An X-ray view of absorbed AGN

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We present a broad-band study of absorbed AGN observed with INTEGRAL, XMM and Chandra. The column density of the absorbing gas suggests that these objects all are Compton thin. This result is also confirmed by the ratios F_X/OIII. The Compton reflection we measure is not immediately compatible with a scenario in which the absorbing and reflecting media are one and the same, while the (neutral) iron line detected in the spectra is narrow and consistent with being produced in the absorbing gas. At lower energies there is clear evidence of a soft component (reproduced with a thermal and/or scattering component). The high energy cut-off (a lower limit in two cases) in found in all sources of our sample and the range of values are in good agrement with that found in other type 1 Seyfert galaxies.

The sample

Source	Type	z	Observations	exp(ks)
IGR J12391-1610	Sy2	0.037	INTEGRAL/Chandra	200/3.2
IGR J07565-4139	Sy2	0.021	INTEGRAL/Chandra	968/3.2
IGR J12026-5349	Sy2	0.028	INTEGRAL/Chandra	728/3.2
NGC 788	Sy2	0.014	INTEGRAL/ASCA	594/40
ESO 103-G35	Sy2	0.013	INTEGRAL/XMM	44/12
IC 4518A	Sy2	0.016	INTEGRAL/XMM	898/11.5
IGR J10404-4625	Sy2	0.024	INTEGRAL/XMM	626/13.5

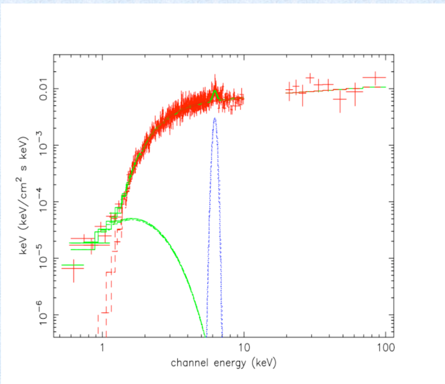
Building a broad-band spectra sample

Quantifying the fraction of missing AGN by surveys which are affected by selection effects due to absorption is necessary if we want fully understand the accretion history of the Universe. Furthermore, the measurement of the intrinsic emission (spectral slope and high energy cut-off) together with the Compton reflection features (Compton hump and iron lines), is crucial to understanding emission mechanisms and geometry/physics of the regions around the central source. INTEGRAL/IBIS is surveying a large fraction of the sky above 20 keV with a sensitivity larger than a few mCrab in well exposed regions, discovering a number of new extragalactic sources. Among these newly discovered AGN, 82% are Seyfert galaxies (Bassani et al. 2006).

In this work we present a deep broad-band spectral analysis of seven absorbed AGN detected by INTEGRAL. Four sources (IGR J12391-1610, IGR J07565-4139, IGR J12026-5349 and IGR J10404-4625) have been discovered first in soft Gamma-ray band and immediately after observed with Chandra (IGR J12391-1610, and IGR J07565-4139 and IGR J12026-5349) and XMM (IGR J10404-4625). Two objects (ESO 103-G35 and IC 4518A) are known AGN (although IC 4518A was never reported at X-ray energies before) and follow up observations with XMM have been used in our broad-band analysis. For one object (NGC 788) ASCA data have been analysed. Using X-ray measurements in conjunction with soft-Gamma INTEGRAL data allow us to bulid a spectrum in three decades of energy, and to ditinguish between the various spectral components characterising the broad-band spectra of AGN. This in turn will alow us, in particular, to study the absorption/reflection medium properties of the sample. These good quality spectra allow us also detailed investigation of the intrinsic continum slope.

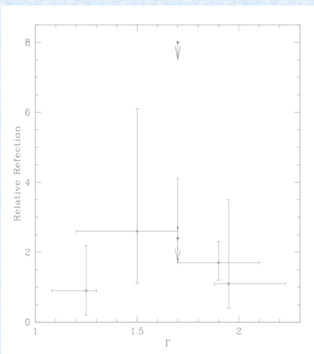
Spectral Model: absorbed power-law + Compton reflection + iron line + soft X-ray emission component

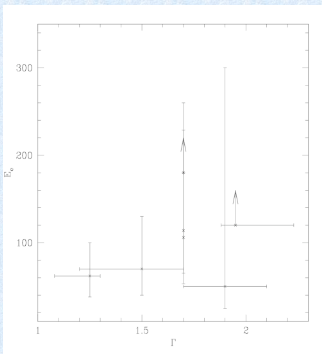
We plot the spectrum of IGR J10404-4625 as an exemple to show the high quality spectra available with XMM & INTEGRAL data. All the spectral components in the broad-band are shown in the figure. All spectral components are absorbed by Galactic column density gas. The results of the fit is reported in the table for whole sample. Chandra observations suffers from pile-up, we fit the data up to 4 keV missing then the iron line energy region



source	Γ	N_H (10^{22} cm^{-2})	$E_{cut-off}$ (keV)	R Refl frac	EW_{Fe} (eV)	KT_{soft} (keV)	F(2-10 keV) (10^{-11} erg cm^{-2} s^{-1})	F(20-100 keV) (10^{-11} erg cm^{-2} s^{-1})
LEDA 170194	1.7*	30^{+18}_{-20}	>180	<2.4	-	$1.3^{+1.7}_{-0.3}$	1.5	4.9
IGR J07565-4139	1.7*	$0.8^{+0.2}_{-0.2}$	114^{+146}_{-49}	$2.7^{+1.4}_{-0.9}$	-		0.35	0.69
IGR J12026-5349	1.7*	104^{+216}_{-54}	106^{+123}_{-43}	<8	-	$1.8^{+0.3}_{-0.3}$	2.5	4.1
NGC 788	$1.25^{+0.05}_{-0.17}$	30^{+6}_{-3}	62^{+38}_{-24}	$0.9^{+1.3}_{-0.7}$	539^{+231}_{-109}	$0.29^{+0.11}_{-0.06}$	1.7	3.8
ESO 103-G35	$1.9^{+0.2}_{-0.2}$	$18.9^{+0.6}_{-1.1}$	50^{+250}_{-25}	$1.7^{+0.7}_{-0.5}$	325^{+100}_{-100}	$0.28^{+0.04}_{-0.03}$	6.1	7.9
IC 4518A	$1.5^{+0.2}_{-0.3}$	14^{+3}_{-1}	70^{+60}_{-30}	$2.6^{+3.5}_{-1.5}$	360^{+106}_{-190}	$0.23^{+0.03}_{-0.02}$	0.58	2.9
IGR J10404-4625	$1.95^{+0.28}_{-0.07}$	$4.6^{+0.3}_{-0.4}$	>120	$1.1^{+2.4}_{-0.7}$	215^{+70}_{-80}	$1.5^{+0.3}_{-0.3}$	1.7	2.5

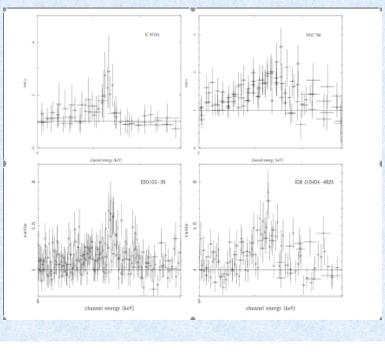
Are the reflecting and absorbing medium one and the same (putative molecular torus)? For $N_H=10^{23-24-25}$ cm^{-2}, the contributions of the torus at the flux at 30 keV are 8, 29 and 55 per cent respectively (Ghisellini et al. 1994). This means that the mesured value of R in our sources is too high to be produced in the absorbing gas with the column densities we found. A possible solution (Risaliti et al. (2002)) should be that the absorber is not homogeneous and that a Compton thick medium covers a large fraction of the solid angle but not the line of sight. The plot on the right shows the reflection fraction vs the photon index for our sample, no evidence of correlation is found.



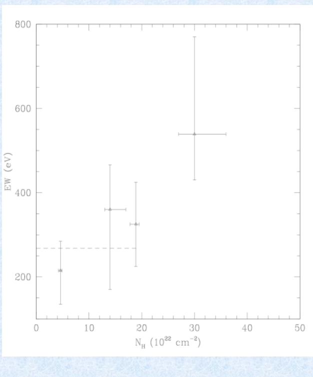


We measure the **high energy cut-off** in five out of seven sources and we find a lower limit in tha case of LEDA 170194 and IGR J10404-4625.

The plot on the left show the high energy cut-off vs the photon index, no evidence of correlation is found



The energy of the line is consistent with neutral or little ionized iron. The line is narrow in all sources as shown in figure. **It is possible that the absorbing gas alone is able to produce the observed iron line?** The value of N_H in the sample is in the range (0.6-300)x10^{22} cm^{-2} with averaged value 3x10^{23} cm^{-2}. A such gas should produce a fluorescence iron line of with equivalent width EW=150 eV and in the range 80-1000 eV (Ghisellini et al. 1994). The values we measure are well within these limits.



The plot on the left shows the **equivalent width of the Fe line vs the absorbing column density**. At N_H< 3x10^{23} cm^{-2} a fit with a constant give us C=268+-60 eV, with χ^2 /dof=1. The only data point with N_H> 3x10^{23} cm^{-2} is that of NGC 788 which has a column density significantly greater then C. Even if we do not have enough statistic to draw any conclusions, we stress that this behaviour represents a strong evidence that the line has to be produced (at least in part) far away from the accretion disc, being absorbed in a different way of the continuum. The evidence of a narrow profile strongly support this scenario, confirming that the best candidate for the line production is the absorbing gas, probably the obscuring torus.