Polarimetry and RM-synthesis issues

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Polarimetry and RM-synthesis issues

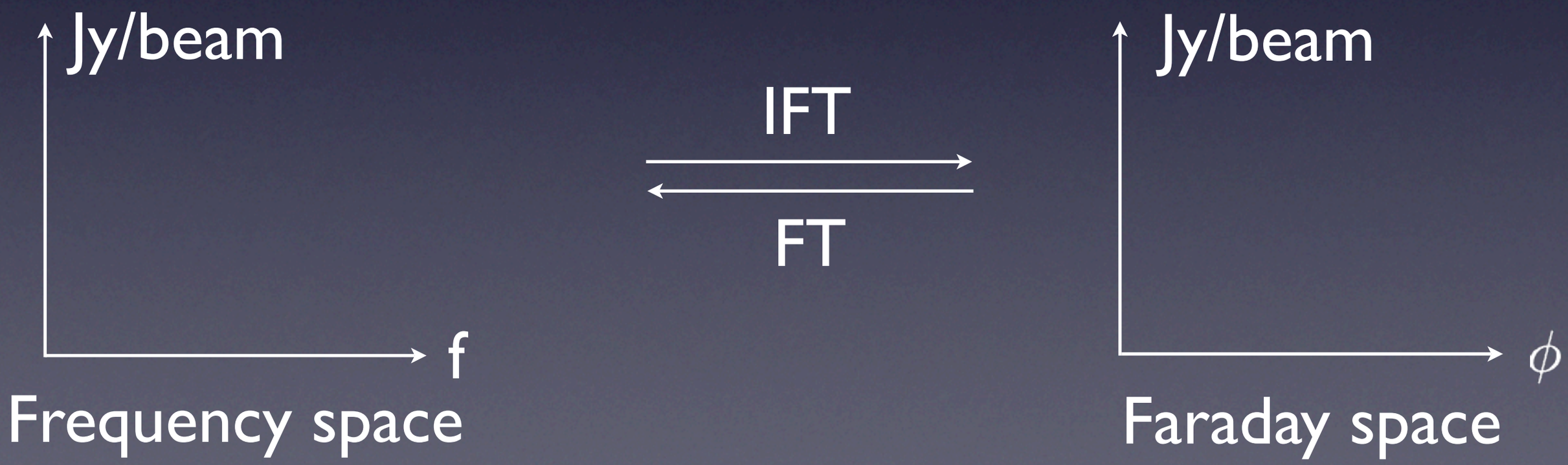
- Physics of RM-synthesis
- Science with RM-synthesis
- Software development plan
- Observations / GSM
- Conclusions

Physics of RM-synthesis

- Use polarized input maps: Stokes' Q and U
- Faraday rotation through traversed medium

$$\phi(\vec{r}) = 0.81 \cdot \int_{there}^{here} n_e \cdot \vec{B} d\vec{r}$$

- RM-synthesis performs Fourier Transform between



Physics of RM-synthesis

- Weighted polarized intensities

$$\tilde{P} = W(\lambda^2)P(\lambda^2)$$

- Fourier transform into Faraday space

$$\tilde{F}(\phi) = F(\phi) \star R(\phi) = K \int_{-\infty}^{\infty} \tilde{P}(\lambda^2) e^{-2i\phi\lambda^2} d\lambda^2$$

- De-convolute with Rotation Measure Spread Function (RMSF)

$$R(\phi) = \left(\int_{-\infty}^{+\infty} W(\lambda^2) d\lambda^2 \right)^{-1} \int_{-\infty}^{+\infty} W(\lambda^2) e^{-2i\phi\lambda^2} d\lambda^2$$

Science with RM-synthesis

- Faint polarized emission in faint sources:
  - Perseus cluster (Brentjens et. al 2005)
  - Abell 2256 (Brentjens et. al 2008, Clarke & Ensslin 2006)
  - Abell 2255 (Pizzo et. al 2008)
- Magnetic fields in Galaxies (Beck et. al 2006)
- Clusters and Cosmic magnetism (Beck et. al 2008)

Science with RM-synthesis

- What is the structure of the magnetized local ISM in the Milky Way?
- What is the structure and strength of magnetic fields in clusters?
- Are intergalactic HI filaments magnetized?
- What kind of objects magnetized the IGM?

Software development

- Stand-alone version for commissioning phase (Q,U-maps as input)
- Image cube data format currently defined
- Online version for science operations: parallelized, working in data pipeline
- Bayesian statistics for error calculation and signal reconsctruction
- Prospective U,V-data imager?

Observations

- large frequency coverage
- if necessarily split into blocks
- well-sampled, but irregular frequency grid
- HBA provide far higher sensitivities
- simultaneous calibration beam

GSM polarized calibrators

- Need a dense grid of polarized calibration sources
- Source models must model all Stokes' parameters
- Must have high frequency resolution and good coverage
- Pulsars are good calibrators (but not for short time scales)
- Ionospheric calibration issues challenging (Atmospheric Faraday rotation)

Conclusions

- RM-synthesis depends on properly calibrated polarized images
- Quality of RM observations depends on a good RMSF, therefore on an appropriate frequency coverage
- Deep images of selected regions require a dense grid of polarized calibration sources
- Need a deep field polarization observation