INTEGRAL observations of AGNs obscured by the Galactic Plane

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ABSTRACT

In this paper we present INTEGRAL observations of 7 AGNs: two newly discovered type 1 Seyferts, IGR J18027-1455 and IGR J21247+5058, and five well known Seyferts, NGC 6814 (type 1.5), Cyg A (Type 2), MCG-05-23-16 (type 2), ESO 103-G035 (type2) and GRS1734-292. For IGR J18027-1455 and IGR J21247+5058 only INTEGRAL/IBIS data were available, while broadband spectra are presented and discussed for the remaining 5 sources for which either BeppoSAX or ASCA data were used in conjunction with INTEGRAL measurements. In the cases of NGC 6814 and GRS 1734-292, data taken in different periods indicate variability in the flux: in the case of NGC 6814 by a factor of 16 over a period of about 10 years. Although limited in size, our sample can be used to investigate the parameter space of both the photon index and cut-off energy. The mean photon index is 1.8, while the cut-off energy ranges from 30-50 keV to greater than 200 keV; in the particular case of MCG-05-23-16, ESO 103-G035 and GRS 1734-292 the cut-off energy is well constrained at or below 100 keV. We have also tested an enlarged sample, which includes INTEGRAL data of 3 more AGNs, against the correlation found by a number of authors between the photon index and the cut-off energy but have found no evidence for a relation between these two parameters. Our analysis indicates that there is a diversity in cut-off energies in the primary continuum of Seyfert galaxies.

Key words: Galaxies – AGNs – Spectral Analysis.

1 INTRODUCTION

The high energy emission of AGNs (Active Galactic Nuclei) is often to the first order well described by a power law of photon index 1.8-2.0, extending from a few keV to over 100 keV; at higher energies there is evidence of an exponential cut-off, the exact value of which is still uncertain (Perola et al. 2002; Risaliti 2002; Dickey & Lockman 1990). Secondary features, which are also commonly present, are considered to be the effects of re-processing of this primary continuum and are relatively well understood (Mushotzky et al. 1993; Dickey & Lockman 1990). Modelling of high energy AGNs spectra has so far generally focussed on how to reproduce and explain the observed primary continuum shape. A good fraction of the proposed models ascribe the power law to the inverse Compton scattering of soft photons in a bath of “hot electrons” (see for example Maraschi & Haardt 1997). Variations to this baseline model depend on the energy distribution of these electrons and their location in relation to the accretion disc. Measuring both the primary continuum and its cut-off energy is therefore crucial for understanding models and discriminating between them. While the photon index distribution has been well investigated (Matt 2001), observational results on the cut-off energy have so far been limited by the scarcity of measurements above 10-20 keV, with most information coming from BeppoSAX broadband spectra. Analysis of type 1 and 2 AGNs (Perola et al. 2002) provides evidence for a wide range of values in the cut-off energy, spanning from 30 to 300 keV and further suggests a possible trend of increasing cut-off energy as the power law index increases; it is not clear however if this effect is due to limitations in the spectral analysis or if it is intrinsic to the sampled source populations.

Direct INTEGRAL measurements enable us to obtain further observational results on the primary continuum and high energy cut-off thus providing more refined parameters for AGNs modelling. The sample of 12 AGNs first detected by INTEGRAL (Bassani et al. 2004) can be taken as a case study: they are representative of the larger sample of AGNs recently reported in the 20-100 keV band (Bassani et al. 2006) and are detected with adequate statistics to allow more in depth analysis. In particular, they are ideal objects for the study of the primary power law component, the presence of any high energy cut-off and the existence of a relation (if any) between these two parameters. Spectral analysis has so far been reported for 5 Seyfert galaxies listed in this ini-
tial sample, 4 of type 2 (NGC 4945, Centaurus A, Circinus Galaxy and NGC 6300, Soldi et al. 2005) and one of type 1 (GRS 1734-292, Sazonov et al. 2004) as well as for the Blazar PKS 1830-211 (De Rosa et al. 2005). In the present paper, we concentrate on the remaining 6 objects: the two newly discovered AGNs, IGR J18027-5058 both of type 1, and the four known Seyferts NGC 6814 (type 1.5), Cygnus A (type 2), MCG-05-23-16 (type 2) and ESO 103-G035 (type 2). The significance of the INTEGRAL detection for the last two objects was quite low at the time of the paper by Soldi et al. (2005), but they were analysed anyway. Their analysis has therefore been updated here as more exposure is available pointing are generated in narrow energy bands using the INTEGRAL Science Data Centre (ISDC) offline scientific analysis software OSA version 4.2 (Goldwurm et al. 2003), including background uniformity corrections (Terrier et al. 2003). Source ghosts are removed from each image using a catalogue of sources built iteratively and containing at the end all the detected objects. The clean images are then mosaiced using a custom tool to produce deep all-sky maps in narrow energy bands. Images from adjacent bands can then be added together to estimate the source overall detection in a broad energy range; typically the 20-100 keV energy range is the most suitable for detecting extragalactic objects (Bassani et al. 2004). Light curves are also created in the same narrow bands and then used for variability and/or spectral studies; in particular, the weighted mean value and associated error in each narrow energy band is calculated and then used to create a raw spectrum.

In Table 1 we report the details of the IBIS/ISGRI observations: best fit positions, exposures and count rates in the range 20-150 keV as well as the value of galactic absorption in each source direction and the fluxes in the 20-100 keV band. All objects are detected with a global significance greater than 7σ; the positional uncertainty for sources of this brightness is around ~1 arcmin (Bird et al. 2006).

Given the angular separation of ~37' between NGC 6814 and the cataclysmic variable RX J1940.2-1025, previous X-ray data of this AGN, obtained with non-imaging collimated instruments, were generally contaminated. In particular, a past single observation at high energy by OSSE (Zdziarski et al. 2000) is clearly incorrect due to the inability of the instrument to resolve NGC 6814 from the Galactic object. Thanks to the imaging capability of IBIS, the detection of NGC 6814 reported in this paper is the first reliable one above 10 keV. In figure 1 the IBIS/ISGRI 20-100 keV map of the sky region around NGC 6814 and RX J1940.2-1025 is shown; this figure indicates the ability of INTEGRAL to discriminate between the AGNs and the Galactic source.

To compile broadband spectra of our sources we either use ASCA/GIS or BeppoSAX/MECS+PDS data available in their respective archives. See Table 2 for a listing of the various observation periods. The ASCA data, spectra and associated files were downloaded from the TARTARUS database (Version 3.1, http://tartarus.gsfc.nasa.gov) or from the HEASARC archive (http://heasarc.gsfc.nasa.gov); the BeppoSAX/MECS data were downloaded from the ASDC (ASI Science Data Center) archive (http://www.asdc.asi.it/bepposax). The PDS spectra were extracted using the XAS package (Chiappetti & Dal Fiume 1997) in order to perform an in depth check for possible contaminations in the background fields, which is an effect likely to occur in sources located in the Galactic Plane (see Soldi et al. 2005).

The spectral analysis was performed using XSPEC version v.11.3.1 (Arnaud 1996). Errors are quoted at the 90% confidence level for the model parameter considered ($\chi^2/r=2.7$). In the following, we always use an absorbed component to take into account the Galactic column density ($\text{H}_\text{a}$), which in the direction of all our objects is significant due to their low Galactic latitude. Extra absorption intrinsic to the source ($\text{H}_\text{a}$) was assumed when required by the data or known to be present from the literature. To account for possible cross-calibration mismatches between instruments as well as to take into account flux variations between the observing periods, a constant factor (C) has always been added to the fit; this constant has been fixed to be 1 between the two ASCA-GIS instruments while it has been allowed to vary within the nominal range of values (0.75-0.95) in the case of the two BeppoSAX instruments.
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Table 1: Observations Log

| Source          | RA     | Dec    | Exposure (ksec) | Count Rate$^d$ | $N_H^\circ$ | $F(20-100\text{keV})$ |
|-----------------|--------|--------|-----------------|---------------|------------|---------------------|
| NGC 6814        | 295.666| -10.329| 252             | 0.69±0.06    | 0.13       | 5.8                |
| Cygnus A        | 299.869| +40.733| 426             | 1.02±0.05    | 0.35       | 17                 |
| IGR J18027-1455 | 270.690| -14.922| 1476            | 0.54±0.03    | 0.50       | 4.8                |
| IGR J21247+5058 | 321.151| -50.980| 438             | 1.21±0.04    | 1.12       | 10.53               |
| MCG-05-23-16    | 146.985| -30.932| 337             | 2.68±0.05    | 0.08       | 16.6               |
| ESO103-G35     | 279.695| -65.408| 41              | 1.08±0.15    | 0.08       | 7.4                |
| GRS1734-292    | 264.369| -29.140| 4040            | 1.08±0.01    | 0.76       | 7.3                |

$^\dagger$: in the 20-150 keV band; $^\circ$: Galactic column density from Dickey & Lockman 1990

Table 2: Observations Periods

| Name            | IBIS/ISGRI    | BeppoSAX NFI | ASCA/GIS |
|-----------------|---------------|--------------|----------|
| NGC 6814        | Feb. 2003-Sep. 2004 | - | May 1993 |
| Cygnus A        | Feb. 2003-Sep. 2004 | Oct. 1999 | -        |
| IGR J18027-1455 | Feb. 2003-Sep. 2004 | - | -        |
| IGR J21247+5058 | Feb. 2003-Sep. 2004 | Apr. 1998 | -        |
| MCG-05-23-16    | Feb. 2003-Sep. 2004 | Oct. 1996 | -        |
| ESO103-G35     | Feb. 2003-Sep. 2004 | - | Sep. 1998 |
| GRS1734-292    | Feb. 2003-Sep. 2004 | - | -        |

3 PREVIOUSLY UNPUBLISHED SOURCES

In this section we present results related to 4 objects for which INTEGRAL spectral data have not yet been reported nor discussed in the literature: the well known AGNs, NGC 6814 and Cygnus A, and two newly discovered galaxies, IGR J18027-1455 and IGR J21247+5058. The baseline model used for these sources is a simple power law seen through galactic absorption ($N_H^\circ$ po in XSPEC); when required extra absorption ($N_H^\circ$ wa) and a narrow gaussian line (ga) have been added to this baseline model.

3.1 NGC 6814

The combined ASCA/GIS and INTEGRAL/ISGRI data (2-150 keV) are well fitted ($\chi^2=91.7/106$) by a single power law having a photon index of $\Gamma$=1.6 plus a cold iron line (see Table 3). The broadband spectrum obtained with this model is shown in figure 2. The iron line is strongly required by the data ($\Delta \chi^2=11.2$ for 2 d.o.f., i.e. more than 99% significant) and has an equivalent width of ~400 eV, higher but compatible within errors with reflection in the accretion disk. Addition of a reflection component having $R=1$ (where $R$ is the solid angle in units of $2\pi$ subtended by the reflecting material) does not improve the fit, probably due to the statistical quality of the data which is not sufficient to constrain this component. Similarly, the introduction of a cut-off to the power law (cutoffpl model in XSPEC) does not improve the quality of the fit but allows us to put a lower limit at $E_{\text{cut}} > 70$ keV. NGC 6814 is a Seyfert galaxy which shows strong variability in its X-ray flux over short (hours) as well as long (days and years) timescales. The constant $C$, introduced to take into account a possible cross-calibration mismatch between the two instruments and/or flux changes between the two observations, gives a value of $16_{-5}^{+9}$. Since from previous works (Ubertini et al. 2003, Malizia et al. 2003) we know that the cross-calibration constant between ASCA/GIS and INTEGRAL/ISGRI close to 1, we can conclude that, as expected, there was a strong variation between the ASCA and INTEGRAL observations, with INTEGRAL providing a higher flux than ASCA. It is worth noting that since we are dealing with the first high energy data not contaminated by the nearby Galactic source, this flux variation is completely due to the Seyfert galaxy. The constant versus photon index contours obtained using our baseline model are shown in figure 3. The ASCA 2-10 keV flux of $1.8 \times 10^{-12}$ erg cm$^{-2}$s$^{-1}$ and its extrapolated 20-100 keV flux of about $4 \times 10^{-11}$ erg cm$^{-2}$s$^{-1}$ suggest that the source was in a very low state during 1993 but had returned to the high state for the first observations with INTEGRAL in May 2003 (see Table 1), much in agreement to what was observed by XTE (see also figure 5 in Mukai et al. 2003). While INTEGRAL observations confirm and extend to the high energy domain the presence of long term variability, flux changes on shorter timescales are more difficult to assess due to the lower statistical significance of the signal. No changes are evident in the ISGRI light curve over the entire observing period.

Similarly to the X-ray band, strong variations have been observed in the optical continuum and line emission on timescales of months and longer (Doroshenko 1988, Sekiguchi & Menzies 1990): the width of the broad emission lines varies to the extent that the source classification changes in time from Seyfert 1 to Seyfert 1.9. Furthermore, the rapid decrease in the broad emission line strengths is thought to be coupled with the observed X-ray flux behaviour (König et al. 1997, Mukai et al. 2003). For its extreme variability and also for the modest width of the optical emission lines, Mukai and co-workers (2003) suggest that NGC 6814 might
belong to the class of Narrow Line Seyfert 1 (NLS1s) galaxies. However, contrary to what we find here, NLS1s have X-ray continua characterised by steeper slopes in the soft and hard X-ray bands than their broad line counterparts. The soft excess is another characteristic of this class of AGNs, but there is no evidence for this feature in our data (the $0.5-2$ keV band has not been reported here due to the low statistics); furthermore the primary power law component is harder than generally observed in NLS1 galaxies. Clearly a better understanding of this peculiar object can only come from coordinated optical/high energy observations with improved temporal coverage. Owing to its location close to the Galactic plane, it is likely that INTEGRAL will continue serendipitous monitoring of this source and so provide further insight into its variability behaviour.

3.2 Cygnus A

The radio galaxy Cygnus A is an active galaxy at the centre of a cooling flow in a cluster of galaxies (Reynolds & Fabian 1996). Due to this unfavourable location, the determination of its high energy spectrum is not easy. Hard X-ray emission from Cygnus A has already been reported by Young et al. (2002) with the RXTE/HEXTE instrument and a previous detection by the PDS instrument on board BeppoSAX is available but was never published. In the present work, the BeppoSAX (MECS-PDS) and IBIS-ISGRI data are combined and analysed with the aim of defining the nuclear spectrum of Cygnus A. To consider both the cluster and the active nucleus, the overall data have been fitted with a bremsstrahlung component plus an intrinsically absorbed power law component. The thermal component refers to the cluster emission while the power law component takes into account the AGN emission; both components are seen though Galactic absorption. Moreover, from the 2-10 keV residuals a strong excess is evident above 6 keV, therefore a Gaussian line has been added to the bremsstrahlung component to take into account the cluster gas iron line. Therefore the overall model is $(\omega^b(bremss+ga+wa^a(po)))$. Fixing the cluster gas temperature to the Chandra value of $kT=6.8$ keV (Young et al. 2002), the model provides our best fit and even when this value is left free to vary we find it compatible with the Chandra estimates. Overall, the physical parameters of both components are in agreement with previous observations (Young et al. 2002): the cluster gas has an iron line at $6.78_{-0.02}^{+0.05}$ eV with an equivalent width of $487$ eV, while the AGN has a photon index $\Gamma$ of 1.8 absorbed by a column density of $N_H=3\times10^{22}$ cm$^{-2}$, compatible with the Seyfert 2 nature of Cygnus A (see Table 3). In figure 4 the combined BeppoSAX/INTEGRAL broadband 2-150 keV spectrum is shown. To this best fit model, we also tried the addition of an extra Gaussian line to account for the AGNs iron line emission, but this feature is not required by the data; the upper limit on the equivalent width of any nuclear iron line is $\sim1$ keV. Also to account for a possible cross-calibration mismatch between the two measurements (BeppoSAX and INTEGRAL) as well as for flux variations between the two observing periods, a constant factor C has been added to the fit; when left free to vary it provides values in the range $0.93-1.27$, implying a good match between the two observations and therefore no evidence for strong variability. Finally, we substituted the simple power law with a cut-off power law; the fit does not improve significantly when the cut-off energy $E_{\text{cut}}$ is left free to vary. Moreover, $E_{\text{cut}}$ must be $>250$ keV. Thanks to the present analysis we are able to estimate the contribution of the cluster as well as that of the AGNs at energies $>20$ keV: if we consider only the cluster, the ISGRI (PDS) flux is $F_{\text{ISGRI-PDS}}=2.4(2.1)\times10^{-12}$ erg cm$^{-2}$ s$^{-1}$, which means that the high energy emission listed in Table 1 is completely dominated by the active nucleus of Cygnus A.

3.3 IGR J18027-1455 and IGR J21247+5058

IGR J18027-1455 and IGR J21247+5058 are totally new discoveries, and although they were seen recognised as AGN candidates...
dates, only recently they have been identified with active galaxies (Masetti et al. 2004). IGR J18027-1455 is a Seyfert of type 1 at a redshift z=0.035. IGR J21247+5058, instead, is a radio source with a quite puzzling optical spectroscopic appearance showing a broad, redshifted Hα line. Since no data at low energy are available for either object, the alignment between a relatively nearby star and a background radio source spectra and residuals from this model are shown in figure 5 and 6, while the best fit parameters are reported in Table 3. We have also searched for possible high energy cut-off in the spectrum of both galaxies (again using the cutoffpl model) but again only lower limits have been found which are $E_{\text{cut}}>40$ keV for IGR J18027-1455 and IGR J21247+5058 respectively. We also tried to fix the photon index to 1.8 for both sources in order to better constrain the high energy cut-off, but while for IGR J18027-1455 we were able to find a range for $E_{\text{cut}}$ of 90-786 keV, for IGR J21247+5058 the value of $E_{\text{cut}}$ is still not constrainable.

This model provides a good fit to the spectrum of both sources and a photon index close to 2 e.g. typical of active galaxies. The source spectra and residuals from this model are shown in figure 5 and 6, while the best fit parameters are reported in Table 3. We have also searched for possible high energy cut-offs in the spectrum of both galaxies (again using the cutoffpl model) but again only lower limits have been found which are $E_{\text{cut}}>40$ keV for IGR J18027-1455 and IGR J21247+5058 respectively. We also tried to fix the photon index to 1.8 for both sources in order to better constrain the high energy cut-off, but while for IGR J18027-1455 we were able to find a range for $E_{\text{cut}}$ of 90-786 keV, for IGR J21247+5058 the value of $E_{\text{cut}}$ is still not constrainable.

### 4 PREVIOUSLY PUBLISHED SOURCES

Next we concentrated on the re-analysis of INTEGRAL data of 3 more sources (MCG-05-23-16, ESO103-G035 and GRS 1734-292), extracted from the first sample of AGNs detected by INTEGRAL (Bassani et al. 2004). In the first two cases more exposure is now available to allow a more in depth study and a good constraint of the primary emission characteristics (see also Soldi et al. 2005 for a discussion of the BeppoSAX data). In the case of GRS 1734-292 our analysis provides slightly different results than a previously published study (Sazonov et al. 2004). The baseline model used in this section is an exponentially cut-off power law spectrum reflected from neutral material plus a narrow gaussian line; the Compton reflection component is characterized by the parameter R and components are seen through both galactic and intrinsic absorption ($\omega_a\omega_b^\ast \text{pexrav+gauss}$). We find that in all these 3 AGNs the primary continuum is well characterised and the high energy cut-off properly constrained.

#### 4.1 MCG-05-23-16

The broadband spectrum of this source has already been discussed by Risaliti (2002) and Mattson & Weaver (2004) using the same BeppoSAX data employed in this paper, with additional RXTE observations below 30 keV in the case of the Mattson and Weaver paper. However, only Risaliti takes into account the possible presence of a cut-off in the high energy spectrum of this source so that our results can be directly compared to his ones. Combining our ISGRI data with the BeppoSAX points provides a good fit (see Table 4) and a set of parameters which are substantially in agreement with those obtained by Risaliti (2002), once the relative uncertainties and the use of a different inclination angle between the reflecting material and the line of sight (30° in Risaliti and 63° in the present work) are taken into account. Our choice of inclination is dictated by the classification of MCG-05-23-16 as a Seyfert 2 galaxy, since this type of objects are more likely to be seen edge-on. Fixing the angle to 30° provides an equally good fit with parameters similar to those reported in Table 4, except for a slightly higher energy cut-off energy (124 keV) and a stronger reflection (R=0.9). In both cases the reflection we obtain is higher than the one measured by Risaliti.
For this galaxy two BeppoSAX observations are available but only those performed on October 3, 1996, is compatible in flux with the INTEGRAL measurement. This BeppoSAX observation has been analysed by Wilkes et al. (2001) and Risaliti (2002). Even if the models used in these two papers are slightly different, the basic results are in agreement and the only noticeable discrepancy is on the cross-calibration mismatch between ISGRI and MECS as well as on flux variations between the two observing periods, the constant factor C has been added to the fit; since the value obtained for this constant is close to 1, we assume that no significant variation has occurred in the source between BeppoSAX and INTEGRAL observing periods. In this source the primary continuum is well constrained both in terms of photon index and cut-off energy as evident in figure 7.

4.2 ESO103-G035

For this galaxy two BeppoSAX observations are available but only one, performed on October 3, 1996, is compatible in flux with the INTEGRAL measurement. This BeppoSAX observation has been analysed by Wilkes et al. (2001) and Risaliti (2002). Even if the models used in these two papers are slightly different, the basic results are in agreement and the only noticeable discrepancy is on the high energy cut-off value: Risaliti locates the power law cut-off at 84 keV, an energy which is higher than that (29 keV) found by Wilkes et al. (2001). Our results, obtained using the model described in section 4 (see Table 4 and figure 8) are in agreement with these previous studies and locate the cut-off energy between these two values confirming that in this object the exponential decline in the power law shape occurs below 100 keV. The cross-calibration constant C between BeppoSAX and INTEGRAL is 0.7±0.2 compatible with no substantial change in the source flux.

4.3 GRS 1734-292

In this case ASCA/GIS and INTEGRAL/ISGRI data provide a broadband spectrum which is equally well fitted by an absorbed power law with no reflection ($R=0$) or with reflection $R$ equal to 1 (see Table 3); in either case the primary power law component requires a cut-off at an energy below 100 keV (see figure 9). The fit with no reflection is slightly better ($\chi^2=130.7$ for 78 d.o.f) and gives parameters ($\Gamma=1.6$, $N_H=0.9 \times 10^{22}$ cm$^{-2}$ and $E_{\text{cut}}=44$ keV) which, within uncertainties, are compatible with those reported in Table 3. In either case, the constant C introduced to account for instrument cross-calibration or variability is in the range 1.4-1.9, thus suggesting a change in the source intensity: a variation in flux of up to a factor of 2 is compatible with the X-ray time history of the source as reported in Sazonov et al. (2004). Our results are compatible with the best fit parameters obtained by these authors, except for the lower value of the cut-off energy which was poorly constrained to be above 100 keV in their analysis. If confirmed, the presence of a high energy cut-off at this value could put the basis for another argument against the hypothesis that GRS1734-292 is a Blazar type of AGNs (see discussion in Sazonov et al. 2004), and thus question its association with the unidentified EGRET gamma-ray source 3EG J1736-2908 (Di Cocco et al. 2004; Sazonov et al. 2004). In Blazars, in fact, the cut-off energy is generally found at higher energies (in the MeV region), while we find a value below 100 keV. This cut-off energy is typical of Seyfert galaxies, which are well known to lack emission in the MeV domain (Maisack et al. 1993). It then follows that it is hard to match ASCA/INTEGRAL data with EGRET measurements if a cut-off is present at these low energies.
this will provide further information on the high energy cut-off in AGNs and a deeper insight into the primary continuum emission.

5 DISCUSSION AND CONCLUSIONS

Analysis of INTEGRAL data alone, or in conjunction with ASCA or BeppoSAX spectral data of a sample of 7 Seyfert galaxies of both type 1 and 2 provides information on the high energy emission of this class of objects. Only in the case of NGC 6814 and GRS 1734-292 do data taken in different periods indicate variability in the flux: in the case of NGC 6814 by a factor of 16 over a period of about 10 years. Although limited in size, our sample can be used to investigate the parameter space of both $\Gamma$ and cut-off energy. The mean photon index is 1.83±0.07, while the cut-off energy ranges from 30-50 keV to greater than 200 keV; in the case of MCG-05-23-16, ESO 103-G035 and GRS 1734-292 the cut-off energy is well constrained at or below 100 keV. We can also test our sample against the correlation found by a number of authors between the photon index and the cut-off energy. First claimed by Piro (1999), it was further analysed and discussed by Matt (2001) and Petrucci et al. (2001), taking advantage of the broad band BeppoSAX observations of AGN. At present it is still debated, since previous works found that the two parameters are not independent in the fitting procedure, with $\Gamma$ increasing as the cut-off energy decreases (Perola et al. 2002). In figure 10, we plot the photon index versus the high energy cut-off for the sample of objects discussed here, to which we have also added the results obtained by Soldi et al. (2005). Although these authors only used high energy data above 10 keV to constrain the power law parameters, their results on $\Gamma$ and cut-off energy for NGC 4945, Circinus Galaxy and Centaurus A are quite solid being independently obtained by different instruments (see Soldi et al. (2005) and references therein). Discussing this correlation in terms of the mechanisms that give rise to the main spectral component goes beyond the scope of this paper. We simply point out here the range of values that these two parameters occupy in our sample: this is an important observational information for modelling of the primary continuum but also for estimating the AGNs contribution to the X-ray Cosmic Diffuse Background (Comastri et al. 1995). From figure 10 it is clear that our data do not show the correlation found by Perola et al. (2002); the values for the photon index, in fact, cluster around 1.8, while the values of the cut-off energy range over a wide interval. We can conclude that the correlation between the high energy cut-off and the photon index remains to be proved and that a diversity in cut-off energy is most likely a property of Seyfert galaxies. INTEGRAL will keep observing AGNs for the duration of the mission and so we expect that more data on this class of objects will become available;
Figure 10. Primary power law photon index against cut-off energy for the sample of AGNs analysed in the present paper plus 3 AGNs (NGC4945, Circinus galaxy and CenA) discussed by Soldi et al. (2005).

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