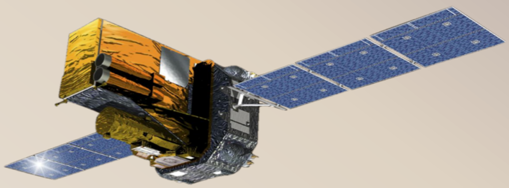
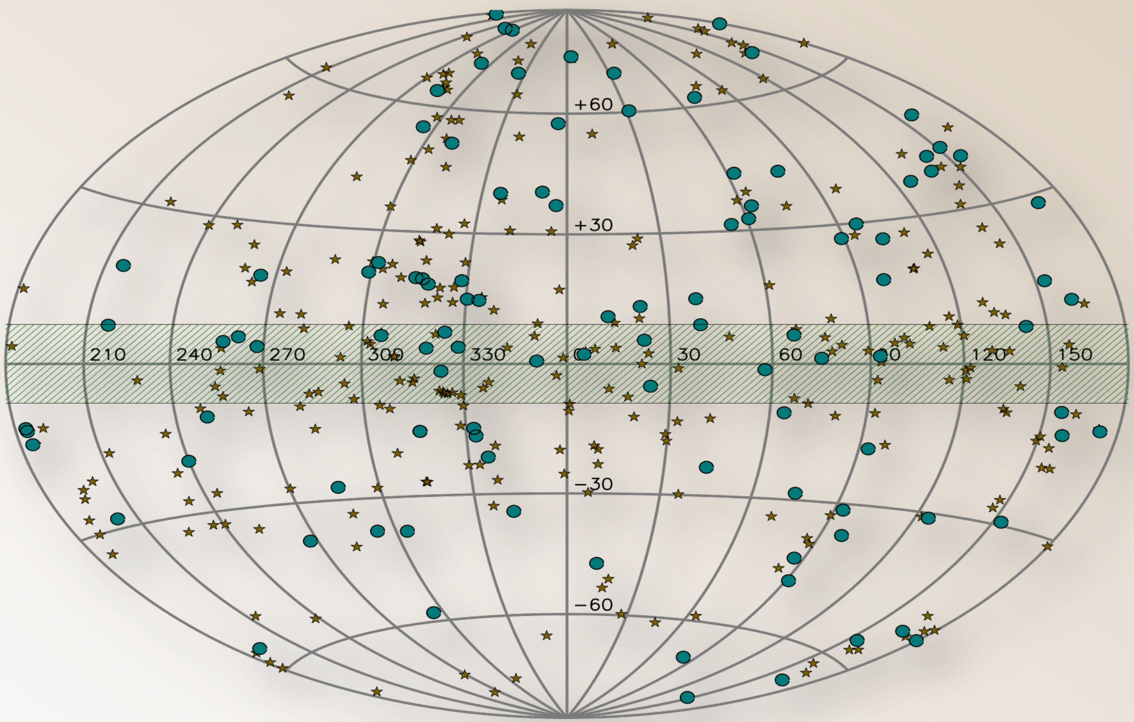


INTEGRAL view of the Extragalactic Sky

Angela Malizia

in collaboration with: L. Bassani, M. Molina, F. Ursini
A. Bazzano, P. Ubertini
T. Bird



Distribution of all AGN (~500) so far detected by INTEGRAL plotted on the sky (Malizia et al. 2012 + 2016 + extra AGN in Russian surveys).

mainly broad line or type 1 AGN, narrow line or type 2 AGN and blazars (QSO and BL Lac) but we can say that all type of AGN observed in soft X-rays now seen above 20 keV

There are sources still of unknown optical class but they have been considered AGN since have been associated with galaxies detected in the IR and/or in the Radio band.

AGN SAMPLE characteristics

All the INTEGRAL AGN have been undoubtedly identified through X-ray and optical follow-up observations and they have been fully characterized in terms of their spectral parameters in a broad energy band (2-100 keV).

Table 1: INTEGRAL/IBIS AGNs

Name	RA	Dec	z	Class	$F_H^{\dagger}$	$F_S^{\dagger\dagger}$	Log $N_H^{\diamond}$	Reference
IGR J00040+7020	00 04 01.92	+70 19 18.5	0.096	Sy2	1.47	0.35	22.52 [22.49 – 22.54]	De Rosa et al. 2012
IGR J00158+5605	00 15 54.19	+56 02 57.5	0.169	Sy1.5	<0.66	0.31	**21.50**	Malizia et al. 2011
IGR J00256+6821	00 25 32.50	+68 21 44.0	0.012	Sy2	1.47	0.05	23.60 [22.92 – 23.93]	Landi et al. 2007a
IGR J00333+6122	00 33 18.34	+61 27 43.3	0.105	Sy1.5	1.38	0.68	21.93 [21.65 – 22.11]	Molina et al. 2009
1ES 0033+595	00 35 52.60	+59 50 05.0	0.086	BL Lac	1.83	5.90	21.55 [21.44 – 21.64]	Donato et al. 2005
IGR J00465-4005	00 46 20.68	−40 05 49.1	0.201	Sy2	3.56	0.12	23.38 [23.25 – 23.52]	Landi et al. 2010a
MKN 348	00 48 47.10	+31 57 25.0	0.015	Sy2	10.60	0.44	23.02 [22.93 – 23.10]	Tartarus Database

optical coordinates of counterpart and redshift

IBIS [20-100 keV] flux

X-ray [2-10 keV data]

Most appropriate optical class: cross check NED and Veron-Cetty Veron 13th catalogue
generally preferred the most recent !

In case of mismatch: class criteria Veilleux & Osterbrock ('87)
line ratio diagnostics of Ho et al. ('93, '97) and Kauffmann et al. (2003)

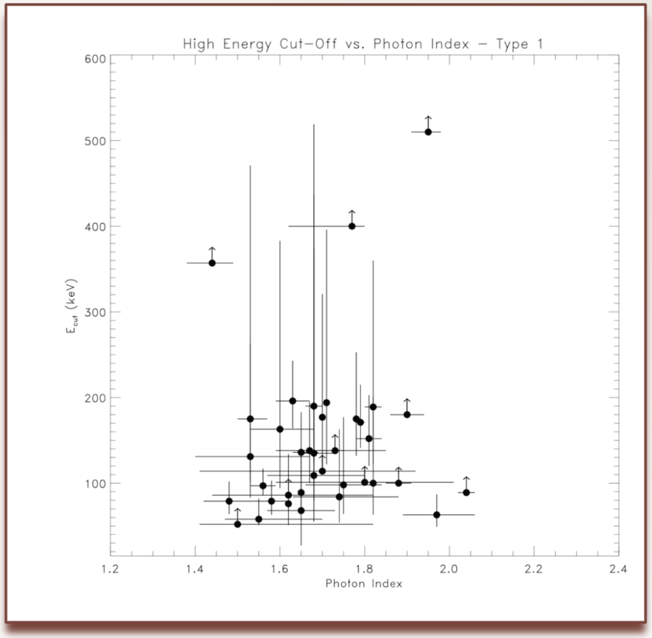
For assigning Seyfert subclasses (1.2, 1.5, 1.8, 1.9): Hα/O[IIII]λ5007 line flux ratio criteria (Winkler '92)

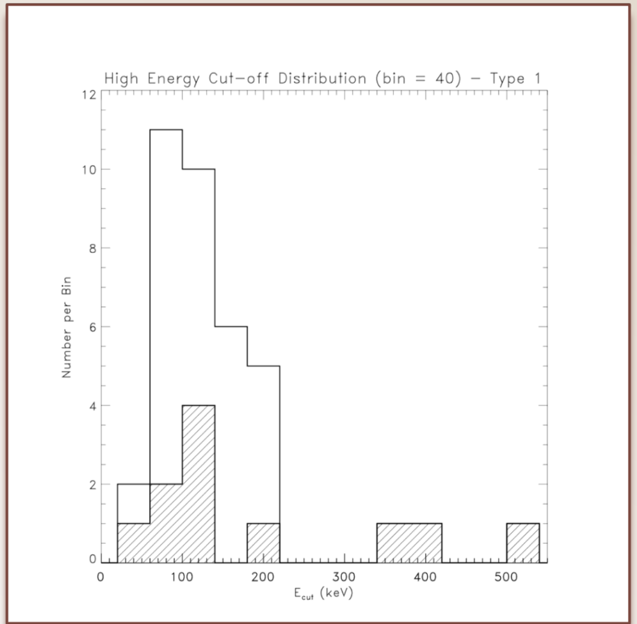
BROAD BAND SPECTRA: high energy cut-off

FIRST CUT OFF constrain in broad line Sey (Malizia+2014)

broadband (0.3–100 keV) spectral analysis by simultaneously fitting
the soft and hard X-ray spectra obtained by XMM and INTEGRAL/IBIS–Swift/BAT on
INTEGRAL complete sample of Sey 1
NOT contemporaneous but cross correlations between instruments OK

photon index and cut-off well constraned





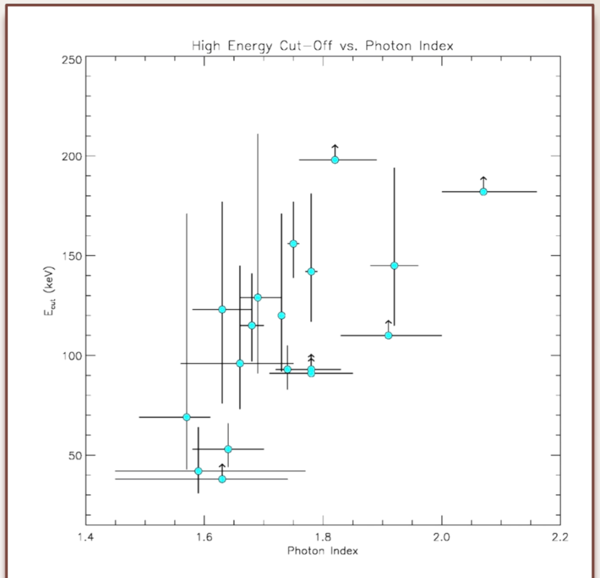
$\langle \Gamma \rangle = 1.73\ (\sigma = 0.2)$

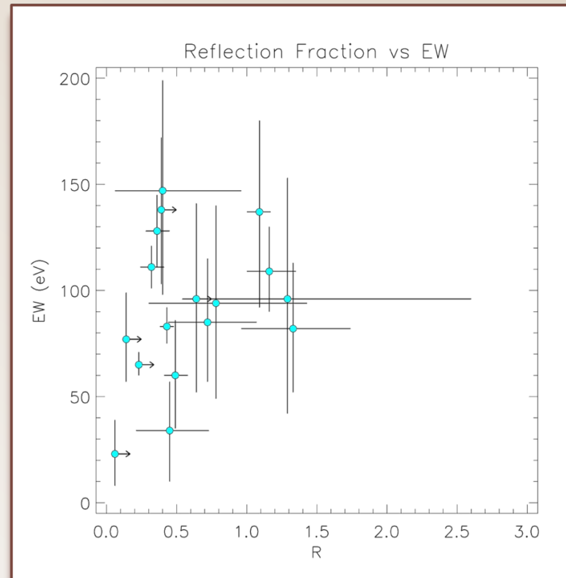
$\langle E_c \rangle = 128$ keV ($\sigma = 46$ keV)

high energy cut-off: confirmation by NuSTAR

broad band (0.5-78 keV) spectral analysis of 18 Sey1 of the complete sample using simultaneous Swift-XRT and NuSTAR observations

Molina et al. 2019MNRAS.484.2735M





$<\Gamma> = 1.74$ ($\sigma = 0.13$)

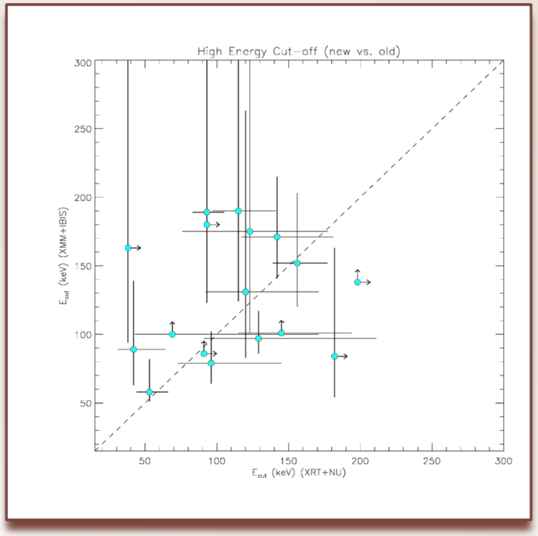
$<R> = 0.58$ ($\sigma = 0.41$)

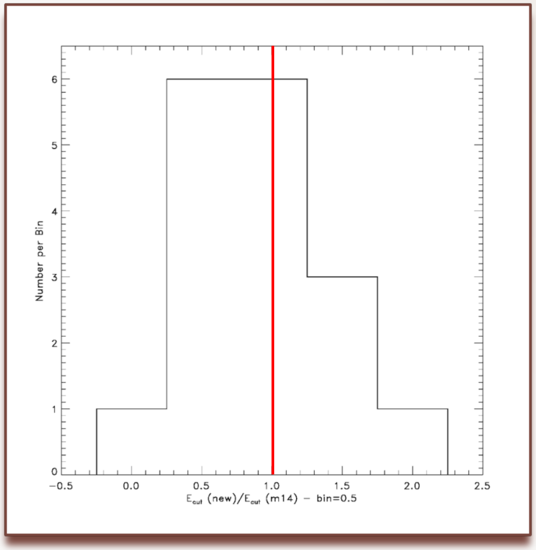
$<E_c> = 111$ keV ($\sigma = 45$ keV)

high energy cut-off: comparison with previous work

Molina et al. 2019MNRAS.484.2735M

XMM-INTEGRAL vs XRT-NuSTAR

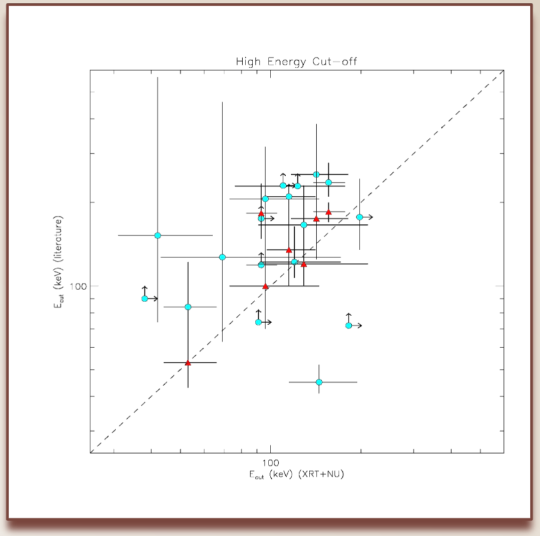


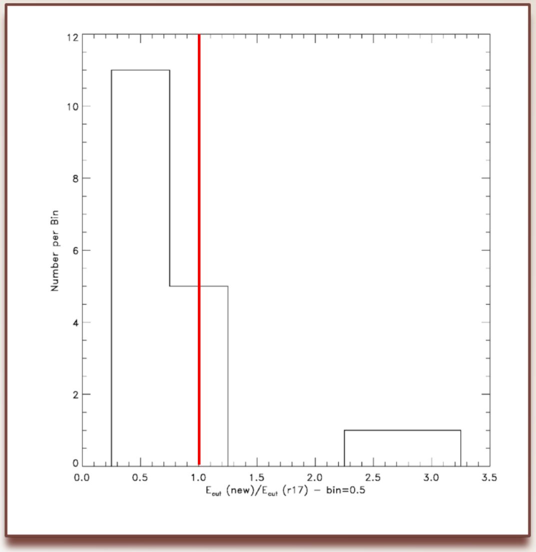


Molina+2018/Malizia+2014

NuSTAR measurements

BAT vs XRT-NuSTAR





Molina+2018/Ricci+2017

M. Molina et al.

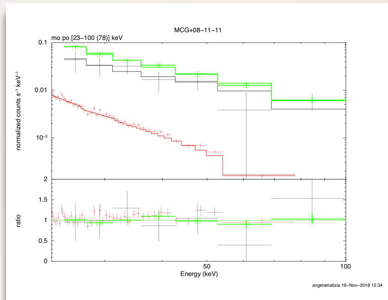
Table 4 - Previous Results

Source	**Malizia et al. 2014**	**Ricci et al. 2017**	**NuSTAR** (Ref)
QSO B0241+62	>138	177^{+66}_{-42}	-
MCG+08-11-011	171^{+44}_{-30}	252^{+131}_{-60}	175^{+110}_{-50} (1)
Mrk 6	131^{+132}_{-48}	122^{+42}_{-15}	-
FRL 1146	84^{+79}_{-30}	>72	-
IGR J12415-5750	175^{+296}_{-74}	>229	-
4U 1344-60	>110	45^{+7}_{-4}	-
IC 4329A	152^{+51}_{-32}	236^{+42}_{-26}	185^{+15}_{-15} (1)
IGR J16119-6036	>100	127^{+333}_{-64}	-
IGR J16482-3036	$163\ ^{+220}_{-69}$	>90	-
GRS 1734-292	58^{+24}_{-7}	84^{+38}_{-26}	53^{+10}_{-10} (1)
2E 1739.1-1210	-	>230	-
IGR J18027-1455	>86	>74	-
3C 390.3	97^{+20}_{-11}	166^{+64}_{-37}	120^{+20}_{-20} (1)
2E 1853.7+1534	89^{+50}_{-26}	152^{+413}_{-78}	-
NGC 6814	190^{+185}_{-66}	>210	135^{+70}_{-35} (1)
4C 74.26 (tot)	189^{+171}_{-66}	>119	183^{+51}_{-35} (2)
S5 2116+81	>180	>175	-
IGR J21247+5058	79^{+23}_{-15}	206^{+111}_{-27}	100^{+90}_{-30} (3)

References: (1): Tortosa et al. (2018); (2) Lohfink et al. (2017); (3) Buisson et al. (2018).

Spectra & light curves

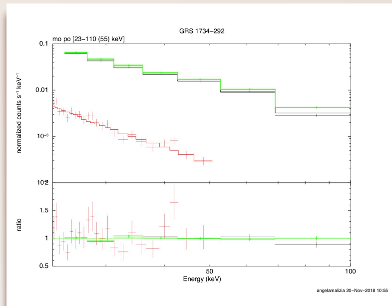
MCG+08-11-11



$\Gamma_{NuSTAR-A}$ = 1.94 [1.90772 1.98356]
$F_{20-100\ keV}$ = 1.78 x 10^{-10} ergs/cm²/s

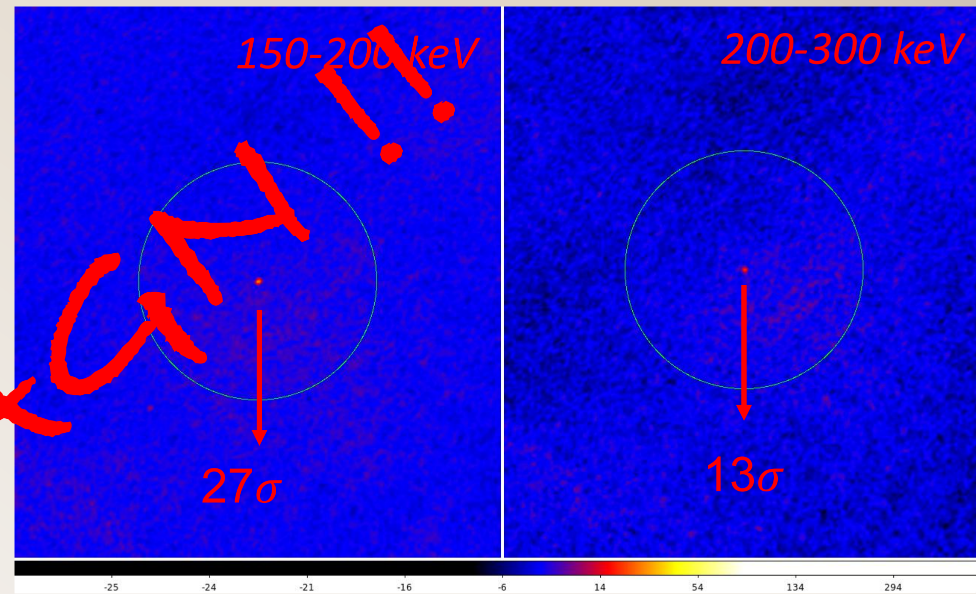
$\Gamma_{cat1500}$ = 1.95 [1.88934 2.01904]
$F_{20-100\ keV}$ = 2.02 x 10^{-10} ergs/cm²/s

GRS 1734-292



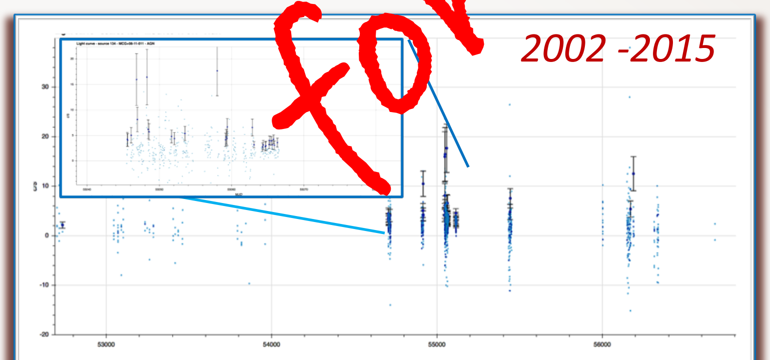
$\Gamma_{NuSTAR-A}$ = 2.10 [1.87659 2.34096]
$F_{20-100\ keV}$ = 1.0 x 10^{-10} ergs/cm²/s

$\Gamma_{cat1500}$ = 2.16 [2.12103 2.20531]
$F_{20-100\ keV}$ = 9.5 x 10^{-11} ergs/cm²/s

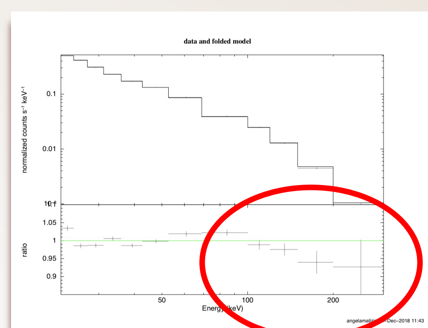


for all AGN !!

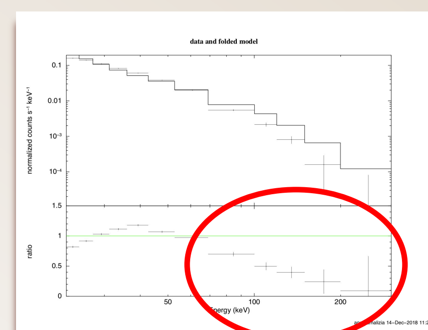
MCG +08-11-11 - 20-100 keV



CEN A



Circinus Galaxy

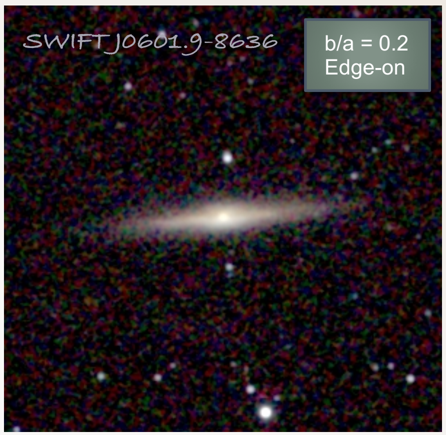


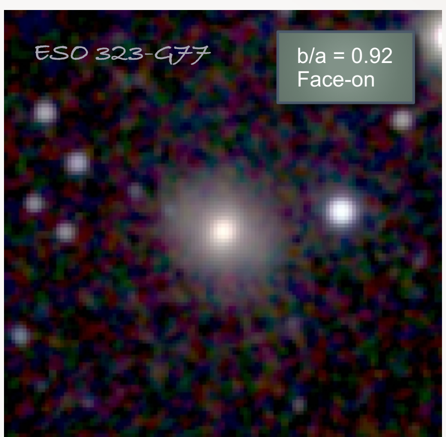
X-ray absorption and large scale structure

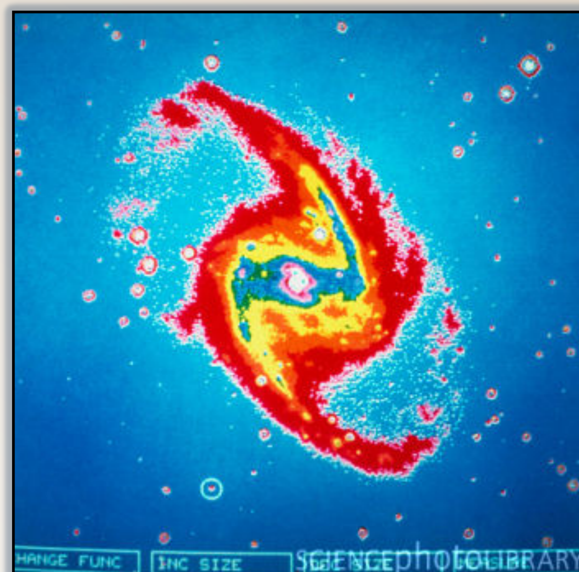
host galaxy & galactic structures

inclination of host galaxy (axial ratio b/a)

presence of bars in the host galaxy



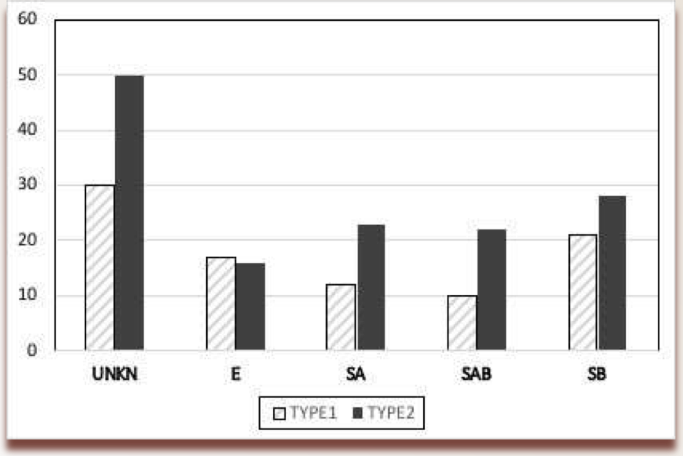


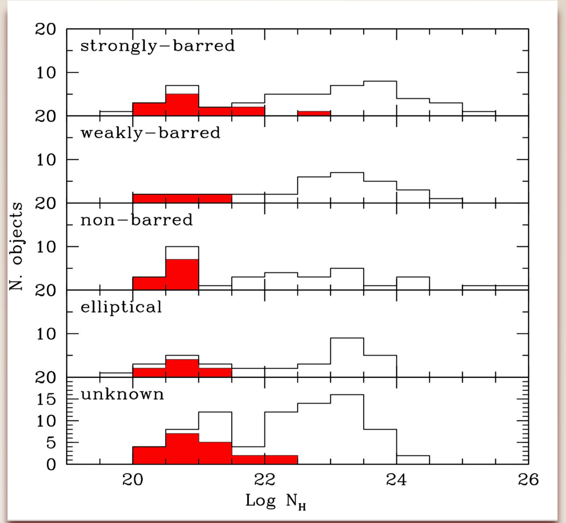


collected **301** b/a measurements
and **229** morphological info
out of 378 Seyferts

absorption and bar strength

Maiolino et al. (1999): strong correlation between the gaseous absorbing column density in type 2 AGN and the presence of bars in their host galaxies, i.e. strongly barred objects have on average column densities two order of magnitudes higher than non barred sources.





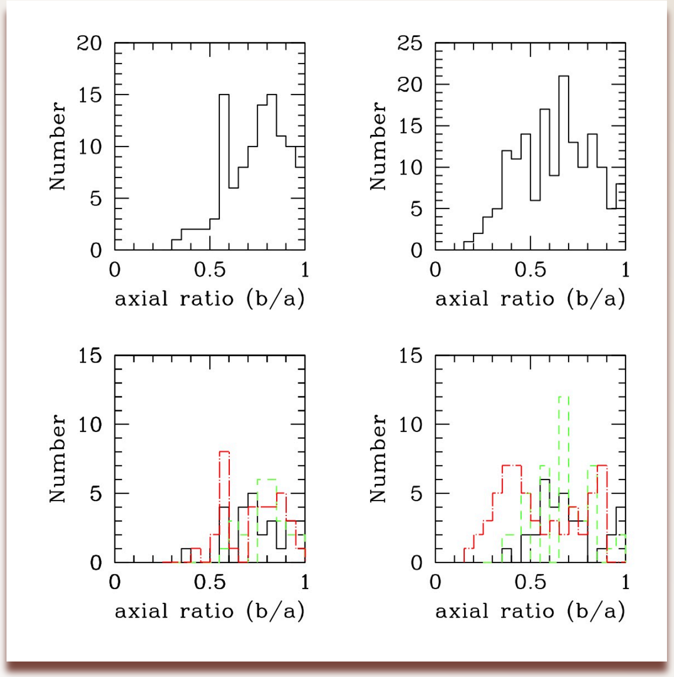
morphology of the INTEGRAL AGN sample

percentage of barred/unbarred galaxies seems to increase/decrease with column density but with large errors

overall trend: gas in bar of host galaxy can contribute to the X-ray absorption especially in CT AGN

Host galaxy inclination

Inclination of host galaxy (axial ratio b/a) can have a role in the X-ray absorption



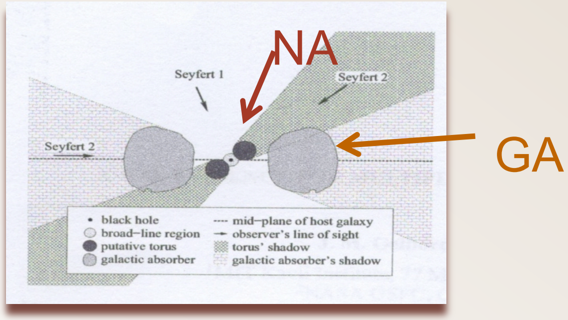
- if absorber/torus aligned with galaxy: Sy1 face-on and Sy2 edge-on
- if not, no correlation between Sy type and axial ratio expected

neither works :

Sy 2 uncorrelated with a/b
Sy 1 correlated with a/b

need for dual absorbers

(proposed by Maiolino & Rieke 95)



deficit of type 1 in edge-on galaxies

looks like these are recovered going to higher energies but still present in the INTEGRAL hard X selected sample

type 2 are distributed over the whole range of b/a

where are the missing type 1 AGN hosted in edge-on galaxies?

conclusions

Malizia et al. in preparation

- Torus misaligned with the galaxy
- Second absorber located in and aligned with host galaxy

↓

Thick enough to hide the BLR

↓

Mis-classified type 2 AGN

↓

Contribution also to CT AGN

Future work

MIR the most suitable band to study the host galaxy

Silicate feature strength (9.7 micron)
index of dust presence

torus models are not able to reproduce deep silicate absorption features ($S_{Sil} < -1$)

extra dust structures on larger scales should be considered

A NEAR INFRARED VIEW OF NEARBY GALAXIES: THE CASE OF NGC 6300
(GASPAR et al. astro-ph 1902.02373)

'An analysis of the Ks-band continuum slope shows an IR excess outside the nucleus and up to ∼27 pc probably associated with hot dust and not related to the putative dusty torus of the UM. ***We propose that this hot dust must be contributing to the AGN obscuration and it could be partially responsible for its Sy2 classification****.'*

Dust-lanes – bars – galaxies