

First results from 18-22cm VLBA polarisation observations of the MOJAVE-I AGNs

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The Science: Studying the Jets of AGN on Scales of 10-100 pc

- Active Galactic Nuclei emit jets of plasma at relativistic speeds
- Polarisation of the synchrotron radiation emitted by these jets can be studied to get information about jet magnetic fields
- Multiwavelength VLBA observations at 18-22cm probe scales from parsecs to 100s of parsecs, enabling study of spectral indices and Faraday rotation

Examples of science addressed by multi-wavelength 18-22cm VLBA observations:

- Jet collimation, bending, interaction with surrounding medium
- Evolution of morphology and magnetic field with distance from jet origin
- Studies of Faraday rotation occurring local to the AGN
- Investigation of specific jet magnetic field structures, such as evidence for helical magnetic fields (expected due to rotation of central accretion disc and jet outflow)

The Experiment: BG196

- Simultaneous VLBA observations at 1358, 1430, 1493 and 1665 MHz (22.1, 21.0, 20.1 and 18.0 cm)
- 135 MOJAVE-I AGN observed across 9 epochs; first epoch obtained in early 2010, observations and processing expected to be finished in 2011-2012
- Designed for intensity and polarisation studies of AGN jets on scales out to 100s of parsecs
- Enables studies of multi-wavelength phenomena, such as spectral indices and Faraday rotation
- First 6 epochs obtained, first 3 (A, B, C) have been calibrated and some results are shown here

Calibration and Imaging

- Preliminary calibration and polarisation (D-term) calibration done using standard techniques
- Polarisation angle calibration done using integrated (VLA) observations of compact polarised sources; for epoch C, used previously calibrated VLBA observation in same mode, due to failure to include EVPA calibrator in VLBA schedule

$$\Delta\chi = \chi_{true} - \chi_{observed}$$

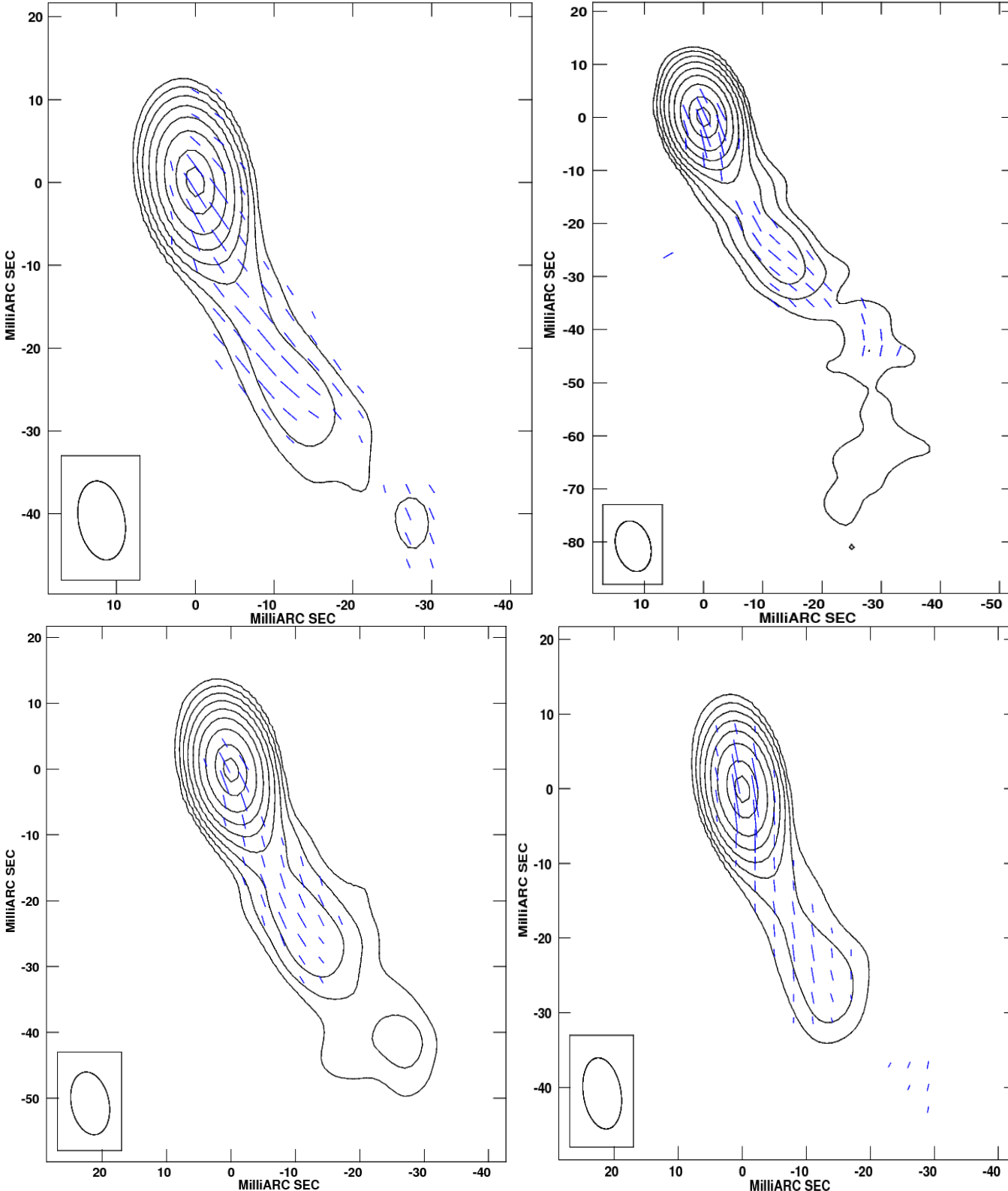
Frequency MHz	Jan 2004 BG139 $\Delta\chi$ (deg.)	Feb 2010 Epoch A $\Delta\chi$ (deg.)	Mar 2010 Epoch B $\Delta\chi$ (deg.)	May 2010 Epoch C $\Delta\chi$ (deg.)
1358	128	130	91	132
1430	113	113	112	113
1493	100	147	84	96
1665	82	91	49	37

- Scripts written to enable semi-automated construction of intensity, polarisation, spectral-index and Faraday-rotation maps

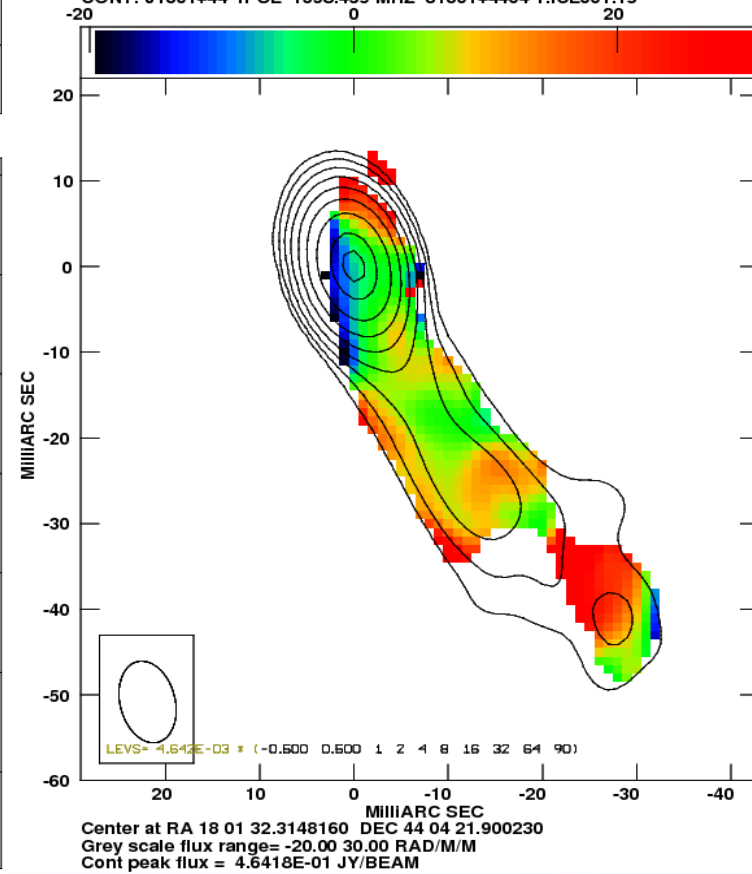
EVPA calibrations for Epoch B

Source: J1801+4404

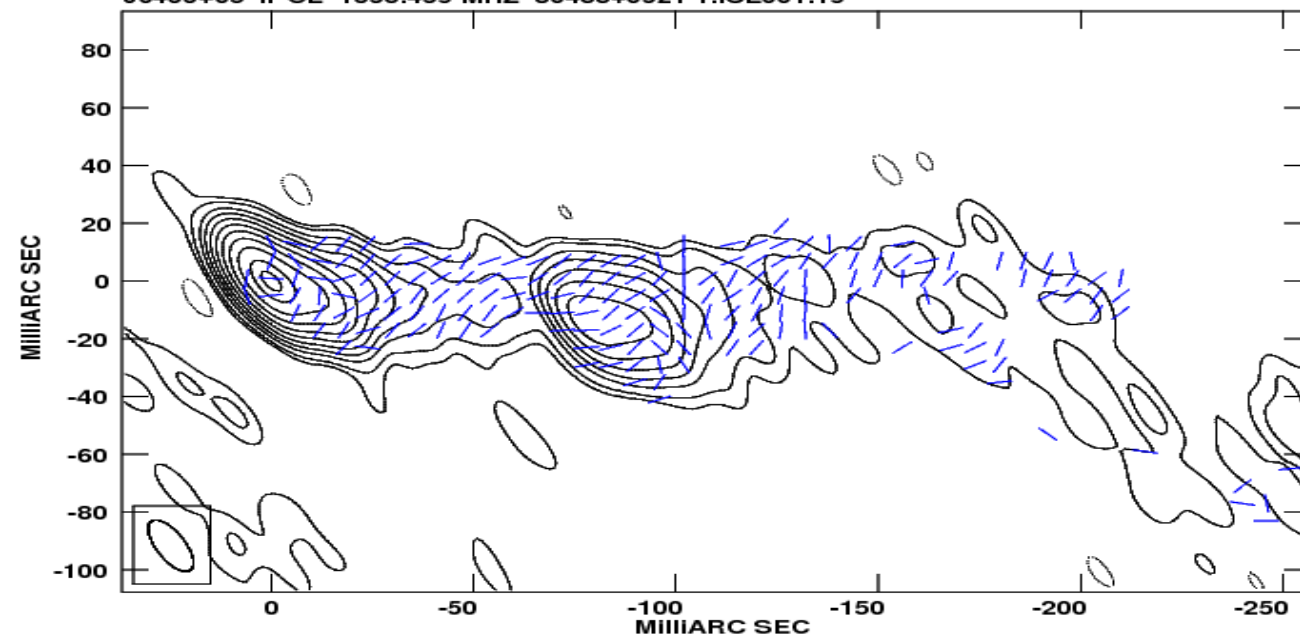
Rotation Measure Map



PLot file version 2 created 17-SEP-2010 12:42:12
 GREY: J1801+44 ROTM J1801+44 M1.ROTMES.1
 CONT: J1801+44 IPOL 1358.459 MHZ J1801+4404 1.ICL001.19



Plot file version 8 created 15-SEP-2010 12:43:57
J0433+05 IPOL 1358.459 MHZ J0433+0521 1.ICL001.19

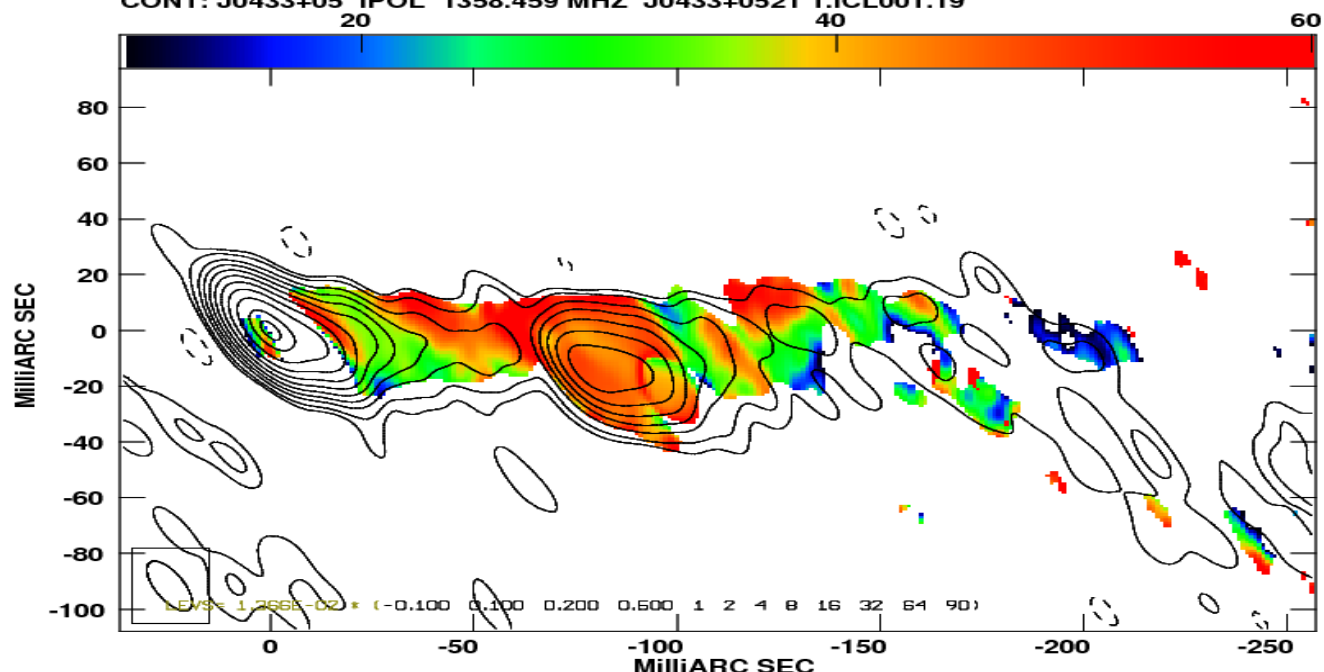


Center at RA 04 33 11.0955280 DEC 05 21 15.619244
Peak contour flux = 1.3661E+00 JY/BEAM
Levs = 1.366E-02 * (-0.100, 0.100, 0.200, 0.500,
1, 2, 4, 8, 16, 32, 64, 90)
Pol line 1 milli arcsec = 1.6667E-01 RATIO
Rotated by 90.0 degrees
PLOT file version 7 created 15-SEP-2010 12:40:05
GREY: J0433+05 ROTM J0433+05 M1.ROTMES.1
CONT: J0433+05 IPOL 1358.459 MHZ J0433+0521 1.ICL001.19

Faraday corrected polarisation Map of 3C120

- The direction of the polarised flux is perpendicular to the magnetic field

Rotation Measure Map of 3C120



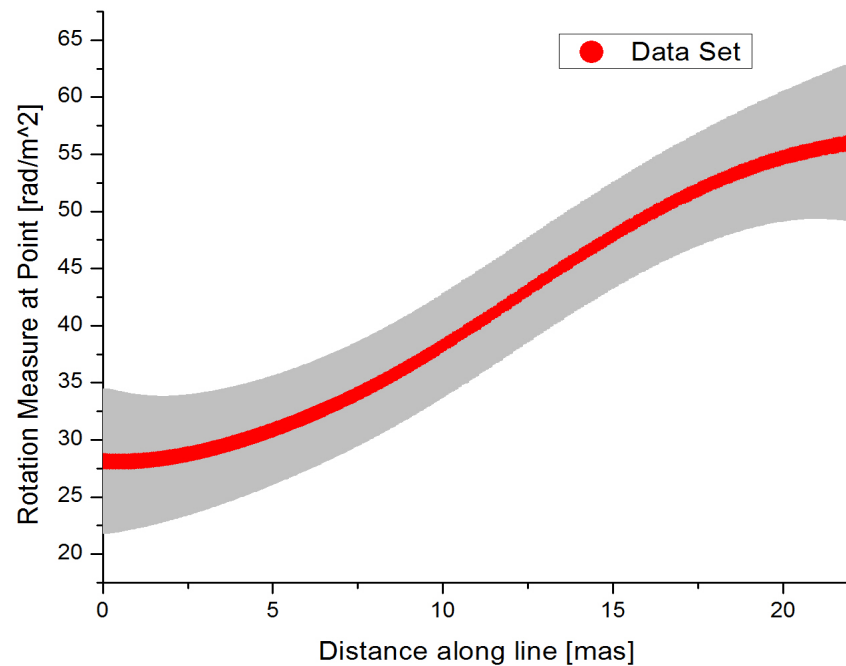
Center at RA 04 33 11.0955280 DEC 05 21 15.619244
Grey scale flux range= 10.00 60.00 RAD/M/M
Cont peak flux = 1.3661E+00 JY/BEAM

- By studying the angle through which the polarisation has been rotated though across 4 frequencies, the Rotation Measure at each point can be found

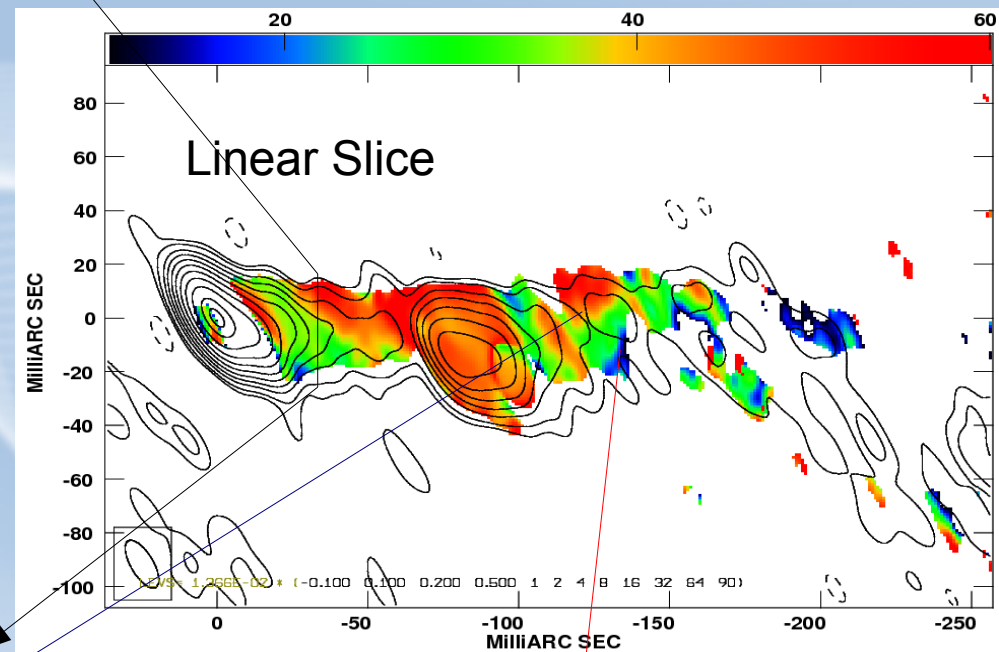
$$\chi_{\text{observed}} = \chi_{\text{intrinsic}} + RM \lambda^2$$

$$RM \propto \int n_e \vec{B} \cdot d\vec{l}$$

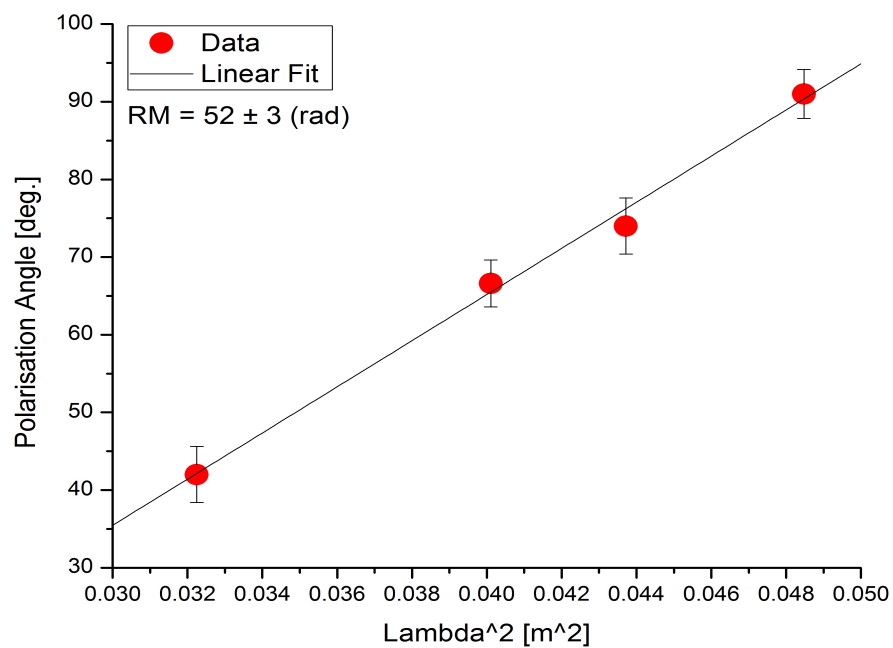
Plot of Rotation Measure of 3C120 along line connecting (294,244) to (294,266)



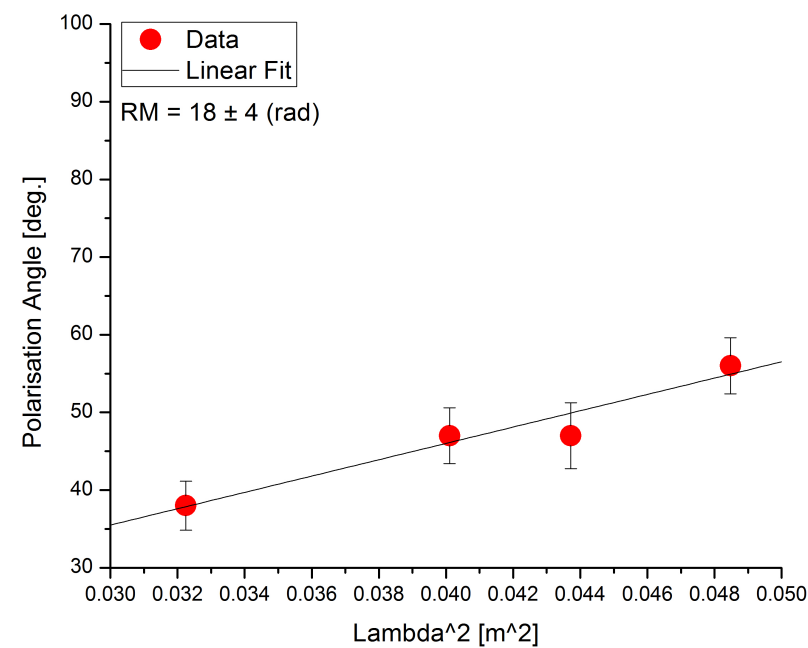
Searching for transverse gradients in
The rotation measure map of 3C120



Rotation Measure of 3C120 at (388,267)

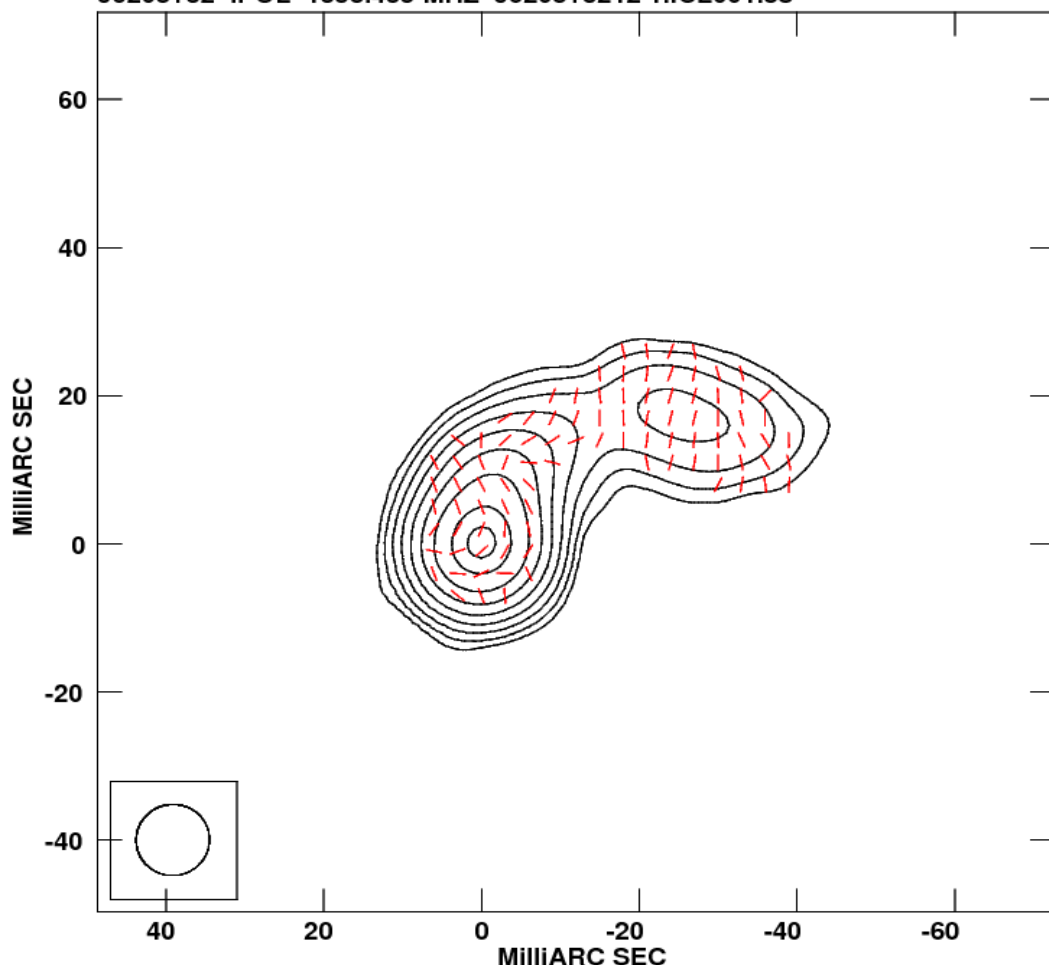


Rotation Measure of 3C120 at (388,241)



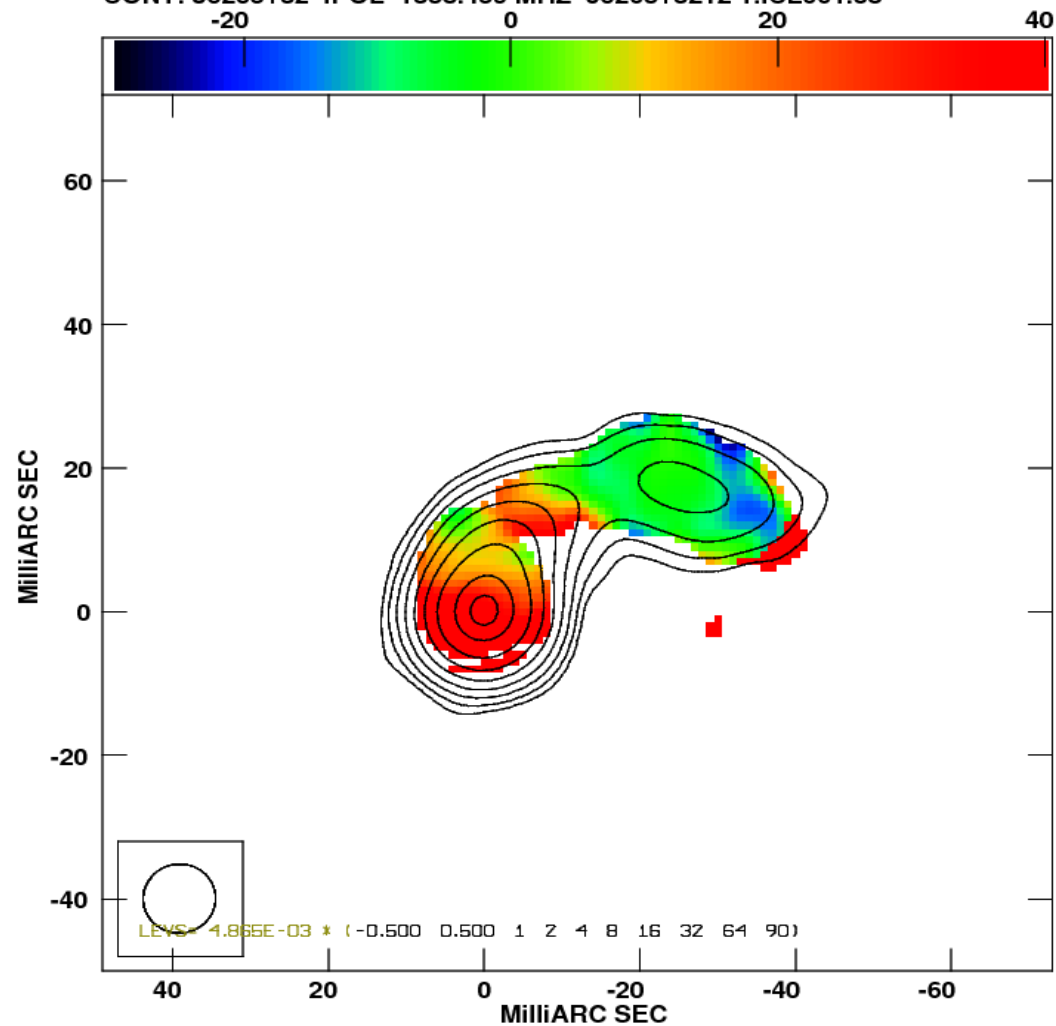
Polarisation structure of J0205+3212

Plot file version 2 created 13-SEP-2010 12:18:49
J0205+32 IPOL 1358.459 MHZ J0205+3212 1.ICL001.38



Center at RA 02 05 04.9253610 DEC 32 12 30.095500
Peak contour flux = 4.8647E-01 JY/BEAM
Levs = 4.865E-03 * (-0.500, 0.500, 1, 2, 4, 8, 16, 32, 64, 90)
Pol line 1 milli arcsec = 5.0000E-01 RATIO
Rotated by 90.0 degrees

PLot file version 1 created 13-SEP-2010 12:16:57
GREY: J0205+32 ROTM J0205+32 M1.ROTMES.1
CONT: J0205+32 IPOL 1358.459 MHZ J0205+3212 1.ICL001.38



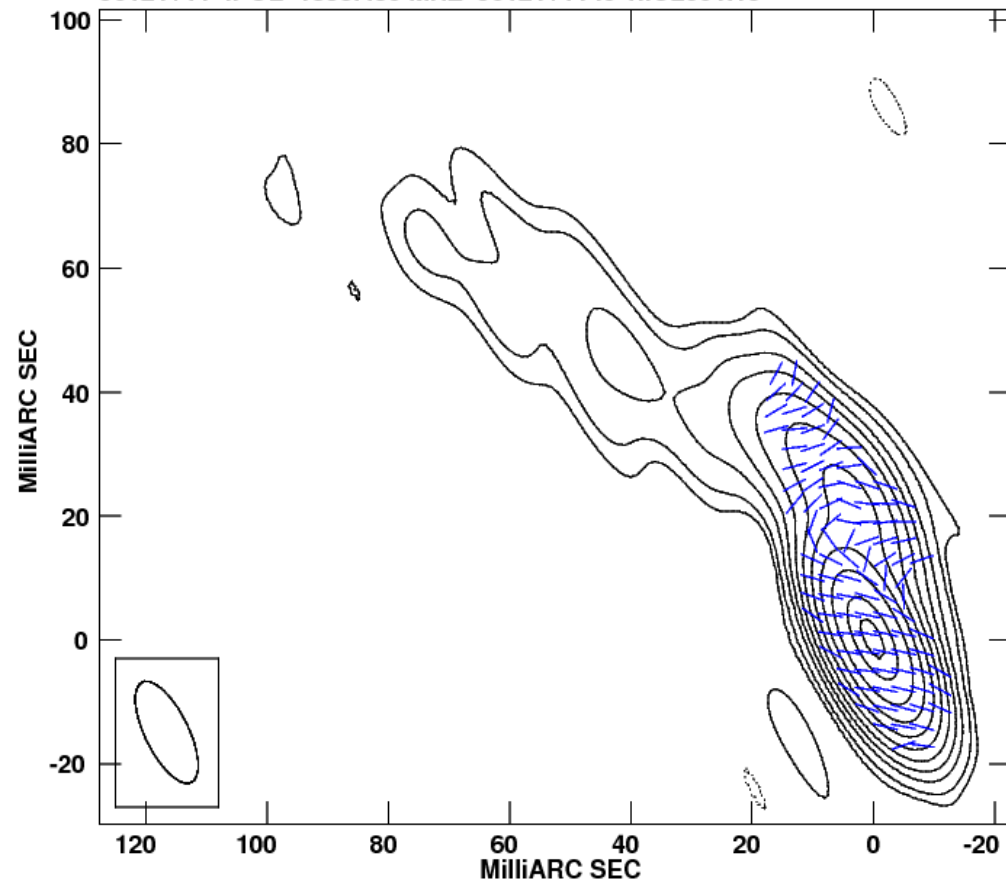
Center at RA 02 05 04.9253610 DEC 32 12 30.095500
Grey scale flux range= -30.00 40.00 RAD/M/M
Cont peak flux = 4.8647E-01 JY/BEAM

Unusual Behaviour in J0121+1149

Sudden changes in polarisation angle

Faraday correction Polarisation Map

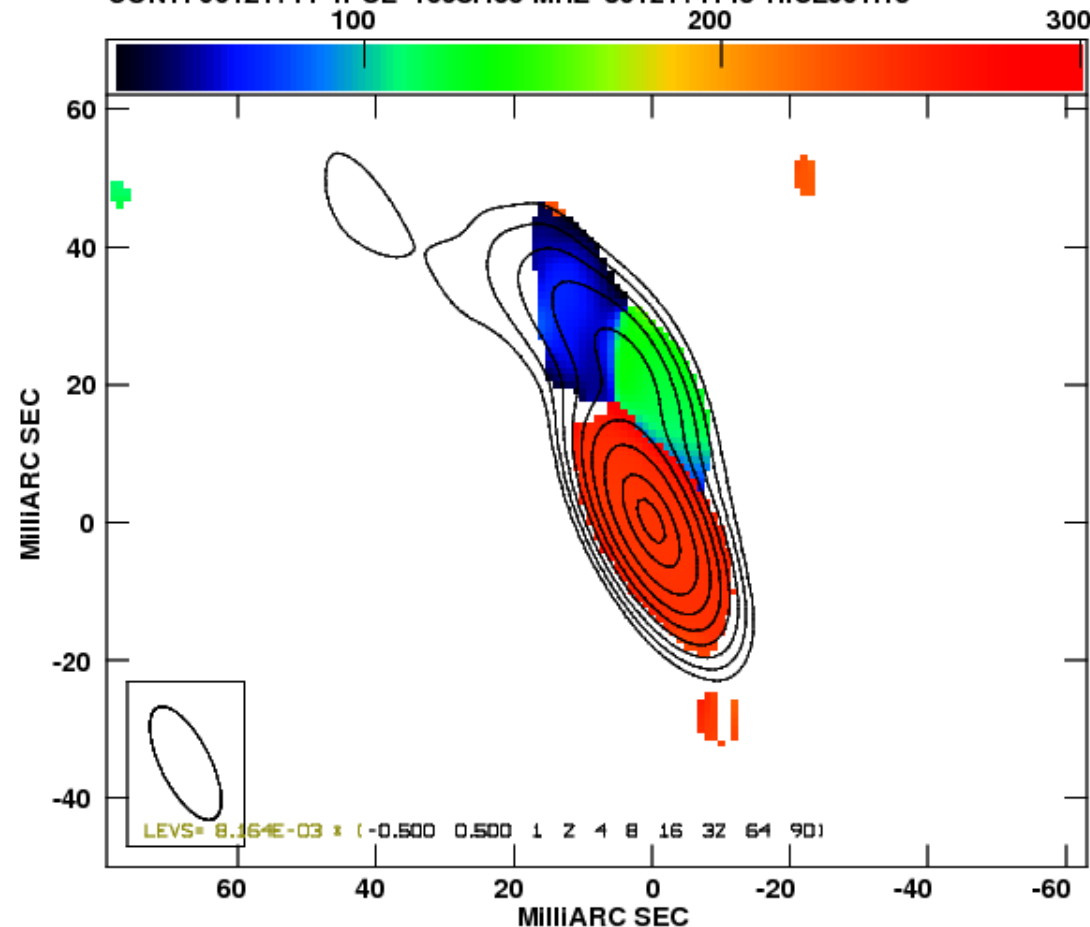
Plot file version 7 created 16-SEP-2010 15:02:44
J0121+11 IPOL 1358.459 MHZ J0121+1149 1.ICL001.19



Center at RA 01 21 41.5950439 DEC 11 49 50.413132
Peak contour flux = $8.1638\text{E-}01$ JY/BEAM
Levs = $8.164\text{E-}03 \times (-0.100, 0.100, 0.200, 0.500, 1, 2, 4, 8, 16, 32, 64, 90)$
Pol line 1 milli arcsec = $2.5000\text{E-}01$ RATIO
Rotated by 90.0 degrees

Rotation Measure Map

Plot file version 8 created 17-SEP-2010 14:44:02
GREY: J0121+11 ROTM J0121+11 M2.ROTMES.1
CONT: J0121+11 IPOL 1358.459 MHZ J0121+1149 1.ICL001.19

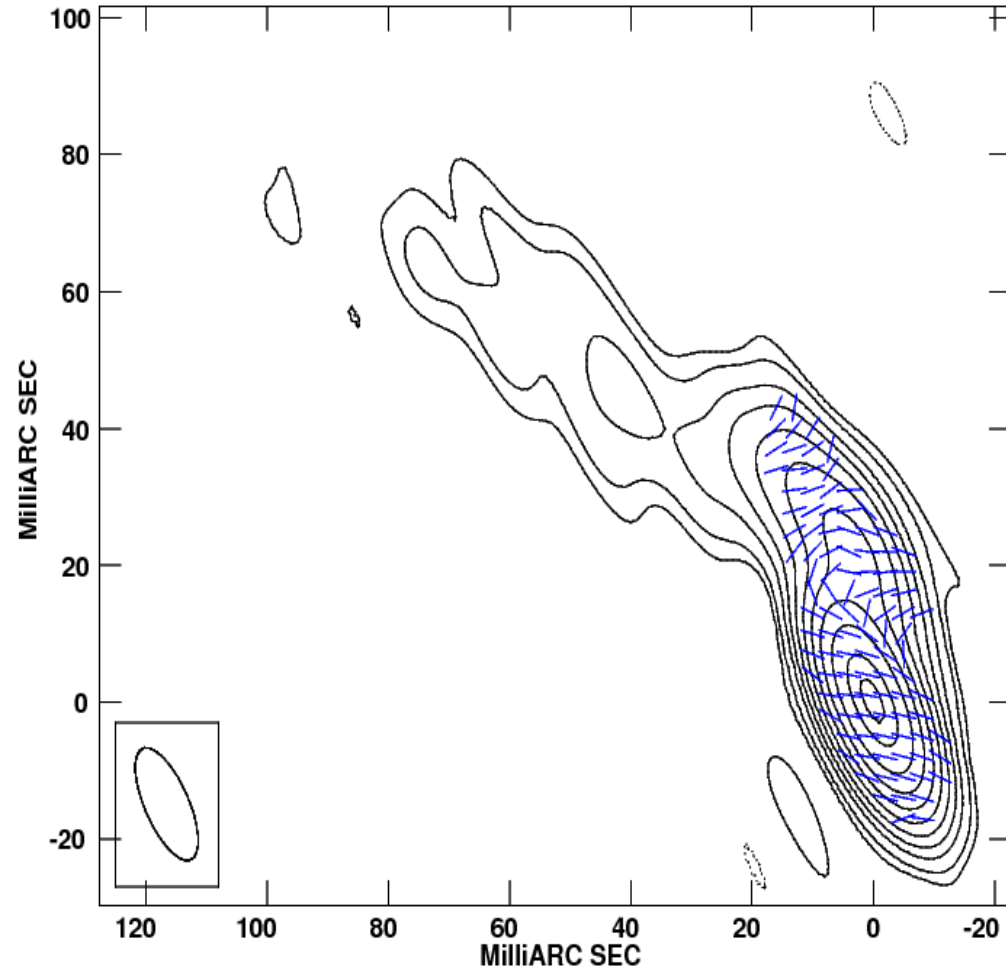


Center at RA 01 21 41.5950439 DEC 11 49 50.413132
Grey scale flux range= 30.0 300.0 RAD/M/M
Cont peak flux = $8.1638\text{E-}01$ JY/BEAM

Unusual Behaviour in J0121+1149

Compare to previous observations

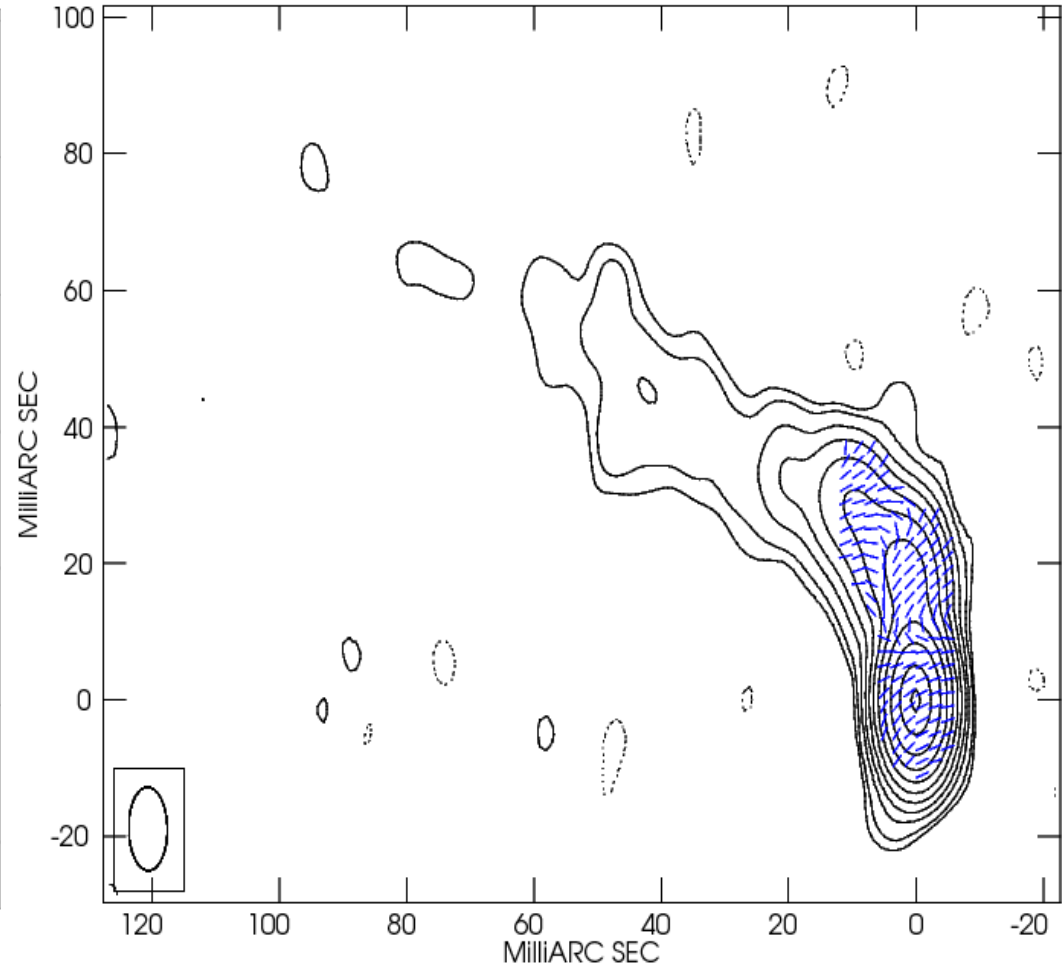
Plot file version 7 created 16-SEP-2010 15:02:44
J0121+11 IPOL 1358.459 MHZ J0121+1149 1.ICL001.19



Center at RA 01 21 41.5950439 DEC 11 49 50.413132
Peak contour flux = $8.1638\text{E-}01$ JY/BEAM
Levs = $8.164\text{E-}03 * (-0.100, 0.100, 0.200, 0.500, 1, 2, 4, 8, 16, 32, 64, 90)$
Pol line 1 milli arcsec = $2.5000\text{E-}01$ RATIO
Rotated by 90.0 degrees

May 2010

Plot file version 5 created 17-SEP-2010 09:07:29
0119+115 IPOL 1354.474 MHZ 0119 A1.ICL001.2



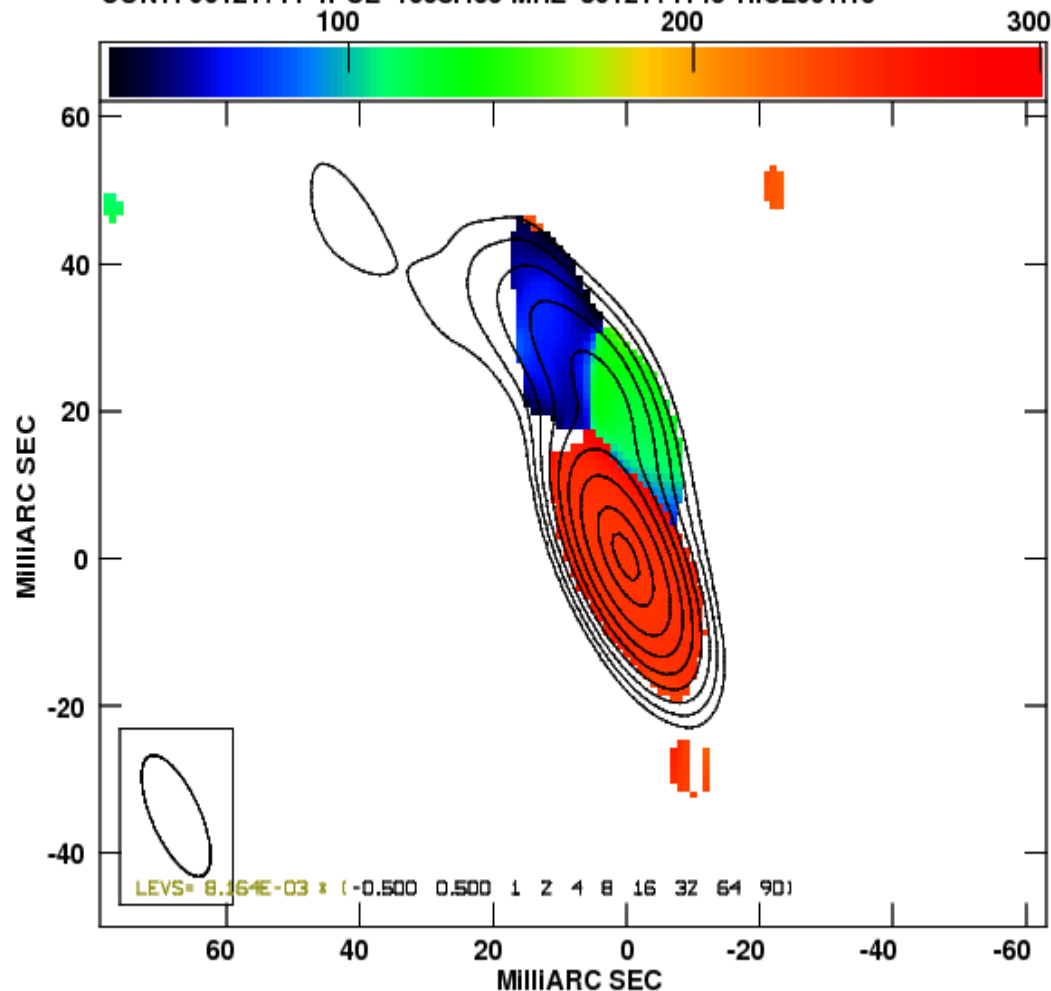
Center at RA 01 21 41.5950430 DEC 11 49 50.413130
Peak contour flux = $8.5997\text{E-}01$ JY/BEAM
Levs = $8.600\text{E-}03 * (-0.100, 0.100, 0.200, 0.500, 1, 2, 4, 8, 16, 32, 64, 95)$
Pol line 1 milli arcsec = $5.0000\text{E-}01$ RATIO
Rotated by 90.0 degrees

Jan 2004

Unusual Behaviour in J0121+1149

Compare to previous observations

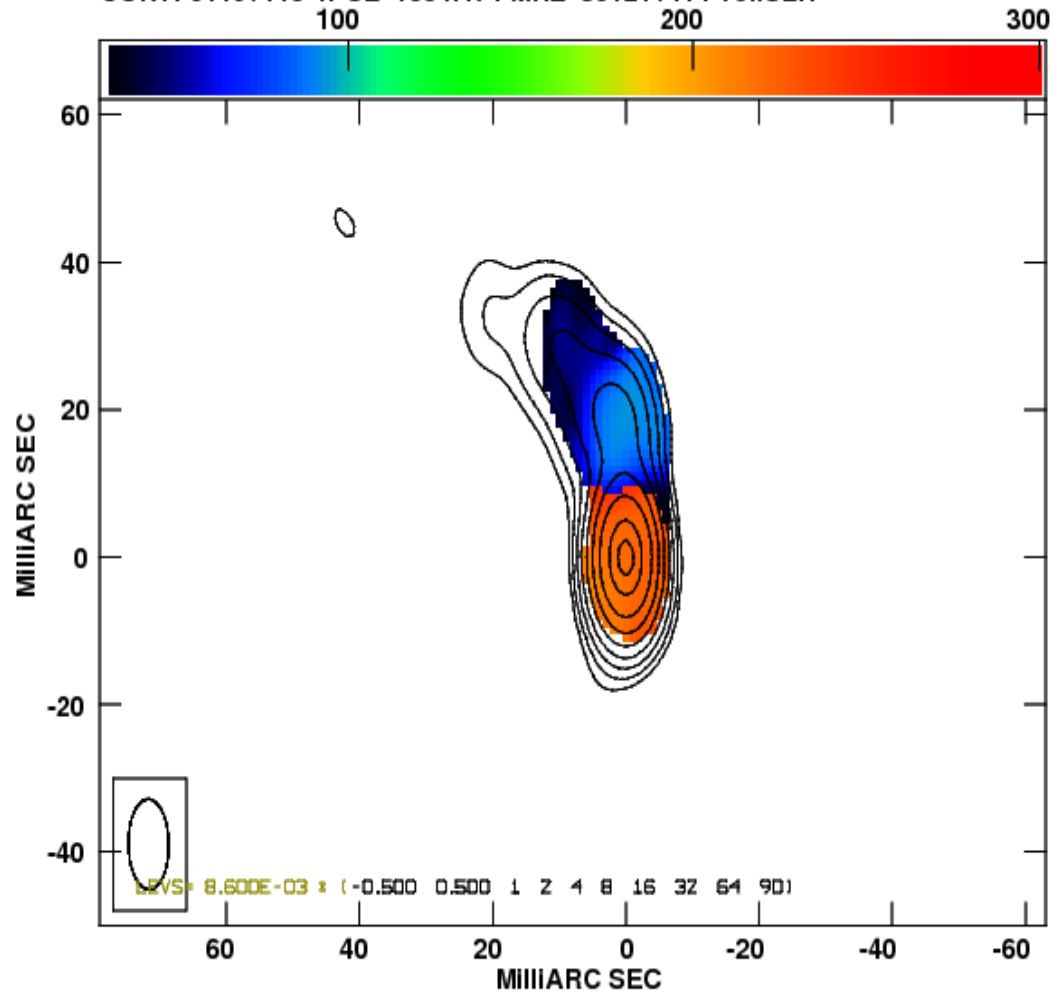
PLot file version 8 created 17-SEP-2010 14:44:02
GREY: J0121+11 ROTM J0121+11 M2.ROTMES.1
CONT: J0121+11 IPOL 1358.459 MHZ J0121+1149 1.ICL001.19



Center at RA 01 21 41.5950439 DEC 11 49 50.413132
Grey scale flux range= 30.0 300.0 RAD/M/M
Cont peak flux = 8.1638E-01 JY/BEAM

May 2010

PLot file version 1 created 17-SEP-2010 14:52:32
GREY: 0119+115 ROTM J0121+114 RO.ROTMES.1
CONT: 0119+115 IPOL 1354.474 MHZ J0121+114 1o.ICL.1



Center at RA 01 21 41.5950430 DEC 11 49 50.413130
Grey scale flux range= 30.0 300.0 RAD/M/M
Cont peak flux = 8.5997E-01 JY/BEAM

Jan 2004

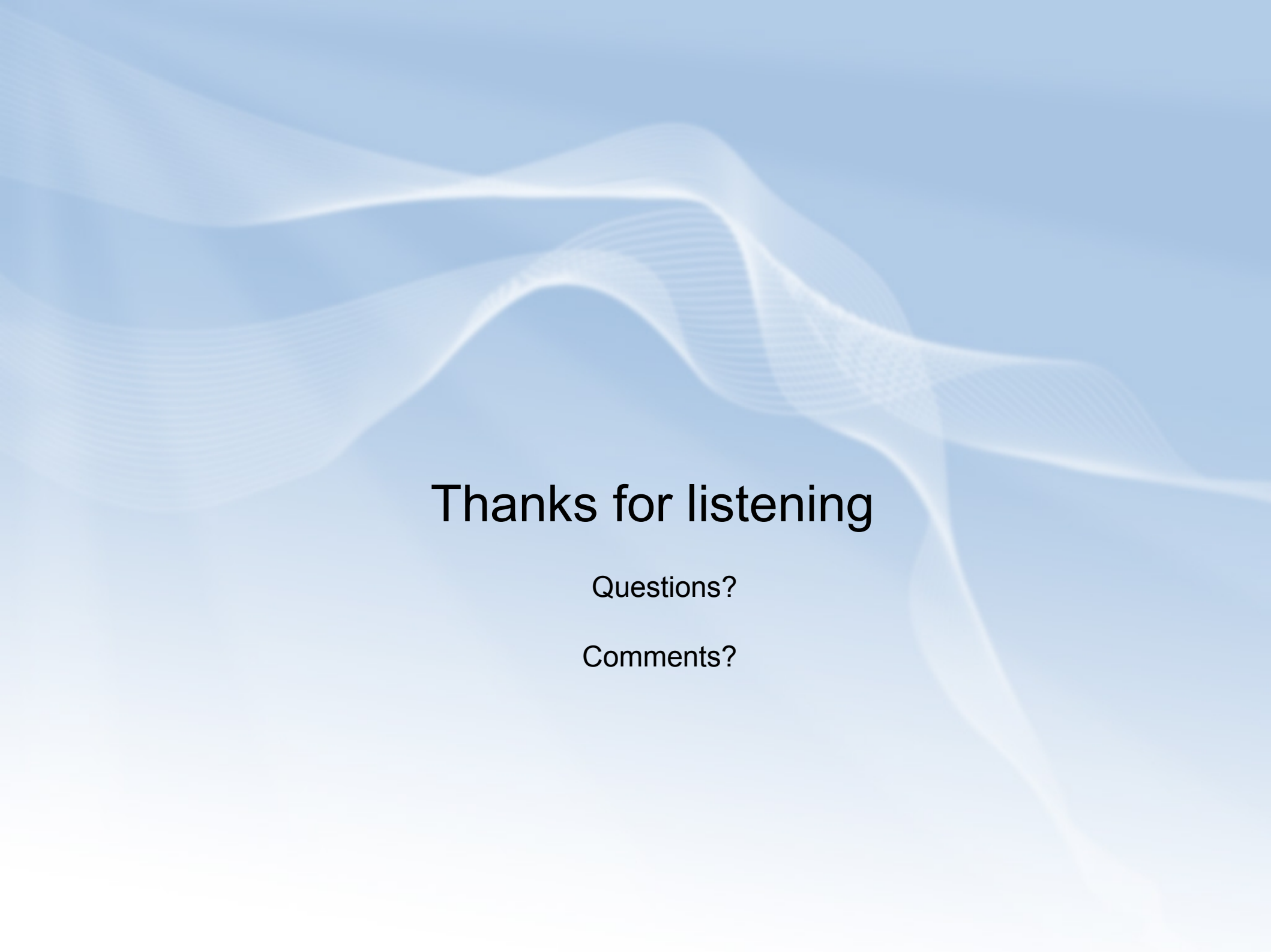
Summary

- 18-22cm VLBA observations well suited to AGN jets on scales out to 10s or 100s of parsecs
- First 3 epochs of 9 observed, calibrated and imaged; data are healthy; analysis for some interesting sources begun
- Plan is to provide calibrated data and images to the community within 1.5 years after last observations are taken, via the MOJAVE website:

<https://www.physics.purdue.edu/astro/mojave/>

- Webpage for this project:

<http://www.physics.ucc.ie/gabuzda/webpage.html>



Thanks for listening

Questions?

Comments?