

A PAPER-32 Stokes I Sky Catalogue

Liju Philip

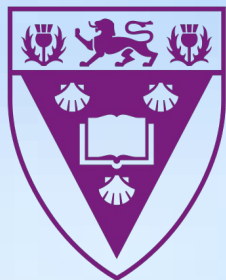
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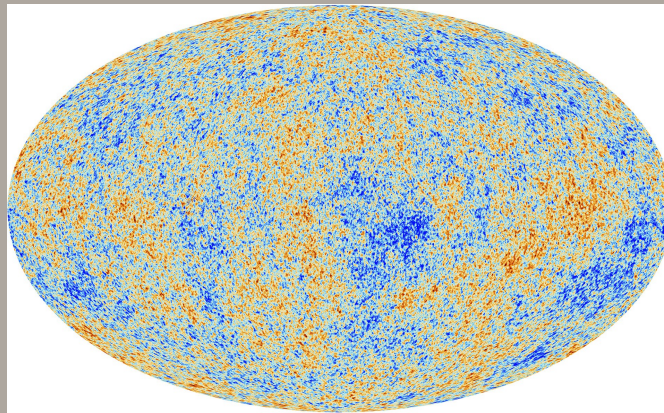
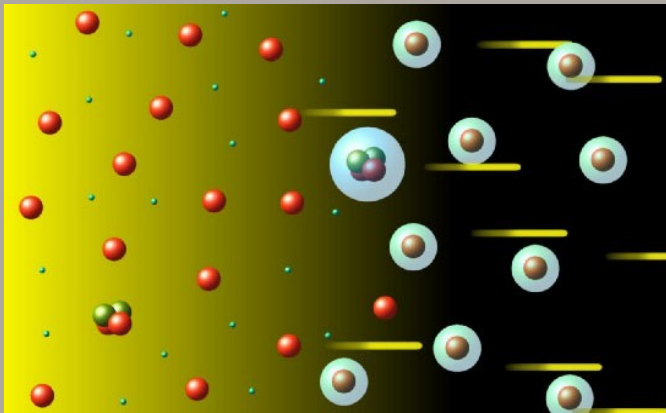
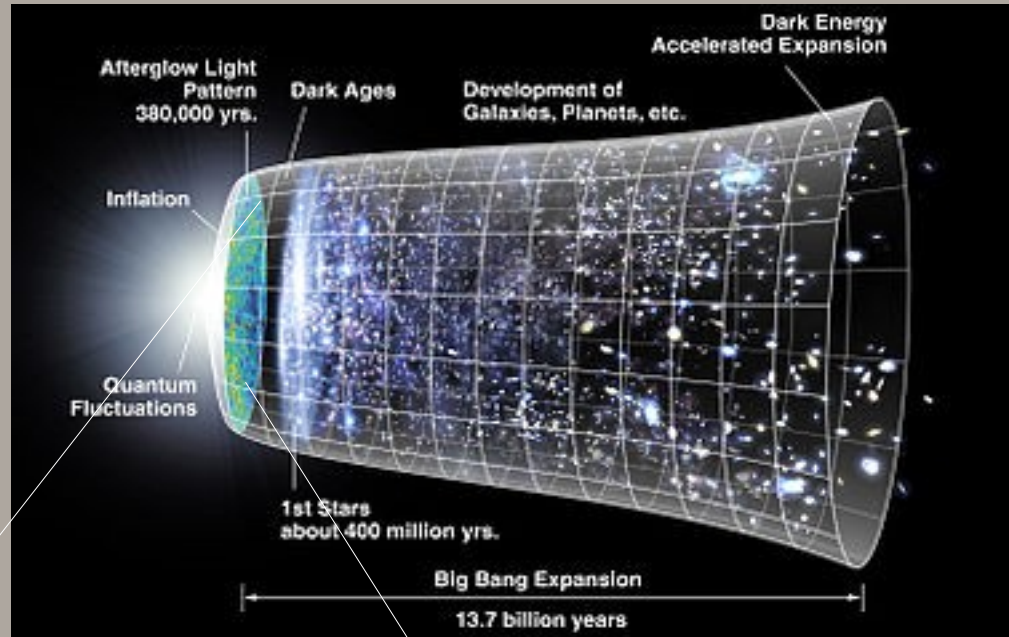
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Where leaders learn



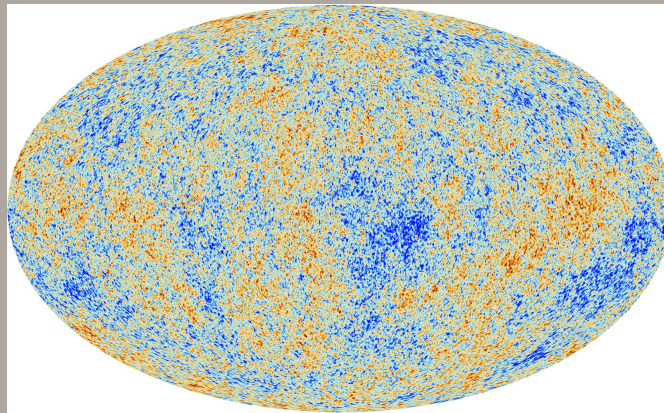
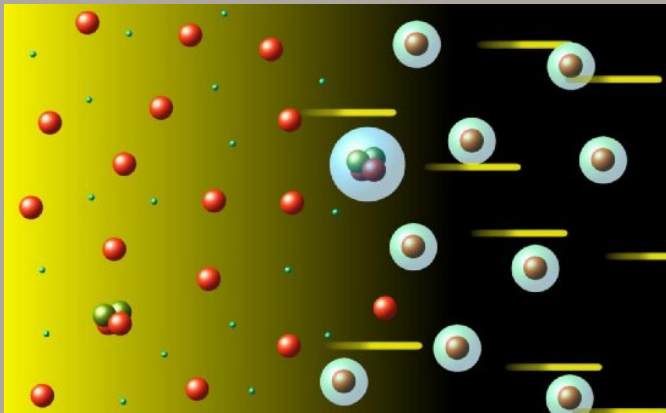
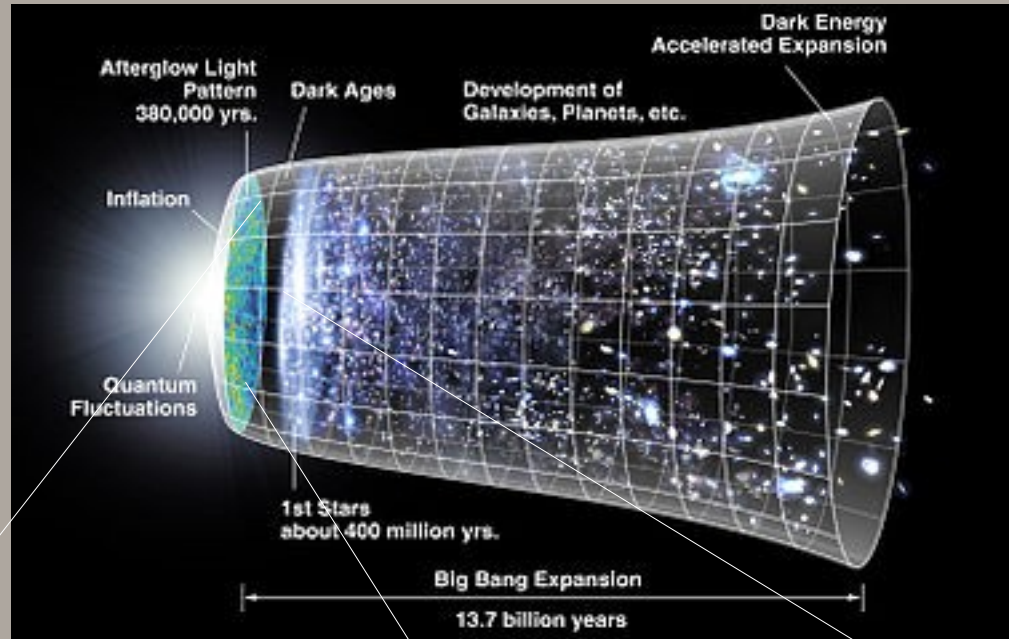
Overview

- Early universe
- Foreground Vs EoR signal
- 21 cm HI emission
- PAPER
- Snapshot imaging
- Direction independent and dependent errors
- Source extraction
- Absolute flux calibration

In the beginning...

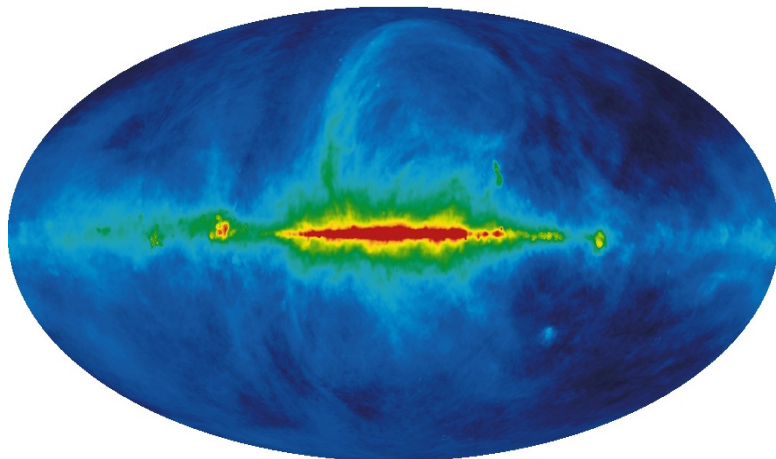
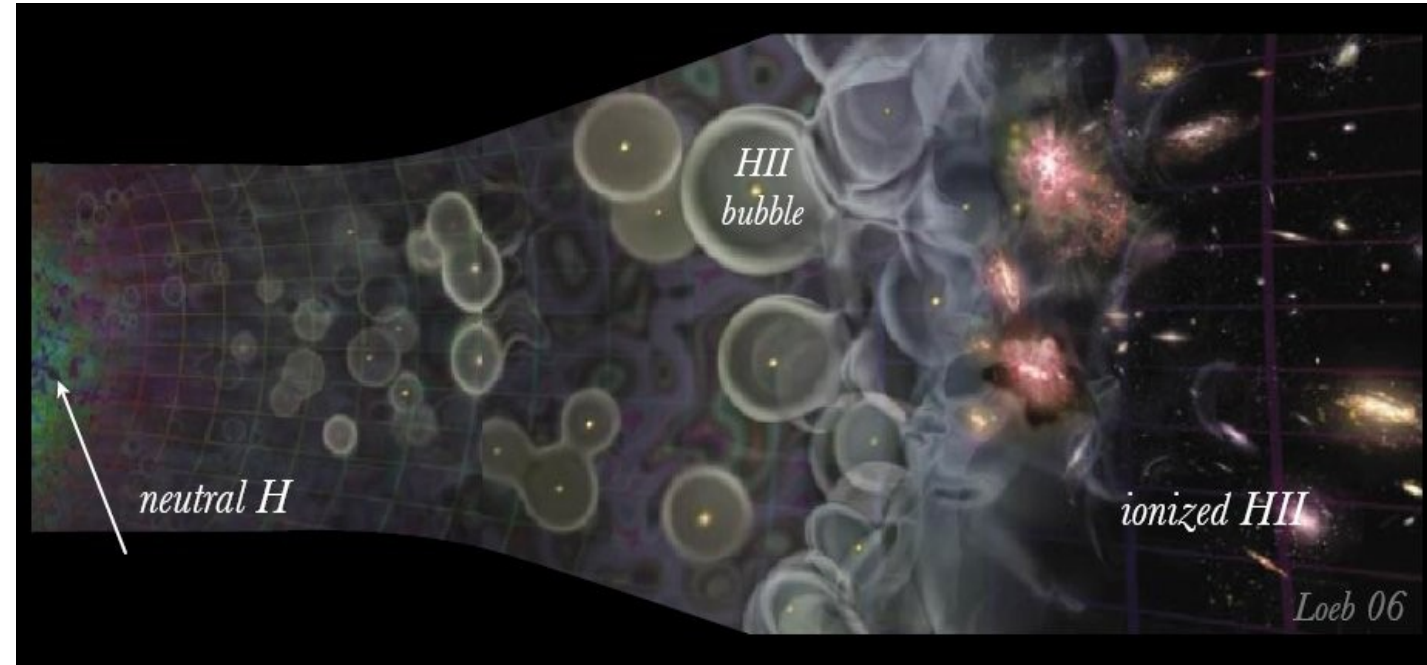


In the beginning...



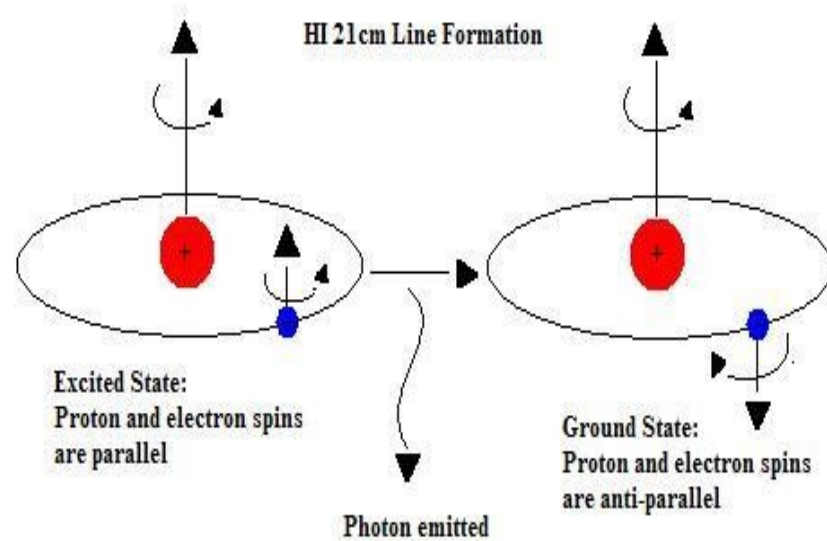
Foreground Vs EoR signal

- Presence of foreground emission that is a few orders of magnitude stronger than the 21-cm signal.



- Foreground emission contains galactic and extra galactic emission.

Probing the EoR with redshifted 21 cm HI emission



- This hyperfine transition arises due to the spin-spin interaction between the electron and the proton in hydrogen
- Extremely small transition probability of 10 million years
- Helps us to study the formation of the first structures during the dark ages and the Epoch of Re-ionization



- An experiment aimed towards the detection of the redshifted 21-cm line from the Epoch of Re-ionization.

- To investigate the birth and evolution of first stars and galaxies as well as the thermal history of the intergalactic medium.



Figure: A PAPER dipole

- An array of 128 dipoles sensitive to the 100-200 MHz range, located in the Karoo.
- A collaboration between UCB (lead), UPenn, NRAO, SKA-SA.

- **PAPER 32**, dipoles distributed pseudo-randomly within a 350 m diameter circle.



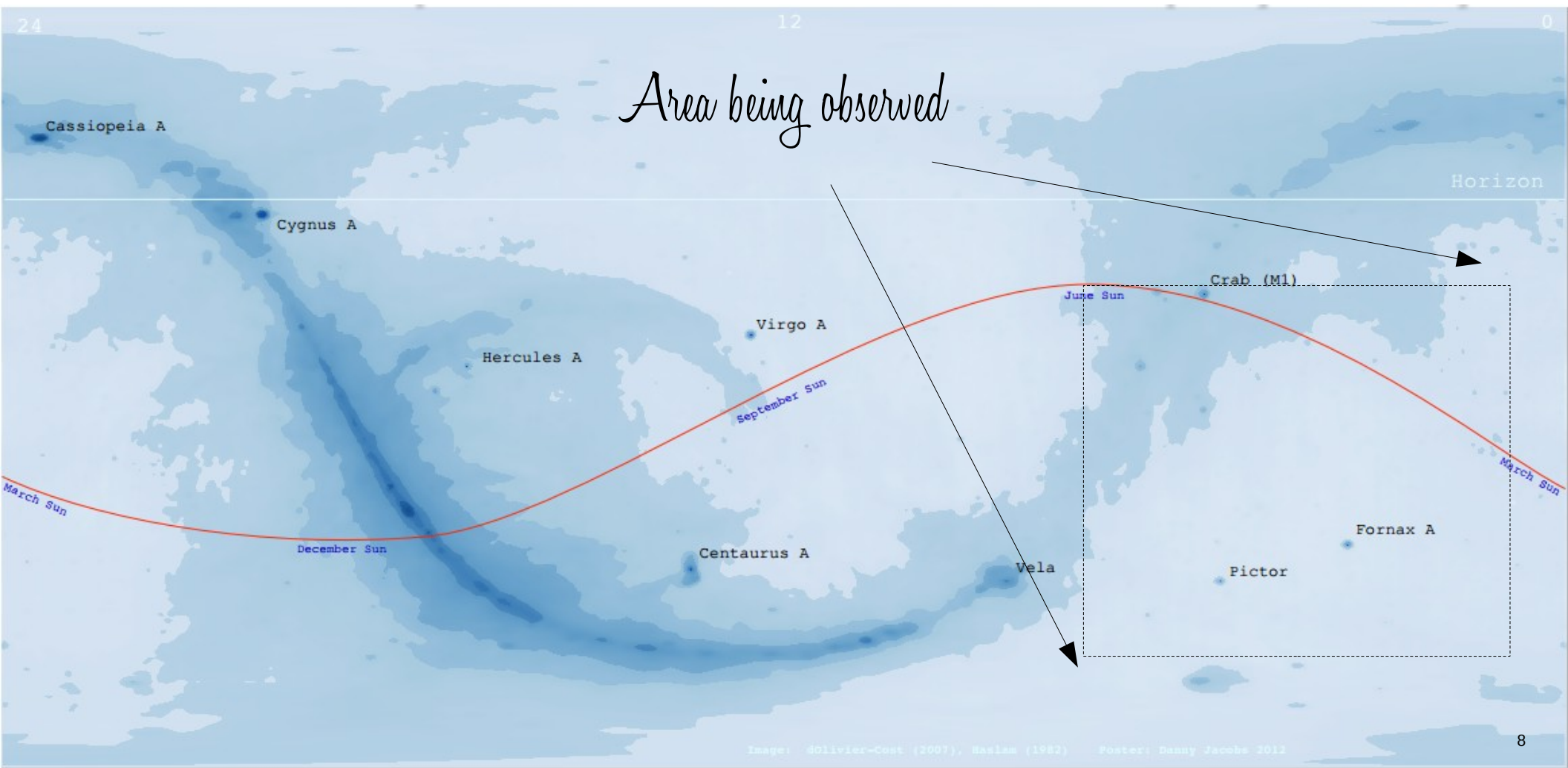
- Generate an all-sky catalogue to be used for calibration and foreground subtraction.



Snapshot imaging

- Data recorded on 15th Sept. 2011 from 12:04 hrs to 04:44 hrs [UT]
- 10 minute observation, integration time of 42.85 seconds per snapshot
- A snapshot image have a FoV of 51.2°

Image courtesy: Danny Jacobs



Radio interferometry measurement equation and calibration

(Hamaker et al. 1996; Hamaker 2000, Smirnov 2011a)

Visibility matrix (V) measured by interferometer pq

$$V_{pq} = \mathbf{G}_p \left(\iint_{lm} \mathbf{B}_{pq} e^{-2\pi i(u_{pq}l + v_{pq}m)} dl dm \right) \mathbf{G}_q^H$$

$$\mathbf{B}_{pq} = \mathbf{E}_p \mathbf{B} \mathbf{E}_q$$

\mathbf{B} term \rightarrow a 2×2 brightness matrix

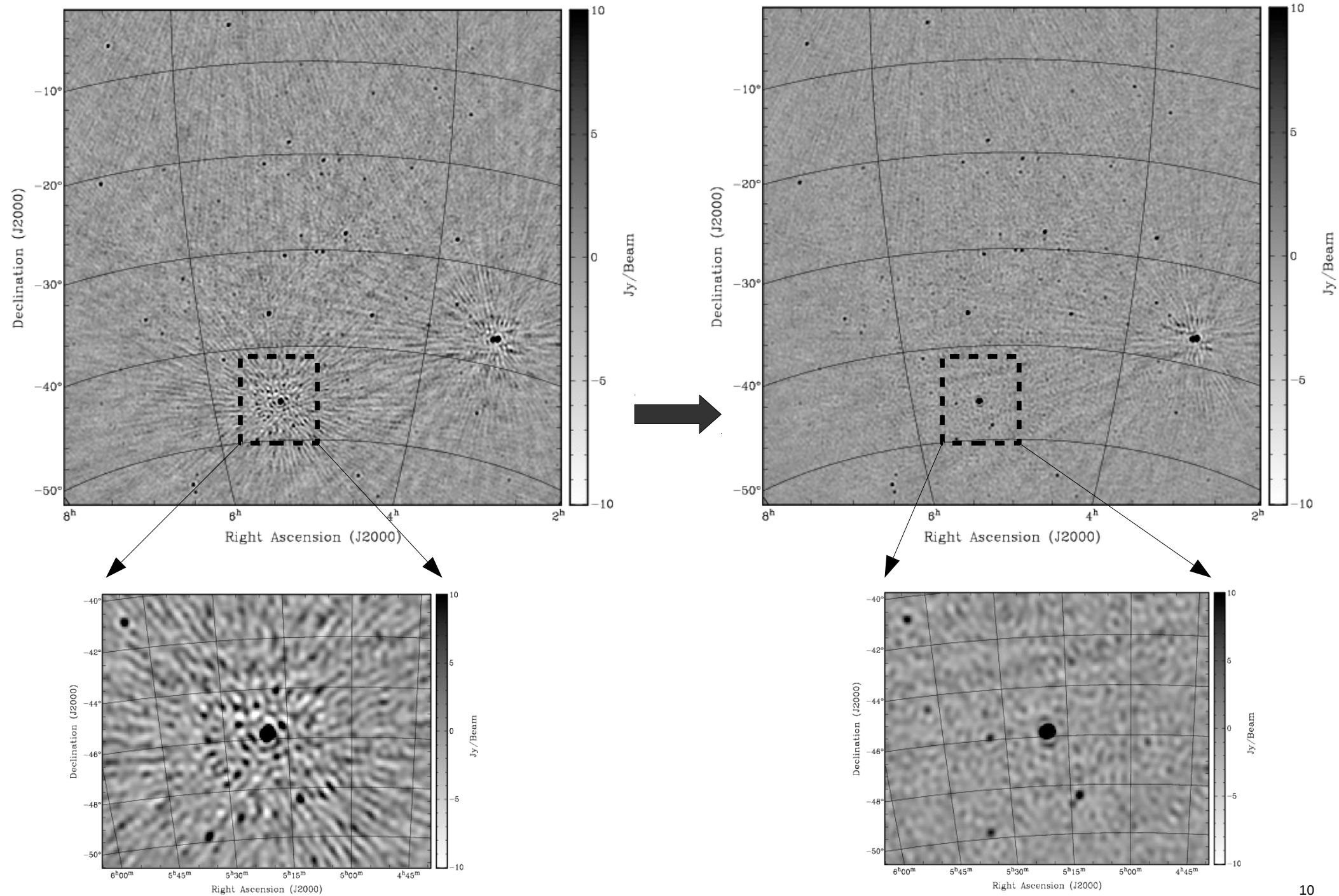
\mathbf{G}_p \rightarrow Jones matrices represent the per-antenna direction-independent effects (DIEs)

\mathbf{E}_p \rightarrow Jones matrices represent the direction-dependent effects (DDEs)

Direction independent errors

Before

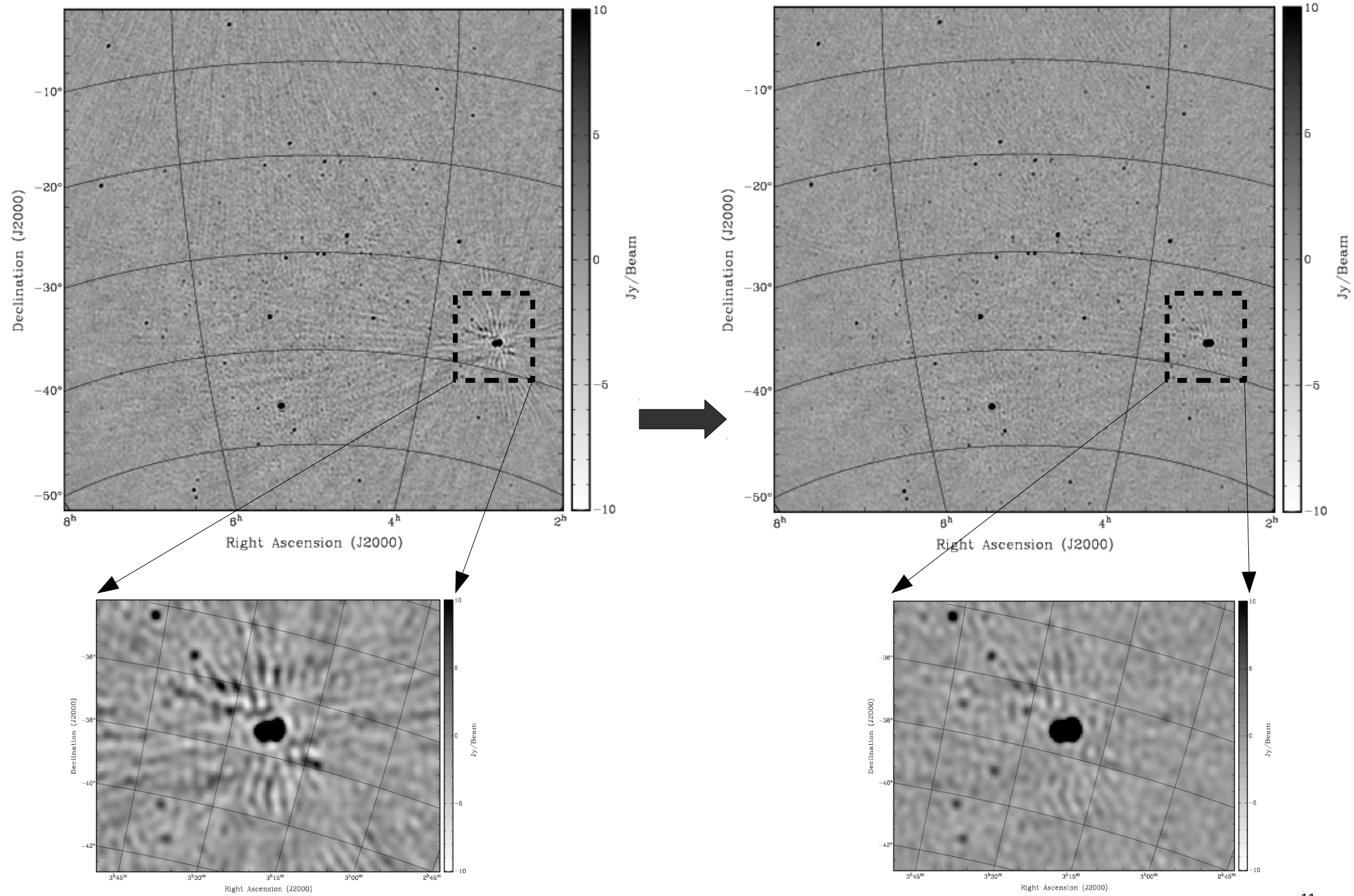
After



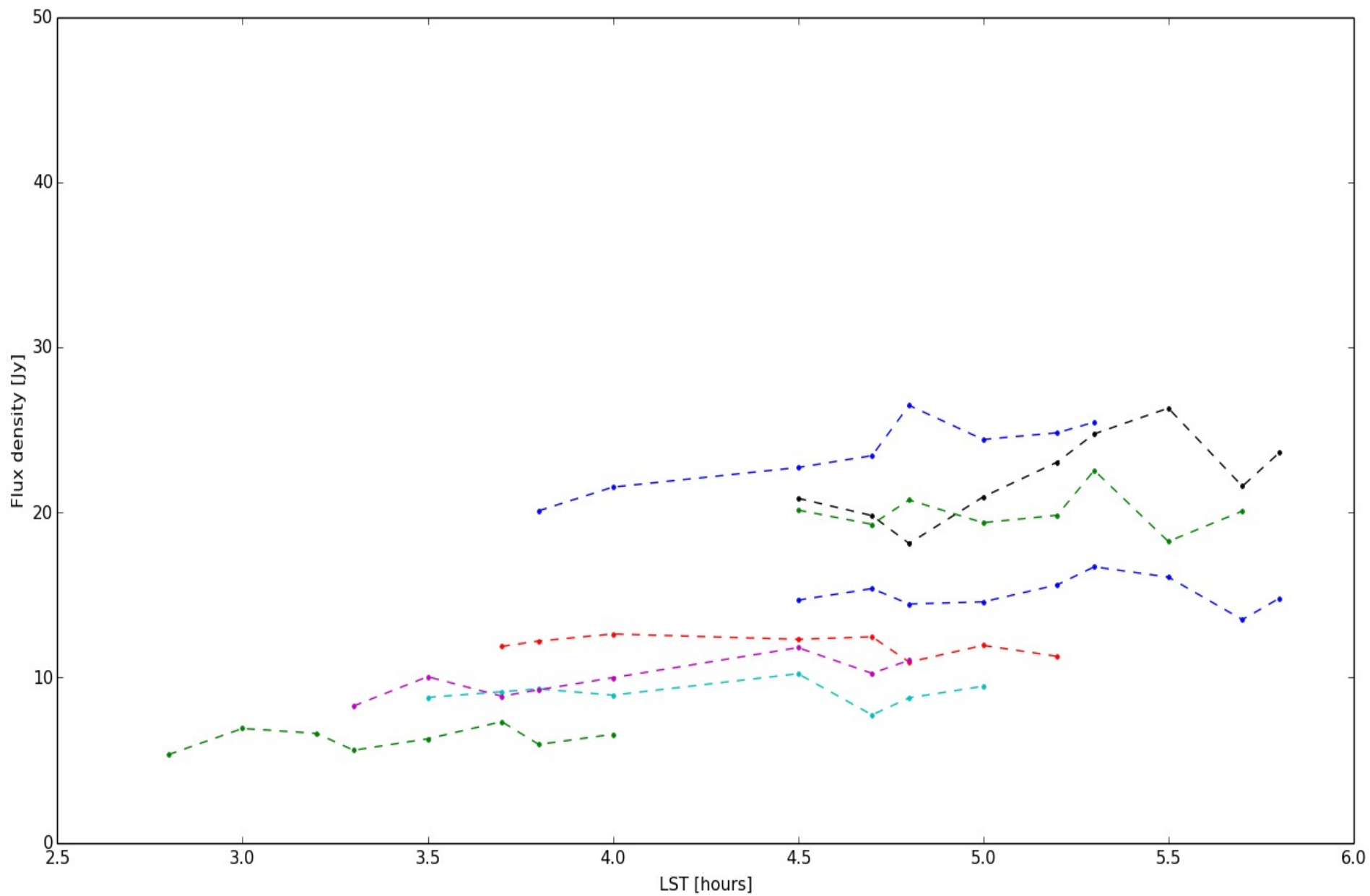
Direction dependent errors

Before

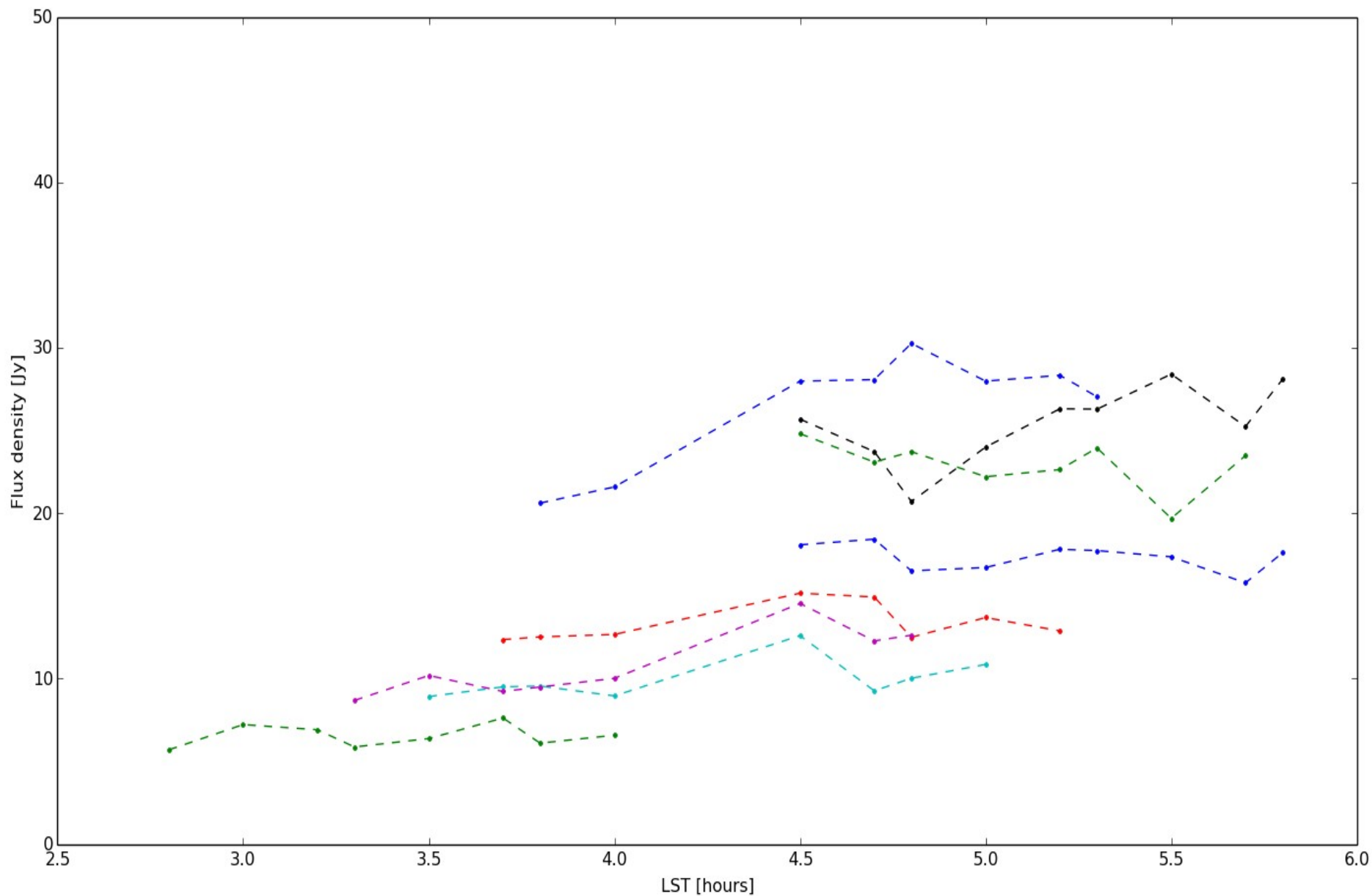
After



Flux density of sources before absolute flux calibration



Flux density of sources after absolute flux calibration



	SOURCE NAME	RA[deg]	DEC[deg]	FLUX[Jy]	ERROR[Jy]
	J2000_1h16m23s-47d20m41s	19.1	-47.34	12.48	0.8641
	J2000_1h14m53s-32d19m10s	19.72	-32.32	5.522	0.7239
	J2000_1h16m40s-52d2m25s	19.17	-52.04	8.467	0.9823
➤ Snapshot imaging	J2000_1h8m42s-34d46m50s	17.43	-34.78	5.441	0.6955
	J2000_1h8m39s-16d2m38s	17.16	-16.04	18.89	0.8245
➤ Direction independent calibration	J2000_1h5m23s-45d13m30s	16.35	-45.06	19.43	0.8138
	J2000_1h5m25s-38d10m46s	16.35	-38.18	7.137	0.7127
➤ Direction dependent calibration	J2000_1h5m23s-45d13m30s	15.79	-27.5	5.839	0.7156
	J2000_1h3m4s-21d51m47s	15.77	-21.86	10.66	0.7286
➤ Absolute flux calibration	J2000_1h3m4s-21d51m47s	14.87	-16.98	10.05	0.8282
	J2000_0h52m20s-43d4m57s	13.09	-43.08	15.33	0.7839
➤ Source extraction	J2000_0h55s-44d27m12s	12.73	-44.45	11.18	0.8211
	J2000_0h46m22s-42d6m0s	11.59	-42.1	32.42	0.7902
	J2000_0h47m54s-25d15m40s	11.98	-25.26	15.47	0.7486
	J2000_0h42m12s-44d12m27s	10.55	-44.21	18.56	0.8463
	J2000_0h44m57s-35d29m42s	11.24	-35.5	9.304	0.7291
➤ Catalogue preparation	J2000_0h44m36s-22d10m58s	11.15	-22.18	6.193	0.7675
	J2000_0h38m42s-38d58m35s	9.676	-38.98	11.79	0.7816
	J2000_0h41m58s-9d20m33s	10.49	-9.343	11.78	1.097
	J2000_0h35m29s-20d1m33s	8.875	-20.03	9.739	0.8236
	J2000_0h25m48s-33d3m40s	6.451	-33.06	7.039	0.7641
	J2000_0h24m47s-29d27m24s	6.199	-29.46	15.56	0.7567
	J2000_0h26m7s-26d0m23s	6.533	-26.01	15.45	0.7715
	J2000_0h23m31s-25d1m26s	5.88	-25.02	7.14	0.7656
	J2000_0h15m39s-38d2m58s	3.915	-38.05	9.865	0.7902
	J2000_0h19m16s-12d39m45s	4.82	-12.66	8.402	1.039

Summary

Future work

Thank You

