

Data combination at low frequencies

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① Introduction

② Data combination at low-frequencies

③ Summary

④ Beam formed observations

The problem is the same:

$$\hat{F}(0,0) = \int \int F(l,m) dl dm$$

Low-frequency arrays

- Wide field of view: degrees to all-sky.
- No moving parts.

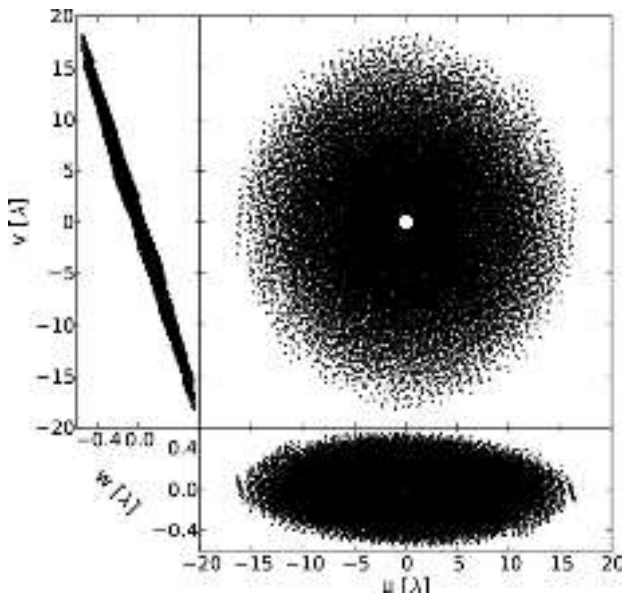


LOFAR LBA dipole

Low-frequency arrays

Telescope	Wavelength m	B_{\min} m	B_{\max} km
MWA	1–4	7	5
LWA1	3.5–11	5	0.5
LWA-OVRO	3.5–11	5	1.5
LOFAR	1.25–30	80	1900
NenuFAR	4–30	25	3
AARTFAAC	3–10	2	3.5

LWA1 zenith snapshot UV coverage



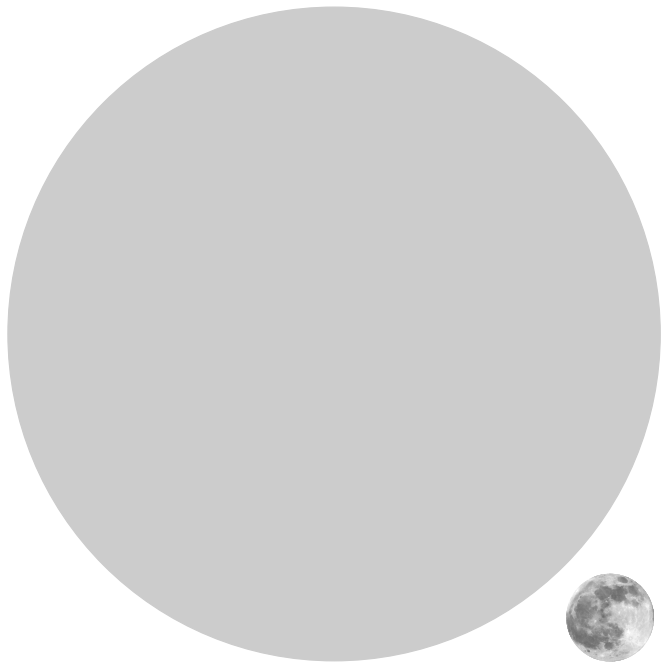
International LOFAR Telescope (ILT)



ASTRON

ASTRON is a research institute for astronomy and astrophysics

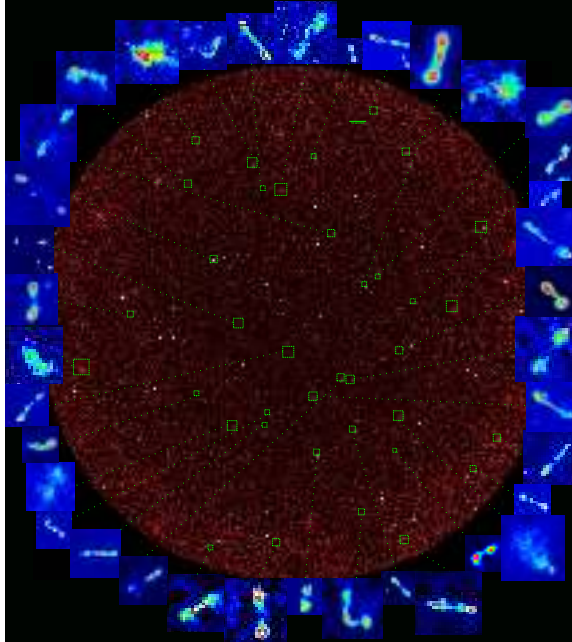




LOFAR FoV @ 140 MHz

Boötes field

LOFAR @ 150 MHz

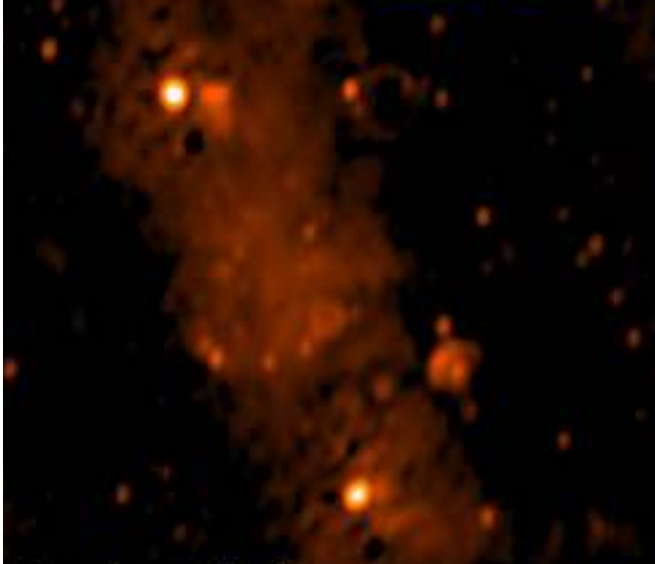


Science cases that benefit from total power

- Spectral indices of supernova remnants.
- Galactic synchrotron emissivity (but see e.g., Su+2018).
- EoR experiments.
- Radio recombination lines.

Science cases that benefit from total power

LOFAR HBA image of the Galactic plane.



Existing total power maps

- Haslam+1981,1982, 408 MHz.
- Dowell+2017, 35–80 MHz.
- Guzman+2011, 45 MHz.
- Alvarez+1997, Maeda+1999, 45 MHz.
- Dwarakanath & Udaya Shankar 1990, 34.5 MHz.
- Roger+1999, 22 MHz.

See de Oliveira-Costa+2008 & Zheng+2016 for a more complete list.

Data combination at low-frequencies

Measure the total power using a filled array and a noise diode.



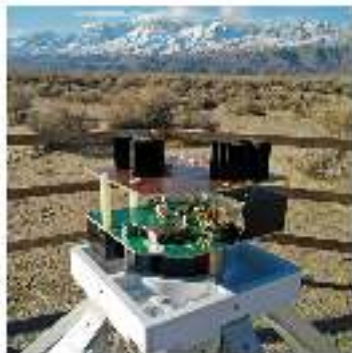
May+1984

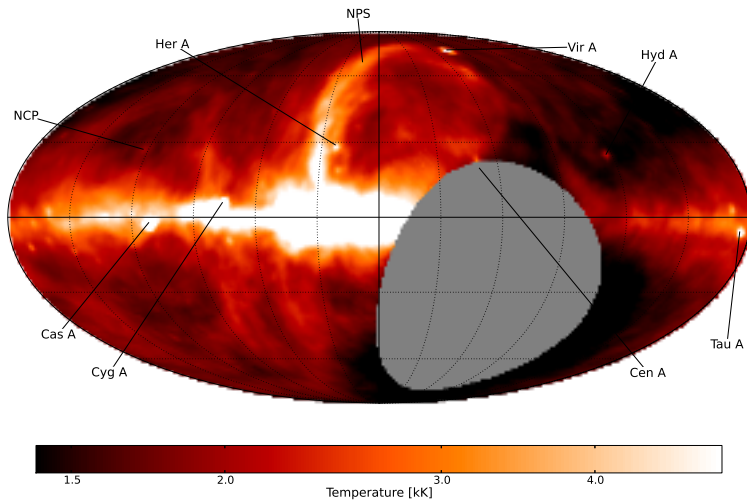
Data combination at low-frequencies

Measure the total power using a dipole equipped with a noise diode.



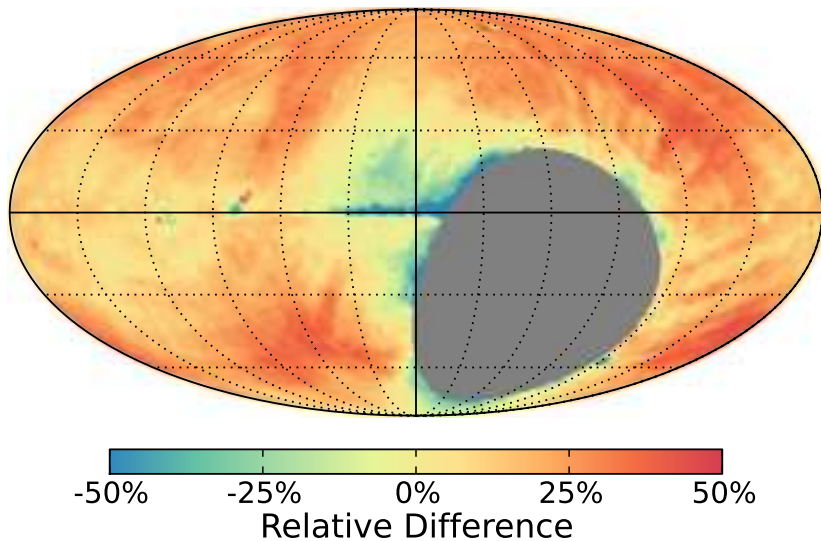
Data combination at low-frequencies





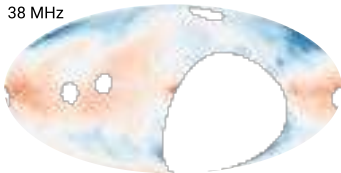
Dowell+2017 74 MHz map

Comparisson with the GSM (de Oliveira-Costa+2008)

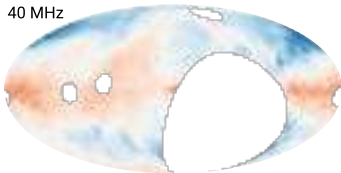


LWA1 vs LWA-OVRO

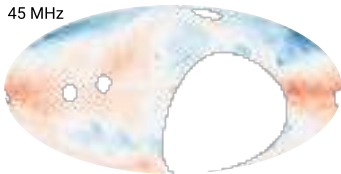
38 MHz



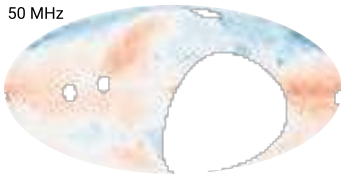
40 MHz



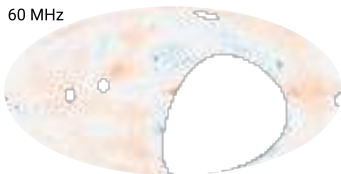
45 MHz



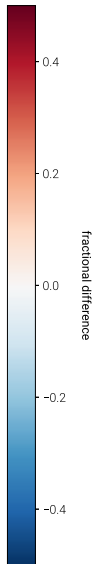
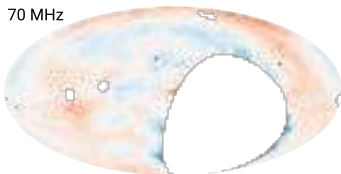
50 MHz



60 MHz

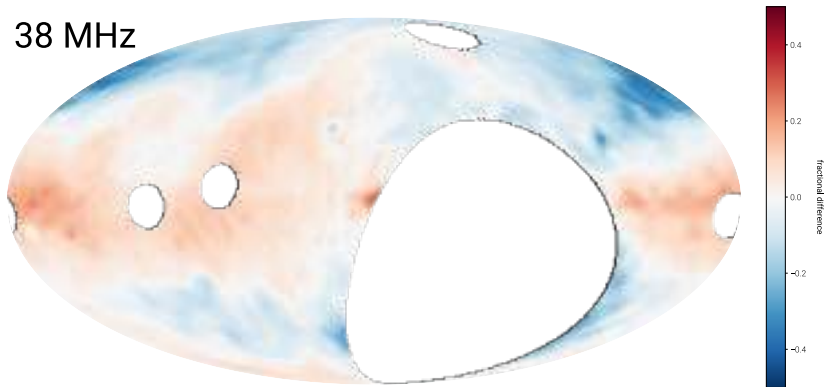


70 MHz



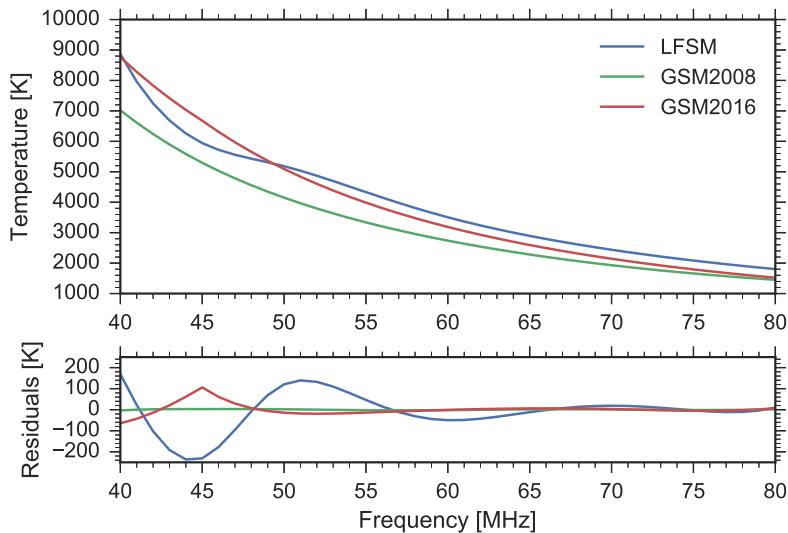
LWA1 vs LWA-OVRO

38 MHz



Eastwood+2017

GSM comparison



Existing total power maps

- ▶ Significant fraction of flux on scales $\leq 0.5\lambda$.
- ▶ Total power needs filled array or single dipole observations.
- ▶ Different global sky models have differences of $\approx 30\%$ at low frequencies.

Image combination

- ❶ Image inteferometer data taking into account W and A terms.
- ❷ Interpolate the total power data in frequency to match the interferometric.
- ❸ Combine using your favorite algorithm (e.g., feather).

Image combination

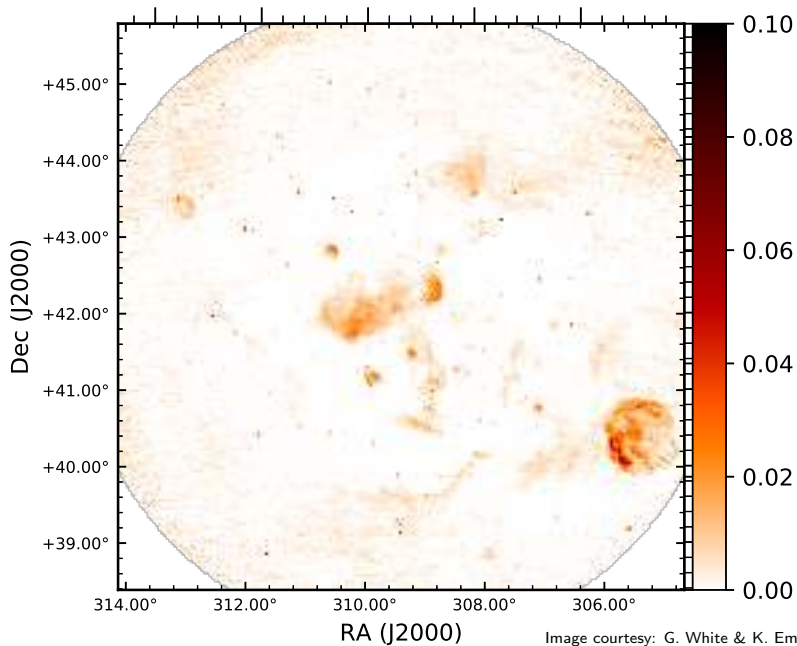
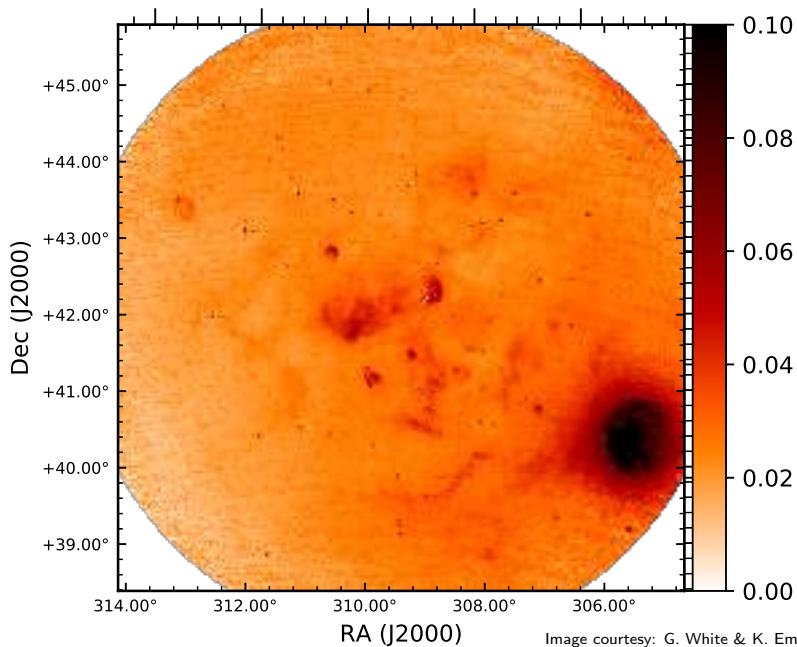


Image combination



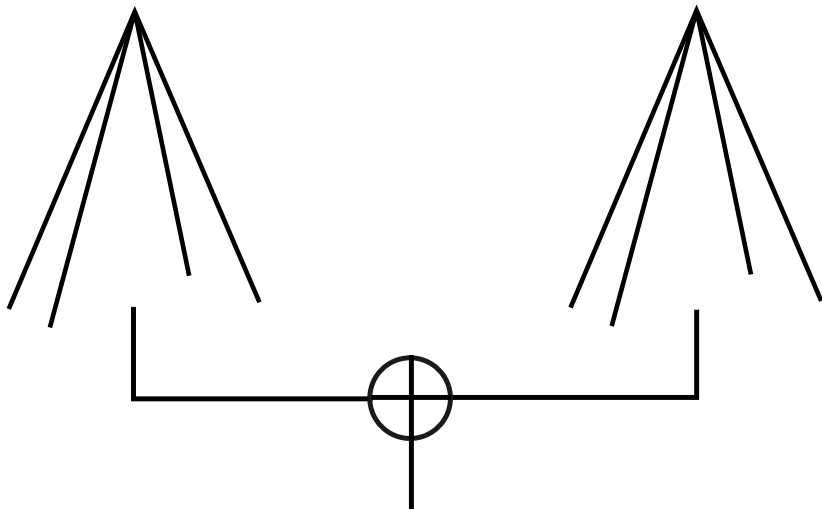
Joint deconvolution

- Great tools being developed in CASA.
- How do we handle the A-term in CASA?

Summary

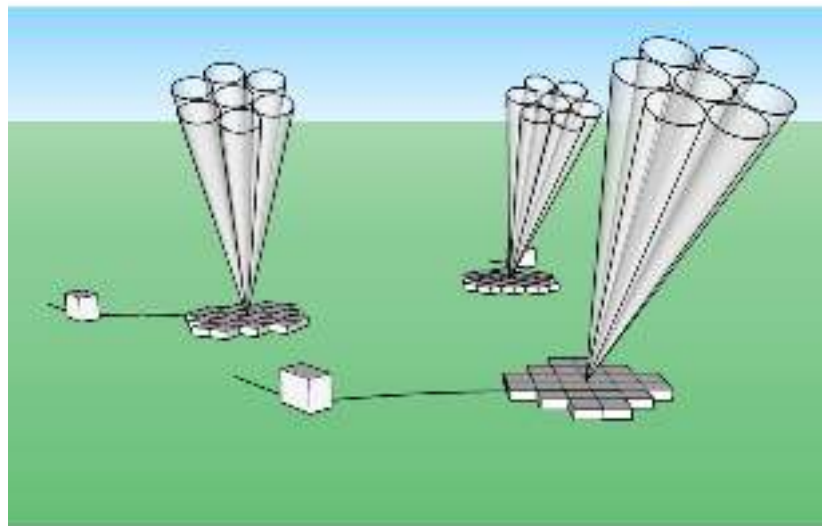
- Existing low-frequency total power maps can be used to measure the zero spacing.
- Image combination seems like a viable option.
- We need to explore joint deconvolution.

Beam forming as an alternative

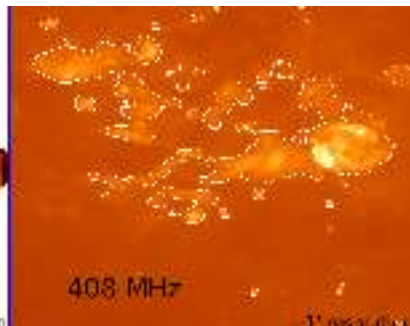
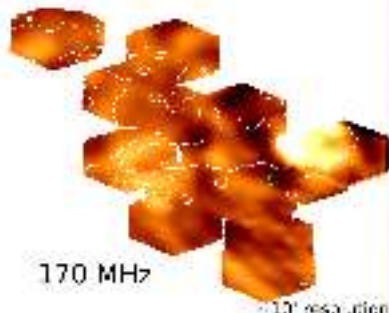


Form a phased array instead of an interferometer.

Beam forming as an alternative



Beam forming as an alternative



Beam forming as an alternative

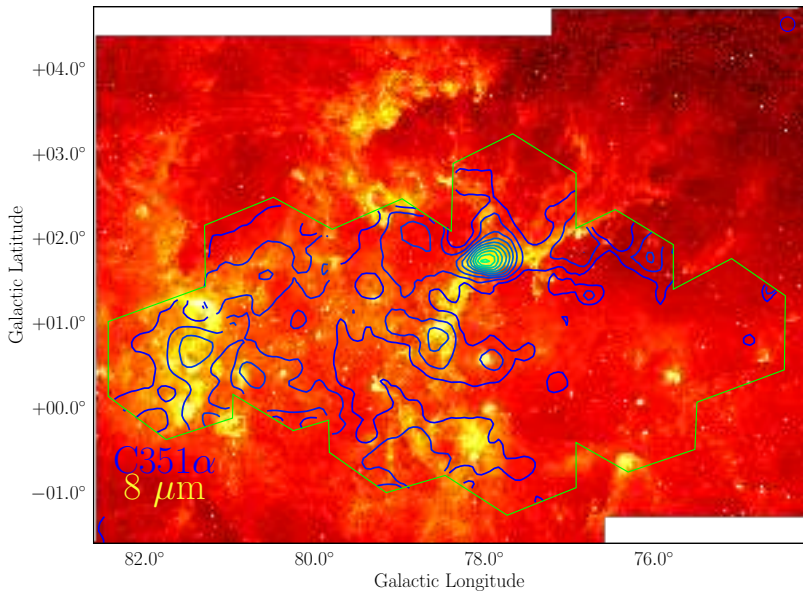


Image courtesy: J. B. R. Oonk