



## *BeppoSAX* observations of 3C 273

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We present preliminary results of *BeppoSAX* AO1 Core Program observations of 3C 273 performed in January 1997. The source was observed 4 times, from January 13th to January 23rd, with typical on-source time for the LECS and MECS of  $\simeq 12$  and  $\simeq 25$  ksec respectively, and of  $\simeq 11$  ksec for the PDS. We also present a close comparison with data obtained during the satellite SVP, in July 1996.

On average, the AO1 flux is about a factor  $\sim 1.8$  higher than the flux detected during the SVP, and roughly on the middle of the historical X-ray flux range. Power law fits with galactic absorption to all observations yield spectral indices in the range  $\Gamma = 1.53 - 1.6$ , with the spectrum extending from 0.2 to at least up to 200 keV without any significant slope change. The broad band spectrum appears basically featureless, marking a clear difference from the SVP data, where an absorption feature at low energy and a fluorescence iron emission line are present.

The lack of cold/warm matter signatures in our data may indicate that, at this "high" level of luminosity, the featureless continuum produced in a relativistic jet overwhelms any thermal and/or reprocessing component, while the two components were at least comparable during the "low" state of July 1996.

### 1. 3C 273 IN BRIEF

3C 273 is a nearby ( $z = 0.158$ ) quasar, and is one of the extragalactic object best studied across the entire electromagnetic spectrum. It shows almost all the features proper of high-luminous quasars, i.e. optical jet with high polarization, double radio lobes, superluminal motion, variability at all frequencies, and signs of thermal emission in the UV. The spectral energy distribution shows two clear peaks at UV ( $\sim 10$  eV) and  $\gamma$ -ray ( $\sim 1$  MeV) energies. A third peak is featured at IR energies [1].

Observations in the medium-hard X-ray band (up to 30 keV with *GINGA*) show a hard power law continuum with photon index ranging between 1.3 - 1.6 [2]. *ROSAT* showed evidence of an excess and/or an absorption edge above the extrapolation of the hard power law at energies  $< 1$  keV [3].

3C 273 shows prominent  $\gamma$ -ray emission

as well, detected by the instruments onboard CGRO. *OSSE* data show the hard power law extending up to  $\sim 1$  MeV, with a break at higher energy [4].

At energies below 1 keV both an absorption feature *and* a soft excess are present in *BeppoSAX* SVP data [5].

The 3C273 observations discussed here are part of the AO1 Core Program dedicated to bright blazars. We will also make a comparison of these data with SVP data. The data reduction presented here has been generally performed with software released *before* September 1997, except that of the LECS data. Data reduction with the updated software for all the onboard instruments, and a more detailed analysis, with all the appropriate references, will be presented in a forthcoming paper [6].

### 2. ANALYSIS

The observations of 3C 273 were performed as part of the *BeppoSAX* AO1 Core Program. The source was observed between Jan. 13th 1997 and Jan. 23rd 1997. In this period 3C 273 has been observed 4 times, for a total effective exposure of 45.2 ksec in the LECS, 92.1 ksec in the MECS,

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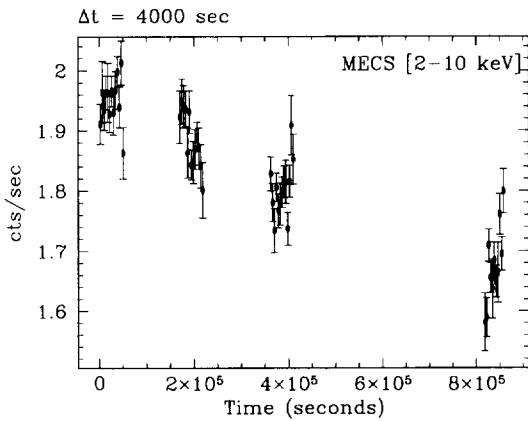


Figure 1. MECS light curve. The bin width adopted is 4000 sec.

and 46.3 ksec in the PDS. For comparison, the exposure times for LECS, MECS and PDS in the SVP were 12, 131 and 64 ksec, respectively.

### 2.1. Temporal

The *BeppoSAX* data better suited for time analysis are those of the MECS on account of better statistics and reliable performance stability. Combined all the four observations, the MECS count rate monotonically decreases on time scale of days (Figure 1). Such count rate variation is significant at 99.99% level. While the first three observations are statistically consistent with a constant count rate, the last observation is not. The count rate reverses the decreasing trend, and increases of  $\sim 12\%$  in about half of a day. The statistical significance of such variation is 99.88%. Finally, it is important to mention that the average AO1 flux was about a factor 1.7 higher than the flux detected during the SVP (see Table 1).

### 2.2. Spectral

MECS data of all the four observations are well described by a single power law with Galactic absorption ( $N_H = 1.69 \times 10^{20} \text{ cm}^{-2}$ ). The energy index is rather flat, with  $\Gamma \simeq 1.55$  for three of the four observations, consistent with *GINGA* results, but slightly flatter than *ASCA* 1994 observation [7]. The spectrum in the third AO1 observation (Jan 17) is instead slightly steeper

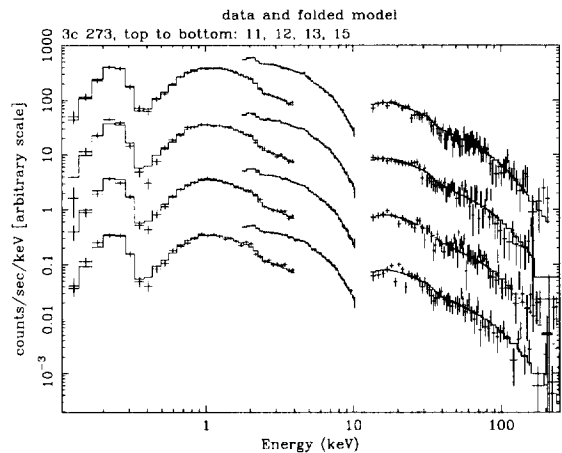


Figure 2. Data for the four observations. The first observation is on top. For clarity, each successive dataset is scaled in count rate by an order of magnitude with respect to the previous one.

( $\Gamma = 1.61 \pm 0.02$ ). Similar spectral variability has been recently reported, based on *ASCA* observations [7], though we can not confirm the anti-correlation of the spectral index with the flux seen by *ASCA*.

A possible Fe emission line at the expected energy is consistent with zero flux. There is not indication of any other spectral feature deviating from the power law in any of the four observations. A summary of power law spectral fits of MECS data can be found in Table 1.

Power law fits to the four PDS datasets alone are satisfactory, and give a spectral index totally consistent with that extrapolated from the fit to MECS data. Due to the larger error in the determination of the slope, spectral variations of small amplitude as observed in the MECS data are not detectable.

LECS data were analyzed with the [0.2-4.] keV range using the updated software released on September 1997, after correction of calibration problems below 0.7 keV. We checked the presence of absorption features using various methods, described elsewhere. The main point is that LECS data are consistent with what derived from higher energy MECS and PDS observations.

Table 1  
Single Power Law Spectral Fits: MECS

Date(OP)	$\Gamma$	$F_{[2-10]\text{keV}}$ ( $10^{-10}$ erg/cm <sup>2</sup> /s)	$\chi^2$ /(d.o.f)
18/Jul/96(SVP)	$1.59 \pm 0.01$	$0.69 \pm 0.01$	102/94
13/Jan/1997(11)	$1.56 \pm 0.02$	$1.22 \pm 0.01$	26/39
15/Jan/1997(12)	$1.56 \pm 0.02$	$1.18 \pm 0.01$	31/39
17-18/Jan/1997(13)	$1.61 \pm 0.02$	$1.11 \pm 0.01$	40/39
22-23/Jan/1997(15)	$1.54 \pm 0.02$	$1.07 \pm 0.01$	41/39

Column density fixed at the Galactic value  $N_{\text{H}} = 1.69 \times 10^{20}$  cm<sup>-2</sup>.

In summary, 3C 273 exhibits a featureless continuum all through the [0.2-200] keV range, well represented by a single (absorbed) power law (Figure 2). This in contrast with SVP observations, where the continuum flux level is almost a factor 2 lower, and an absorption feature is present in the LECS data at  $\sim 0.6$  (observer frame) keV, as well a soft excess below 0.3 keV. To check the reliability of SVP absorption feature and soft excess detection, we computed the ratio between the SVP and the AO1 LECS counts, as this quantity is essentially instrumental-effect free. Figure 3 unambiguously shows that the soft excess and the absorption feature are genuinely present in lower state observed during the SVP.

### 3. DISCUSSION

The compared analysis of SVP and AO1 *BeppoSAX* data of 3C 273 led to the following preliminary scientific results:

1. The X-ray spectrum is probably the combination of a jet-like component and a more isotropic disk-like component. The jet-like radiation passes through partially ionized absorbing material, causing the trough observed in SVP data.
2. The light curve and the comparison with SVP data cannot be interpreted in terms

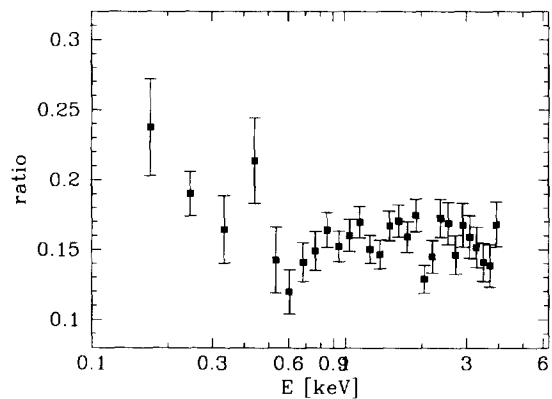


Figure 3. Ratio of SVP/AO1 LECS data.

of variable jet-like emission, and a stable disk-like one. In fact, the disk-like component must have varied since SVP observation, otherwise a weak soft excess should be present in AO1 data. This means that the jet and disk emission are both variable, probably not-correlated.

3. The SVP absorption feature is probably due to highly ionized oxygen along the line of sight. At the moment, it is not clear if the lack of absorption in LECS AO1 data is consistent with the increased ionization of the absorbing material caused by the higher continuum level with respect to the SVP. A detailed analysis is in progress.

This research has made use of SAXDAS linearized and cleaned event files (rev0.0) produced at the *BeppoSAX* Science Data Center.

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