X-ray radio galaxies

giant fraction and obscuration

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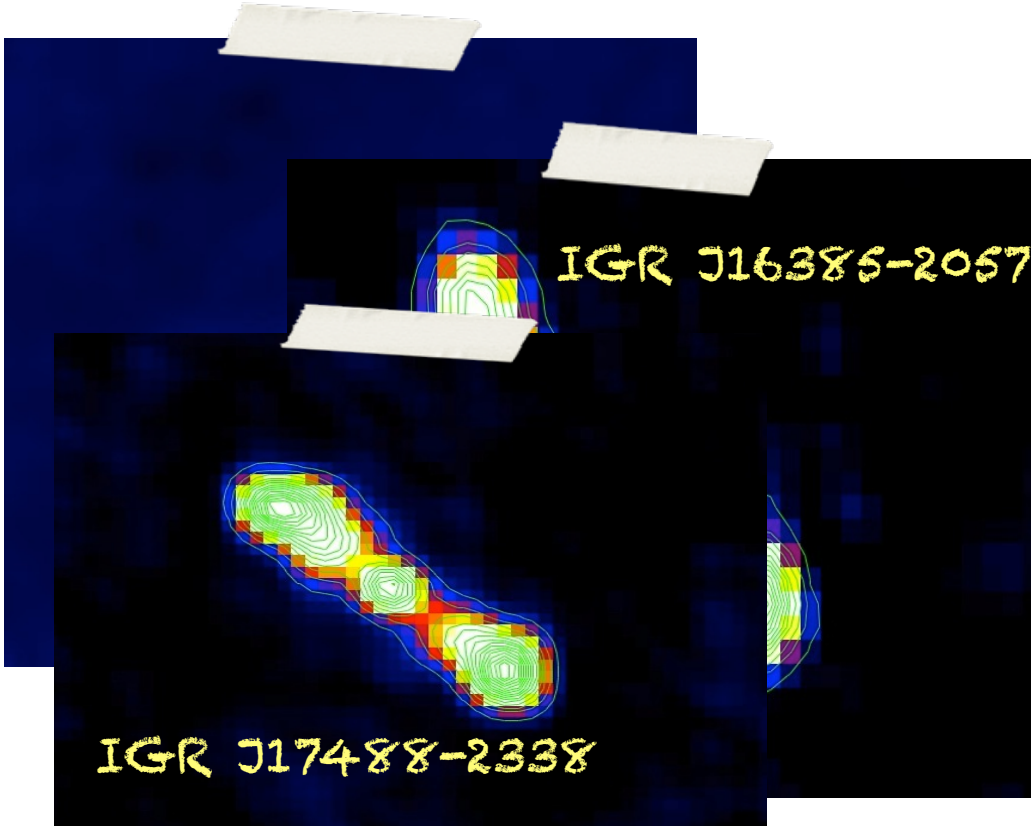
Hernandez-Garcia, Bassani, Venturi, Molina, Dallacasa, Ubertini, Bazzano, Malizia, La Franca, Landi

the hard X-ray sample selection

Starting Point: the **INTEGRAL AGN** (Malizia et al. 2012) and **SWIFT/BAT** AGN from 70 month catalogue by Baumgartner et al. (2013)

RADIO MORPHOLOGY

search for a double lobe morphology



the hard X-ray sample

64 Radio Galaxies (+ 3 candidates):

→ 27 from the INTEGRAL survey

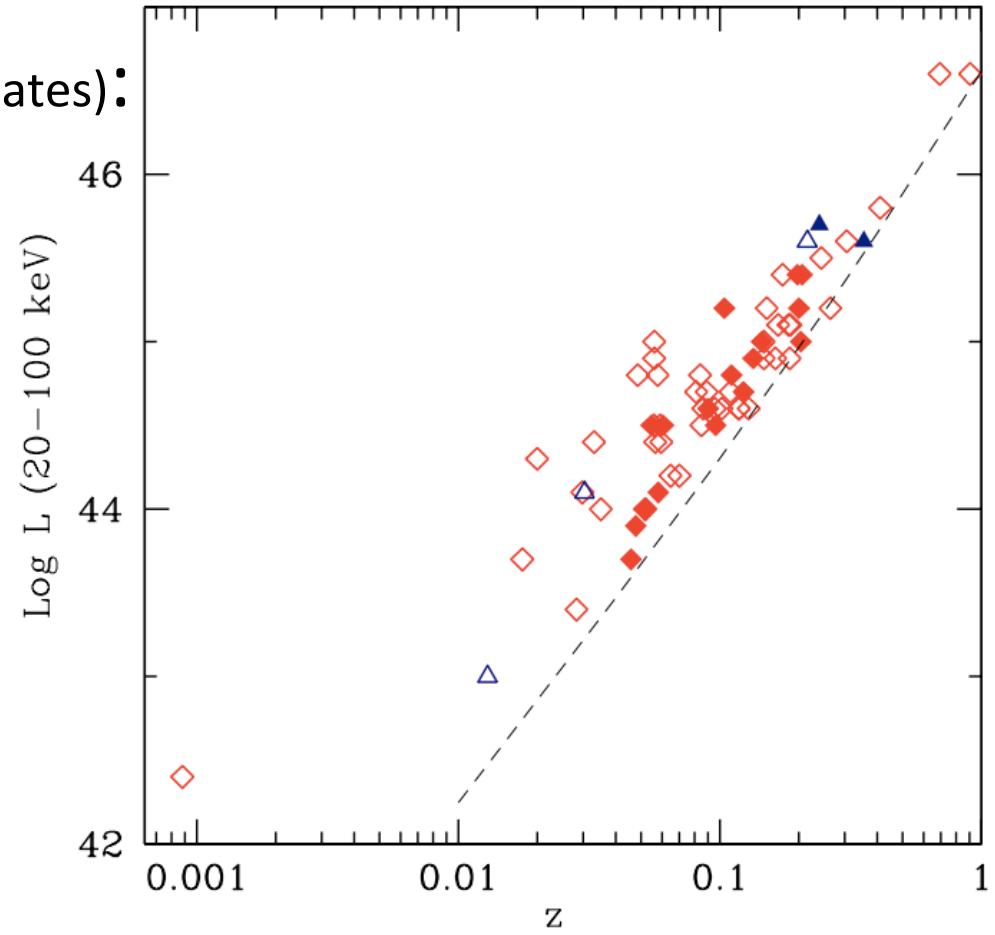
→ 63 from the Swift survey

→ 22 have detection in both

Opt class	Morph type
25 type 1	51 FR II[a]
12 type 1.2–1.5	6 FR I[a]
9 type 1.8–1.9	6 FR I/FR II
19 type 2	1 C
2 unknown	3 unknown

Mostly HERG

Log L_{Bol}/L_{Edd}>0.01



Sensitivity limit 9x10 $^{-12}$ cm $^{-2}$ s $^{-1}$ (14-195 keV)

7-10% of all hard X-ray AGN are radio galaxies

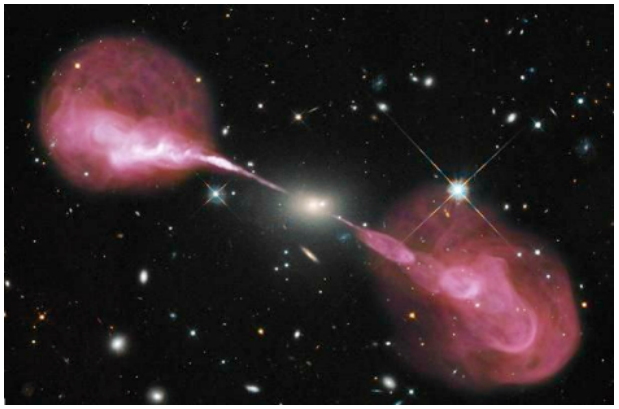
hard X-ray radio galaxies

Estimate of the fraction of GIANT RADIO GALAXIES

Bassani et al. 2016

Estimate of the fraction of absorbed radio galaxies

Panessa et al. 2016



giant radio galaxies

Sources with size > 0.7 Mpc
> 20% of soft gamma-ray selected RG

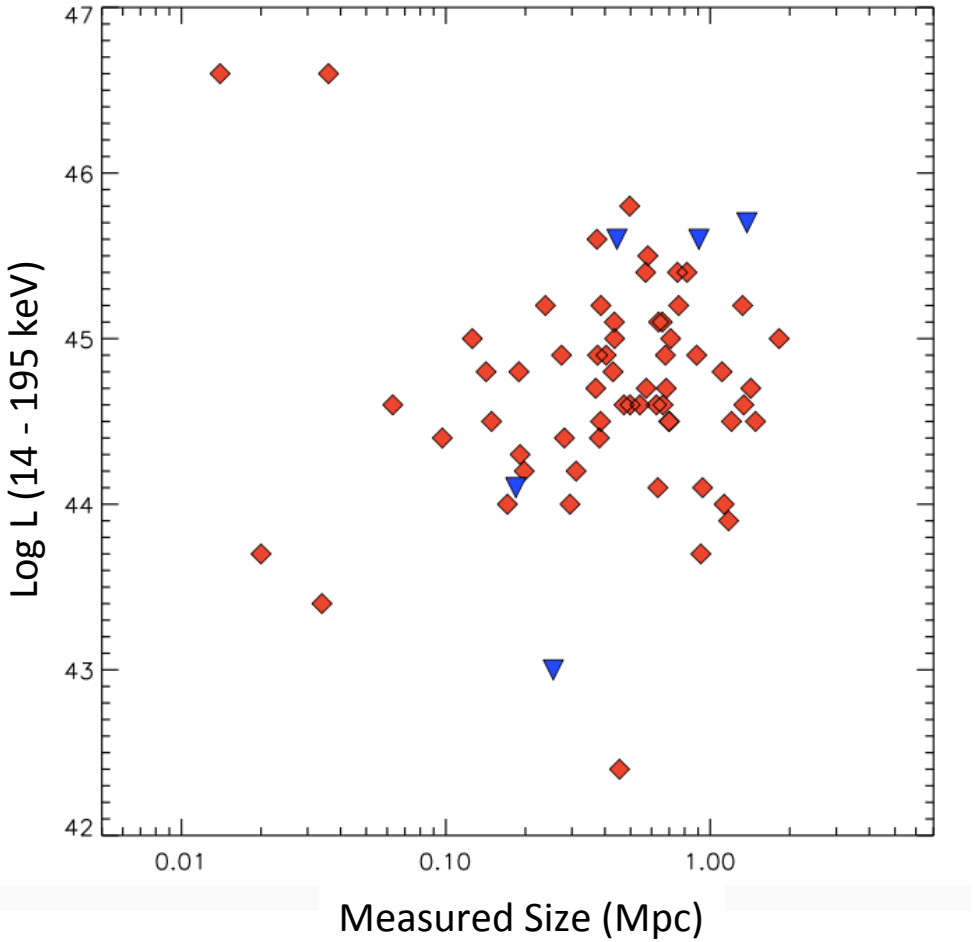
Typical percentage in radio selected sample are:

- ✓ 6% in 3CR catalogue (Ishwara-Chandra & Saika 1999)
- ✓ 1% for z<0.2 ~3500 NVSS, SUMSS & WENSs images (Andernach et al. 2014)
- ✓ 5.6% among 672 FRII with known z (Nilsson 1998)
- ✓ 5.5% among 401 FR II in the SDSS sample (Kozile-Wierzbowska & Stasinska 2011)
- ✓ 2% among 46 HEG in the sample (Buttiglione et al. 2010)

1-6% in radio versus 20% in soft gamma

giant radio galaxies

Bassani et al. 2016

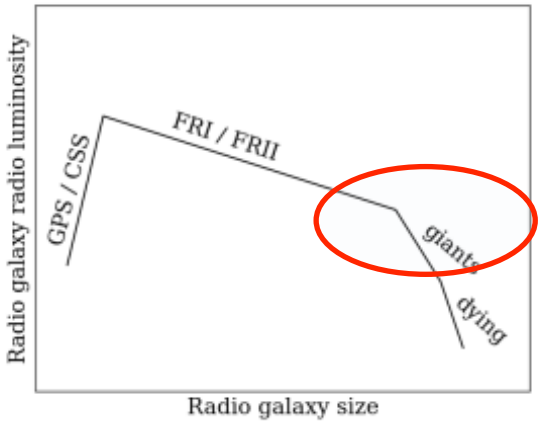


60% → LAS > 0.4 Mpc
22% → LAS > 0.7 Mpc

Largest radio Angular Size (in arcsec)
versus 14-195 KeV Luminosity → no correlation

GIANT RADIO GALAXIES: Largest and most energetics single entities in the universe

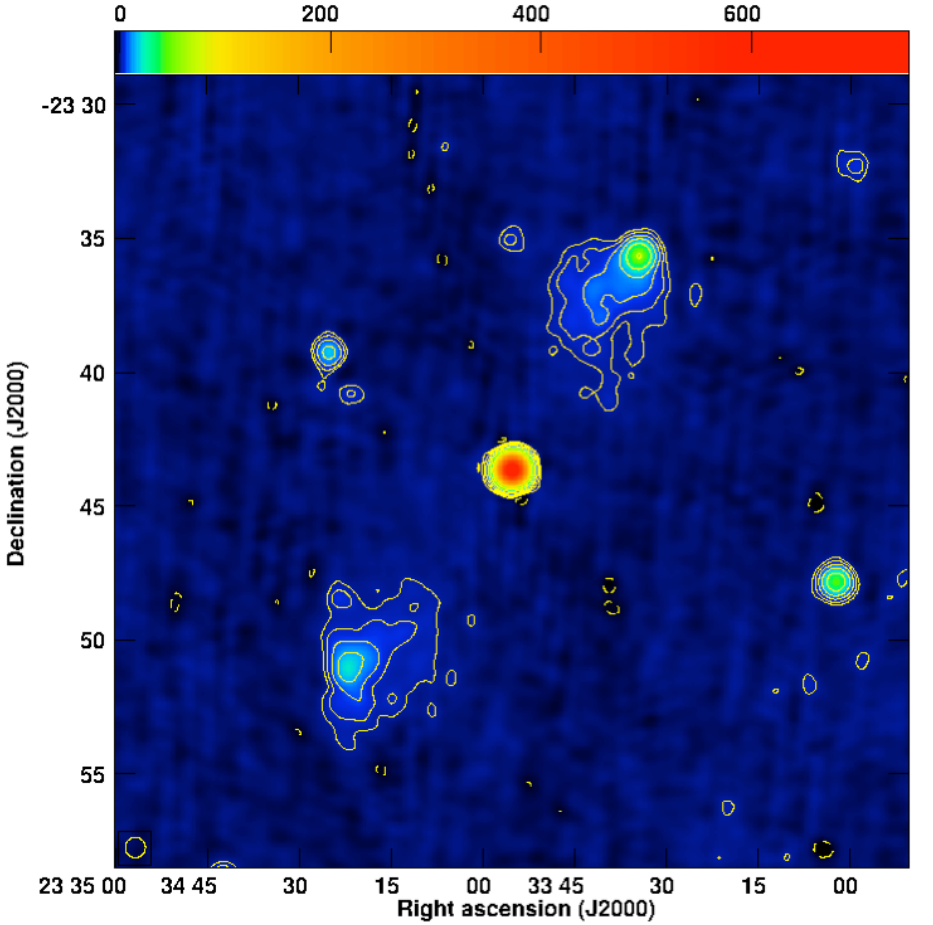
Main reasons for the production of such large scale structures still unclear

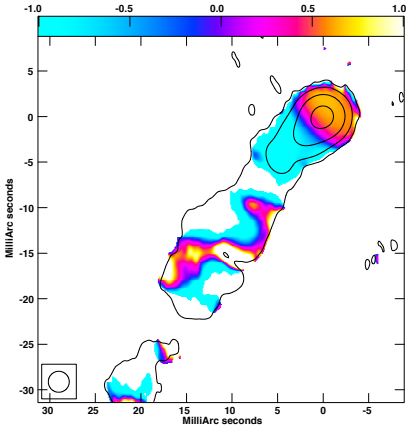


- ✓ play a role in the formation of large-scale structures -- used to probe the Warm-Hot Intergalactic Medium (Malarecki et al 2013)
- ✓ unique laboratories where to study particle acceleration processes and understand cosmic magnetism (Kronberg et al. 2004)
- ✓ ideal targets to study the duty cycle of radio activity → episode of restarting activity

THE REACTIVATING NUCLEUS OF PBC J2333.9-2343

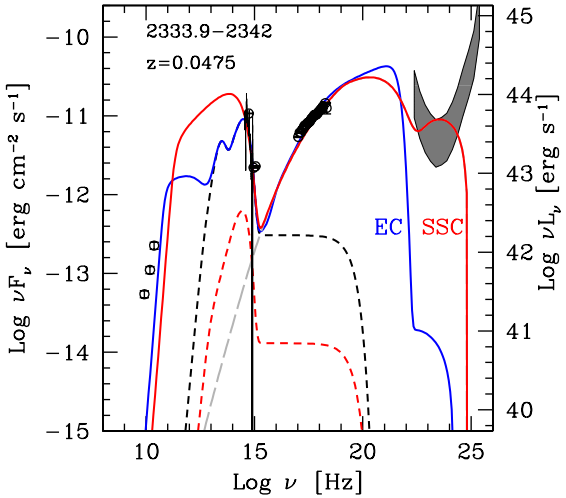
from giant radio galaxy to blazar!





→ small angle!

↑



Hernandez-Garcia et al. 2017

Live at 18:30 (Caudini room)!!

hard X-ray radio galaxies

Estimate of the fraction of absorbed radio galaxies

Panessa et al. 2016

the unified model in radio galaxies

- ✓ Does the presence of a jet influence the surrounding medium?
- ✓ Is the unified model still valid when a jet is present?

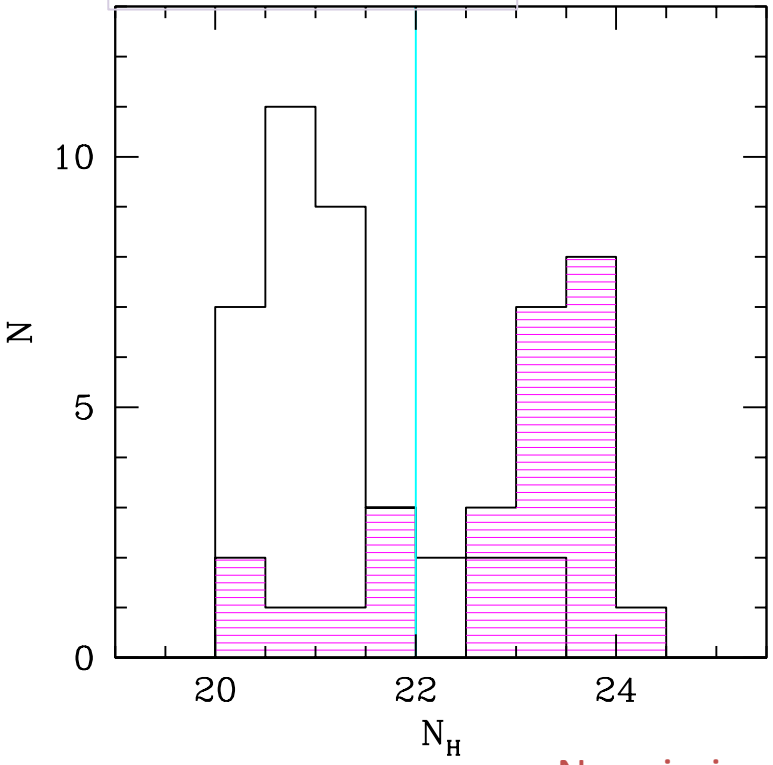
(are we still stucked at the Urry&Padovani scheme?)

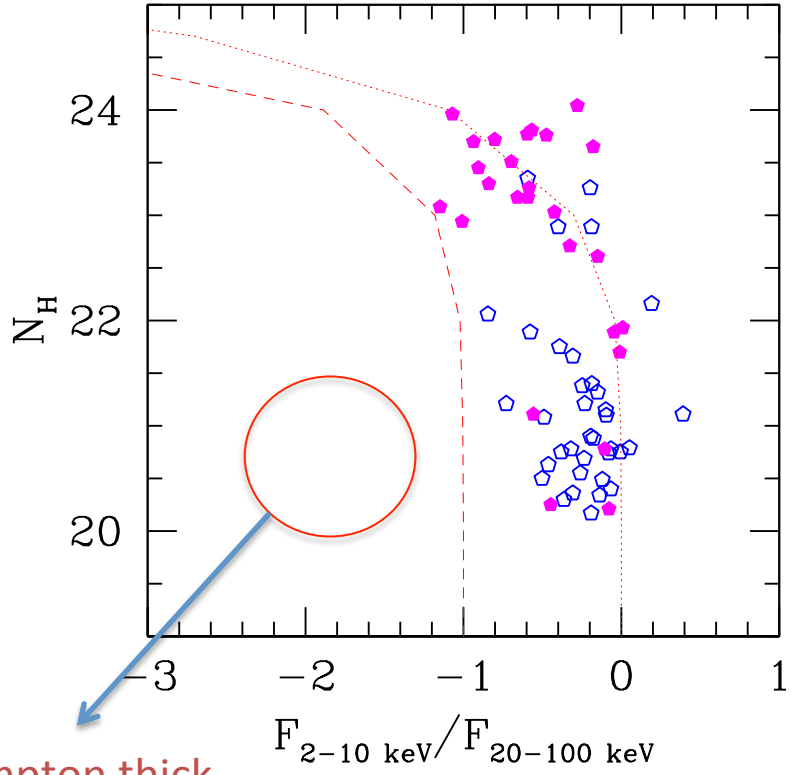
In the local Universe, only a handful of CT radio galaxies are found
(e.g., Hardcastle, Evans & Croston 2006, Eguchi et al. 2009,
Guainazzi et al. 2006, Guainazzi et al. 2004)

the column density distribution

estimate of the column density via high quality broad-band spectra

Panessa et al. 2016





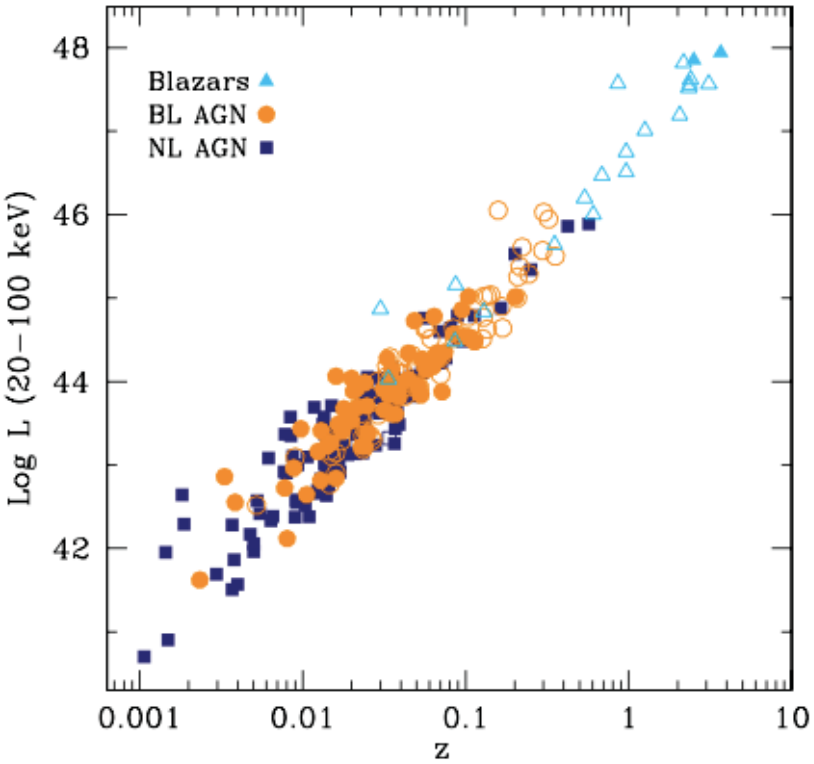
No missing Compton thick

- ✓ Fraction of obscured objects: 40% (75% among type 2 AGN)
- ✓ Fraction of Compton thick objects: 2-3% (4% among type 2 AGN)

comparison with a radio quiet sample

total INTEGRAL AGN sample in Malizia et al. (2012):

→ 22 out of 271 AGN are radio galaxies



fraction of absorbed AGN

→ 49 (+6,-7) % in RQ

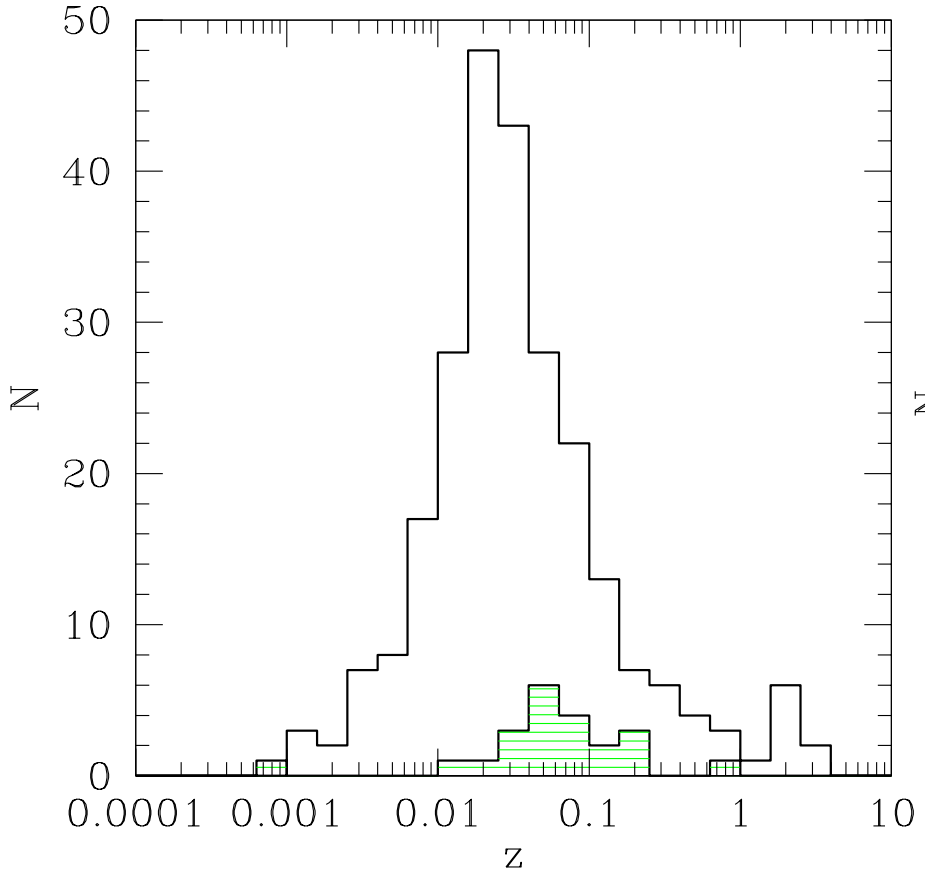
→ 36 (+21,-16) % in RG

fraction of Compton thick AGN

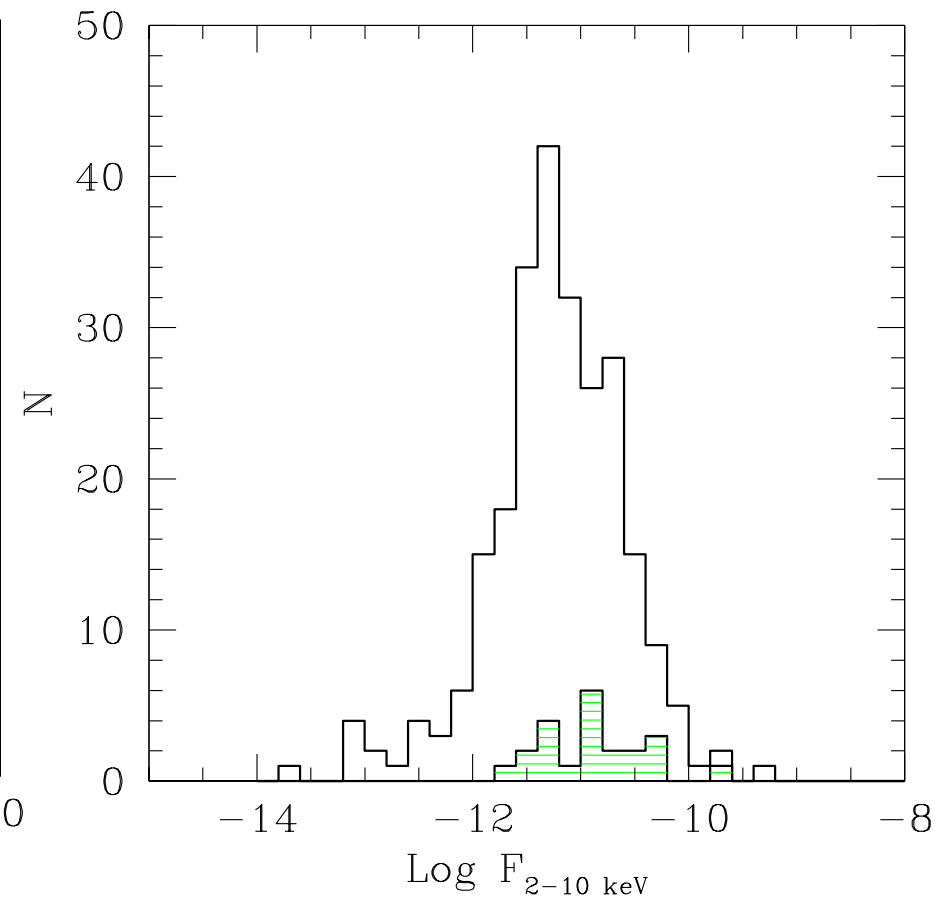
→ 6 (+3,-3) % in RQ

→ < 1.3 % in RG

comparison with a radio quiet sample



the null hypothesis can be rejected at 1% level

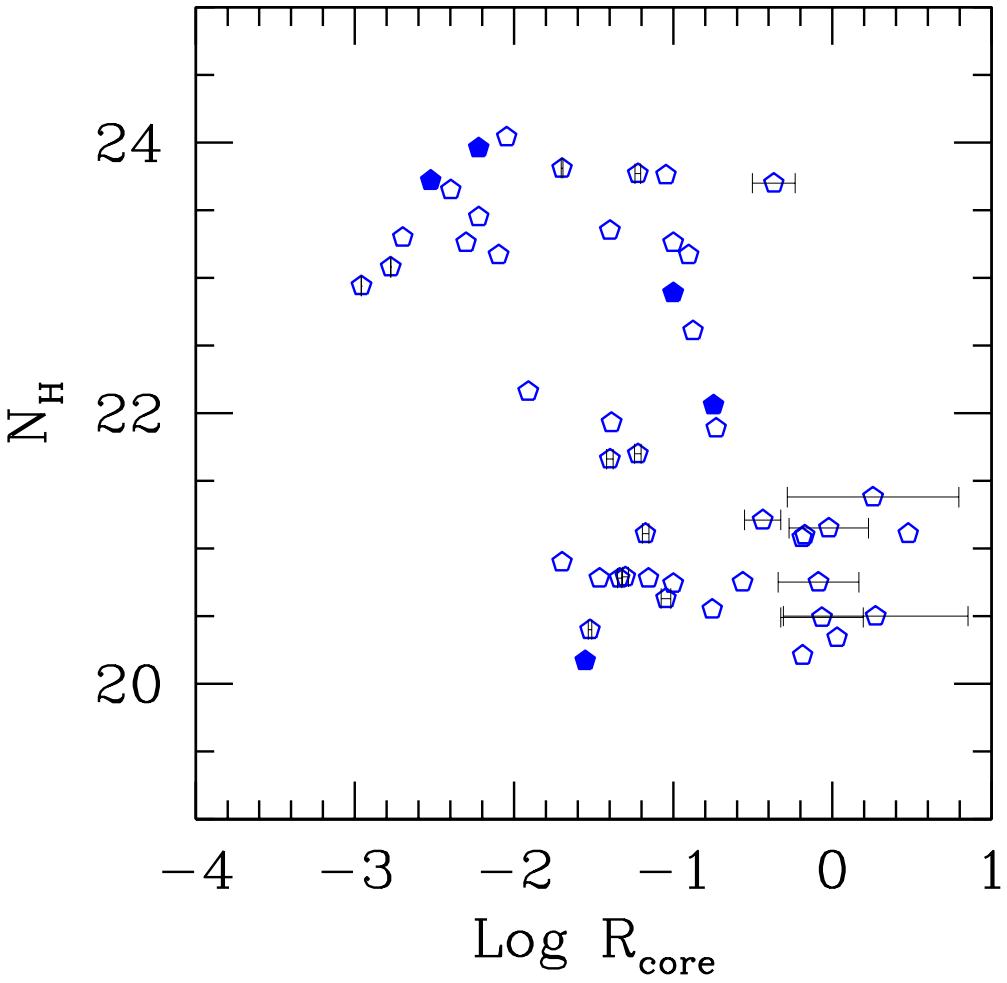


the null hypothesis cannot be rejected at 1% level

Low fraction of Compton thick objects → both samples affected by selection biases?

However, no confirmed Cthick among radio galaxies in the local Universe (Ursini et al. in preparation)

the radio core dominance



Radio core dominance:

→ R_core= S_core/(S_tot - S_core)

core and the total flux densities at 5 GHz

the null hypothesis probability of correlation of 0.00027

→ anti-correlation

confirmation of a previous result (Grandi et al. 2006)

Thank you!