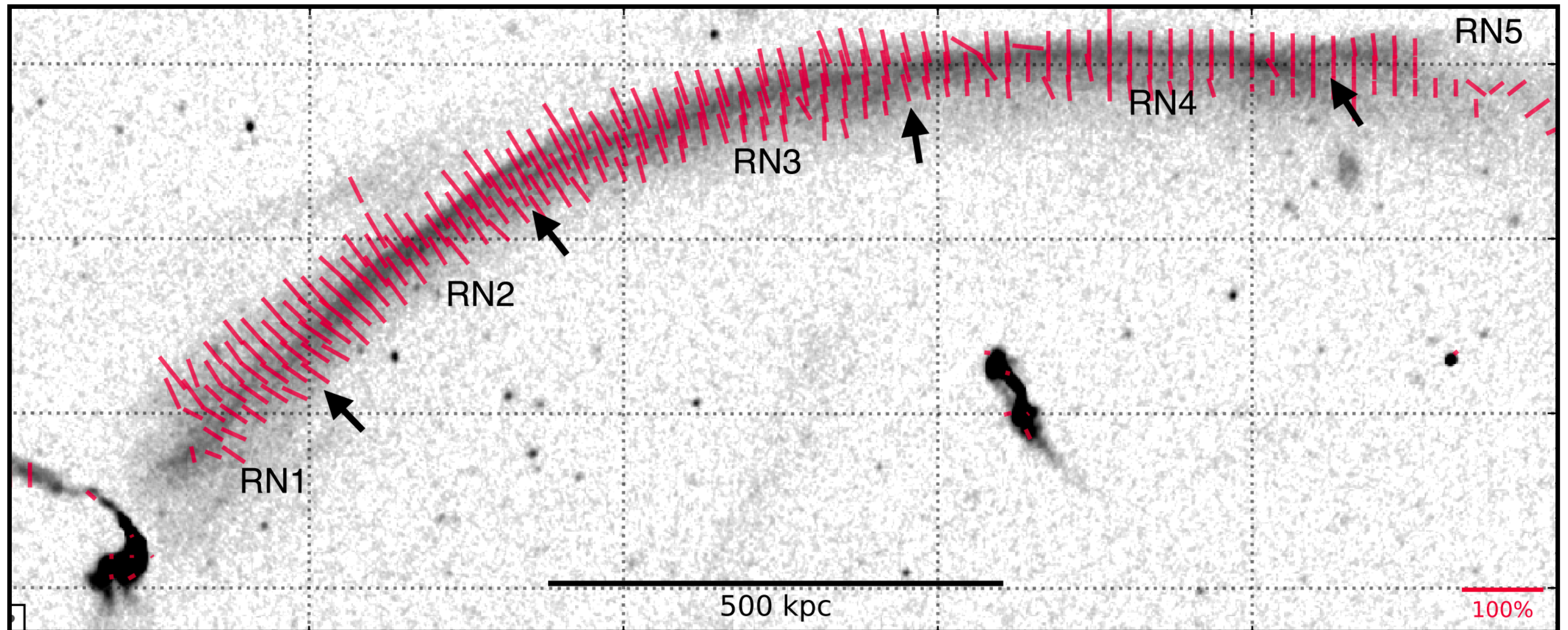
- High degree of polarization (up to 50%)
- highly aligned magnetic field



the Sausage relic ($z=0.19$)

Unique polarization properties of relics

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Large scale diffuse emission in MACS J0717+3745 ($z=0.5458$)

- **chair-shaped relic:**

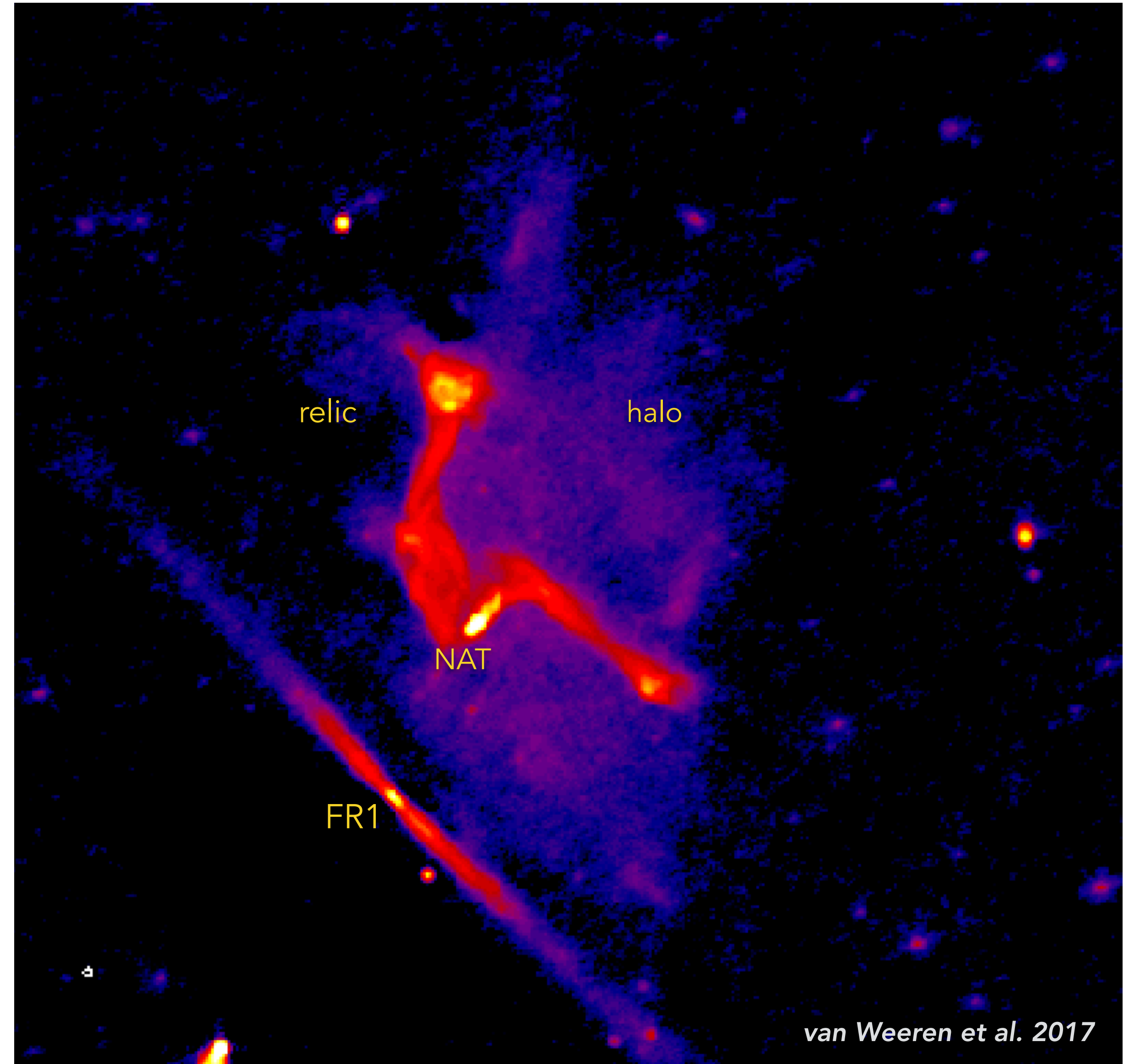
- about 0.9 Mpc large
- some isolated from the relic
- small -scale filaments in the halo region
- Narrow angle tail galaxy embedded in the relic

- **halo**

- a giant irregular radio halo
- one of the most powerful halo known to date

- **polarization**

- high degree polarization across the relic
- significant polarization is detected at the cluster center



VLA (2-4 GHz) image

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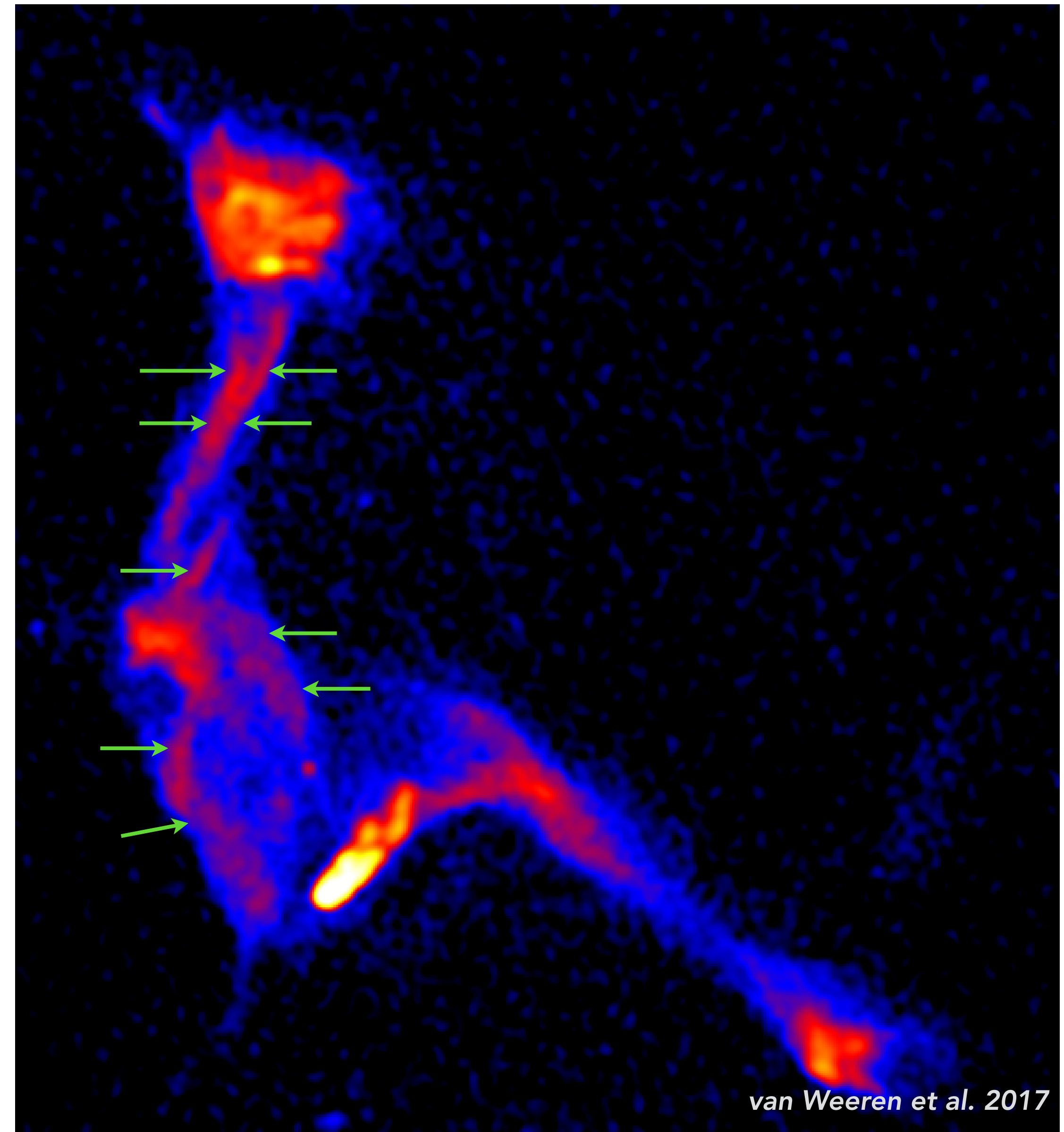
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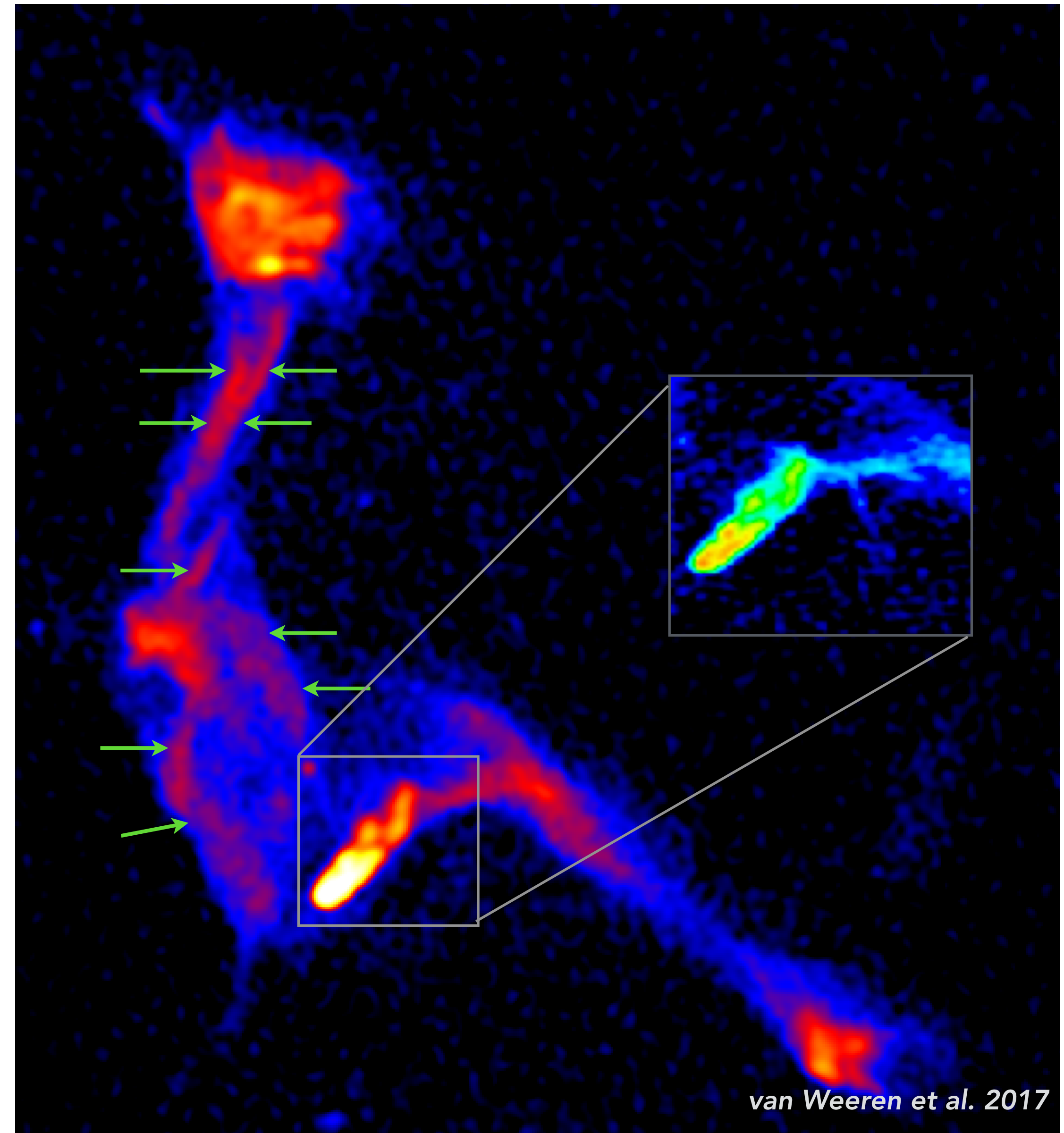
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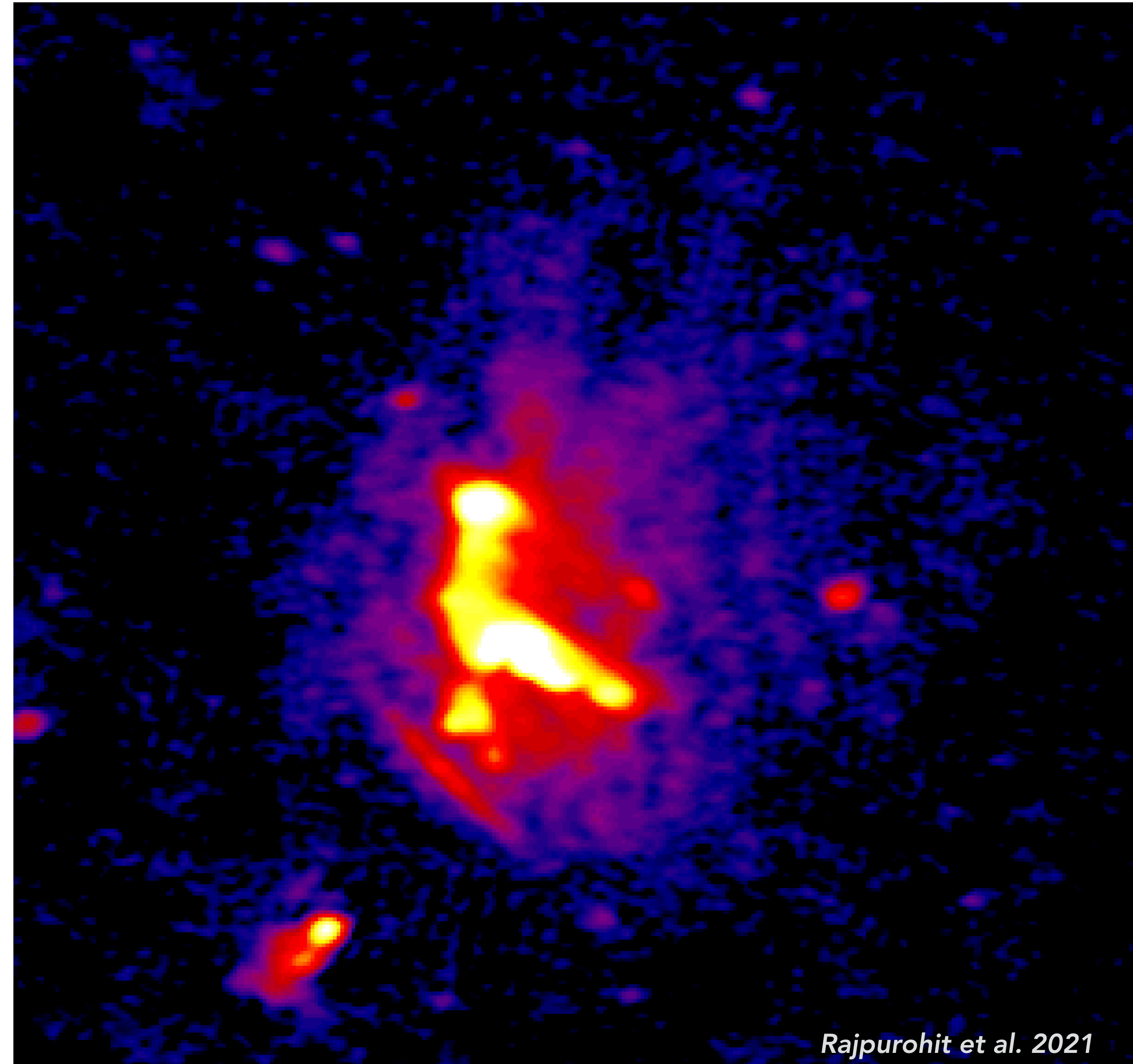
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Rajpurohit et al. 2021

LOFAR (144 MHz) image

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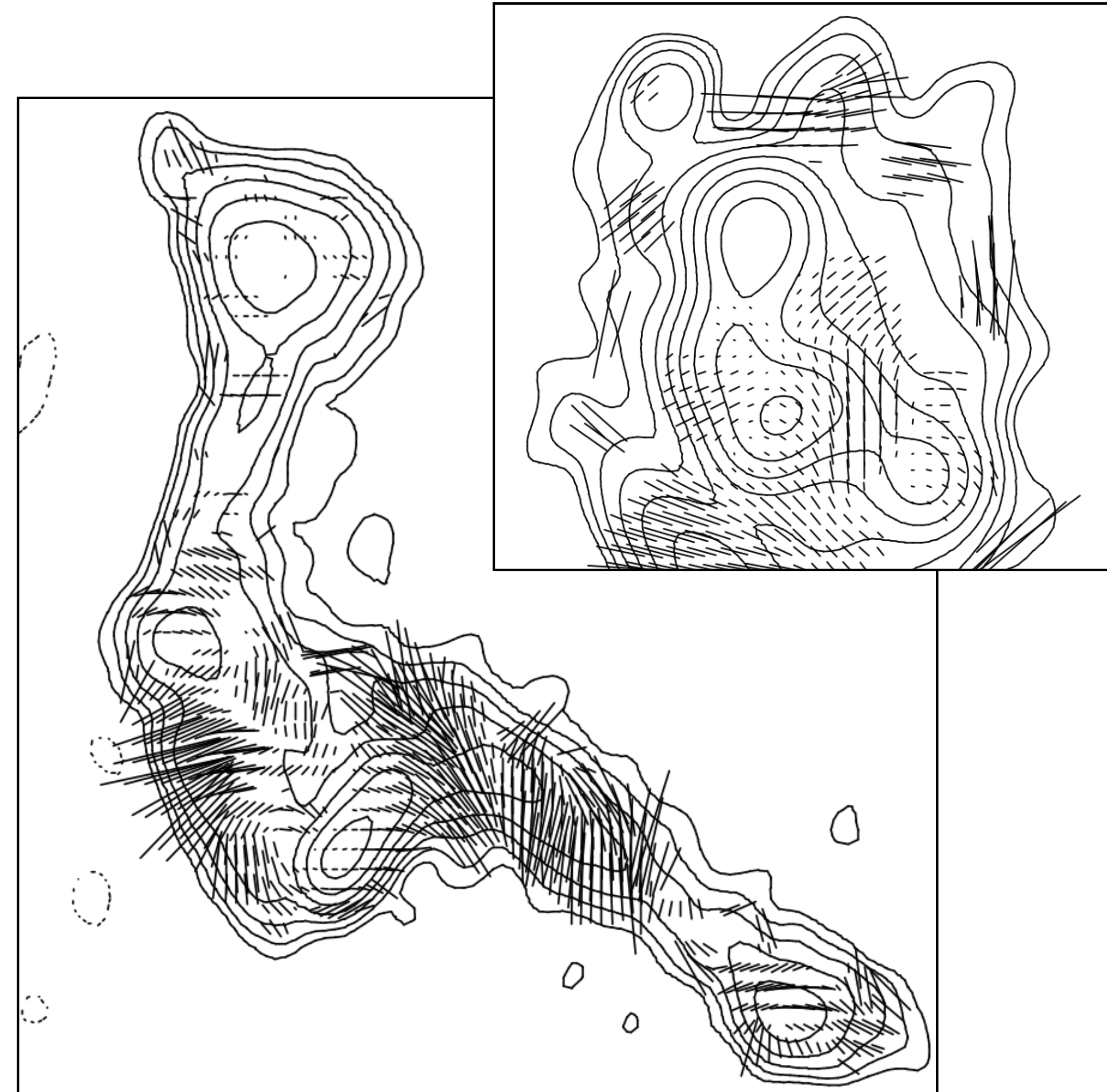
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1.5 GHz

Bonafede et al. 2009

Questions

- What are the properties of the ICM magnetic field ?
- What causes depolarization ?
- Is there any connection between the relic and a nearby AGN?
- Is the halo polarized ?

Deep VLA radio observations over a wide frequency range (45 hours)

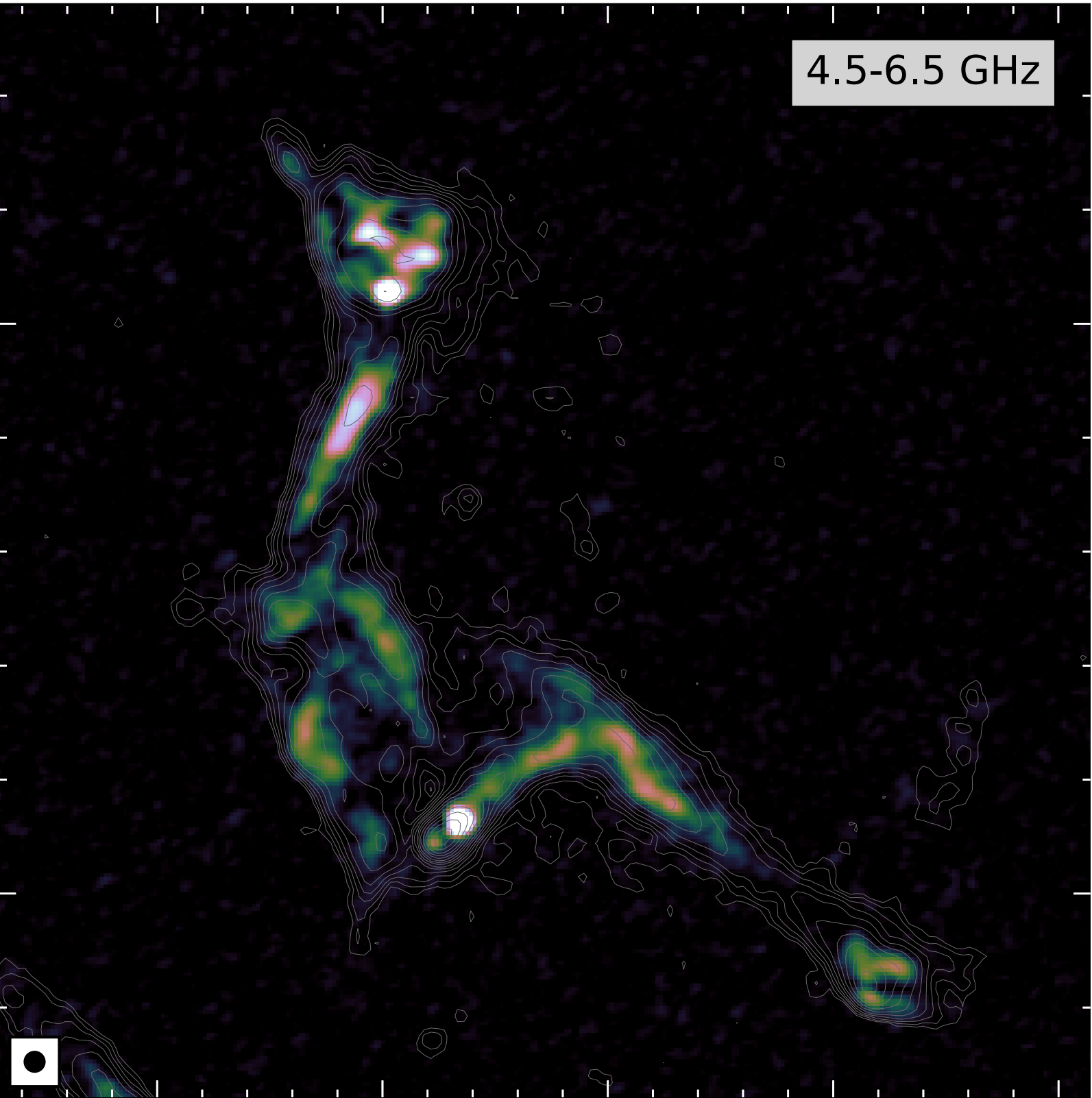
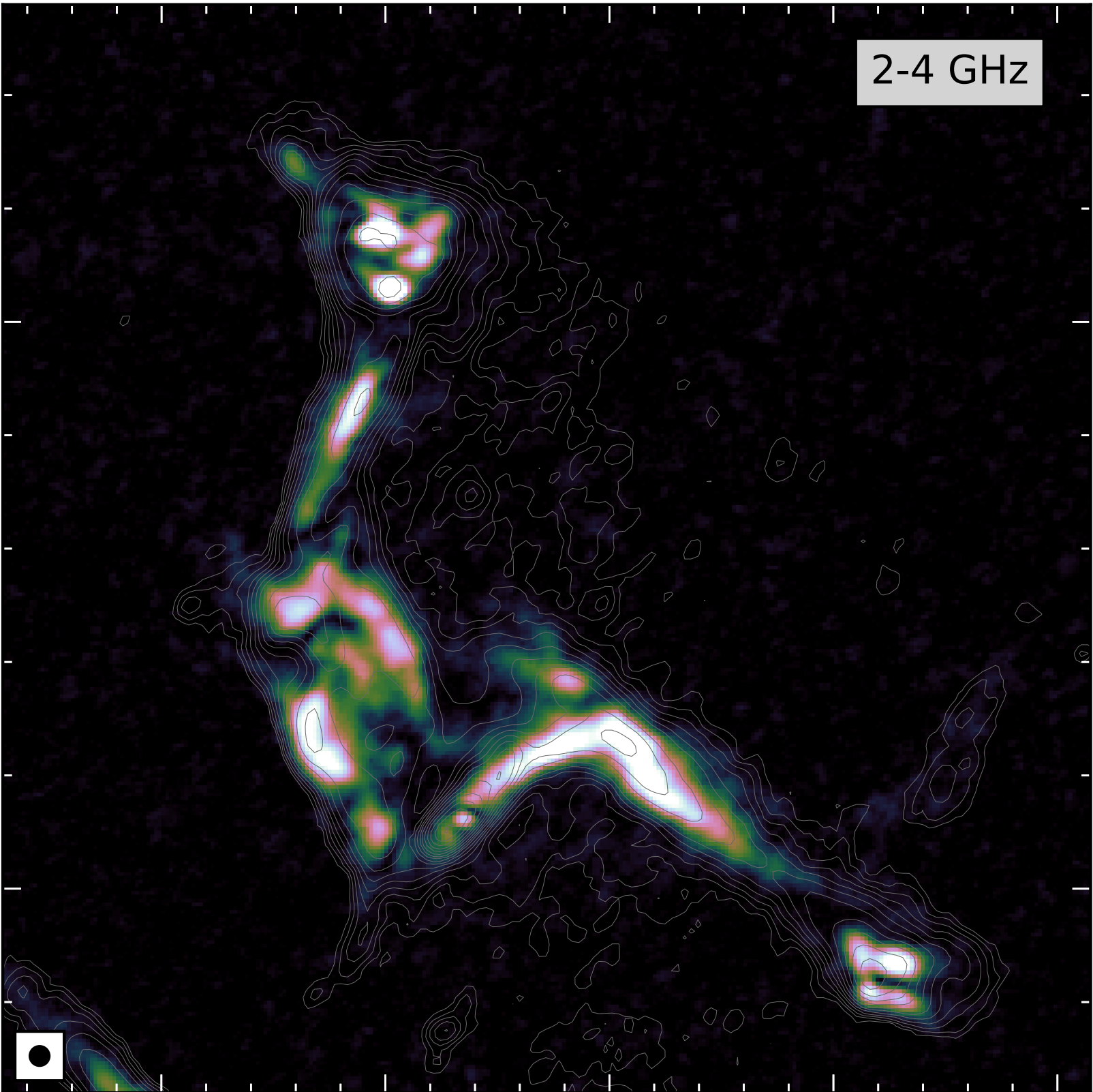
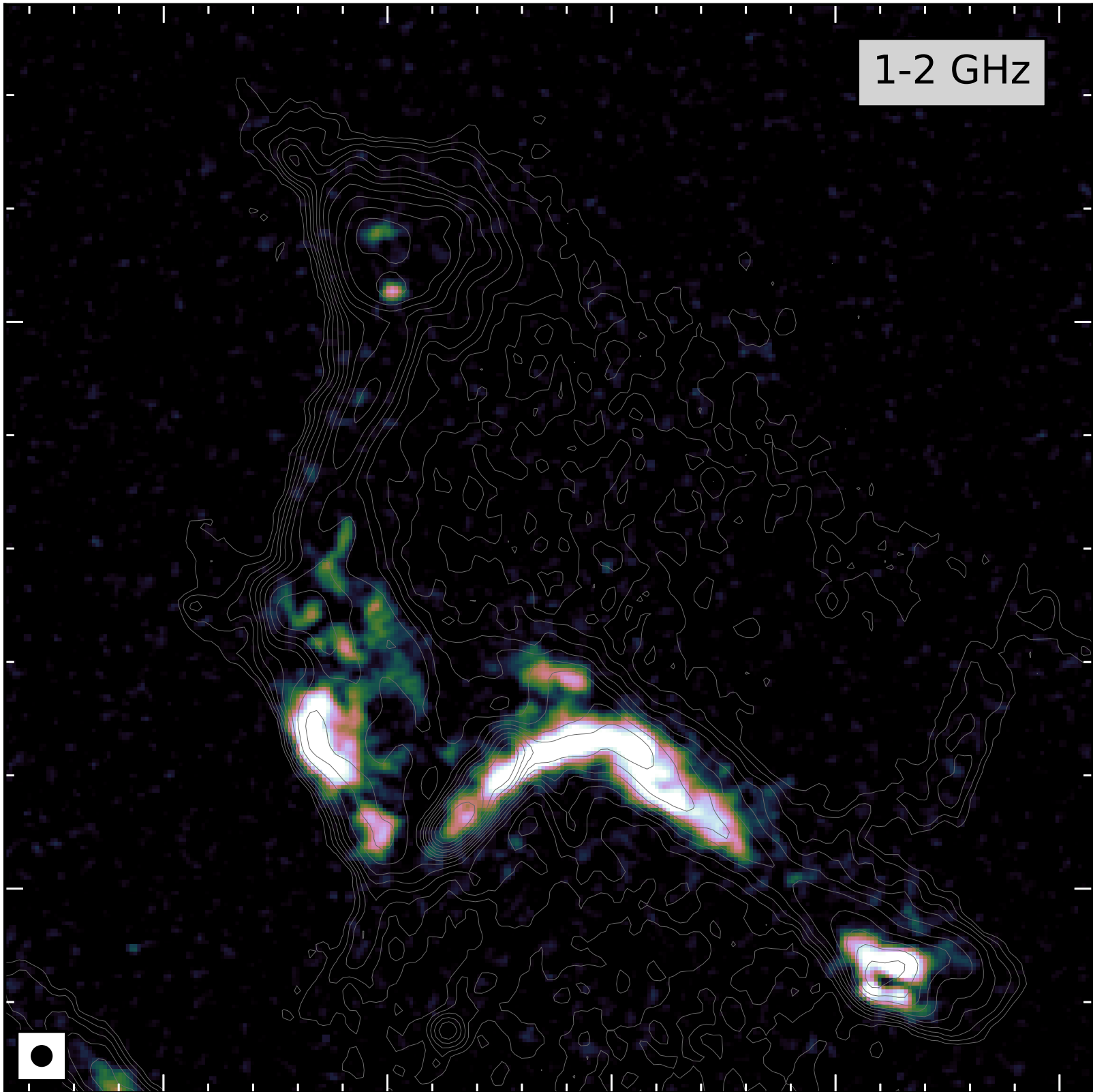
PI: R J. van Weeren

- L-band **VLA** observations from 1-2 GHz (ABCD array)
- S- band **VLA** observations from 2-4 GHz (ABCD array)
- C-band **VLA** observations from 4-8 GHz (ABCD array)

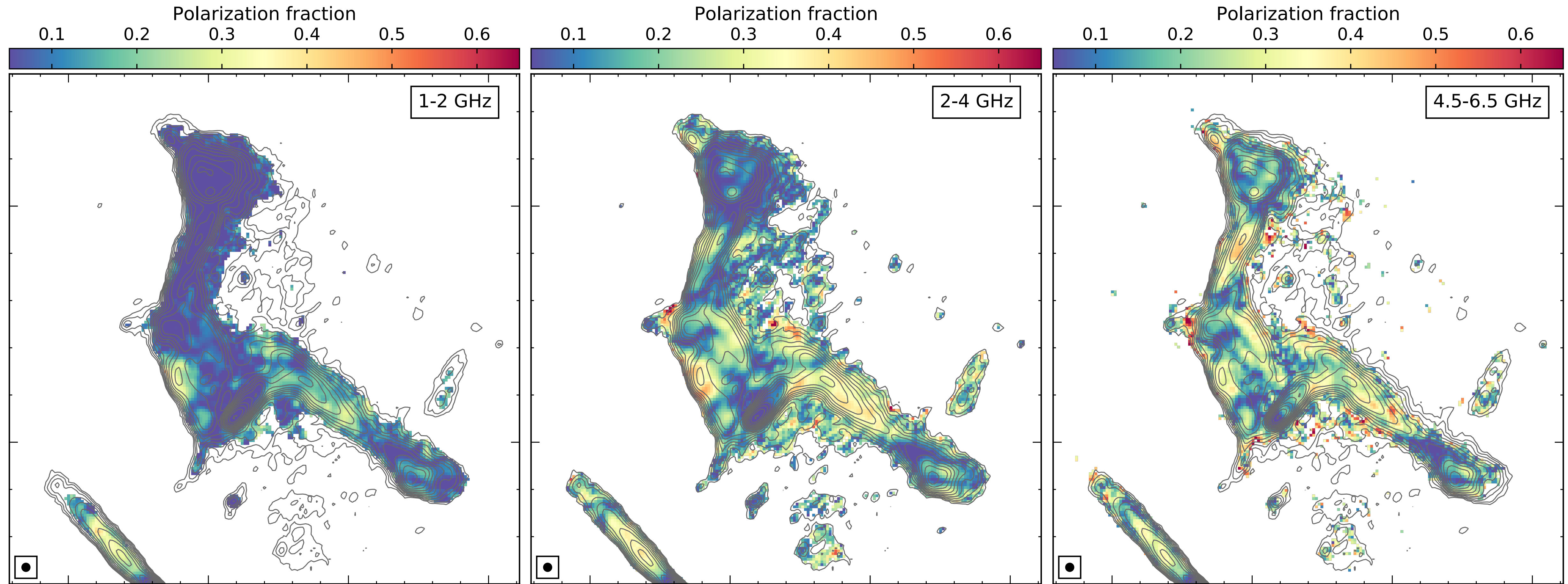
bright relic can be studied at 1-5 arcsec resolution



Patchy polarized emission: between 1 and 6.5 GHz

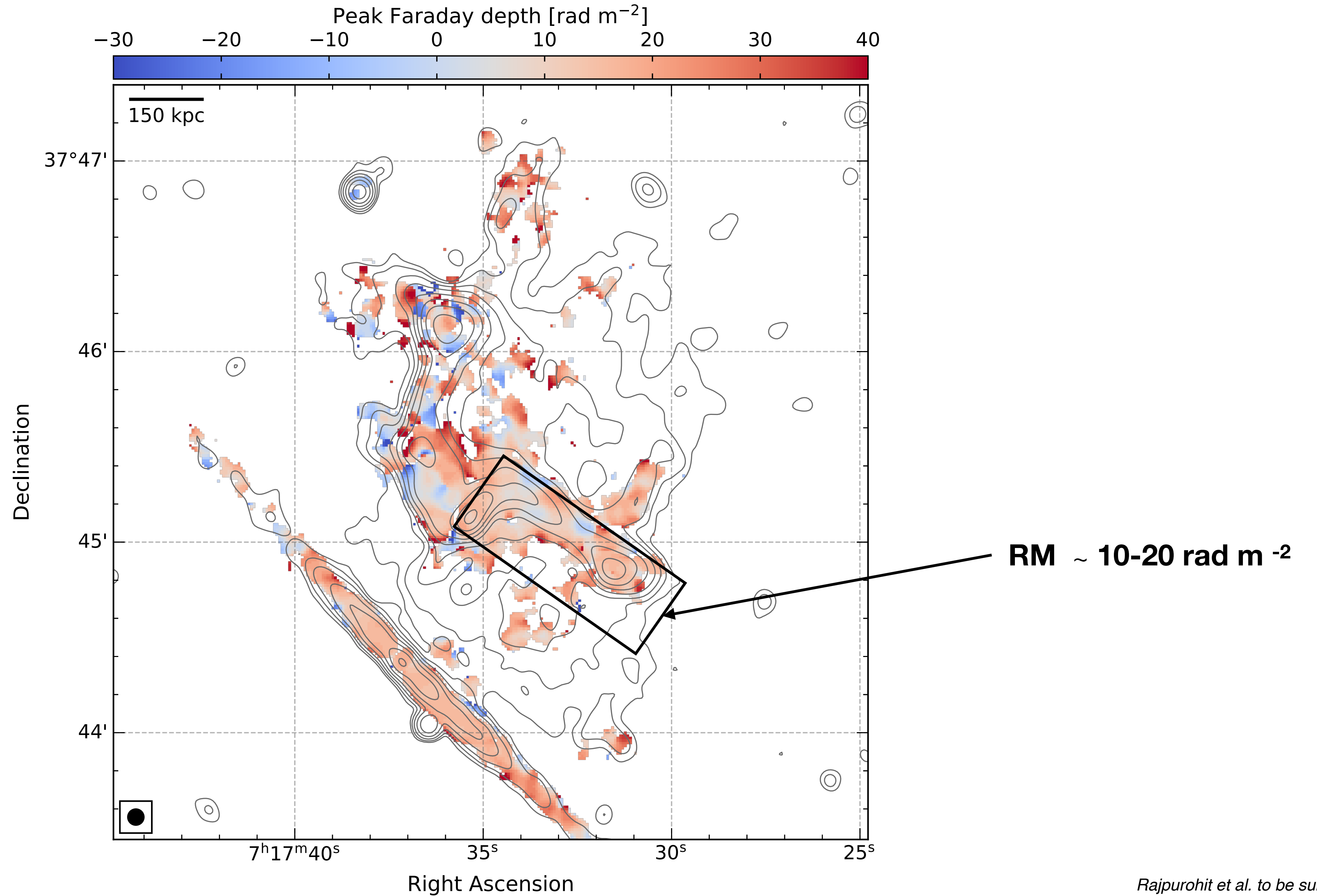


The relic is highly polarized: reaching a fractional polarization of 50%

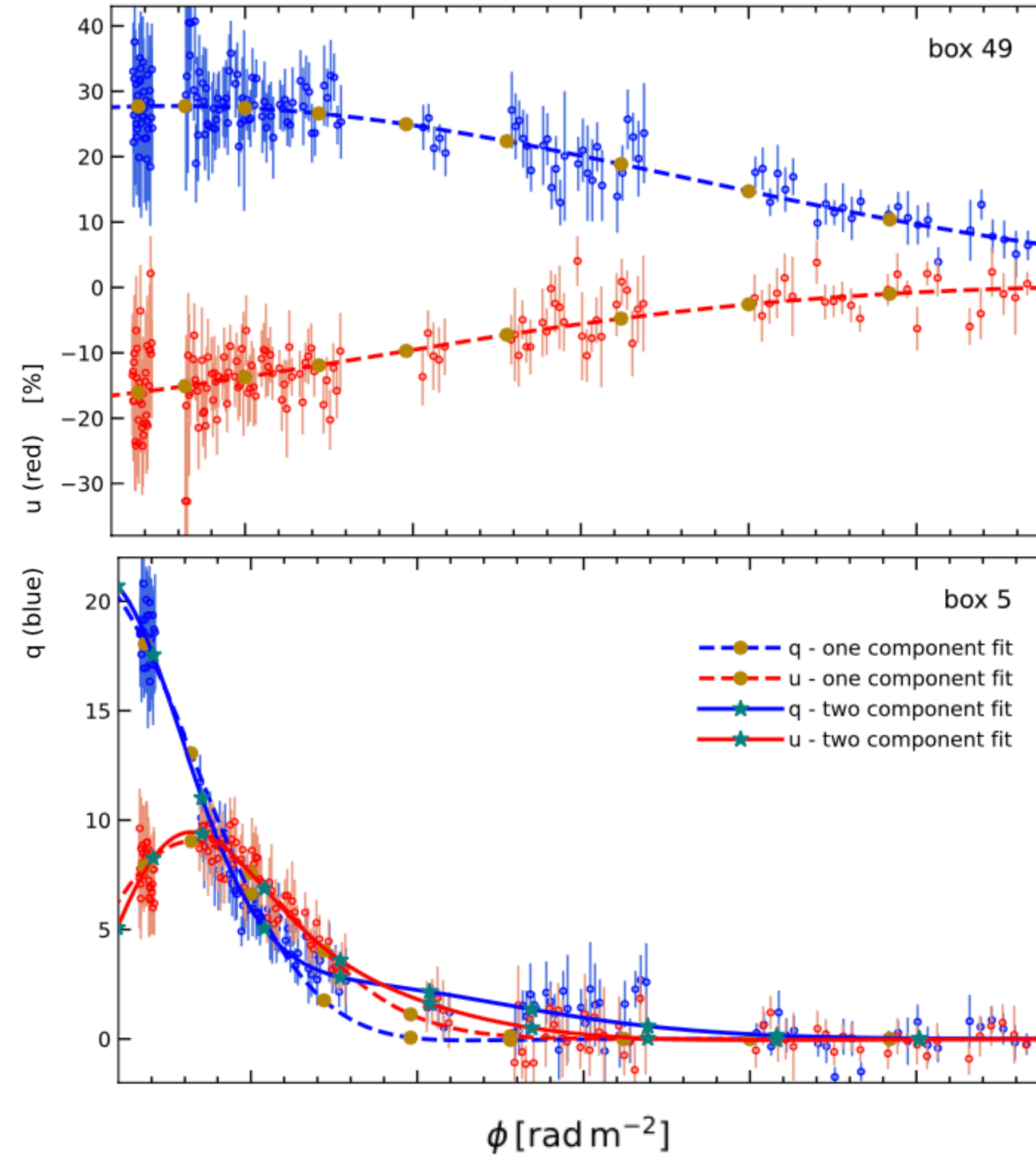
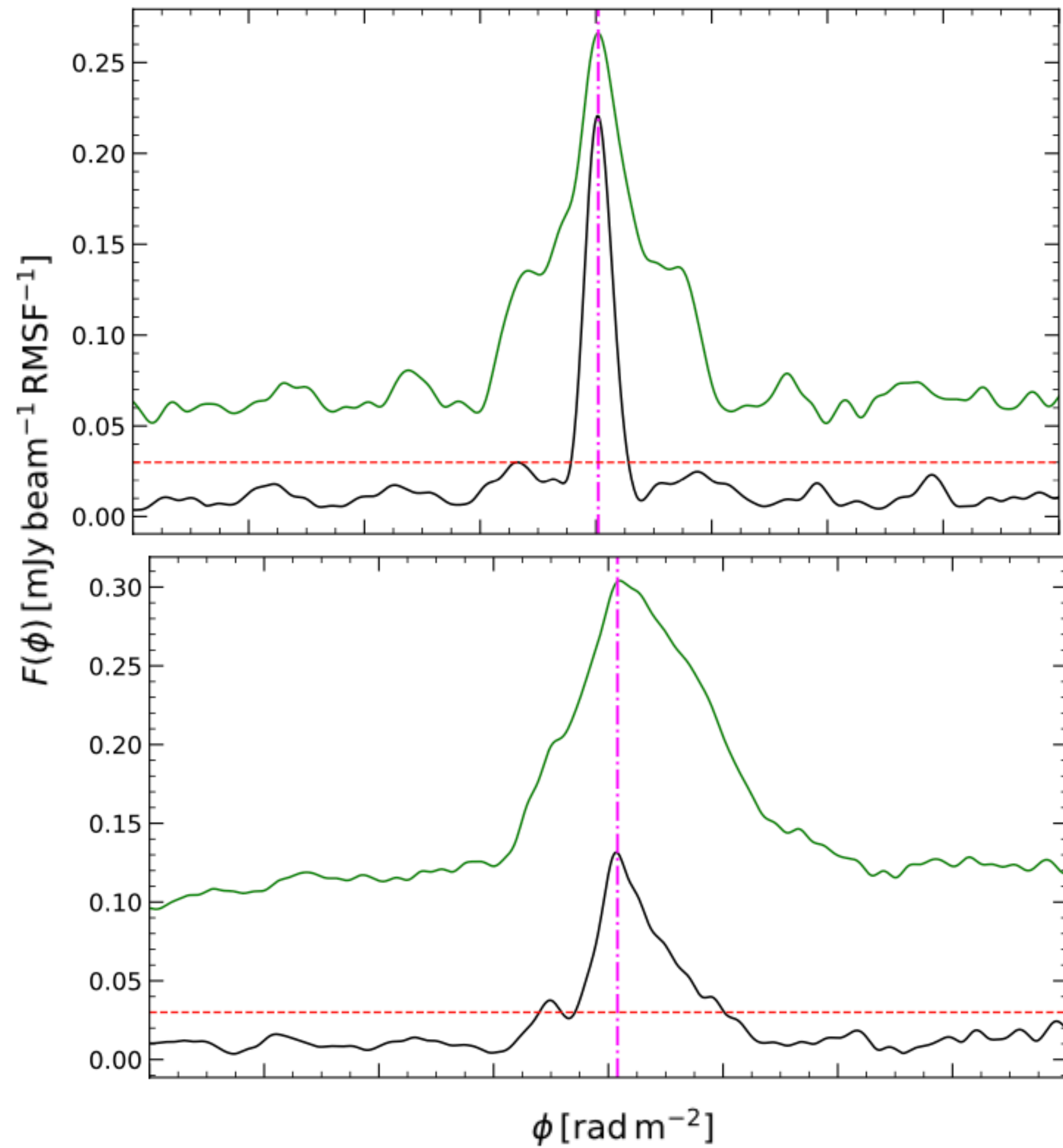


strong depolarization in the northern part

Strong RM fluctuations in the northern part of the relic



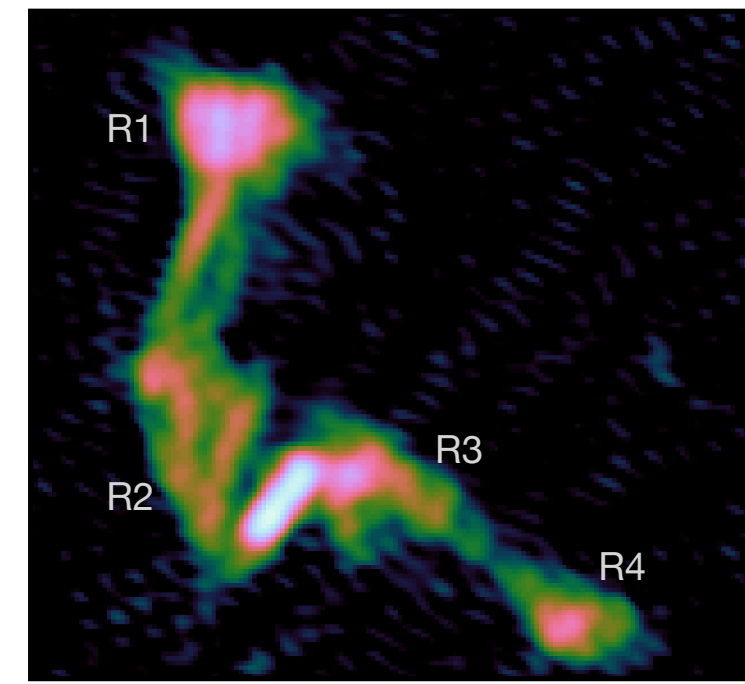
Northern region of the relic reveals a broader spectrum and the presence of two RM components



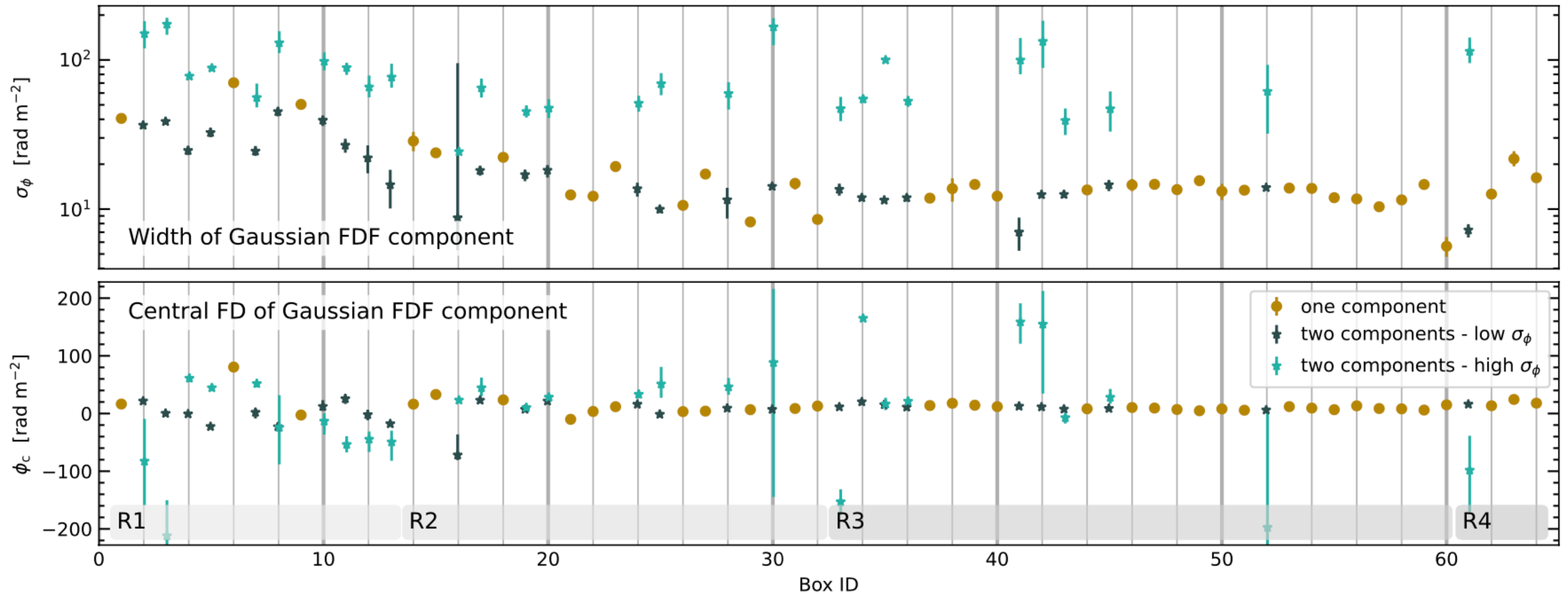
RM fluctuations cause depolarization

$$\frac{p_2}{p_1} = e^{-2\sigma_{\text{RM}}^2} (\lambda_2^4 - \lambda_1^4)$$

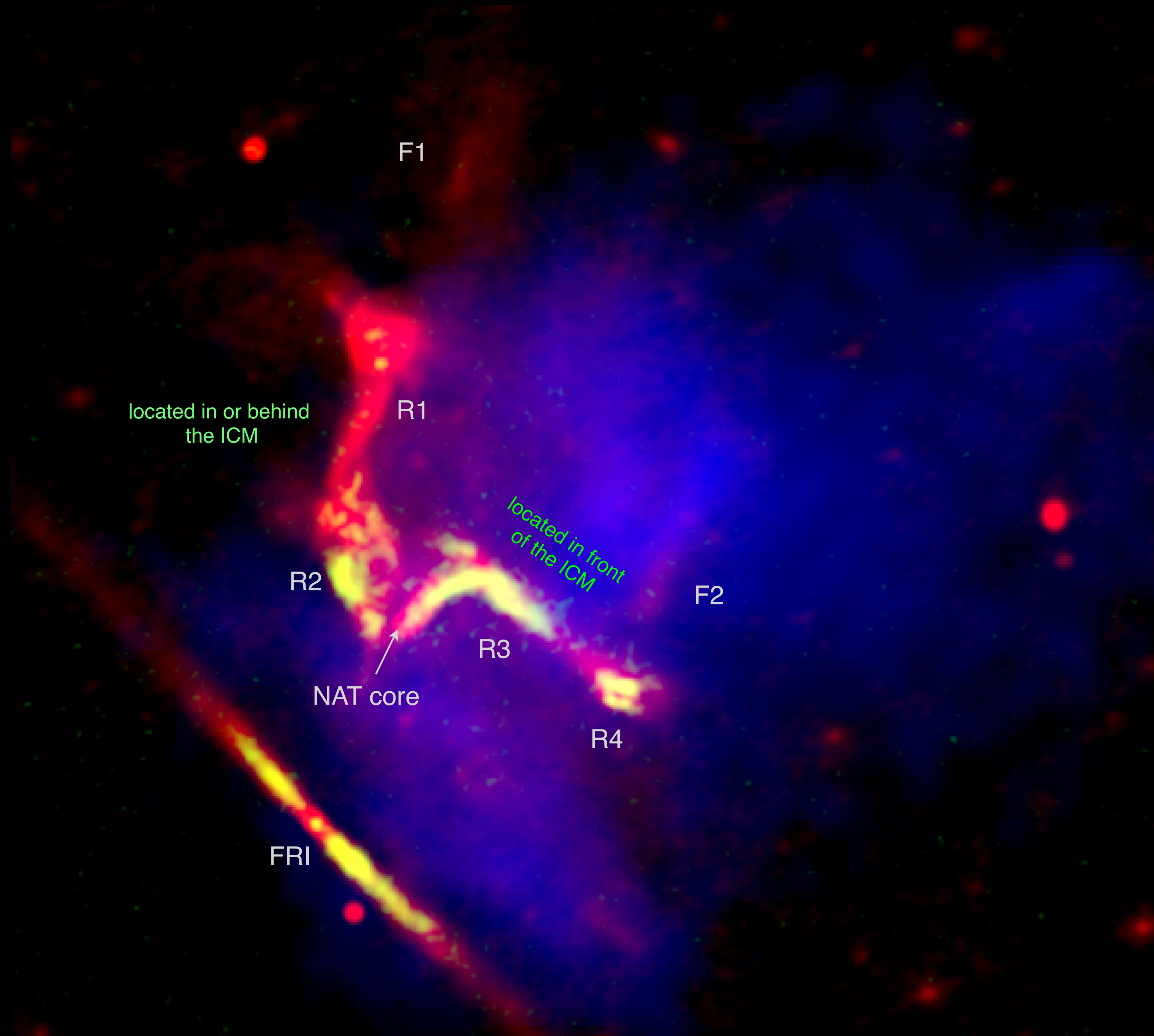
Faraday distributions seem consistent with the turbulent ICM



- high Faraday dispersion at the northern part (about 180 rad m^{-2})
- there is also a component close to the Galactic RM at low Faraday dispersion



X-ray emission
total power emission
polarization 1-2 GHz



located in or behind
the ICM

located in front
of the ICM

F1

R1

R2

R3

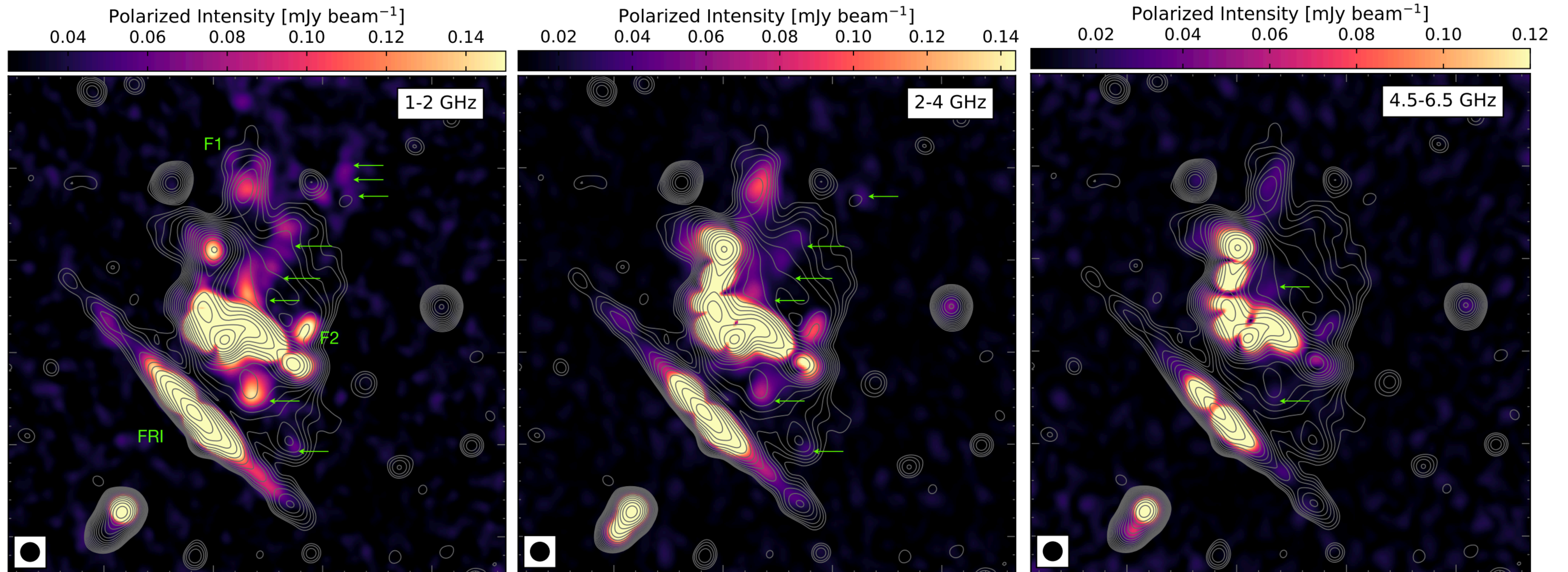
R4

F2

NAT core

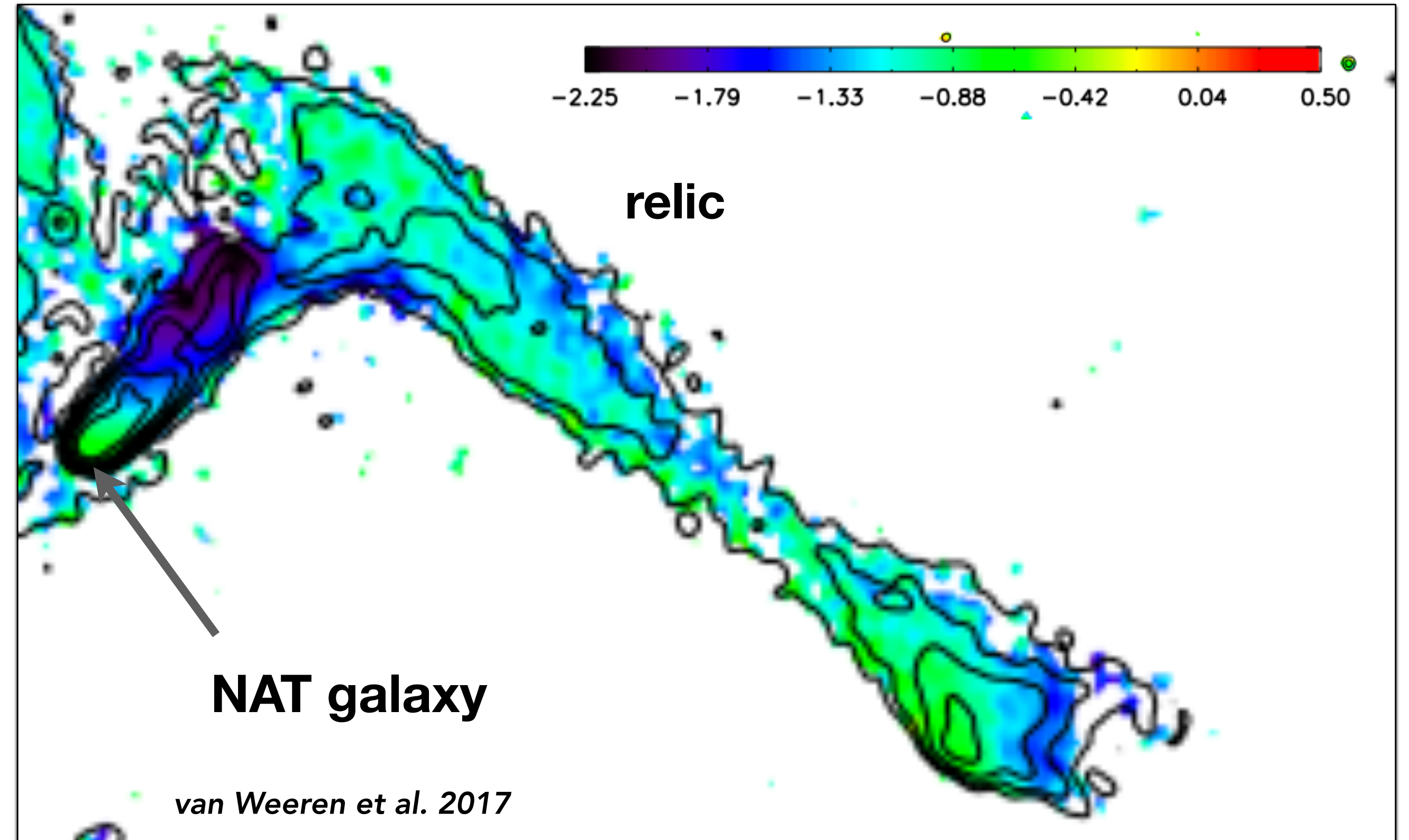
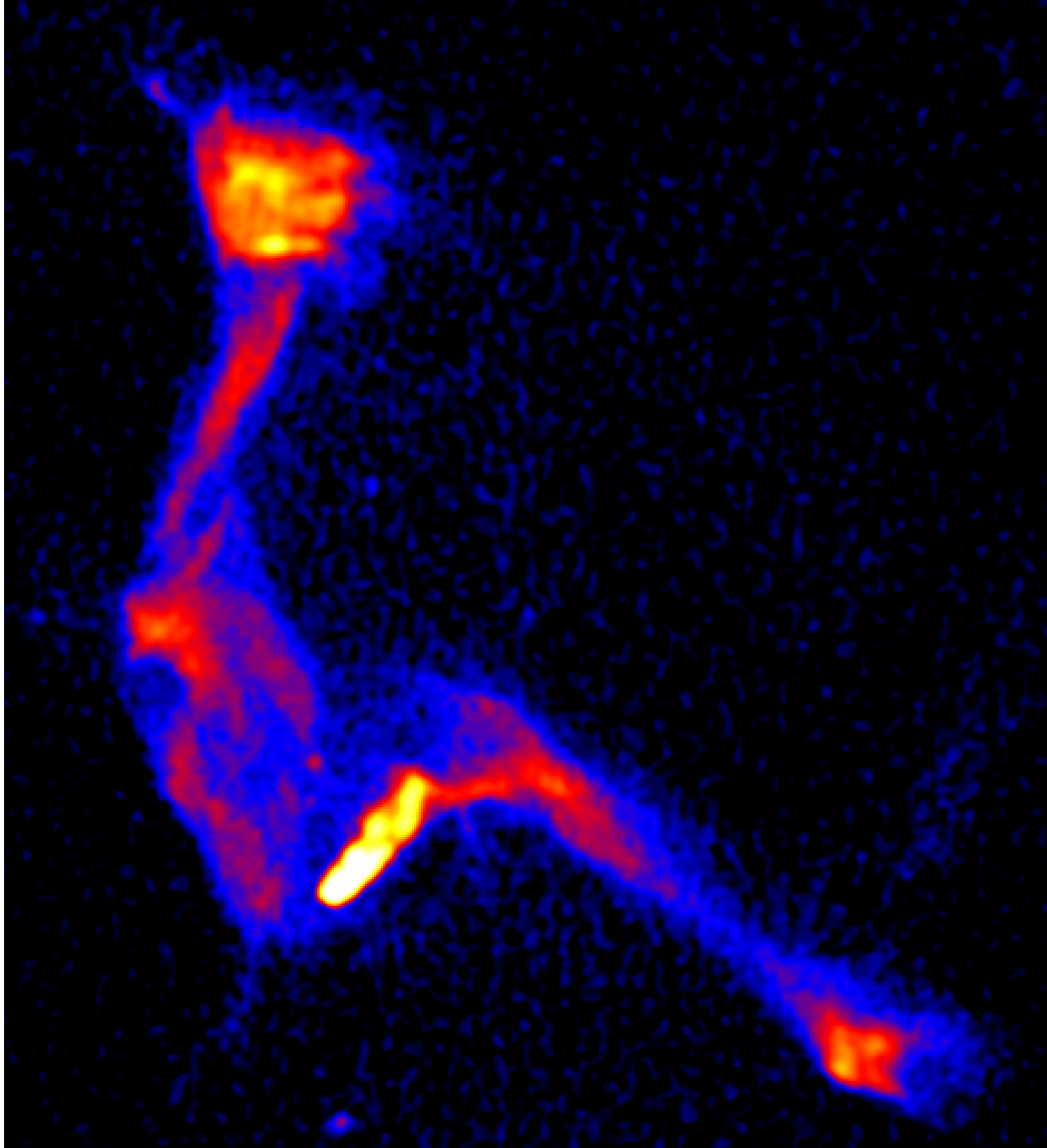
FRI

Polarized patches detected at the cluster center are not associated with the halo emission



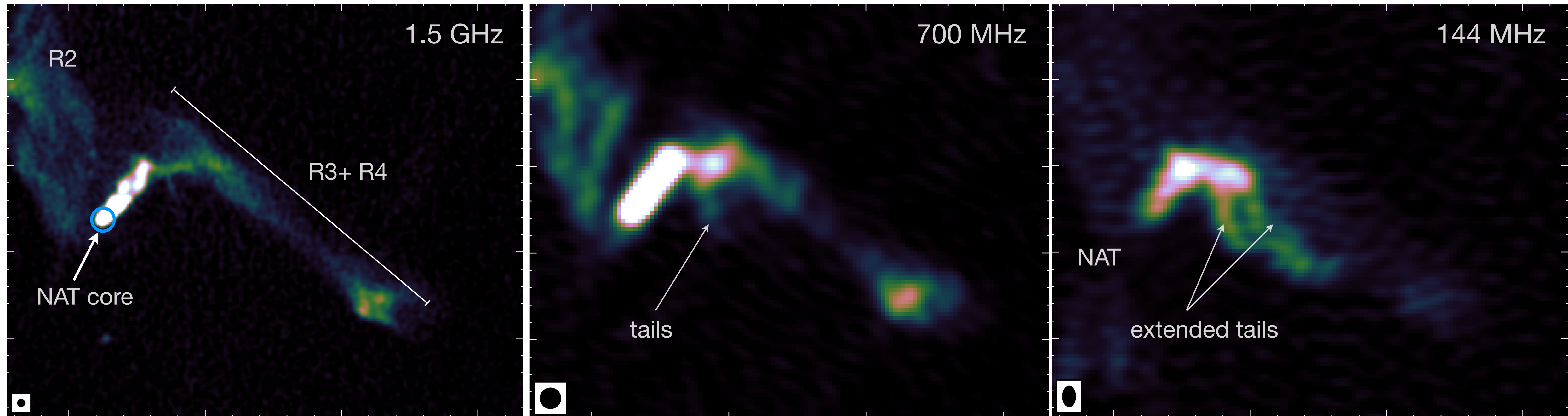
shows low Faraday dispersion (12 rad m⁻²), similar to the southern part of the relic

MACS J0717.5+3745: a part of the relic emission is connected to the narrow-angle-tail galaxy



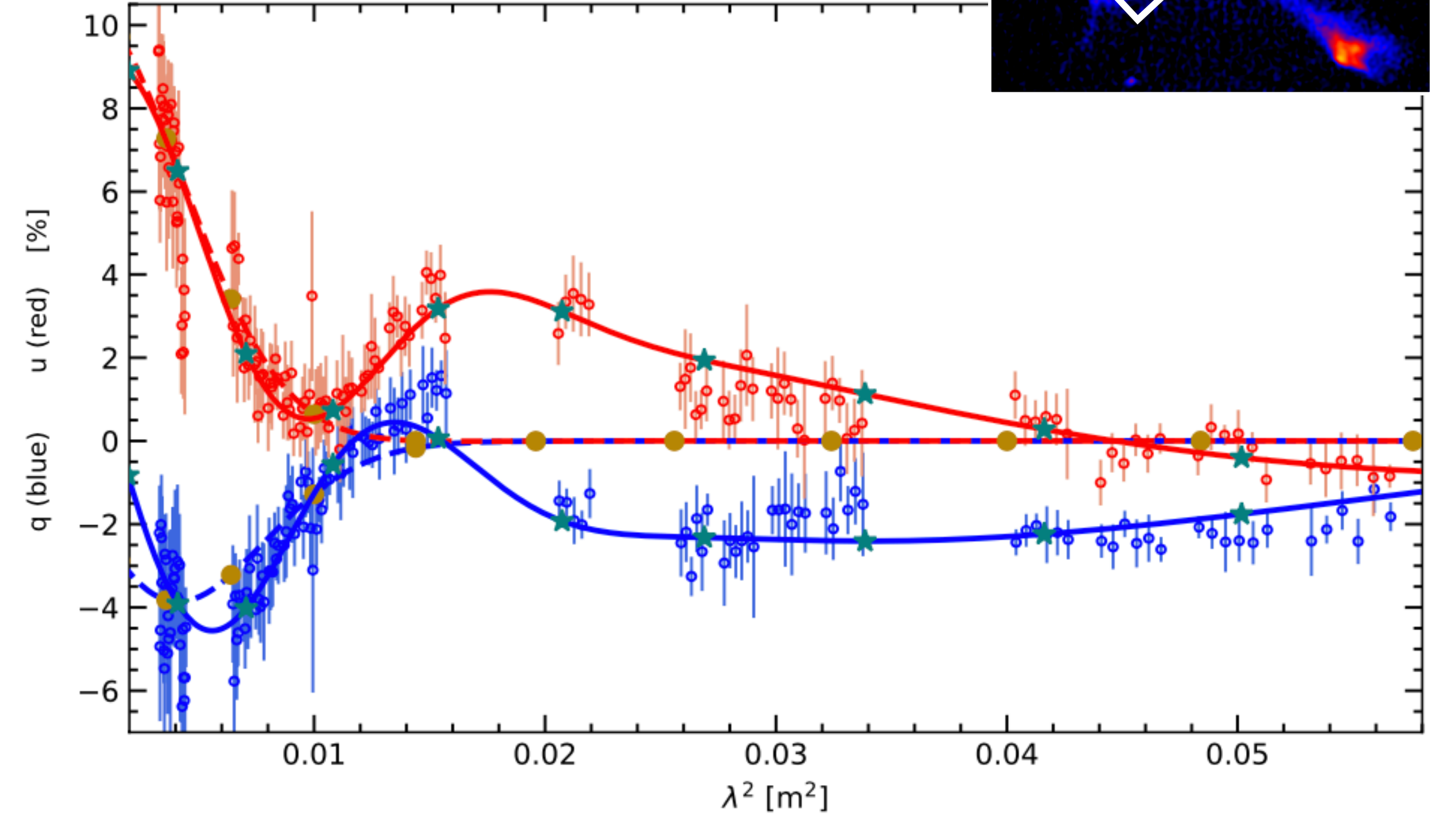
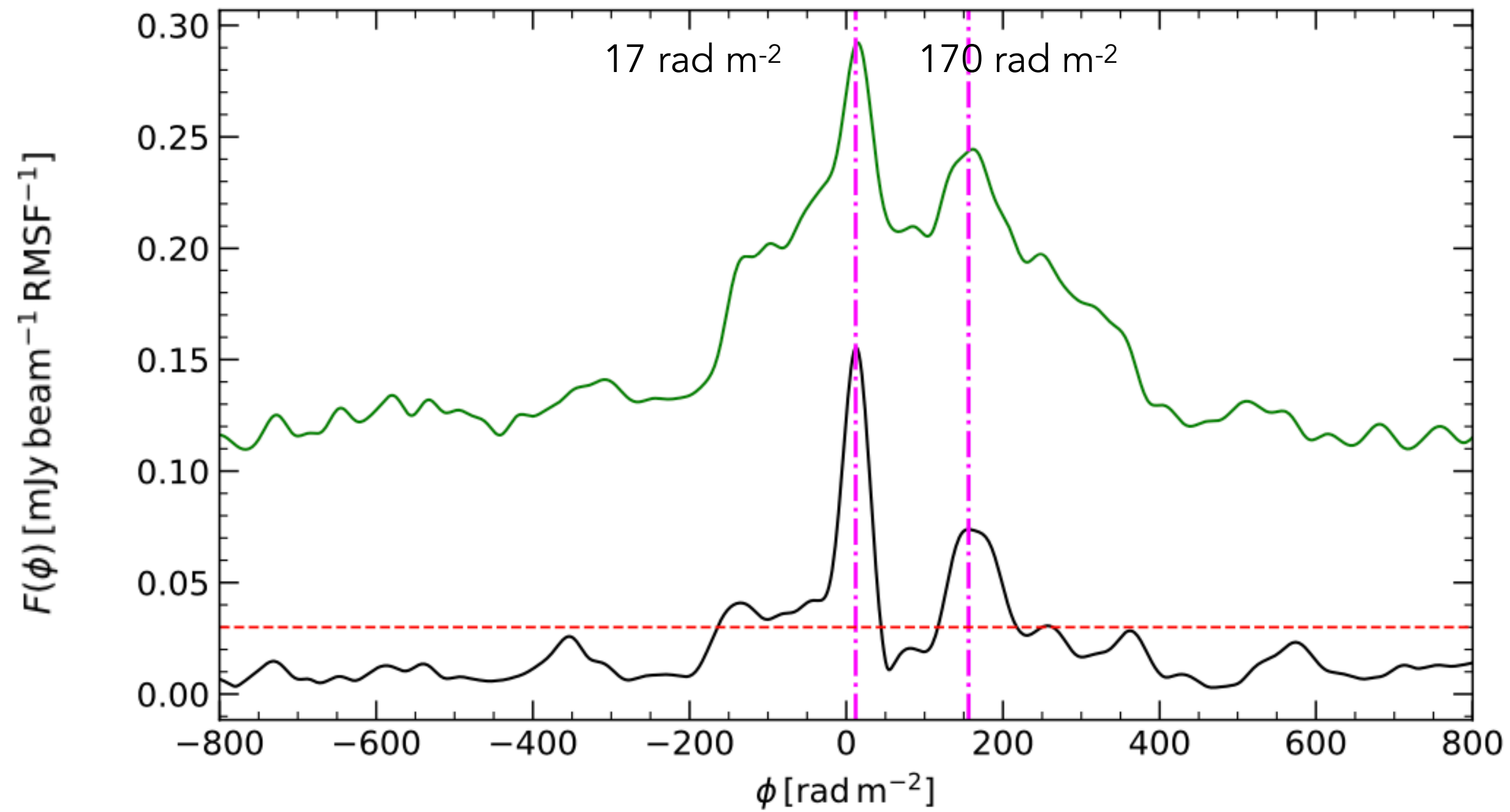
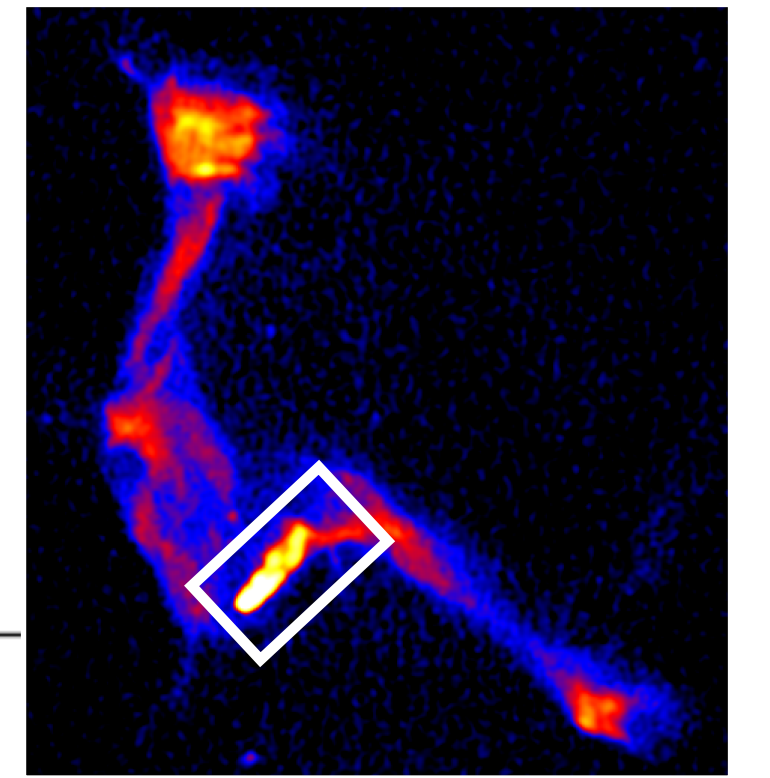
shock re-acceleration of fossil plasma?

We see extended lobes at low frequencies



the NAT and the relic are seen in projection?

The presence of two clear RM components at the NAT



polarization and spectral analysis suggests that the NAT and the relic are just seen in projection, thus the NAT is very likely not providing seed electrons to the relic

Summary

- SKA will allow us to study the magnetization of the ICM over a wide frequency range
- MACS J0717+35 relic shows a complex Faraday distribution
- ICM magnetic field can be highly turbulent
- upper limit for the radio halo polarization is 3% at 3 GHz