Radio/Interferometry use cases

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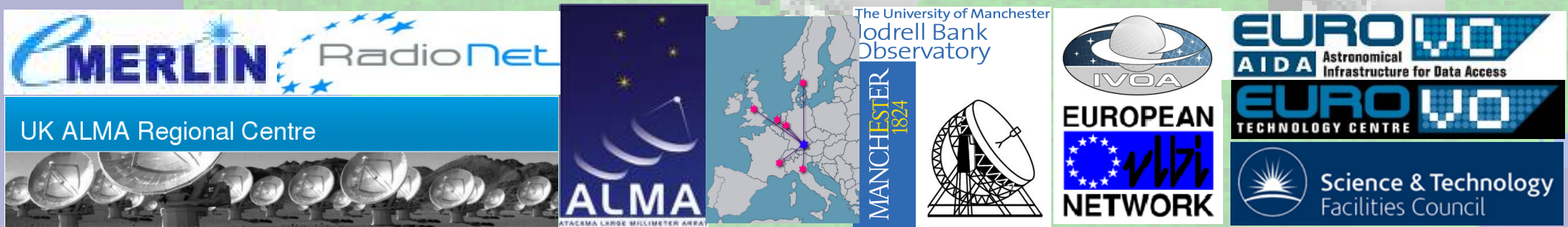
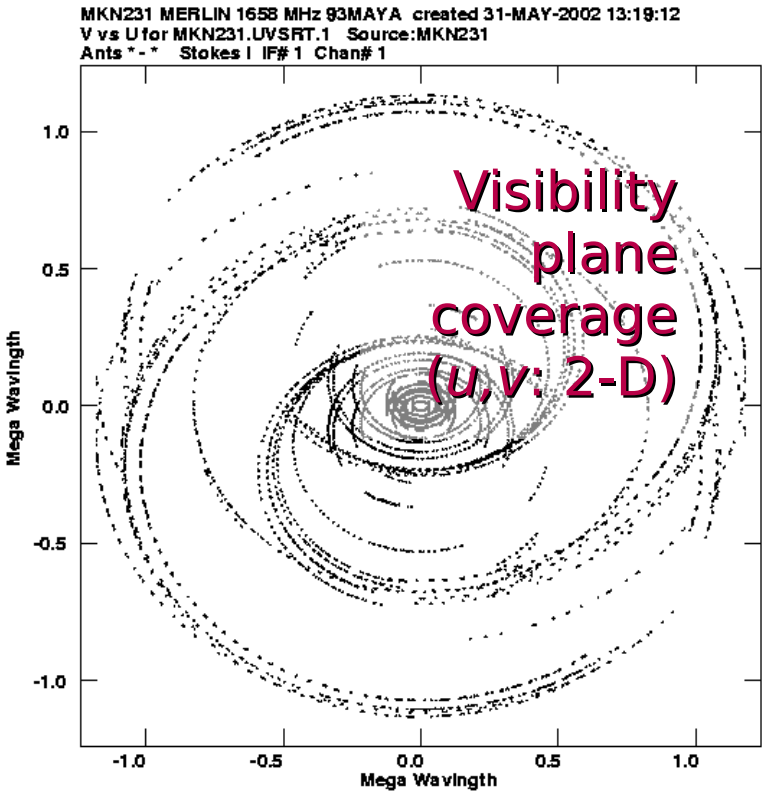
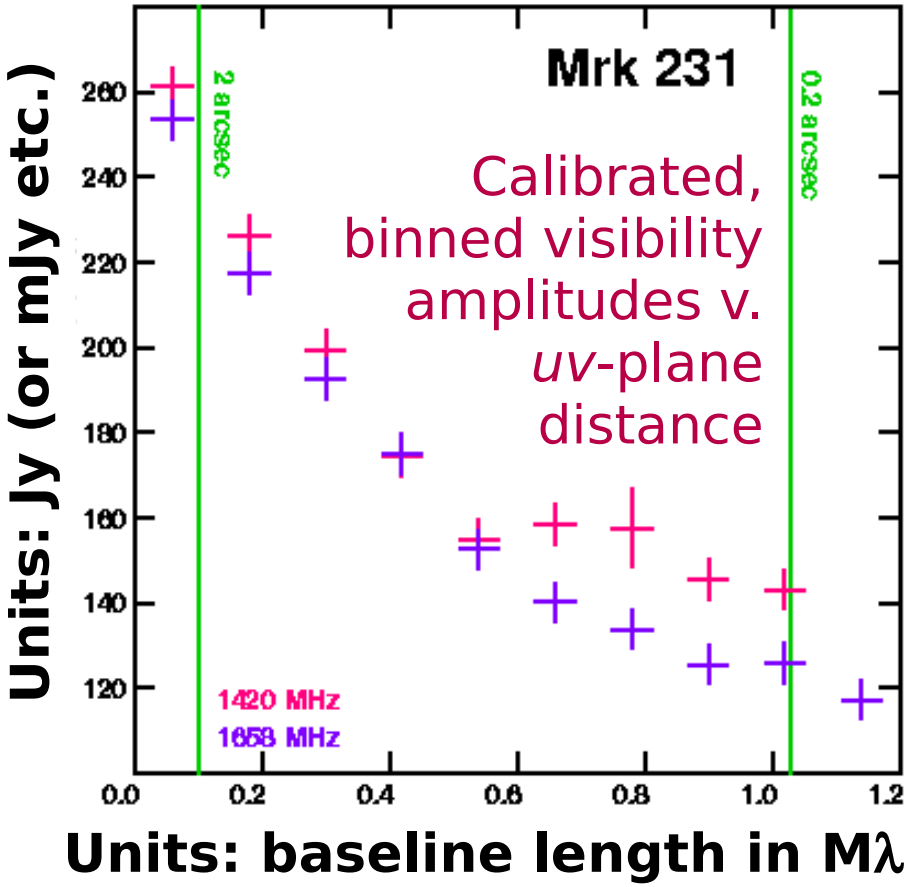
- Outstanding issues for data standards
  - Visibilities
  - Polarization (discussed yesterday, not here)
  - Units
- Use cases
  - Finding calibration sources
  - Galactic plane surveys
  - Extracting variability and multi-ν curves
  - Advanced polarization and 'cube' products



Properties under development

- Visibility data
  - Selection of calibrated data and products
  - Characterization of Fourier plane coverage



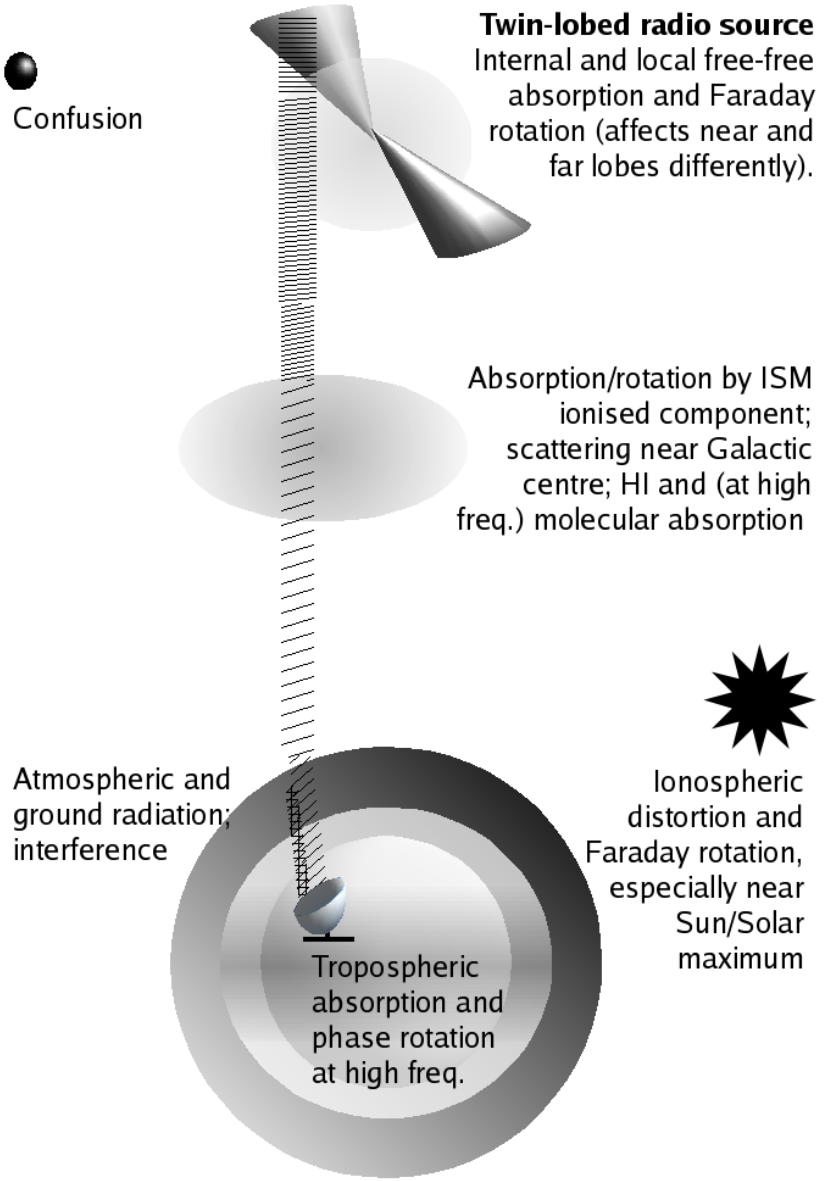


More peculiar units usage

- Flux density
  - Most images, cubes, often spectra **Jy beam^{-1}**
  - Require beam size (Spatial Resolution)
  - Jy arcsec^{-2} or similar at coarsest Char level?
    - confuse some users, probably not universally applied
- Frequency as spectral coordinate
  - Spectral channels spaced evenly in frequency
  - Cannot give single accurate resolution in m
  - Detailed data requests in frequency units

Selection of calibration sources
mainly for ALMA, *e*-MERLIN, EVLA, VLBI

- Overall flux scale
- ϕ & amp across bandpass
- Time-varyingϕ & amp
  - 'phase calibration'
  - including astrometry
- Polarization leakage and origin of pol. angle
- In addition to instrumental or atmosphere measurements



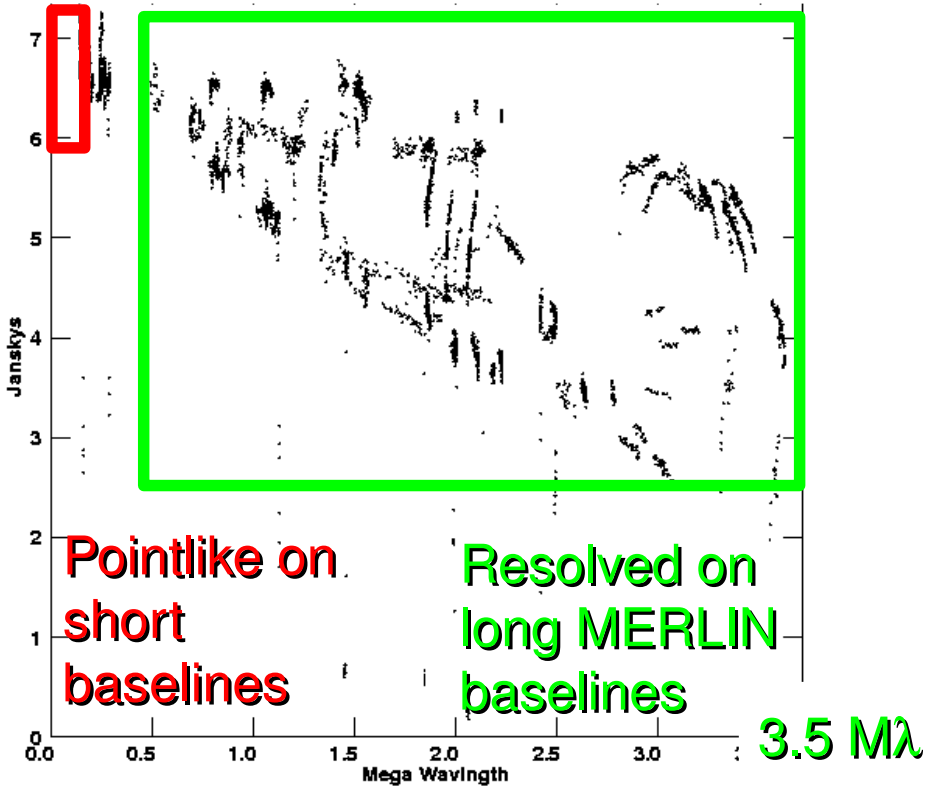
Information for source selection
(requirements vary with role)

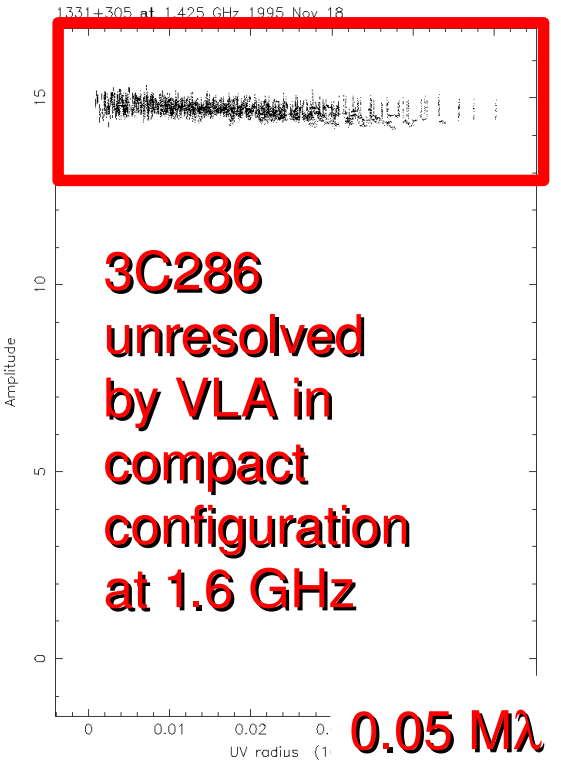
- Sources used:
  - Extra-galactic QSO etc.
  - Cool/radio stars
  - Planets and moons
- Position and accuracy (down to mas level)
  - Proper motions, ephemerides etc.
- Model of flux distribution
  - Point
  - Disc or Gaussian or other fitted model
  - Clean Components table (probably part of ...)
  - FITS image
- Model of polarized intensity distribution
  - Pol. intensity and pol. angle for point

Scope of descriptions

- Frequency range of applicability
  - Brightness, thus detectable structure $f(\nu)$
  - Spectral index/curvature (maybe in CC one day)
  - Excluded ranges (e.g. due to interference, lines)
- Time range or variability parameterization
- Spatial scales / image fidelity
  - Sensitivity & spatial resolution of image models
  - Dirty beam (sidelobes indicate quality)
  - Amplitude/*uv* distance plot or parameterisation
  - *uv* coverage or antenna positions are of indirect use only

Scope of descriptions





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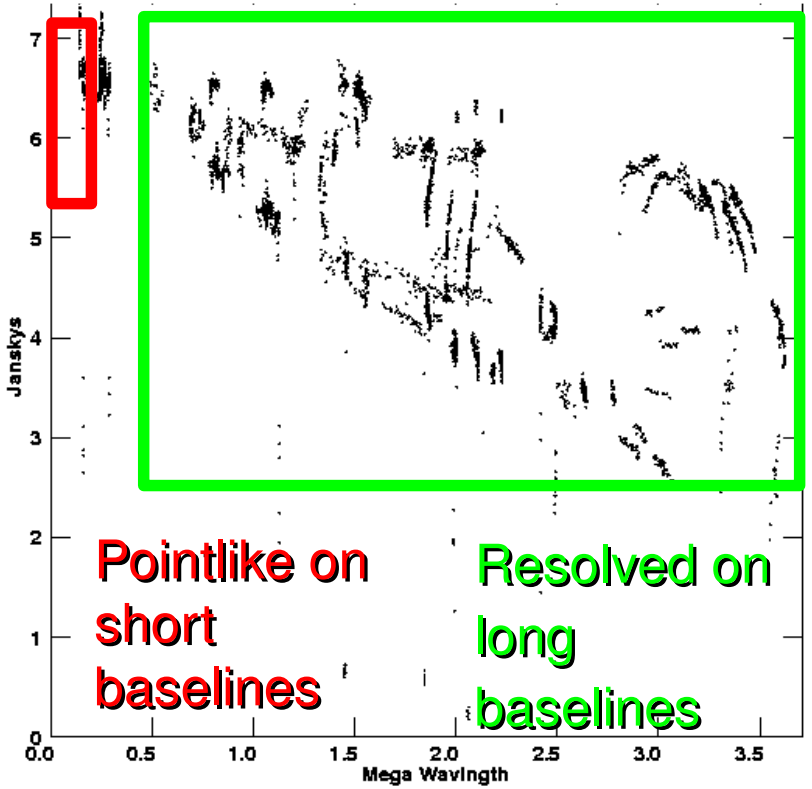

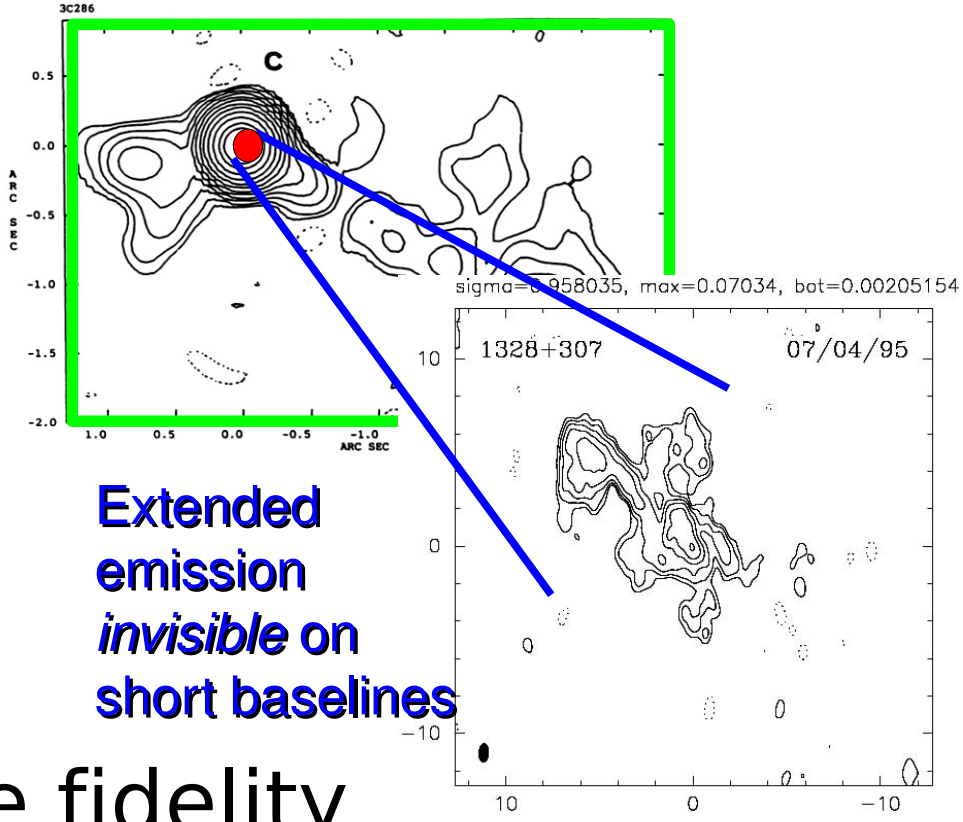

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Wide field/low frequency

LOFAR, SKA, some EVLA/*e*-MERLIN, also CMB

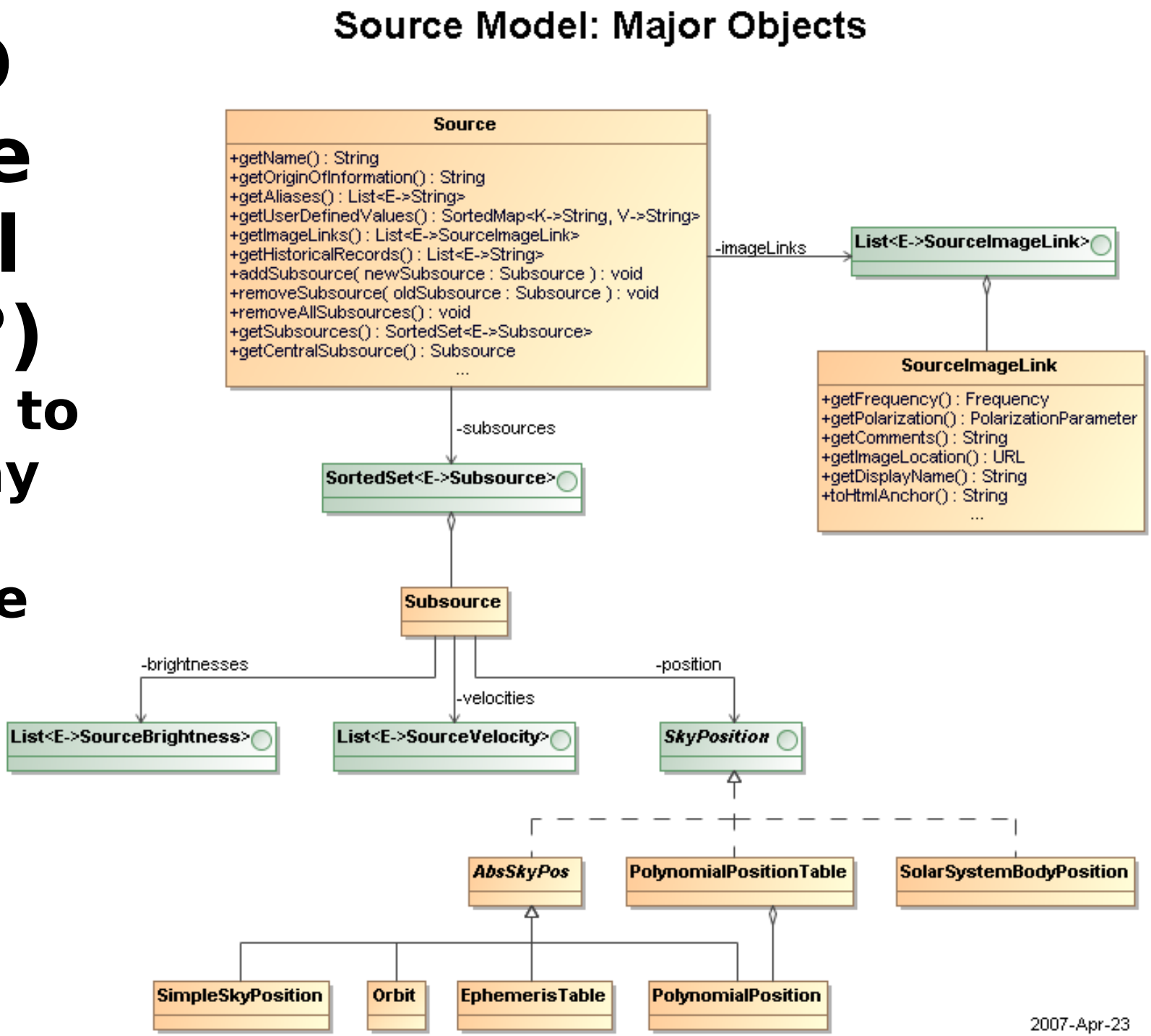
- Sources throughout field of view
  - FoV determined by:
    - Individual dishes primary beams
    - Integration (shortest data averaging) time
    - Spectral resolution (channel width
    - Some observations are 'all sky'
- Models for field-based calibration/removing confusion
  - Catalogues of points or image CCs e.g. NVSS
  - Use of HEALPIX coordinates
  - Use of shapelets and other all-sky models

Whence calibrator information?

- Information should be 'accountable'
  - References
  - Accuracy
- Published data
  - ADS, CDS, NED, observatory web sites
    - Catalogues
      - SPECFIND cross-ID of cm-wave radio sources (Vollmer et al.)
    - Plots (images, amp v. *uv*-distance...)
    - FITS images/CC (CASA equivalent needed)
- NRAO EVLA/ALMA source model (SDM?)
  - Differences from IVOA model
  - Need translation

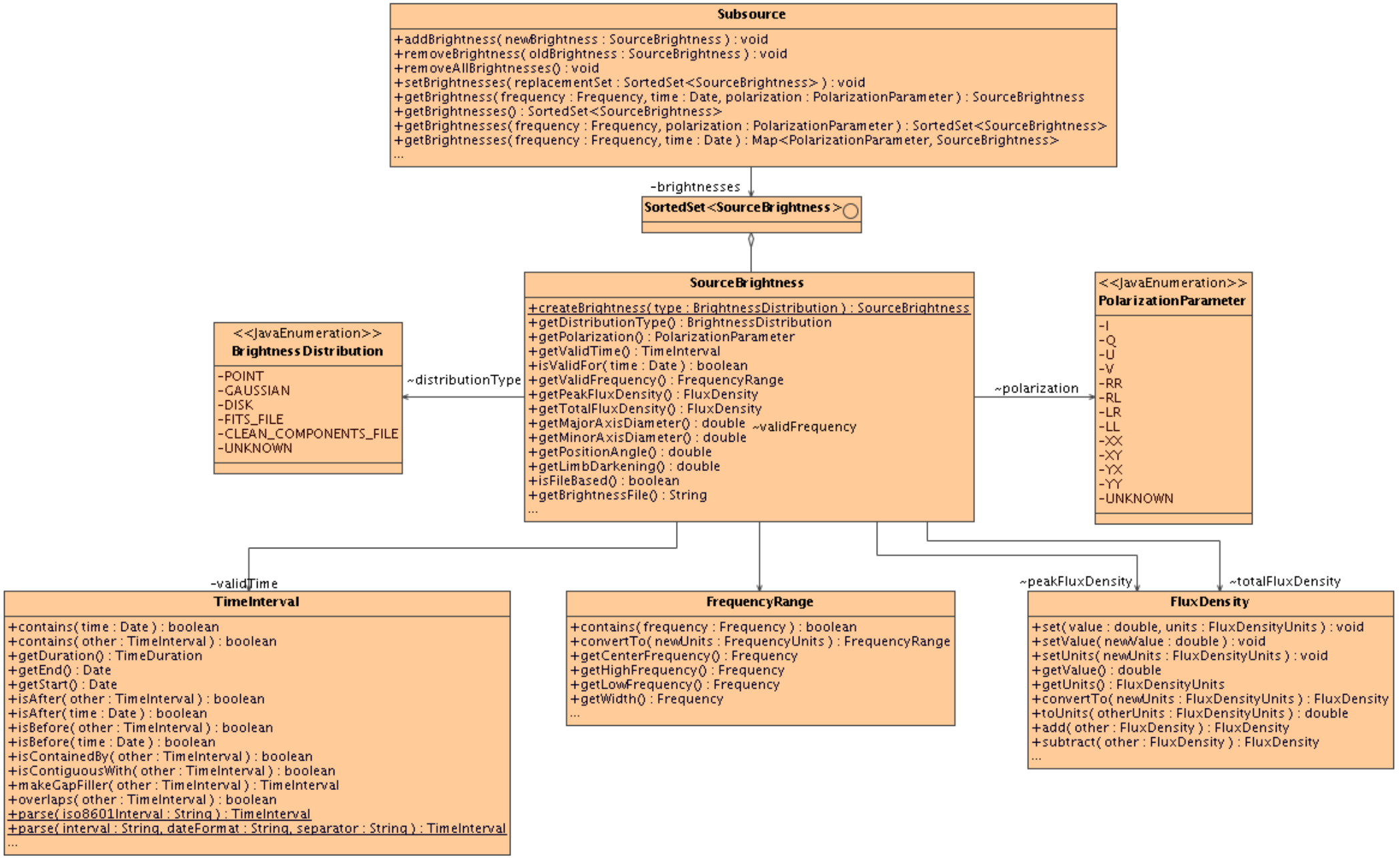
NRAO source model (SDM?)

NB not up to date, may not be complete



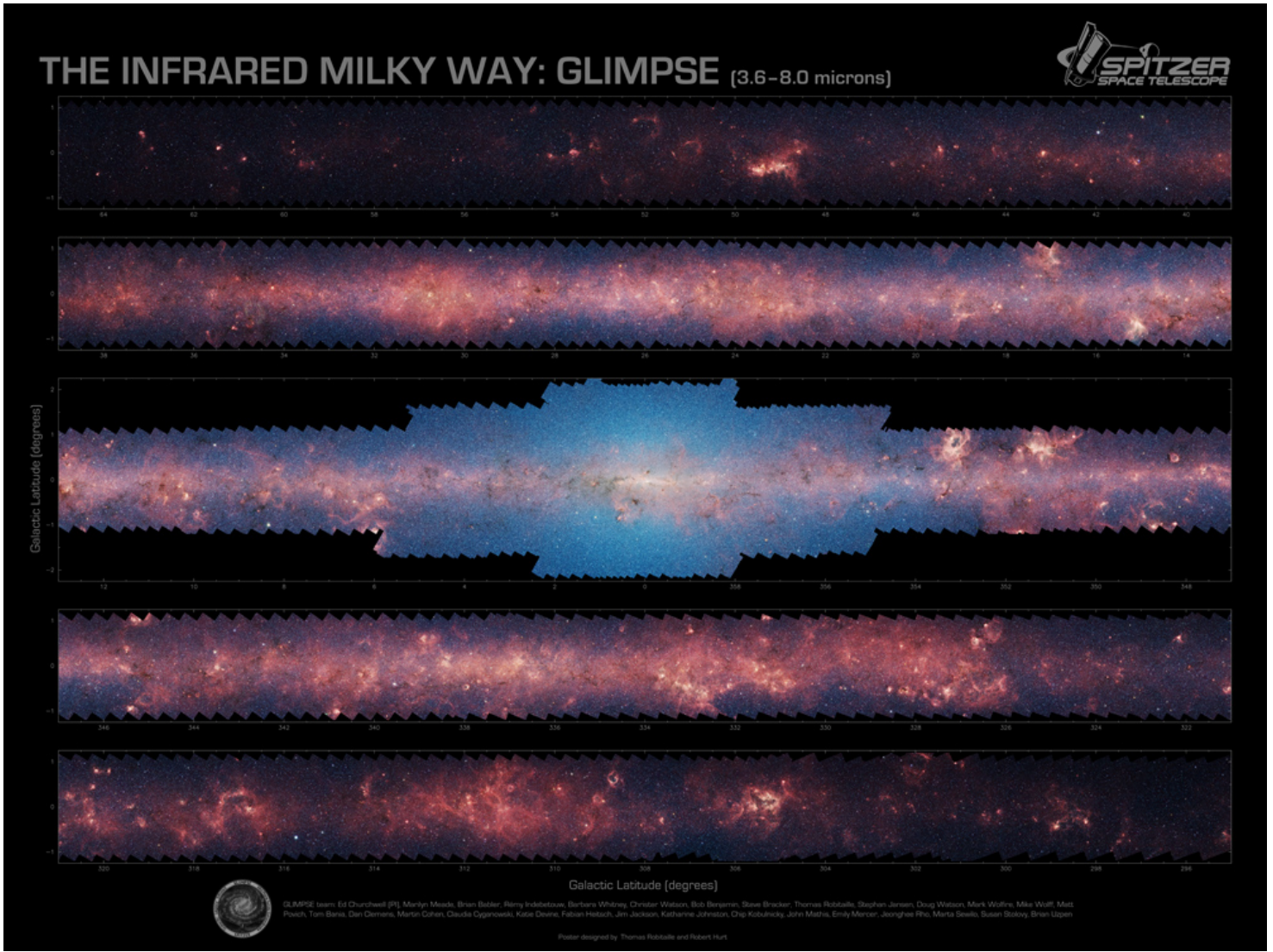
NRAO source model: brightness

Subsource & SourceBrightness



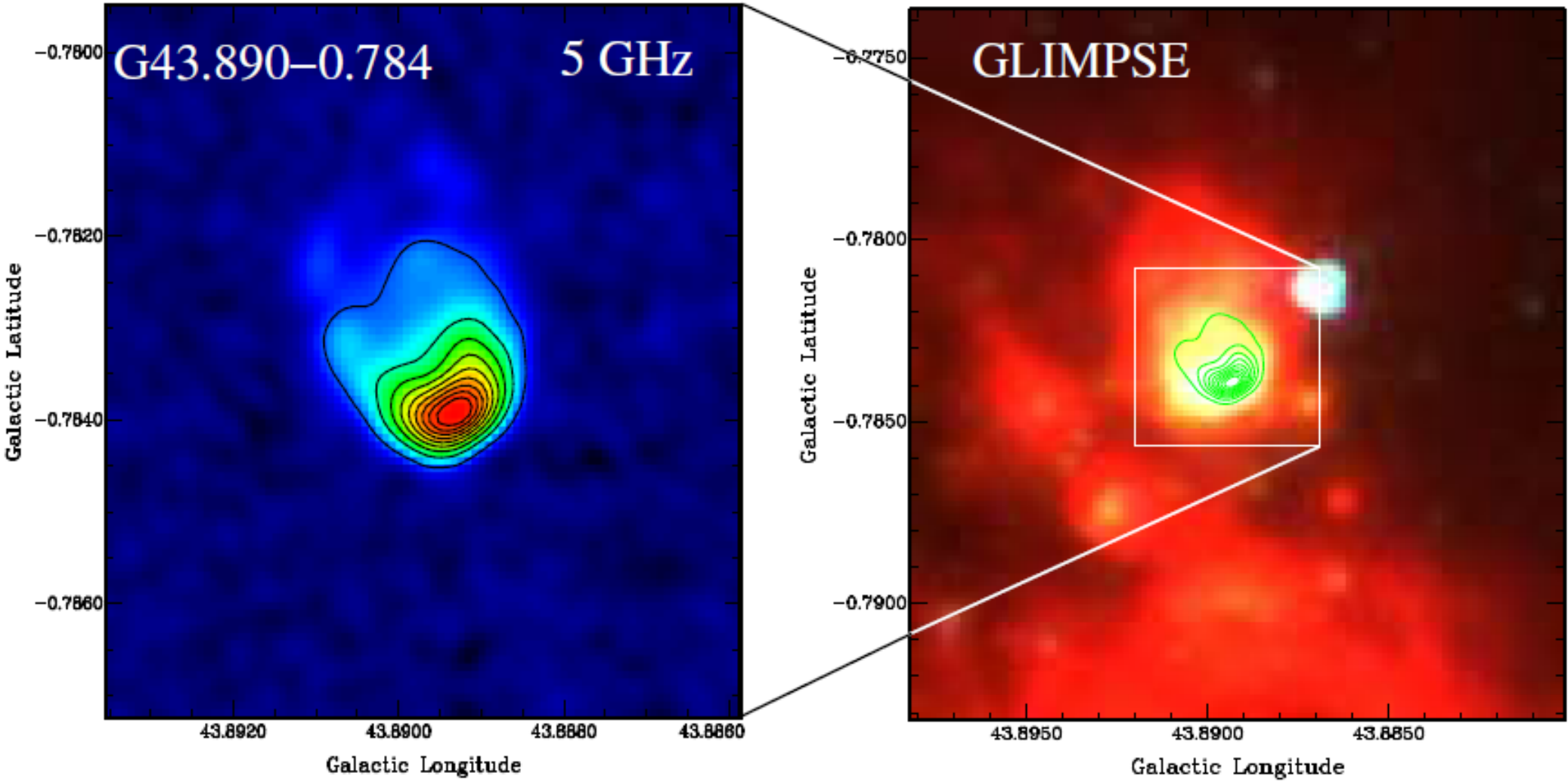
Galactic plane surveys

- Neat regions in Galactic coordinates
  - Selection or avoidance



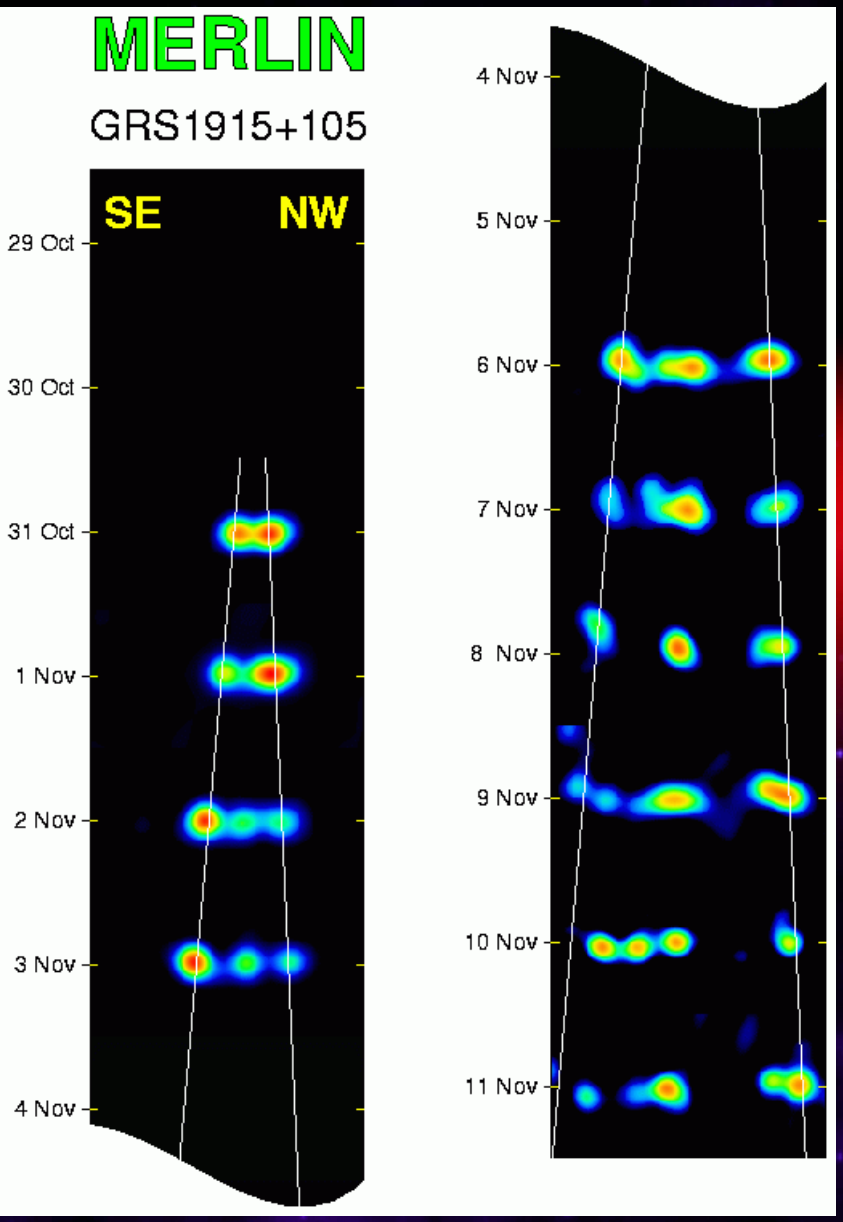
Galactic plane surveys

- CORNISH 5-GHz survey (Purcell et al. 2009)
- Methanol Multi-beam spectral survey



X-ray binary radio variability

Devised by Tony Rushton



Sporadic 0.9*c* jets

Core is rapidly variable

Cartoon: Dana Berry (CfA/NASA)

GRS 1915 data discovery

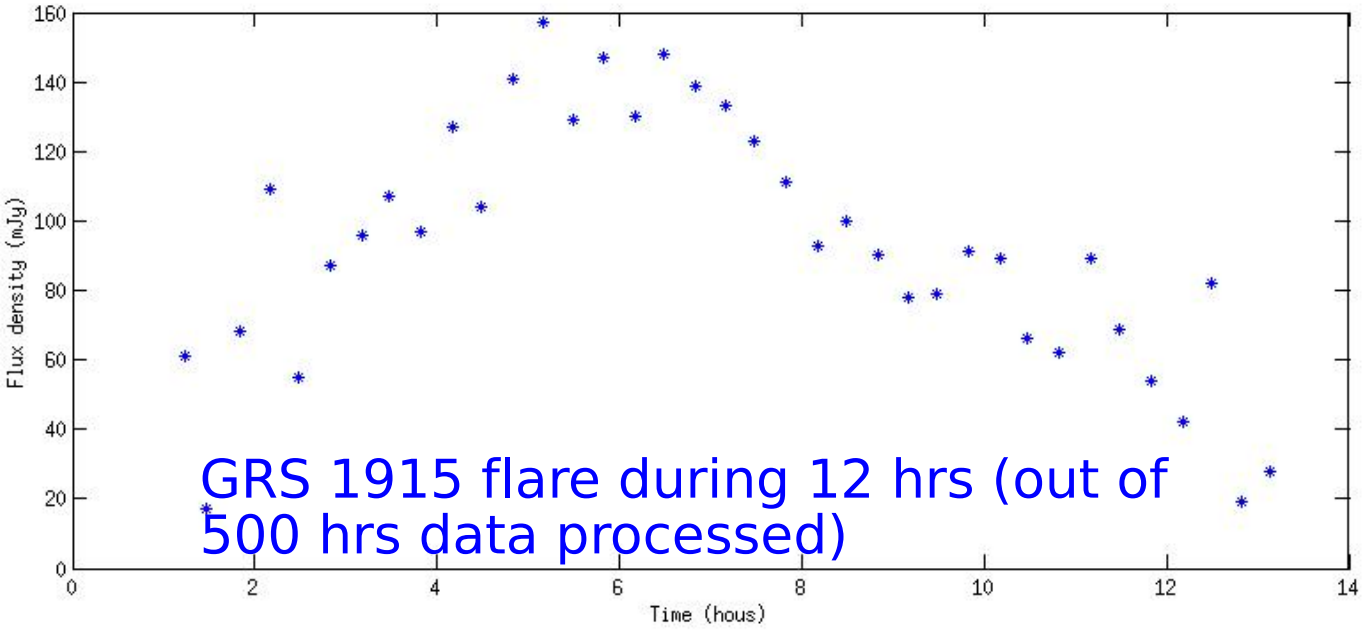
- Query (probably specified) radio archives
- Selection criteria
  - Data around standard GRS 1915 position
  - Calibrated visibility data
  - Frequency 1 to 30 GHz
  - Sufficient duration to map
    - Sensitivity 10 mJy or better
- Get list of suitable data with additional info:
  - Frequency bounds and (channel) resolution
  - Time duration and resolution (integration time)
  - Polarizations present
  - 2D map if already available

Request radio 'light' curve

- First step is to get total intensity map of suitable epochs (if not already available)
  - Measure position of GRS 1915
- Send data access request for flux ∝ time:
  - In total intensity
  - At position measured for that epoch
  - In specified time-averaging intervals
  - In chosen frequency range
  - Possibly in chosen *uv* distance range
- VO needs to mediate request but not to know how archive pipeline manages it.

Archive pipeline process

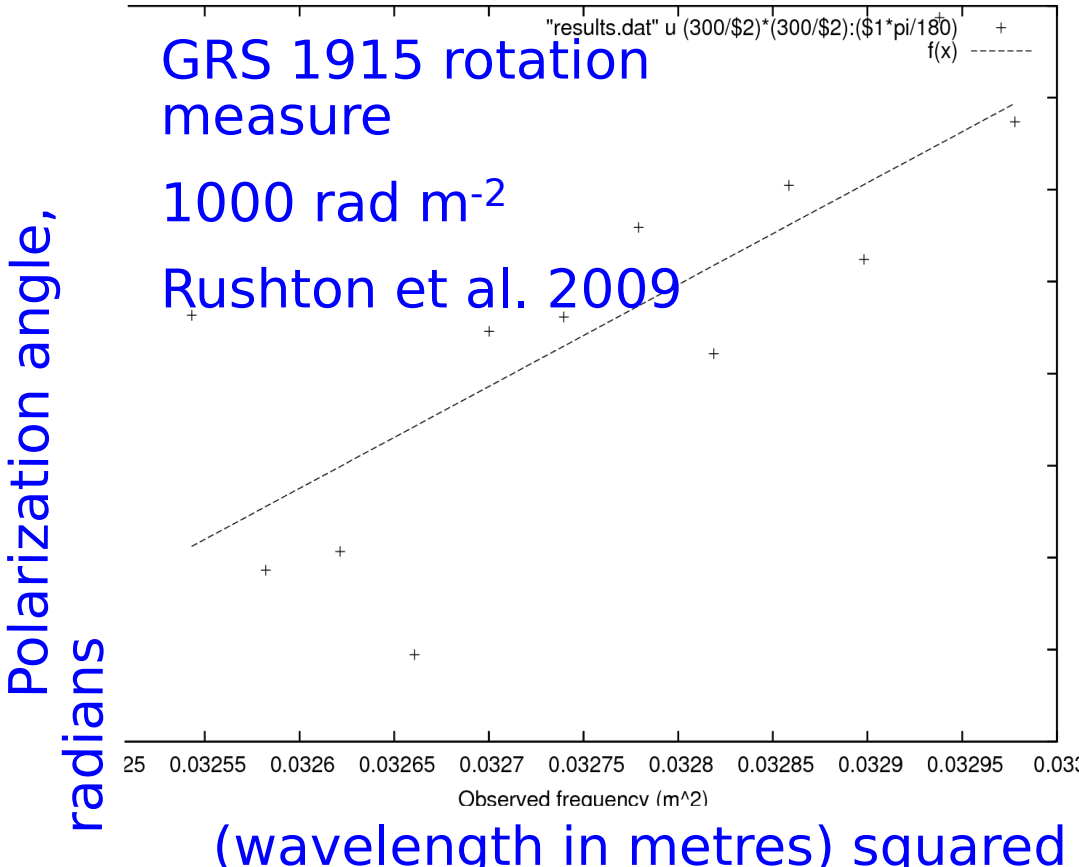
- Archive inserts values in pipeline which:
  - Selects requested frequency and *uv* range
  - Rotates phase centre of *uv* data to position
  - Averages over all baselines present
  - Averages over requested time intervals
  - Measures visibility amplitude per interval
  - Returns table of times and flux densities to user



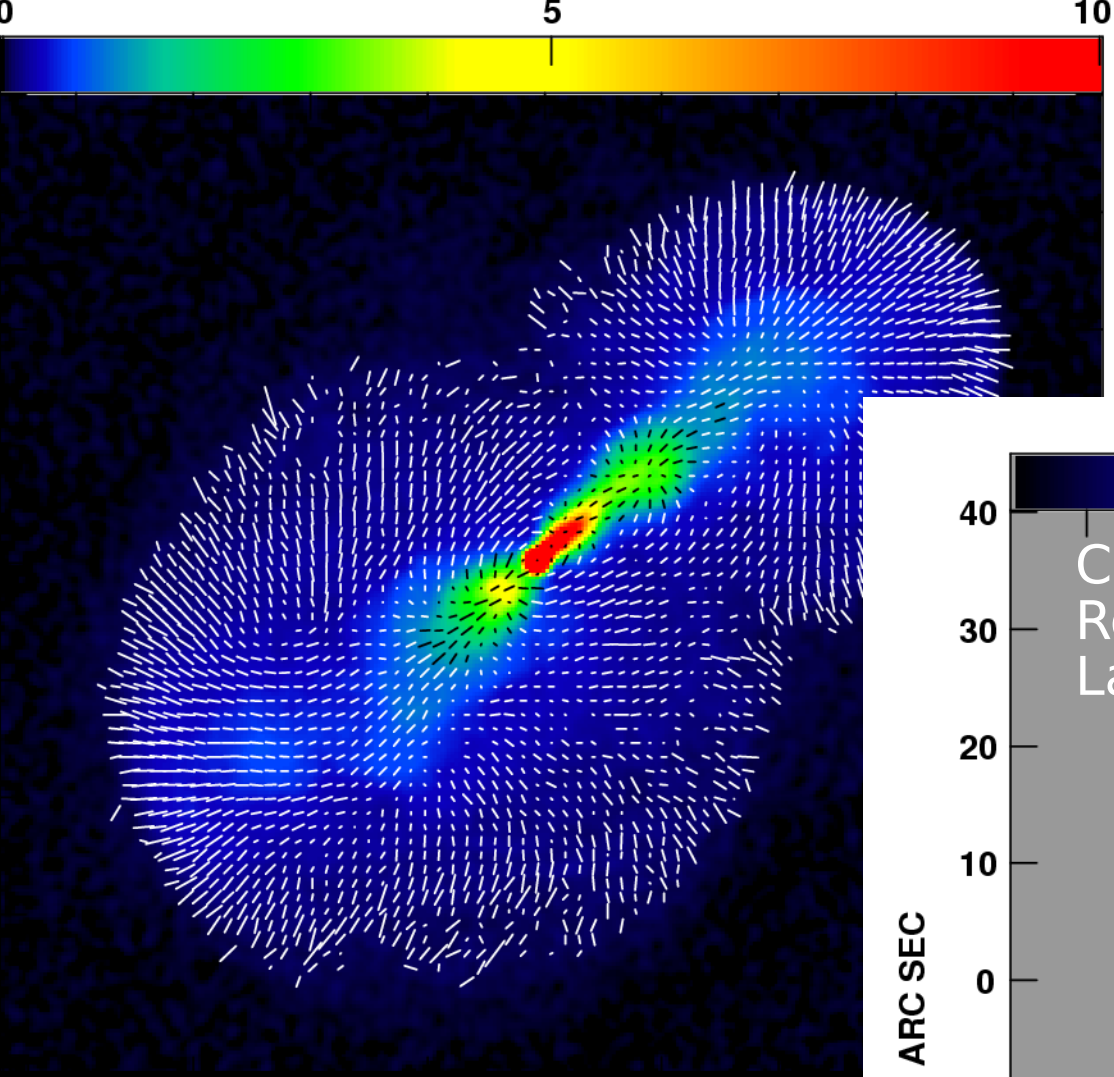
GRS 1915 flare during 12 hrs (out of 500 hrs data processed)

Rotation measure extraction

- Select data with Stokes Q and Stokes U
- Get polarization angle maps
  - One per epoch
  - Per narrow frequency interval
    - 1 MHz @ 1.6 GHz
    - Matching resolution across each band
- Measure polarization angles
  - Polarised emission is compact
- Rotation Measure is PA change with λ^2



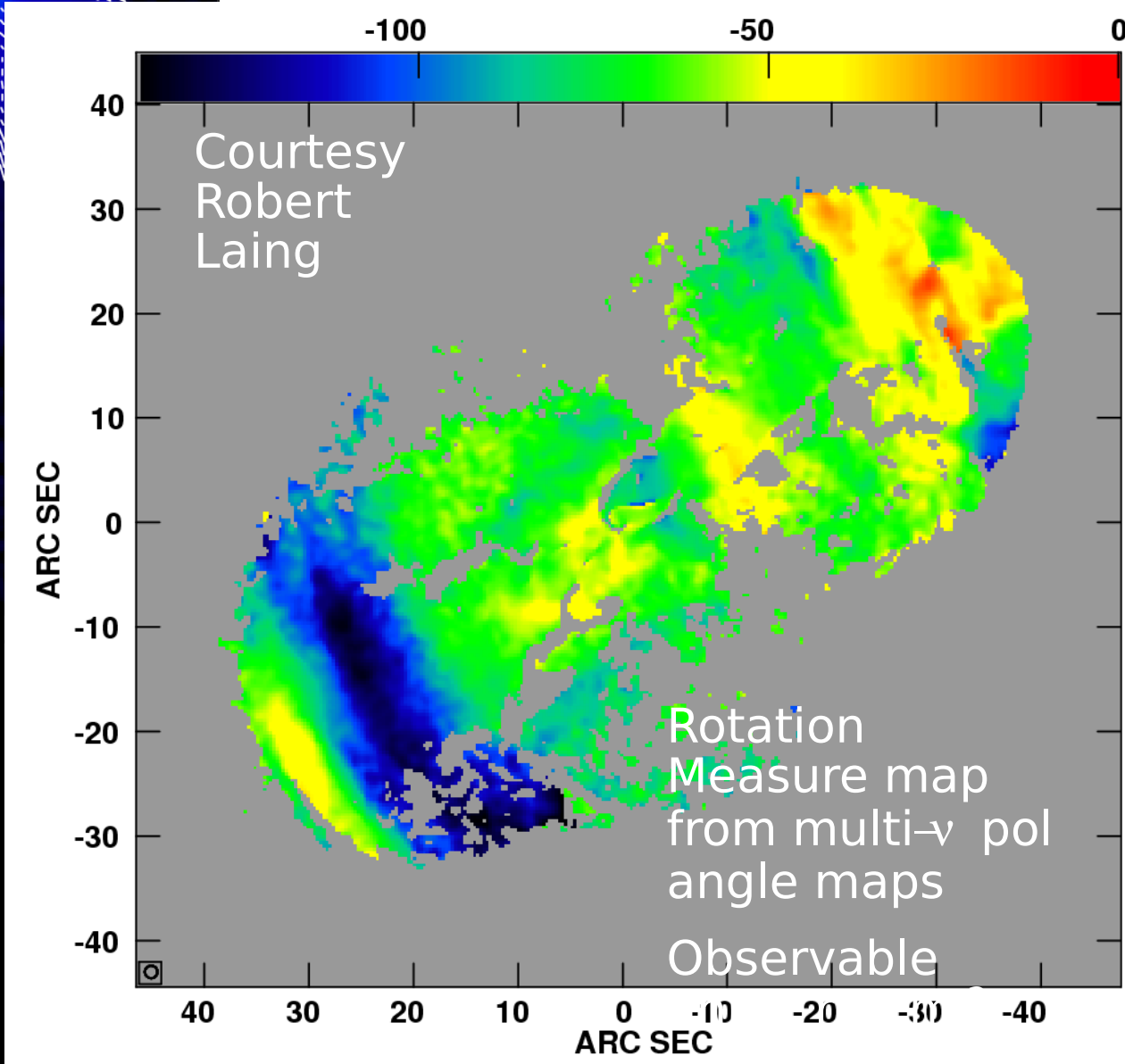
Map products and units



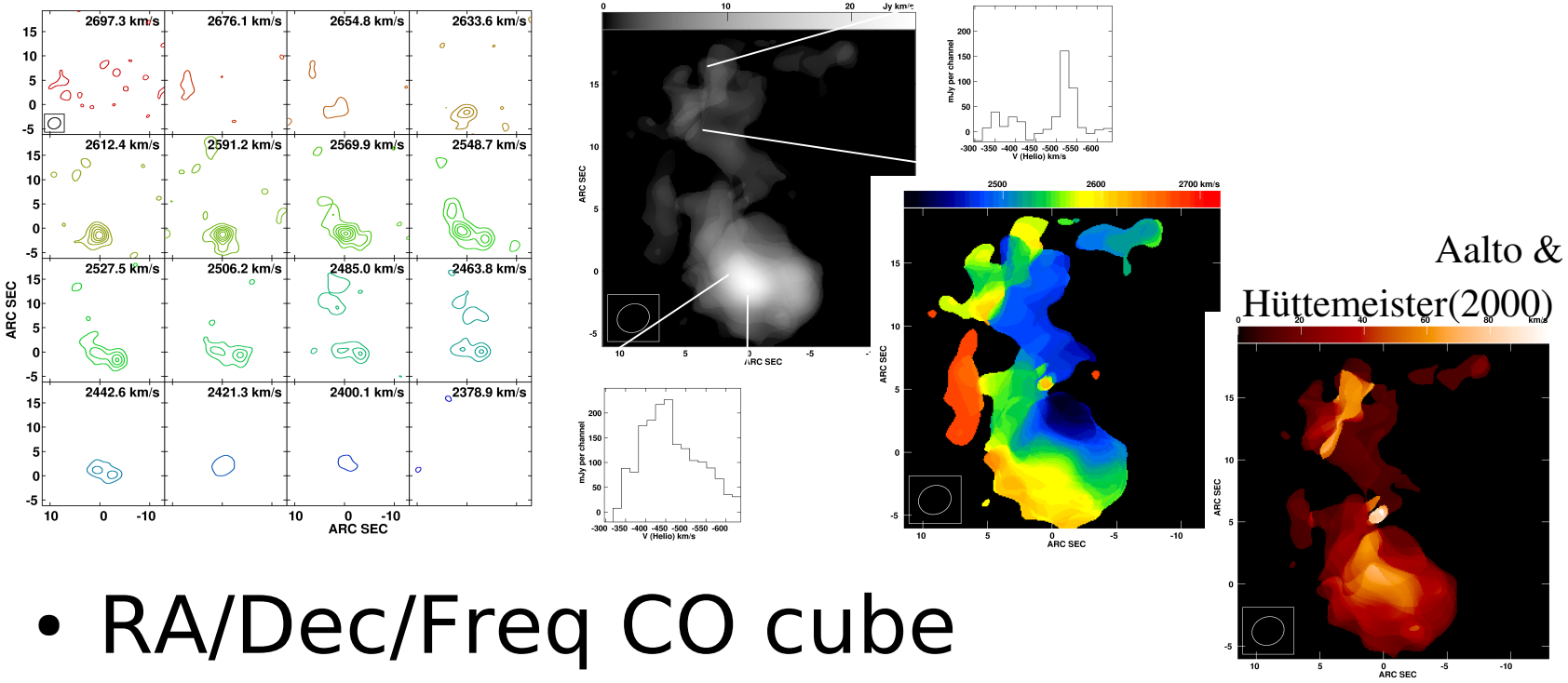
Vectors show E-field direction

Length proportional to polarized intensity

Made from maps of Pol angle (observable units: degrees) and Pol Intensity (Jy/beam)



ALMA/IRAM use case



- RA/Dec/Freq CO cube
  - Convert to velocity (LSR, radio convention)
  - Cutouts, simple squashes - VO tools?
  - Smoothed spectra, moments with noise cut-off
    - Specialised server-side pipeline controlled via UWS