



Shanghai Astronomical Observatory

VLBI, MERLIN, and VLA Observations of NRAO530

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NRAO530 (1730-130)

a well known OVV

$m_{pg} = 18.5$ mag (Whelch and Spinrad 1973)

$z = 0.902$ (Junkkarinen 1984)

The source is detectable from radio to γ -ray

ROSAT $\sim 1.84 \times 10^{-6}$ Jy at 1.3 keV

(Brinkmann et al. 1994)

EGRET $\sim 4.6 \times 10^{-11}$ Jy at 2.55~GeV

(Fichtel et al. 1994; Thompson et al. 1995).



Radio band

- ◆ VLBI at 1.7 GHz:

 - flux variation at radio bands (e.g., Bondi et al. 1994)

 - structure oriented in north-south direction

 - ~ 25 mas (Romney et al. 1984, Bondi et al. 1994)

- ◆ Proper motion:

 - 7.4 to 7.9 $h^{-1}c$ at 86GHz (Bower et al. 1997)

 - 7 to 29 $h^{-1}c$ at 22 and 43 GHz (Jorstad et al. 2001)





kpc scale

- ◆ VLA observation at 1.4 GHz:
an unresolved core and a second unresolved component 11" around in P.A. -90°
(Perley 1982)
- ◆ without evidence for a connection between the two (Romney et al. 1984).
- ◆ In this paper, we try to find the connection between them



The alignment of EGRET detected AGNs

- ◆ The EGRET detected AGNs are aligned from pc- to kpc-scales (Hong et al. 1998), e.g. 3C273 and 3C345
- ◆ Most EGRET detected quasars have small ΔPA
- ◆ BL Lac Object and a few quasars of gamma ray sources have large ΔPA

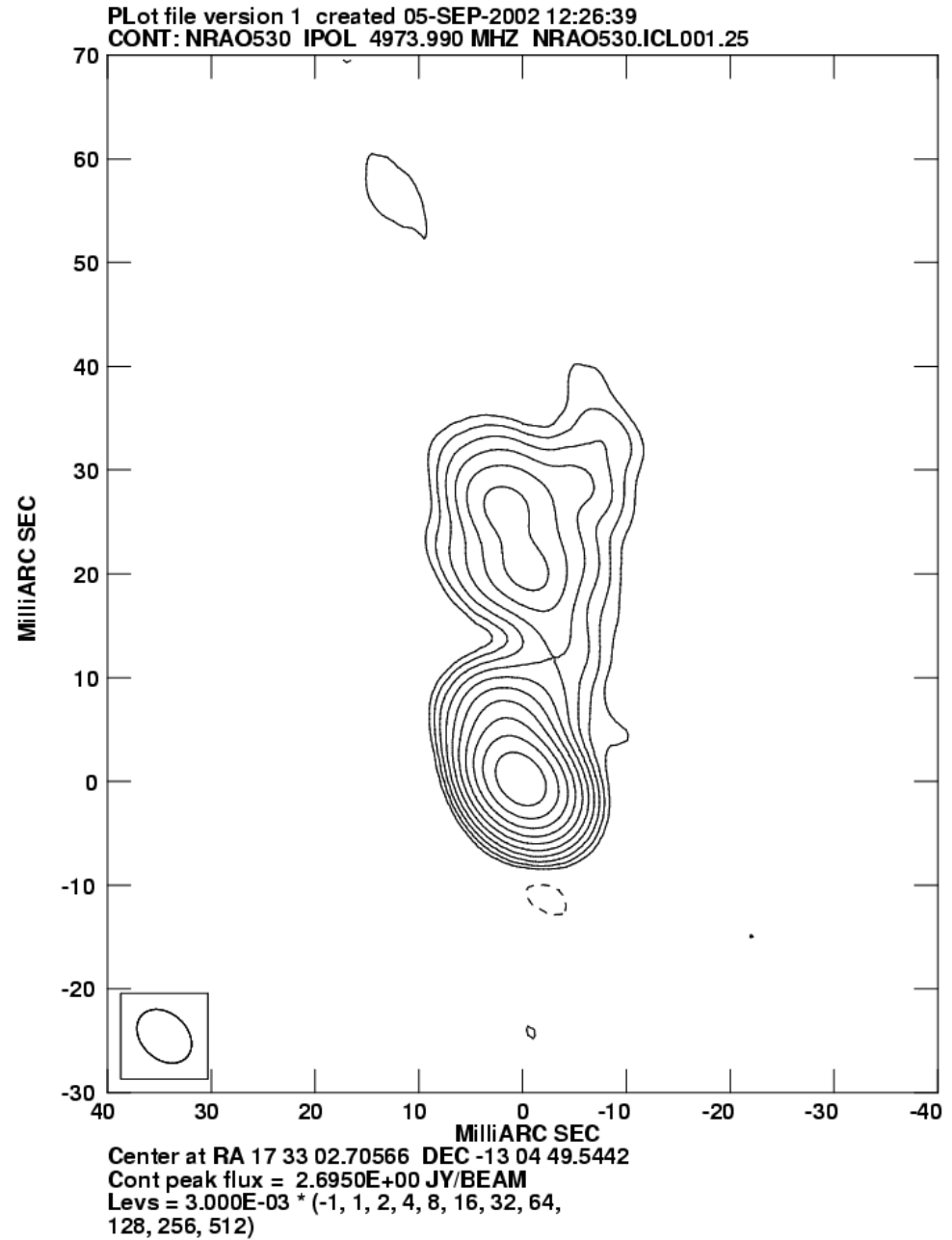


Observations

- ◆ EVN + MERLIN • 5GHz, Feb. 9, 1999
- ◆ MERLIN (archive data), 1.6GHz, May 8, 1998
- ◆ VLA • 8.4 GHz • Nov. 27, 1992 • Calibrator
- ◆ VLA • 4.8 GHz • June 17, 2003 • Calibrator
- ◆ VLBA, archive data at 15GHz, 6 epochs from 1995 to 2004 (from Matt Lister)

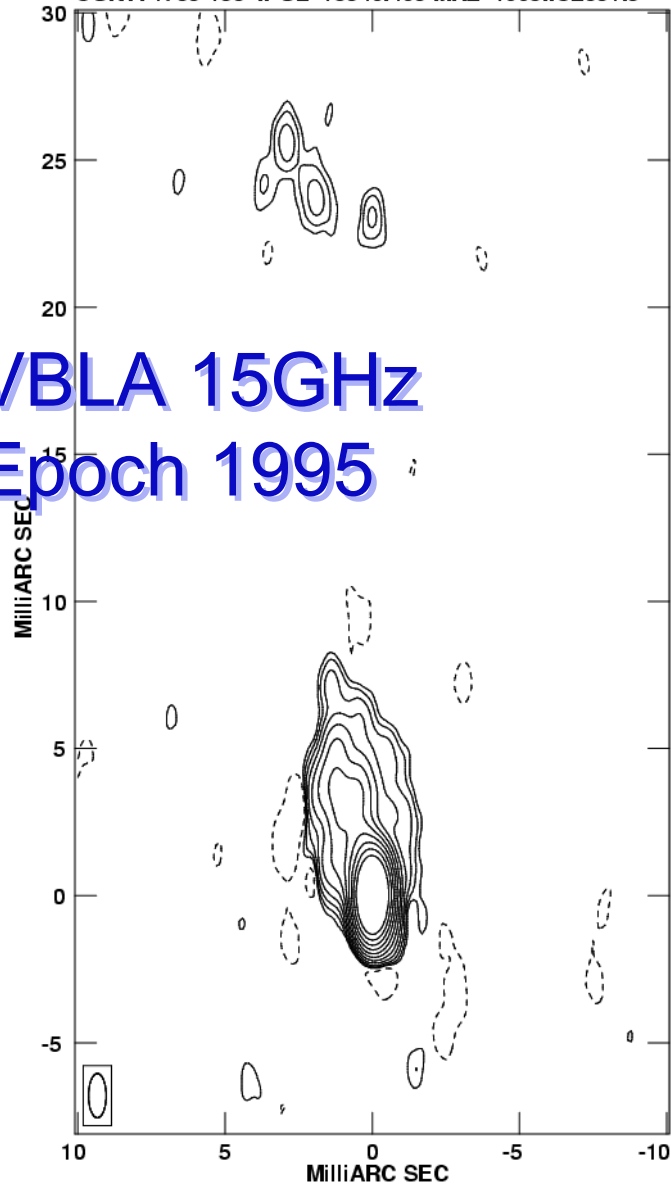
EVN observation at 5 GHz

Nov. 12 – 15,



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CONT: 1730-130 IPOL 15349.490 MHZ 1995.ICL001.3

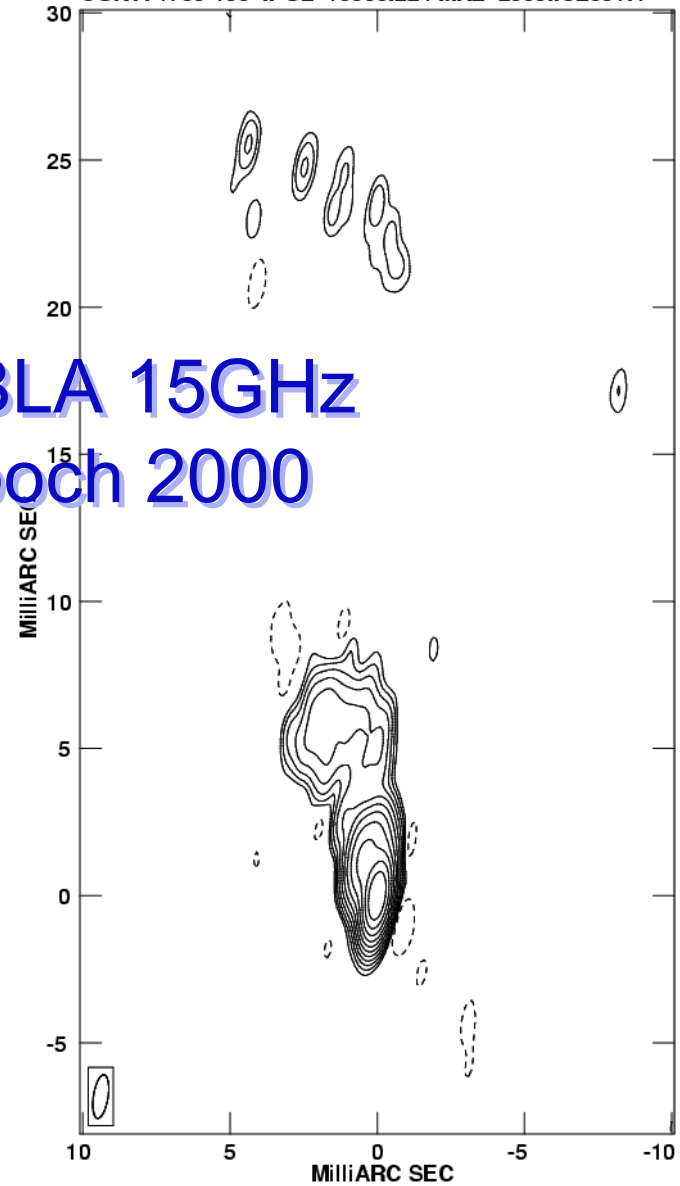
VBLA 15GHz Epoch 1995



Center at RA 17 33 02.70577 DEC -13 04 49.5480
Cont peak flux = 8.7990E+00 JY/BEAM
Levs = 1.000E-03 * (-1, 1, 2, 4, 8, 16, 32, 64,
128, 256, 512, 1024)

PLot file version 1 created 18-SEP-2004 16:07:26
CONT: 1730-130 IPOL 15335.224 MHZ 2000.ICL001.4

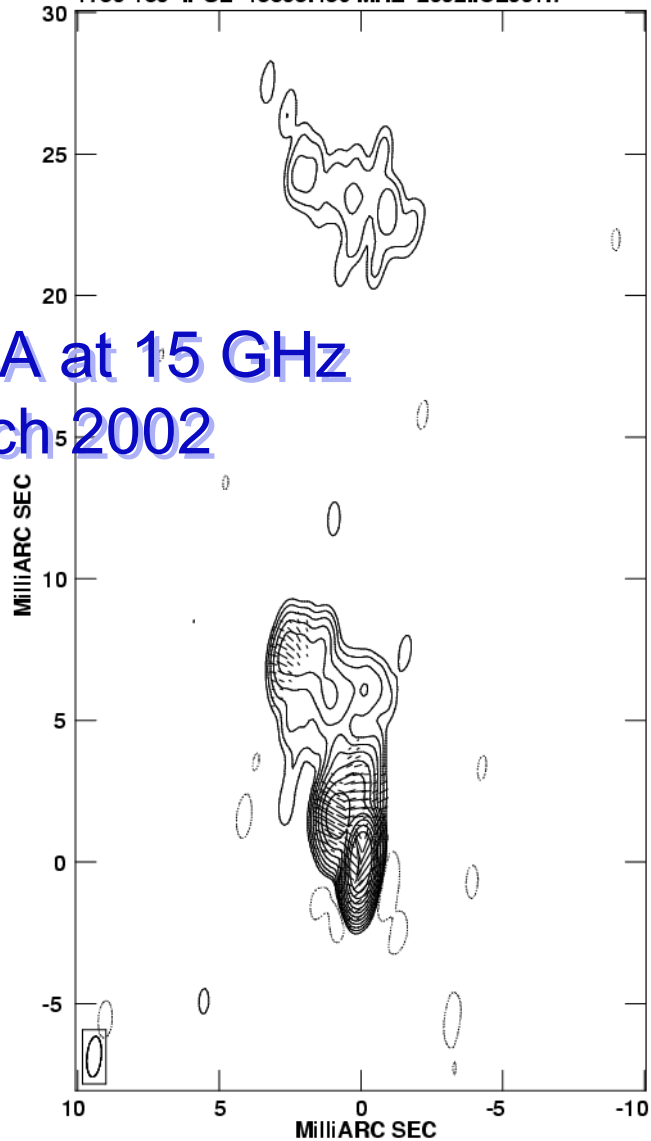
VBLA 15GHz Epoch 2000



Center at RA 17 33 02.70578 DEC -13 04 49.5483
Cont peak flux = 1.8368E+00 JY/BEAM
Levs = 8.000E-04 * (-1, 1, 2, 4, 8, 16, 32, 64,
128, 256, 512, 1024)

Plot file version 1 created 17-SEP-2004 09:34:04
1730-130 IPOL 15365.459 MHZ 2002.ICL001.7

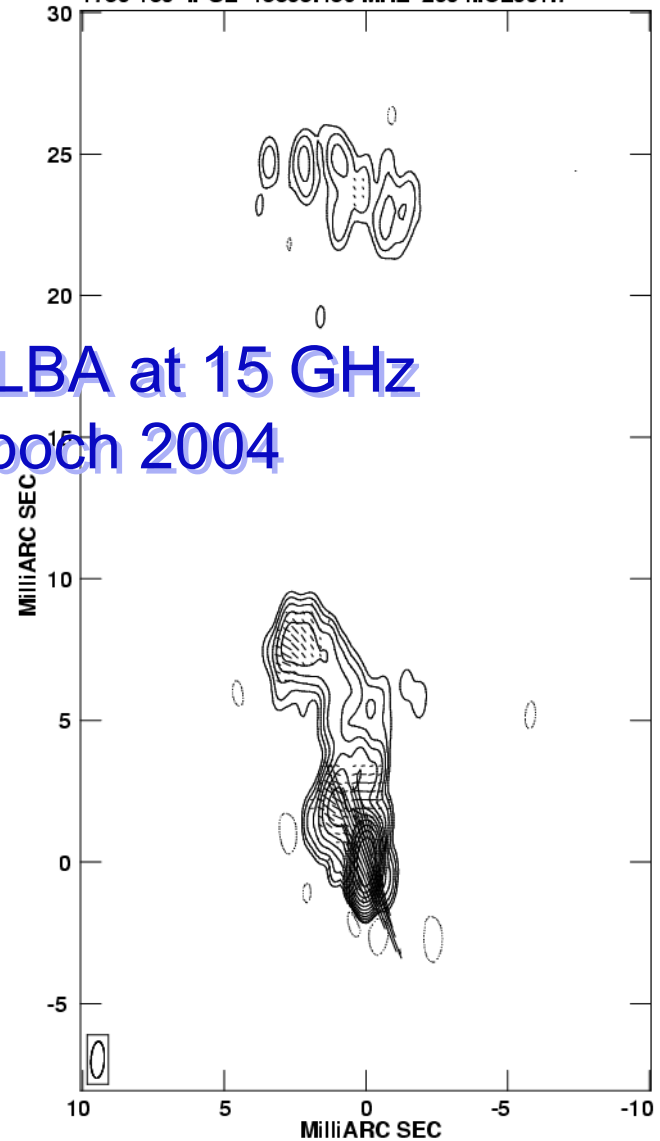
VLBA at 15 GHz epoch 2002



Center at RA 17 33 02.70579 DEC -13 04 49.5482
Peak contour flux = 4.7365E+00 JY/BEAM
Levs = 1.000E-03 * (-1, 1, 2, 4, 8, 16, 32, 64,
128, 256, 512, 1024)
Pol line 1 milli arcsec = 1.5000E-02 JY/BEAM
Rotated by -16.8 degrees

Plot file version 1 created 17-SEP-2004 13:32:23
1730-130 IPOL 15365.459 MHZ 2004.ICL001.7

VLBA at 15 GHz epoch 2004



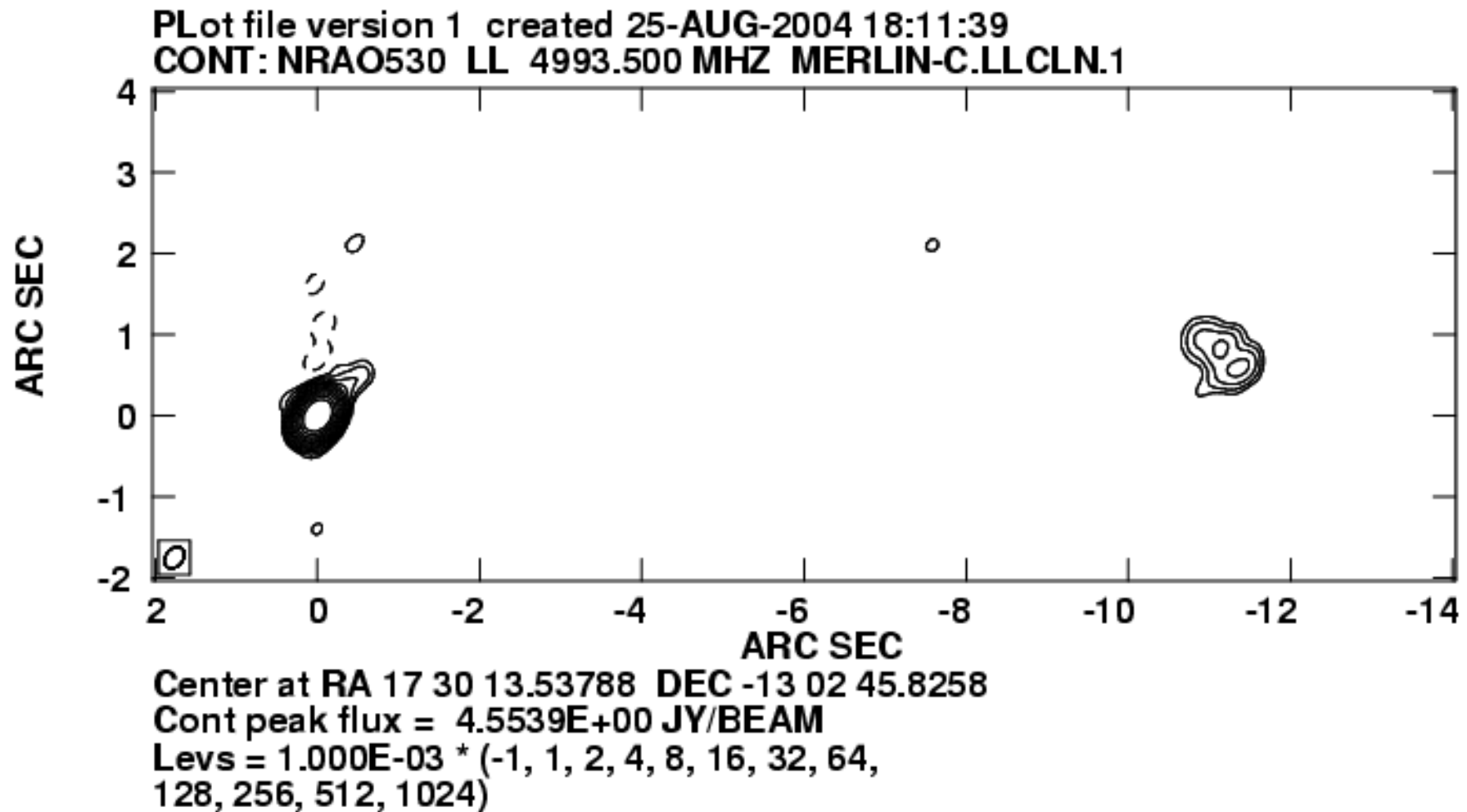
Center at RA 17 33 02.70579 DEC -13 04 49.5482
Peak contour flux = 3.3395E+00 JY/BEAM
Levs = 1.000E-03 * (-1, 1, 2, 4, 8, 16, 32, 64,
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Pol line 1 milli arcsec = 1.5000E-02 JY/BEAM
Rotated by -13.0 degrees



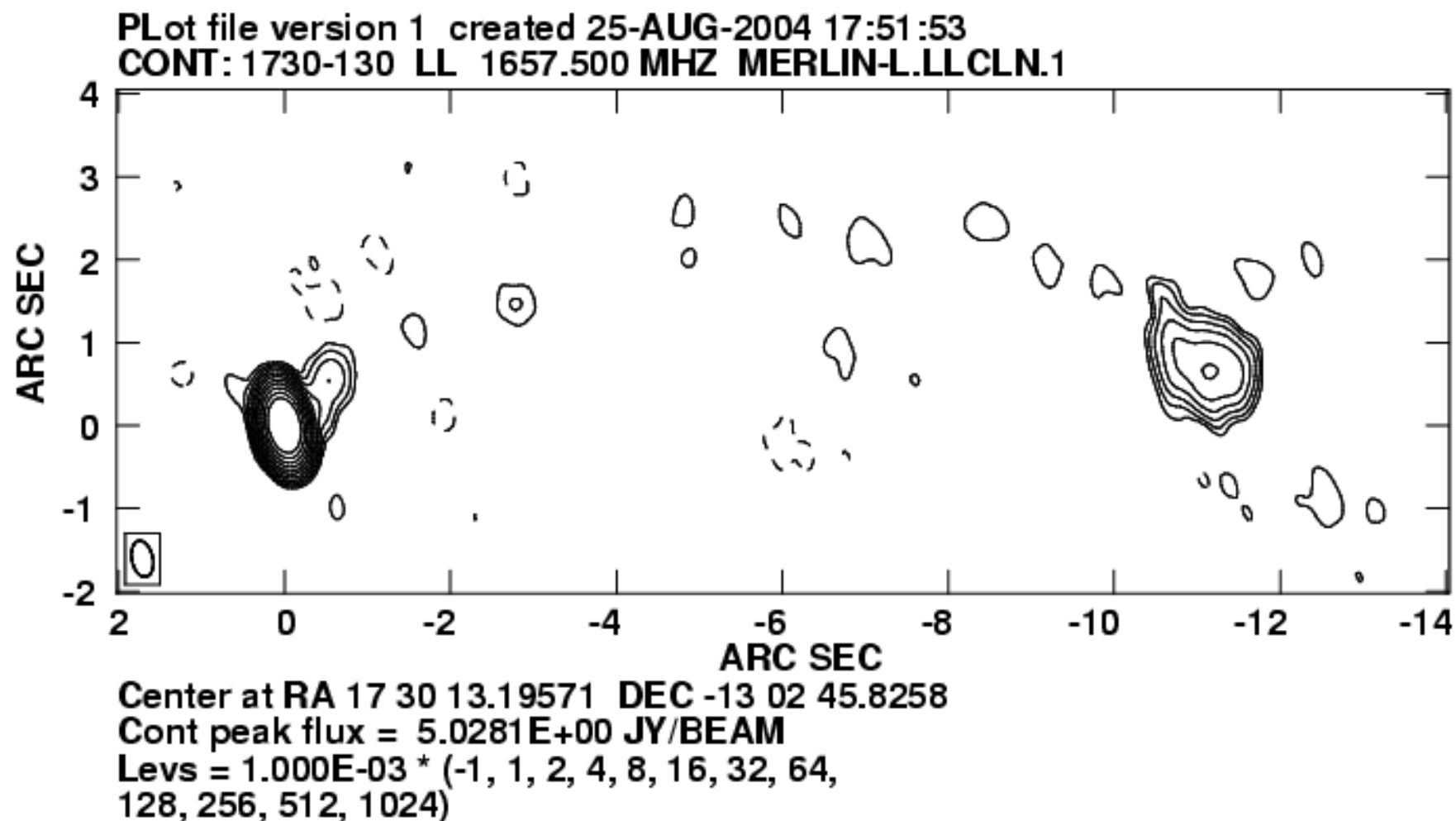
VLBI observations

- ◆ Core – jet structure
- ◆ Jet extended to north about 25 mas
- ◆ Both the morphology and the flux density are variable
- ◆ Polarization are detected in core area and it is variable (both in intensity and polarized angle)

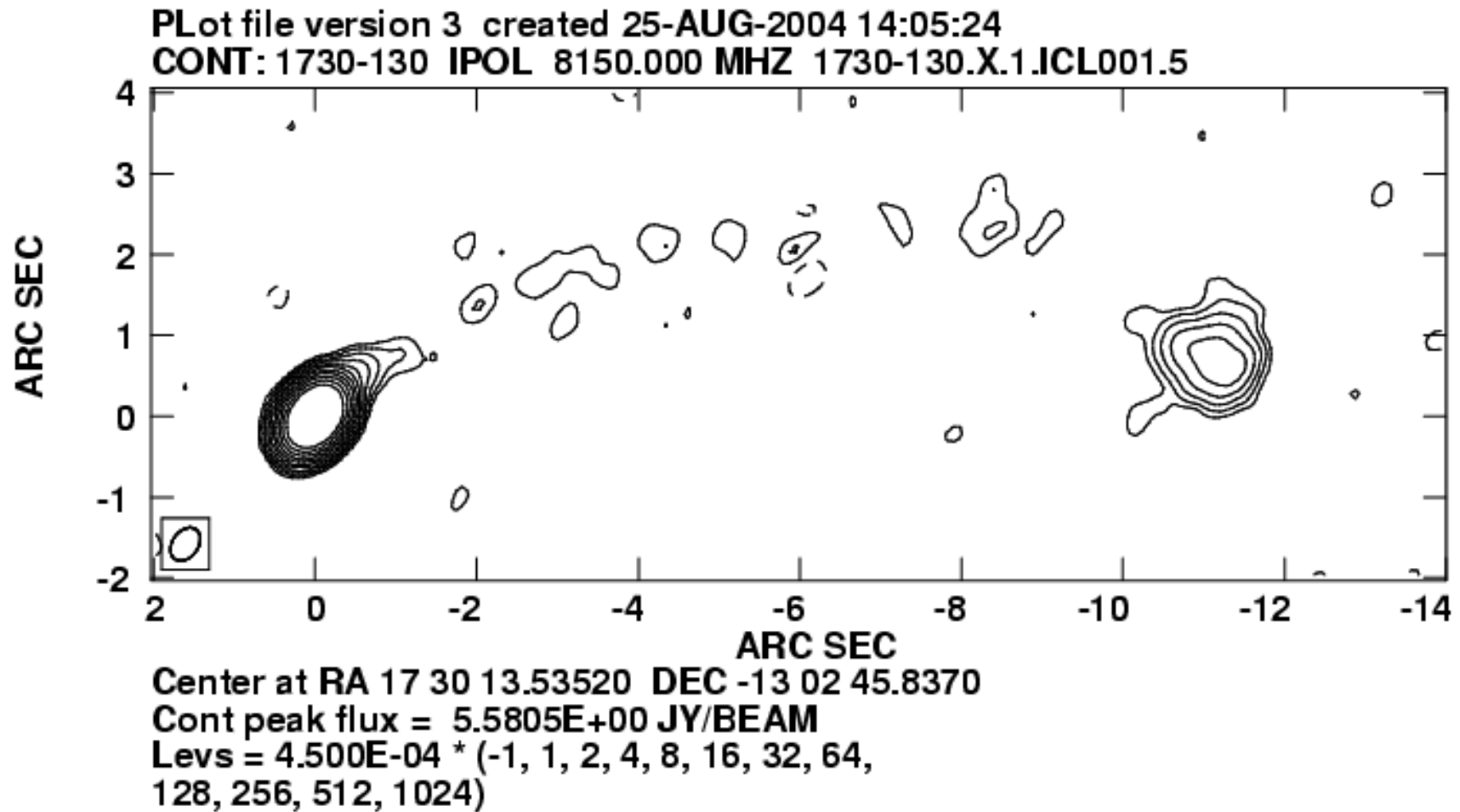
MERLIN image at 5 GHz



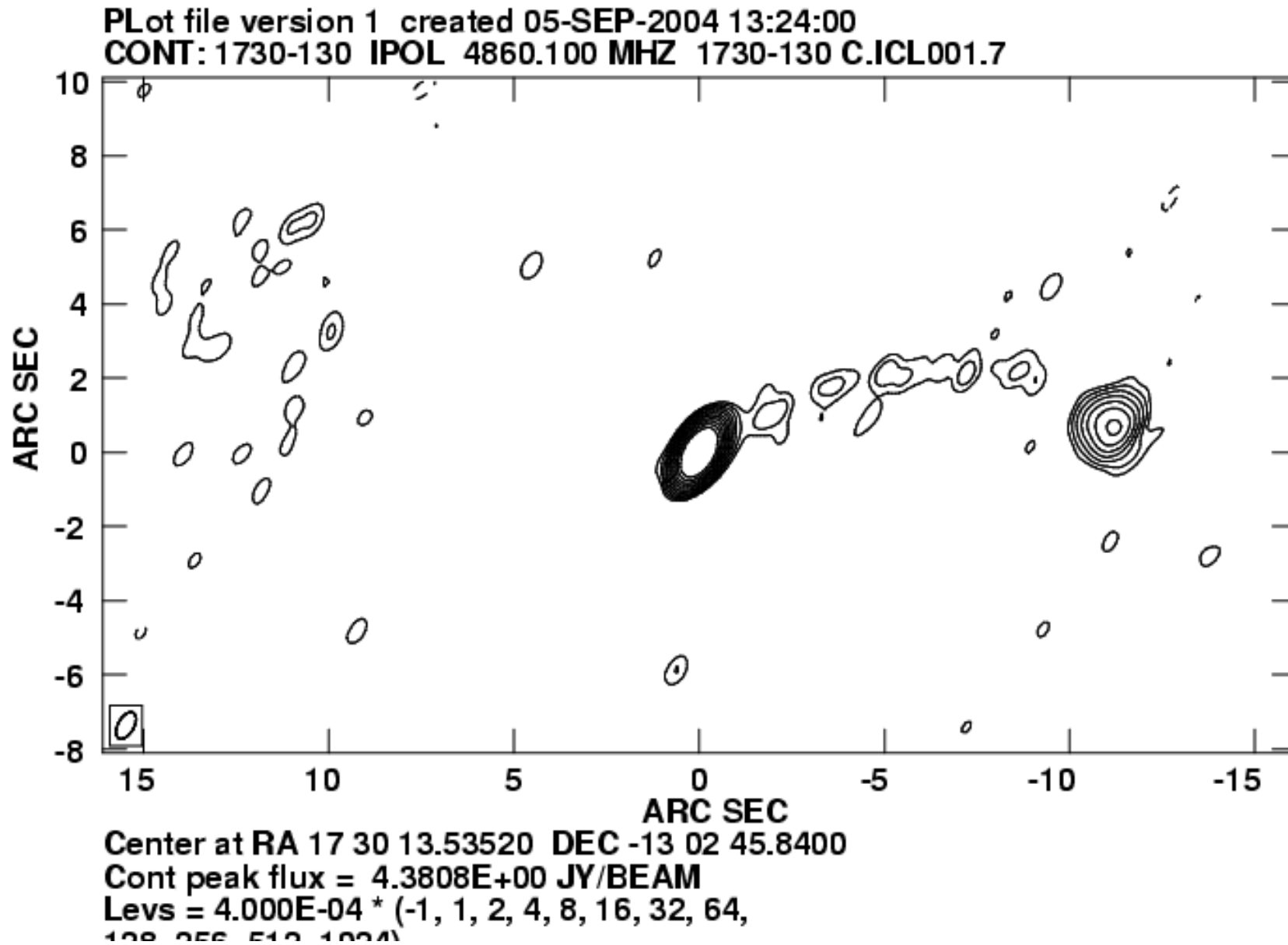
MERLIN image at 1.6 GHz

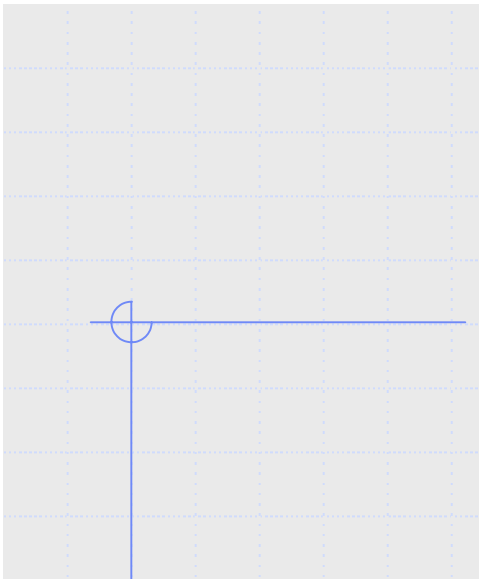


VLA image at 8.1 GHz

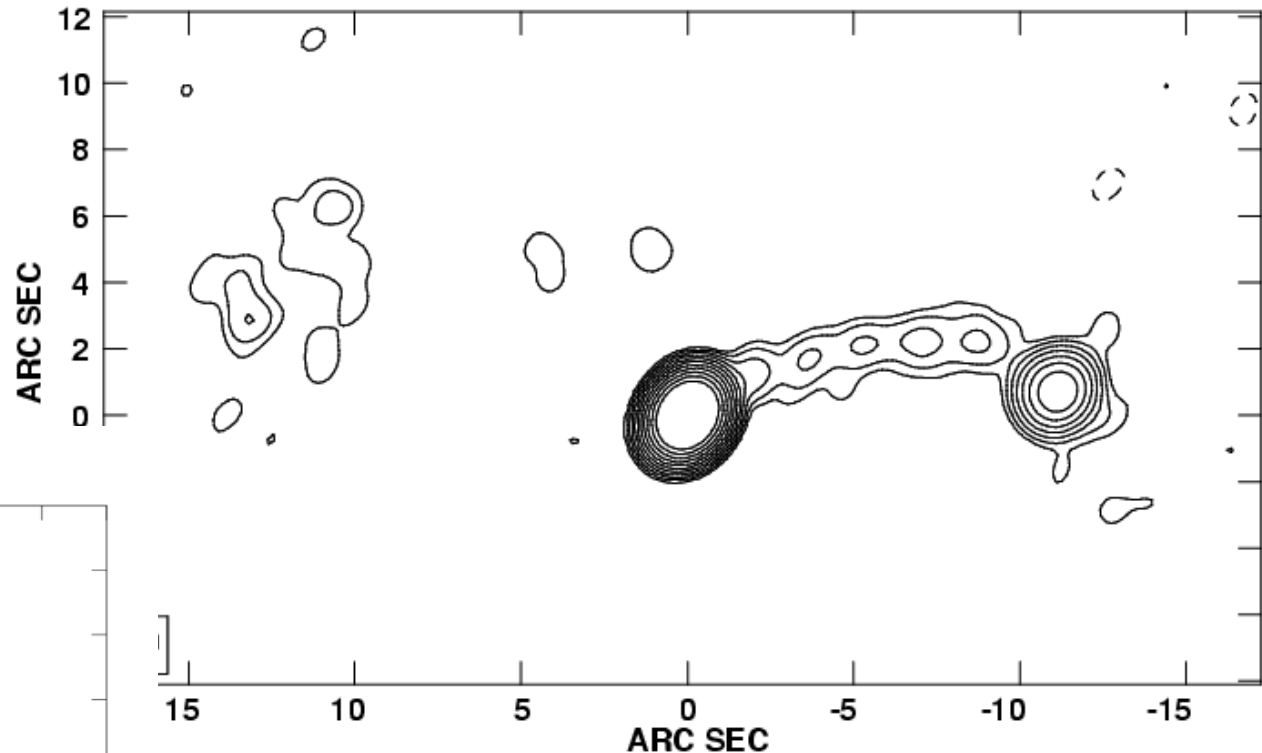


VLA image at 5 GHz



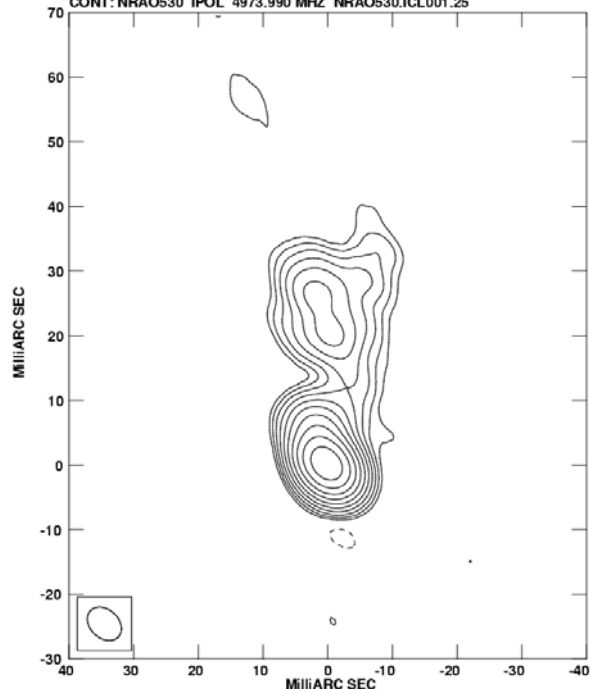


PLot file version 1 created 05-SEP-2004 13:29:10
 CONT: 1730-130 IPOL 4860.100 MHZ 1730 C TAP.ICL001.4



iter at RA 17 30 13.53520 DEC -13 02 45.8400
 it peak flux = 4.3854E+00 JY/BEAM
 s = 4.000E-04 * (-1, 1, 2, 4, 8, 16, 32, 64,
 , 256, 512, 1024)

PLot file version 1 created 05-SEP-2002 12:26:39
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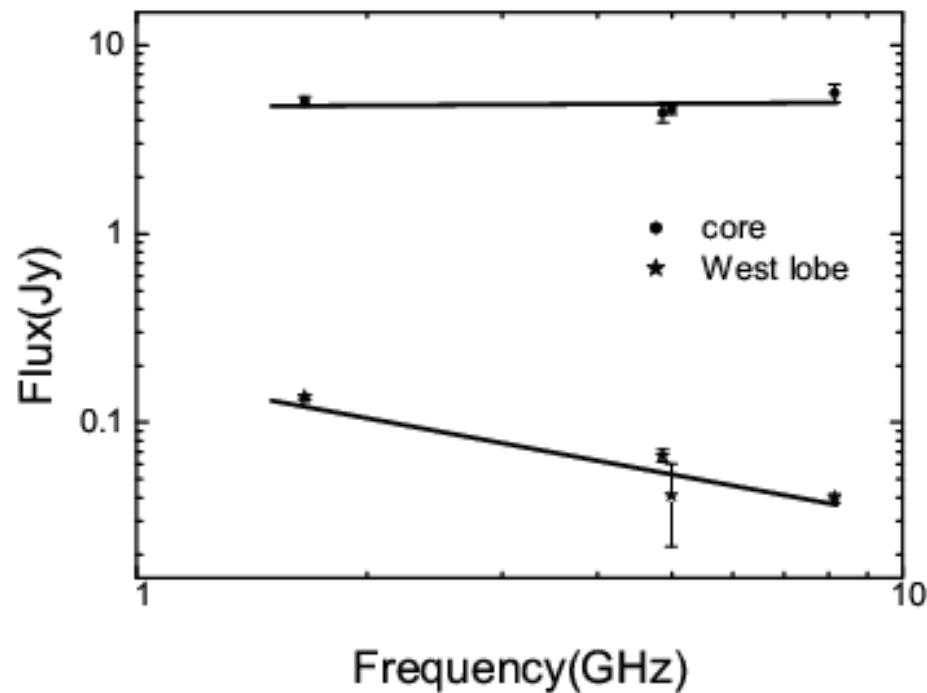
Center at RA 17 33 02.70566 DEC -13 04 49.5442
 Cont peak flux = 2.6950E+00 JY/BEAM
 Levs = 3.000E-03 * (-1, 1, 2, 4, 8, 16, 32, 64,
 128, 256, 512)

Core has a flat spectrum

$$(\alpha = -0.02, S \propto \nu^{-\alpha})$$

while west lobe has a steep spectrum

$$(\alpha = 0.8)$$





Conclusion

- ◆ pc scale: an oscillating jet consists of a number of emission components north to the core
- ◆ kpc scale: a core jet structure in P. A. -50° double lobes in the East-West direction
- ◆ Lobe/counter-lobe = 5.5
- ◆



unclear

- ◆ Why the jet bent 90° from pc scale to kpc scale?
- ◆ interaction between the jets and the interstellar medium (IMS)?
- ◆ jet moves in a helical trajectory on the surface of a cone
- ◆ the jet axis at pc scale is very close to the line of the sight
- ◆ the large Δ PA could be the projective effect



Further study

- ◆ High sensitivity VLBI observation at 1.6 GHz to see where the jet start to bend from pc to kpc scale (EVN?)
- ◆ Polarization study to measure the rotation of polarized angle (VLBA?)



Thanks