l'Observatoire de Paris | LUTH

Laboratoire Univers et Théories

Linking radio and gamma-ray emission in a specific blazar

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Journée des doctorants du LUTH

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I- Radio-loud AGNs

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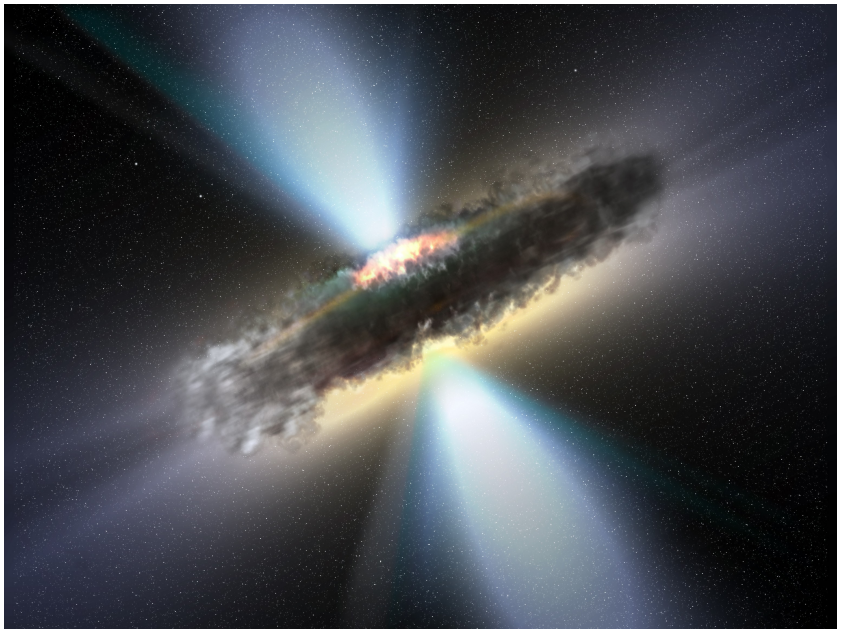
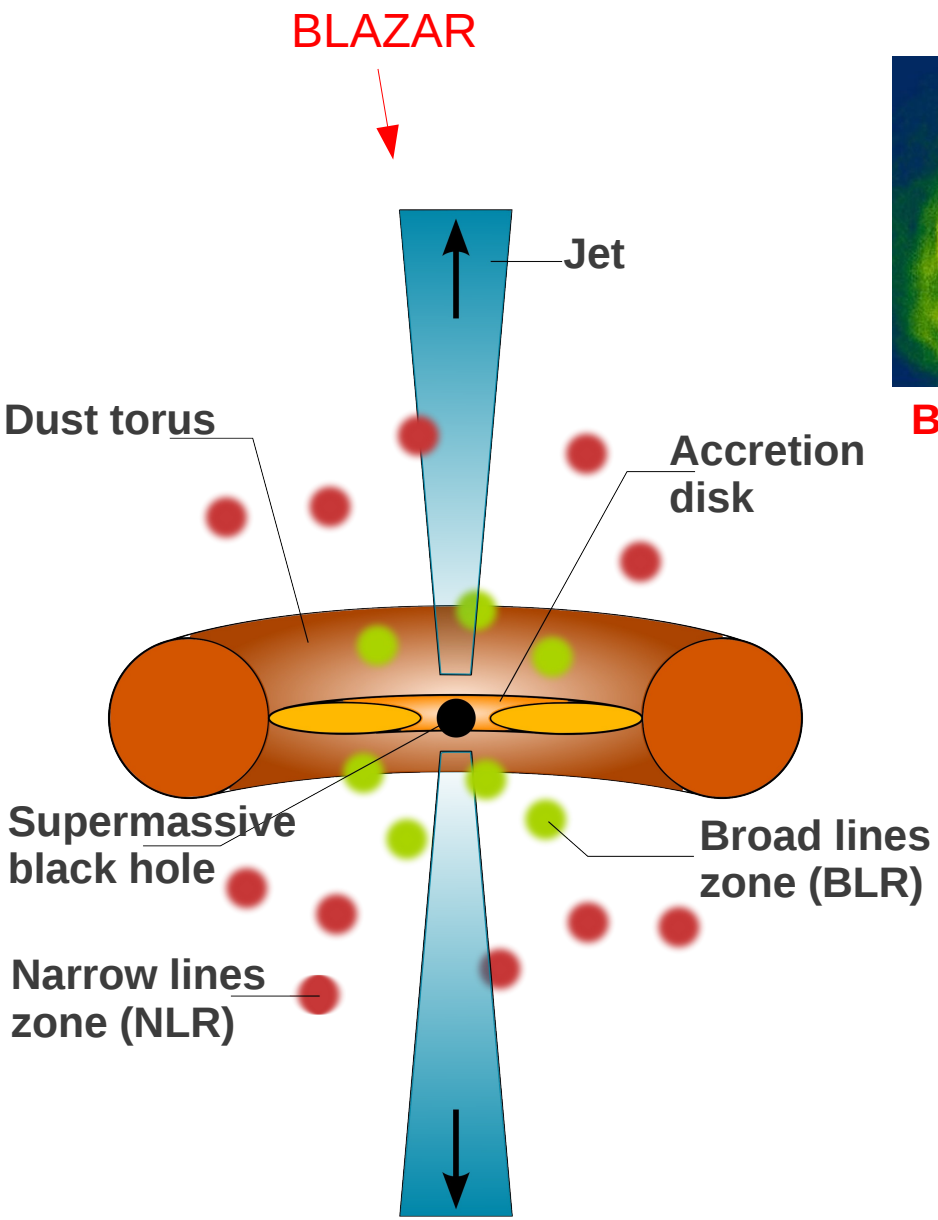
Some figures

- Supermassive Black Holes (SMBH) are present in the center of all massive galaxies.
- SMBH have masses from 10^6 to 10^{10} $M_\odot$
- ~5% of SMBHs are active, they form thus an Active Galactic Nuclei (AGN)
- ~ 10% of AGNs have radio jets (radio loud AGN)
- Most luminous known objects in the univers : from 10^{43} to $10^{46}\, erg.s^{-1}$

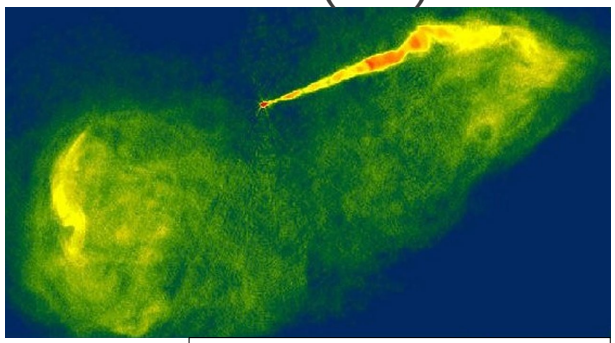


I- Radio loud AGNs

Structure of a radio loud AGN

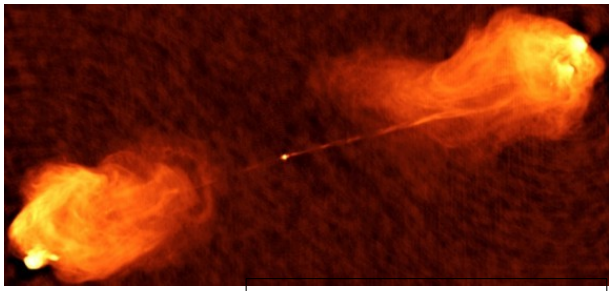


M 87 (FRI)



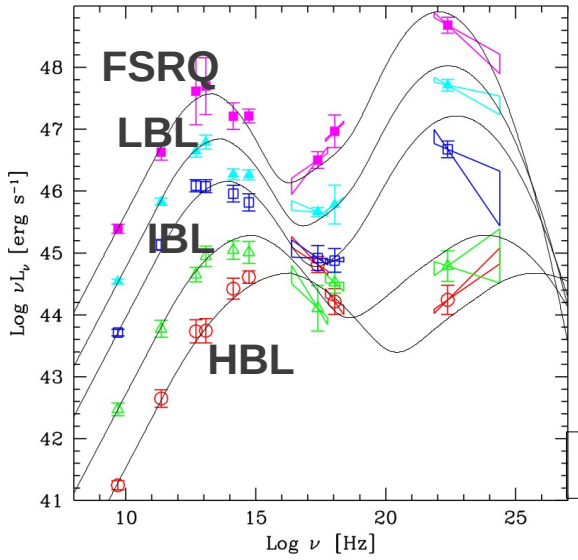
BL LAC *NRAO 20cm (1999)*

Cygnus A (FRII)



FSRQ *NRAO 6cm (1996)*

The Blazar sequence



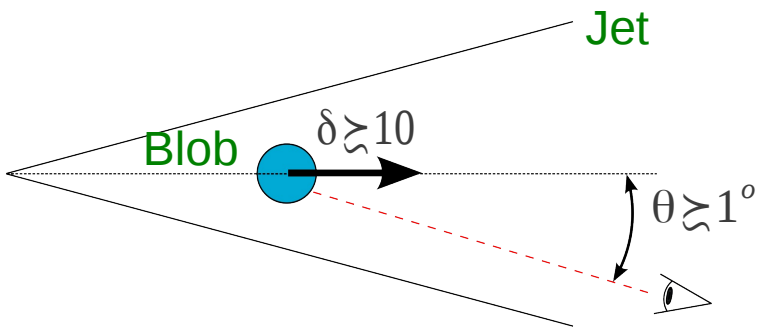
Fossati et al. (1998)

I- Radio loud AGNs

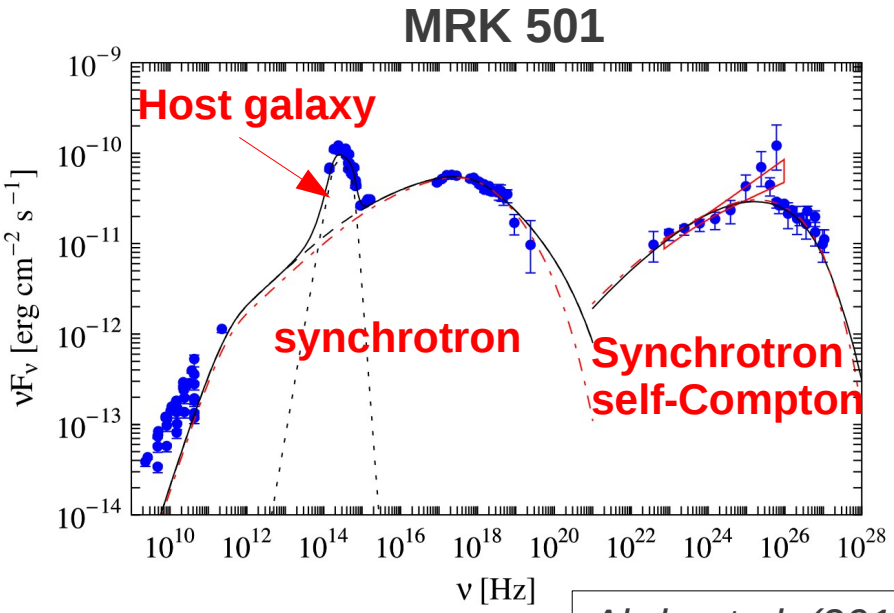
HBL case

- Majority of blazars seen in very high energies are HBLs
- Efficient model for HBL emission spectra

Sblob code



Stationnary leptonic SSC model



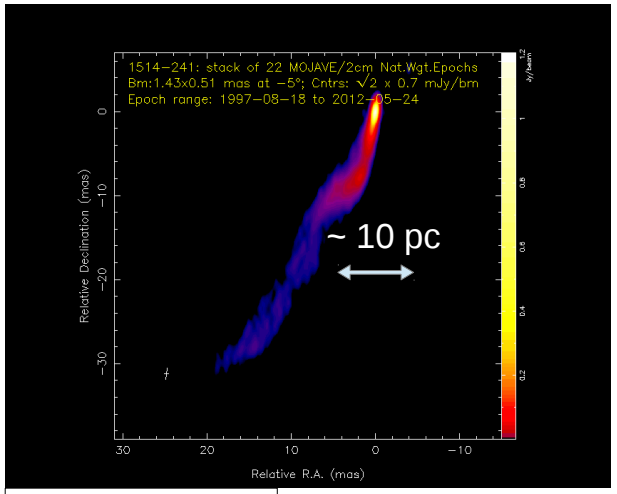
Abdo et al. (2011)

I- Study of a LBL blazar

II- Study of a LBL blazar

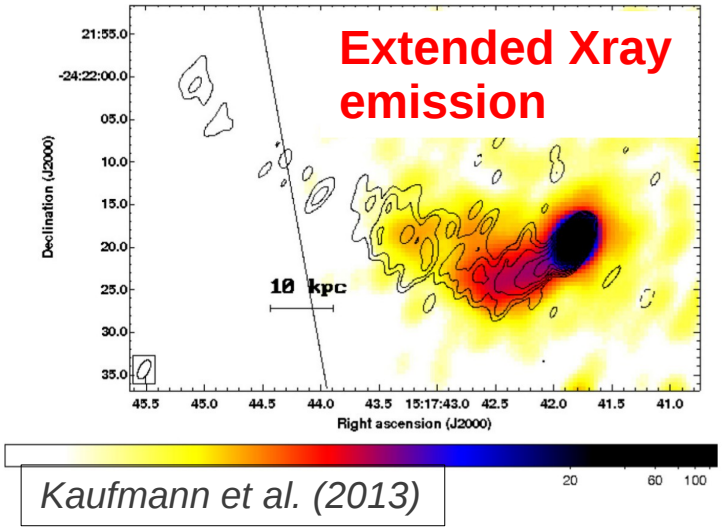
Complex case of Ap Librae

Radio short scale



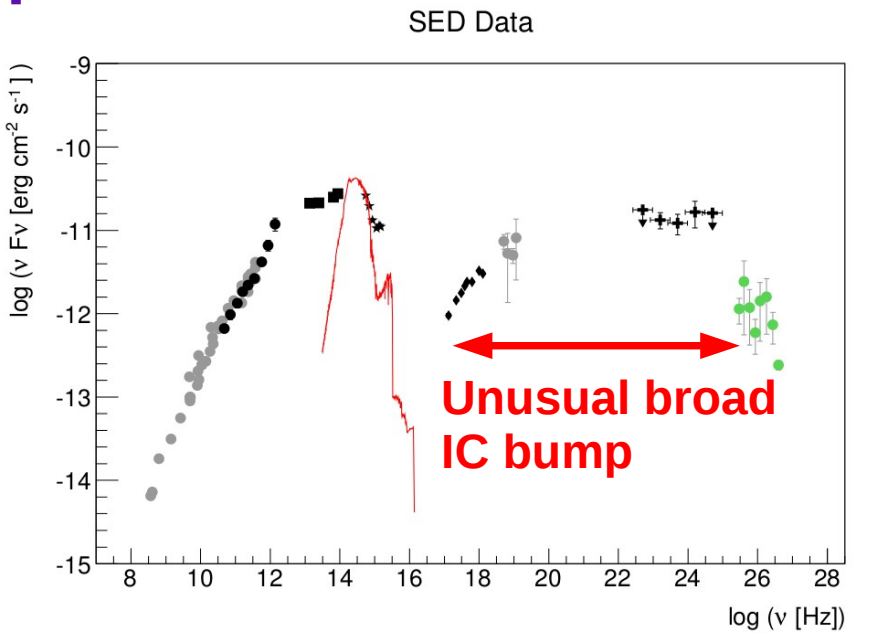
MOJAVE 2cm

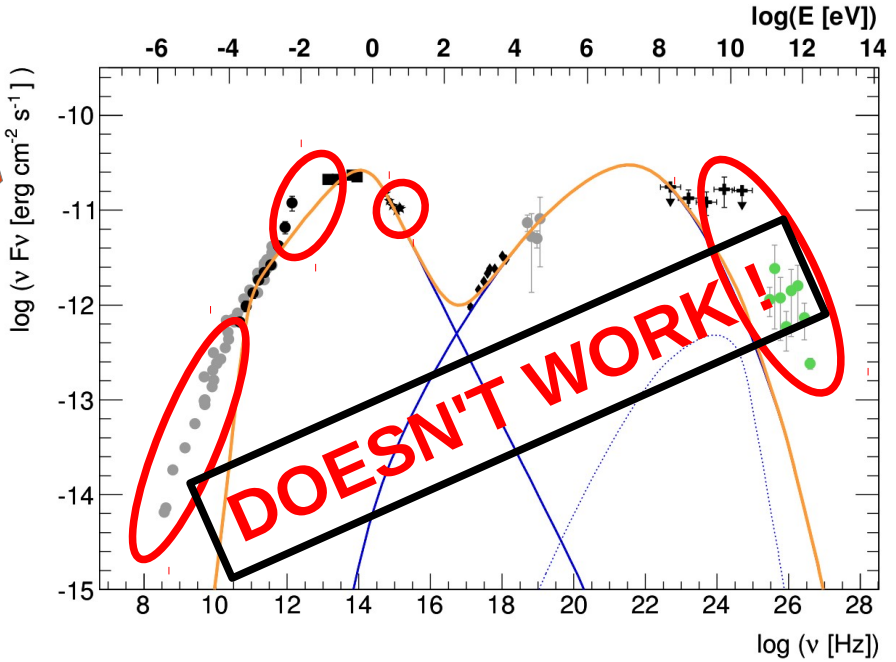
Radio & Xray large scale



Kaufmann et al. (2013)

Simple zone SSC modelling

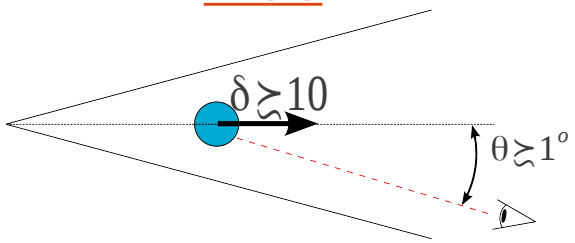




II- Study of a LBL blazar

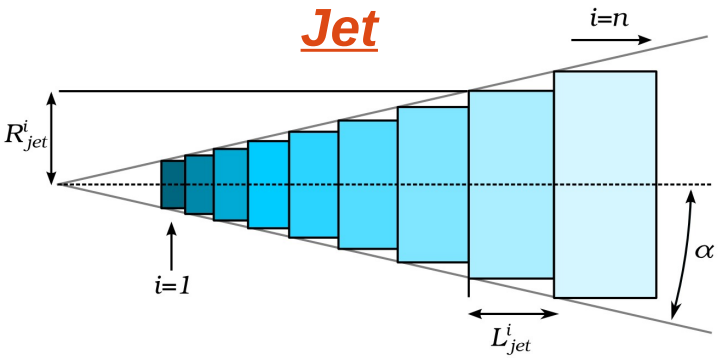
New code : « *Bjet* »

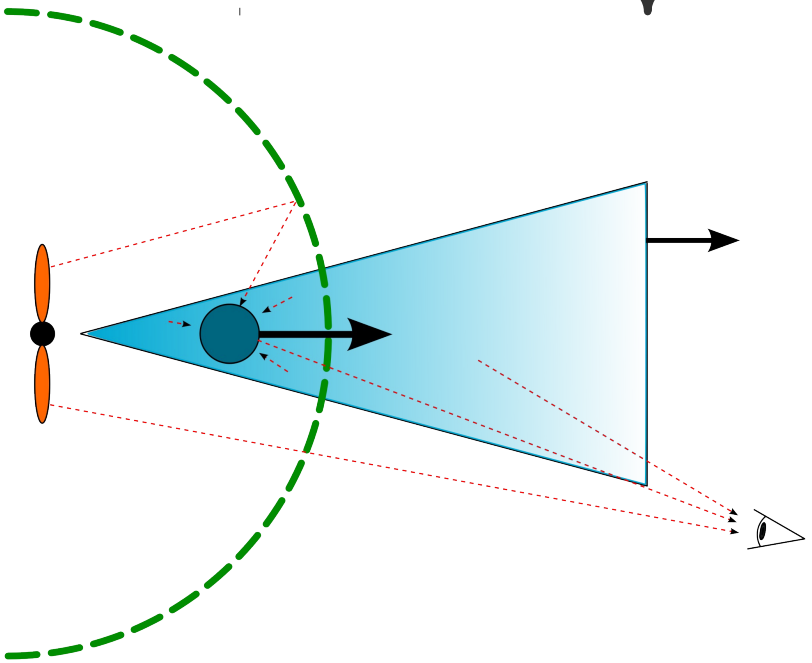
Blob



+

Jet



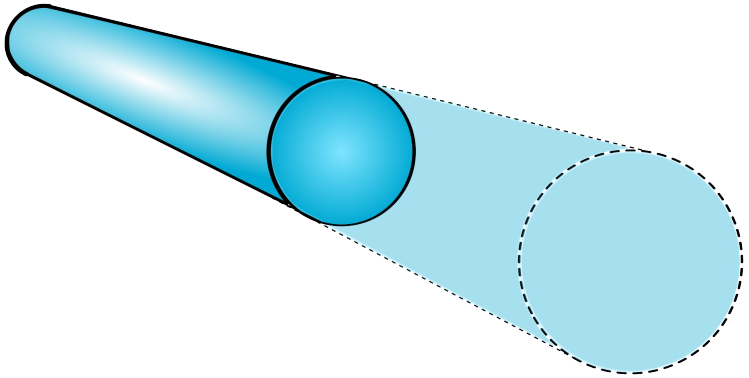


- Blob-jet interaction seems necessary to describe some sources IBL, LBL or FSRQ
- Efficient code but too much free parameters...

II- Study of a LBL blazar

Physical constraints by the radio study

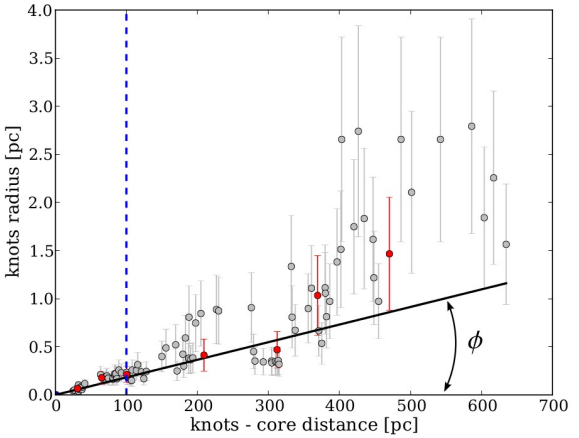
Radio Core = base of the extended jet



Constraints from the radio core dimensions :

- Opening angle **α**
- Angle with the line of sight **θ**

Radio Knots grows linearly with the distance to the core



- Deduction of a knot collimation angle **Φ**

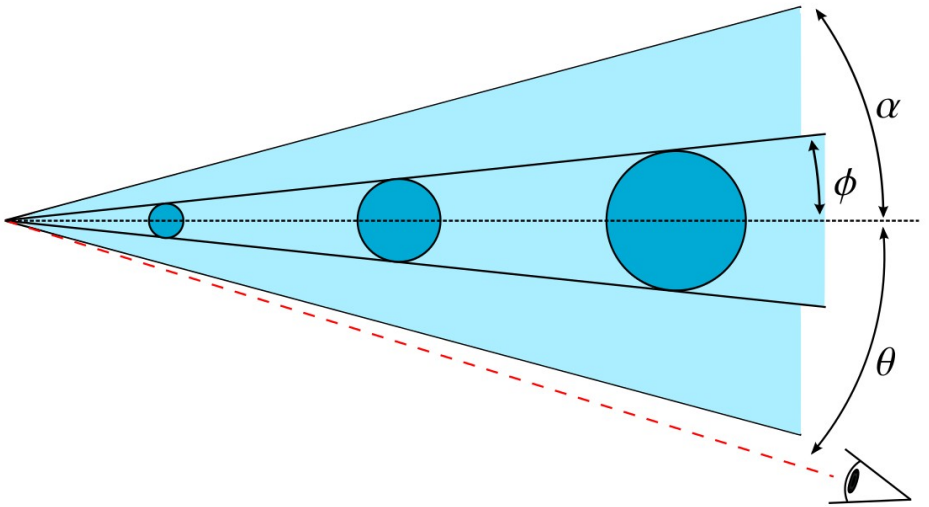
Constant velocity for differents knots along the jet

- Give the doppler factor **δ** !

II- Study of a LBL blazar

General view

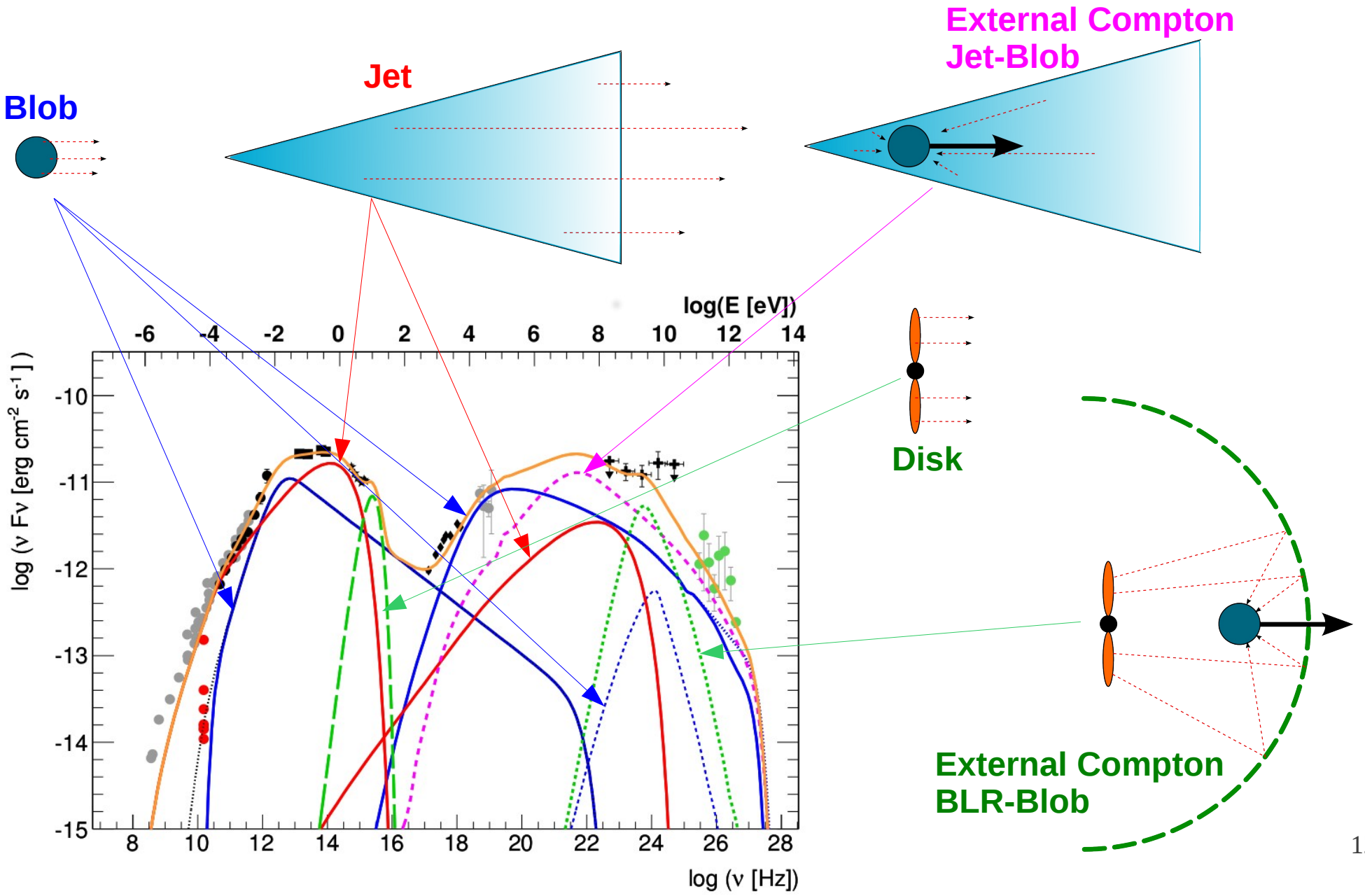
- We found **Φ < α < θ**
- Average values :
  Φ = 0,1°
  α = 0,4°
  θ = 1,4°
  δ = 22
- The jet is not pointing exactly to us
- 2 « jets » are imbricated



Can an HE blob be consistent with this scheme ?

II- Study of a LBL blazar

Modelling



II- Study of a LBL blazar

Energetics

Linear expansion of the blob :
V expansion = V alfven

$$\rho_b = \frac{1}{4\pi}\left(\frac{B}{v_A}\right)^2 \simeq 1.14 \times 10^{-19} g.cm$$

- Deduction of the density
- Assumption of a neutral environment
  1p = 1e-
- **Blob :** dominated by **HE population**
- **Jet :** dominated by **cold population**

Powers

Power	Blob	Jet	Disk	Total
Radiation	42.68	42.62	43.70	43.77
Magnetic	40.94	42.87		43.09
Electrons	43.89	43.73		44.14
Protons	46.72	47.50		47.57

Units: log(P [erg.s−1])

Mass outflow rate :

$$\dot{M}_{out} = \frac{1}{c^2}\left(\frac{P_{j,p}}{\Gamma_j} + \frac{P_{b,p}}{\Gamma_b}\right) = 6.19 \times 10^{25} g.s^{-1}$$

Upper limit on the **accretion efficiency :**

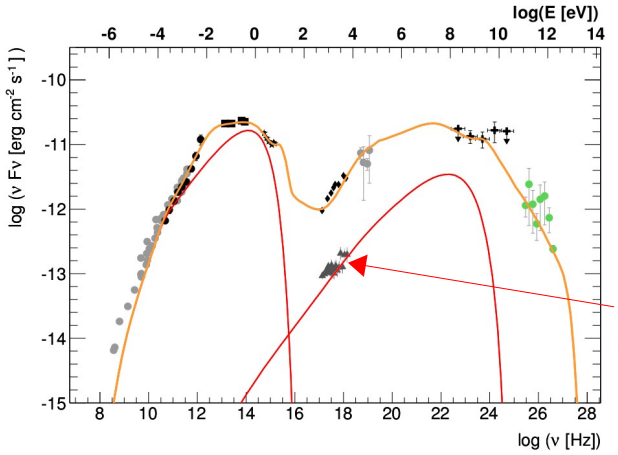
$$\eta = \frac{L_d}{\dot{M}_{in}c^2} \Rightarrow \eta \leq \frac{L_d}{\dot{M}_{out}c^2} \leq 9.9 \times 10^{-4}$$

ADAF ?
Maybe but lot of incertainties about L_disk...

II- Study of a LBL blazar

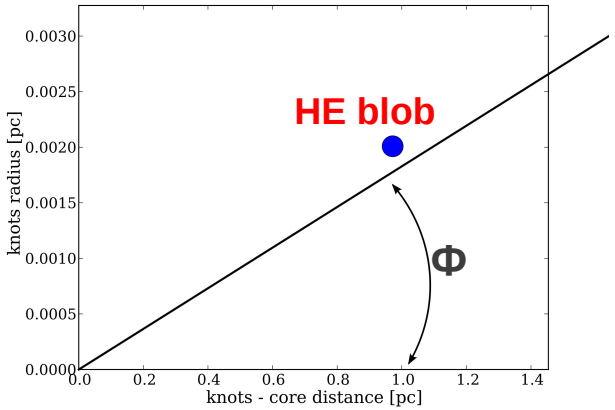
Results

- Good fit with Chandra extended jet data

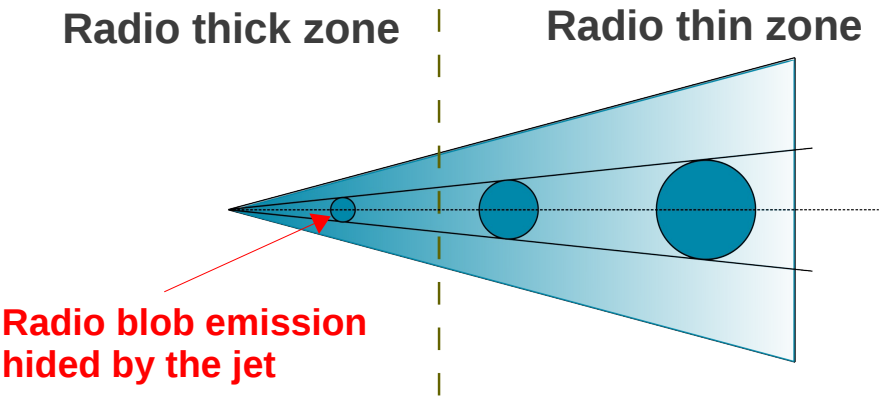


Chandra
Kaufmann et al. (2013)

- HE blob size & position consistent with the knots aperture Φ



- Absorbtion radio of the blob near the core consistent with radio maps



- Consistent doppler factor value
- Consistent energetics
- Good MWL fit

HE blob and radio knots can be strongly linked

II- Study of a LBL blazar

Categorisation of the source

- Rather **FRII** type than **FRI**
  - Critical efficiency Between BL Lac and FSRQ
  - Strong power *Ghisellini & Tavecchio (2008)*
  - Xray extended jet
  - MHD simulations of strong extended jet

  } **Not a genuine BL Lac**

- No emission lines, low flux of the second bump → **Not a classical FSRQ**

None of the categorisations match these features

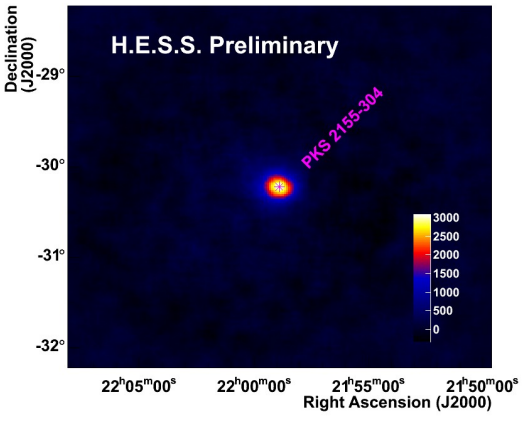
Can we see others source of the same kind ?

- Radio broken spectrum around $2{,}5.10^2$ GHz
- Very broad second bump
  - Positive X slope
  - ~ Flat Fermi spectrum, Fermi flux ~ max synch flux

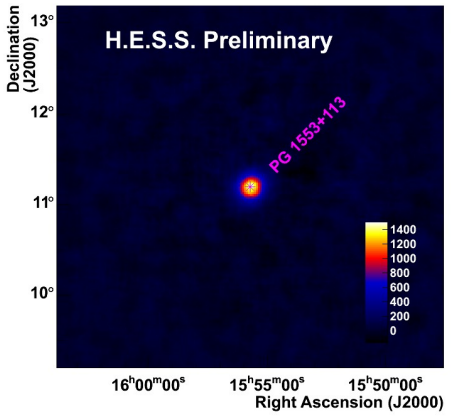
Yes, ten of sources in minimum are good candidates to test the model !

III- First HESSII results

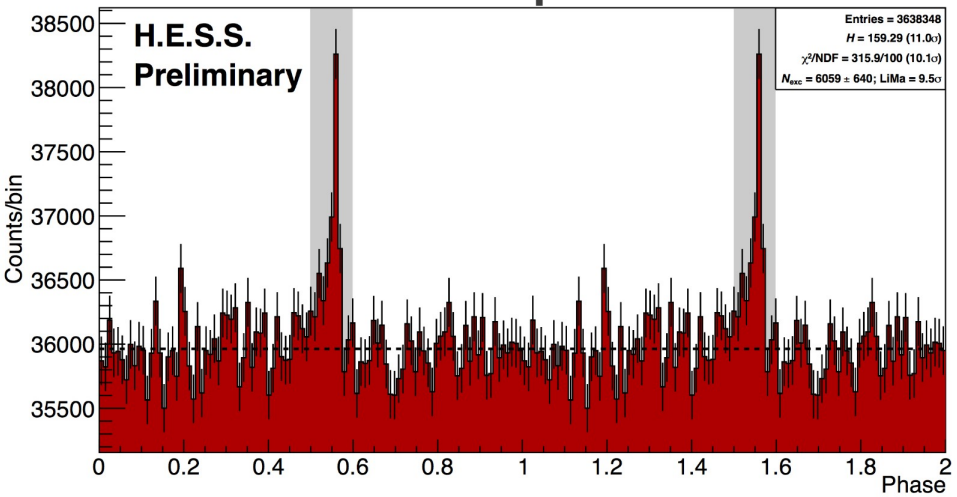
PKS 2155-304



PG 1553+113



Vela pulsar



Work in progress with the
« HESS2 First AGN Results Task Group »