Reduction and Analysis of Continuum Observations

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Continuum & polarization mapping with the Effelsberg dish

Single-horn receivers (1.4, 2.6 and 8.4 GHz):

- Coordinate system: RA/DEC, L/B, ...
- Turned maps possible (along elongated sources)
- Scanning alternately in two perpendicular directions

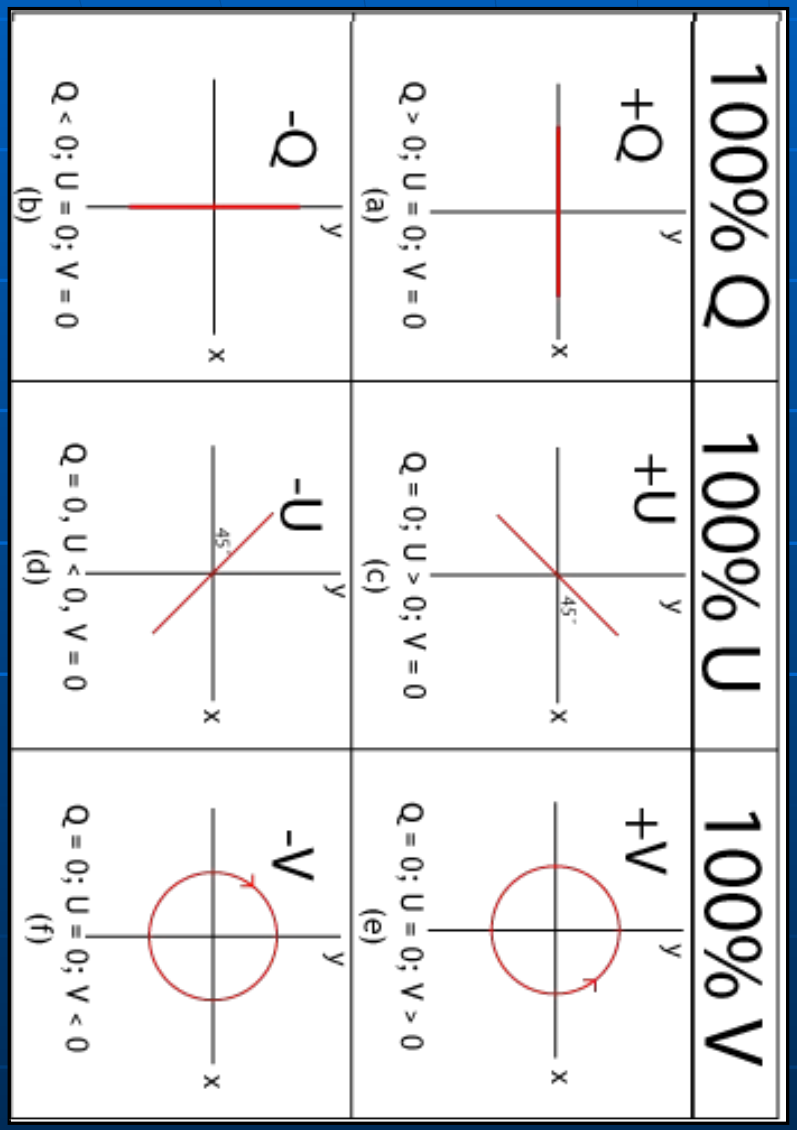
Multi-horn receivers in secondary focus (4.8, 10.4, 32 GHz):

- Coordinate system: only AZM/ELV
- Only one scanning direction (to allow for software beam switching and restoration)

Ø These receivers detect circularly polarized (& unpolarized) signals (Stokes channels R and L)

Ø The digital correlator generates signals in channels U and Q

Stokes parameters



Polarization angle:

$\psi = 0.5 \arctan (U/Q)$

counted counterclockwise from the north

Synchrotron emission:

Polarization "vector" is oriented $\perp$ to the magnetic field

(B-"vector" is aligned with the magnetic field)

Initial data reduction

TOOLBOX on a PC in Effelsberg:

- Filtering of RFI
- Baselevel subtraction of subscans
- Averaging of points in scanning direction to obtain square pixels
- Combination of subscans into map
- Transformation into MBFITS maps

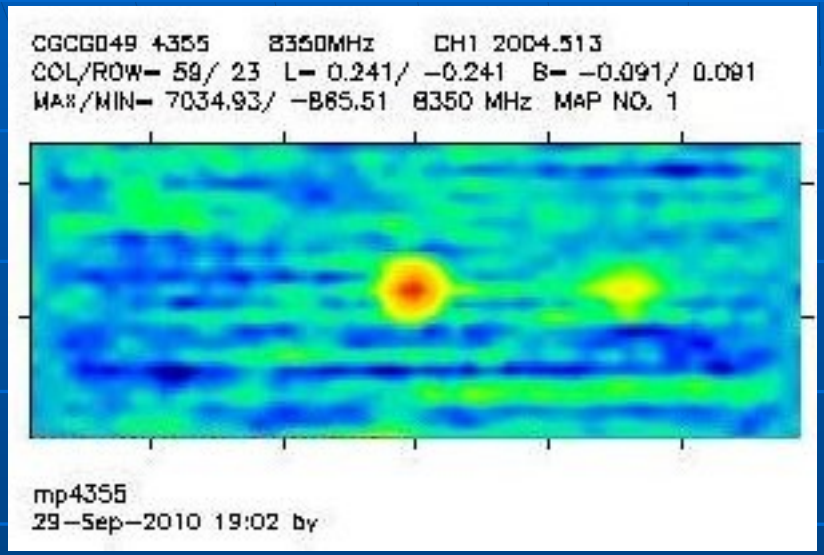
Ø Result: 4 maps (in Stokes R, L, U, Q) per horn and per frequency channel

Pipelines on a PC in Effelsberg or Bonn:

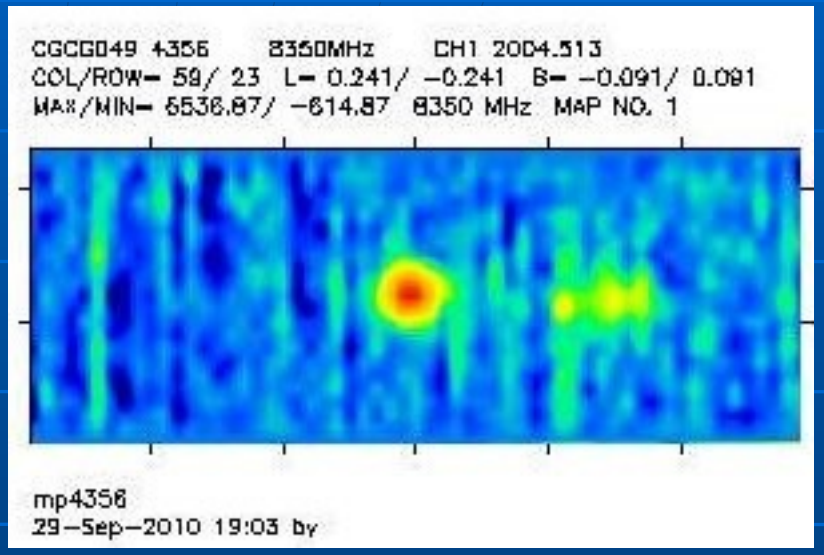
- Restoration of multi-horn maps
- Transformation into RA/DEC coordinate system
- Gaussian fits to maps of calibration sources (to calibrate the flux scale and the absolute polarization angle)

Raw Stokes maps (8.35 GHz)

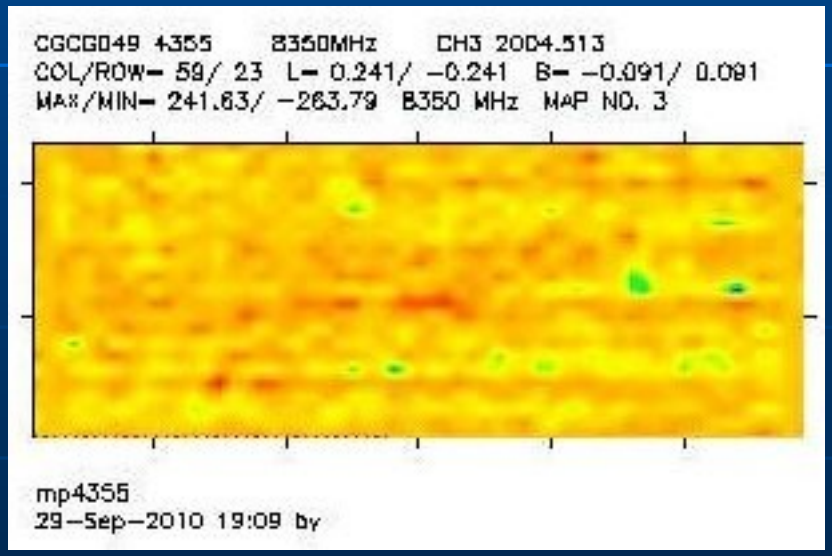
I



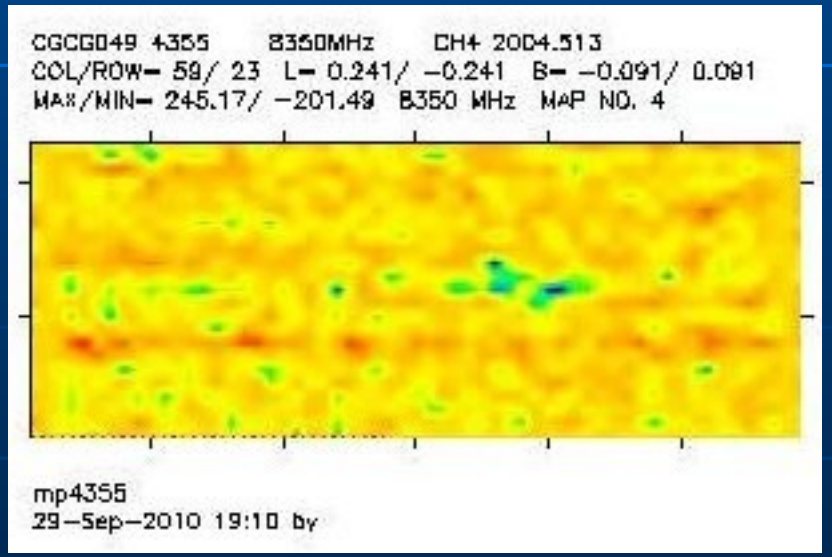
I



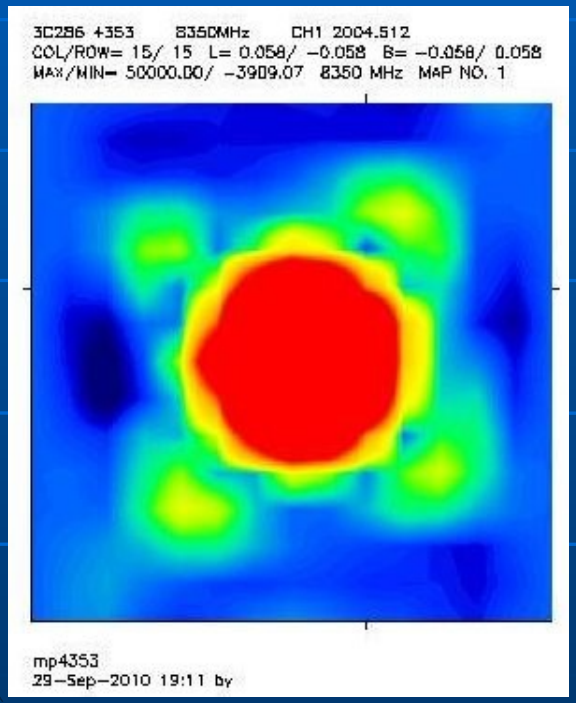
U

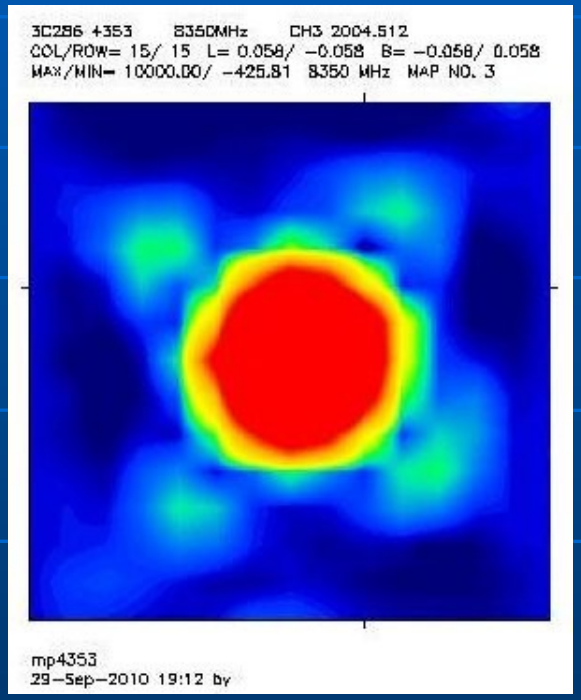


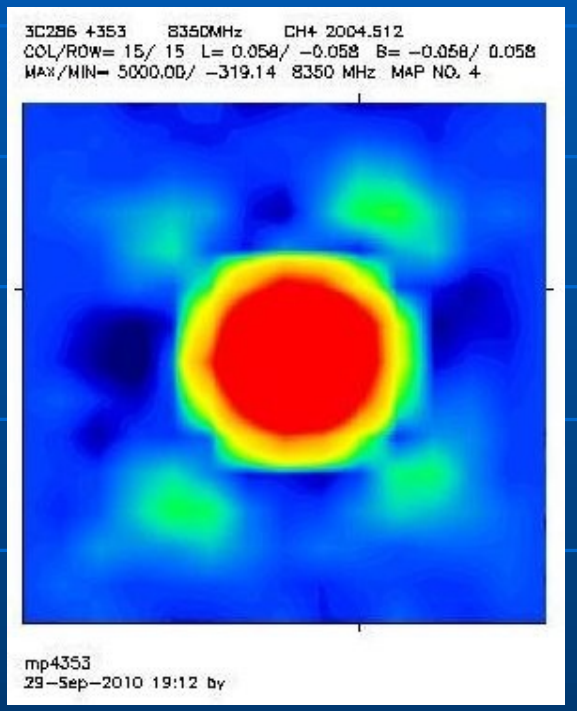
Q



Raw calibrator maps (8.35 GHz)

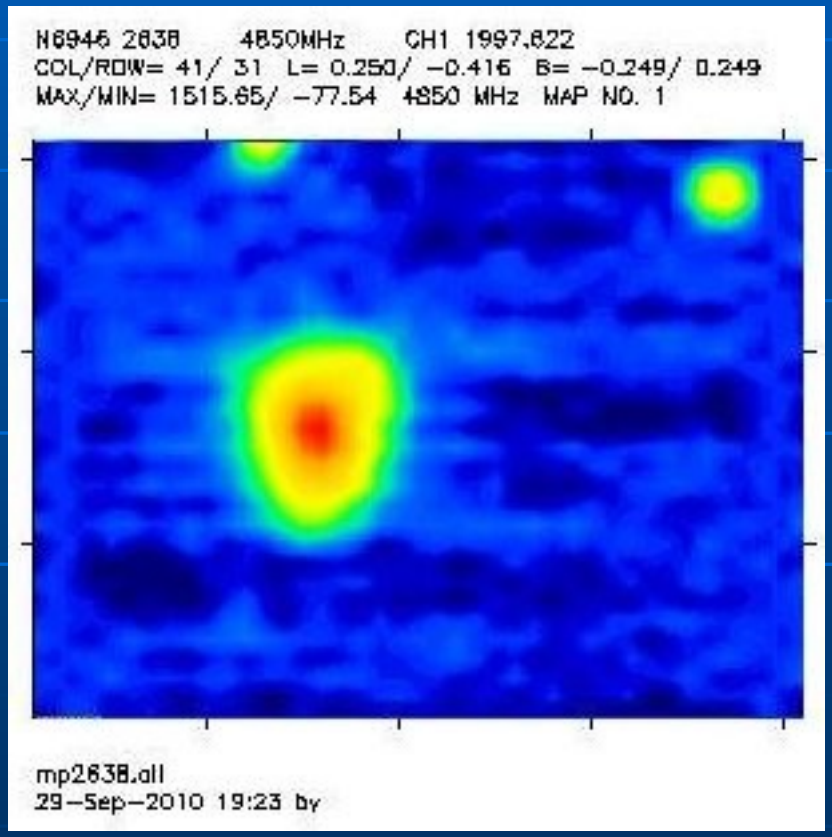


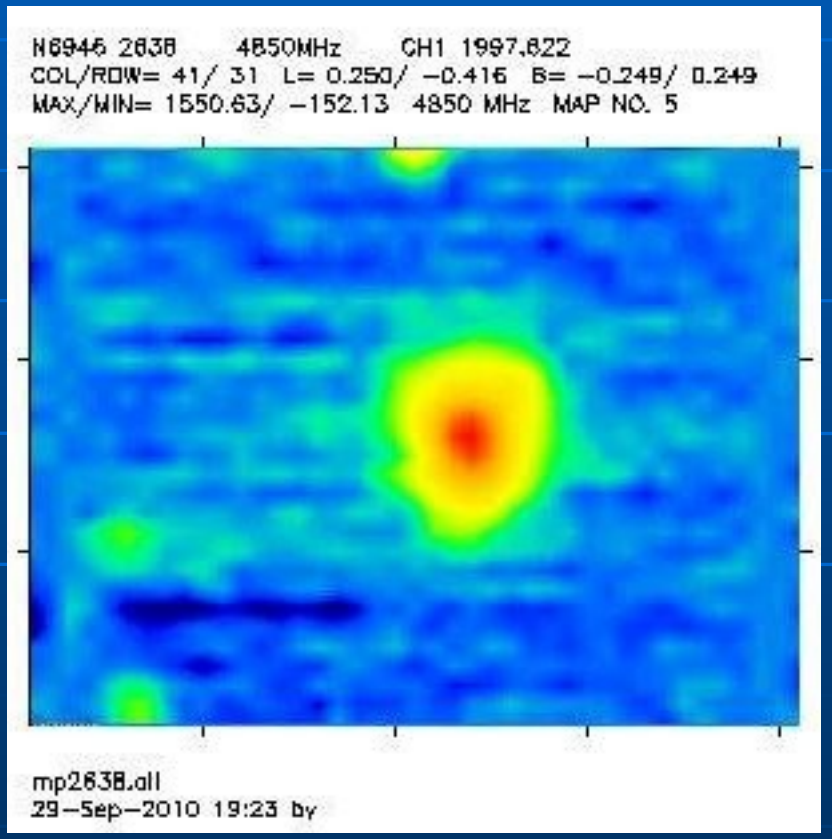




I **U** **Q**

Dual-horn observations (4.75 GHz)





Advanced data reduction

OZMAPAX on PC in Effelsberg or Bonn:

- Removal of RFI spikes
- Correction of distortions due to clouds
- Correction of baselevel distortions due to sources
- Checking of pointing errors
- Measuring noise

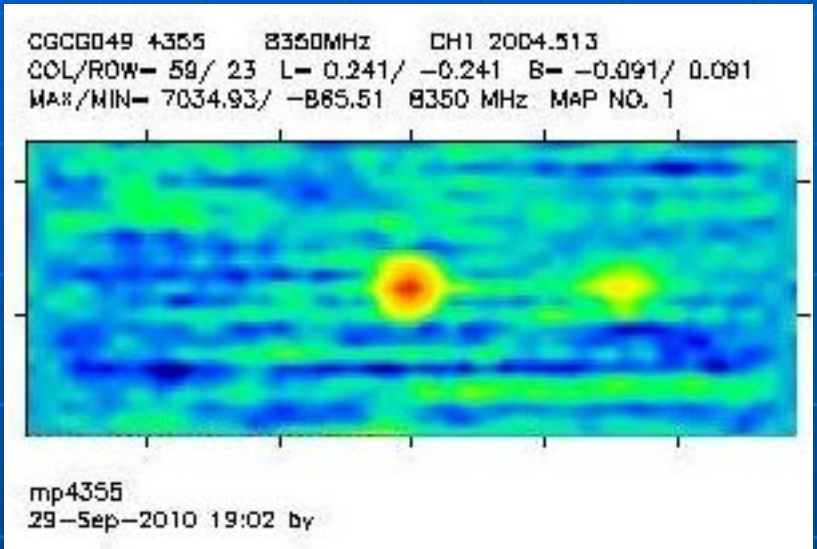
TURBOPLAIT: Combination of all maps to one final map in each Stokes parameter (I and U and Q)

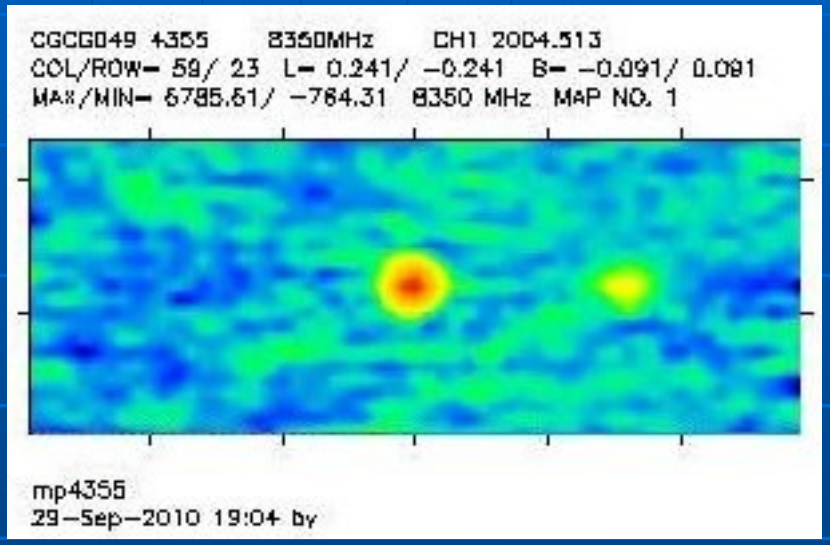
REBEAM: Remove sidelobes in I, U and Q

POLDEN: Combination of the final maps in U and Q to maps in polarization intensity (PI) and angle (PA) and polarization percentage (PC)

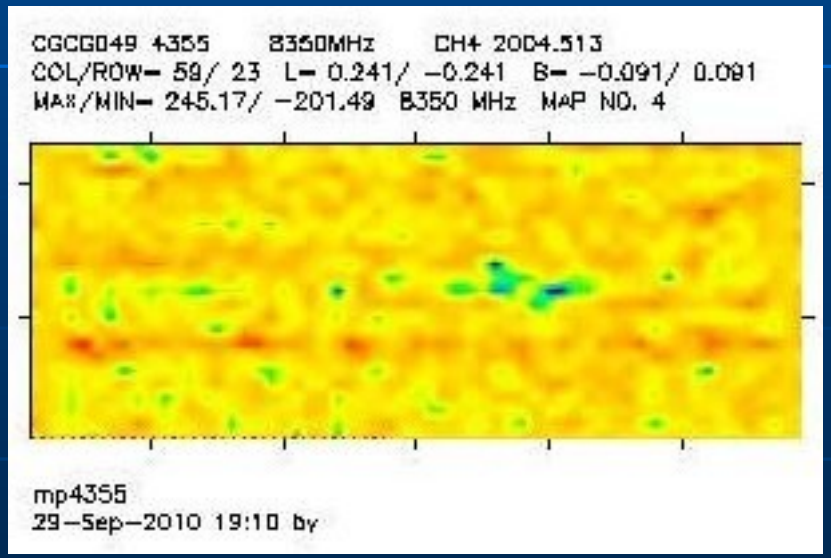
Removal of scanning effects by clouds

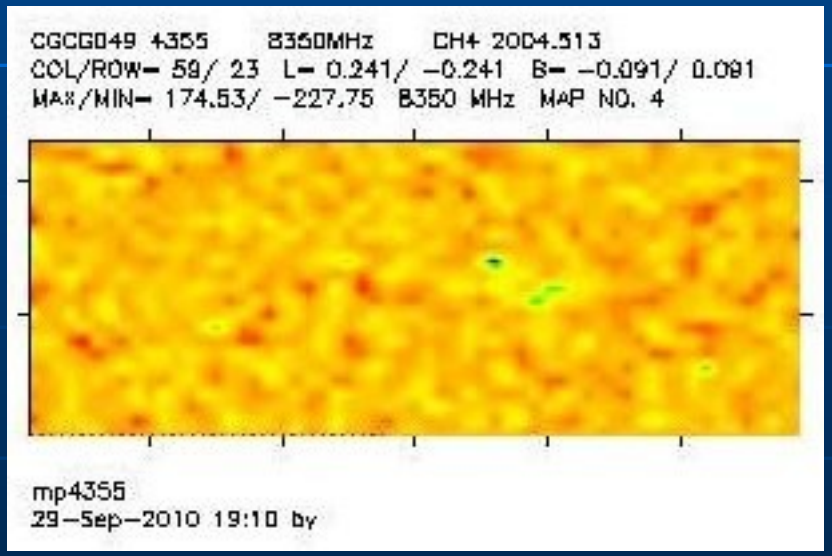
I



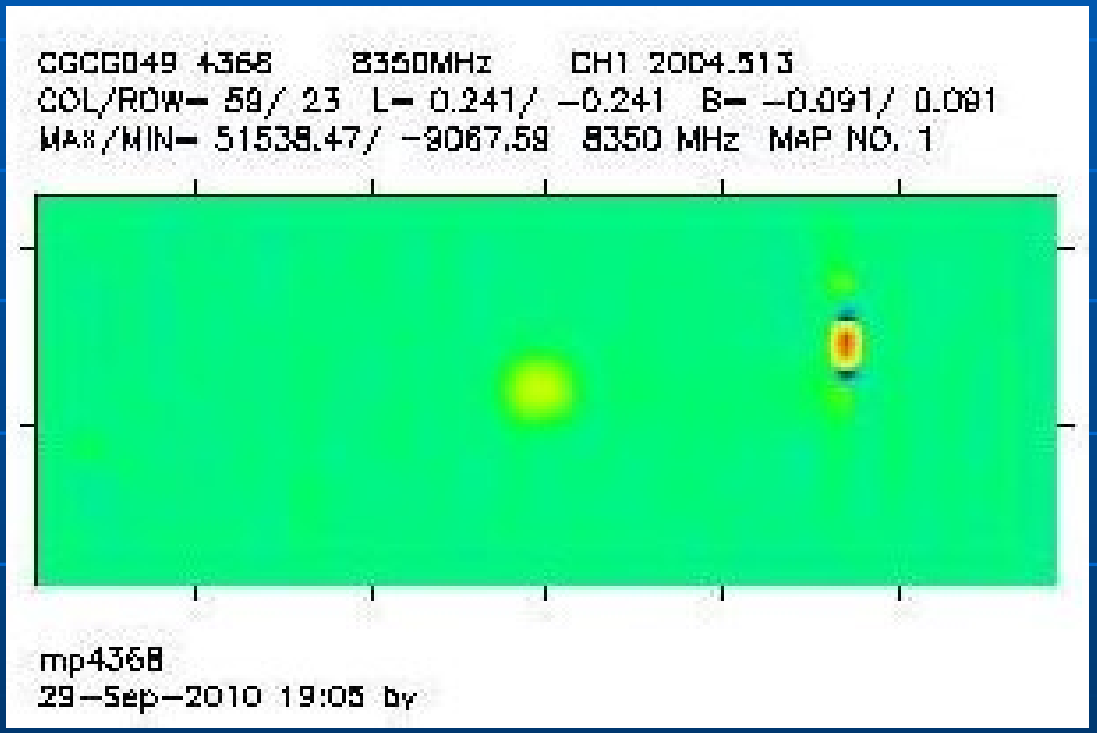


Q





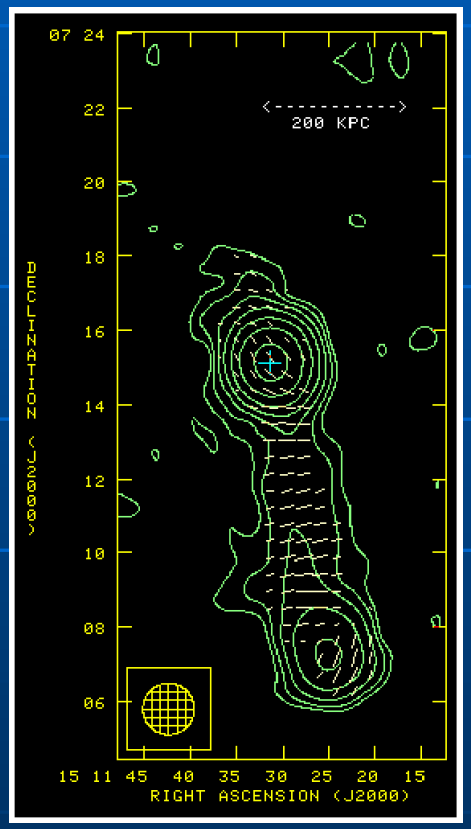
RFI

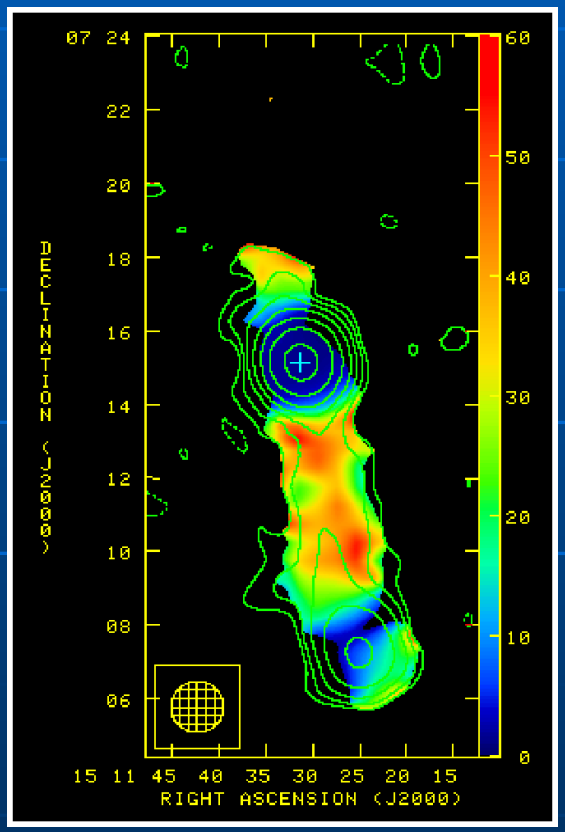

CGCG049 4368 8350MHz CH1 2004.513
COL/ROW= 59/ 23 L= 0.241/ -0.241 B= -0.091/ 0.091
MAX/MIN= 51538.47/ -9067.58 8350 MHz MAP NO. 1
mp4368
29-Sep-2010 19:05 by

Data analysis

- Flux integration in Stokes I, U and Q
- Maps of spectral index and errors
- Maps of Faraday rotation measures (RM) and errors
- Profiles of I, PI, polarization degree, spectral index, RM
- Determine large-scale magnetic field patterns
- Equipartition magnetic field strengths

The target for today & tomorrow: the giant radio galaxy CGCG 049-033

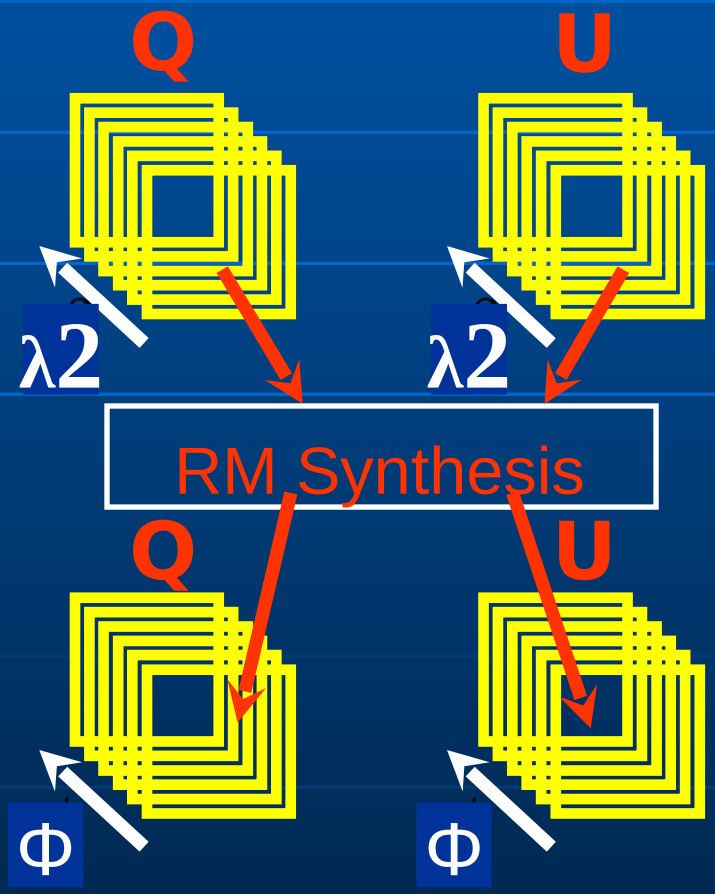




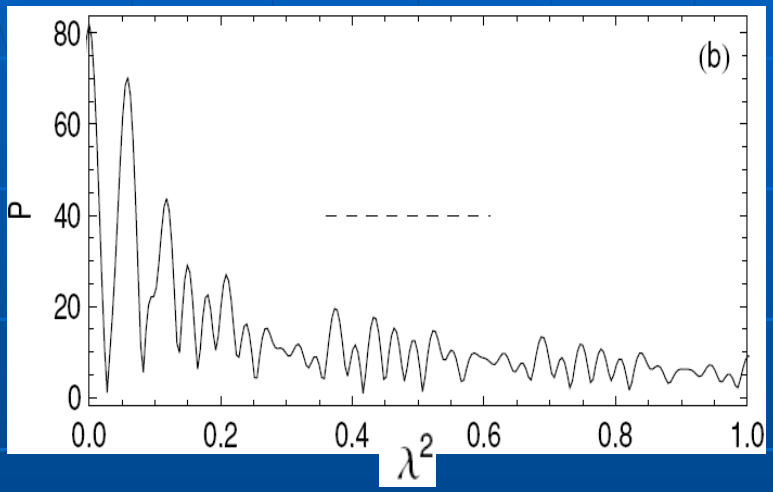
Effelsberg 3.6cm: I+B, I+p (Bagchi et al. 2007)

The future: Spectro-Polarimetry (RM Synthesis)

RM synthesis works on observed Q,U cubes in wavelength to produce **RM-cubes** in Faraday depth:



Spectro-polarimetry in radio continuum



$F(\phi)$?

What is the source distribution along the line of sight (in “Faraday space”) ?

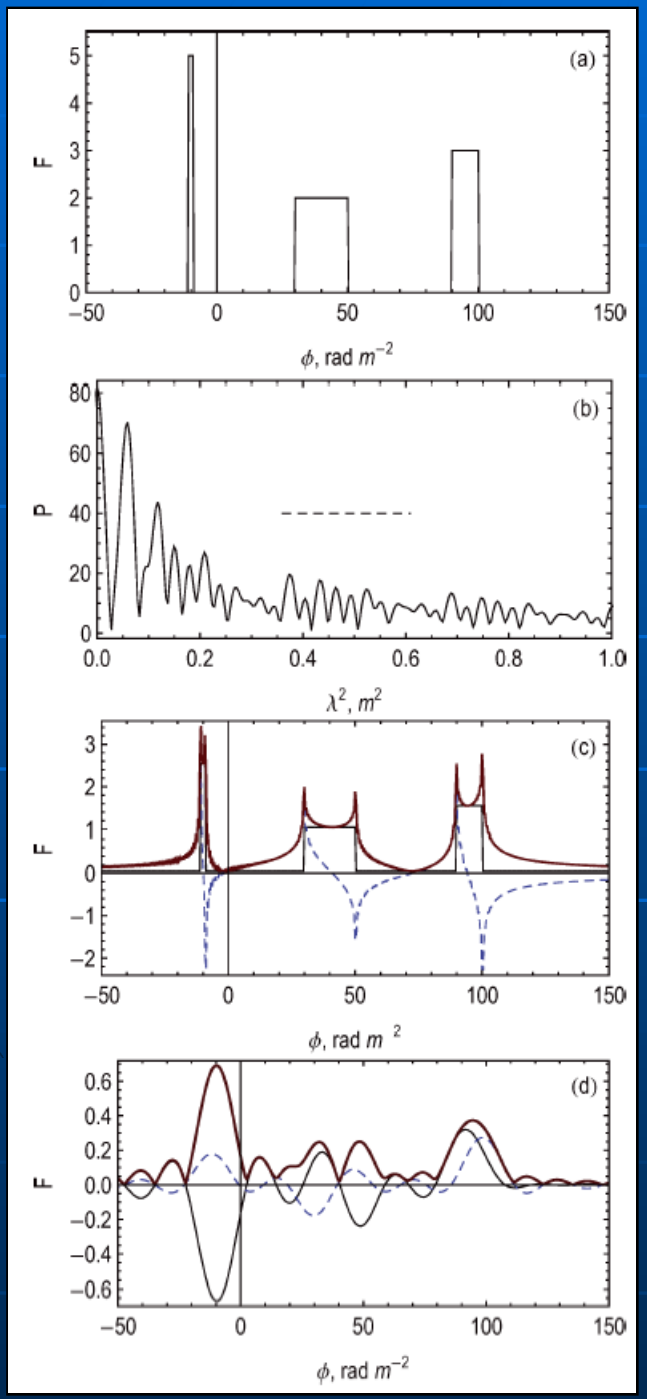
Burn (1966) noted that the observed complex polarized intensity *P* is related to the Faraday spectrum *F*(*φ*) as:

$$P(\lambda^2) = \int_{-\infty}^{\infty} F(\phi) \mathrm{e}^{2\mathrm{i}\phi\lambda^2} \, \mathrm{d}\phi$$

$$F(\phi) = \frac{1}{\pi} \hat{P}(k),$$

$$k = 2\phi$$

Fourier transform ("**RM Synthesis**") first introduced into multi-channel polarization observations by Brentjens & de Bruyn (2005)



(a) Structures in Faraday space (real part)

(b) Observed polarized intensity

(c) RM Synthesis (real and imaginary part) for full coverage in wavelength

(d) RM Synthesis for a limited wavelength coverage (0.6-0.8m)

Future is bright & 3-D