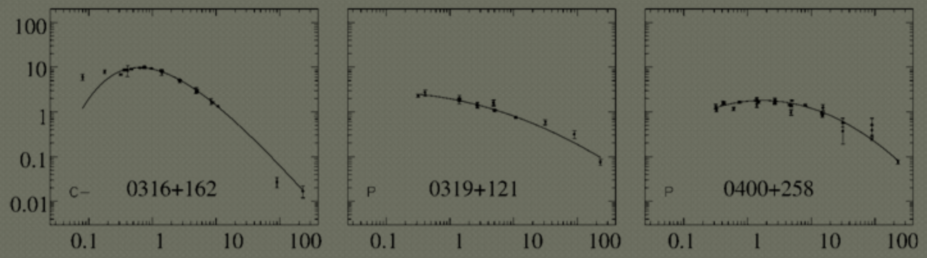


The quest for peaked spectrum sources with LoFAr

Tjibaria Pijloo
Leiden University
pijloo@strw.leidenuniv.nl

Supervisor astronomy: Huub Röttgering
Supervisor physics: Maarten de Jong

Overview

- LOFAR Radio Telescope
- Scientific context
- Aim of research
- Observation
- Research method
- Results
- Conclusion

LOFAR Radio Telescope (1)

- LOFAR characteristics
  - International Radio Telescope in The Netherlands
  - Unexplored frequency range: 10 – 240 MHz
  - Interferometer of HBA and LBA antenna stations (instead of array of single dish telescopes)

LOFAR Radio Telescope (2)

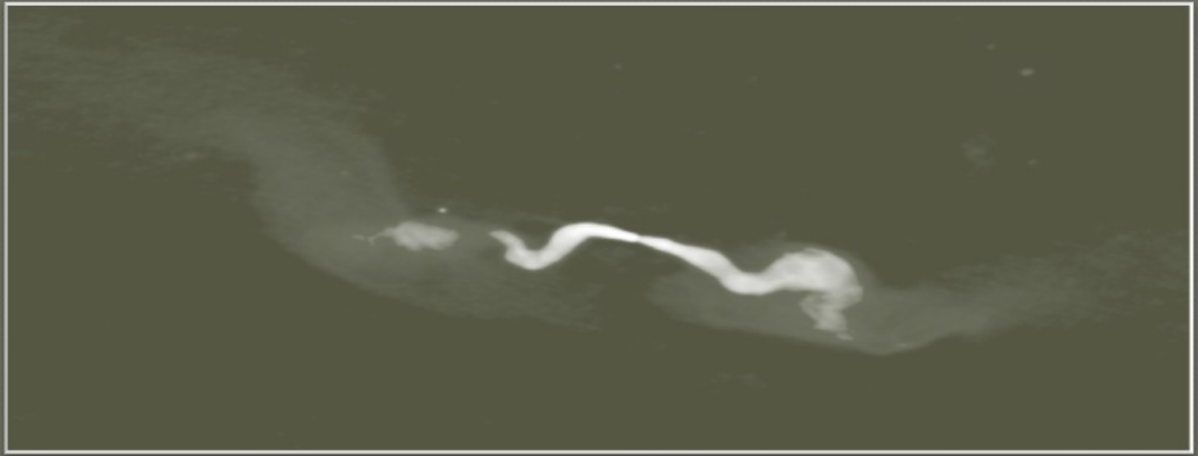
LOFAR characteristics:

- Antenna stations are stationary (not-movable parts) and station/interferometer beam is formed electronically
- At the moment 26 stations are online (18 CS, 6 RS and 2 IS)
- With its high resolution (better than 1” at 240 MHz) and its superb sensitivity, LOFAR will be sensitive to possibly the most distant CSS and GPS sources (Snellen et al. 2008)

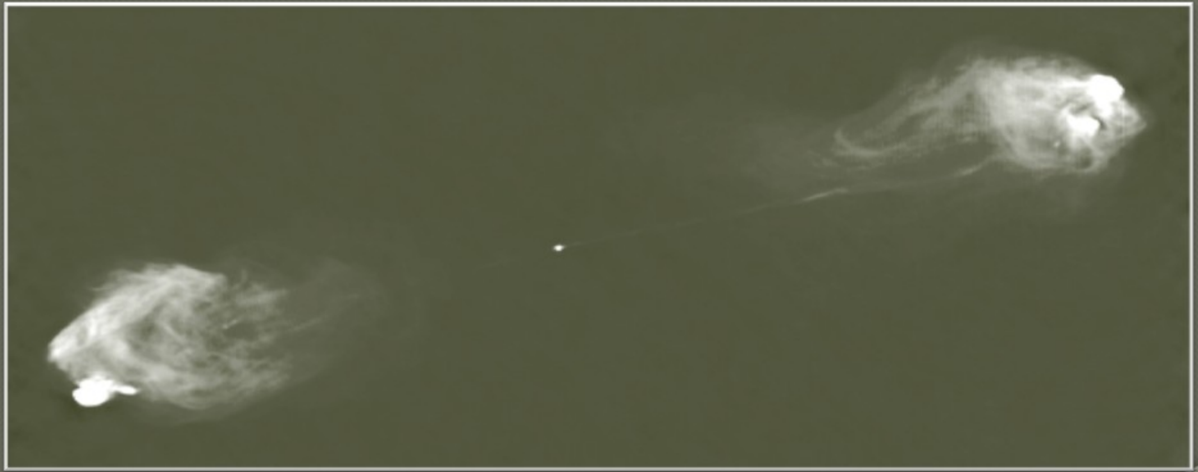
Scientific context (1)

Large powerful radio sources

- FR I
  3C31
  ~400 kpc

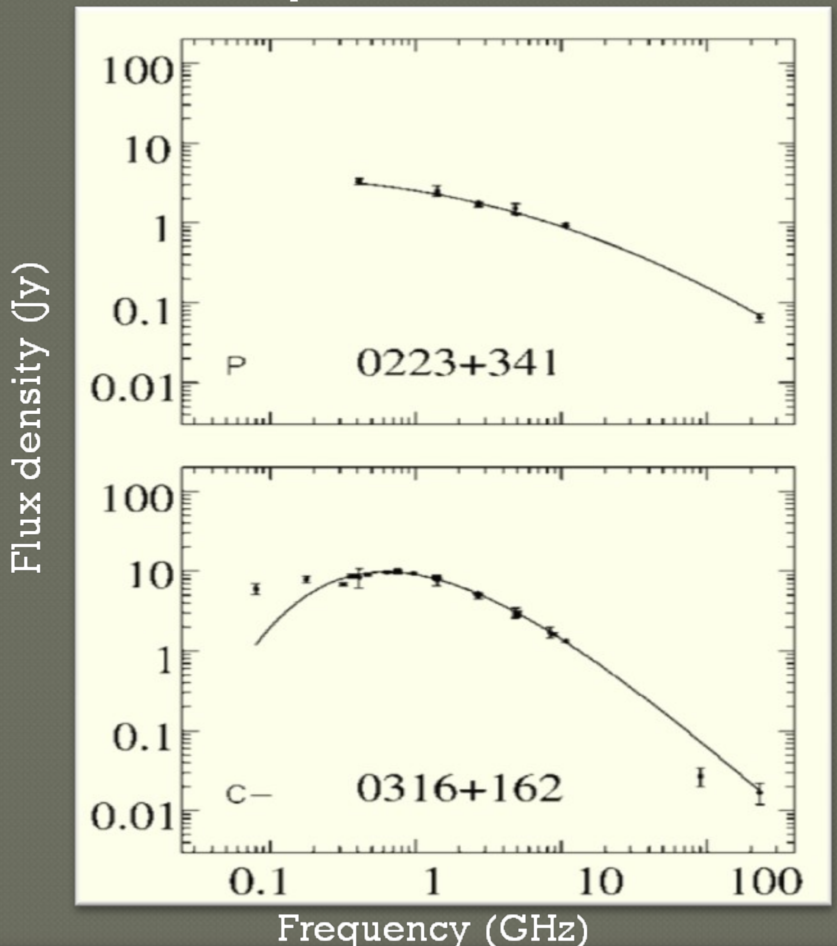


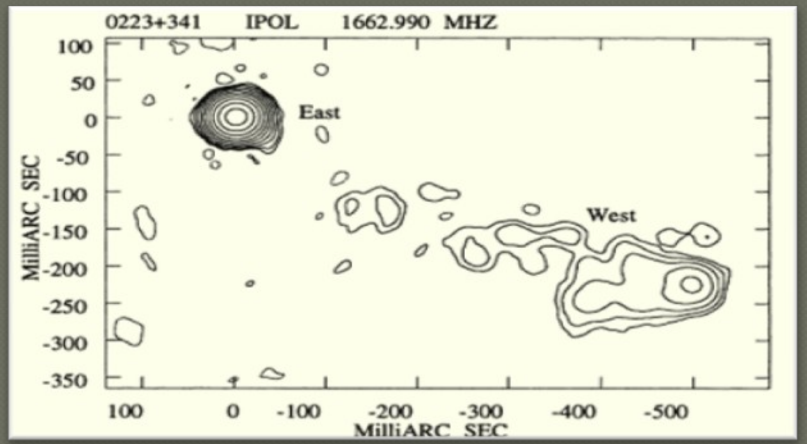
- FR II
  Cygnus A
  similar size

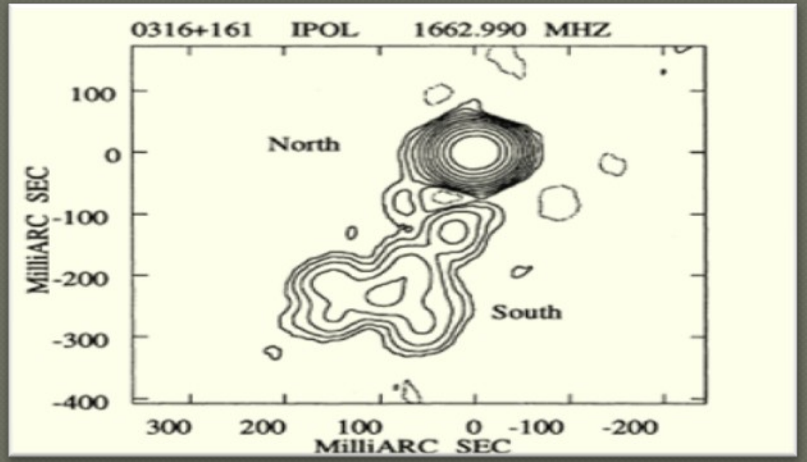


Scientific context (2)

Small powerful radio sources: GPS and CSS







Scientific context (3)

Small powerful radio sources: GPS and CSS

	CSS	GPS
Percentage of radio pop.	30%	10%
ℓ (kpc)	1-20	<1
ν_{peak} (GHz)	<0.5	0.5-10

Characterized by peaked spectrum

If peak is caused by SSA:

$$\nu_{peak} \sim 8 B^{1/5} S_m^{2/5} \theta^{-4/5} (1+z)^{1/5} GHz$$

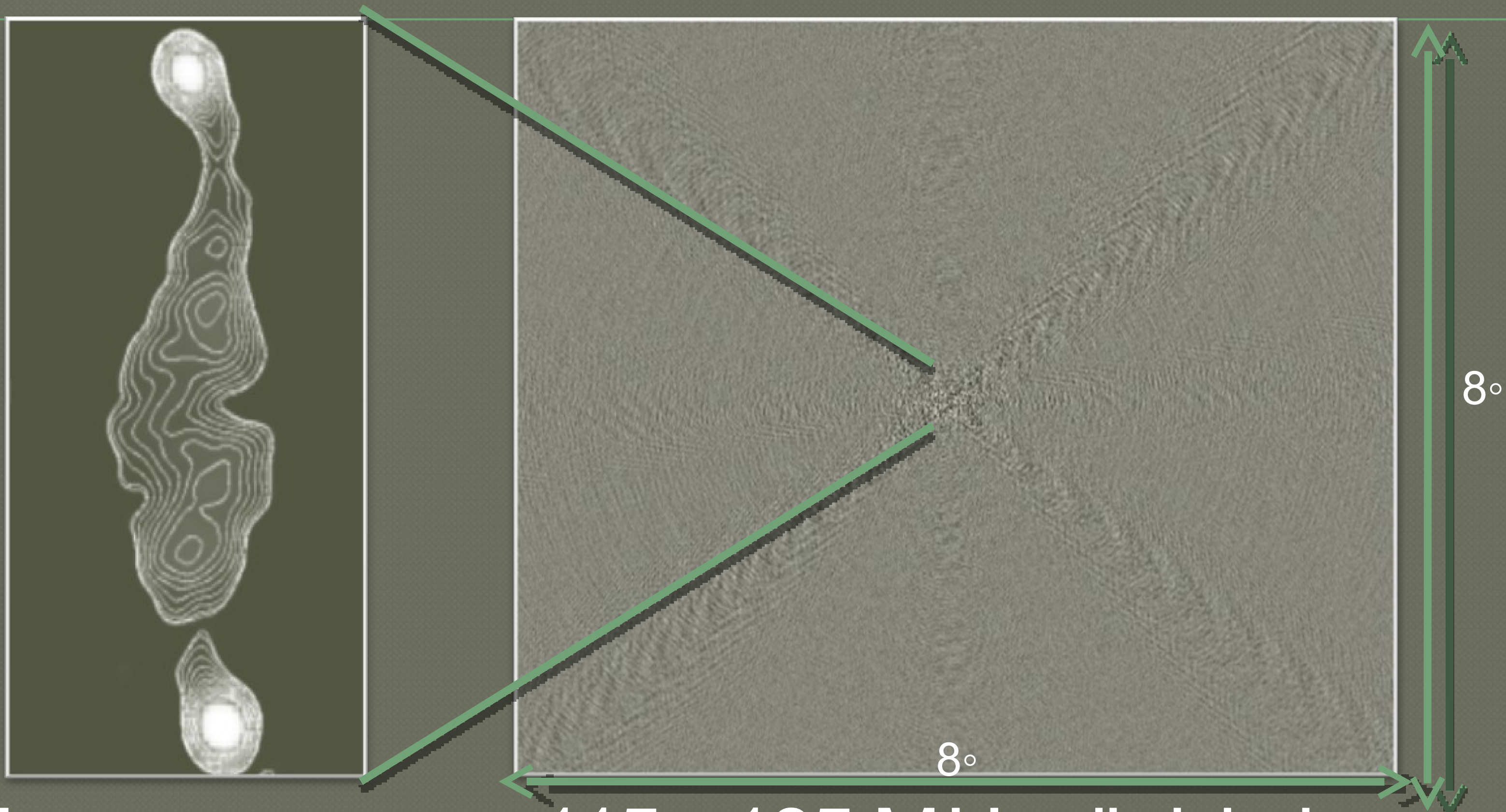
Scientific context (4)

CSS/GPS sources are (most likely) young radio sources, which will eventually evolve into large radio sources (FRI/FRII):

- High expansion velocities found, indicating GPS ages of 10^2-10^3 yr
- Both statistical and analytic knowledge of them provides key information about the origin and evolution of powerful radio sources.

Preliminary LOFAR research on CSS sources

Observation



Frequency range 115 - 185 MHz divided over 62 SBs (24h (3s int.) & 60h (3s int.) observations)

Aim of research

- Make a radio spectrum per source
- Find the number of CSS in the LOFAR field
- Scientific aim:

  - Peak analysis:
    Does SSA cause the peakedness?

  - Statistics:
    # CSS as function of ν_{peak}

Research method (1)

- Data reduction:
  Flagging and compressing data with DPPP

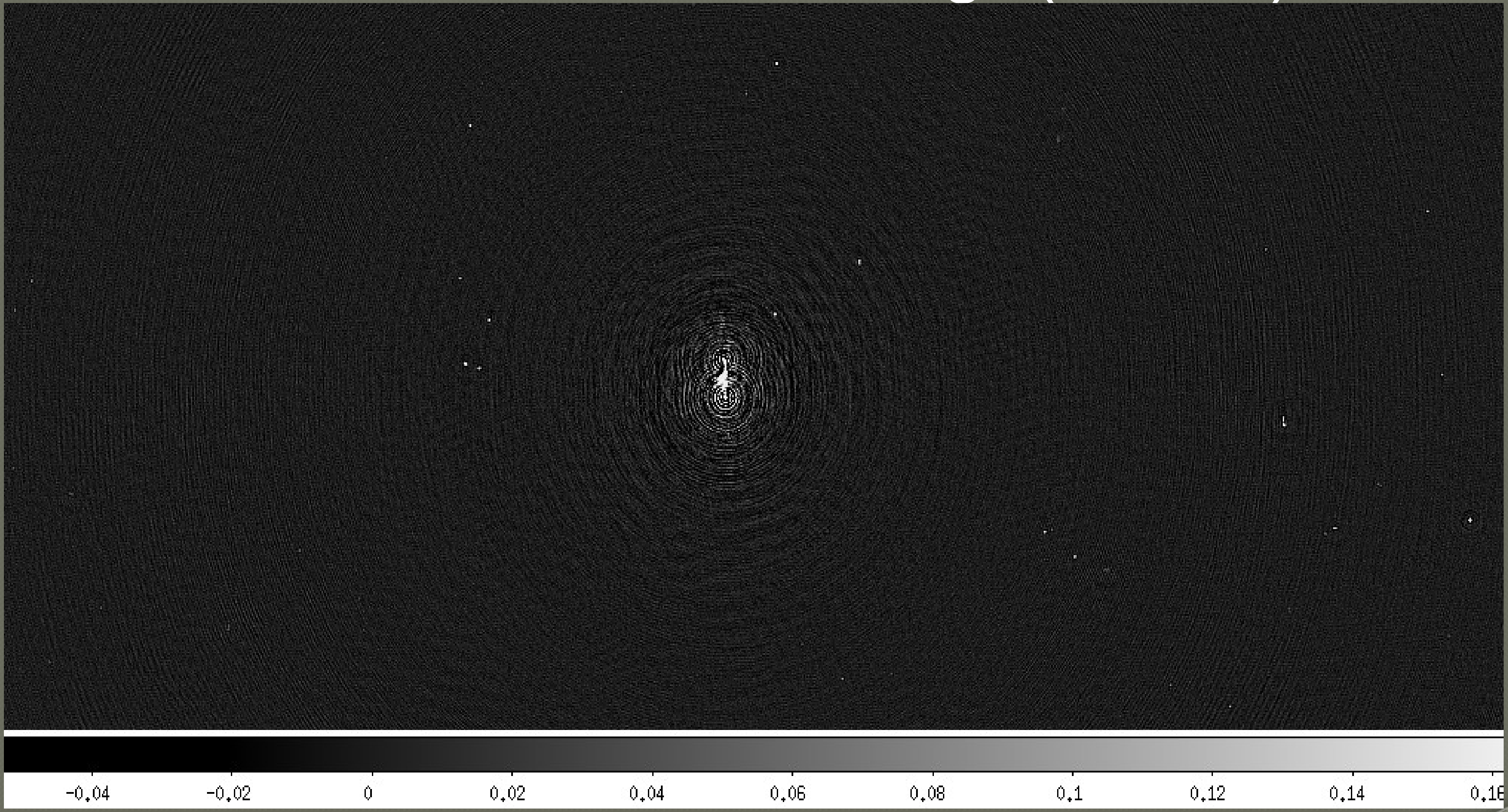
- Calibration:
  Phase and amplitude gain calibration and self-calibration cycles with BBS

Research method (2)

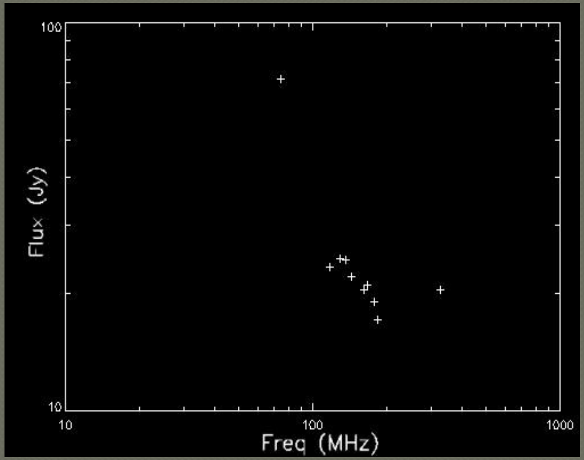
- Retrieving results:
  Imaging with CASA, source detection and making spectra with BDSM
- Analysis:
  - Determining # CSS sources
  - Fitting SSA formula to their spectra to constrain the mechanism behind their convex spectra

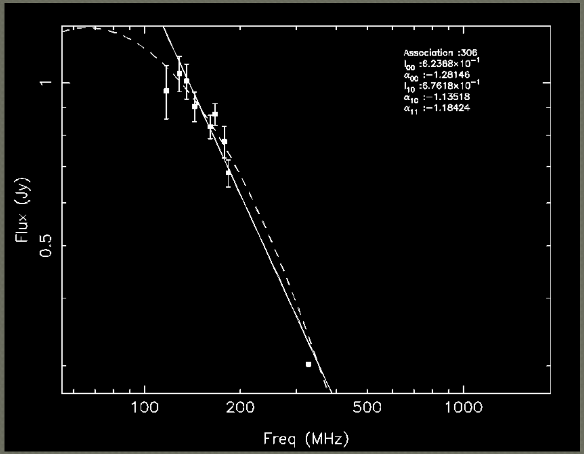
Results (1)

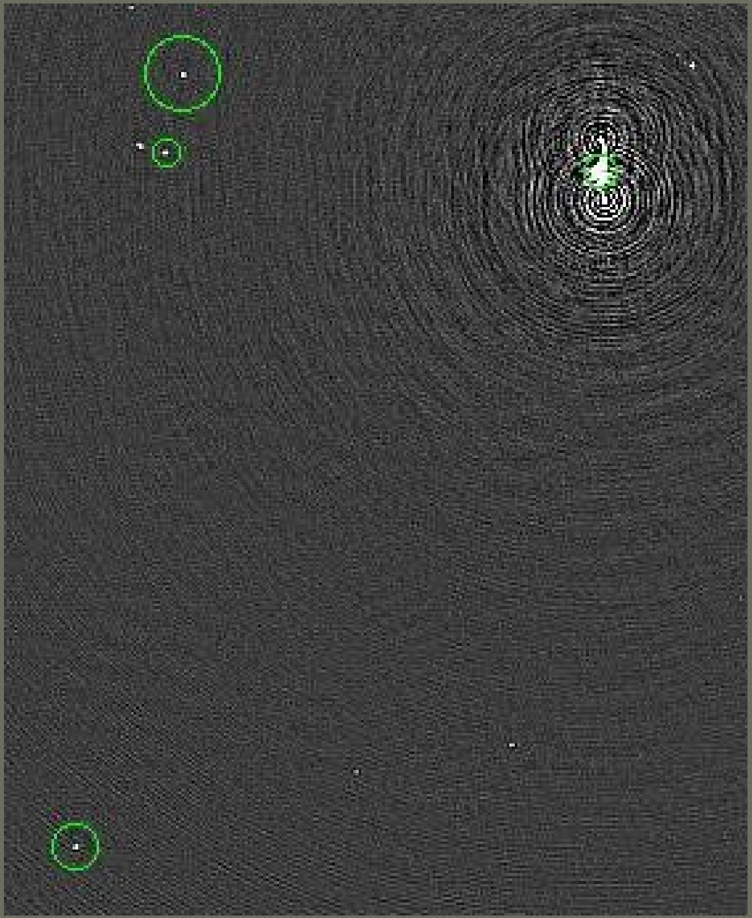
- Central subfield of final image (39 SBs)



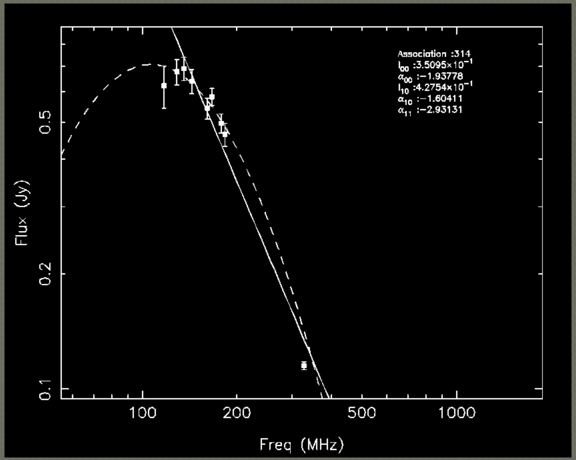
Results (2)


100
10
Flux (Jy)
10
100
1000
Freq (MHz)

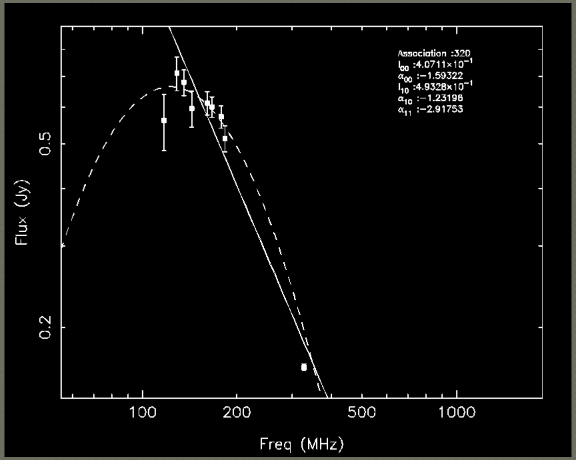

Association :306
I_{00} :6.2388×10^{-1}
α_{00} :−1.28146
I_{10} :6.7618×10^{-1}
α_{10} :−1.13518
α_{11} :−1.18424
1
0.5
Flux (Jy)
100
200
500
1000
Freq (MHz)



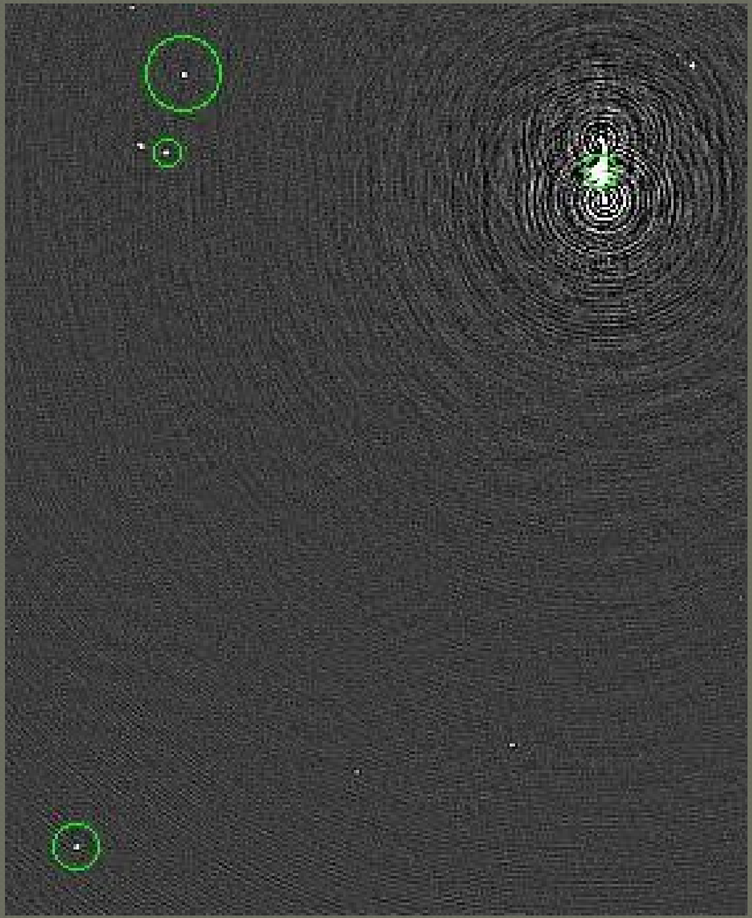
Results (3)



Association :314
I_{00} :3.5095×10^{-1}
α_{00} :−1.93778
I_{10} :4.2754×10^{-1}
α_{10} :−1.60411
α_{11} :−2.93131
Flux (Jy)
0.1
0.2
0.5
100
200
500
1000
Freq (MHz)



Association :320
I_{00} :4.0711×10^{-1}
α_{00} :−1.59322
I_{10} :4.9328×10^{-1}
α_{10} :−1.23196
α_{11} :−2.91753
Flux (Jy)
0.2
0.5
100
200
500
1000
Freq (MHz)



Conclusion

- LOFAR data is good in terms of sensitivity
- Beam correction not present in calibration yet, which makes identifying CSS sources not possible at this stage
- Once beam correction is implemented in the LOFAR calibration pipeline, LOFAR will do extremely well in the quest for peaked spectrum sources, due to great sensitivity and resolution

Contact information

Tjibaria Pijloo
pijloo@strw.leidenuniv.nl
www.strw.leidenuniv.nl
Sterrewacht Leiden

Leiden Institute of Physics