Soft and Hard X-ray variability of the Flat Spectrum Radio Quasar 3C 273

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ABSTRACT: A spectral and time variability study of 3C 273 has been performed using all XMM-Newton and INTEGRAL observations from 2003 to 2006 available in the public archives. Preliminary studies of lightcurves from optical to X-rays suggest a different trend between the soft (0.2-1 keV) and hard (20-100 keV) fluxes. Spectra of all the observations were carefully analysed with particular attention to simultaneous or quasi-simultaneous XMM-Newton and INTEGRAL data. Taking advantage of the wide energy band covered by the two satellites, we inspected power-law deviations that could indicate the presence of an accretion flow. The XMM-Newton spectra were also systematically searched for the presence of iron lines.

DATA SAMPLE AND ANALYSIS

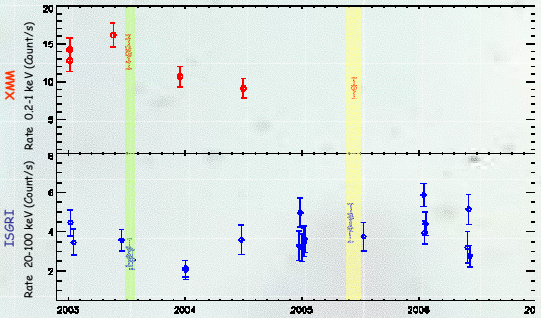
INTEGRAL DATA: All public pointings with the source in the FCFOV (< 5 deg to the pointing direction) have been analyzed. Selected observations are in Revolutions: 28, 30, 32, 78, 82, 89, 90, 93 (during 2003), 148, 149, 207, 267, 268, 270 (2004), 272, 273, 320, 321, 334 (2005), 397, 398, 399, 443, 444, 445, 464 (2006) for a total exposure time of ~1.2Ms.
The standard analysys has been performed for IBIS/ISGRI data using of the off-line scientific software OSA version 7.0.

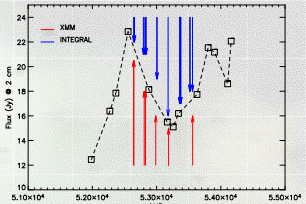
XMM-NEWTON DATA: We have processed and analyzed 8 observations since 2003 up to 2005 (see lightcurves). Data of the OM and PN instruments have been processed by means of the Science Analysis Software SAS version 8.0. For each observation lightcurve and spectrum extraction has been performed by using an anular region with R_{in} and R_{out} of 6.5 and 40 arcsec, respectively. Parameters Flag and Pattern were set to 0.

SWIFT DATA: Since no XMM data are available after 2005, we selected two Swift/XRT observations (05090004, 05090009) that are quasi-simultaneous to INTEGRAL data. The spectral analysis of UVOT and XRT data has been carried out as described in Foschini et al. (2007) and using standard parameters.

LIGHTCURVES in 0.2-1 keV and 20-100 keV

Lightcurves have been produced for 3C 273 from optical (XMM/OM) to hard X (INTEGRAL/ISGRI) bands.
OM magnidutes are constant within errors over the whole sample, therefore optical/UV data are not reported in the figure below. Since there is no evidence of strong variability within each single observation, XMM-Newton data have been rebinned on each pointing. Nevertheless the error bars in the figure below represent the standard deviation of count rate inside each observation. INTEGRAL count rate has been computed on each single revolution with standard deviation given as error bar. Strong flux variations show up in the X-ray bands: at the beginning of 2003 the source was increasing its flux level in 0.2-1 keV band, followed by a long decrease (2004) and a slow enhancement in 2005. Instead, the flux in the 20-100 keV range suggests an anticorrelated trend to the soft X emission and a correlation to the radio flux, that suggests the presence of a jet.

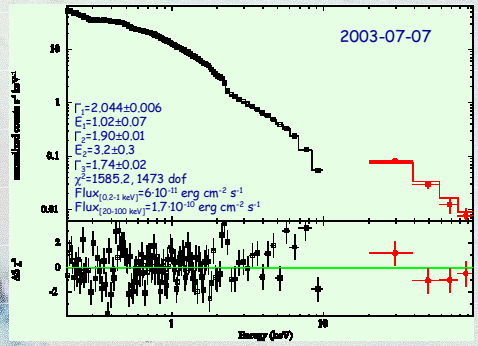




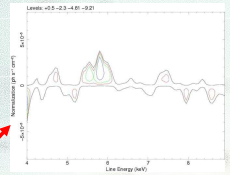
The data set covers a period from 2003 to 2005 over a wide variation of the radio flux.

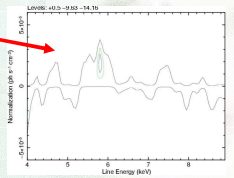
PRELIMINARY SPECTRAL RESULTS

A spectral analysis of all XMM observation is on progress and preliminary fits with a simple broken power-law confirm the trend found by Foschini et al. (2006). For all the quasi-simultaneous spectra the joint best fit is obtained with a double broken power-law. For all we checked for the presence of iron lines in PN data. The method takes advantage of Monte Carlo simulations and it is deeply described in Tombesi et al. (2007). We compare here the spectrum with high flux in the 0.2-1 keV band and low hard flux in 20-100 keV (2003-07-07, marked in green) and the spectrum with oposite trend in the two flux bands (2005-07-10, marked in yellow).



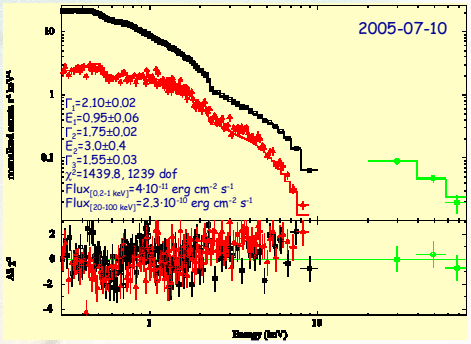
In 2003-07-07 we found a significative line emission at 6.72±0.05 keV in the source frame with an equivalent width of 16±6 eV.
Here the confidence contours are plotted for the F-test (68%, 90%, 99%) and MonteCarlo simulations (90%, 99%)





No lines are detected in the observation of 2005-07-10.

With respect to the 'yellow spectrum' (low 0.2-1 keV flux and high 20-100 keV flux), the 'green spectrum' (high 0.2-1 keV flux and low 20-100 keV flux) is characterized by a steeper power-law slope at high energies and by the presence of an iron emission line. In accordance with the model proposed by Grandi&Palumbo (2004) we can argue that the 'green spectrum' is dominated by the Seyfert component, emerging at low energies and producing a steepening in the high energy range. Conversely, when the jet emission rises ('yellow spectrum'), we obtain a harder power-law slope in the hard energy range and no iron line is detected.



QUASI-SIMULTANEOUS OBSERVATIONS

The dominance of the soft X emission during the low jet contribution should reveal the Seyfert like component as suggested by Grandi & Palumbo (2004). In order to disantangle the Seyfert and jet components a spectral analysis of ***simultaneous*** data is needed. Among the available data we recognize 6 data groups with a quasi-simultaneous broad band coverage (described in Table aside): for each spectrum we performed a joint fit using both broken power-law and a double broken power-law model. In all fits the Galactic exstinction is fixed to NH=1.68·1020 cm-2 and z = 0.158.

XMM-Newton			INTEGRAL			SWIFT		
OBSID	DATE	Exposure	Revolution	DATE	Exposure	OBSID	DATE	Exposure
0112771001	2003-06-18	3870 s	0078-0082	2003-06-16	17460 s			
0159960101	2003-07-07	40600 s	0089	2003-07-07	38020 s			
0112770501	2003-07-08	5640 s	0089-0093	2003-07-07-10				
0136550801	2004-06-30	13900 s	0207	2004-06-23-24	56320 s			
0136551001	2005-07-10	19300 s	0334	2005-07-09-10	20650 s	05090004	2003-07-10	2169 s
				2006-05-26-31	23760 s	05090009	2006-05-26	2332 s

CONCLUSIONS AND FUTURE WORK

We have presented the preliminary results of lightcurve and spectral analysis of simultaneous observations of the Flat Spectrum Radio Quasar 3C 273 performed by XMM-Newton, Swift/XRT and INTEGRAL/ISGRI instruments. We have selected and compared two simultaneous observations that suggest an oposite dominance of the Seyfert and Jet components. The accreetion picture, however, is still matter of debate and a continuous monitoring of the source is needed, with particular attention to simultaneous spectral analysis.