PROCEEDINGS OF SCIENCE

A preliminary census of soft excess occurrence from a small sample of Radio-Loud Narrow-Line Seyfert 1

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About two-dozen of very Radio-Loud Narrow-line Seyfert 1s (RL-NLSy1s) have been proposed as blazar candidates in 2008 by Yuan and collaborators. The detection at gamma-rays of a few RL-NLSy1s has confirmed the blazar-like nature of the objects and suggested that RL-NLSy1s are a new class of gamma-ray AGN. With this starting point, we analysed archival X-ray observations of RL-NLSy1s with the goal of finding similarities and differences with respect to the well X-ray characterized population of Radio-Quiet NLSy1s. We focus here on the soft excess contribution to X-ray spectra as a function of radio loudness. The study described here is designed to provide for the first time constraints on the relative strength of the accretion- and the jet-powered contribution to the X-ray emission of RL-NLSy1s.

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Introduction

The fraction of Radio-Loud (RL) objects in the Narrow-Line Seyfert 1s (NLSy1s) population is very small [1]. The radio loudness R is defined in this proceeding as the ratio of the radio flux at 1.4 GHz and the optical flux at 440 nm. RL-NLSy1s exhibit typical features of blazars in radio: the extreme cases (i.e. PMN J0948+0022 and PKS 1502+036) have been recently detected in gamma-ray [2], and show the typical spectral energy distribution and variability of Flat Spectrum Radio Quasars (see also [3]). 40% of the whole sample of the radio loudest RL-NLSy1s has not been detected in X-ray to date, due to the lack of pointed observations. Only a few other sources are well characterized in X-rays to date. On the contrary, Radio-Quiet NLSy1s [4] have been thoroughly investigated in X-rays and, typically, show a spectrum consisting of a strong and variable soft-excess with KT=0.1-0.2 keV, plus a power-law with a spectral index $\Gamma \sim 2.2$ [5]. Another study of X-ray characteristics of NLSy1s, based on 150 objects found within the Sloan Digital Sky Survey, is reported in [6].

1. Our Goal

It is not clear if Radio-Loud NLSy1s show the same X-ray features of their Radio-Quiet counterparts, or distinctive ones (a first analysis of the X-ray characteristics of RL-NLSy1s is presented in [7] , based on archival data from Swift and XMM for 4 sources). A possible scenario is that the jet and typical NLSy1s accretion features are mixed in the X-ray spectra. We present here the results from a small and heterogeneous sample of X-ray archival data. To address these issues, we are preparing observation campaigns in X-rays/optical/radio on the ROSAT undetected or not well characterized Very Radio-Loud NLSy1s.

2. Sample selection

To select blazar candidates among NLSy1s, we consider two signatures of jet emission: the radio loudness (R) and the gamma-ray activity. In our analysis we consider the whole sample of Very Radio-Loud NLSy1s: 23 sources reported in [8] (very Radio-Loud objects, e.g., with R>100) and the 6 radio loudest objects from [1] (R > 50). We also considered the NLSy1s from the Sloan Digital Survey with a counterpart in the PLANCK catalog (with positions coincident within 2 sigmas); we found another 2 sources. We further added the sources with a counterpart in the FERMI AGN catalog (Abdo et al 2009). Starting with this sample of 32 objects, only for a few sources we have found archival X-ray data: we report here the results for 7 sources observed with XRT, XMM, Chandra. The complete study, and the sample list will be presented in a forthcoming paper (Pacciani et al, in preparation).
All the spectra where fitted with a power-law plus black-body component, keeping the column density to the Galactic value. One source only (IRAS 11119+326) shows extra absorption ($N_H=1.07^{+0.12}_{-0.10}$ 10^{22} cm^{-2}); this source is also optically absorbed [1].

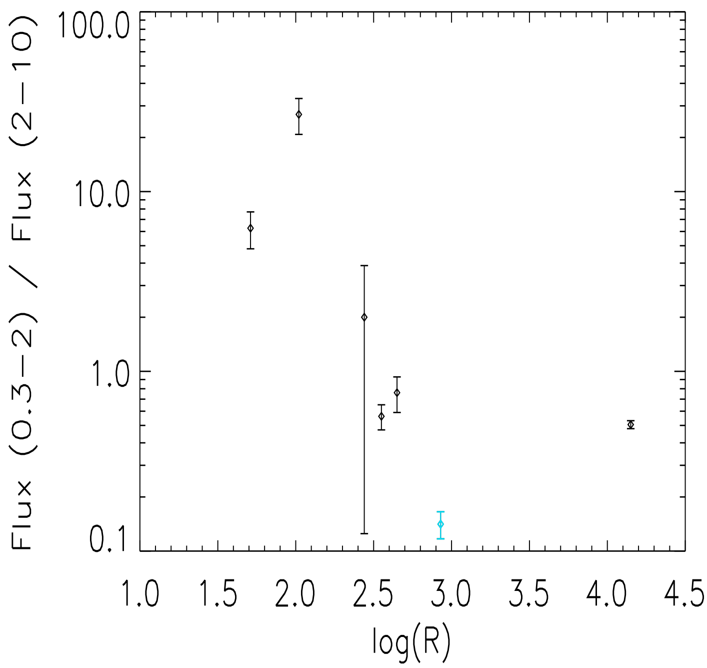

Figure 1: Soft-to-hard X-ray flux vs radio loudness for a small sample of RL-NLSy1s. The cyan dot is for the absorbed source (IRAS J11119+3257).

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3. Results

Fig. 1 displays a preliminary result of the present study, the search for correlation between the Radio Loudness and the soft-to-hard ratio RX (RX = ratio between the 0.3-2 keV and 2-10 keV bands fluxes). The cyan dot is for the absorbed source (IRAS J11119+3257), most probably an outlier in the distribution.
At this preliminary stage, a correlation seems to appear, showing that the soft-excess relative strength is weaker for the radio loudest sources. However, the few points do not allow to draw grounded inferences and it is necessary to add more points to meaningfully test if there is a correlation. The absorbed source (IRAS 11119+3257) is at the lower right corner of the correlation plot. We actually do not know whether the soft-to-hard ratio for this source is biased by intrinsic absorption. Data and analysis reported here will be published in a forthcoming paper (Pacciani et al, in preparation).

4. Discussion

For comparison, we refer in the discussion mainly to the systematic characterization of RQ-NLSy1s of [5], although X-ray spectra of RQ-NLSy1s often show complex behaviour. But we are aware that recent works favour different modeling of the spectra. Leighly (1999) studied 19 objects with ASCA. The fit of the X-ray data were performed with a black-body component plus

a power-law model. A gaussian profile has been used to model the line of the iron K complex, if present. The soft-excess is found in all but one absorbed source. The black-body temperature was always between 100-200 eV. The distribution of power-law photon index was peaked at 2.2, (softer than in Seyfert 1, that is peaked at 1.8) [1].
We found the soft-excess feature in about half of the objects. We have to exclude the absorbed source, IRAS 11119+326. Another object is a rather faint source: the 3 ks observations with Chandra for 2MASS J1644253+2619132 does not allow to establish the presence of the soft excess component (as noted in [8]). For comparison, the soft excess is an ubiquitous feature in the Radio-Quiet sample of [5]. On the blazar side, only a modest fraction of blazars have a soft-excess signature (e.g., 3C 273 reported in [9] and PKS 1510-08).
We point out that our sample, although selected on the basis of the Radio Loudness, is based on archival X-ray observations, and it is not bias free. All the listed sources were already detected in soft X-ray with ROSAT. This implies that our sample is probably biased towards objects that are bright in soft X-rays, and by a few powerful gamma-ray emitter. On account of this, the correlation shown in Fig. 1 could be the result of soft X-ray sources with low values of R, and the powerful gamma-ray emitters with high values of R and hard X-ray spectra.
What is still missing in the sample are the objects undetected with ROSAT (in the list of [8] they represent 40% of the whole sample). To give a definitive census of soft X-ray excess in Radio-Loud NLSy1s we need to investigate a subsample of Radio-Loud sources that are not detected with ROSAT.

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5. The Next Step

From this preliminary analysis, we have evidenced the necessity of a systematic study of Very Radio-Loud NLSy1s in X-ray: The blazar-like nature of the 4 RL-NLSy1s detected in gamma-ray, the hints of correlations in X-ray and Radio, and the lack of pointed observations with X-ray observatories for the X-ray weak RL-NLSy1s motivate the necessity of broad-band campaigns at least in radio, optical, X-ray (and possibly in gamma-ray) for the Very Radio-Loud Narrow-Line Seyfert 1s. We are addressing this study, with one Very Radio-Loud NLSy1 obtained with XMM, and other targets that will be asked for X-ray characterization with XMM, Chandra and Swift/XRT.

References

[1] S. Komossa, *Radio-Loud Narrow-Line Seyfert 1 Galaxies*, *ASP Conference Proceedings* **07** (373) 719;

[2] A. Abdo, et al, *Radio-Loud Narrow-Line Seyfert 1 as a New Class of Gamma-Ray Active Galactic Nuclei*, *ApJL* **09** (707) 142;

[3] L.C. Gallo, et al, *The spectral energy distribution of PKS 2004-447: a compact steep-spectrum source and possible radio-loud narrow-line Seyfert 1 galaxy*, *MNRAS* **06** (370) 245;

[4] W.N. Brandt, & Th. Boller, *Ultrasoft Narrow-Line Seyfert 1 Galaxies: What Physical Parameter Ultimately Drives the Structure and Kinematics of Their Broad Line Regions?*, *ASP Conference Series* **99** (175) 265;

[5] K.M. Leighly, *A Comprehensive Spectral and Variability Study of Narrow-Line Seyfert 1 Galaxies Observed by ASCA. II. Spectral Analysis and Correlations*, *ApJS* **99** (125) 317L;

[6] R.J. Williams, et al., *Narrow-Line Seyfert 1 Galaxies from the Sloan Digital Sky Survey Early Data Release*, *AJ* **02** (124) 3042;

[7] L. Foschini, et al., *Blazar nuclei in radio-loud narrow-line Seyfert 1?*, 2009, *AdSpR* **09** (43) 889;

[8] W. Yuan, et al, *A Population of Radio-Loud Narrow-Line Seyfert 1 Galaxies with Blazar-Like Properties?*, *ApJ* **08** (685) 801;

[9] P. Grandi, et al, *BeppoSAX observation of 3C 273: broadband spectrum and detection of a low-energy absorption feature*, *A*&A **97** (325) 17L;

[10] F. Tavecchio, et al. 2000, *G*amma-loud Quasars: A View with BeppoSAX, *ApJ* **00** (543) 535.

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