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Radio-loud AGNs with peculiar shape of hard X-ray spectrum: figuring out the reasons

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Abstract. We analyze the hard X-ray properties of five radio-loud active galactic nuclei with peculiar spectral shape. High-energy exponential cut-offs (HEC) in their hard X-ray 3-500 keV spectra are too high for radio loud AGNs (above 100 keV) or even absent.The probable reason of such visible spectral "peculiarity" can be due to the "jet contamination", i.e we see some mixture of the jet and nuclear emission, but not pure emission of the innermost nucleus. Here we try to estimate the jet and nuclear components of the spectra for a sample of "peculiar" RL AGNs to find out whether these are real or fake features.

Keywords. active galactic nuclei

1. Introduction

One of the prominent physical differences between AGNs of various classes is related with jets and RL/RQ dichotomy. The most known scheme of it referred to as "spin/gap-paradigm" associates jet activity with high values of a central sup er massive black hole (SMBH) spin and with accretion disk (AD) rotation direction (Garofalo *et al.* (2010)). Prograde disks with high SMBH spin ($a \geqslant 0.75$) and retrograde ones correspond to RL AGNs with jets, whereas low SMBH spin in prograde systems ($a \leqslant 0.5$) corresponds to RQ ones with no jets. Thus AD in RQ AGNs fit to geometrically thin, radiatively efficient, steady state Shakura & Sunyaev (1973) disk with zero viscosity at the sonic point and radial infall inside the innermost stable orbit; whereas in RL AGNs they are "torqued" magnetized disks by Agol & Krolik (2000). In such systems SMBH spin energy can dissipate through the sonic point into the disk due to magnetic reconnection between the inner part of AD and SMBH horizon. One of the consequences of this model is that the innermost part of AD in RL AGN is disrupted and smeared away by centrifugally-driven jet outflows, leading to low HEC values in the primary emission spectrum ($\leqslant$100 keV), whereas high HEC values are prescribed to RQ AGN spectrum. However, some objects were found to contradict this in Fedorova *et al.* (2017). The most probable reason of this "peculiarity" can be due to the "jet contamination". Following the results of Miller-Jones *et al.* (2008); Zdziarski *et al.* (2003) it is reasonable to suppose that jet emission spectra have the same photon indices from radio to X-rays. Here we test this possibility and use it to separate the jet emisison from primary nuclear one in RL AGN X-ray spectra.

2. X-rays vs. radio: spectral modeling

Here we try to estimate the jet and nuclear components in the spectra of five RL AGNs to clear out whether these are real or fake features. For this purpose we have modelled the data of XMM-Newton, Suzaku, Swift and INTEGRAL on five AGNS (3C 382, 3C 111, 3C 390.3, Pictor A, 3C 120) in the energy range 3-300 keV comparing them with the

Table 1. Best-fit results for the *INTEGRAL* spectra during the different phases.

Object	Γ_{Planck}	Γ_{prim}	R	$\Gamma_{jet\text{-}X}$	E_C, keV	k
3C 382	1.56±0.08	1.76±0.05	0.68±0.19	1.57±0.07	30±4	line not detected
3C 111	1.6±0.06	1.76±0.04	0.29±0.11	1.63±0.05	112^{+450}_{-65}	83.75
3C 390.3	1.66±0.14	1.41±0.03	1.28±0.17	1.66±0.03	36±4	117.0
Pictor A	2.0±0.02*	1.61±0.38	0.99±0.23	2.00±0.12	⩾400	24.1
3C 120	1.24±0.04	1.91pm0.09	⩾ 0.14	1.42±0.22	⩾150	25.9

* it's au upper index of bknpow, the lower one is 1.75±0.04

PLANCK data in 27 GHz - 1 THz range. To test whether is reasonable to use the same photon index for radio and X-ray spectra of a jet, we used two recipe. First one is based on the simple extrapolation of the PLANCK radio spectra of an AGN to X-rays, supposing that the photon index of the spectra of the jet base is the same in radio and in X-rays, i.e. $\Gamma_{Planck} = \Gamma_{jet-X}$. The second one uses the connection between the intensity of Fe-K emission line near 6.4 keV and primary continuum. Afterwards, the results obtained by both methods are compaerd to undestand, how the $\Gamma_{Planck} = \Gamma_{jet-X}$ equality reasonble is. To perform the spectra modelling, we use the model consisting of: reflected power-law comptonized emission of the corona (photon index Γ_{prim}, reflection coefficient R and HEC E_c), power-law jet emission (photon index Γ_{jet-X}), Gaussian Fe-Kα emission line frozen at 6.4 keV (line energy E_{line}, width σ and equivalent width EW). Using the first method, we had frozen the Γ_{jet-X} value to Γ_{Planck} one, obtained with simple or broken (for Pictor A) power-law (po or bknpo) fitting to the PLANCK spectra. In the second method this parameter was free, and we suppoe a linear dependence between 5-7 keV perimary nuclear emission flux and Fe-K line equivalent width $F_{5-7,prim} = k * EW$. The coefficient k can be estimated as $min(F_{5-7,total}/EW)$. Note that this give us possibility to estimate the upper limit on the nuclear contribution to the spectrum only.

3. Conclusions

• The photon indices of jet power-law emission obtained in a free-to-vary mode (second method) are compatible with the values obtained for the PLANCK spectra. This give us possibility to separate the jet contributions to the X-ray spectrum using the extrapolation of the jet base synchrotron emission from the radio to X-rays.

• HECs in the primary nuclear spectra, obtained using both methods, are below 100 keV or compatible with this within the error limits for 3C 382, 3C 111 and 3C 390.3, what means that in fact they do not contradict to the predictions of the spin/gap-paradigm. But in the same time HECS are essentially higher than 100 keV for Pictor A and 3C 120, indicating that thir nuclear spectra are truly peculiar in this sense.

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