THE $XMM-NEWTON$ VIEW OF $\gamma-$RAY LOUD ACTIVE NUCLEI

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ABSTRACT

Notwithstanding the big efforts devoted to the investigation of the mechanisms responsible for the high-energy ($E > 100$ MeV) $\gamma-$ray emission in active galactic nuclei (AGN), the definite answer is still missing. The X-ray energy band ($0.4-10$ keV) is crucial for this type of study, since both synchrotron and inverse Compton emission can contribute to the formation of the continuum. Within an ongoing project aimed at the investigation of the $\gamma-$ray emission mechanism acting in the AGN detected by the EGRET telescope onboard CGRO, we firstly focused on the sources for which X-ray and optical/UV data are available in the *XMM-Newton* public archive. The preliminary results are outlined here.

Key words: Galaxies: active – BL Lacertae objects: general – Quasars: general – X-rays: galaxies.

1. INTRODUCTION

The discovery of $\gamma-$ray loud AGN dates back to the dawn of $\gamma-$ray astronomy, when the European satellite *COS-B* ($1975-1982$) detected photons in the $50-500$ MeV range from 3C273 (Swanenburg et al. 1978). However, 3C273 remained the only AGN detected by *COS-B*.

A breakthrough in this research field came later with the Energetic Gamma Ray Experiment Telescope (EGRET) on board the *Compton Gamma-Ray Observatory* (CGRO, 1991-2000). The third catalog of point sources contains 271 sources detected at energies greater than 100 MeV and 93 of them are identified with blazars (66 at high confidence and 27 at low confidence), and 1 with the nearby radiogalaxy Centaurus A (Hartman et al. 1999). Therefore, EGRET discovered that the blazar type AGN are the primary source of high-energy cosmic $\gamma-$rays (von Montigny et al. 1995).

Later on, Ghisellini et al. (1998) and Fossati et al. (1998) proposed a unified scheme for $\gamma-$ray loud blazars, based on their physical properties (see, however, Padovani et al. 2003). Specifically, the blazars are classified according to a sequence going from BL Lac to flat-spectrum radio quasar depending on the increase of the observed luminosity, which in turn leads to a decrease of the synchrotron and inverse Compton peak frequencies, and an increase of the ratio between the emitted radiation at low and high frequencies. In other words, the spectral energy distribution (SED) of blazars is typically composed of two peaks, one due to synchrotron emission and the other to inverse Compton radiation. Low luminosity blazars have the synchrotron peak in the UV-soft X-ray energy band and therefore are "high-energy peaked" (HBL). As the synchrotron peak shifts to low energies (near infrared, "low-energy peaked", LBL), the luminosity increases and the X-ray emission can be due to synchrotron or inverse Compton or a mixture of both. For the Flat-Spectrum Radio-Quasars (FSRQ), the blazars with the highest luminosity, the synchrotron peak is in the far infrared and the X-ray emission is due to inverse Compton.

Moreover, the two-peaks SED is a dynamic picture of the blazar behaviour: indeed, these AGN are characterized by strong flares during which the SED can change dramatically. The X-ray energy band can therefore be crucial to understand the blazars behaviour and to improve the knowledge of high-energy emission.

2. SAMPLE SELECTION AND DATA ANALYSIS

To investigate the X-ray and optical/UV characteristics of $\gamma-$ray loud AGN in order to search for specific issues conducive to the $\gamma-$ray loudness, we cross correlated the $3^{\rm rd}$ EGRET Catalog (Hartman et al. 1999), updated with the identifications performed to date, with the public observations available in the *XMM-Newton* Science Archive to search for spatial coincidences within $10'$ of the boresight of the EPIC camera. Fourteen AGN have

Table 1. Main characteristics of the observed AGN.

3EG	Counterpart	Type*	Redshift
$J0222+4253$	$0219+428$	LBL	0.444
$J0237+1635$	AO $0235+164$	LBL	0.94
$J0530-3626$	PKS $0521-365$	FSRQ	0.05534
$J0721+7120$	S5 $0716+714$	LBL	>0.3
$J0845+7049$	S5 $0836+710$	FSRQ	2.172
$J1104+3809$	Mkn 421	HBL	0.03002
$J1134-1530$	PKS $1127-145$	FSRQ	1.184
$J1222+2841$	ON 231	LBL	0.102
$J1229+0210$	3C 273	FSRQ	0.15834
$J1324-4314$	Cen A	RG	0.00182^{**}
$J1339-1419$	PKS $1334-127$	FSRQ	0.539
$J1409-0745$	PKS $1406-076$	FSRQ	1.494
$J1621+8203$	NGC 6251	RG	0.0247
$J2158-3023$	PKS $2155-304$	HBL	0.116

* LBL: low frequency peaked BL Lacertae Object; HBL: high frequency peaked BL Lacertae Object; FSRQ: flat-spectrum radio quasar; RG: radio galaxy.

** This redshift is not indicative and the distance of 3.84 Mpc is adopted here.

been found (Table 1) as of April $14^{\rm th}$, 2005, for a total of 43 observations. For three of them there are several observations available: 15 for 3C 273, 6 for Mkn 421, 9 for PKS $2155-304$. The data from 6 sources of the present sample are analyzed here for the first time and, among them, one has never been observed in X-rays before (PKS $1406-706$).

Data from the EPIC camera (MOS, Turner et al. 2001; PN, Strüder et al. 2001) and the Optical Monitor (Mason et al. 2001) have been analyzed with `XMM SAS 6.1` and `HEASoft 6.0`, together with the latest calibration files available at April $14^{\rm th}$, 2005, and by following the standard procedures described in Snowden et al. (2004). In addition, the Optical Monitor makes it possible to have optical/UV data simultaneous to X-ray for most of the selected sources, with the only exception of PKS $0521-365$, Mkn 421, and Cen A.

3. MAIN RESULTS

The main findings of this study can be summarized as follows:

(i) the EGRET blazars studied here have spectral characteristics in agreement with the unified sequence of Ghisellini et al. (1998) and Fossati et al. (1998);

(ii) no evident characteristics conducive to the $\gamma-$ray loudness have been found: the photon indices are generally consistent with what is expected for this type of sources, with FSRQ that are harder than BL Lac; there are hints of some differences in the photon indices when compared with other larger catalogs (e.g. *BeppoSAX* Giommi et al. 2002), particularly for FSRQ: the sources best fit with a simple power law model show a harder photon index (1.39 ± 0.09 vs 1.59 ± 0.05); however, the statistics is too poor to make firm conclusions (3 sources vs 26 in the *BeppoSAX* catalog);

(iii) three sources show Damped Lyman α systems along the line of sight (AO $0235+164$, PKS $1127-145$, S5 $0836+710$), but it is not clear if the intervening galaxies can generate gravitational effects altering the characteristics of the blazars so to enhance the $\gamma-$ray loudness;

(iv) no evidence of peculiar X-ray spectral features has been found, except for the emission lines of the iron complex in Cen A.

More details of the analysis will be available in Foschini et al. (2005).

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