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*BEPPO*OBSERVATIONS OF THE BL LAC OBJECT 0716+714

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Abstract

The BL Lac object 0716+714 has been observed with *Beppo*SAX for about 44 hours on 14-15 November 1996. A preliminary analysis of MECS data is reported. The source was found in a low state (about 0.1 mCrab) comparable to the low state observed by ROSAT. A variability of a factor 2 on a time scale of several hours was observed.

1 Introduction

The BL Lac object S5 0716+714 is one of the targets included in our *Beppo*SAX Core Program proposal to observe a sample of bright blazars with steep X-ray spectrum around 1 keV detected in high energy γ-rays with EGRET.

0716+714 (see Ghisellini et al. 1997 for a review of its characteristics) is showing variability all over the electromagnetic spectrum (Wagner et al. 1996, Ghisellini et al. 1997), and in particular in the X-ray domain dramatic variations up to a factor 7 were observed (Cappi et al. 1994).

2 Observations

0716+714 has been observed by the X-ray astronomy satellite *Beppo*SAX (Boella et al. 1997a, Scarsi 1997) for about 44 hours from 14 November 1996 00:01 to 15 November 1996 20:16. We report here a preliminary analysis of the data obtained with the Medium Energy Concentrator Spectrometer (MECS, see Boella et al 1997b). Simultaneous optical data, obtained as part of a longer campaign, are reported by Massaro 1997.

Due to its high declination, 0716+714 is in a favourable position to be observed from an equatorial orbit satellite like *Beppo*SAX, since it is never occulted by the Earth. The only interruptions to the observations are those due to the transit across the South Atlantic Geomagnetic Anomaly (SAGA) where the MECS (as most other instruments onboard) is switched off. We have collected some 135.8 ksec of data with the MECS, distributed on 26

SAX orbits.

Data analysis has been done from the Final Observation Tape, delivered to us a few months after the observation, using the XAS software package (Chiappetti & Dal Fiume 1996, see also http://sax.ifctr.mi.cnr.it/Xashelp/). We have monitored the main HouseKeeping parameters and found no anomalies in the observations. Since the background increases approaching the SAGA, and its level close to the SAGA varies during the day as the orbit precedes and enters the SAGA at different locations, we have preliminarily removed all intervals where the Emin ratemeter was higher that 42 cts/s. We have applied no other time window, which gives us a total exposure time between 129.3 and 130 ksec for the three different MECS units.

The source gross spectrum has been extracted in 5.25 mm (~10 arcmin) radius circle around the source position. All accumulations have used standard position linearization and event energy normalization using the relative gain history accumulated from the built-in Fe-55 sources (probably the MECS were switched on just before the beginning of our observations after a few hours of power off ; this is apparent from the detector temperature, and from the relative gain which decreases of some 2% in the first 15 hours to settle then on a stable value)

For a rough extraction of the background we have used an annulus of 10.5 mm radius around the source area. Since the source was found to be quite weak, and because of the uncertainties in the estimation of the background (see next section for a discussion), we did not dare so far to accumulate a light curve with a high time resolution. We accumulated instead for each individual SAX orbit the count rates in the band where the source is clearly detected (normalized detector channels 25 to 110) in the same way described above for spectra. This gives a coarse light curve with an irregular spacing of ~ 103 minutes with an exposure time of ~ 4900 s on each bin.

3 Results

0716+714 was quite weak during our observation, although clearly detected. The extraction of a net spectrum for a source of this intensity and slope is not obvious given the characteristics of the MECS background (see e.g. Fig. 18 in Boella et al. 1997b). In fact the spectrum of the background shows a hump around 6 keV. The intensity and shape of this hump is known to be spatially modulated, therefore the spectrum we extracted in an annulus around the source has to be considered only representative. Work is in progress by the MECS team to model the instrumental background as a function of energy and position using the entire data set of the Performance Verification phase (Chiappetti et al. 1997). There is evidence that a contribution to the background is due to residual counts from the Fe-55 calibration sources (its spatial distribution scales with the relative intensity of the two sources, and with the inverse of the distance from them), but an enhancement remains in the central part of the field of view, which deserves further work.

For this reason we consider in the remainder of this paper only data below 5 keV, and we will not attempt a formal spectral fit until the completion of the background analysis will allow a more precise subtraction. We estimate the average intensity of 0716+714 during our observation to be of the order of slightly less than 0.1 mCrab, with a slope slightly steeper than a Crab-like spectrum, or otherwise comparable in intensity and slope with the low state observed by ROSAT (Cappi et al. 1994) ; see Fig. 1.

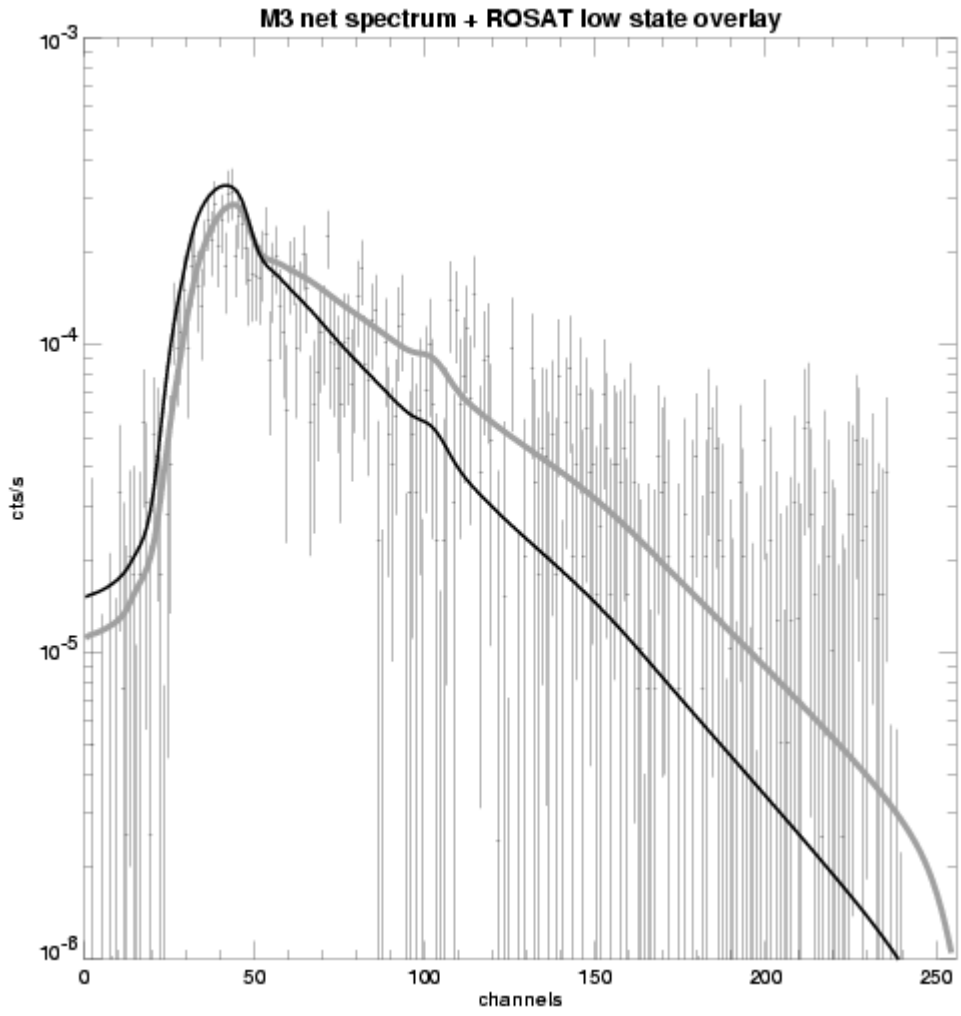

Fig.1 : The counts spectrum of 0716+714 (single MECS unit). The gray solid line is a 0.1 mCrab Crab-like spectrum. The black solid line is the ROSAT low state fit from Table 2 of Cappi et al. 1994

For what variability is concerned, we have accumulated orbit-by-orbit light curves in the 1-5 keV range, as well as dividing this energy interval at 2.5 keV. A light curve is reported in Fig. 2. In order to improve the signal-to-noise ratio (which is of the order of 8-9 σ for gross counts of a single MECS unit) we have added together the data of the three detectors (which gives 16 σ) and subtracted the background light curve (constant at a level of $2.2\infty10^{-2}$ cts/s). This way we see variations of a factor 2 in net intensity, namely a decrease from 3.8 to $1.9\infty10^{-2}$ cts/s in the first 13 hours, followed by a recovery up to $3.7\infty10^{-2}$ cts/s on the same time scale, and a further less regular drop to $1.7\infty10^{-2}$ cts/s at the end of the observing period. Variations of similar extent are observed in the two 1-2.5 and 2.5-5 keV range, and, using the hardness ratio, we are so far not able to give any indication of spectral variability with time or intensity.

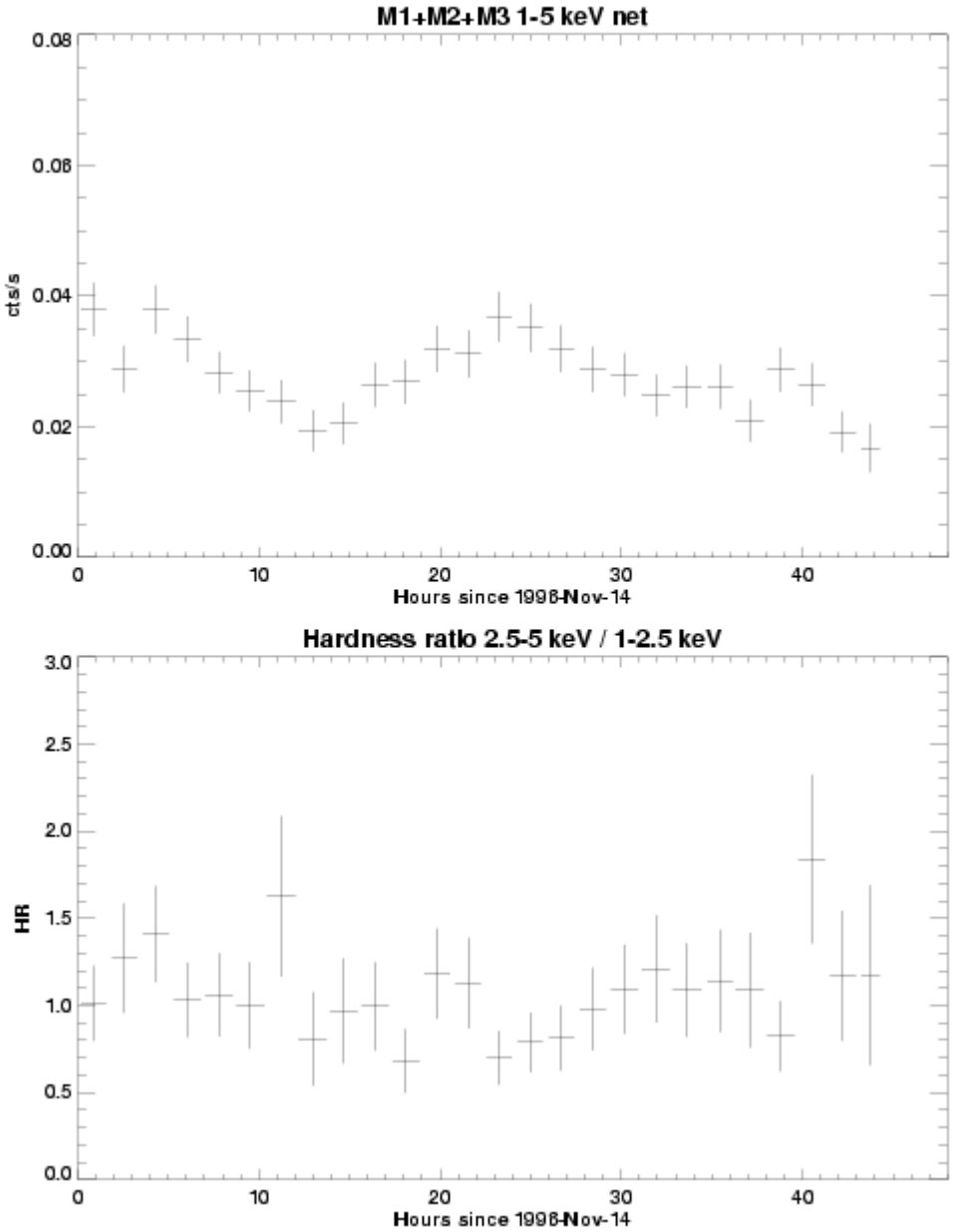

Fig.2 : Light curve of 0716+714 in the 1-5 keV band (three MECS unit summed)

4 References

G.Boella et al. 1997a : A&A Suppl. **122**,299
G.Boella et al. 1997b : A&A Suppl. **122**,327
M.Cappi et al. 1994 : MNRAS **271**, 438
L.Chiappetti & D.Dal Fiume 1996 : 5th Intnl. Workshop on 'Data Analysis in Astronomy', Erice, Oct 27-Nov 3 1996, to be published by World Scientific Publishing Corp.
L.Chiappetti et al. 1997 : in preparation
G.Ghisellini et al. 1997 : preprint, submitted to A&A
E.Massaro 1997 : these proceedings
L.Scarsi 1997b : these proceedings
S.J.Wagner et al. 1996 : AJ **111**,2187