RADIO SPECTRA AND MORPHOLOGY OF RADIO-LOUD BROAD ABSORPTION LINE QUASARS

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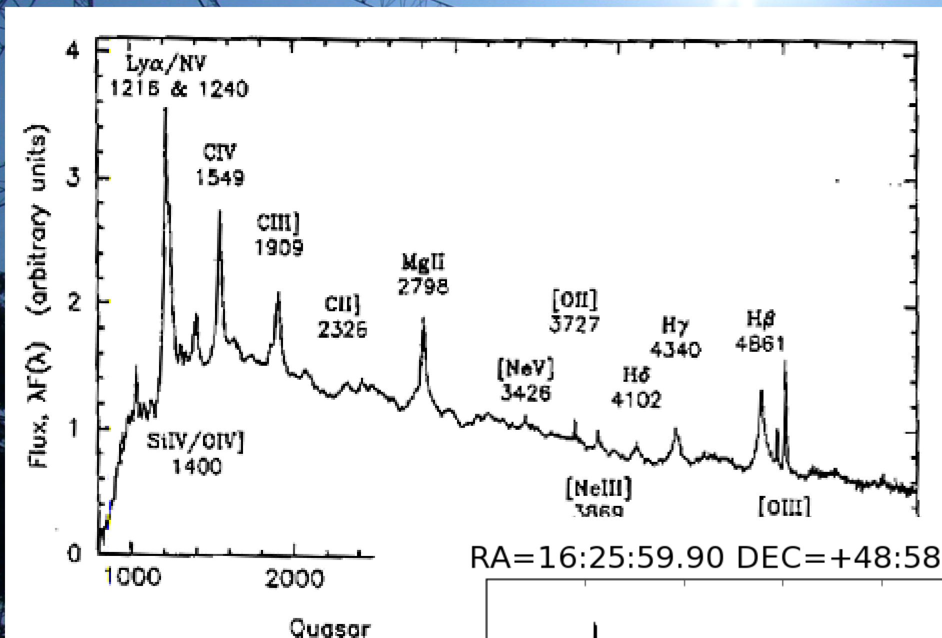
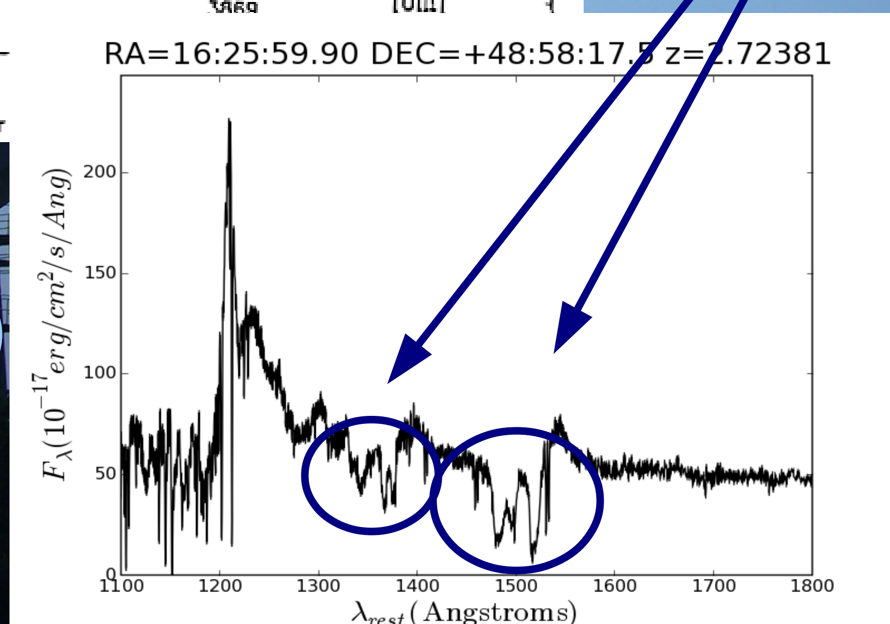




Broad absorption towards the blue wing of some UV emission lines, shifted up to ~ 0.2 c

- Most probably intrinsic
- Al III, Mg II, Si IV, C IV
- HiBALs, LoBALs, FeLoBALs.

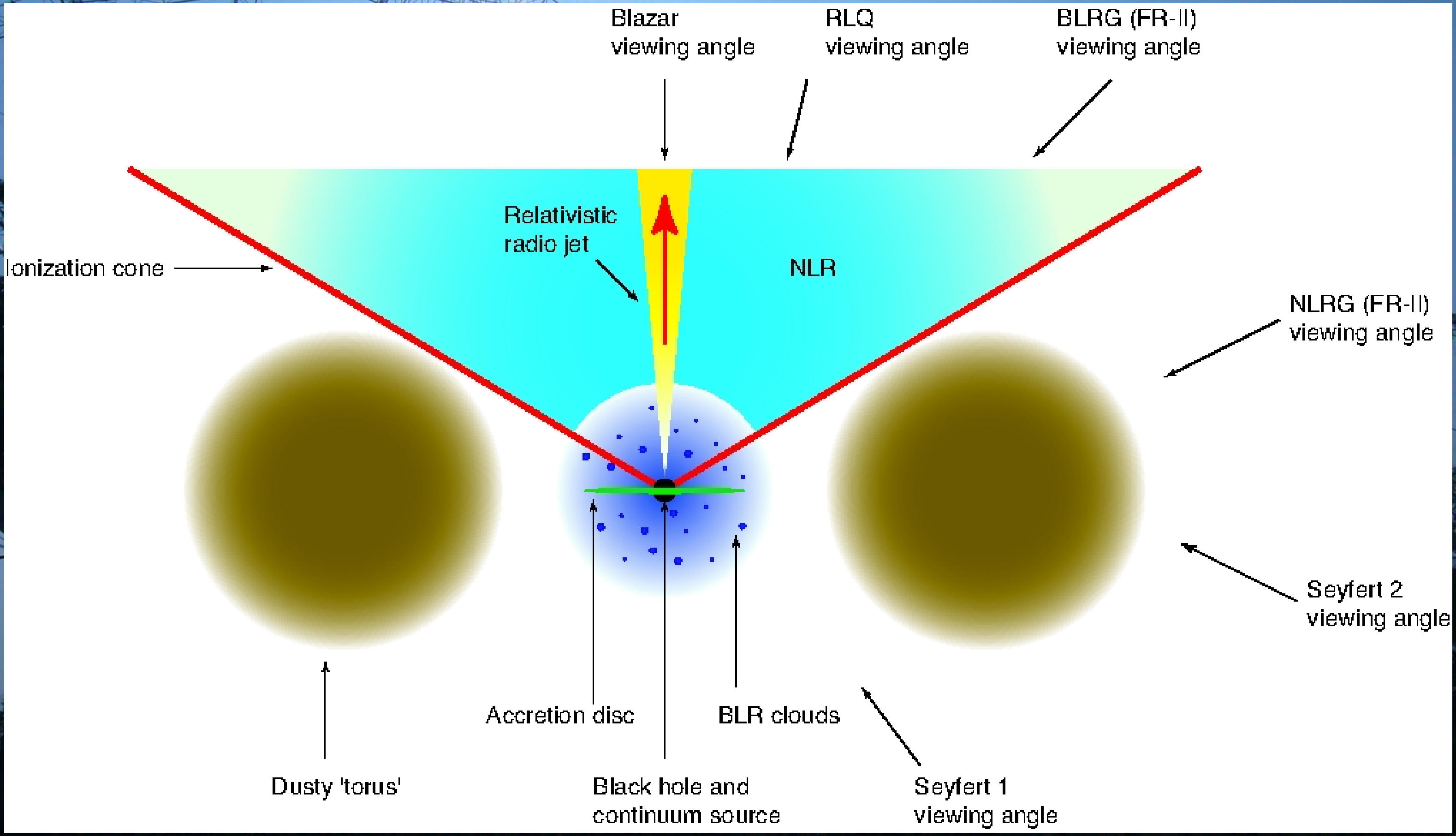
How many?

~ 20 %

BAL QSOs *vs* "normal" QSOs

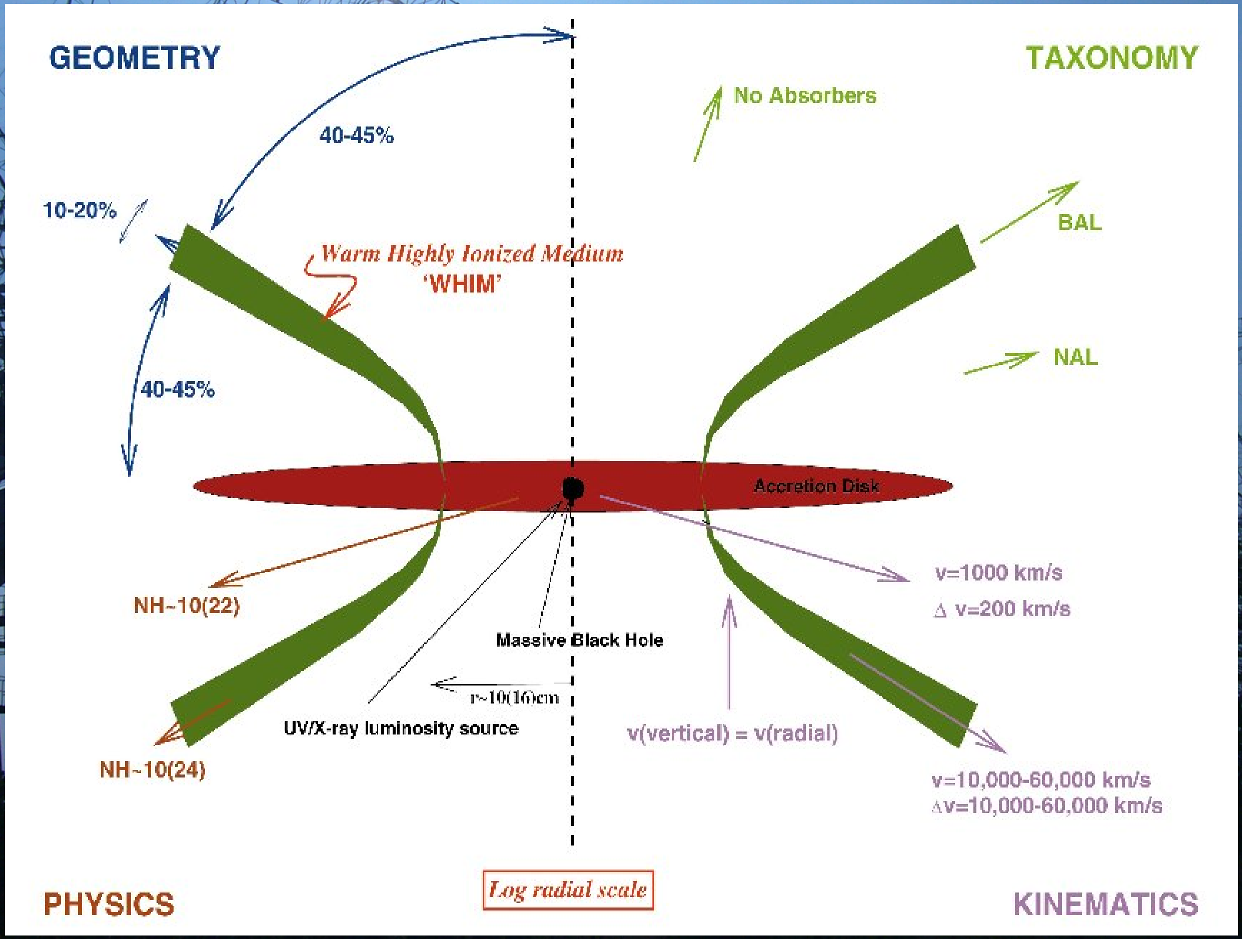
- X-Rays: Emission intrinsically similar, BAL QSOs more absorbed (Green et al. 2001, Gallagher et al. 2007)
- Optical: BALs more reddened, more highly polarized, UV absorption (Goodrich 1997, Krolik & Voit 1998)
- Mid-IR: Similar properties (Gallagher et al. 2007)
- Sub-mm, mm: No differences (Lewis et al. 2003, Willott et al. 2003, Priddey et al. 2007)

Unification scheme of AGN



Explanations for the BAL phenomenon

Orientation Scenario:



Elvis (2000)

Explanations for the BAL phenomenon

Orientation Scenario:

PRO:

- Naturally explains why BAL/non-BAL QSOs are so similar
- Explains higher reddening/obscuration in BAL QSOs
- Explains higher polarisation (optical band) via resonant scattering

CONTRA:

- Variety of radio spectral indices (Becker et al. 2000, Montenegro-Montes et al. 2008)
- Found both edge-on (FR II) and polar (strongly beamed) BAL QSOs (e.g., Gregg et al. 2006, Zhou et al. 2006)

Explanations for the BAL phenomenon

Evolutionary Scenario: Young or recently refueled quasars

PRO:

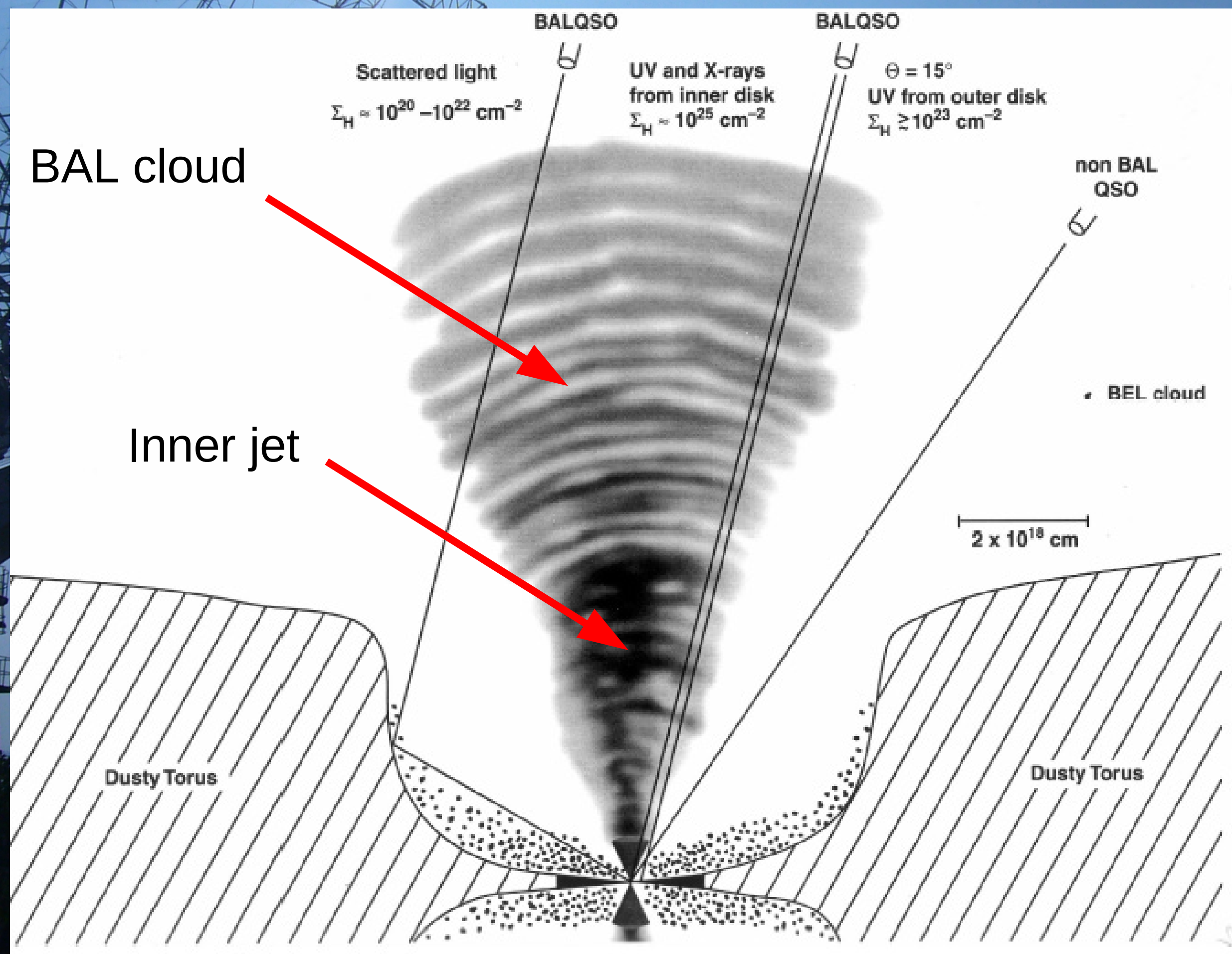
- Anticorrelation between radio-loudness and the BAL phenomenon (Gregg et al. 2006)
- Radio-Loud BAL QSOs are compact sources “like” CSS/GPS (Montenegro-Montes et al. 2008)

CONTRA:

- Same cold and warm dust properties of BAL/non-BAL QSOs (Becker et al. 2000 - Gregg et al. 2000, 2006 - Kunert-Bajraszewska & Marecki, 2007 – Willott et al. 2004)

Explanations for the BAL phenomenon

Cross-over model



(Punsly, 1999)

Sample of 25 RL BAL QSOs + 34 non-BAL QSOs ($S_{1.4}$>30 mJy)

- Radio continuum & polarisation (Effelsberg, VLA, GMRT, IRAM)
- Morphology & orientation (EVN, VLBA)
- Polarisation: particle density & magnetic fields (Effelsberg, VLA)
- Infrared spectroscopy: central black hole mass (TNG)

Radio continuum & polarisation

Effelsberg 100-m dish

- Observations during 2007, 2008, 2009
- Polarisation and continuum at 2.6, 4.8, 8.3, 10.4 GHz
- 25 RL BAL QSOs + 34 non-BAL QSOs

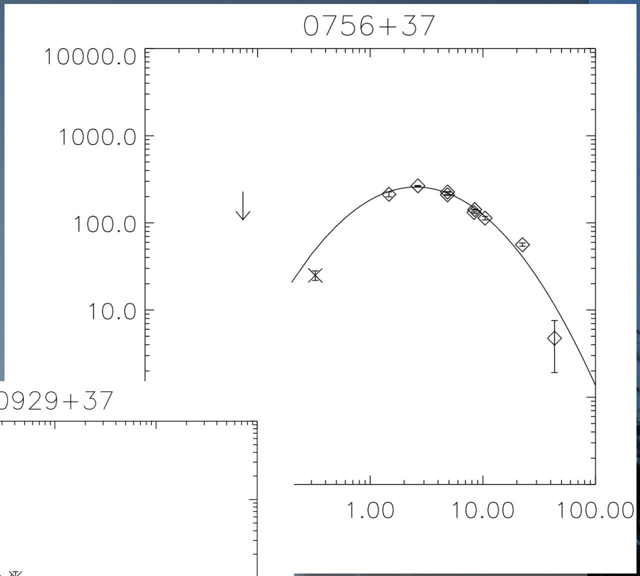
Very Large Array

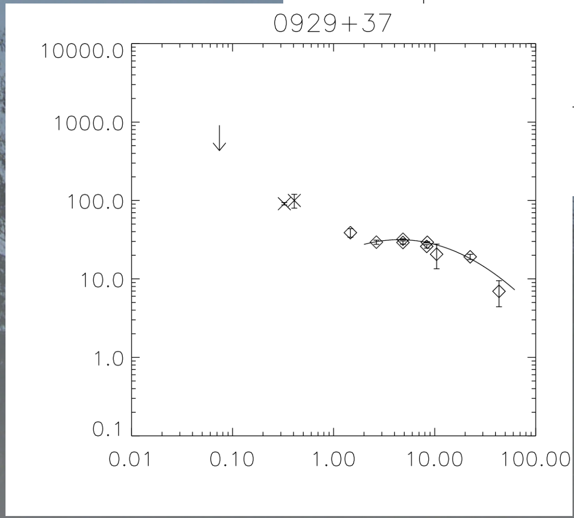
- Observations performed in July 2009 (~40 hours)
- Polarisation and continuum at 1.4, 4.8, 8.4, 22, 43 GHz
- 25 RL BALs + 34 non-BAL QSOs

Results

➡ Fit of the spectra with an analytical function (Orienti et al. 2010)

- Both for non-BAL and BAL sample
- Determination of the peak frequency
- Evidence of low-frequency components
  (12% BAL QSOs, 18% comparison QSOs)





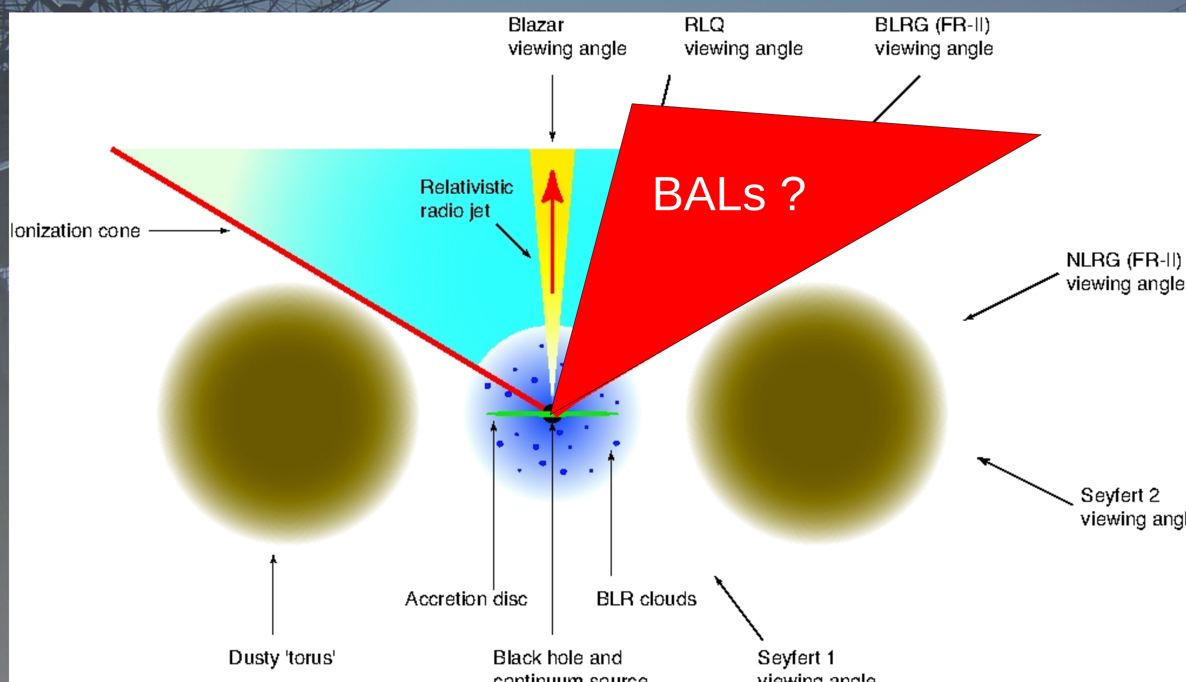
Results

Spectral characteristics

- Peak frequency of the synchrotron emission
- Spectral index

GPS: 32% BAL QSOs
23% non-BAL QSOs

steep: 70% BAL QSOs
70 % non-BAL QSOs

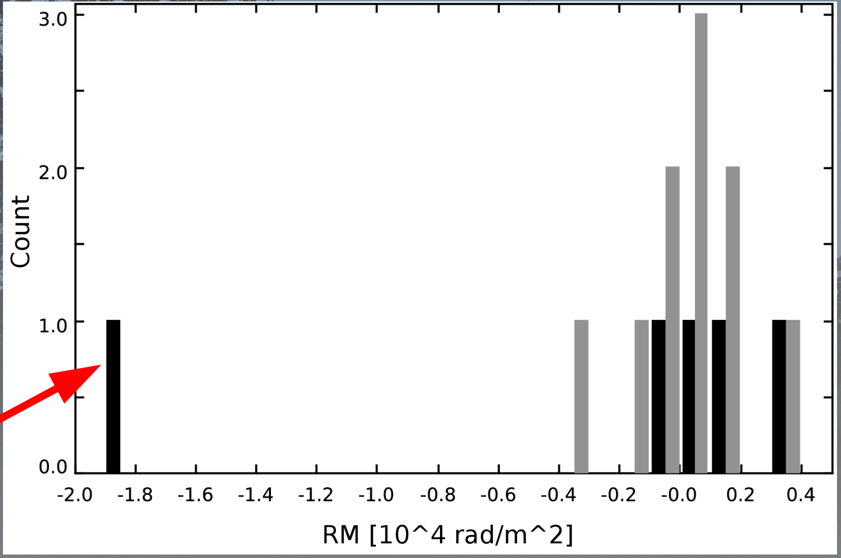


Results

Polarimetry

- Polarisation percentage — ~ 1-10% → Similar to non-BAL QSOs
- Rotation Measure — Values similar to non-BAL QSOs

$$RM = 8.1 \times \int (n_e \cdot B_{\parallel}) dL \quad [rad \cdot m^2]$$



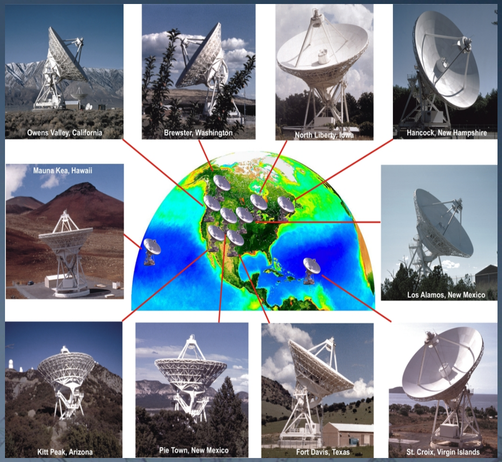
Benn et al. (2005)
(-18350±570 rad/m^2)

Bruni et al. (in prep.)

Morphology & orientation

VLBA

- First 6 brightest sources of the sample
- 4.8 and 8.4 GHz observations (February 2010)



EVN

- Second 5 brightest sources of the sample
- 4.8 GHz observations (October 2009)

VLBA results

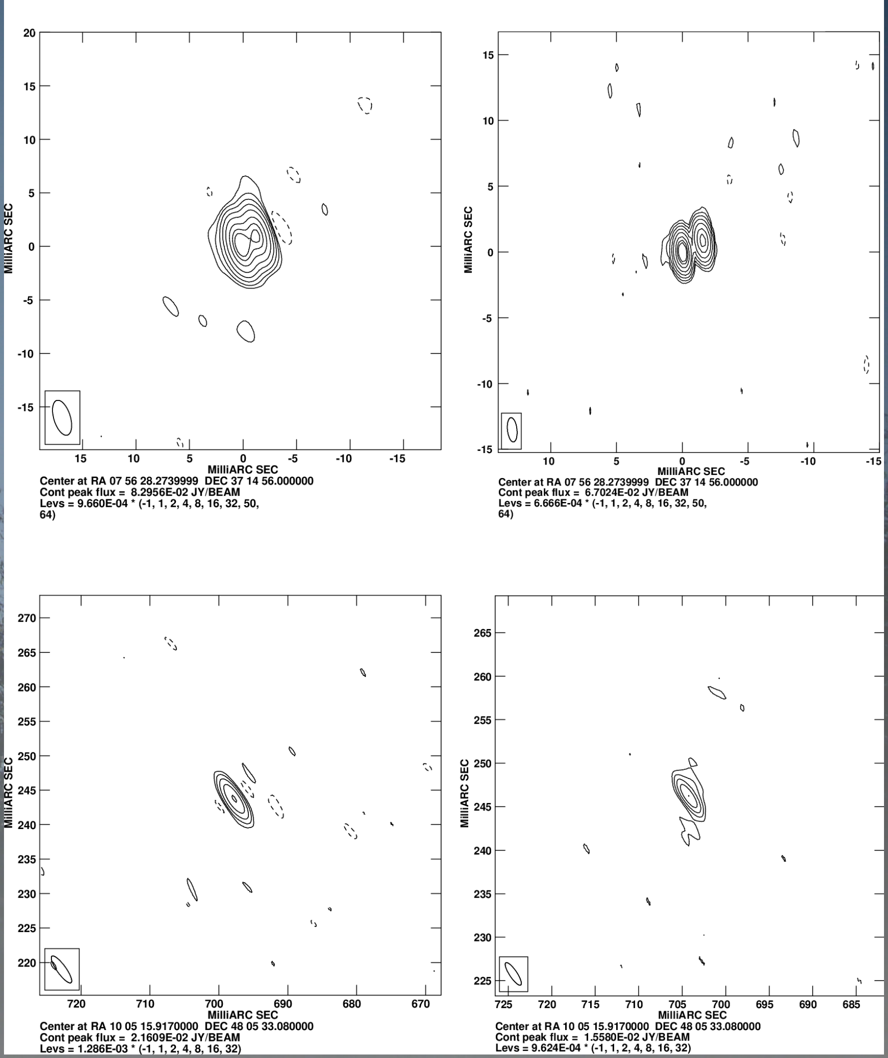
0756+37

- Double structure both in C and X band
- Spectral index for A: -0.34, B: -0.36
- Projected linear size: 40 pc

1005+48

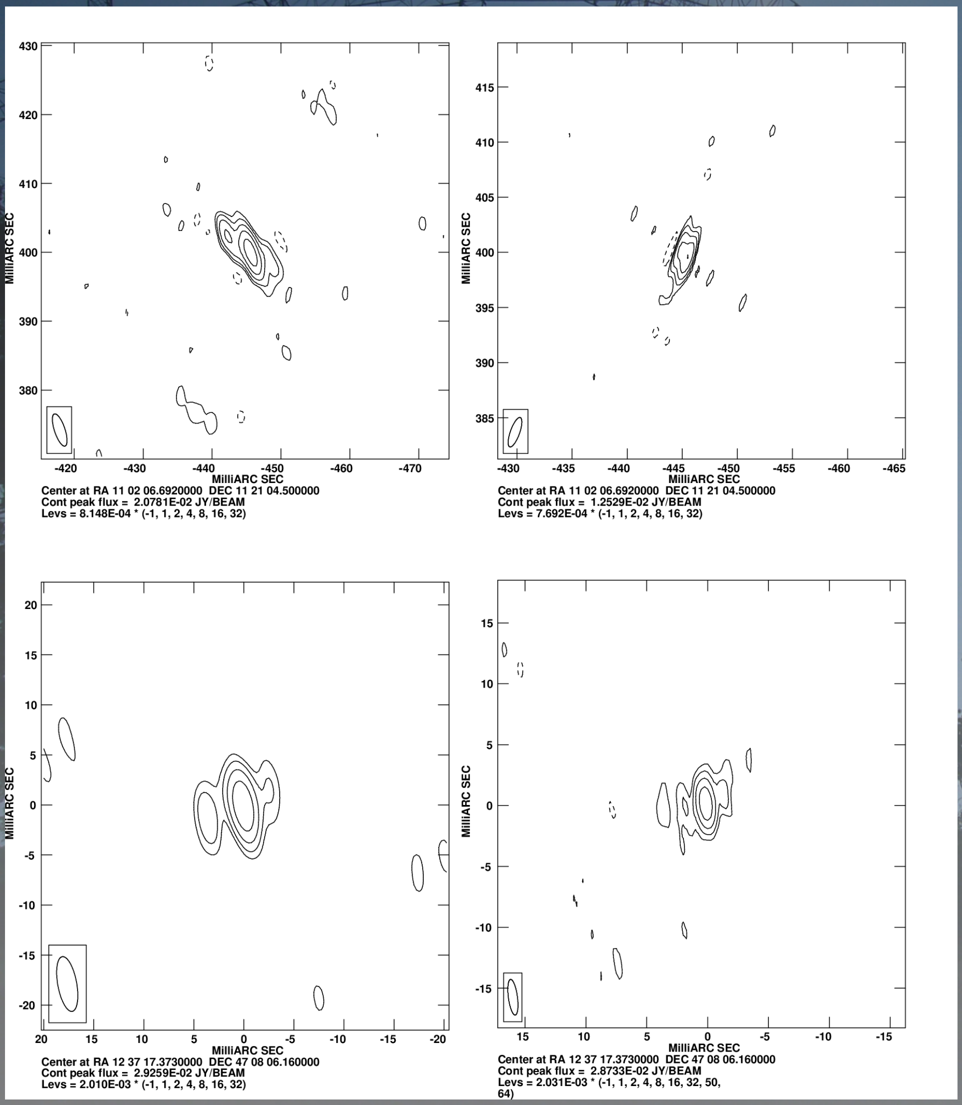
- Unresolved in C & X band
- Flat spectral index: -0.44
- Projected linear size < 18.7 pc

4.8 GHz 8.4 GHz



VLBA results

4.8 GHz 8.4 GHz



1102+11

- Symmetrical structure in C band
- Spectral index for component A: -0.9
- Projected linear size (C band): 18.67 pc

1237+47

- Symmetrical structure both in C & X band
- Inverted spectrum for all the components (0.38, 2.0, 0.40)
- Projected linear size: 76.77 pc

EVN results

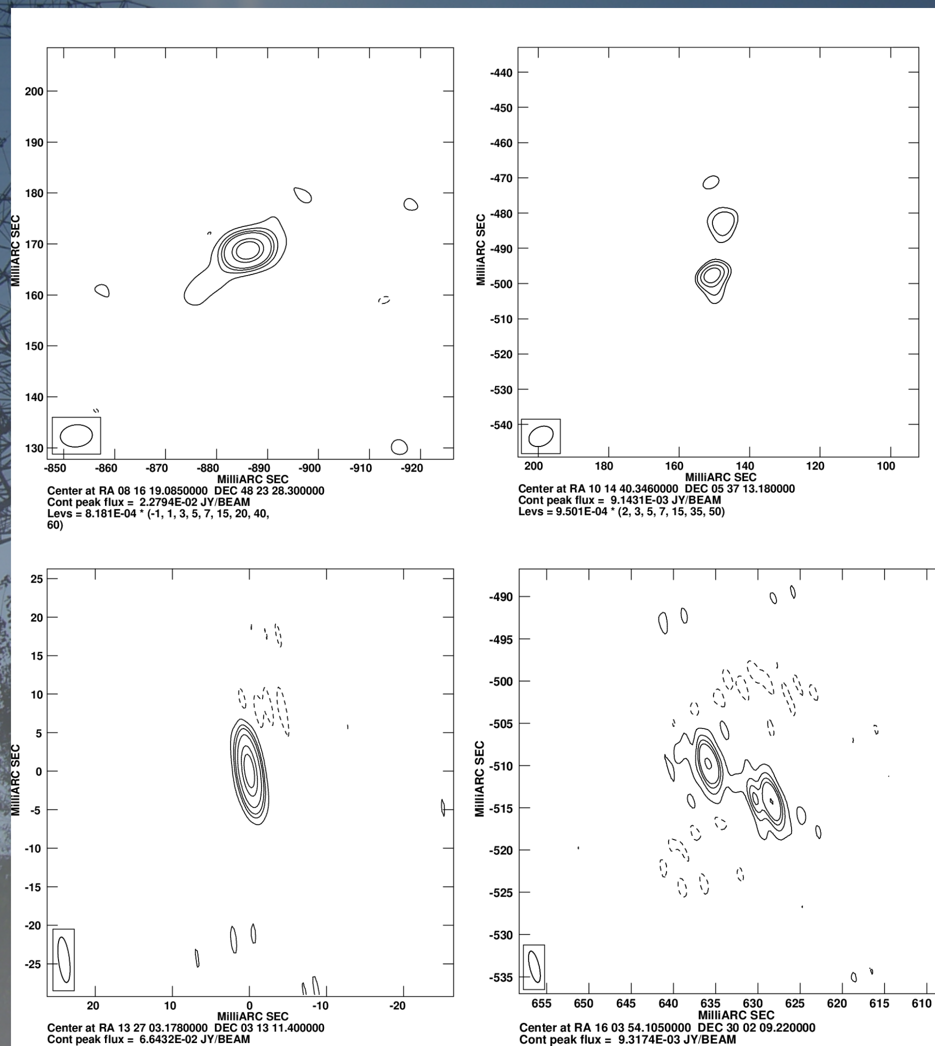
4.8 GHz

0816+48

- Unresolved
- Linear size <87.27 pc

1327+03

- Unresolved
- Linear size <40.05 pc



1014+05

- Asymmetric
- Core-jet structure?
- Linear size: 461.7 pc

1603+30

- Three components
- Equatorial?
- Linear size 167.1 pc

Conclusions

- No particular orientation, only steep-spectrum majority
- Both GPS and low frequency peaked, old components in some cases
- Not extremely young radio jet
- Some resolved, different morphologies, sizes from ~10 to ~500 pc

↓

The most probable model is the Elvis one
(but it must account for both steep and flat sources)


...Thank you!