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Interferometric Imaging of Type III Bursts in the Solar Corona

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Outline

- Motivation
- Observation
- Interferometric Imaging
- “Results”

Science Questions

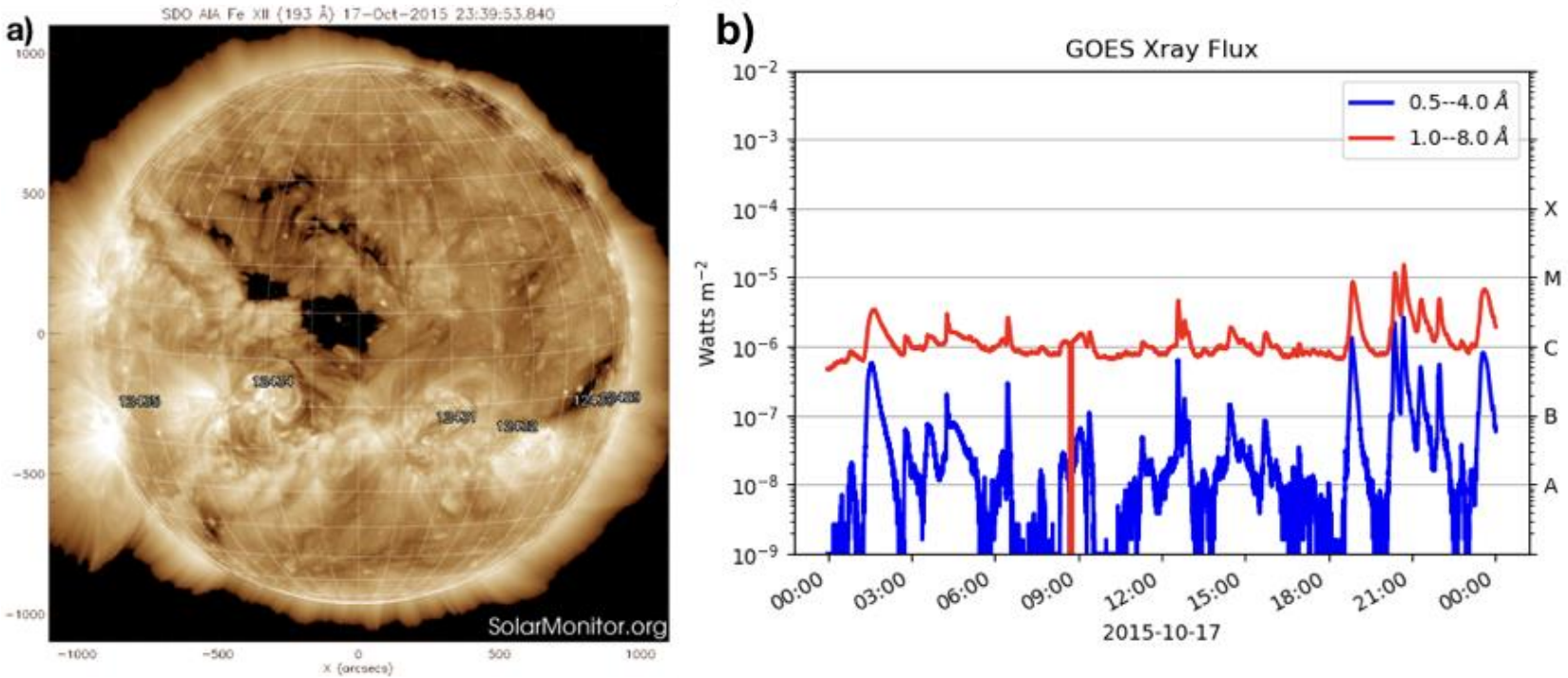
- Can radio scattering in the corona be constrained with LOFAR?
- What effect do imaging algorithms have on results?
- Can the source be fitted from visibility data.

Observation

- Type III burst on 2015-10-17 from 13:21UTC
- Observed with LOFAR core and remote stations
- 86 km baseline, sub-arcminute resolution (~ 22 arcseconds at ~ 30 MHz)

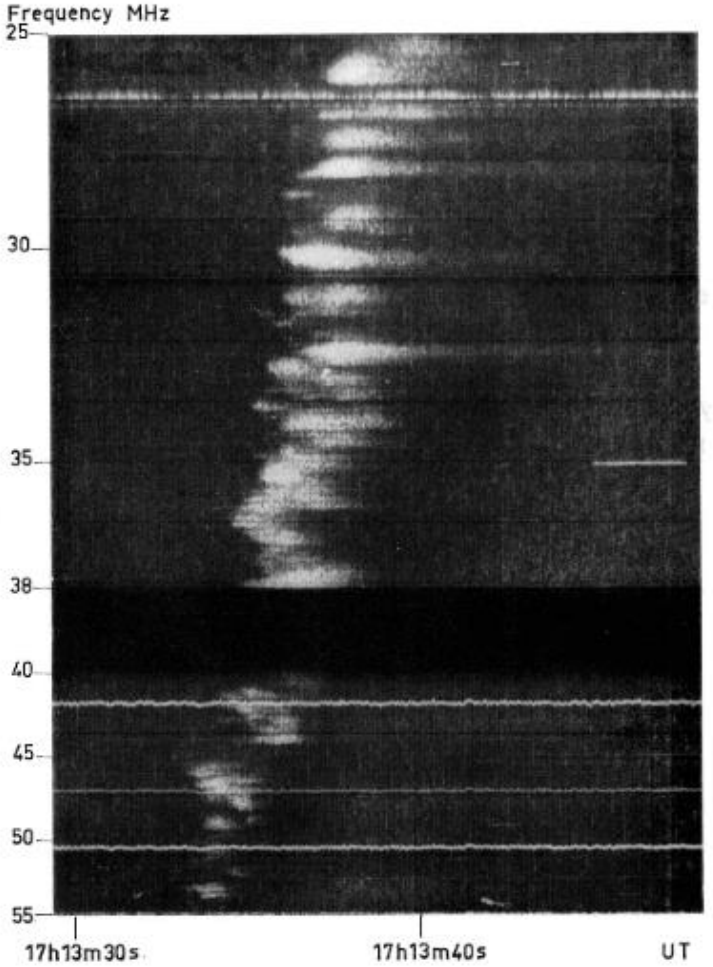
Observation

The Sun on 2015-10-17

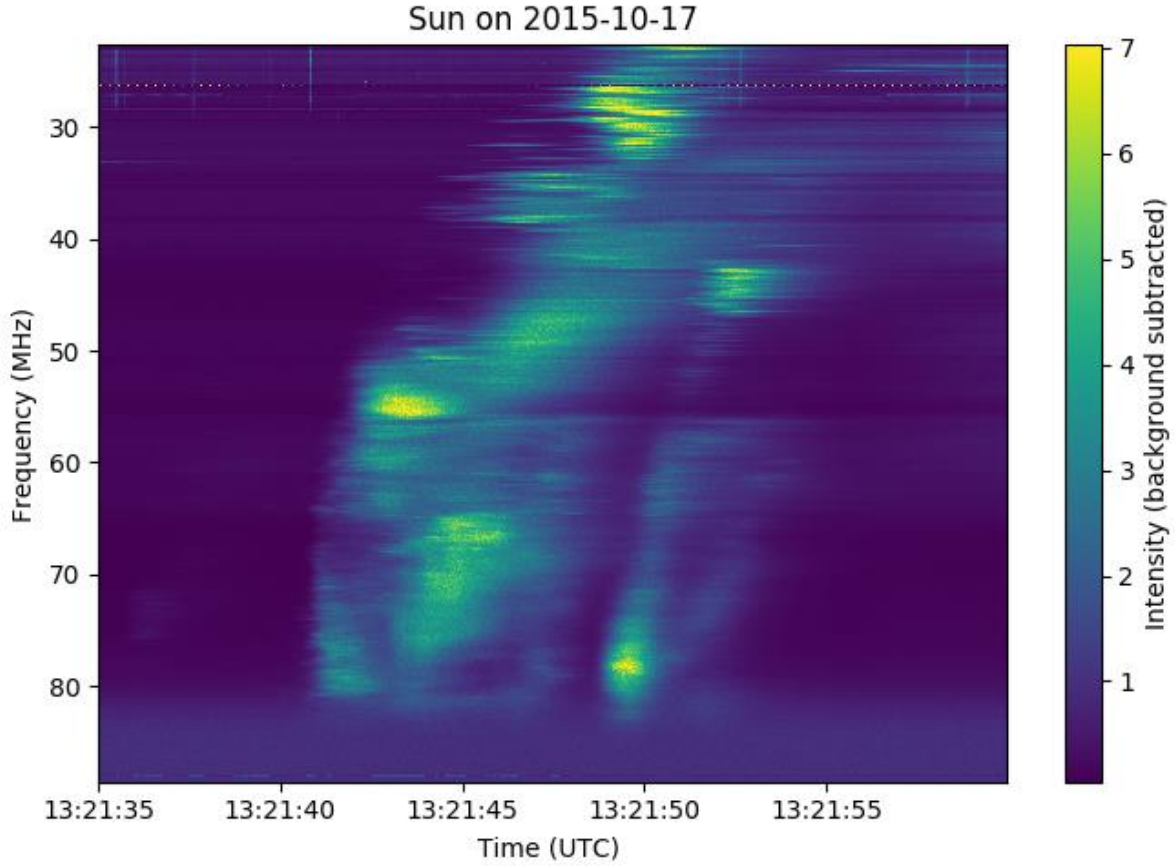


Type IIIb bursts

- First described by de La Noe and Boischot (1972)
- Multiple striations in an envelope
- Overdense regions in corona (Takakura and Yousef, 1975)
- Order of magnitude for source size



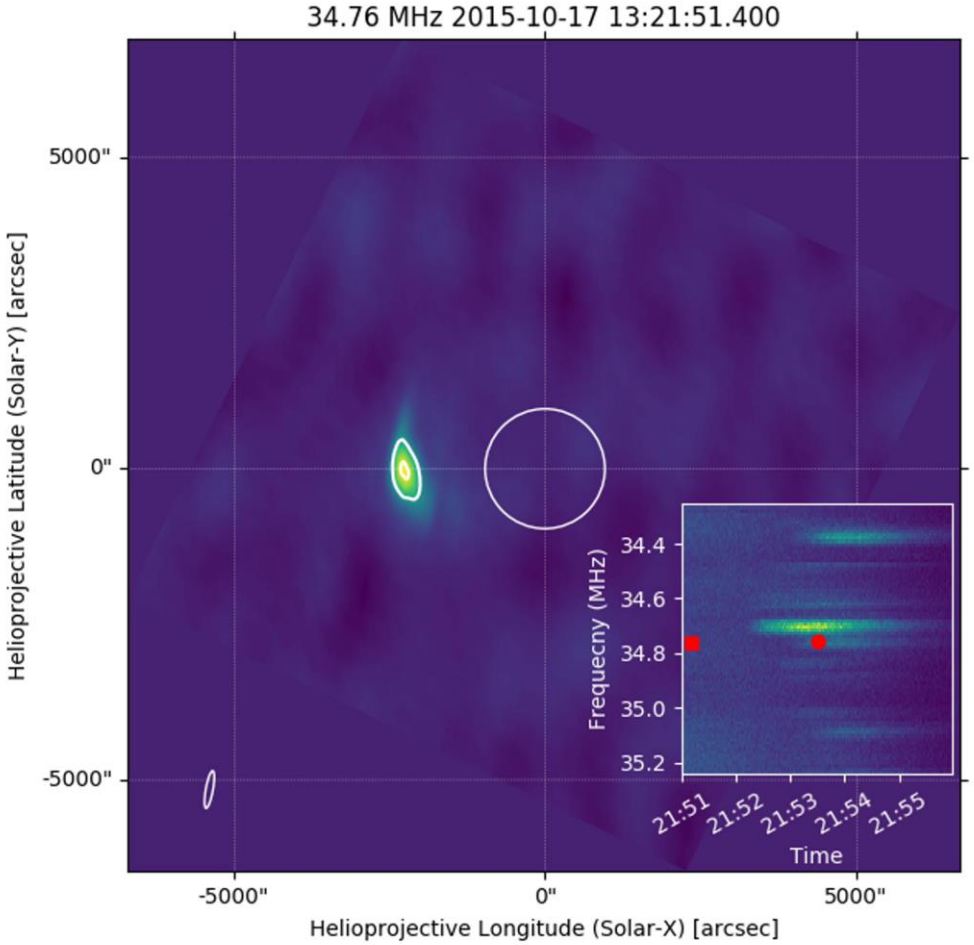
Observed burst



Imaging Striae

```
(int3) murphp30@lofar:/mnt/murphp30_data/typeIII_int$ wsclean -j 36 -mem 85 -no-reorder -no-u
pdate-model-required -weight briggs -1 -mgain 0.8 -size 1910 1910 -scale 5.2338asec -pol I -da
ta-column CORRECTED_DATA -auto-threshold 3 -beam-fitting-size 4 -interval 77138 77158 -interv
als-out 20 -use-differential-lofar-beam -fit-beam -make-psf -niter 5000 -name striae/clicks2/
burst2/SB075/briggs0/wsclean-SB075 /mnt/murphp30_data/typeIII_int/L401003_SB075_uv.dppp.MS/
```

“Good” Striae



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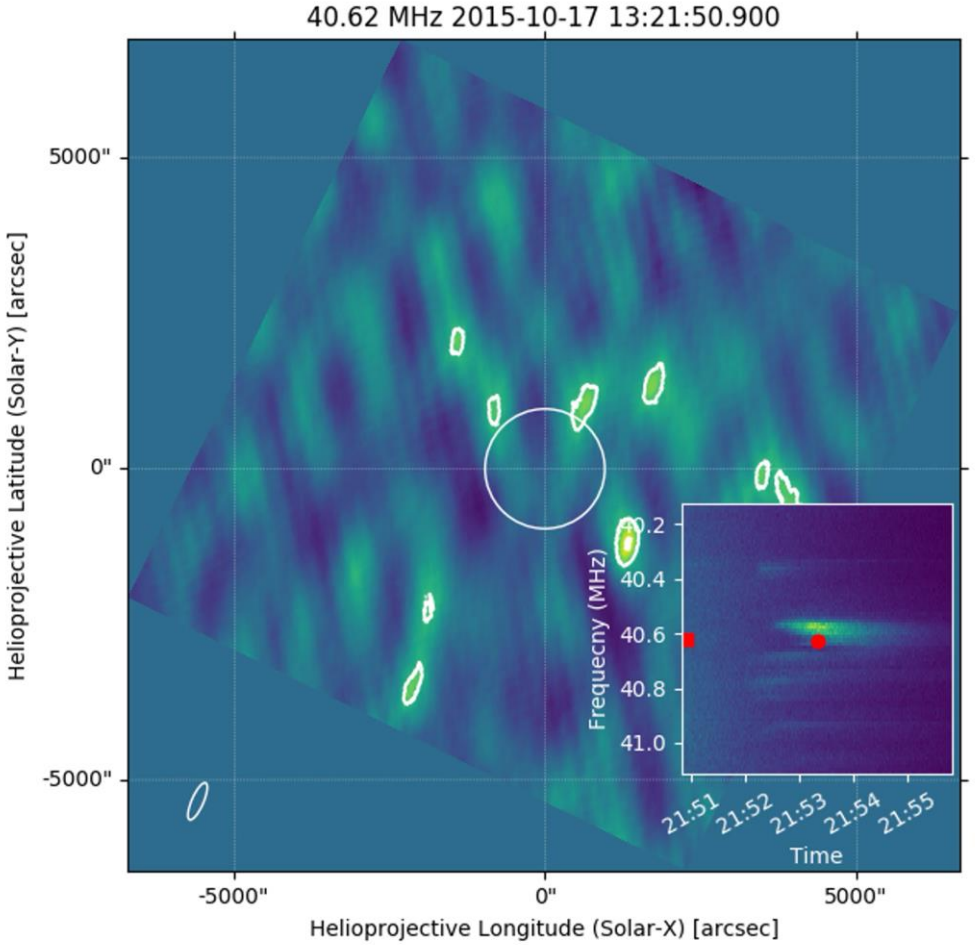
“Bad” Striae



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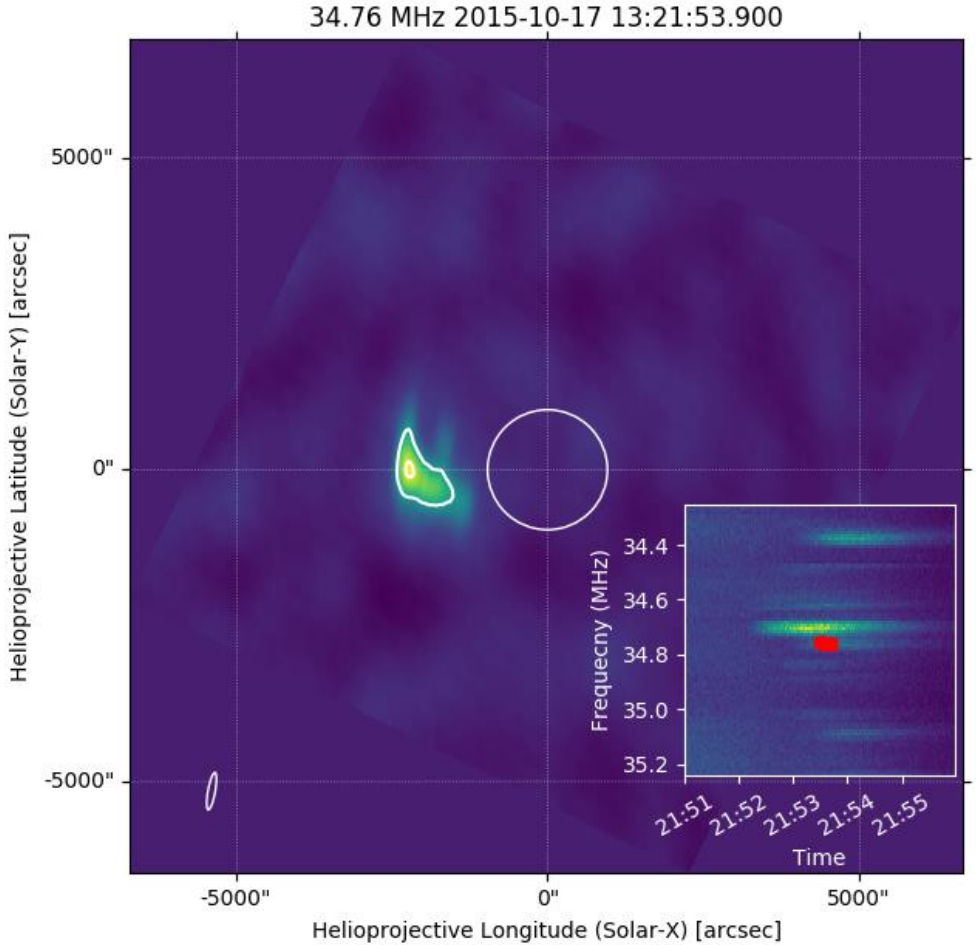
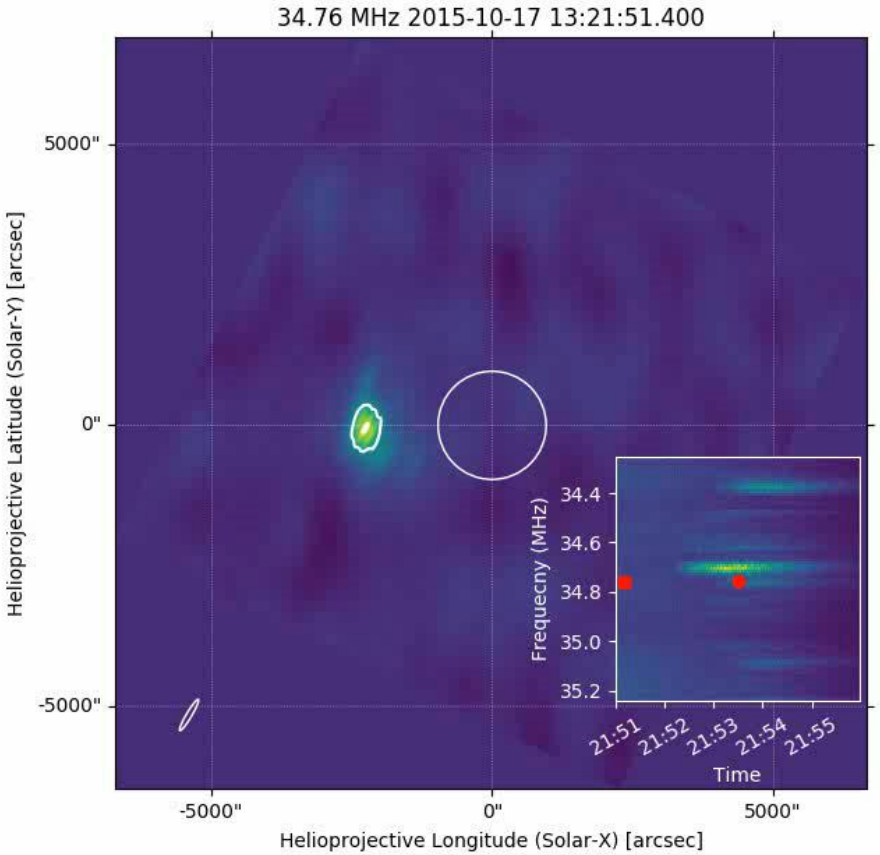
Imaged Sources

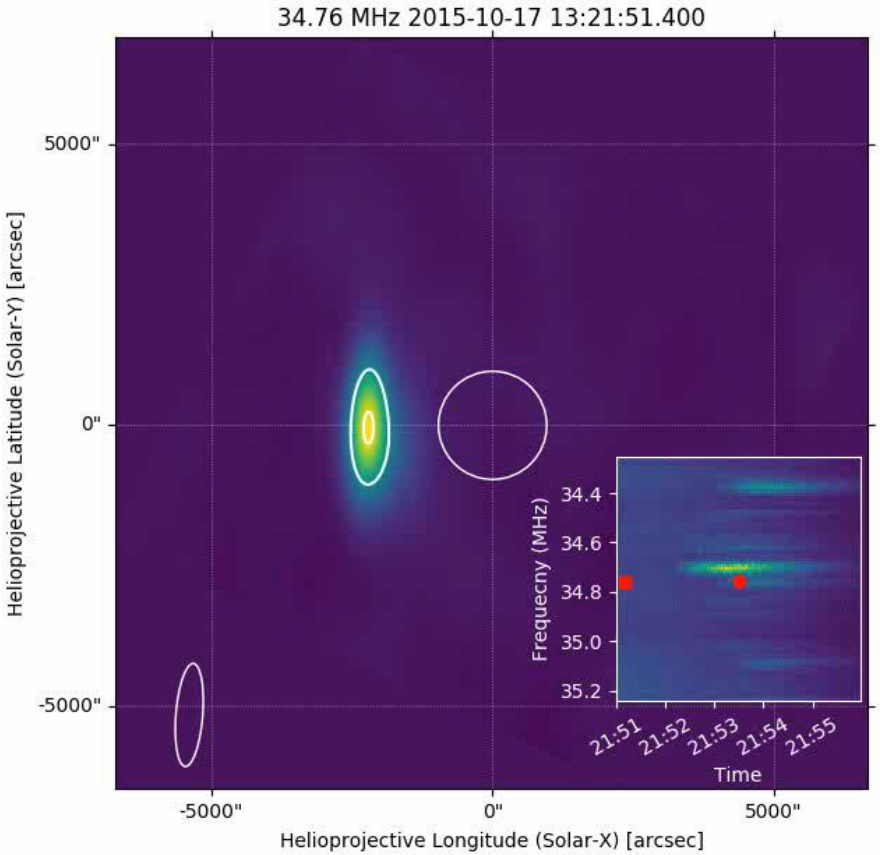
- Find area from contours
- Not necessarily gaussian
- Dynamic source
- Parameter dependent?



Briggs 0

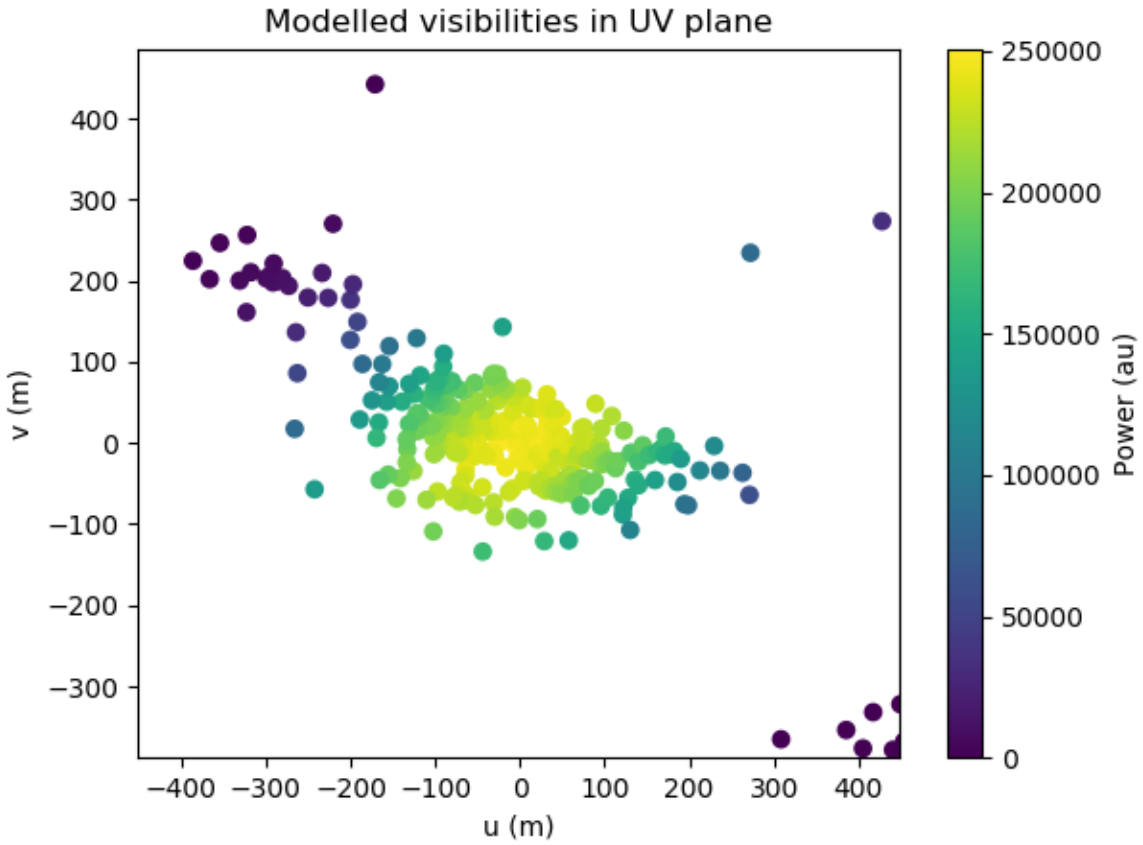


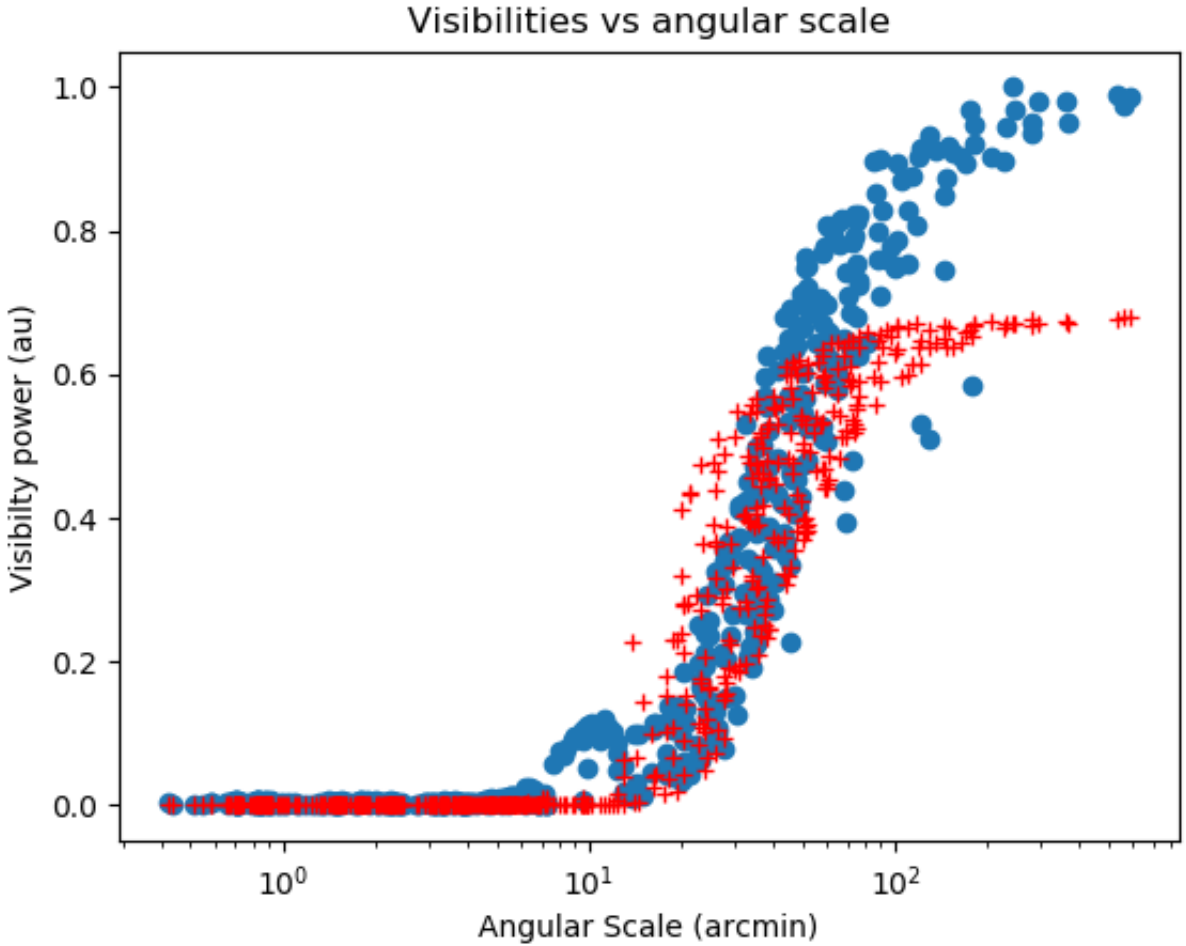
Briggs 1

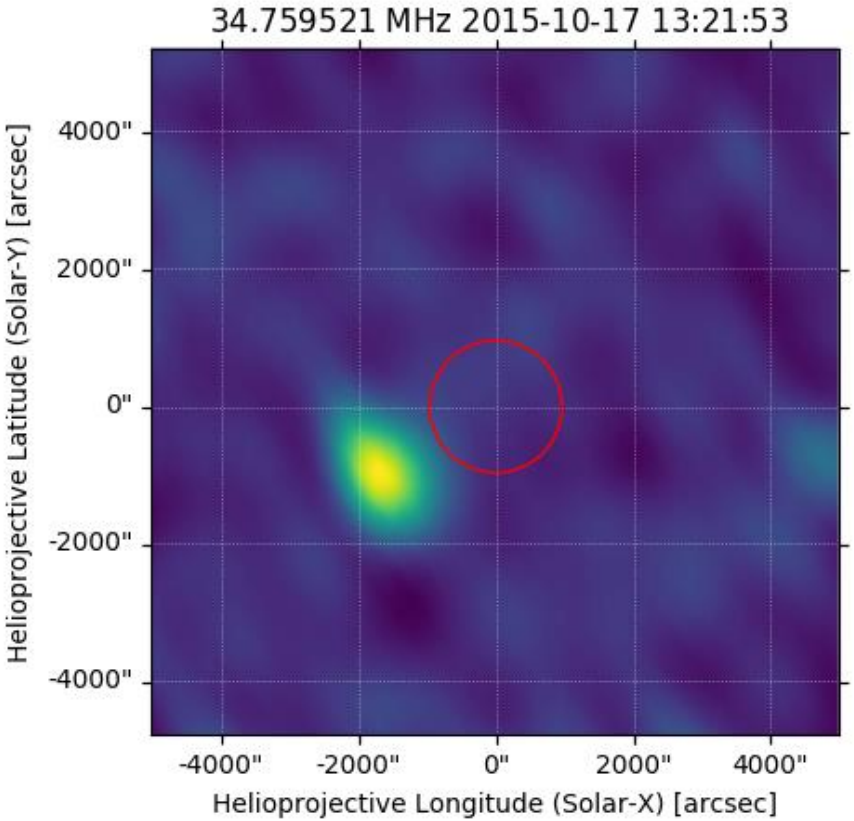


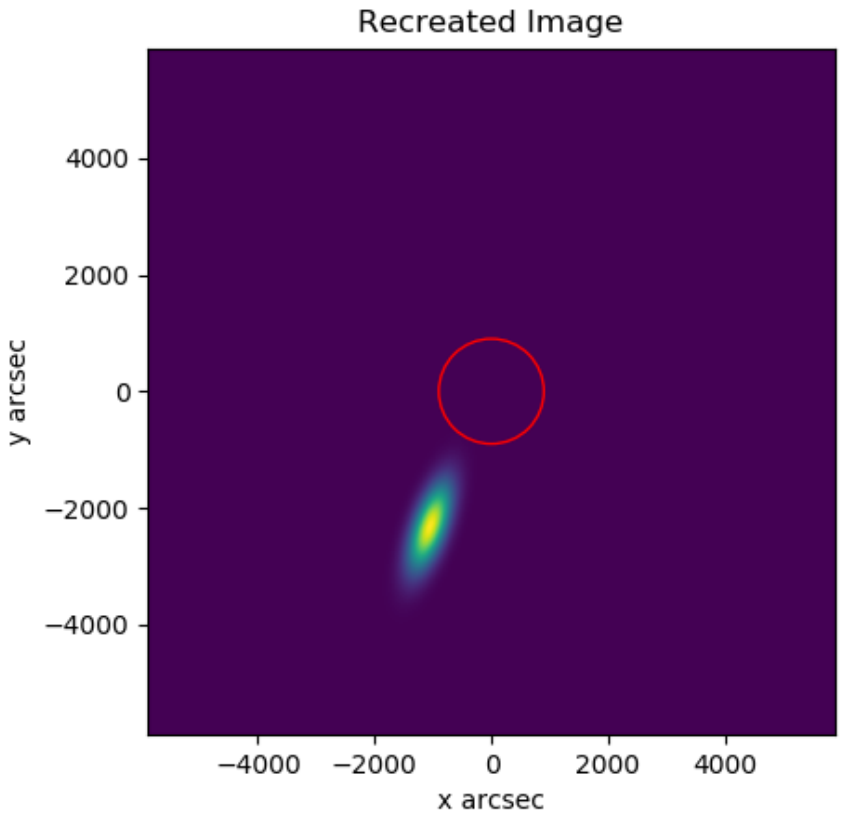
Forward Fitting Visibilities

- Assume gaussian source
- Fit Fourier transform of source (another gaussian) to visibilities
- Recreate sky brightness


Modelled visibilities in UV plane
v (m)
u (m)
Power (au)
400
300
200
100
0
−100
−200
−300
−400 −300 −200 −100 0 100 200 300 400
250000
200000
150000
100000
50000
0


Visibilities vs angular scale
Visibilty power (au)
1.0
0.8
0.6
0.4
0.2
0.0
10^0
10^1
10^2
Angular Scale (arcmin)


34.759521 MHz 2015-10-17 13:21:53
Helioprojective Latitude (Solar-Y) [arcsec]
4000"
2000"
0"
-2000"
-4000"
-4000"
-2000"
0"
2000"
4000"
Helioprojective Longitude (Solar-X) [arcsec]


Recreated Image
y arcsec
4000
2000
0
−2000
−4000
−4000
−2000
0
2000
4000
x arcsec

“Results”

- Sources approx 10 - 20 arcminutes
- Bad striae = bad calibration?
- WSClean images vary with parameters
- Visibility forward fit **almost** works

Next steps

Many, many next steps.

- Perfect visibilities forward fit
- Rigorous source size/area analysis
- Source center location + motion
- Magnetic field extrapolation