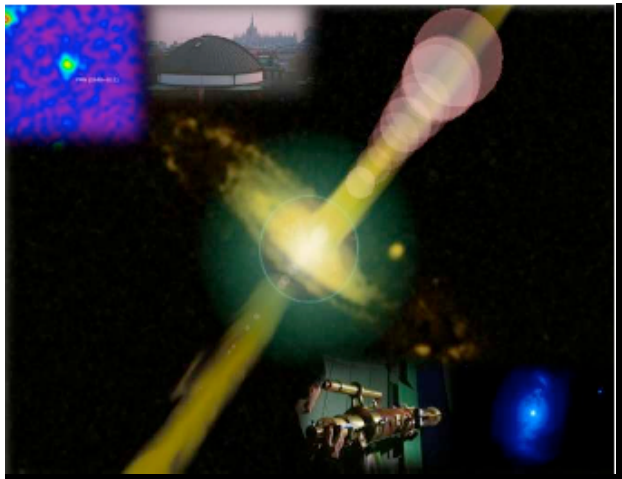


Narrow-Line Seyfert 1 Galaxies and their place in the Universe

Milano (Italy), Civic Acquarium Auditorium, 4-6 April 2011

The INTEGRAL NLSy1

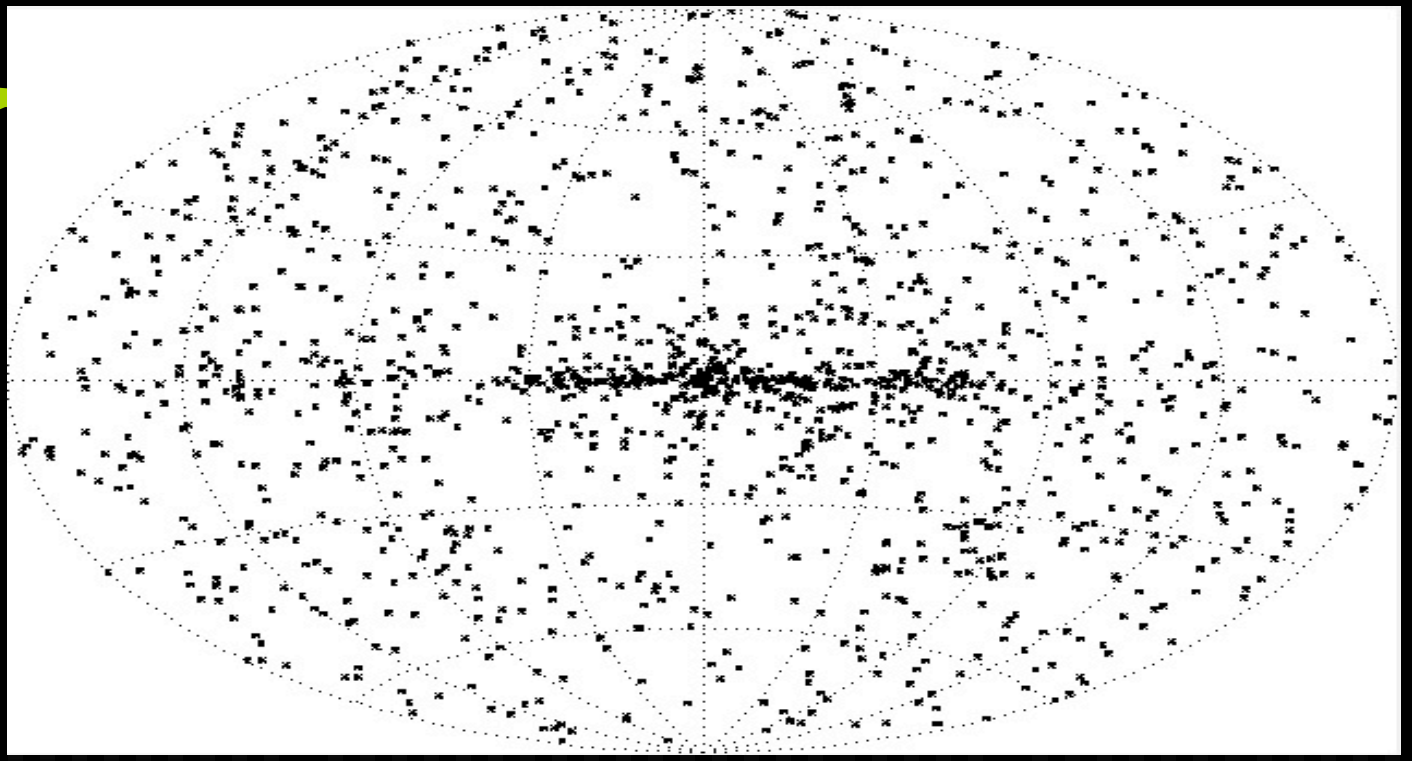
FRANCESCA PANESSA

on behalf of the IBIS survey/AGN team

Istituto di Astrofisica Spaziale e Fisica Cosmica - Roma

INAF

A golden age for hard X-ray studies

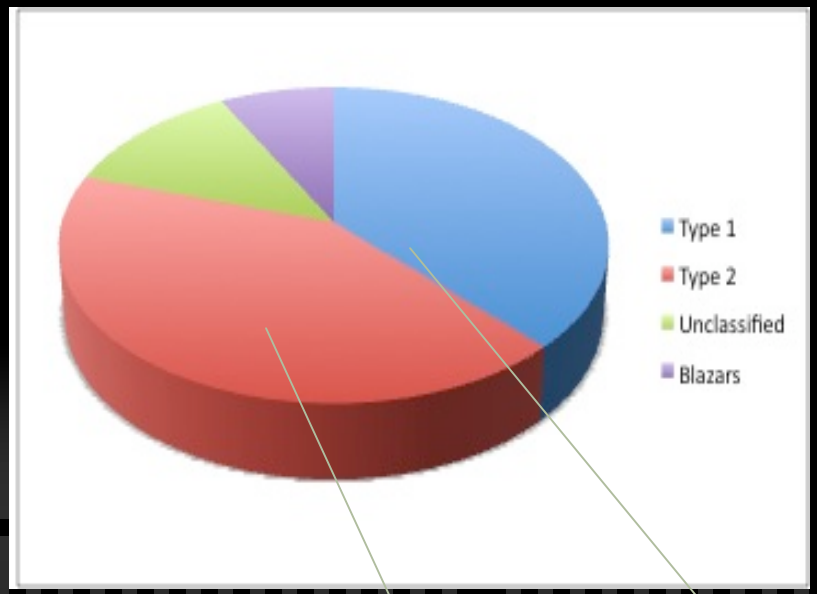


Adapted from Swift-BAT/ INTEGRAL-IBIS surveys

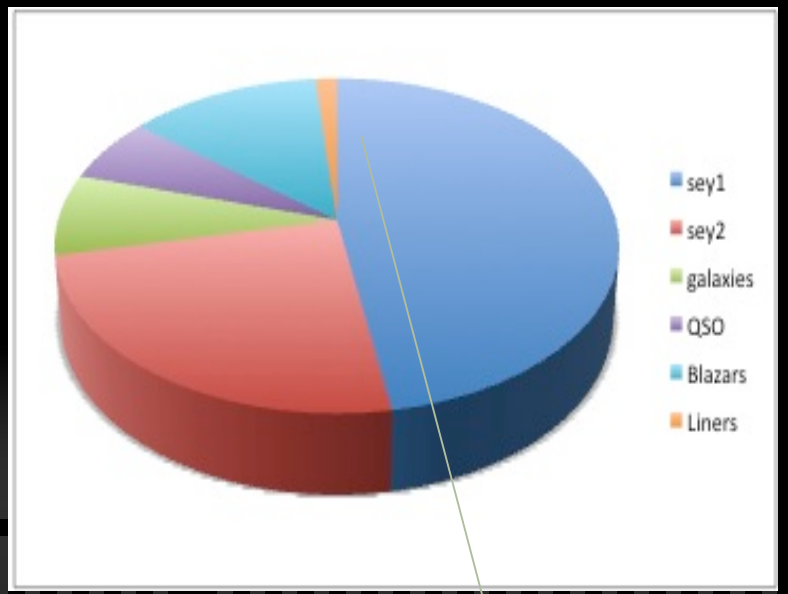
(Cusumano et al. 2010, Bird et al. 2010, Tueller et al. 2009, Krivonos et al. 2007)

Around 1500 sources detected so far: most are AGN, even on the Galactic plane

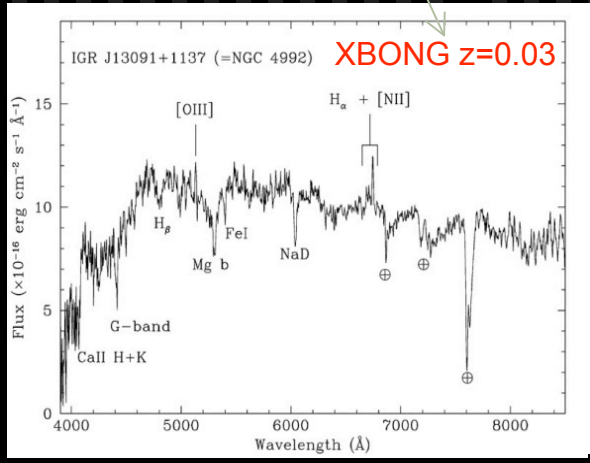
Which AGN are hard X-ray emitters?

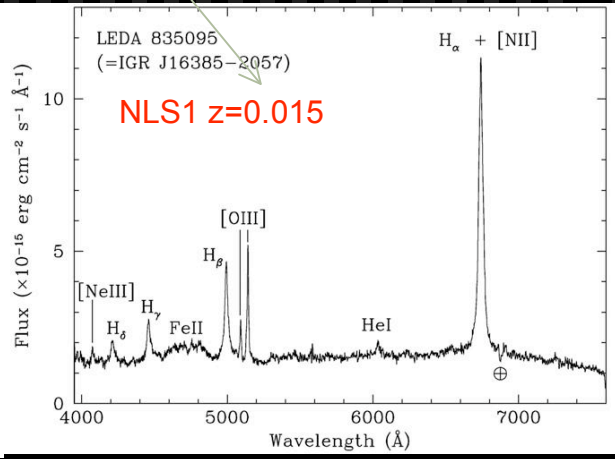


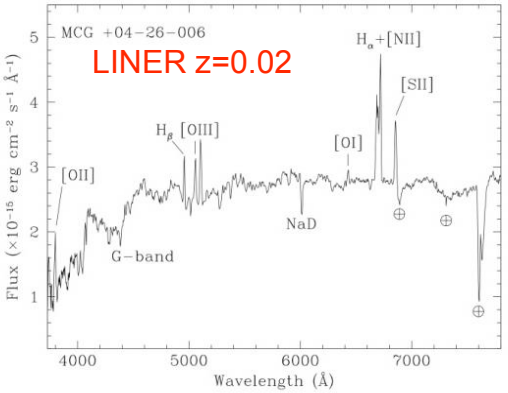
INTEGRAL/IBIS cat 4 AGN (Bird et al. 2010)
Total = 258 AGN



SWIFT/BAT 54 months Cat (Cusumano et al. 2010)
Total = 643 AGN







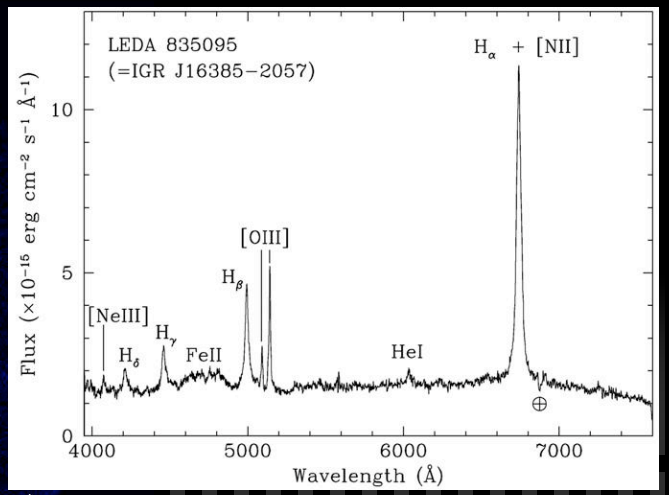
Optical identification and classification

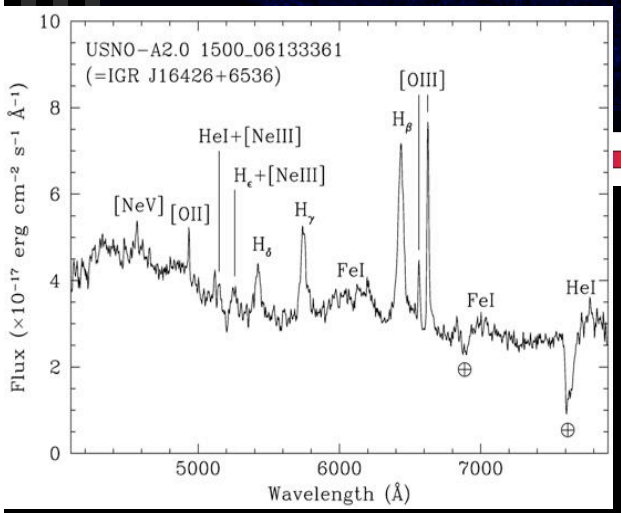
Bird et al. (2010)

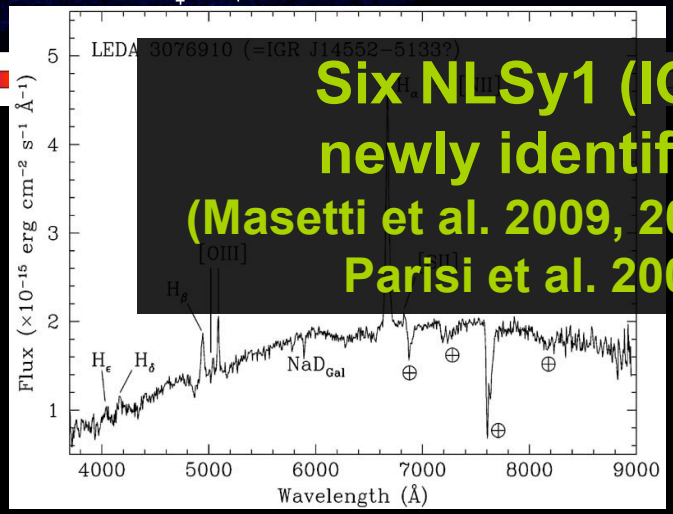
Criteria:

→ [O III] λ5007/Hβ ratio <3
→ FWHM(Hβ) ≤ 2000 km/s
→ Fe II/Hβ > 0.5

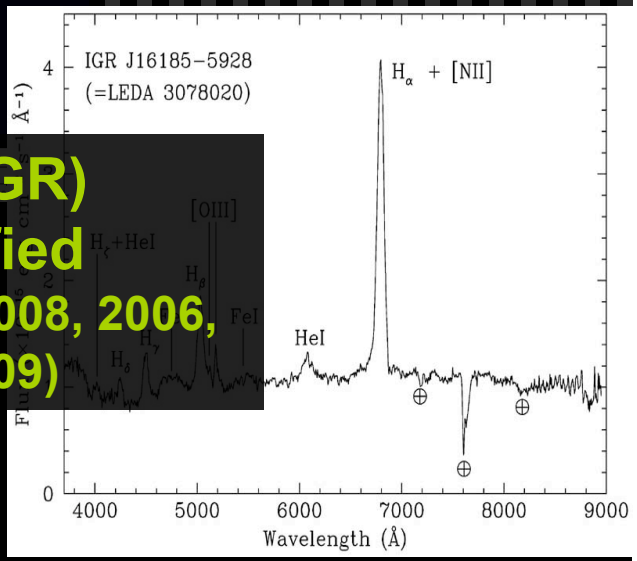
Osterbrock & Pogge (1985)







Six NLSy1 (IGR) newly identified (Masetti et al. 2009, 2008, 2006, Parisi et al. 2009)



Hard X-ray selected INTEGRAL NLSy1

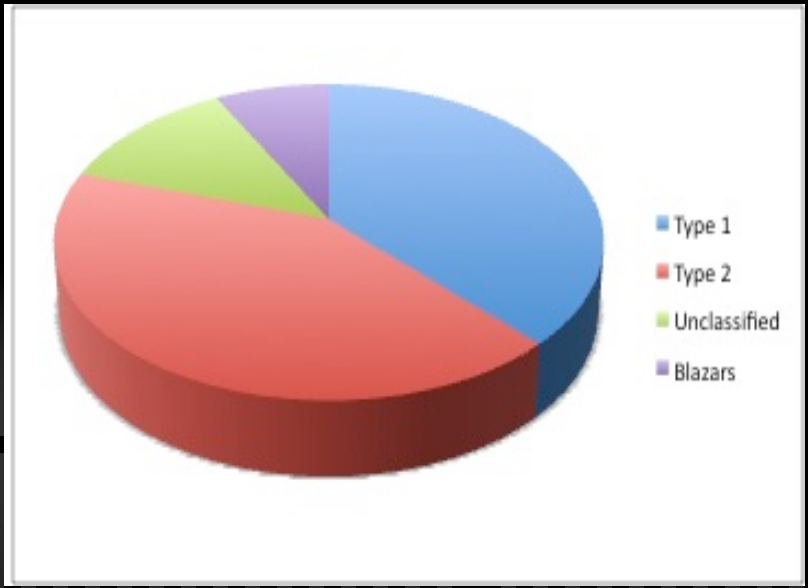
1H 0323+342
NGC 4051
Mrk 766
NGC 4748
Mrk 783
NGC 5506
IGR J14552-5133
IRAS 15091-2107
IGR J16185-5928
IGR J16385-2057
IGR J16426+6536
IGR J19378-0617
ESO 399-IG 020
Swift J2127.4+5654

Fourth IBIS Catalogue (Bird et al 2010, ApJS)

14 Narrow Line Seyfert 1

10 never observed before below 10 keV
7 New XMM observations
2 New Suzaku data
5 Swift/XRT data
1 Fermi Radio-Loud NLSy1
...other new data are coming...

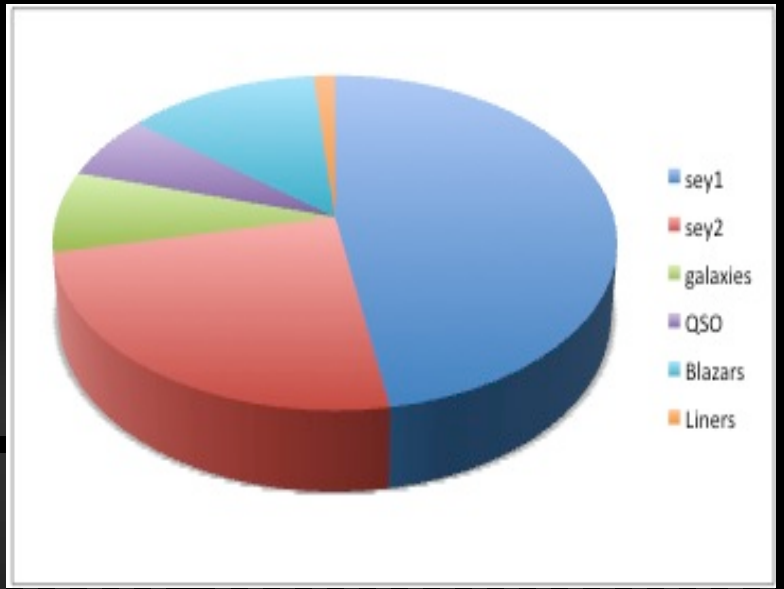
How many NLSy1 in the hard X-ray sky?



INTEGRAL/IBIS cat4 AGN (Bird et al. 2010)
Total = 258 AGN

14 NLSy1 / 98 Seyfert 1

14% of BLSy1
6% of AGN

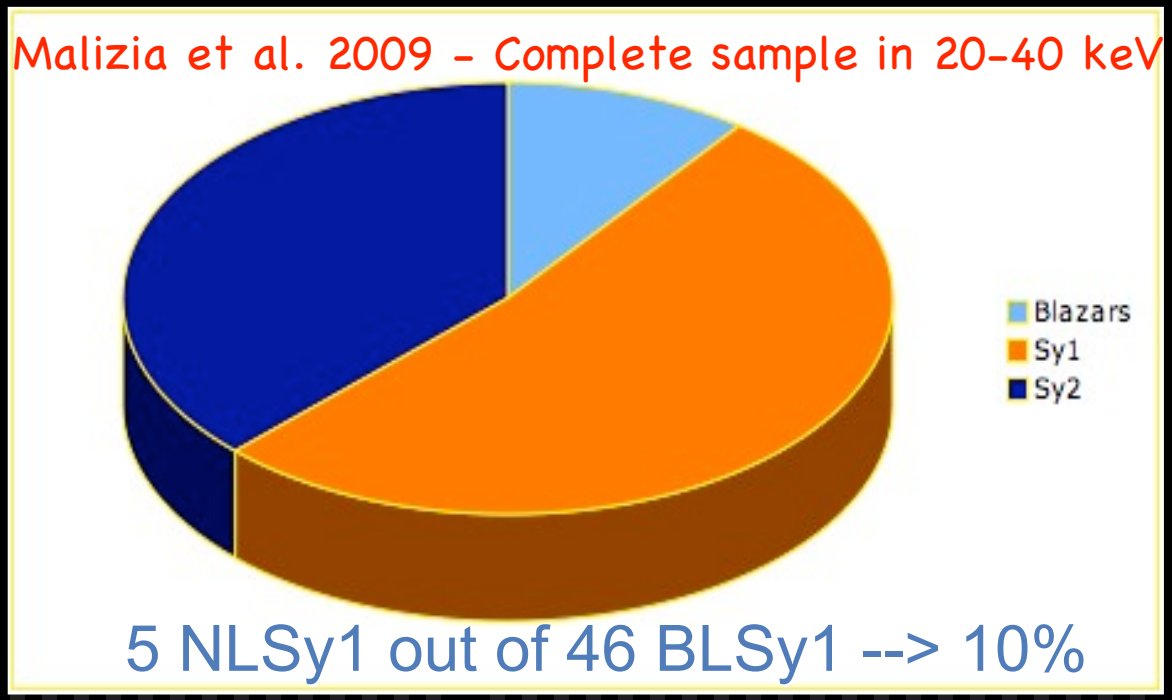


SWIFT/BAT 54 months Cat (Cusumano et al. 2010)
Total = 643 AGN

14 NLSy1 / 307 Seyfert 1

> 5% of BLSy1
> 2% of AGN

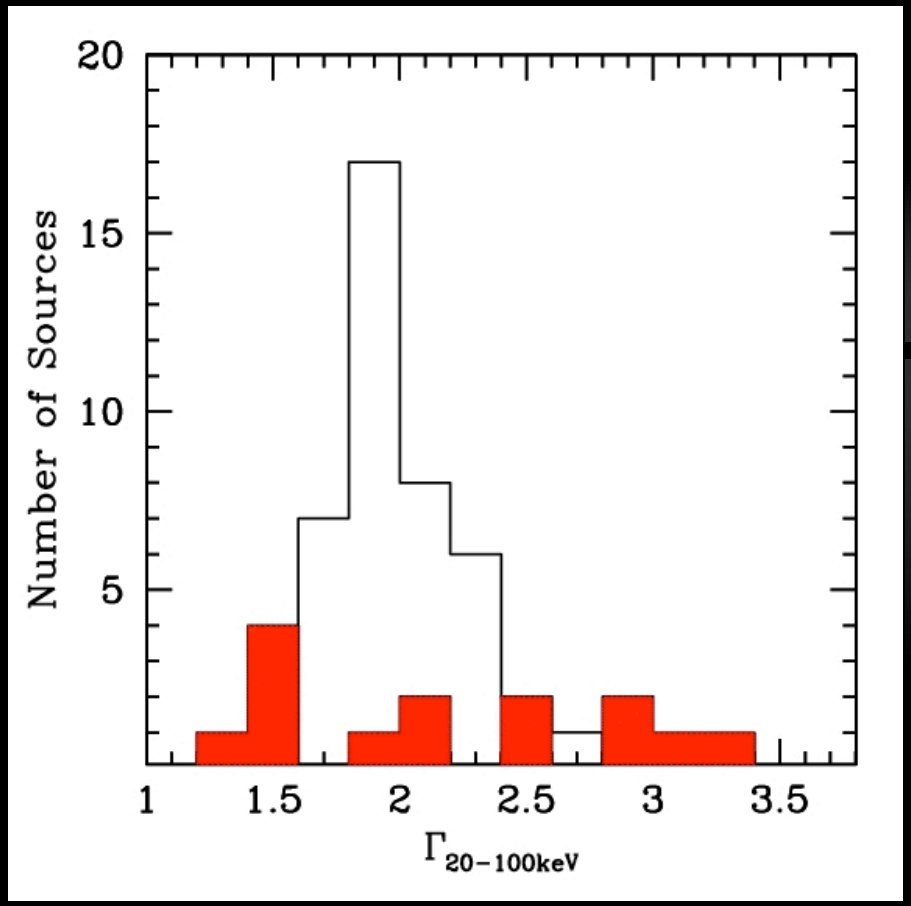
How many NLSy1 in the hard X-ray sky?



- ✓ 5-15 % of NLSy1 in the hard X-ray sky

  - ✓ ROSAT: 46 % (BLSy1, Grupe et al. 2004)
    1 % (AGN in deep field, Hasinger et al. 2000)
  - ✓ OPTICAL: 15% (vs. BLSy1, Zhou et al. 2006, Williams et al. 2002)

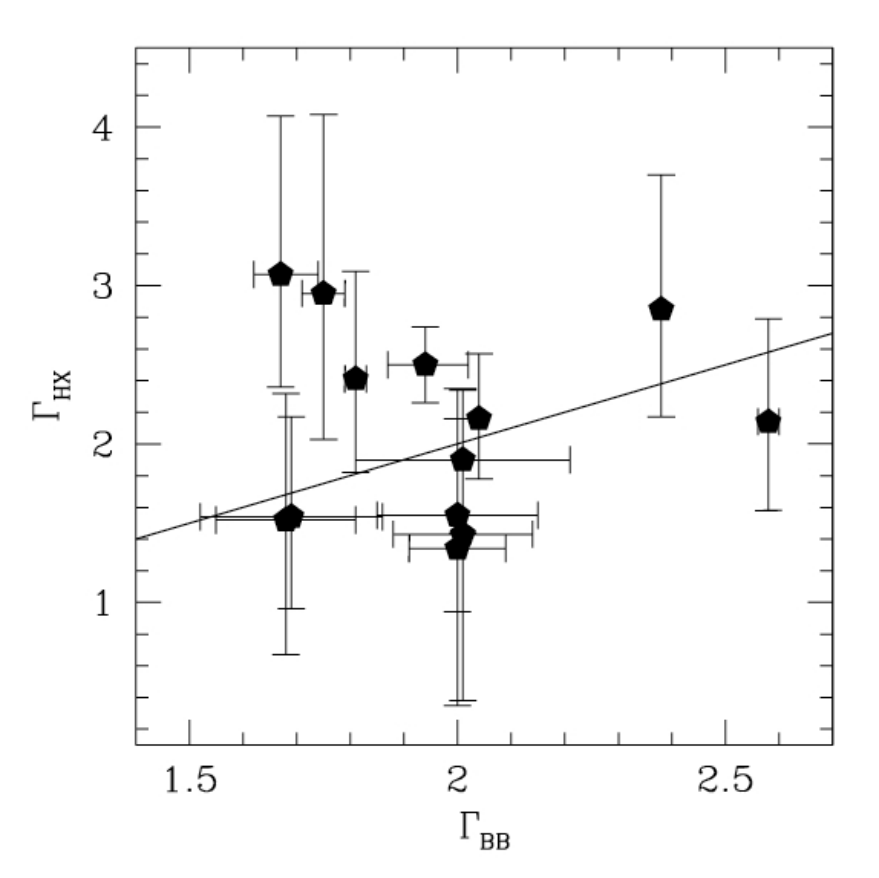
Average INTEGRAL spectra: hard X-ray photon index



- ✓ Hard X photon index broadly distributed
- ✓ $< \Gamma >_{NLSy1} = 2.2 +/- 0.7$
  - ✓ $< \Gamma >_{BLSy1} = 2.00 +/- 0.04$ (Molina et al. 2009 & in prep)
  - ✓ $< \Gamma >_{BLSy1} = 2.23 +/- 0.01$ (Ajello et al. 2008)

Are we missing steeper spectrum NLSy1?

Average INTEGRAL spectra: broad-band photon index



- ✓ Broad-band photon index 0.3-150 keV

- ✓ $< \Gamma >_{NLSy1} = 1.97 +/- 0.07$
- ✓ $< \Gamma >_{BLSy1} = 1.74 +/- 0.20$

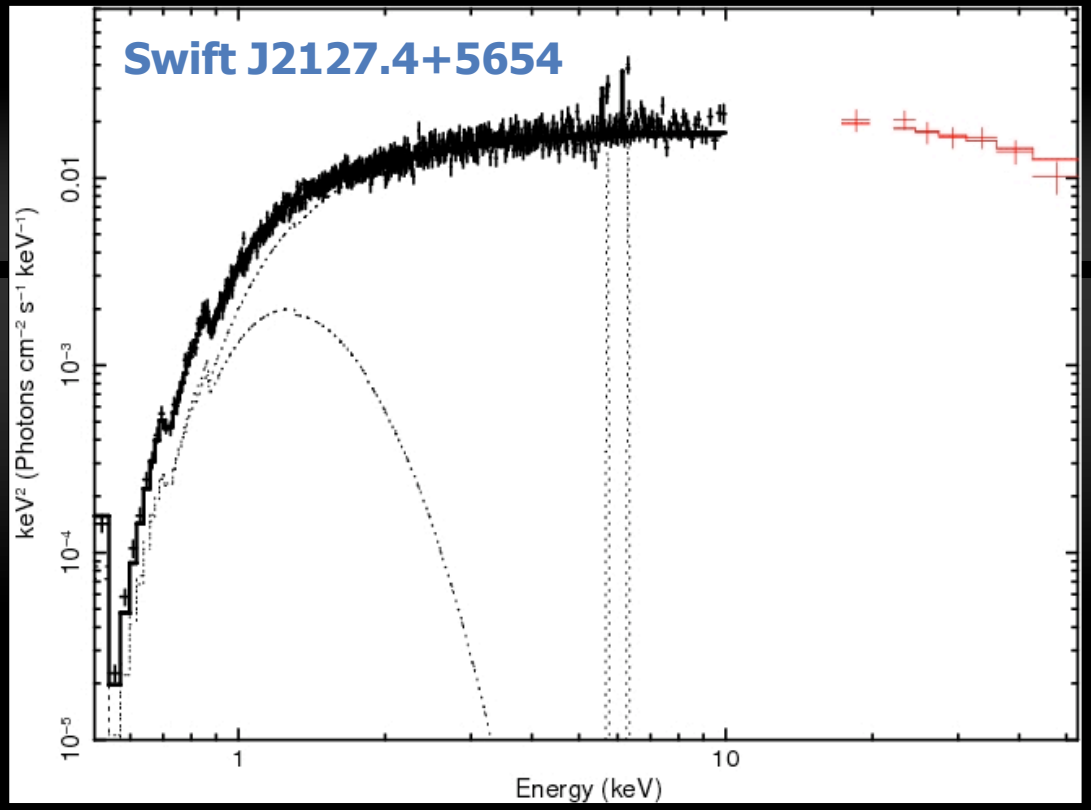
(Molina et al. 2009)

- ✓ $< \Gamma >_{NLSy1} = 1.94 +/- 0.07$
- ✓ $< \Gamma >_{BLSy1} = 1.73 +/- 0.04$

(Bianchi et al. 2009)

NLSy1 have steeper spectra (Leighly 99)

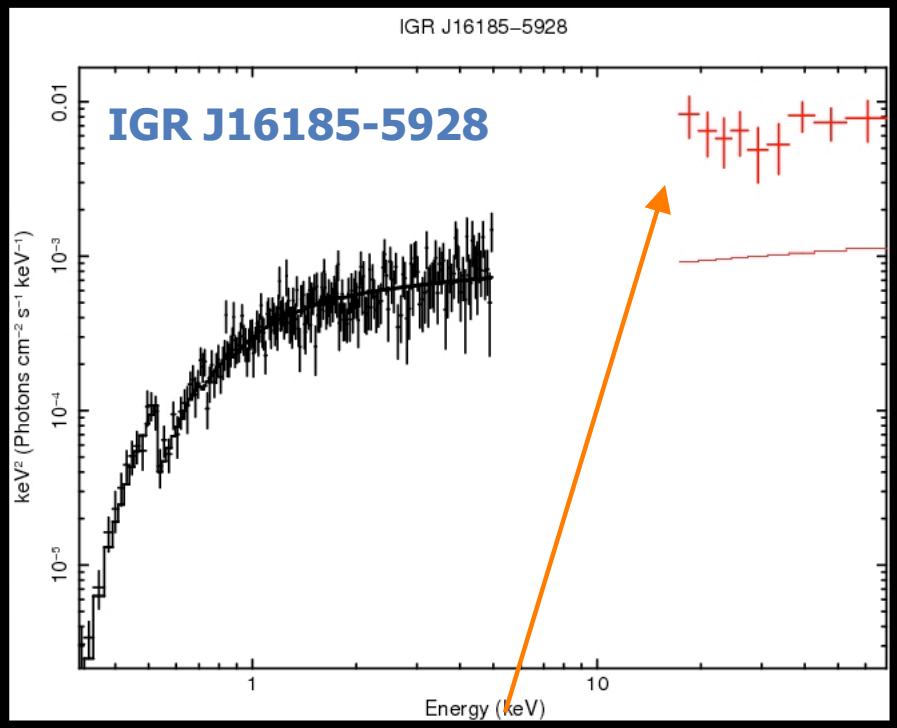
Average INTEGRAL spectra:
high energy cut-off and reflection

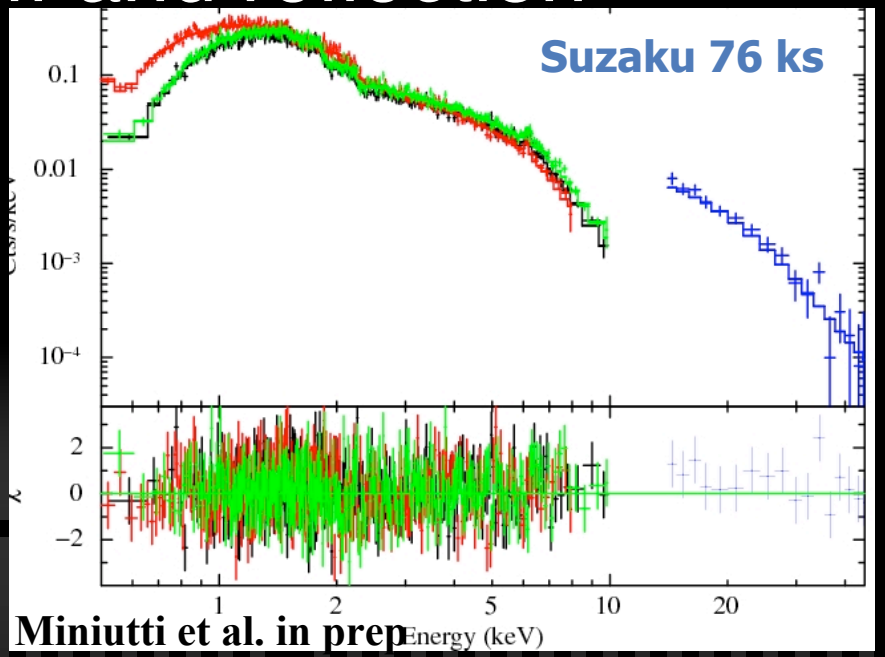


High energy cut-off and reflection component constrained in one NLSy1:

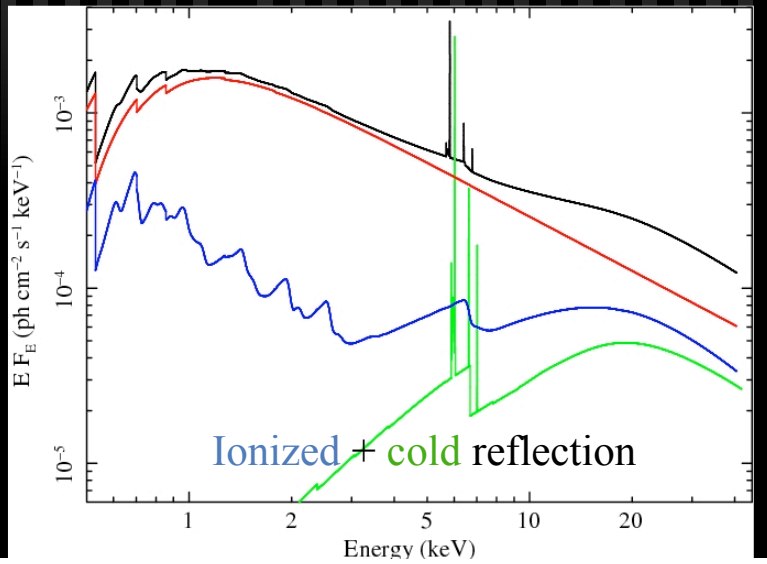
- ✓ $E_{cut\text{-}off}$ = 50 (+50 , -17) keV
- ✓ R = 1.0 (+ 0.5, -0.4)

Average INTEGRAL spectra:
high energy cut-off and reflection



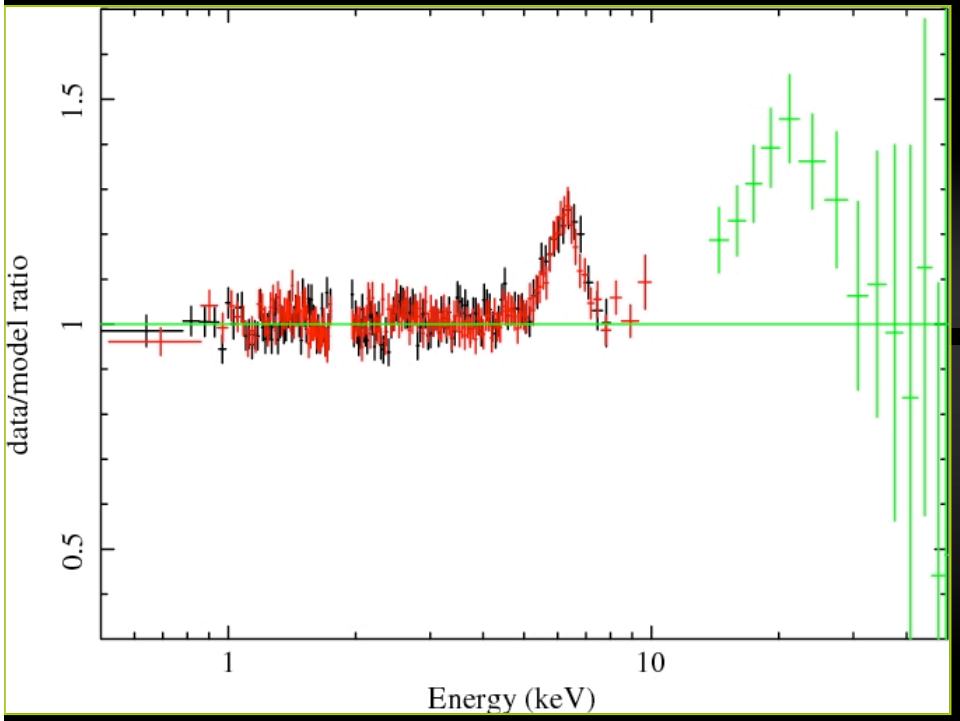


Miniutti et al. in prep



Strong variability between XMM+INTEGRAL

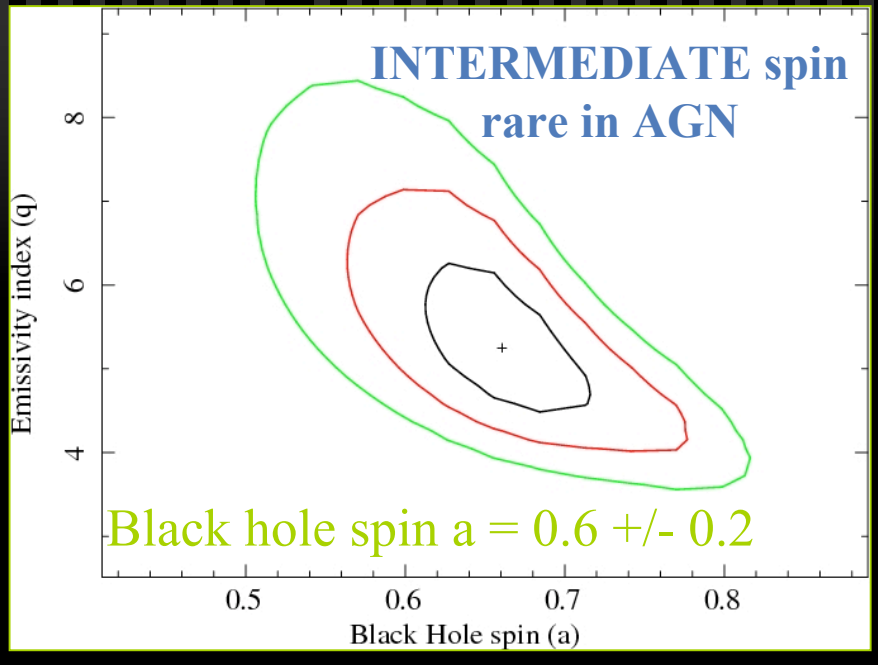
Average INTEGRAL spectra:
Fe emission line



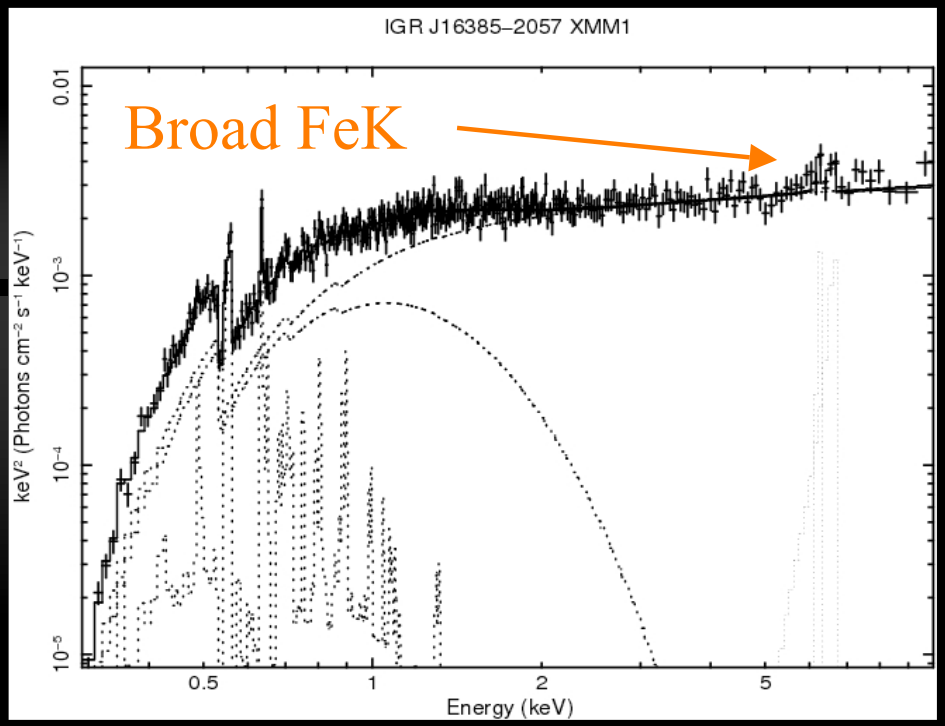
(Miniutti et al 2009 MNRAS)

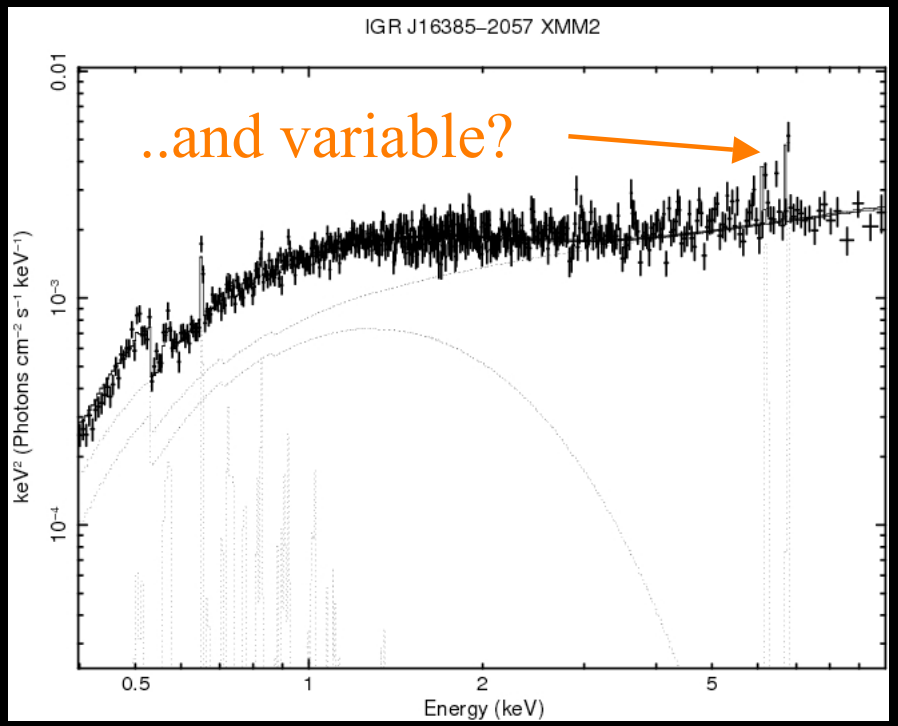
→ Broad relativistic iron emission line (originating in reflection from the innermost region of the AD)

✓ Narrow to moderately broad Fe emission line in 6/8 NLSy1 with XMM-Newton datasets



Variable broad Fe: IGR J16385-2057

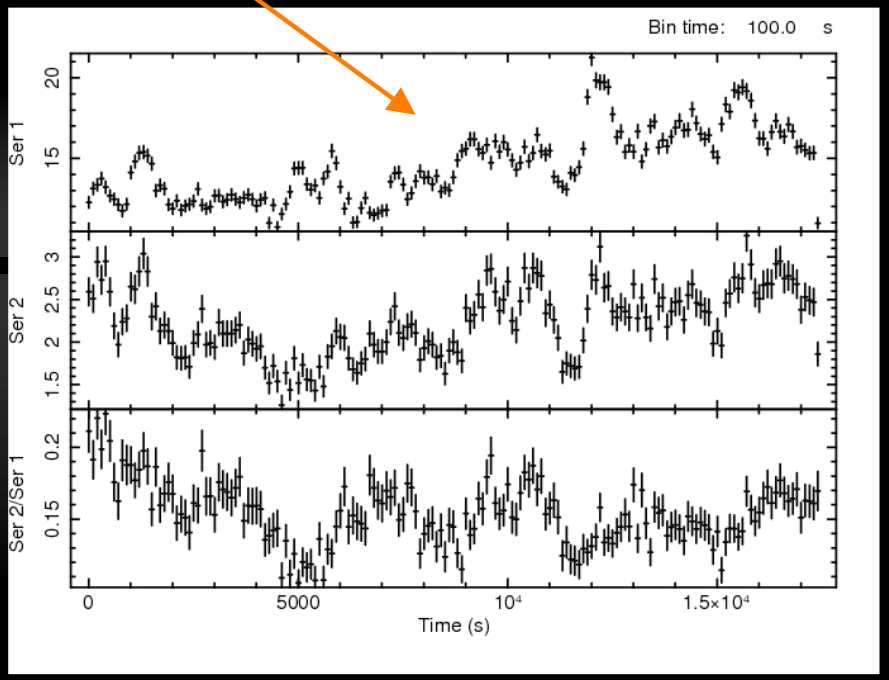




NLSy1 with water maser detection (Tarchi et al in prep, Castangia et al. in prep.) --> no X-ray absorption

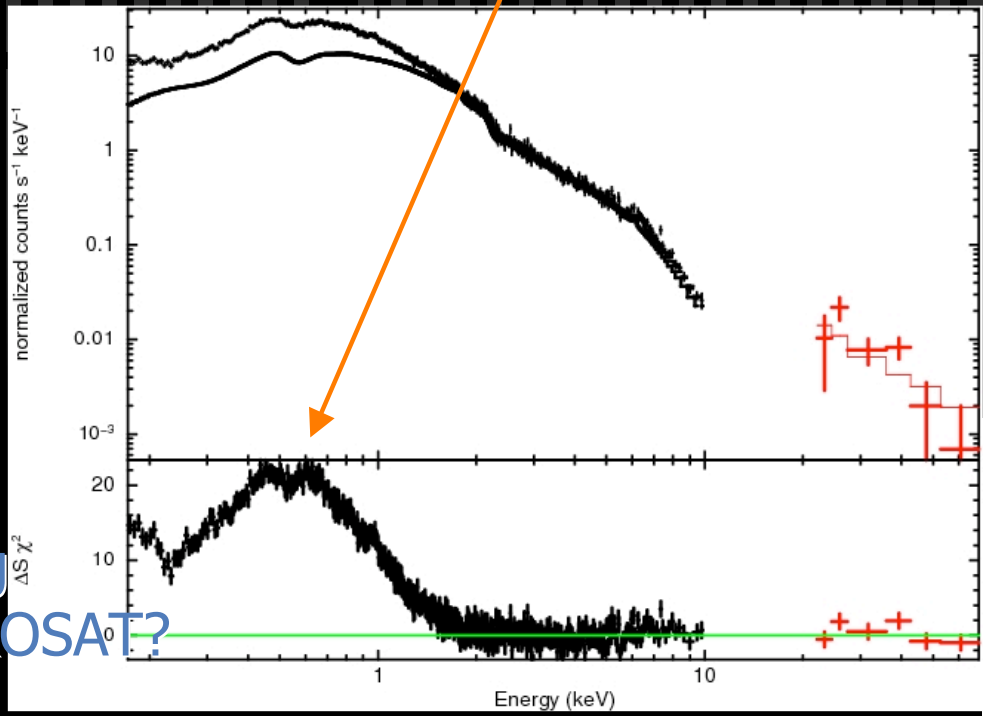
Average INTEGRAL spectra:
soft X-ray excess

Variability



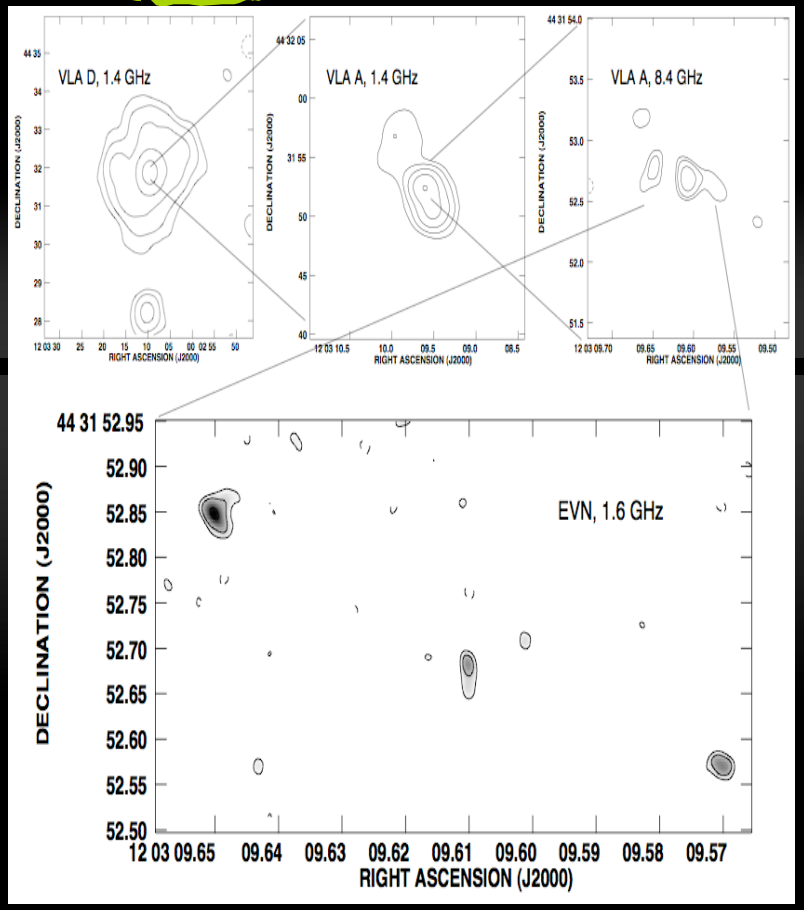
✓ Soft X-ray component always present (except for one source)

✓ Dominates the X-ray spectrum only in IGRJ19378-0617



Is the hard X-ray selection reducing The soft X-ray bias introduced by ROSAT?

INTEGRAL NLSy1:
radio-loudness



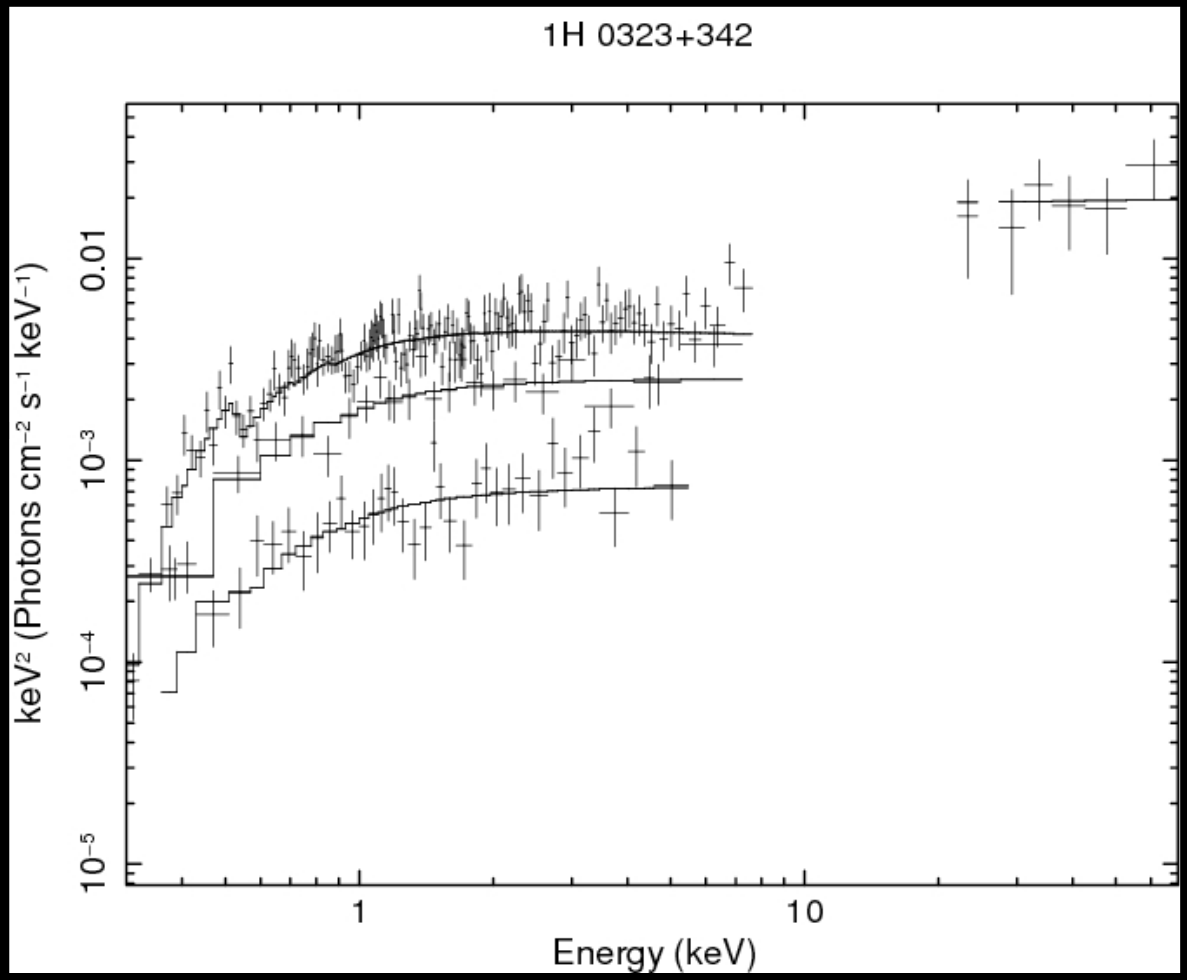
- ✓ INTEGRAL NLSy1 are radio emitters:
  - from 6 to 362 mJy
- ✓ Radio Loudness:
  - all radio-quiet (Panessa et al. 07)
  - 3/11 radio-quiet (Terashima&Wilson03)
  - 1 blazar-like Fermi NLSy1
- ✓ VLBI --> very radio-quiet

(Giroletti & Panessa 2009)

Fraction of radio-loud is likely 1%
compared to 8% of Komossa 2007

NGC 4051 --> Log R (L_R/L_X) = -5.8

A blazar-like Fermi NLSy1: 1H0323+342

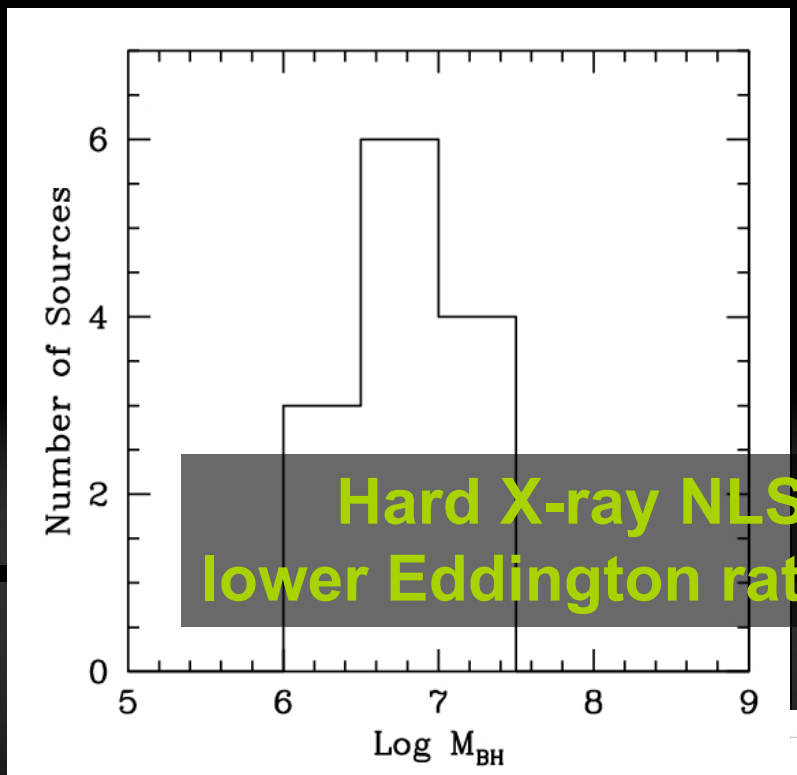


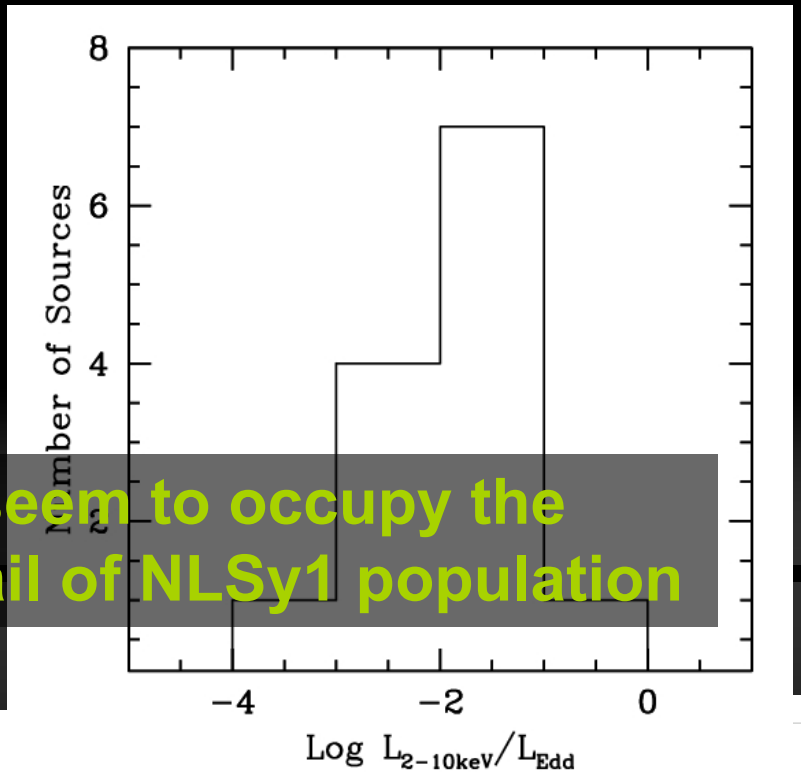
- ✓ XRT data + IBIS
- ✓ Flux variation in:
  - 4 days:
    0.2e-11 (cgs)
    1.1e-11 (cgs)
  - 4 months:
    0.6e-11 (cgs)

(see also Foschini et al. 2009)

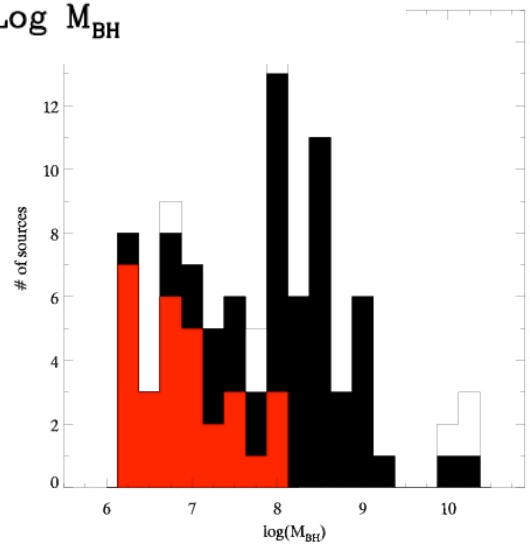
A blazar NLSy1 in a 10^7 M_{sol} black hole galaxy

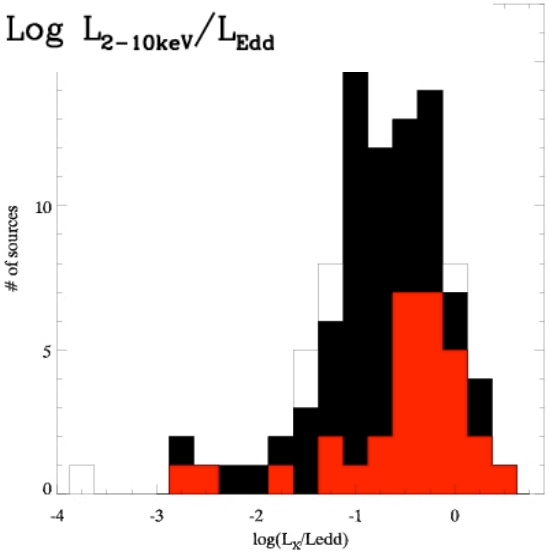
Black hole mass and Eddington ratio





Hard X-ray NLSy1 seem to occupy the lower Eddington ratio tail of NLSy1 population





Bianchi et al. 2009

Summary

SAMPLE of INTEGRAL HARD X-ray NLSY1

- ✓ Fraction of NLSy1 in hard X-rays: 5-15%
- ✓ Hard X-ray indices distributed as in BLSy1
  - are we missing steeper spectrum NLSy1?
- ✓ No strong dominant/variable soft excess
  - are we reducing the strong soft X ROSAT selection?
- ✓ Hard X-ray variability from 10 to 70%
- ✓ Small black hole masses & relatively high Eddington ratios
  - are we selecting the lower efficiently accreting NLSy1?