The Bologna Complete Sample: radio and gamma-ray data.

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ABSTRACT: We selected a complete sample of nearby radio galaxies that is free of selection effects with respect to the orientation of the nuclear relativistic jet . Radio properties and the connection with their gamma-ray observations are discussed.

THE PROJECT

AIM: statistical study of parsec scale properties in different class of sources

METHOD : definition and observations of sample free from selection effects due to θ → need to look at low frequencies samples.

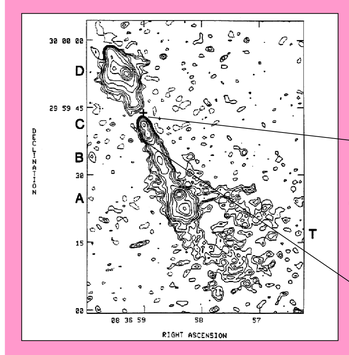
SAMPLE : → 94 sources from B2 catalog and 3CR catalog with no contraint on nuclear properties
→ Criteria: 1) flux density limit > 0.25 Jy at 408 MHz for the B2 + > 10 Jy at 708 MHz for 3CR
2) declination > 10 deg; 3) galactic latitude $|b| > 15^0$; 4) redshift $z < 0.1$

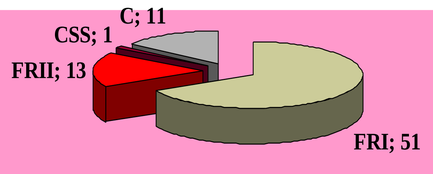
OBSERVATIONS: -) Radio band: 5 GHz VLBA + 1.6 GHz EVN and 1.6 GHz VLBA observations for fainter sources ($S_{(core, VLA)} < 5$ mJy)→ work in progress with 76 objects yet analized.
-) Gamma-ray: Fermi Catalogs

Typical resolution at 5 GHz ~ 2 mas (~3.6 pc at z=0.1 → core region) and noise level ~ 0.1 mJy/b

RESULTS: Radio data

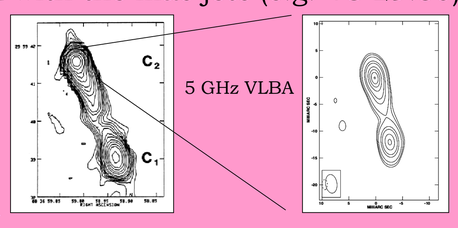
• *Kiloparsec structures*:





For the majority of source, kpc jets are **aligned** with the mas jets (e.g. 4C 29.30).

4C 29.30: 6cm VLA



5 GHz VLBA

* *Parsec scale structures*: **-) 41% are one sided (core+jet)** with S_J / S_{cJ} ≥ 10 (except for 0055+30 and 0220+43) is consistent with the presence of relativistic jets,
-) 20% are unresolved corresponding to 14FRI+1FRII with faint relativistic jets in the plane of sky;
-) Z shaped sources:3C 310 + 4C 26.42 (see Fig.1) that exhibit two-sided morphology (core+jet+ counterjet) on parsec scale with the evidence of mildly relativistic jets

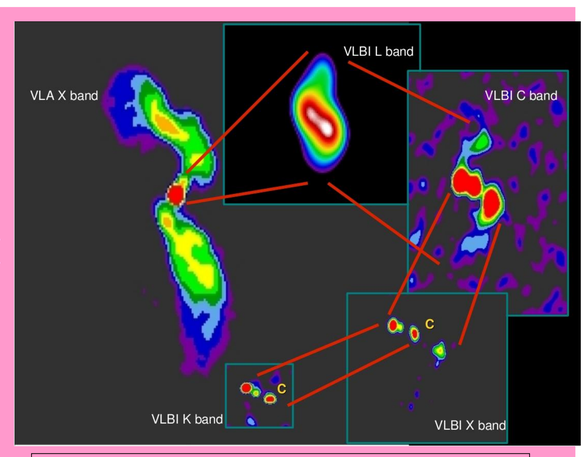
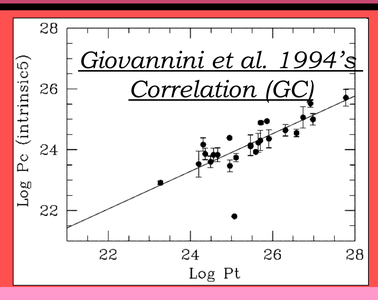


Fig.1 : 4C 26.42 images at different resolutions

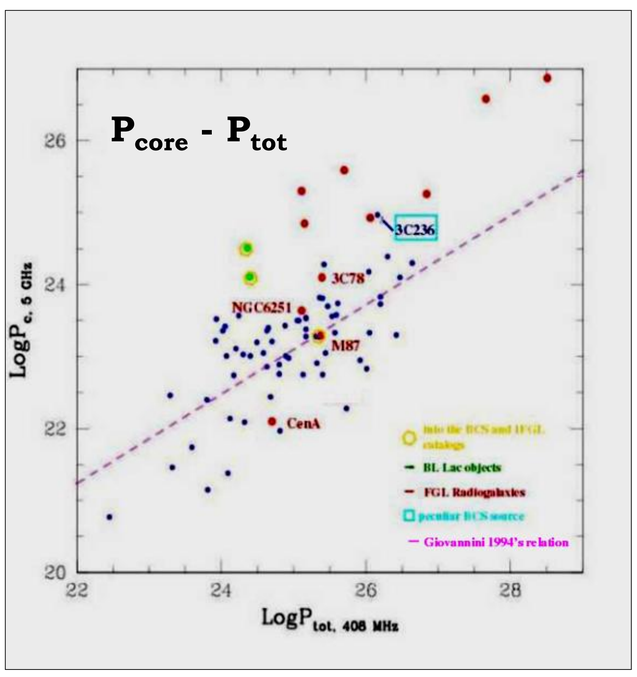
* ***Core dominance CD***: $P_{(core, observed)} / P_{(core, estimated)}$ where (θ is the viewing angle)

$\log P_{(core, estimated)} = 0.62 \log P_{(tot, 408MHz)} + 7.6$ (θ=60)

for BCS:→ CD: >1 → θ < 60^0 → boosting effects
0.25-1 → θ > 60^0 → deboosted emission
>> 1 → restarted activity? (e.g., ***3C 326*** and 2 BL Lacs + 0222+36 have >10)
< 0.25 → no solution → presence of nuclear variability
→ presence of core in a low radio phase (e.g. for 4 FRI + 4 NL extended powerful FRII)



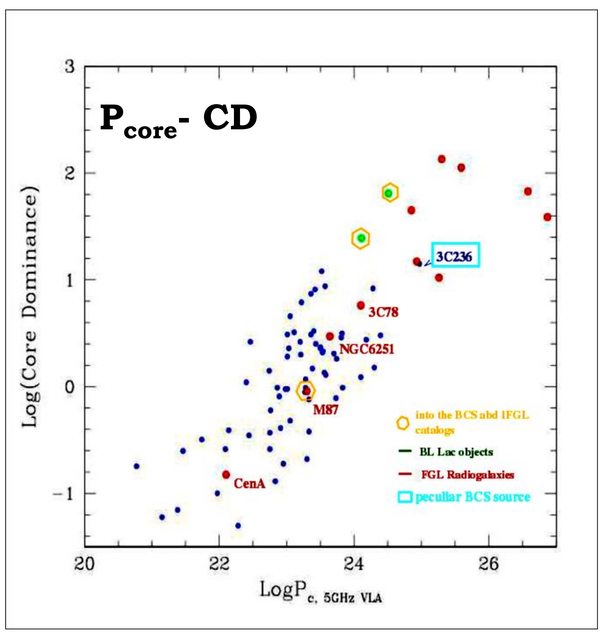
RESULTS: FERMI data

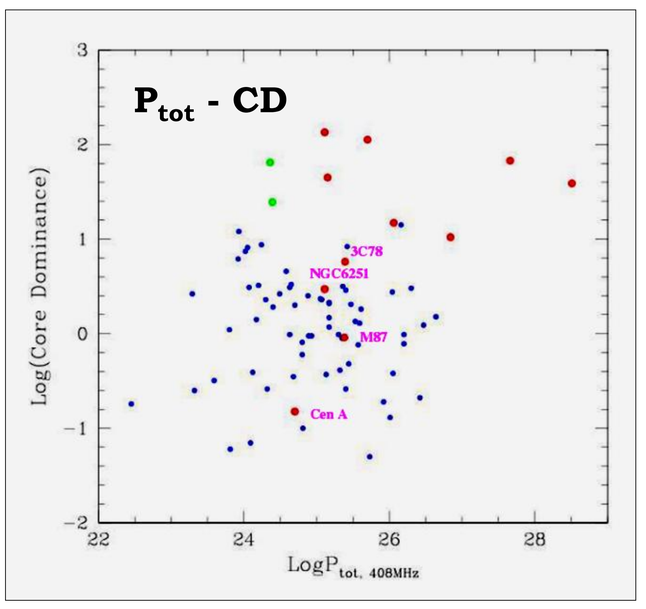


- Among the BCS,there are 3 FGL :*2 BL Lacs + M87*

-As expected, among the FGL Radiogalaxies (RG), the majority Of sources are above the Giovannini 1994's correlation (GC) → they have high core dominance which indicates small θ

-*M87 + Cen A are peculiar objects* being below the GC while 3C 236 is *interesting* being not in the FGL Catalogues (see Notes on sources below)





- In the **P_{core} – CD** plane, FGL RGs occupy a well defined region with high CD and high P_{core}.

- In the **P_{tot} – CD** plane, the FGL RGs spread over P_{tot}, meaning indipence of Fermi emission from P_{tot}, but they are segregate at high CD values that suggests the indipendence of the Fermi emission from P_{tot}, but the presence of a relation with P_{core}, as beaming effects plus also intrinsically high P_{core} .

- Gamma-ray emission from BCS sources with **low CD** could be detected by Fermi in the next future using stacking observations.

Notes on sources:

- M87 has small CD and large θ but it is detected by Fermi as a consequence of its proximity (z=0.04)

- Cen A, despite its small CD, is a FGL sources as the Fermi emission is not only nuclear but it comes also from lobes.

- 3C 236 has P_{core}, P_{tot} and CD similar to the FGL RGs but it is not a Fermi source. In this case, the high CD is due to the restarted activities (see above the comment on CD for BCS). It is like a young source. It could be detected by Fermi in the future

For details, see
Giovannini et al. 1994, ApJ 435, 116
Giovannini et al. 2001, ApJ 552, 508
Giovannini et al. 2005, ApJ 618, 653
Liuzzo et al. 2009a, A&A, 501, 933L
Liuzzo et al. 2009b, A&A, 505, 509L
Liuzzo et al. 2011, in preparation