Max-Planck-Institut für Radioastronomie

May 11th, 2015

AGN Polarisation, COST, Strasbourg

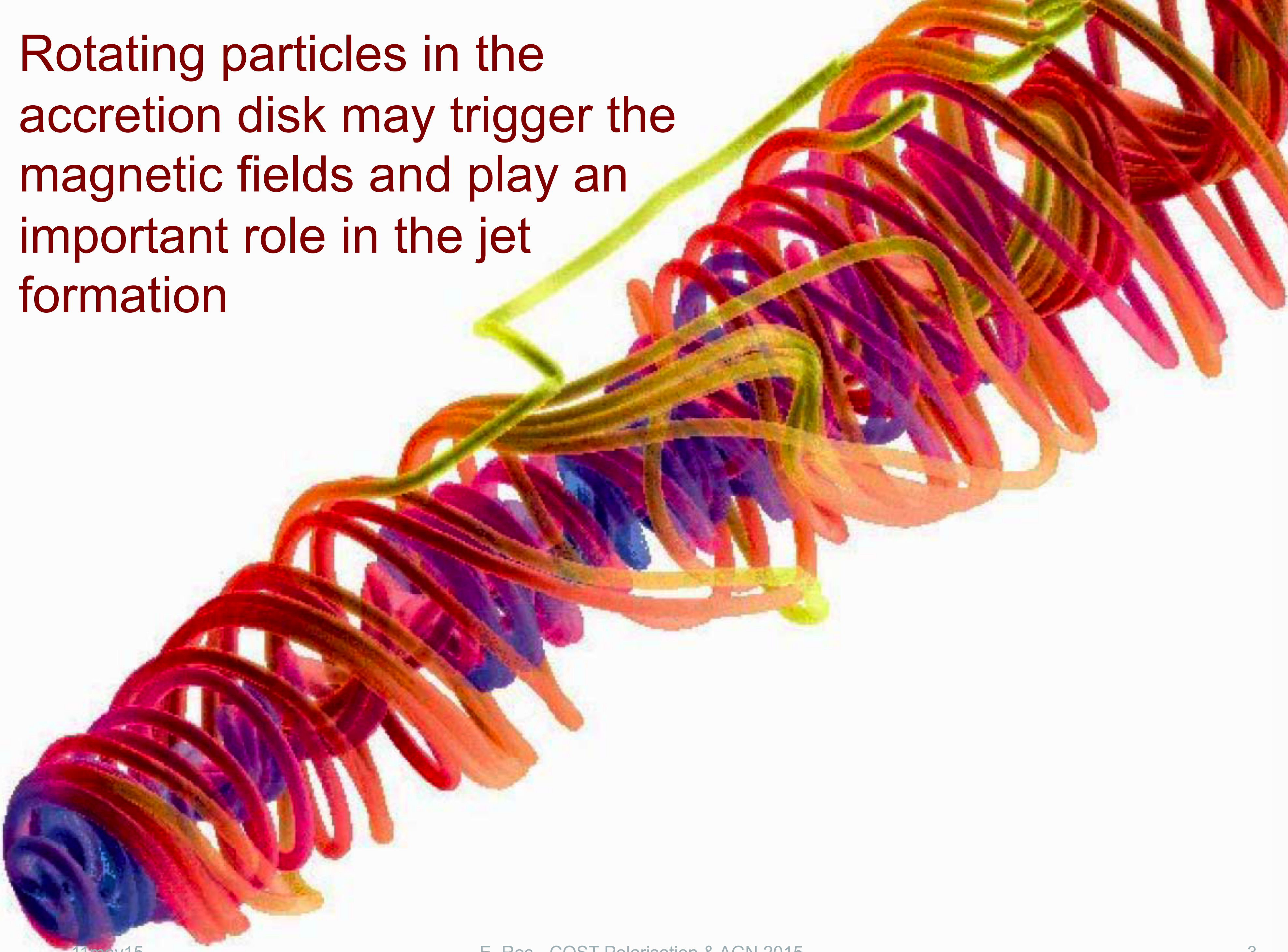
Eduardo Ros (MPIfR & Univ. Valencia)

MILLIMETRE-VLBI POLARISATION IN AGN JETS

Collaborators (GMVA project)

- PI: Antxon Alberdi
- Eduardo Ros
- Thomas Krichbaum
- Miguel Pérez-Torres
- Jon Marcaide
- Iván Martí-Vidal
- José C. Guirado

Rotating particles in the accretion disk may trigger the magnetic fields and play an important role in the jet formation



Polarisation with mm-VLBI

- 43/86/230 GHz VLBI on AGN: no self-absorption, higher resolution
- Polarised fine structure probes regions <0.4 pc in AGN
- Discrimination between
  - BP model: jet anchored to magnetised rotating disks
  - BZ model: jet driven by BH spin
- Interaction of magnetic plasma (associated to shocks) with recollimation shocks

Polarisation with mm-VLBI (ii)

- Intrinsic linear polarised emission, comparison with single-dish polarisation observations

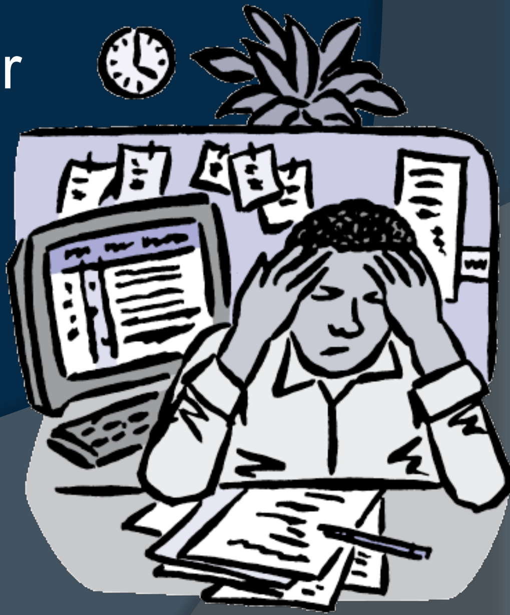
See Agudo's talk

- Imaging of internal structure of VLBI core:
  - Is it a recollimation shock?
  - Is P homogeneous or stratified?
- B geometry across and along the jet
- Polarisation angle w.r.t. jet structural angle?

Field orientation

- Field in jet from accretion disk: **helical**
- VLBI observations: B parallel to jet, **toroidal**
- But…
  - Magnetic field **tangled** due to re-collimation shocks or external medium interaction
  - **Relativity** can make a toroidal field in the rest frame to look like poloidal in the observer frame
  - **Faraday rotation** flips the field angle, caused by to internal or external plasma
  - Shocks can compress B preferently perpendicular to jet: apparently **toroidal**

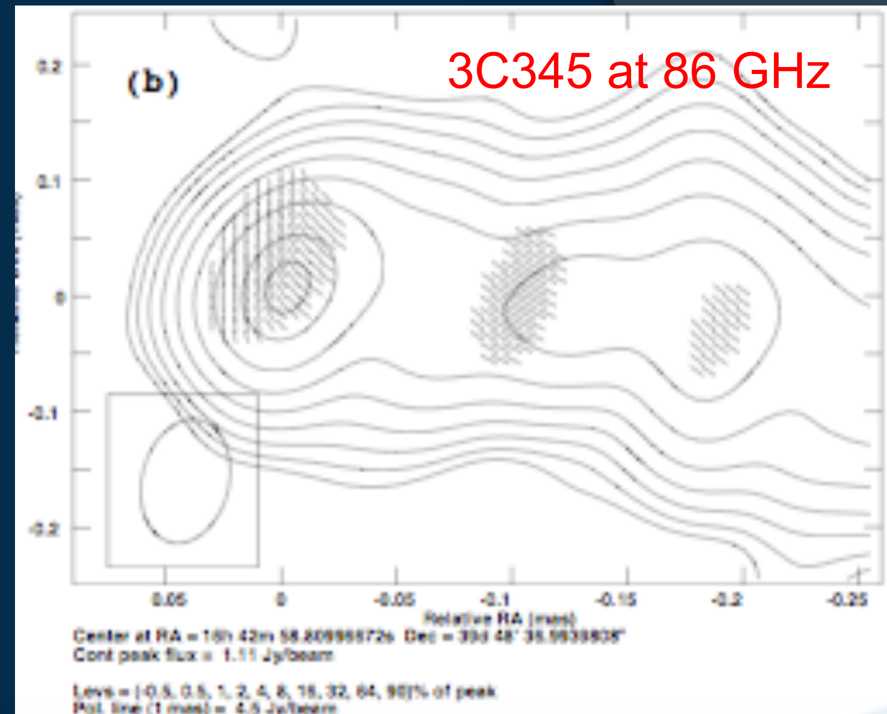
See Laing's review talk




October 2012

Outlook

- Improvements in sensitivity by bandwidth and performance enhancements
- Improvements in resolution:
  - 86 GHz new calibration methods (see Martí-Vidal et al. 2012)
  - RadioAstron observations

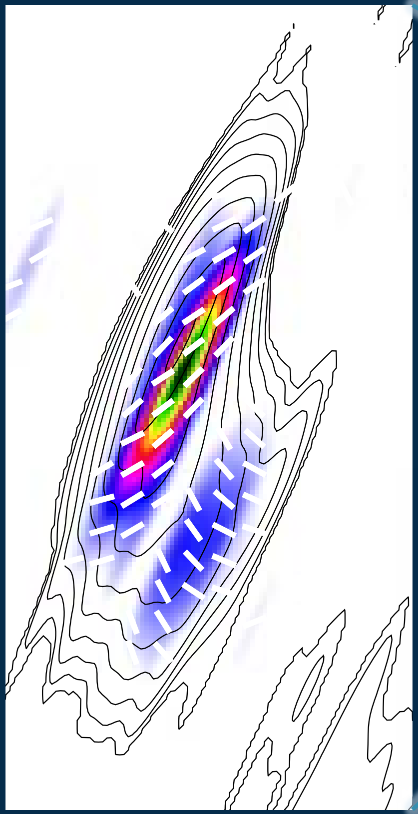


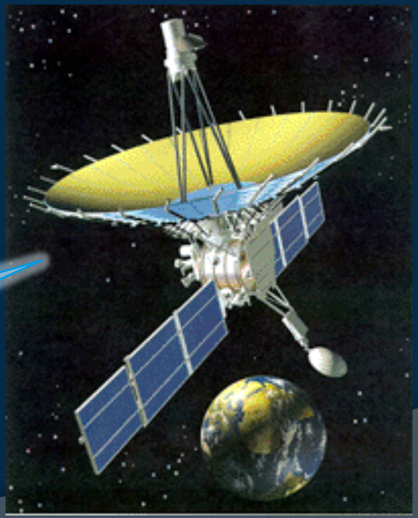
Martí-Vidal et al. (2012)

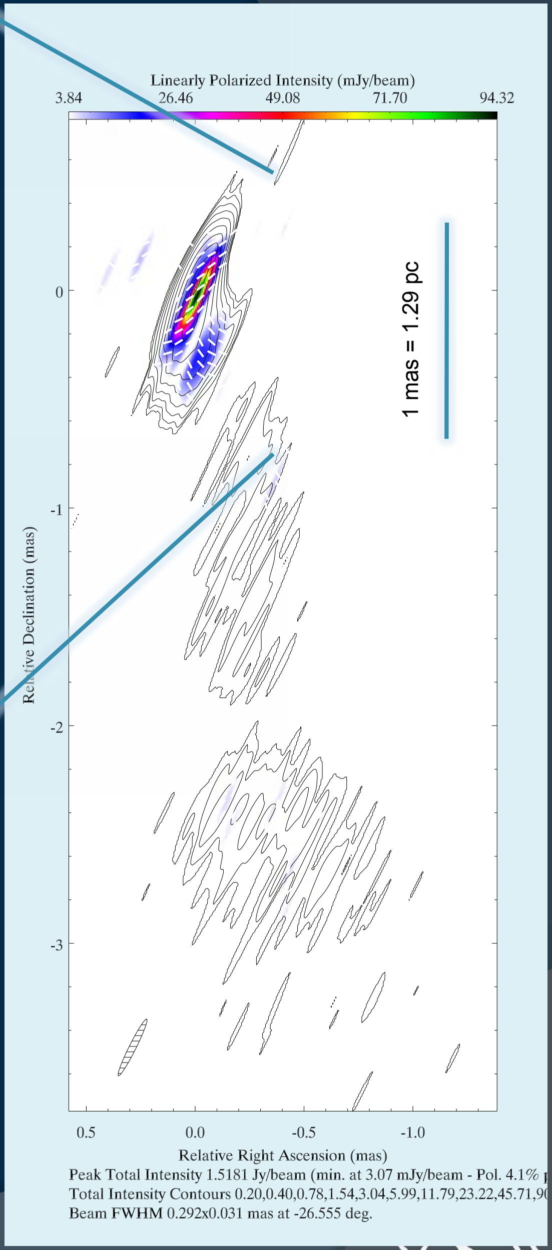
Slide from AGN pol. meeting
October 2012, Brussels

High resolution: RadioAstron

- Example: BL Lac at 22 GHz
- K-band resolution comparable to mm-VLBI
- Resolved core region at 1.3cm

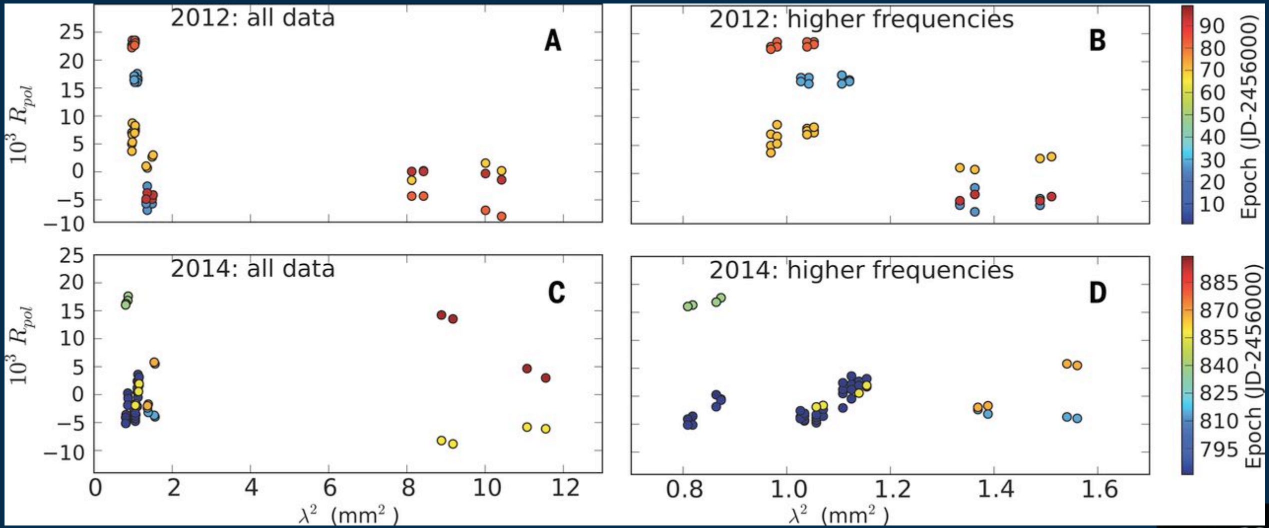




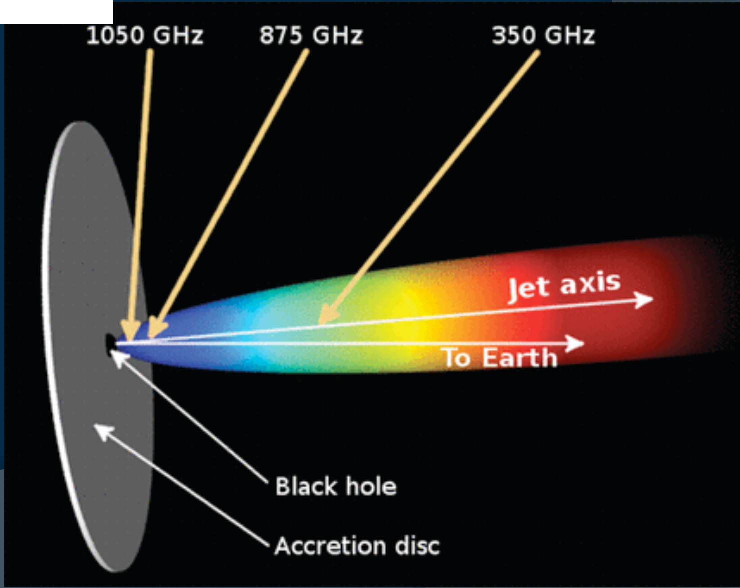


See Bruni's poster

ALMA results:
B much higher than expected!!



Polarisation ratio as function of λ^2 for ALMA observations



Trick: using a gravitational lens as a lupe for accessing the region close to the BH

RM ≈ 3×10^8 rad/m^2 ➔ B ≥ 10 G

Martí-Vidal et al. (Science 348, 311, 17apr2015)

Polarimetry beyond 3mm: EHT *m* much higher than usual

- Results by Johnson et al. (in prep.) report about $m \geq 50\%$ for the longest baselines
- Notice that for synchrotron radiation with a flat spectral index:

$$m = \frac{\alpha - 1}{\alpha - 5/3}; \; \alpha = 0.5 \rightarrow m = 0.7$$

- Depolarisation at shorter baselines?

m

Max-Planck-Institut für Radioastronomie

Our project

ECOST-STSM-MP1104-220215-056416
Alberdi (IAA) visited Ros & Krichbaum (MPIfR)
22/27feb2015

Sample selection

- 3-mm flux density $S_{86\ \mathrm{GHz}} \geq 0.8$ Jy
- Fractional polarisation $\langle m \rangle \geq 3.5\%$
- Core-jet structure
- Flat radio spectral index $-0.18 < \alpha < 0.21$
- Variability, flaring state

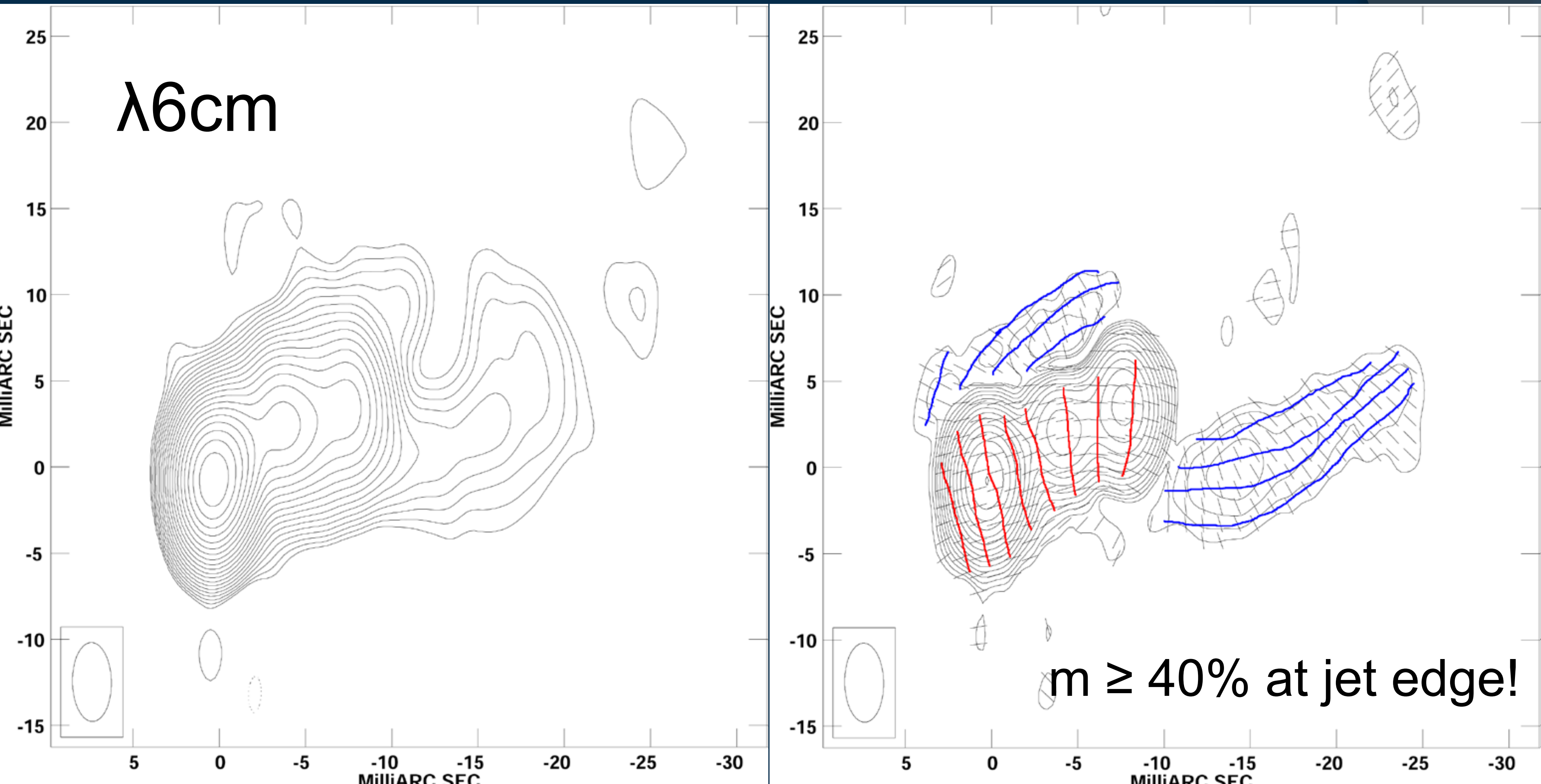
Source (J2000)	RA (J2000)	DEC (J2000)	Average Flux (Jy)	Polarization Degree %	AGN Class	z	pc/mas
J0927+3902	09:27:03.0139	+39:02:20.851	4.0	4.16	Q	0.695	7.12
J1058+0133	10:58:29.6050	+01:33:58.824	3.1	4.01	BLLac	0.888	7.68
J1419+5423	14:19:46.5974	+54:23:14.787	0.8	3.90	BLLac	0.153	2.63
J1635+3808	16:35:15.4930	+38:08:04.500	2.2	3.54	Q	1.813	8.54

The array: GMVA

Observations on 27/29sep2014 and 14/15may2015
GMVA (VLBA+Europe)
8-hr track on 4C 39.25/0923+392 and 4C 01.28/1055+018

Image credit: T.P. Krichbaum (MPIfR)

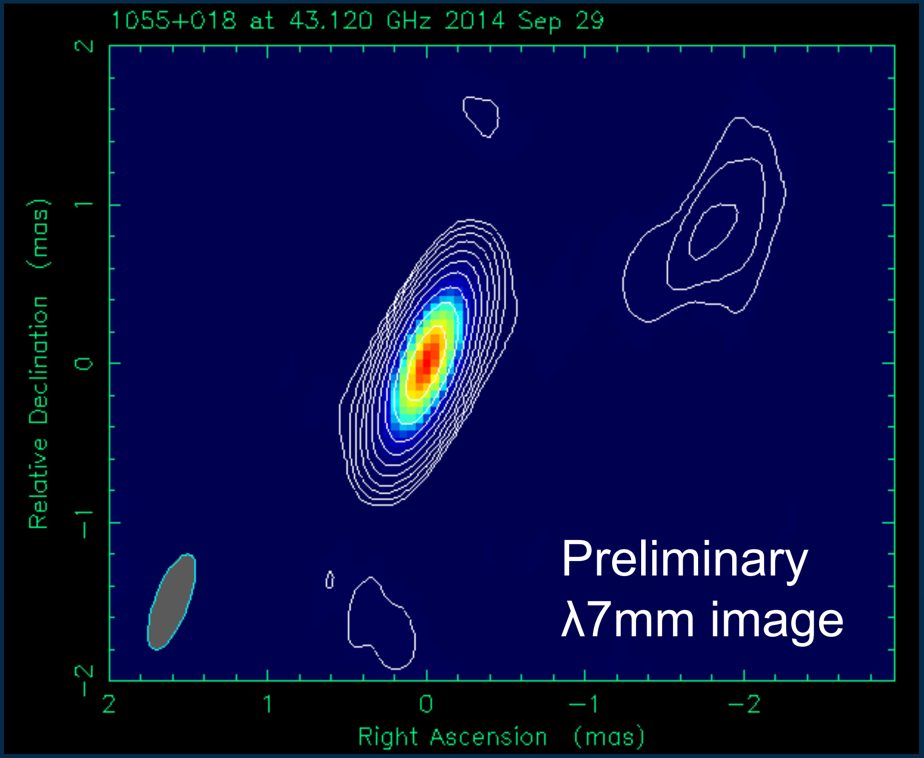
Target 1055+018 (4C 01.28)



z = 0.889

Attridge 1998; Attridge, Roberts, & Wardle 1999

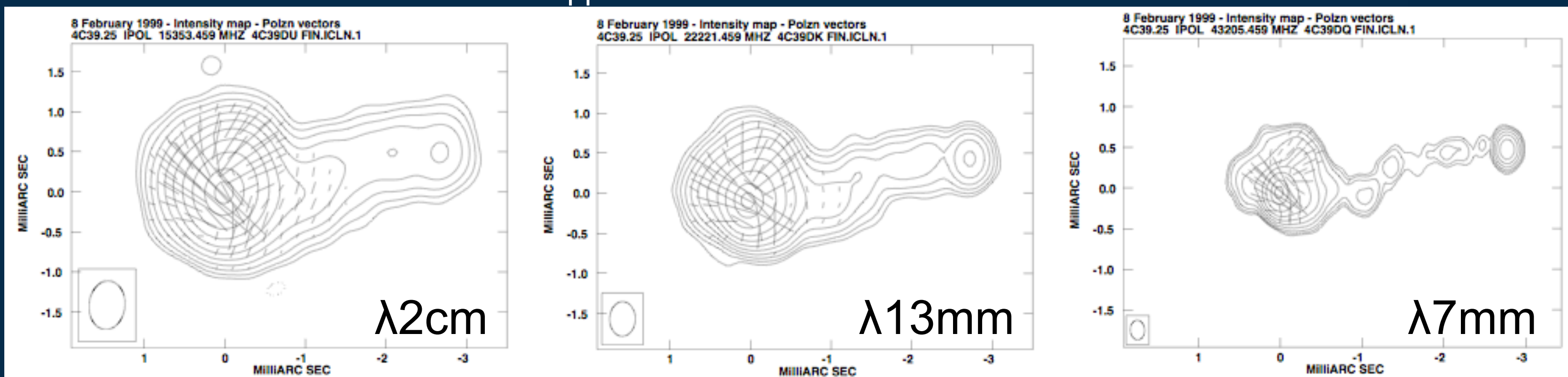
Target 1055+018 (4C 01.28)



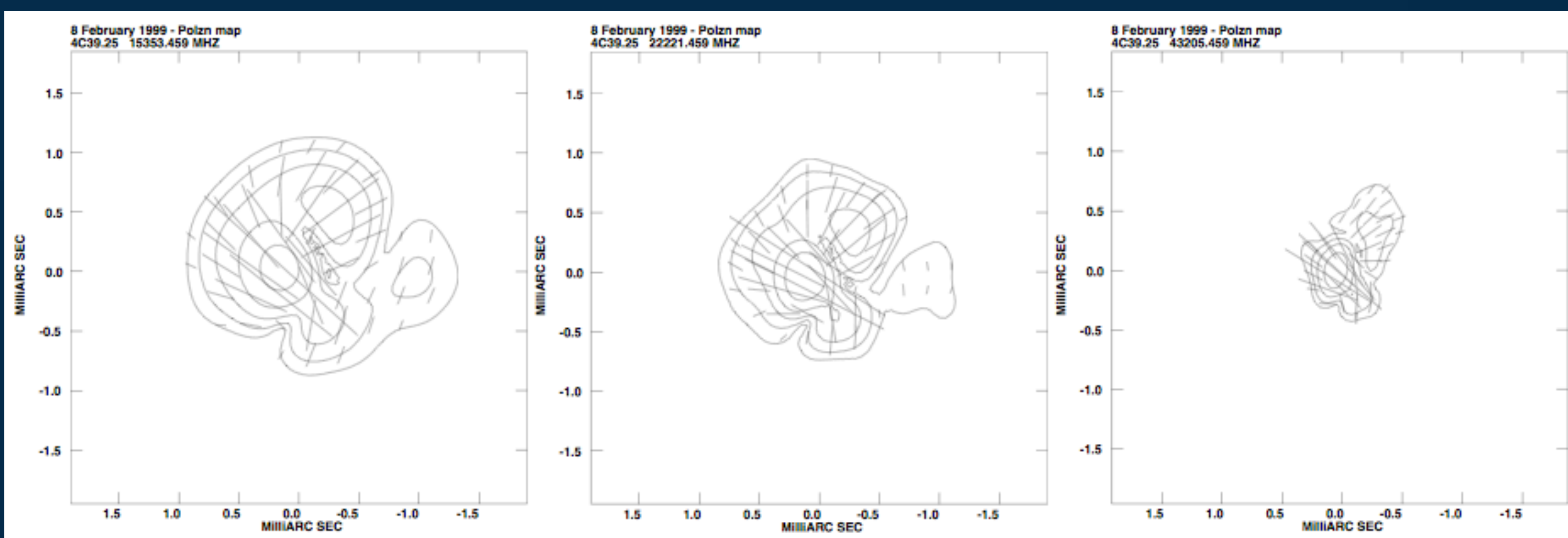
Quasar
z=0.888 (1mas=7.78pc)
LAT source
β_{app}=8.05 (MOJAVE)
Presently flaring at λ1mm (4.5 Jy, see http://goo.gl/aonQip)

The source 0923+392/4C 39.25

z=0.695, Quasar, no LAT, β_{app}=2.76 (MOJAVE) Alberdi et al. (A&A 361, 569, 2000)



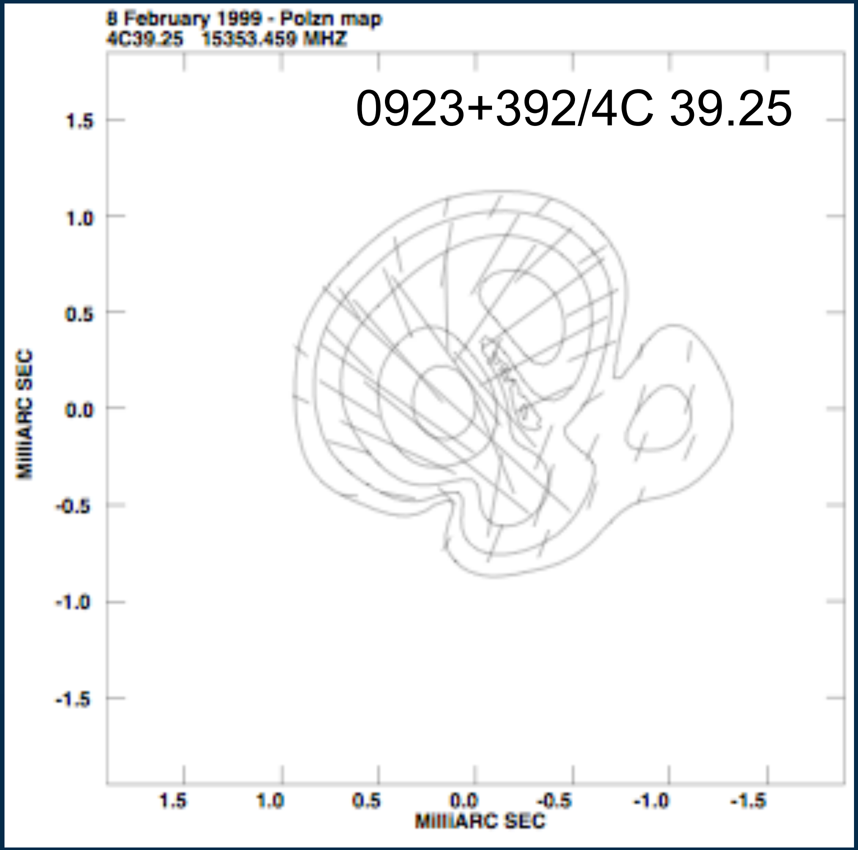
I+χ



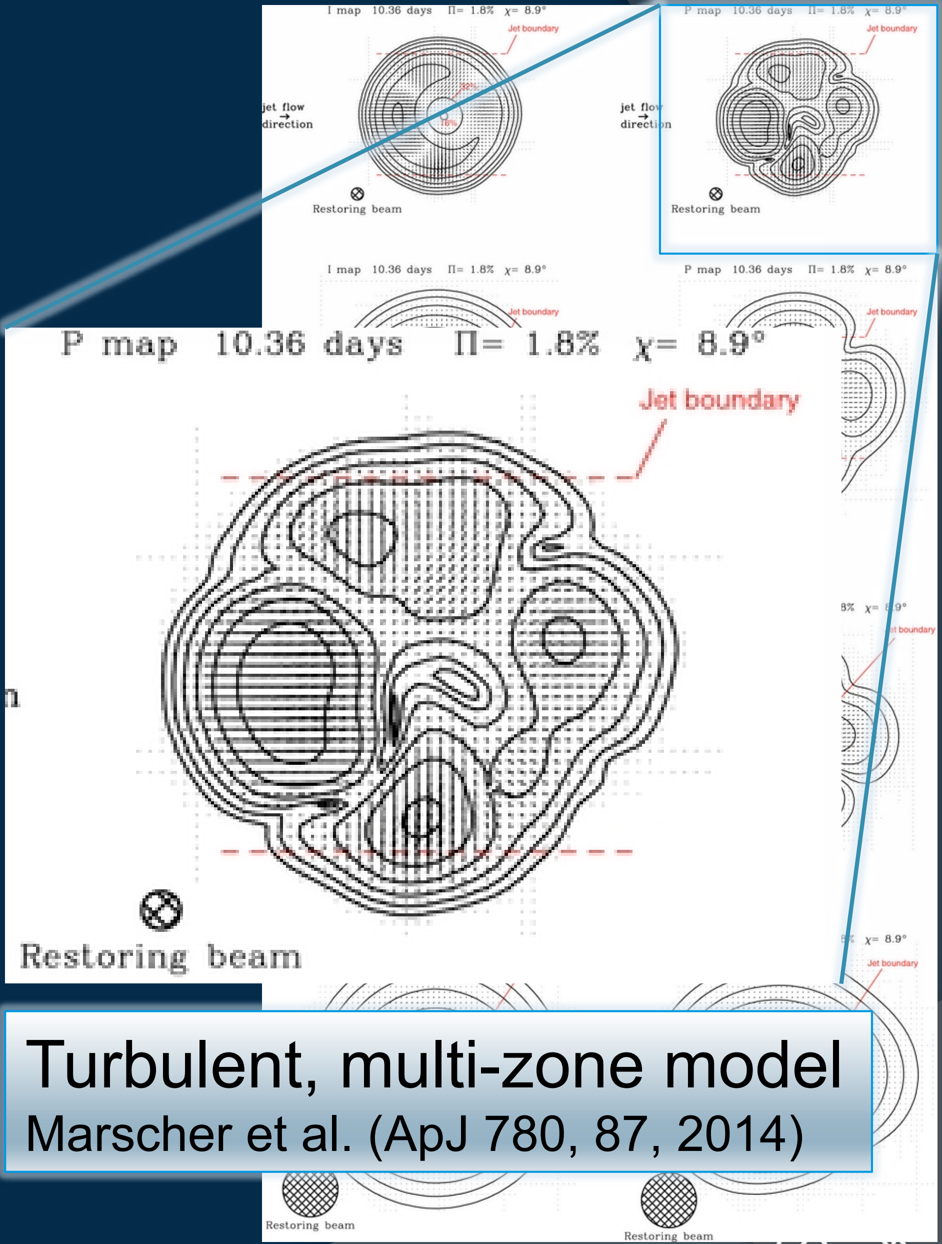
P+χ

09feb2011

Chance?

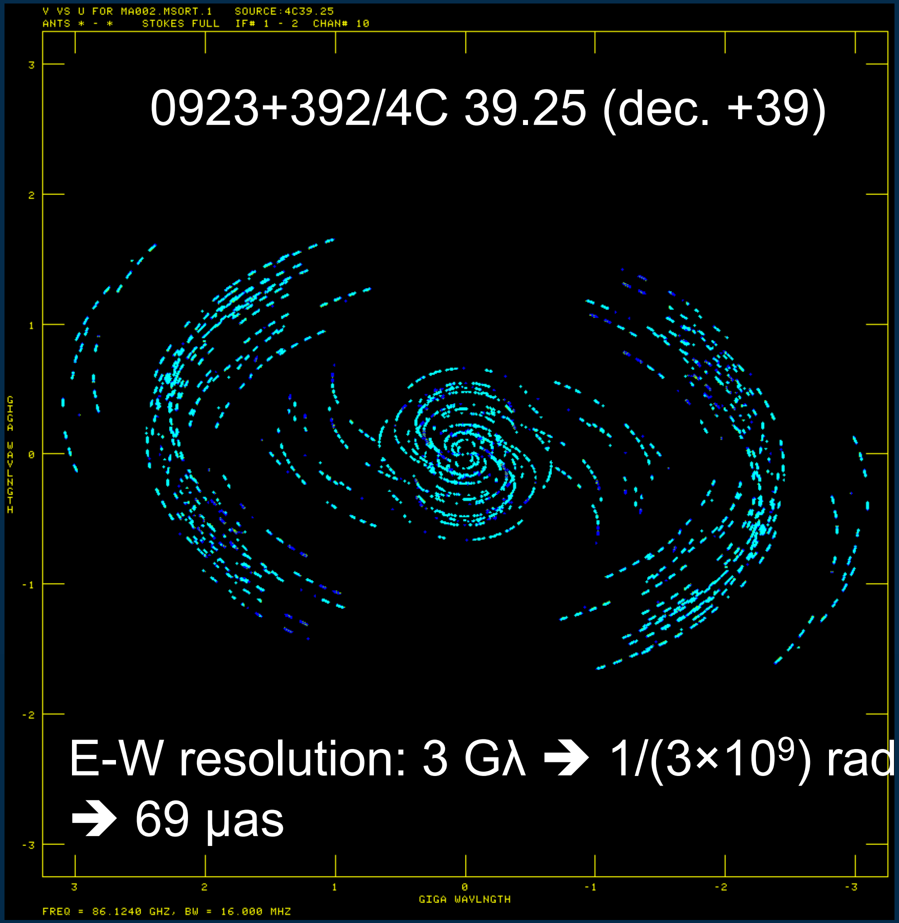


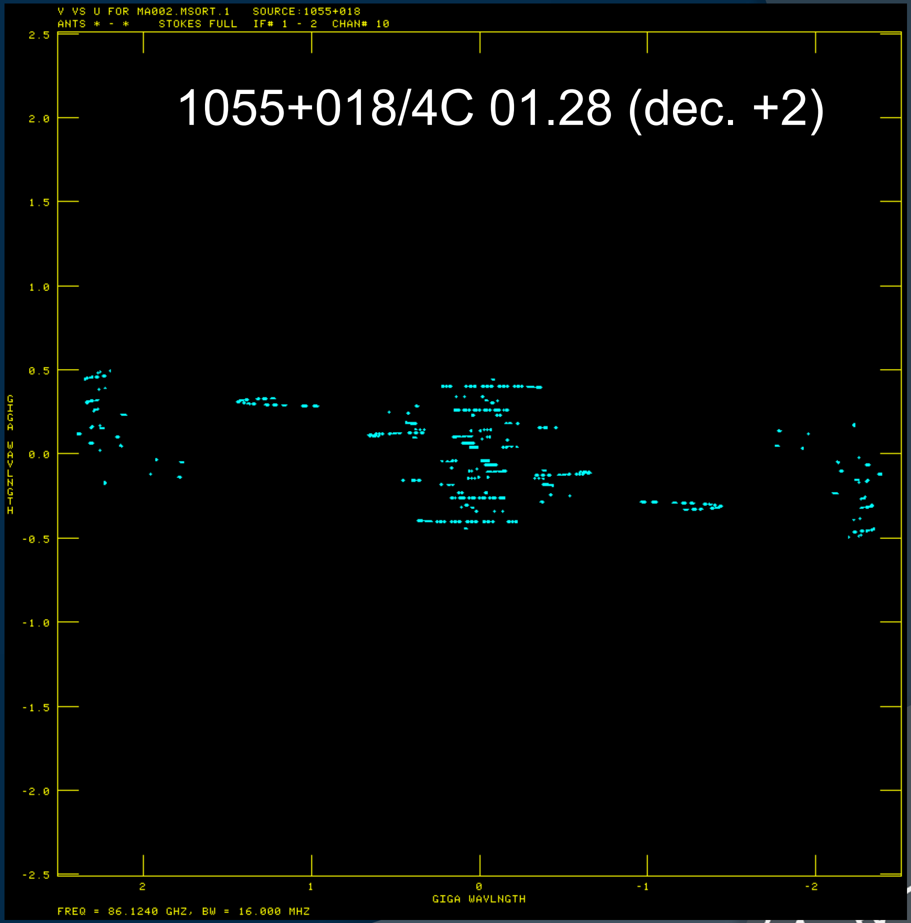
Alberdi et al. (A&A 361, 569, 2000)



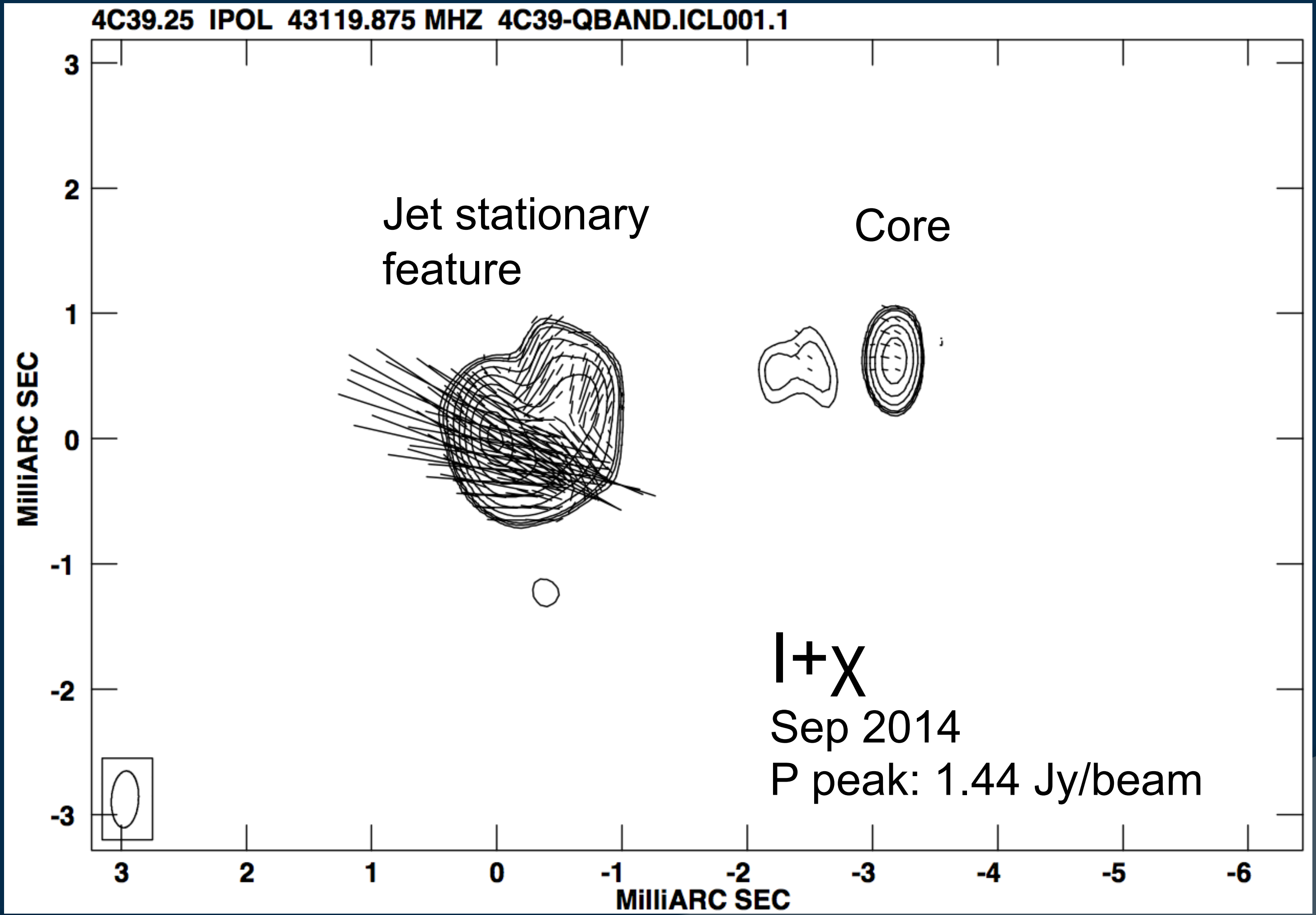
Turbulent, multi-zone model
Marscher et al. (ApJ 780, 87, 2014)

Sep 2014 – observations
(MA002 – VLBA+EB+PV+PdB+YS)

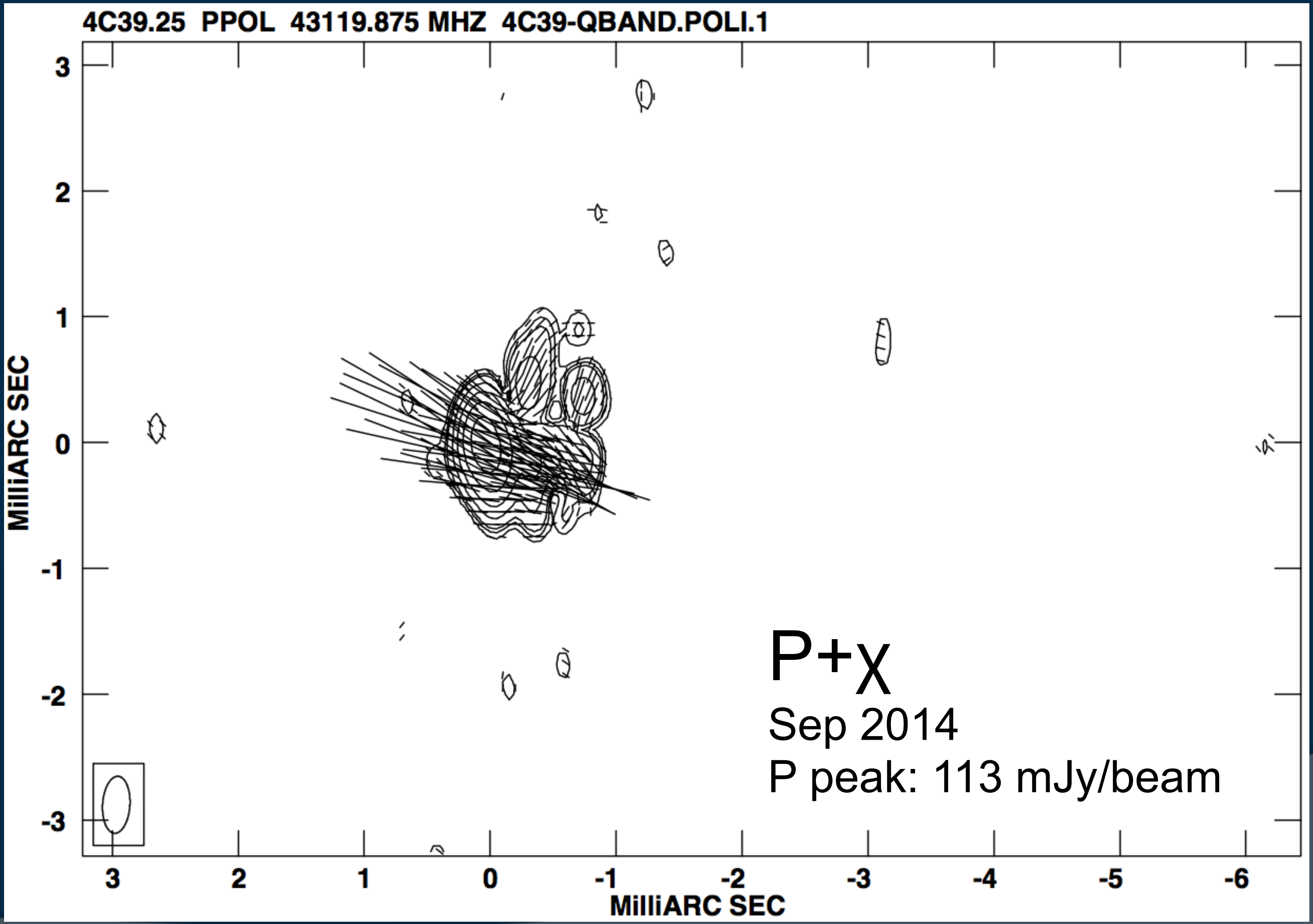




Preliminary results: 7mm, 0923+392/4C 39.25



Preliminary results: 7mm, 0923+392/4C 39.25



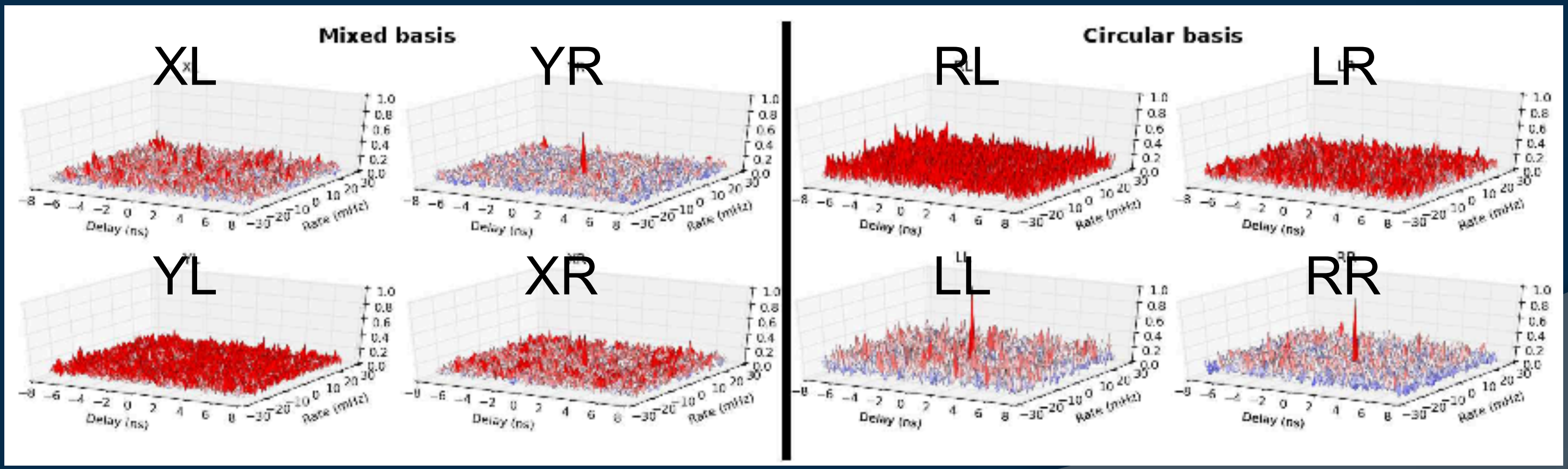
Preliminary results (λ3mm)

- Sources detected for all baselines
- RL delay determined
- Amplitude calibration in progress
- D-terms to be computed
- Final images pending

Promising progress

- Millimetre VLBI including ALMA underway
- ALMA Phasing Project: XY to RL conversion successfully completed

86 GHz Onsala-Effelsberg Pol. Obs



Martí-Vidal et al. (EVN Symposium 2014, arXiv:1504.06579)

Merci – thank you!