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# The relationship between X-ray emission and accretion in X-ray selected AGNs

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**Abstract.** We study the link between the X-ray emission in radio-quiet AGNs and the accretion rate on the central Supermassive Black-Hole (SMBH) using a well-defined and statistically complete sample of 70 type1 AGNs extracted from the XMM-Newton Bright Serendipitous survey (XBS). To this end, we search and quantify the statistical correlations between the main parameters that characterize the X-ray emission (i. e. the X-ray spectral slope and the X-ray loudness), and the accretion rate, both absolute ($\dot{M}$) and relative to the Eddington limit (Eddington ratio, $\lambda$). Here, we summarize and discuss the main statistical correlations found and their possible implications on current disk-corona models.

**Key words.** active galaxies, X-ray properties, accretion rate

## 1. Introduction

It is now accepted that the engine of AGNs is powered by the accretion of matter onto the SMBH, placed in the center of the host galaxy: the matter is heated ($\sim 10^6$ K) through viscous and magnetic process and forms an accretion disk around the SMBH emitting in the UV-optical region. A fraction of energy is also emitted in the X-ray band with a spectrum that can be represented, at a zeroth order, by a power-law from 0.1 to 100 keV. It is believed that X-rays are produced in a hot corona ($\sim 10^8$ K) reprocessing the primary UV-optical emission of the disk via inverse-Compton mechanism (Haardt & Maraschi 1991). The main properties of X-ray emission change significantly from source to source. Recent results suggest that the differences can be partly related to the value of accretion rate or to the black-hole mass (Grupe et al. 2010, Risaliti et al. 2009, Vasudevan & Fabian 2009). The aim of this work is to establish the actual link between X-ray properties and the parameters that quantify the accretion rate by analyzing a well defined sample of 70 type1 AGNs selected from the XMM-Newton Bright Serendipitous survey (XBS). In this work we study the spectral index $\Gamma$ between 0.5 and 10 keV and the bolometric correction $K_{\rm bol}$, defined as the ratio between bolometric luminosity and $2-10$ keV luminosity. $\Gamma$ gives direct information about the energy distribution of the electrons in the corona, while $K_{\rm bol}$ quantifies the relative importance between disk and corona. The approach followed is to search for statistically

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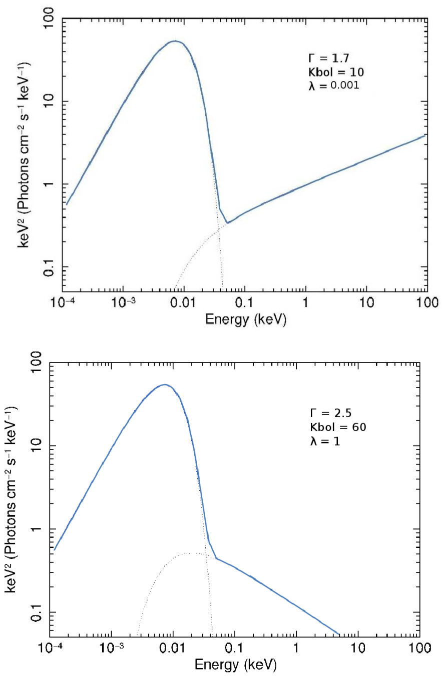


**Fig. 1.** Theoretical spectral energy distributions that represent two extreme cases of accretion: $\lambda \sim 10^{-3}$ (upper panel) and $\lambda \sim 1$ (lower panel). See text for more details.

significant correlations between these parameters and the value of accretion rate, absolute ($\dot{M}$) and normalized to Eddington limit ($\lambda$), presented in (Caccianiga et al. 2013).

## 2. Results

We find that $\Gamma$ depends significantly on $\lambda$ while the dependence on $\dot{M}$ is weak. By using partial correlation we demonstrate that the observed correlations are not induced by redshift. We find a similar $\Gamma - \lambda$ correlation also using the hard $2 - 10$ keV spectral index. Therefore the observed correlation is directly linked to the primary component of the X-ray emission and not due to secondary spectral component (e.g. soft excess). We also find a correlation between $K_{bol}$ and $\lambda$ while, again, the dependece on $\dot{M}$ is weak. We represent graphically the results of the $\Gamma - \lambda$ and $K_{bol} - \lambda$ correlations by showing the theoretical SEDs in two extreme cases of low and high Eddington ratios (Fig. 1): these SEDs were built using a Shakura & Sunyaev disk model plus a power-law in the range between 0.01 and 100 keV with a cut-off at 0.1 keV. The values of $\Gamma$ and $K_{bol}$ are taken from our fits of the $\Gamma - \lambda$ and $K_{bol} - \lambda$ correlations.

To simplify the comparison, we assume the same disk emission normalization in both cases. The comparison of the two SEDs suggests that the variation of $K_{\rm bol}$ could be entirely attributed to the variation of $\Gamma$. We also test this idea by using the partial correlation analysis and we conclude that the correlations observed in this work can be in principle explained by the $\Gamma - \lambda$ correlation alone. This result suggests a speculative interpretation based on the electron cooling of corona: for high values of $\lambda$, a large number of photons comes from the accretion disk and cools corona electrons rapidly, thus poducing steep X-ray spectra and high values of $K_{\rm bol}$. For low $\lambda$, less photons are available and this makes electron cooling inefficient, thus producing flat X-ray spectra and low values of $K_{\rm bol}$.

Full details are reported in Fanali et al. (2013).

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