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*Advancing Astronomy and Geophysics*

# The new class of FRO radio galaxies

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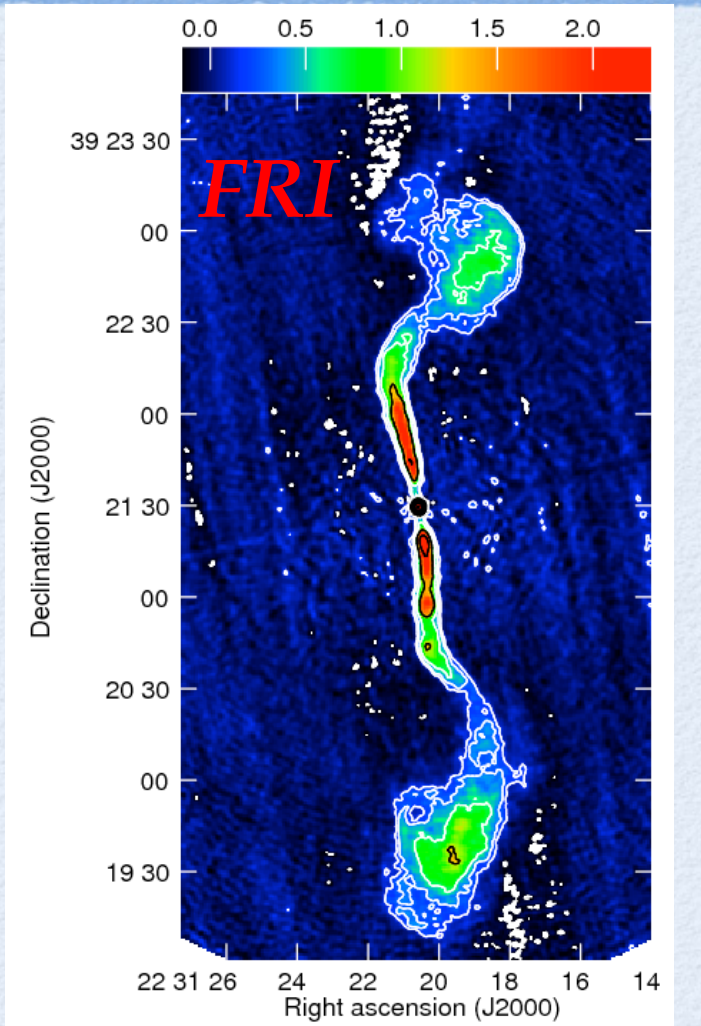
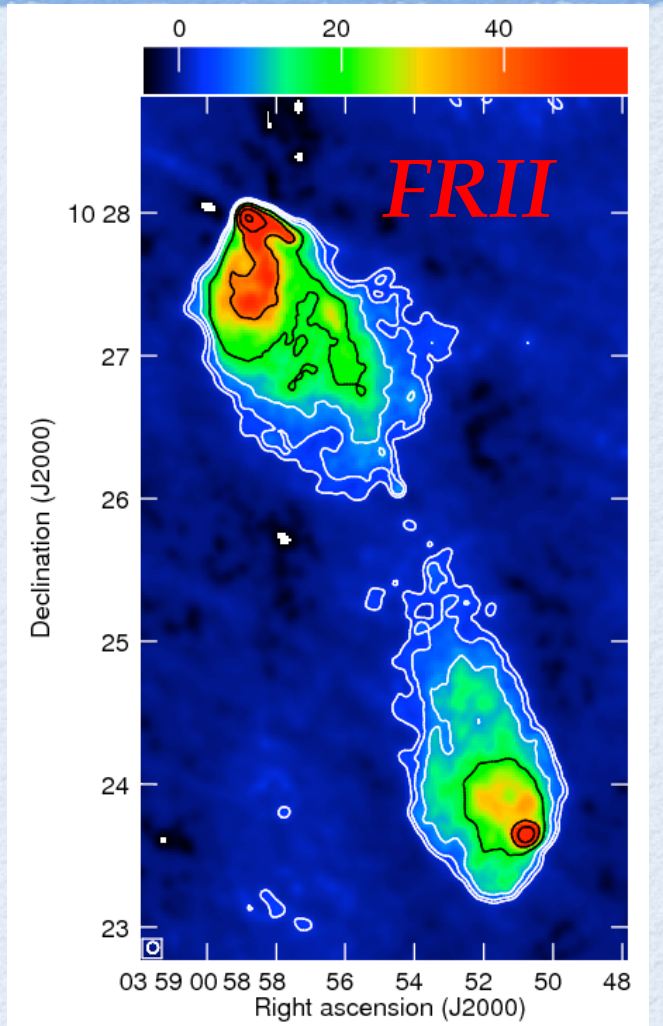
# Local Radio Galaxies (RG)

Fanaroff & Riley (1974)



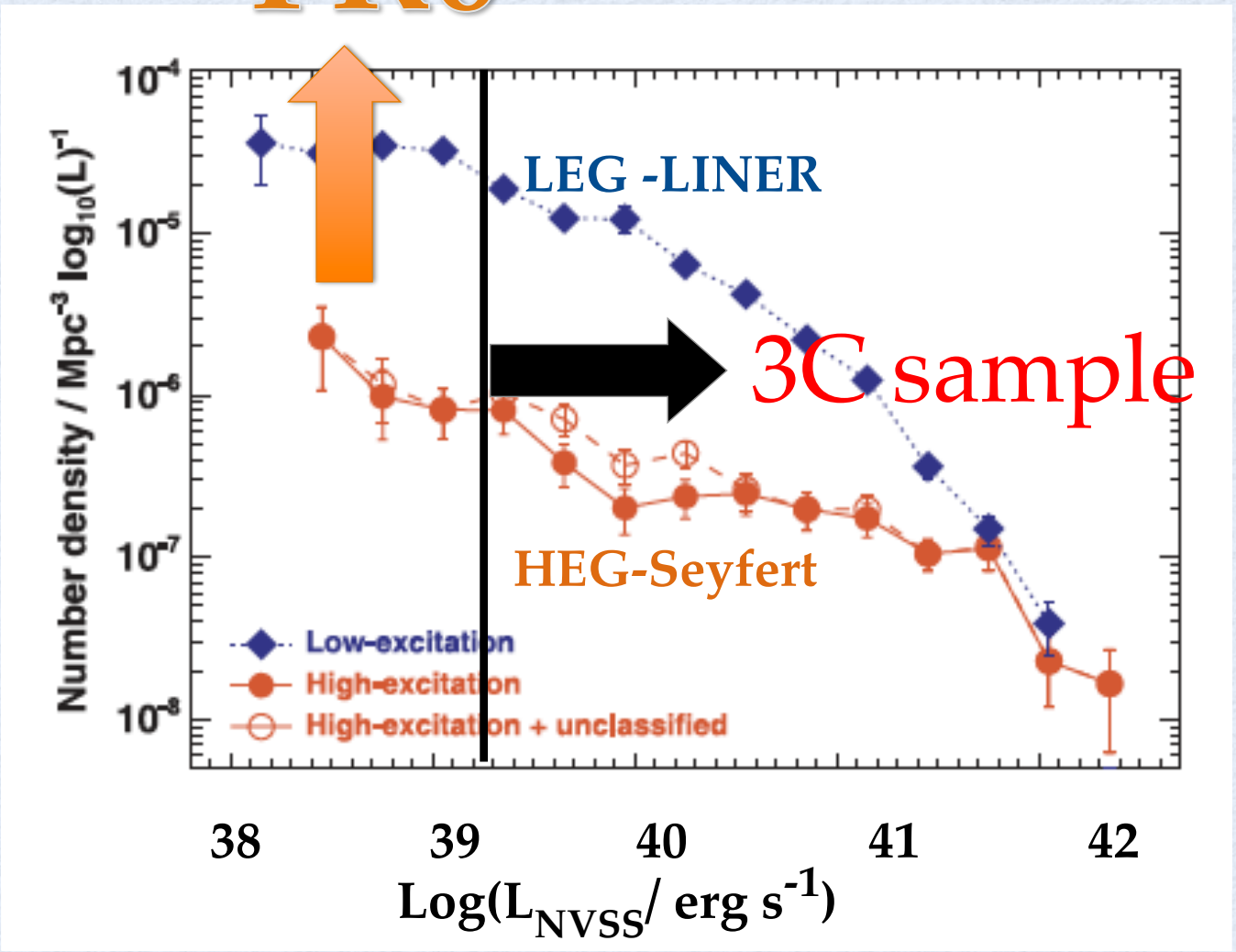




~0.1-1 Mpc

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

# Radio Luminosity Function

FR0




Best & Heckman (2012)

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

*The bulk of the low-lum RG population is still unexplored?*

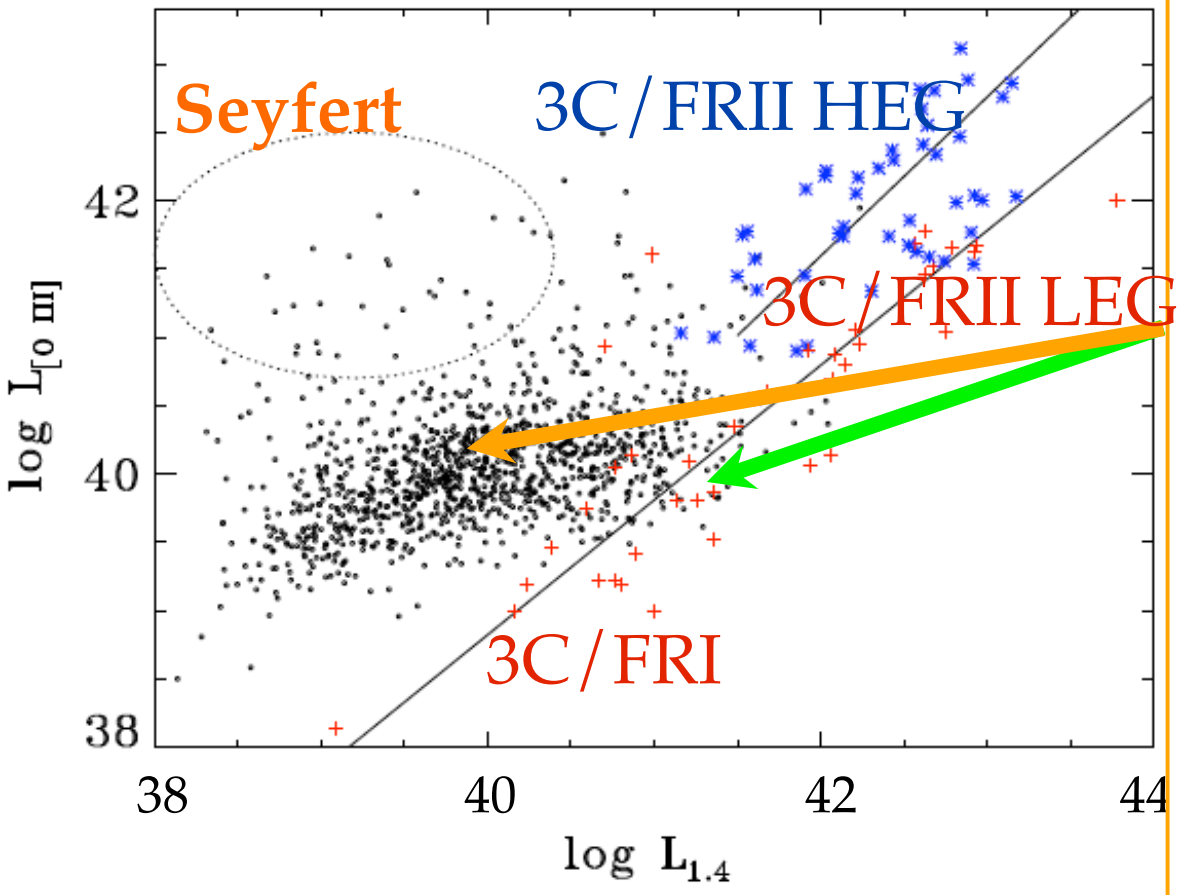
WHO ARE THEY??

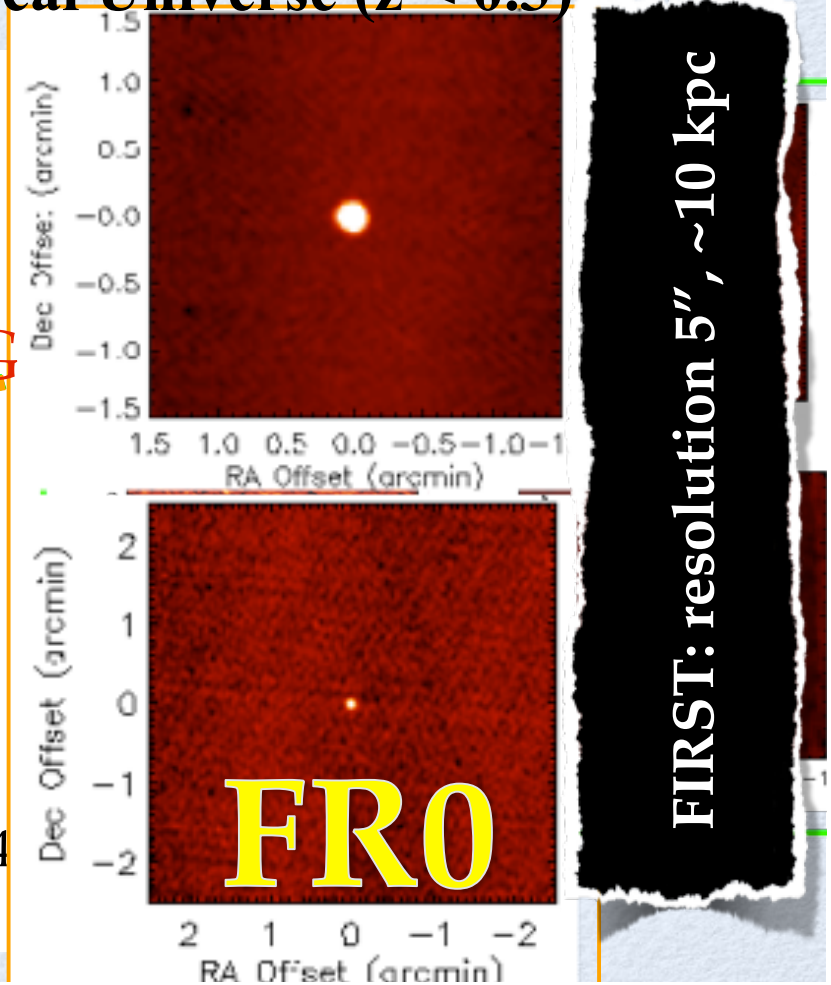
# FR0 is not a new class..

- The presence of compact radio-sources at the center of early type galaxies (ETG) has been already recognized in the ’70s (Ekers & Ekers 1973) and later (Wrobel & Heeschen 1991, Sadler 1984, Slee et al. 1994)
- The low-L AGN show a compact structures, occasionally accompanied by short jet-like features or diffuse emission (Ho & Ulvestad 2001)
- The vast majority of these sources (80%) are unresolved at a 5″ resolution, indicating that they are confined within less than 10 kpc.
- The advent of large area multi-wavelength surveys opens the opportunity to set the studies of compact radio sources on strong statistical foundations

# Local Radio-Loud AGN population

**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)**



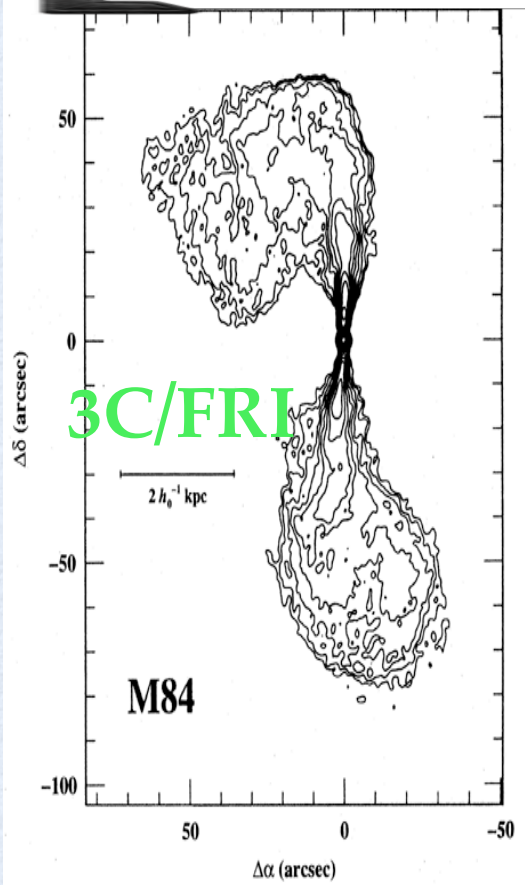



# EXTENDED vs COMPACT

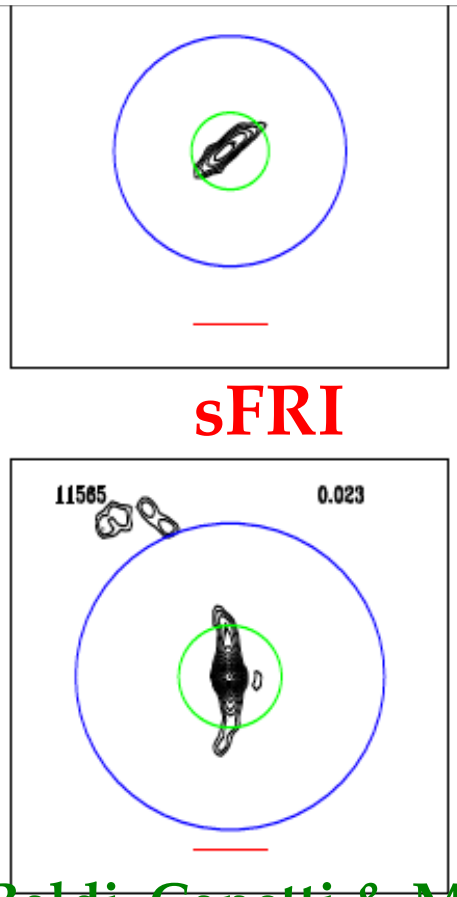
We classify 227 FRI ( size > 30 kpc), 14 FRI (sFRI, 10 < size < 30 kpc) and 108 FR0 (size < 5 kpc) from the FIRST catalogue based only on the radio morphology with z<0.15.

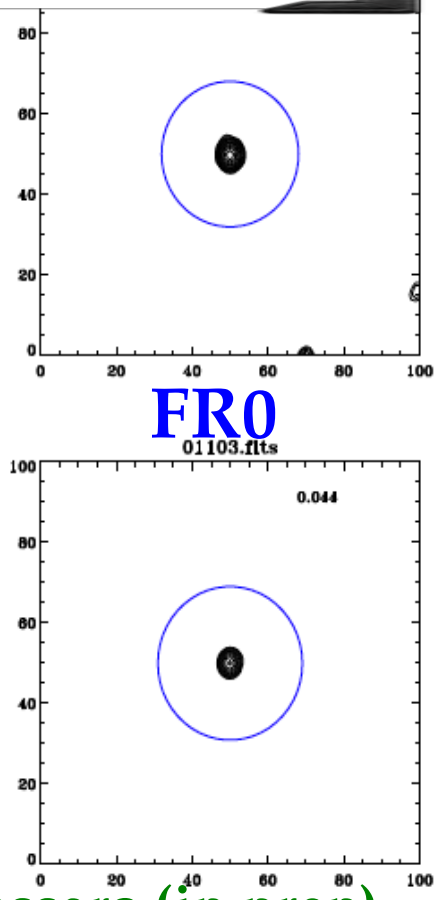
*Space density*

*1 : 1 : 2 : 15*







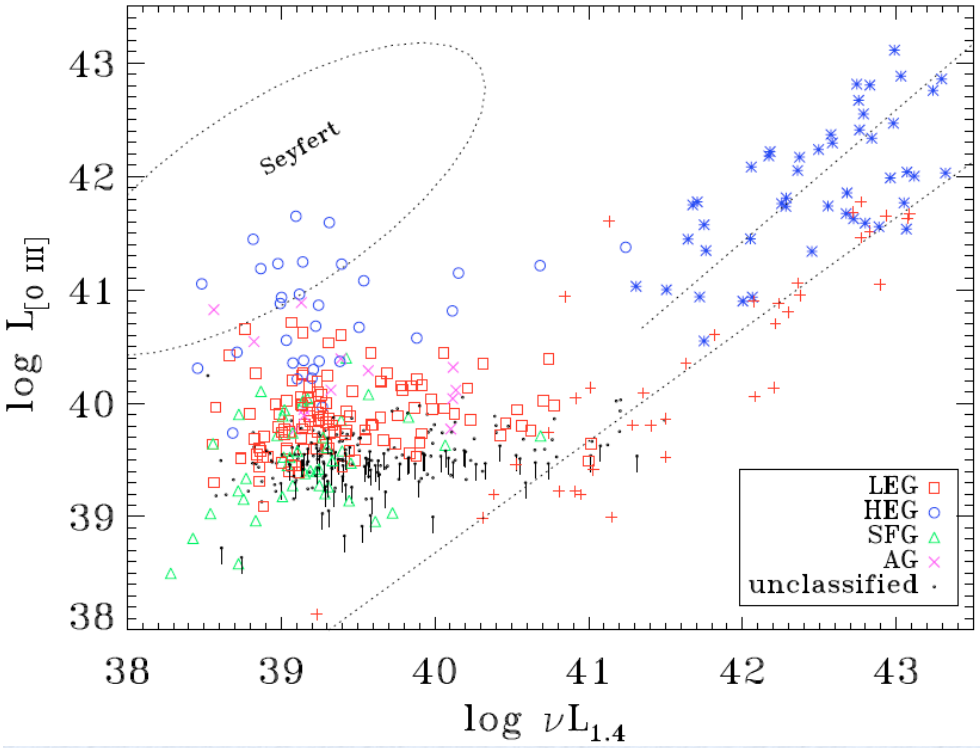



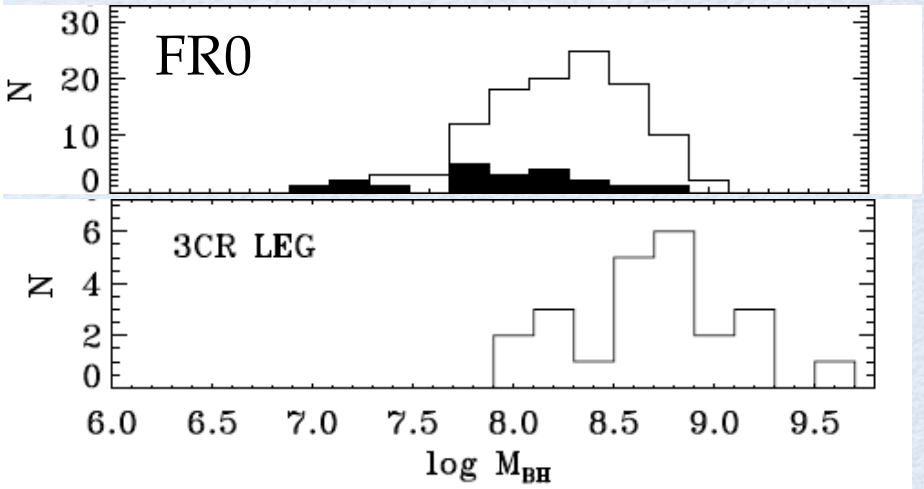

Capetti, Massaro & Baldi (2016)

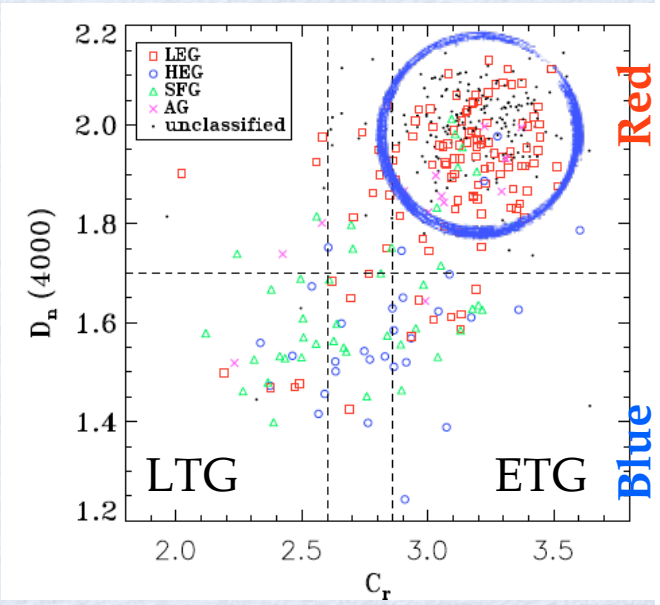
Baldi, Capetti & Massaro (in prep)

# Spectro-photometric properties of Best et al. sample

Baldi & Capetti (2010) studied the properites of the sample:




**Most of the Best et al. sample consits in AGN with nuclear and host properties similar to the 3C/FRI and LEG RG.**

# let me think...

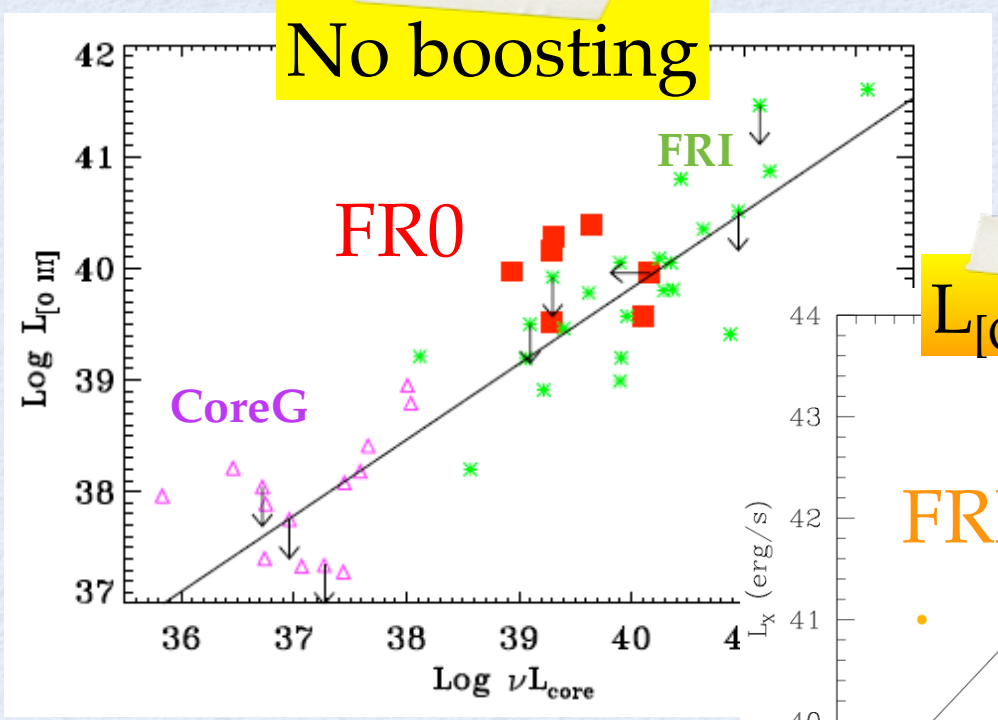
The bulk of the local RL AGN population (with a space density 15-30 times higher than 3C sample) shows a lack of total radio emission w.r.t the classical 3C/FRI and LEG radio galaxies, although the nuclear and host properties are indistinguishable

Let's focus the radio properties with a higher resolution

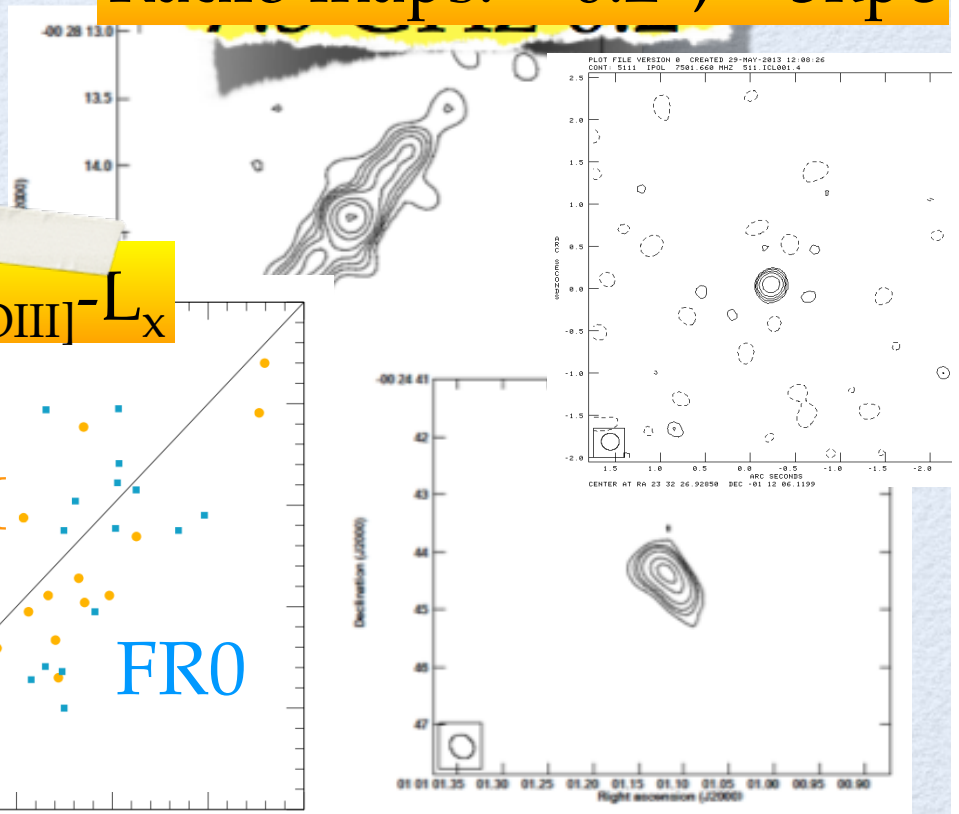
# JVLA observations

**Baldi, Capetti & Giovannini 15**

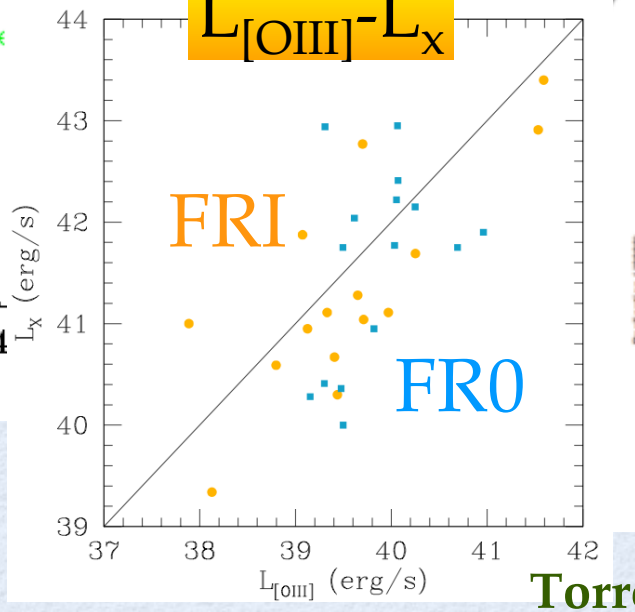
No boosting




Radio maps: < 0.2", < 3kpc



$L_{[OIII]}$-$L_X$




**Torresi, Baldi et al (in prep.)**

**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.**

# FR0 radio galaxies

**Baldi, Capetti & Giovannini 15**

★ compact radio morph.

★ lack of extended emssion

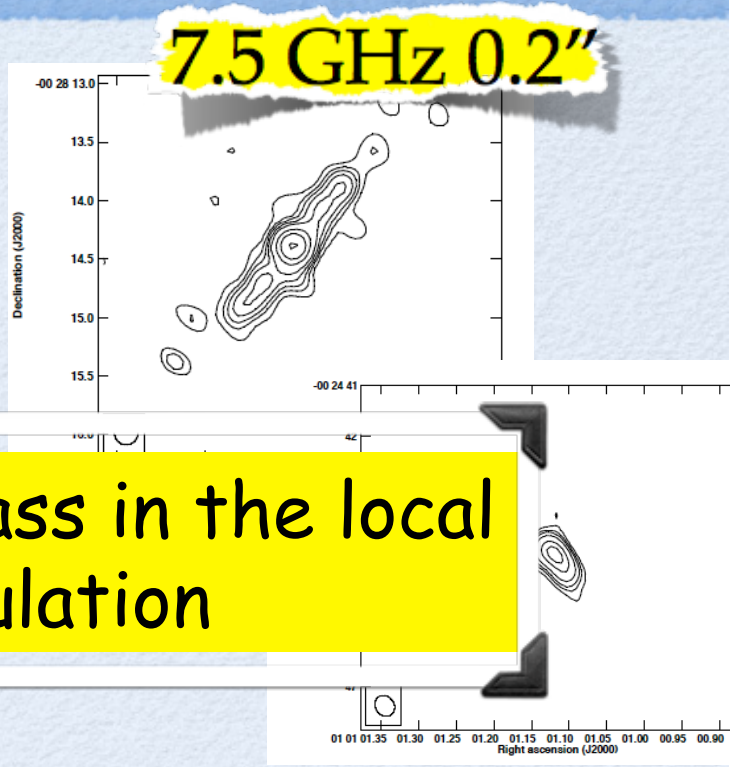
★ high core dominance

★ LE

★ red (elliptical) hosts, large BH mass

★ dominant radio class of the RL AGN population (Best et al sample)

FR0

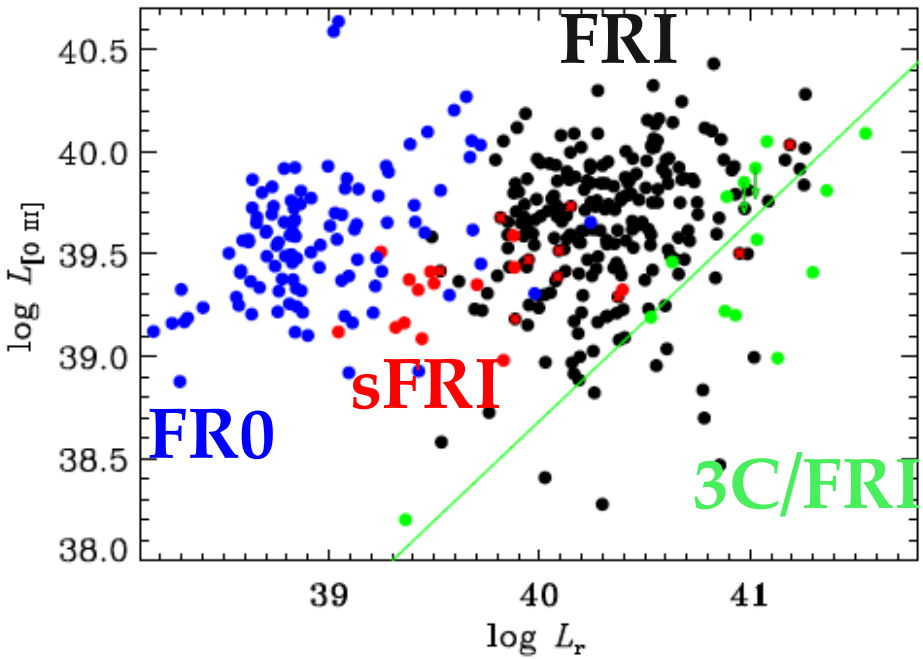


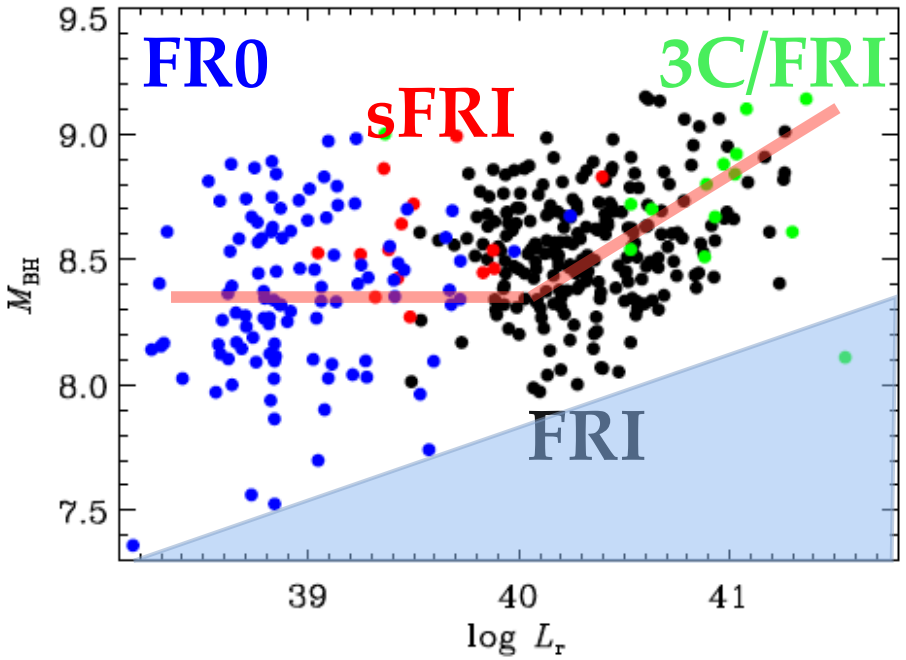

FR0 is the dominant radio class in the local radio-loud AGN population

**Sadler+ 14**

*Compact FR0 are the dominant source population at 20 GHz (AT20G-6dFGS sample)*

# FR0 vs FRI IN FIRST

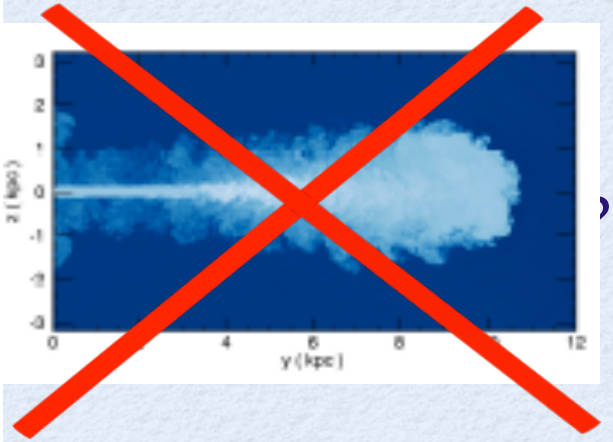




- Low-lum RG form a continuous distribution from 3C/FRI to FR0
- No correlation $L_{[OIII]}$-$L_r$ : radio morph and $L_r$ irrelevant to AGN power
- Minimum BH mass required to exceed a given $L_r$

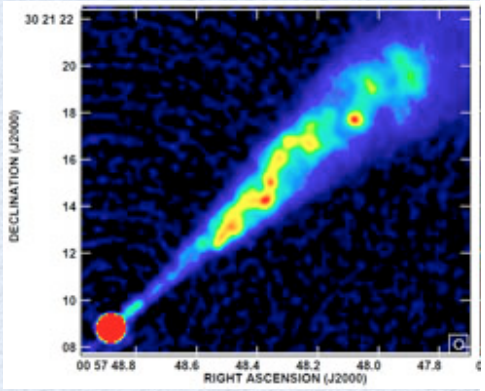
Baldi, Capetti & Massaro (in prep)

# What sets a FR0?

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



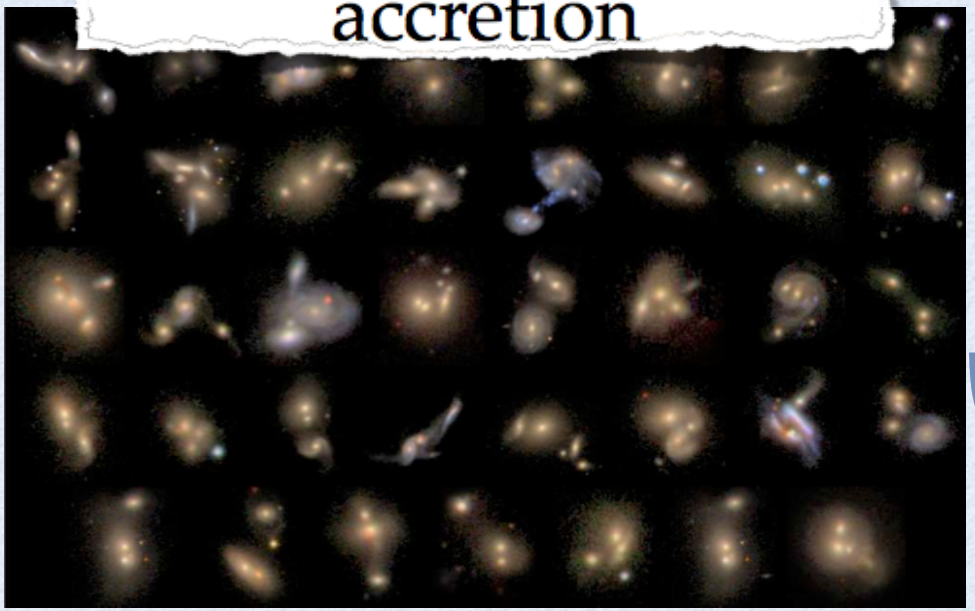

*low jet bulk speed* Γ



# the ultimate origin of the low speed?

small BH spin

Galaxy evolution via BH mergers and gas accretion



Volonteri+ 13

Assuming a dependence between BH spin (the BH mass) and jet Γ **(McKinney 05, Tchekhovskoy+ 10, Chai+ 12, Maraschi+ 12)**

BH Spin, Γ

**FR0** **FRI-FRII**

**Γ~1-3** **Γ > 5**

# Summary & Future

- **FR0** : RG with similar nuclear and host properties of FRI, but compact radio structure and lack of substantial large scale radio emission
- FR0 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 FR0 radio properties
- The low jet speed might originate from their small BH spin
  - How to test this scneario? study of the jet sideness
  - **Next**: JVLA/eMERLIN study of a large sample of FR0, FR0/FRI environment


THANK YOU