Active Galactic Nuclei: What’s in a name?

The new class of FRO radio galaxies

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Local Radio Galaxies (RG)

FRI

FRII

Flux-limited samples (such as, 3rd Cambridge Catalogue, $F_{178\text{MHz}} > 9 \text{ Jy}$) include FRI and FRII.

Fanaroff & Riley (1974)

~0.1-1 Mpc
Radio Luminosity Function

3C samples and successors probe only a part of the LF of RL AGN.

The bulk of the LL RG population is still unexplored!

Who are they??

Best & Heckman (2012)
Which is the typical RG in the local Universe?

- FRI
- FRII

$mJy$-level AGN

$≈5-10$ kpc
Best et al. (2005/2012) select 2215/7302 low-luminosity radio-loud AGN (F > 5mJy) cross-matching SDSS (DR2/DR7) and NVSS and FIRST with Flux > 5 mJy in the local Universe (z < 0.3)
We classify 227 FRI (size $> 30$ kpc), 14 FRI (sFRI, $10 < $ size $< 30$ kpc) and 108 FR0 (size $< 5$ kpc) from the FIRST catalogue based only on the radio morphology with $z<0.15$.

**Space density**

| Type  | 1 | : | 1 | : | 2 | : | 15.4 |

Capetti, Massaro & Baldi (in prep)
Baldi & Capetti (2010) studied the properties of the sample. Most of the Best et al. sample consists in AGN with nuclear and host properties similar to the 3C/FRI and LEG RG.
The bulk of the local RL AGN population (with a space density 15-30 times higher than 3C sample) shows a lack of total radio emission w.r.t the classical 3C/FRI and LEG radio galaxies, although the nuclear and host properties are indistinguishable.

Let’s focus the radio properties with a higher resolution.
The JVLA observations (at 1.4, 4.5 and 7.5 GHz with a resolution down to 0.2") show compact radio morphology, symmetric jets and core+jet.

Baldi, Capetti & Giovannini 15

No boosting

Radio maps: < 0.2", < 3kpc

CoreG

FR0

FR1

\( L_{[\text{OIII}]} - L_x \)

Torresi, Baldi et al (in prep)
FR0 radio galaxies

- compact radio morph.
- lack of extended emission
- high core dominance
- LEG spectrum
- red (elliptical) hosts, large BH mass
- dominant radio class of the RL AGN population (Best et al sample)

FRI

7.5 GHz 0.2"

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Sadler+ 14

Compact FR0 are the dominant source population at 20 GHz (AT20G-6dFGS sample)
What sets a FR0?

To account for the numerous population of FR0 in the local Universe, two possible scenarios:

- Evolutionary effect
- Young radio sources?
- Intermittent activity?
- Low jet bulk speed
- Jet more subject to instabilities and entrainment causing premature disruption
the ultimate origin of the low speed?

assuming a dependence between BH spin (the BH mass) and jet $\Gamma$ (McKinney 05, Tchekhovskoy+ 10, Chai+ 12, Maraschi+ 12)

Galaxy evolution via BH mergers and gas accretion

Volonteri+ 13

BH Spin, $\Gamma$

FR0 $\Gamma \sim 1-3$

FRI-FRII $\Gamma > 5$
FRO: RG with similar nuclear and host properties of FRI, but compact radio structure and lack of substantial large scale radio emission

FRO population appears to be the dominant class of RG in the local Universe, rather than FRI and FRII.

Radio morphology and luminosity are irrelevant to AGN power.

Slow jets (low $\Gamma$) may account for the FRO radio properties

The low jet speed might originate from their small BH spin

- How to test this scenario? study of the jet sidedness
- Next: JVLA study of a large sample of FRO.
THANK YOU