Applying a new method of analysis to GMRT drift-scan surveys

Liam Connor
Richard Shaw
Ue-Li Pen

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- Lessons learned at GMRT
  - RFI mitigation
  - Calibration, polarization leakage

- 24-hr drift scan surveys
  - m-mode analysis
  - Pulsar holography
GMRT EoR project

- Observe at ~150MHz, z ~9
- Take advantage of large collecting area
Basic set up

- Thirty 45m dishes
- 16MHz bandwidth
- Vis resolution of 7.8kHz, ¼ seconds
- dual-pol antennas
Challenges

- Complex gain calibration
- RFI mitigation (worsens with time)
- Polarization leakage
- Foregrounds
- Hardware/software challenges
RFI removal

- Line RFI is flagged/masked
- Broad-band RFI removed with SVD
- Celestial sources have distinct fringe rotation across baselines; RFI does not
Progress

- RFI, calibration, foreground removal
- Paciga et al. 2013 current an upper limit on EoR power spectrum of \((248\text{mK})^2\)
New generation of experiments

- Wide-field, transit telescopes
- Conceptual change needed
24hr drift scan surveys

- Telescope points at constant declination
- Let sky pass over head for multiple days of observing
- **Note:** Sky’s signal is periodic in sidereal days
Periodic in $\phi$, why not take Fourier transform?

$$V_m = \frac{1}{2\pi} \int d\phi V(\phi) e^{-im\phi}$$
• Take spherical harmonic expansion of both sky and telescope object

\[ T(\hat{n}) = \sum_{lm} a_{lm}^T Y_{lm}(\hat{n}) \]

\[ B_{ij}(\hat{n}; \phi) = \sum_{lm} B_{ij,lm}(\phi) Y_{lm}^*(\hat{n}) \]
v = Ba + n

- **Sky information**
- **Instrumental noise**

Contains all telescope information
Filtering with KL-modes

Foregrounds

21cm signal

$10^6 \times$ brighter

$2 \times$ fainter
Choosing a ring

- Competing issues:
  - Ionospheric path length
  - Integration time
  - Pulsars?
Pulsar holography

- Data is gated in time (16 gates = $T_{psr}$)
- “off” gates are subtracted from “on” gate
- Lone pulse allows for gain/polarization calibration
Pulsar holography

- Build up pulsar tracks through beam
- Map complex beam pattern
- Quantify polarization leakage
Moving to m-modes

- Initial sanity checks: How do the m-mode visibilities look?

\[ m = \frac{2\pi d_{ew}}{\lambda} \]
More to come ...