INTEGRAL AND *XMM-NEWTON* OBSERVATIONS OF 3C 273 IN 2003 – 2005

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ABSTRACT

We present INTEGRAL and quasi-simultaneous XMM-Newton observations of 3C 273 during 2003 – 2005. These data are part of a program meant to monitor the high-energy emission of this bright quasar in order to measure the different components contributing to the emission above 0.2 keV and their respective variability. 3C 273 was found to be in a weak and rather soft state compared to the historical record of high-energy observations. Here we describe our results and discuss their possible physical interpretation.

Key words: X-rays, AGN:individual:3C 273.

1. INTRODUCTION

3C 273 is a radio loud quasar, with a jet showing superluminal motion, discovered at the very beginning of quasar research (see review by Courvoisier 1998). Being the brightest and the nearest (z=0.158) quasar, 3C 273 was intensively studied at different wavelengths. In the current work we present the analysis of the quasi-simultaneous *INTEGRAL* (Winkler et al. 2003) and *XMM-Newton* observations in 2003 – 2005.

2. OBSERVATIONS

The details of the analysed data are given in Table 1. In order to increase the statistics for *INTEGRAL* data we have combined all data taken at appproximately the same time. Analysis were done with OSA 5.0 (*INTEGRAL*) and SAS 6.5 (*XMM-Newton*). JEM-X 2 and JEM-X 1 were alternatively operated during periods 1 – 3 , and 4 – 5, respectively. No simultaneous observations are available for the third period of *INTEGRAL* observations.

Table 1. Journal of INTEGRAL and XMM-Newton observations of 3C 273.

Period	Observation Epoch	ISGRI/JEMX Exposure(ks)
1	2003-01-05 – 2003-01-18	182.5/12.4
2	2003-06-01 – 2003-07-23	308.9/40.3
3	2004-01-01 – 2004-01-02	15.2/13.8
4	2004-06-23– 2004-06-24	67.1/29.2
5	2005-05-28– 2005-07-11	269.1/68.7
XMM-Newton observations.		PN Exp (ks)
1	2003-01-05 – 2003-01-07	5.97
2	2003-07-07 – 2003-07-08	40.60
4	2004-06-30 – 2004-06-30	13.93
5	2005-07-10 – 2005-07-10	19.33

3. SPECTRAL AND TIMING ANALYSIS

It has been found in previous X-ray observations that the high energy continuum could be fitted by a hard power law with a variable photon index. Observations by *EXOSAT* first indicated the existence of a soft excess, at energies < 1 keV (Turner et al. 1985). Using a model with two power laws, modified by Galactic absorption, we obtain good fit to the combined (0.2 – 100 keV) *INTEGRAL* and *XMM-Newton* spectra of periods 1, 2, 4, and 5, see Table 2.

The quality of the model fit for the second data set can be improved by adding a Fe line at 5.72$\pm$0.06 keV (which corresponds to the dereddened value of 6.622$\pm$0.07 keV) with a half width of about 300 eV. This is the only observation where the Fe line is observed. Surprisingly enough during this observation the flux in the 2 – 10 keV energy band was the highest. As it is clearly seen from the Table 2 and Figure 1, the slope of the soft excess was found to be more variable than the slope of the harder component.

Table 2. Two power law fit to PN, JEM-X, and ISGRI 3C 273 spectra. The fit was done leaving free intercalibration factors for ISGRI (C_i) and JEM-X (C_j) with respect to the PN camera. Flux is given in 10^{-11}erg cm^{-2} s^{-1} units.

Set	N_H(cm^{-2})	Γ_1	Γ_2	F(0.1-2)	F(2-10)	F(20-60)	C_i	C_j	chi2/dof(dof)
1	1.79e-20(fix)	2.79±0.06	1.66±0.03	9.47±1.08	8.76±0.53	6.53±0.40	0.6	1.09	0.98(1374)
2	1.79e-20(fix)	2.40±0.03	1.66±0.02	9.97±0.78	10.13±0.53	12.10±0.65	1.31	1.05	1.12(1984)
3	1.79e-20(fix)		1.57±0.1			13.3±5.64	1.(fix)	1.25	0.95(162)
4	1.79e-20(fix)	2.70±0.06	1.63±0.02	6.05±0.74	6.73±0.35	7.91±0.41	0.88	0.36	0.97(1627)
5	1.79e-20(fix)	2.88±0.04	1.57±0.01	6.87±0.43	8.46±0.18	13.92±0.30	1.06	0.68	1.07(2103)

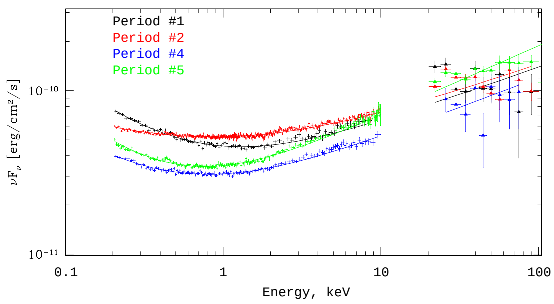

Figure 1. PN and ISGRI spectra at different epochs.

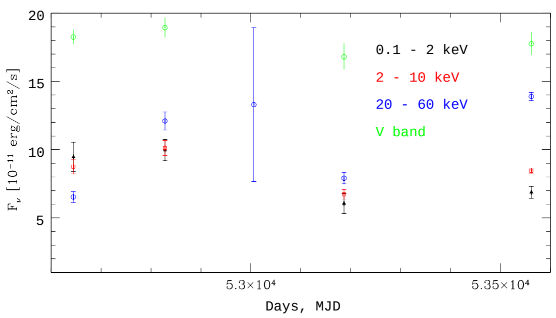

Figure 2. Lightcurves in 0.2 – 2 keV (black, PN data), 2 – 10 keV (red, PN data), 20 – 60 keV (blue, ISGRI data), and Johnson V-filter (green, OMC data) bands.

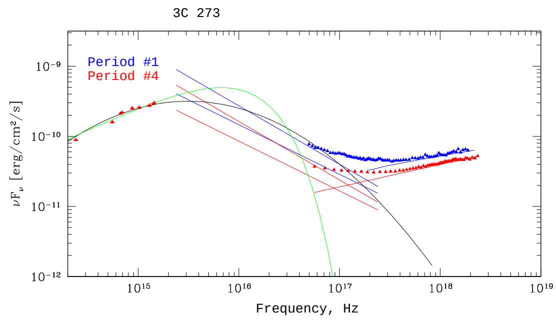

Figure 3. June 2004 broadband spectra of 3C 273 (red triangles), along with the January 2003 data (blue triangles) and various models, see text.

4. DISCUSSION

The overall spectra of blazars (plotted as νF_ν) have two pronounced continuum components: one peaking between infrared and X-rays, and the other in the γ-ray regime. The radiation is emitted from a relativistic jet, directed close to our line of sight. 3C 273 is not an exception to this picture, but an additional 'big blue bump' dominates the optical emission. Although its origin is far from being understood, it is believed that it could be due to the thermal emission from the surface of the accretion disk, although the analysis of the blue bump variability supposes that two components, variable on different time scales, must contribute to the total emission at these wavelengths (Paltani et al. 1998). The observed soft excess is often explained as a hard tail of the blue bump. To test it we have fitted the observed soft excess with simple model described above (Table 2). On the Figure 3 the example of such a fit is shown for the first (blue points) and fourth periods (red points), along with the multiwavelength spectrum, almost simultaneous to the period 4. Taking into account small variations in the optical flux (Figure 2), it seems that it is not easy to explain the observed variations of the soft excess if as hard tail of the blue bump. For the illustration we have fitted optical data with a standard $E^{-1/3}exp(-E)$ model (green line), and a quadratic approximation (black line) often used in literature.

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