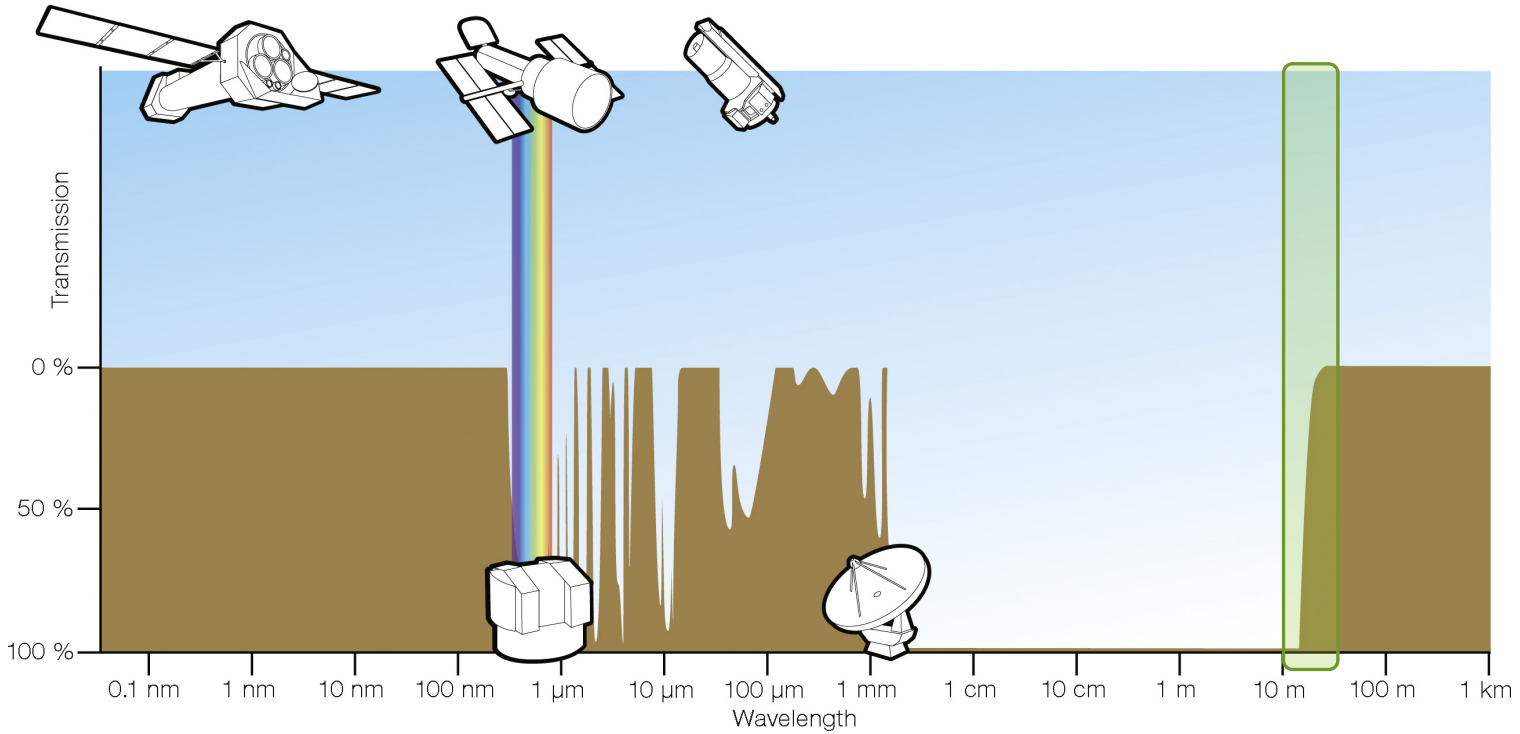
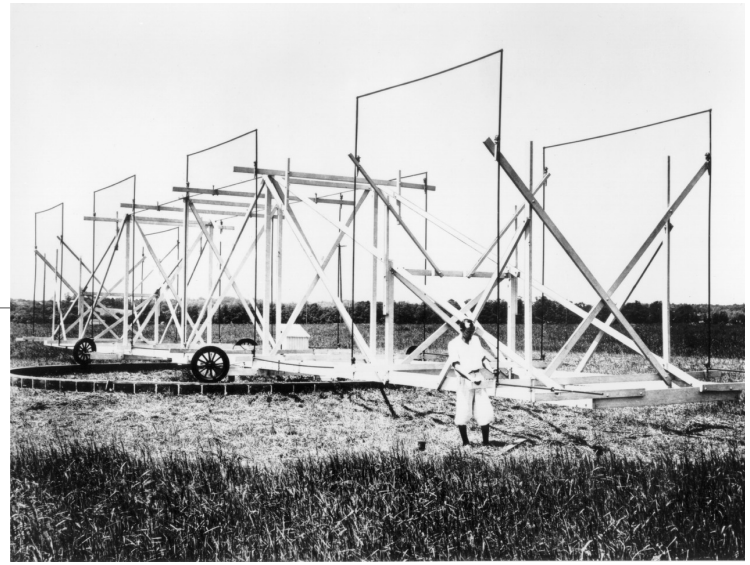
Decameter astronomy

Christian Groeneveld
(INAF - IRA)

Decameter wavelength band



Source: F. Granato (ESA/Hubble)

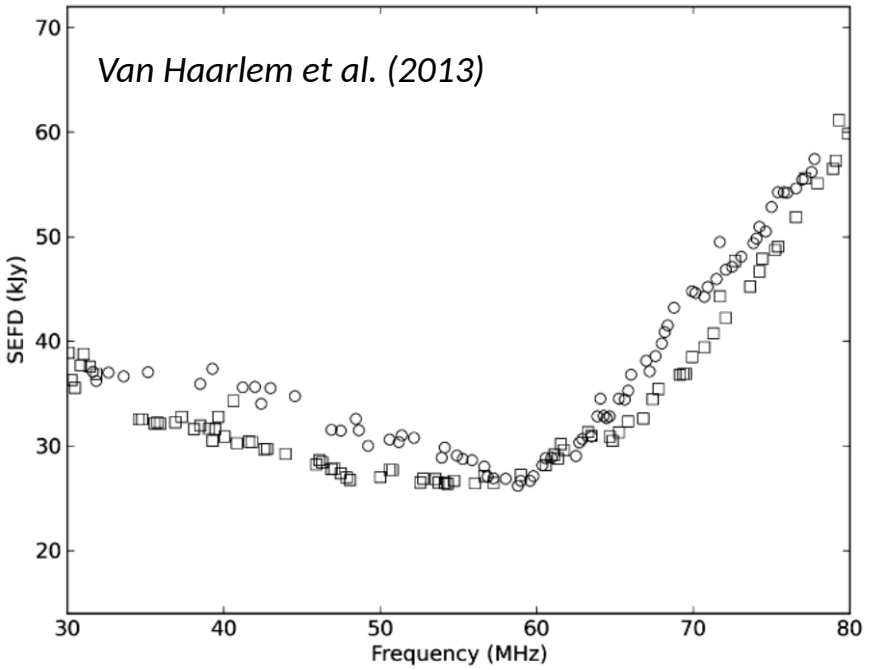


Source: *ukrinform.com*

Why are there no deep surveys?

- Ionosphere changes heavily in time (~second)
- Ionosphere changes heavily in frequency (1/v)
- Faraday rotation (1/v^2)
- Corrections change severely throughout FoV
- Reflected RFI (during daytime)

Source: A. R. Offringa



Lowest frequencies with LOFAR LBA

In principle 10-80 MHz

LoLSS: 42-66 MHz

Decameter band: 16-30 MHz

Calibration

LoLSS-like calibration strategy

Library for Low Frequencies – minor changes for decameter

Biggest challenges:

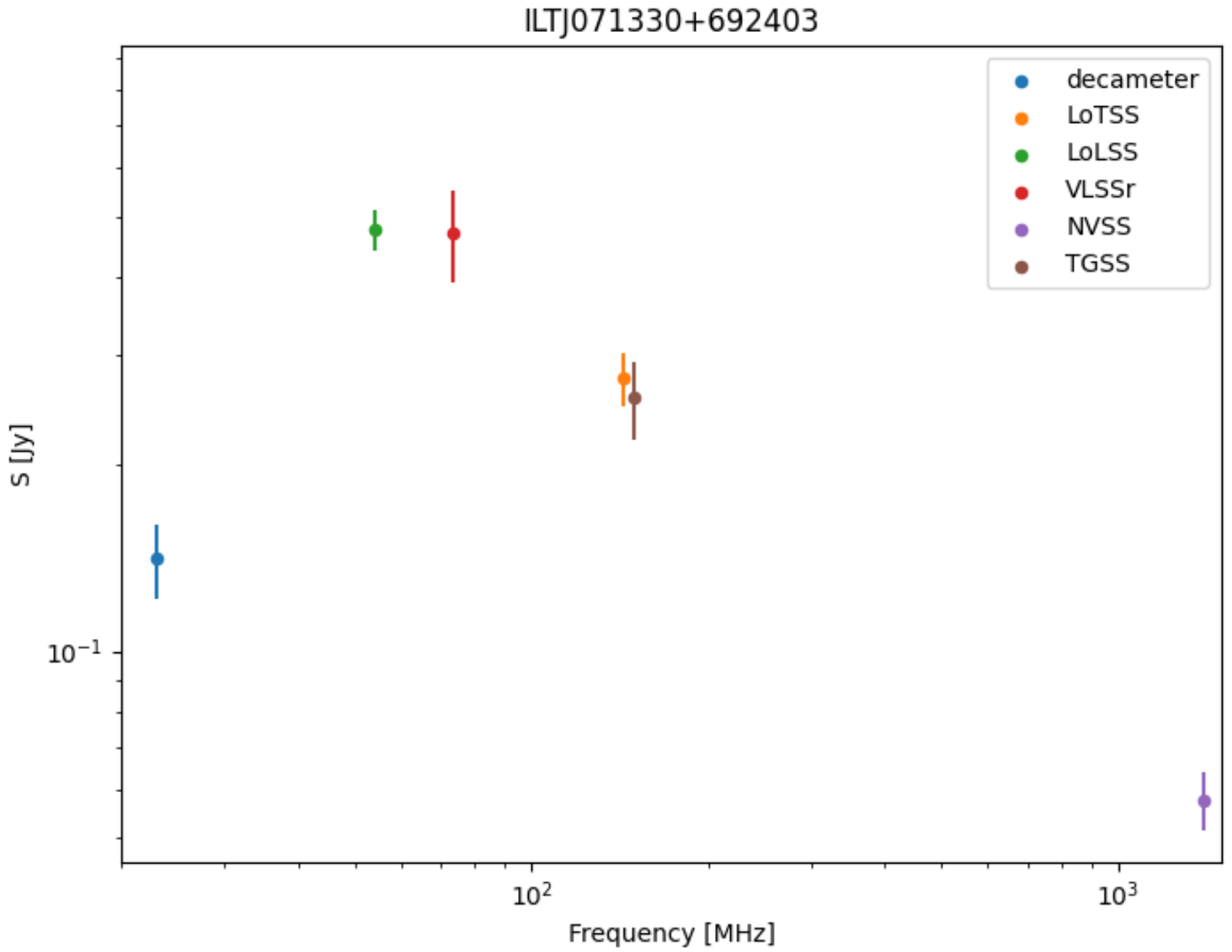
- Ionosphere changes fast across the sky: but SNR too low for sufficient coverage
- Beam not well modeled

What can we see?

Decameter sky

Turnovers at low frequencies

- Peaked spectrum sources



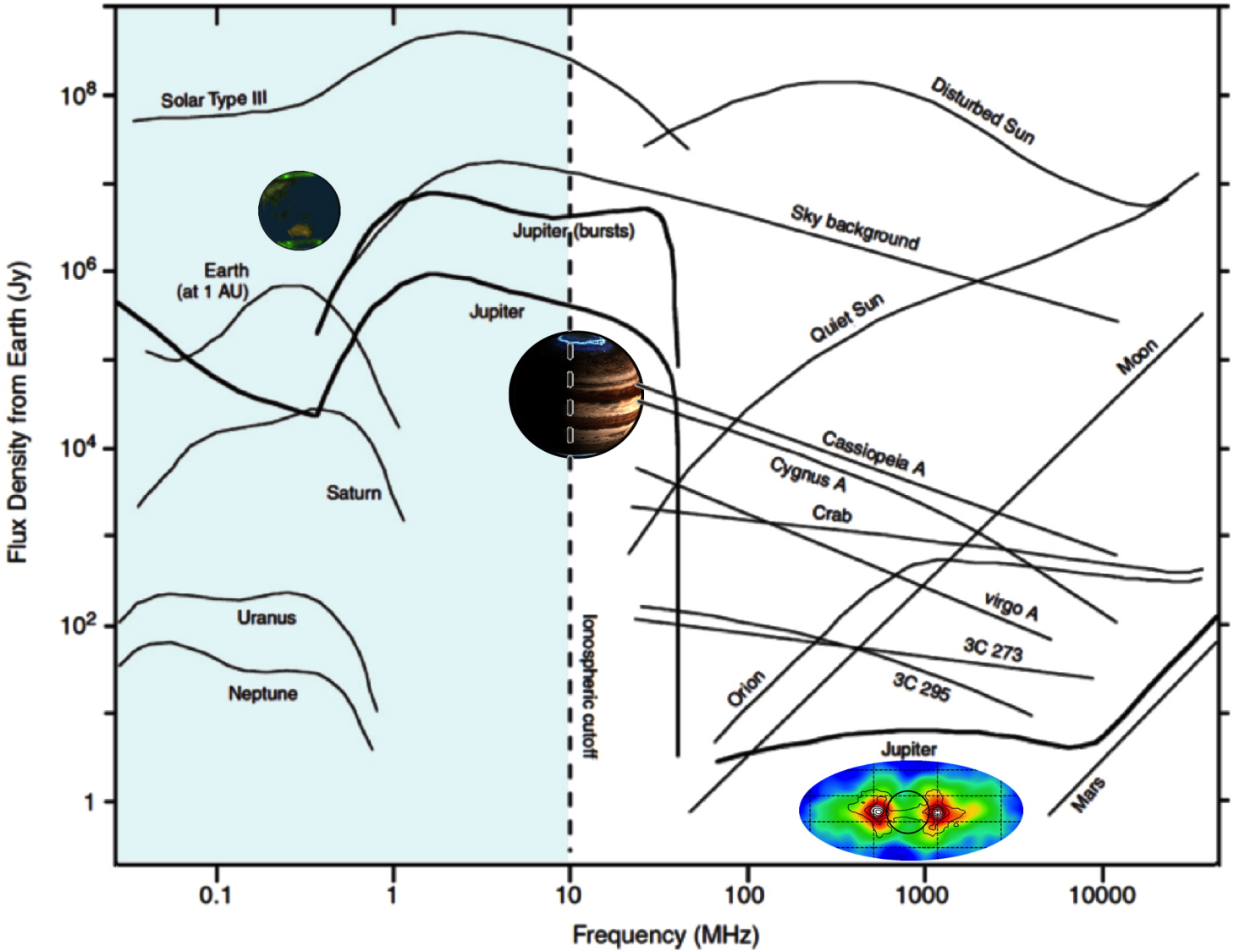
Lotte Jansen

Decameter sky

Turnovers at low frequencies

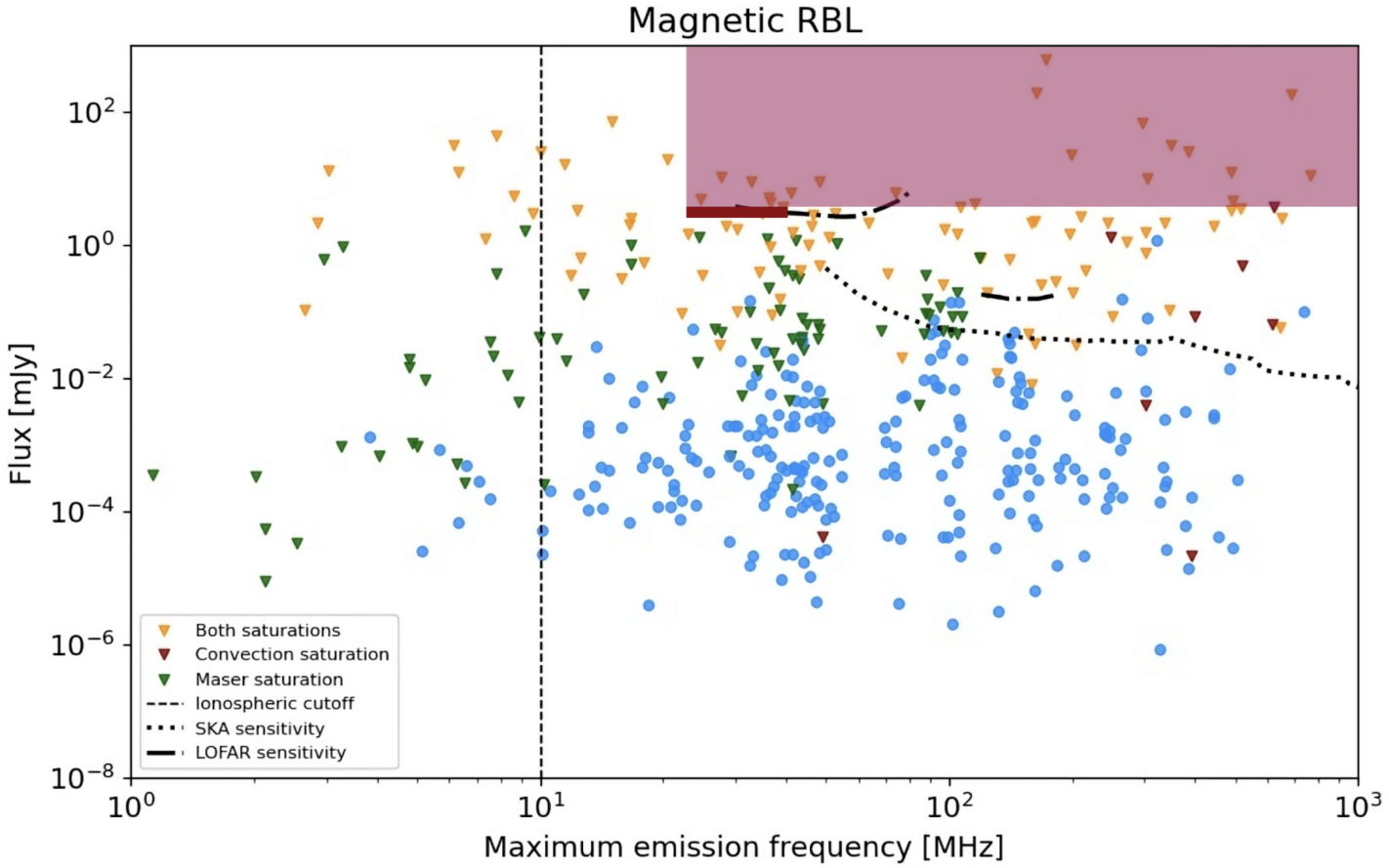
- Peaked spectrum sources

Unique radiation mechanisms



ECMI emission from Jupiter-Io interaction (e.g. Zarka 1992)

Source: *P. Zarka*



Cristina Cordun

Potential planet detections: low frequencies might be able to detect

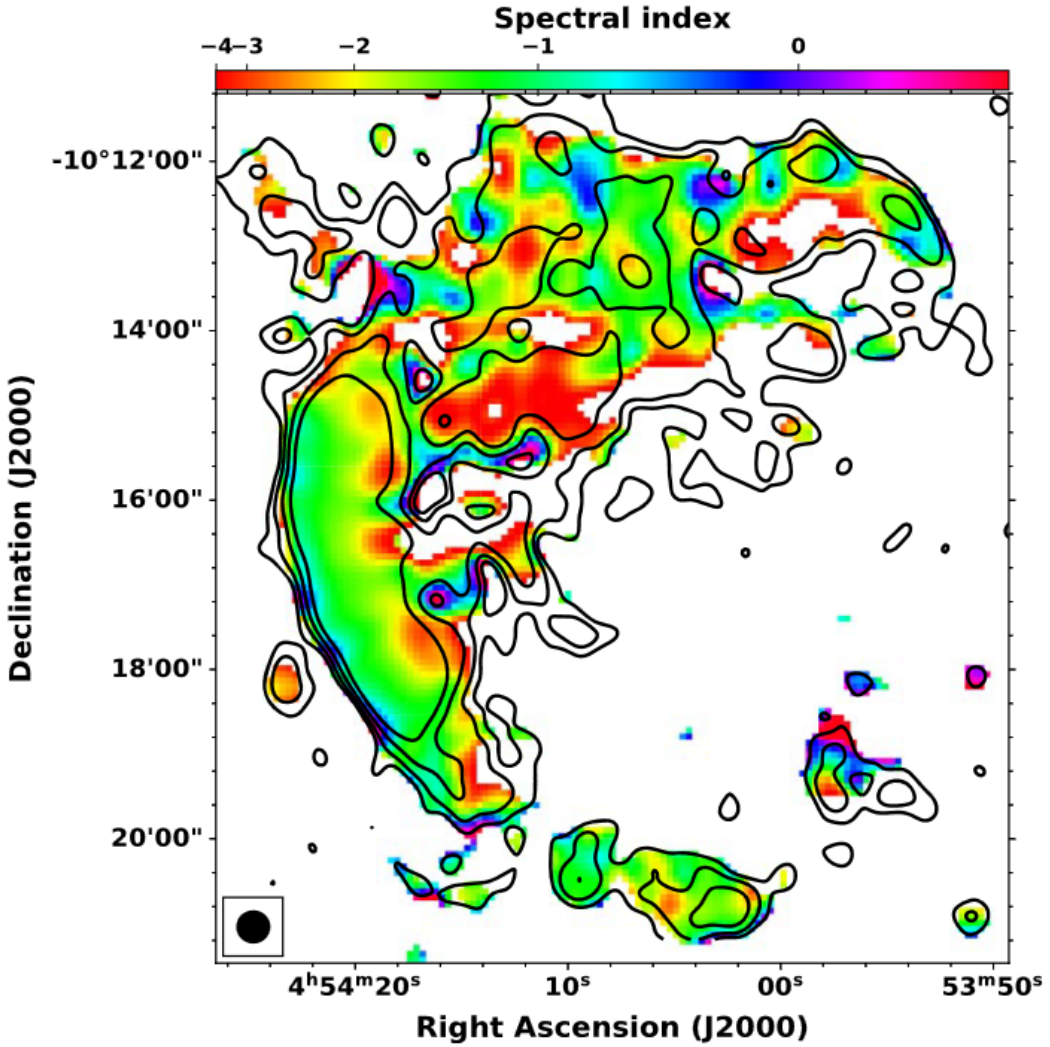
Decameter sky

Turnovers at low frequencies

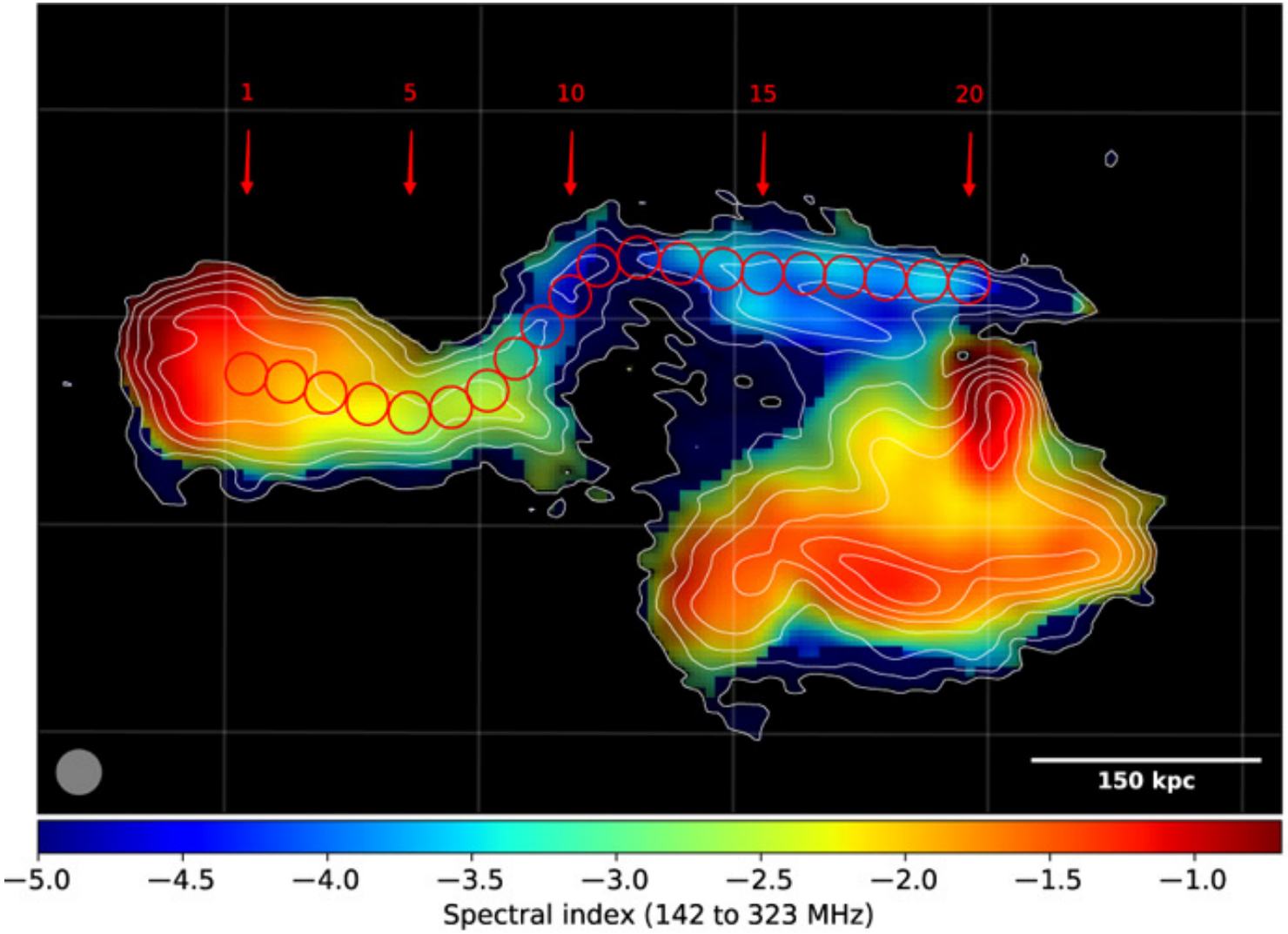
- Peaked spectrum sources

Unique radiation mechanisms

(Ultra) steep spectrum sources



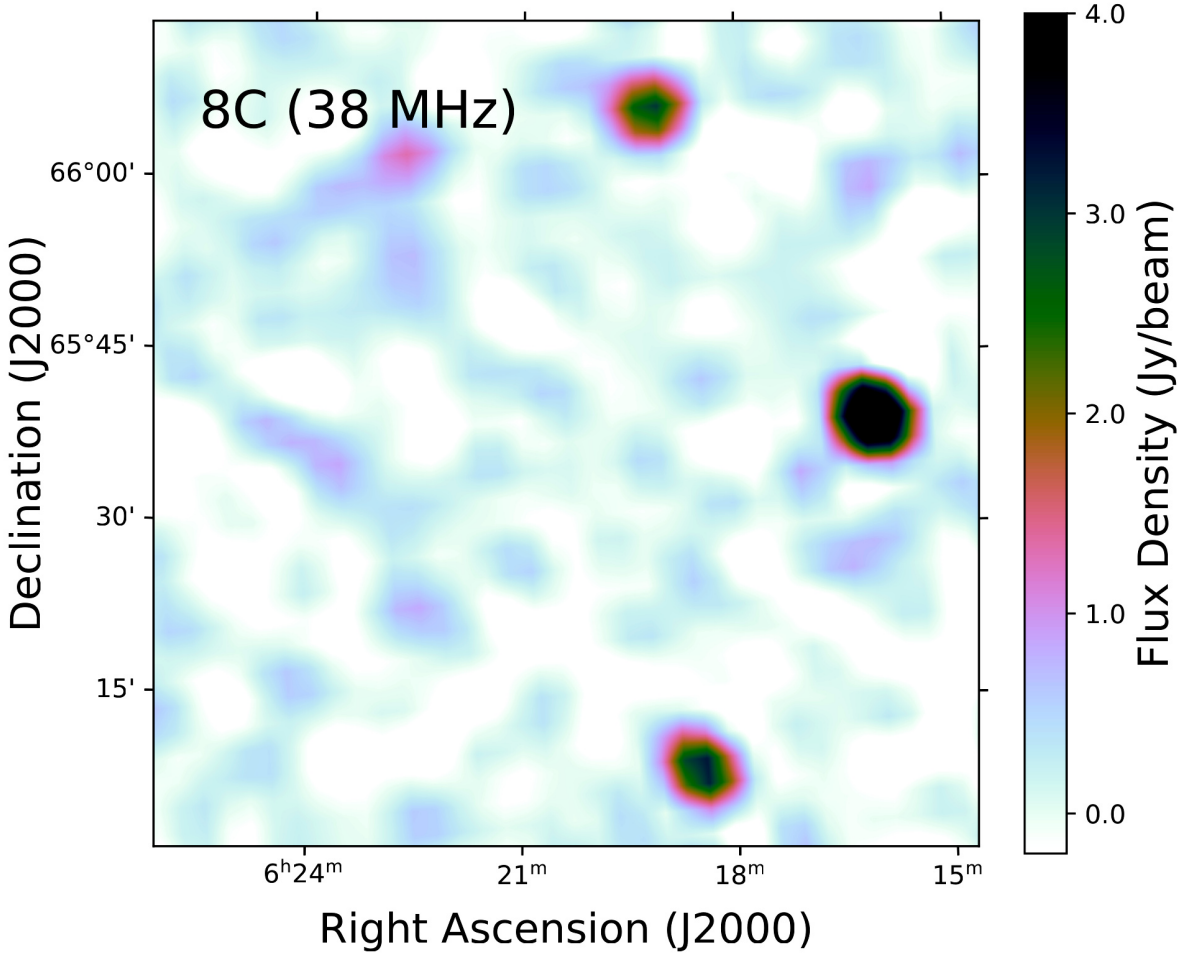
Source: *Santra et al. 2024*

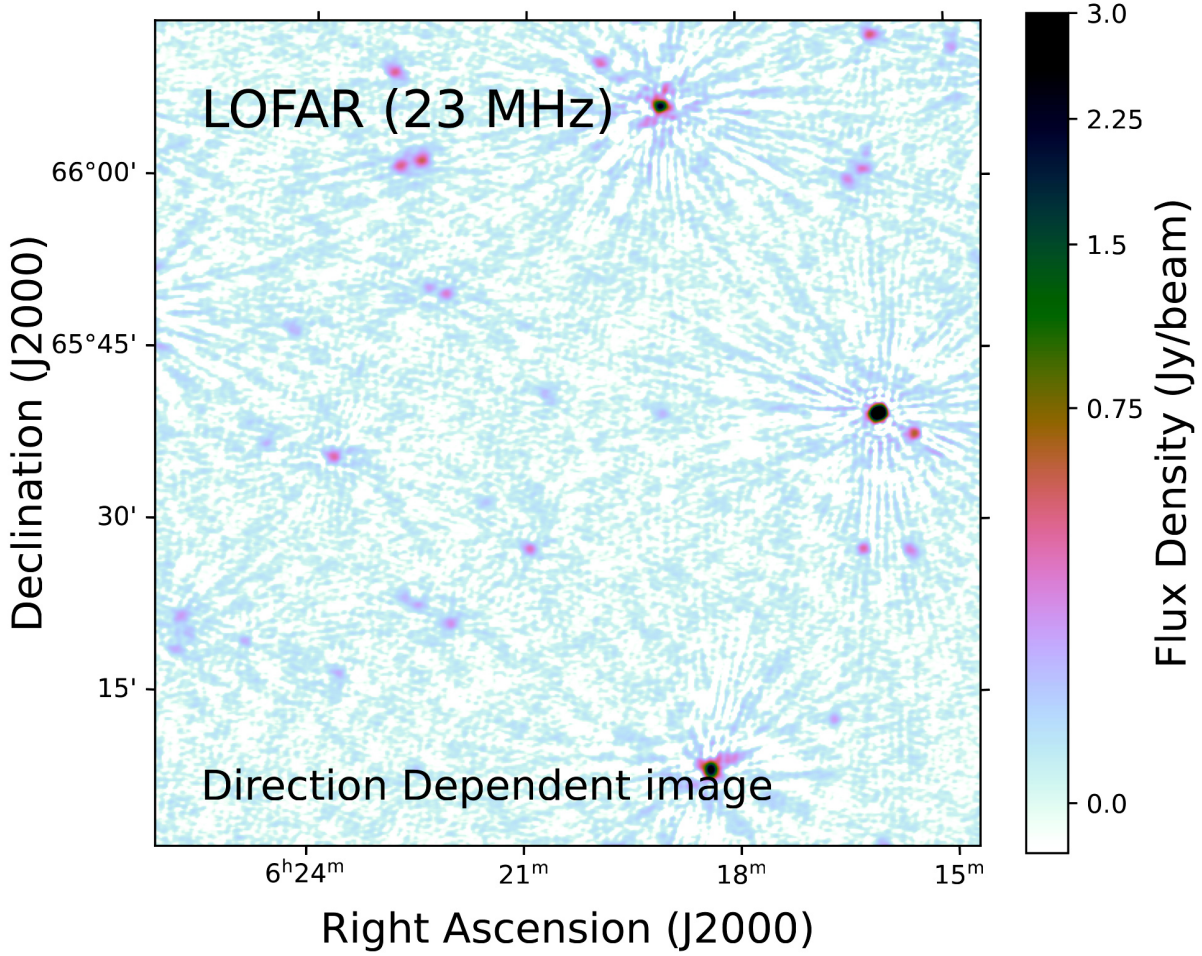


Source: de Gasperin et al. (2017)

Your science!

Decameter observations


8C (38 MHz)
66°00'
65°45'
30'
15'
Declination (J2000)
6h24m
21m
18m
15m
Right Ascension (J2000)
4.0
3.0
2.0
1.0
0.0
Flux Density (Jy/beam)


LOFAR (23 MHz)
66°00'
65°45'
30'
15'
Declination (J2000)
Direction Dependent image
6h24m
21m
18m
15m
Right Ascension (J2000)
3.0
2.25
1.5
0.75
0.0
Flux Density (Jy/beam)

nature astronomy

Article

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Characterization of the decametre sky at subarcminute resolution

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Check for updates

C. Groeneveld[1] ✉, R. J. van Weeren[1], E. Osinga[1], W. L. Williams[2], J. R. Callingham[1,3], F. de Gasperin[4], A. Botteon[4], T. Shimwell[1,3], F. Sweijen[1,3], J. M. G. H. J. de Jong[1], L. F. Jansen[1], G. K. Miley[1], G. Brunetti[4], M. Brüggen[5] & H. J. A. Röttgering[1]

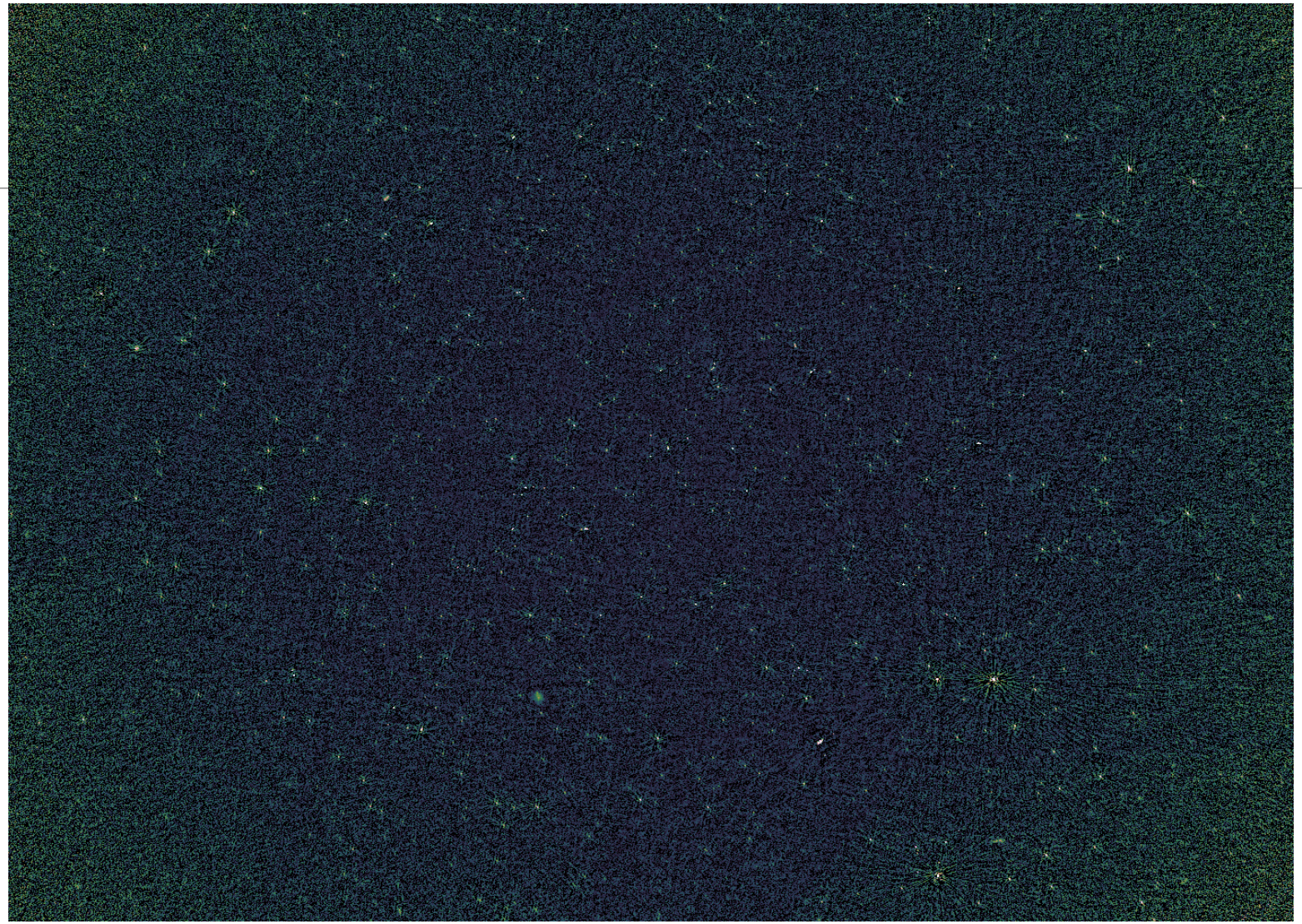
The largely unexplored decametre radio band (10–30 MHz) provides a unique window for studying a range of astronomical topics, such as auroral emission from exoplanets, inefficient cosmic ray acceleration mechanisms and fossil radio plasma. The scarcity of low-frequency studies is mainly due to severe ionospheric corruption. Here we present a calibration strategy to correct for the ionosphere in the decametre band. We apply this to an observation from the Low-Frequency Array (LOFAR) between 16 and 30 MHz. The resulting image covers 330 square degrees of sky at a resolution of 45″, reaching a sensitivity of 12 mJy per beam, which is an improvement by an order of magnitude in terms of sensitivity and resolution compared to previous decametre observations. Residual ionospheric effects cause additional blurring between 60″ and 100″. We have identified four fossil plasma sources in the surveyed region. These sources probably harbour rejuvenated radio plasma from past active galactic nuclei outbursts. Three are near the centre of low-mass galaxy clusters. Notably, two of these sources display the steepest radio spectral index among all the sources detected at 23 MHz. This indicates that fossil plasma sources constitute the primary

Paper published (2024)

Progress of LOFAR Decameter Sky Survey

- Full sky survey: five target beams + Calibrator beam
- Calibrators all done – allows for selection of 'easy' targets

- Ionosphere potentially severe…
- 8/362 pointings succesfully reduced
- Focus on interesting fields
- Working on fully functioning pipeline in LiLF – harder than we thought



Future potential

- LOFAR 2.0
- Stokes V
- Science:
  - Radio halos (galaxy clusters)
  - Peaked-spectrum sources
  - Re-energised fossil plasma
  - Exoplanets (Cristina Cordun)
  - Ionosphere
  - Other sources… (any suggestions?)

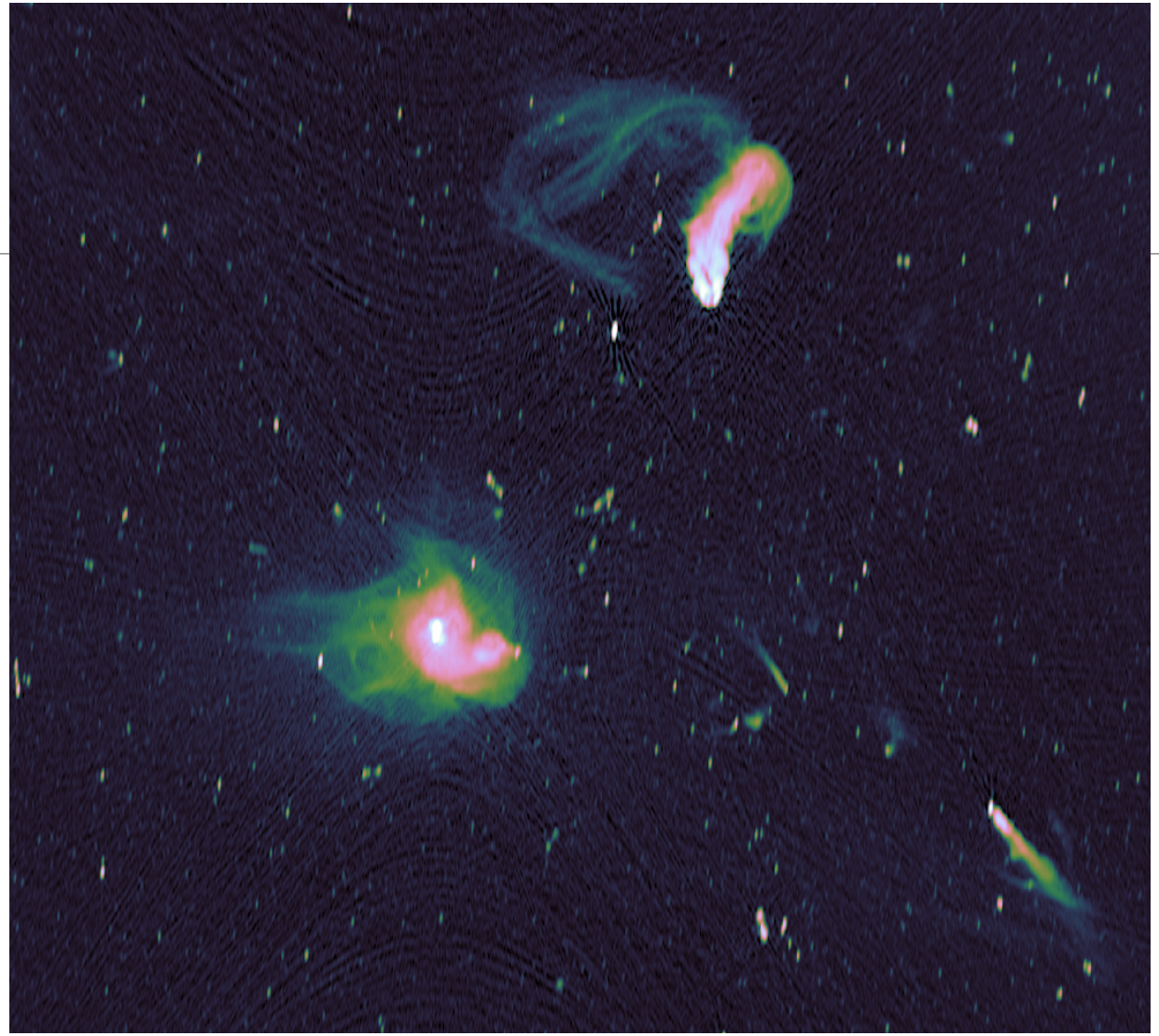
BONUS - Perseus

LOFAR HBA/LBA images of Perseus

Reveals large filamentary structures

MeerKAT proposal: but declination +41 !!

→ DDT proposal, 1hr plus polarisation (we got 2hr)



Conclusion

LOFAR is capable of observing below 30 MHz

Survey under way

Also MeerKAT is stable with declinations above 40 degrees