X-RAY EMITTING EROS AND OBSCURED QSOS

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ABSTRACT

We present XMM-Newton data along with optical and near-infrared photometric properties of one of the X-ray emitting EROs (XBS J0216-0435) with the highest F(2-10 keV)/F(R) ratio (>200) among those present in the literature. This ERO has been discovered in the XMM-Newton Bright Serendipitous Survey and it is an excellent candidate to be a high redshift (z>0.6, possibly z∼2) X–ray obscured and optical type 2 QSO.

Key words: Extremely Red Objects - Active Galactic Nuclei - QSO.

1. INTRODUCTION

X-ray obscured (NH>10^{22} cm^{-2}) and optically absorbed QSOs (hereafter QSO2) represent an important ingredient for the X-ray Cosmic Background (Gilli et al. 2001, Ueda et al. 2003) and many efforts have been made so far by the scientific community to find them and to study their properties. Extremely red objects (R-K>5, EROs) with X-ray fluxes Fx>5×10^{-15} erg s^{-1} cm^{-2} and with X-ray-to-optical flux ratios equal or larger than 10 are among the best candidates to host QSO2. Indeed, in these latter sources, the UV and optical emission could be totally suppressed by the large amount of dust producing red optical-NIR colors, while the X-ray emission is less affected by the absorbing medium producing high F(2-10 keV)/F(opt). We present here recent results obtained for an X-ray emitting ERO (XBS J0216-0435) discovered in the XMM-BSS survey and characterized by an extremely high X-ray-to-optical flux ratio. Hereafter, we assume H_0=65 km s^{-1} Mpc^{-1} and Ω_M=0.3, Ω_Λ=0.7. All the magnitudes are in Vega system.

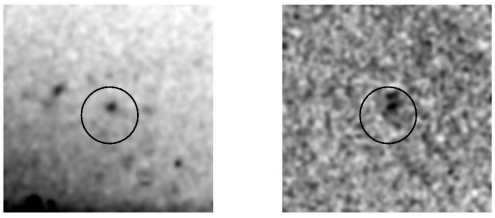

Figure 1. R–band image (30″×30″, left panel) and K–band image (30″×30″, right panel) of XBS J0216-0435. North is up and east to the left. The circle of 4″ of radius marks the X–ray position of XBS J0216–0435.

2. XBS J0216-0435

Broad-band properties – The XMM-BSS (XMM-Newton Bright Serendipitous Survey) is a project carried out by the XMM-Newton Survey Science Center (Watson et al. 2001). The source sample is composed by two subsamples of high Galactic latitude (|bII|>20°) and bright (Fx∼10^{-13} erg cm^{-2} s^{-1}) serendipitous XMM sources selected in two complementary energy bands: 0.5-4.5 and 4.5-7.5 keV (see Della Ceca et al. 2004 and Caccianiga et al. 2004). Here we focus on the optical, near-infrared and X-ray properties of one of these sources: XBS J0216-0435 (Fx∼10^{-13} erg cm^{-2} s^{-1}).

Our own R–band and K–band photometric observations have been performed at the ESO New Technology Telescope (NTT) using the ESO Multi-Mode Instrument (EMMI, 1 hour of exposure time) and at the Telescopio Nazionale Galileo (TNG) using the Near Infrared Camera Spectrometer (NICS, 15 minutes of exposure) respectively (see Fig. 1). A weak (R∼24.5 mag) optical counterpart is visible within 4″ from the X-ray position of XBS J0216-0435 (see the circle in Fig. 1, left panel). Within the same distance from the X-ray position two possible weak near-infrared objects are visible (K'∼19.5 mag, Fig. 1, right panel). All the sources appear extended in the optical and NIR images. We find that the optical source is spatially coincident with the southern near-infrared source. This latter is also the near-infrared

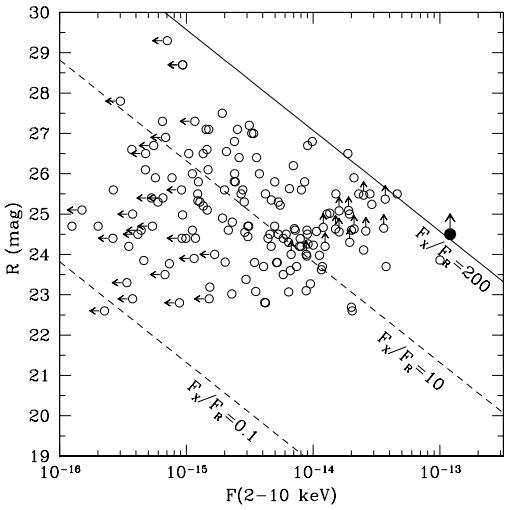

Figure 2. R–magnitude vs. 2–10 keV flux for XBS J0416–0435 (filled circle) and for other X–ray emitting EROs (empty circles) taken from the literature (see Severgnini et al. 2005, Brusa et al. 2005). Upper and lower limits of the 2–10 keV fluxes and R magnitudes are marked with arrows. The two dashed lines define the region where unobscured type 1 AGN typically lie.

source closest to the X-ray position (less than $1''$). Given the colour of the two sources (R-K'$\sim$5 for the southern source and R-K'$>$6 for the northern one) XBS J0216–0435 turn out to be an ERO.

XBS J0216-0435 is the X-ray source with the highest F(2-10 keV)/F(R) ($\gtrsim$220) among the XMM-BSS objects. Moreover, it is one of the X-ray emitting EROs in the literature with the highest X-ray flux among those with the highest F(2-10 keV)/F(R) ratio. This is shown in Fig. 2 where R–magnitudes are reported as a function of 2-10 keV flux for XBS J0216-0435 (filled circle) and for other X–ray emitting EROs (empty circles) taken from the literature (see Severgnini et al. 2005, Brusa et al. 2005).

X-ray spectral analysis – A single absorbed power-law model (typical of obscured AGN) gives a good description of the overall X-ray spectrum of XBS J0216-0435 (χ^2/dof$\sim$1, see Fig. 3). Under the hypothesis that the object lies at z$>$0.6, i.e. the minimum z for extra-Galactic EROs with such high F(2-10 keV)/F(opt) and F(2-10 keV)/F(K), we find an intrinsic NH$>10^{22}$ cm^{-2} and a de-absorbed rest–frame L(2-10 keV)$>10^{44}$ erg s^{-1}. If we associate the 2 keV excess shown in Fig. 3 to the neutral iron Kα line at 6.4 keV rest-frame the source is placed at z$\sim$2 with an intrinsic L(2-10 keV)$\sim 6\times10^{45}$ erg s^{-1}.

Conclusion – The X-ray spectral analysis of the XMM–BSS X-ray emitting EROs (XBS J0216-0435) suggests the presence of an high redshift (z$>$0.6, possibly z$\sim$2) obscured QSOs in this source. The extended appearance in the optical and near-infrared bands along with the extremely high X-ray to optical and X–ray to near-infrared flux ratios support the idea that the host galaxy dominates

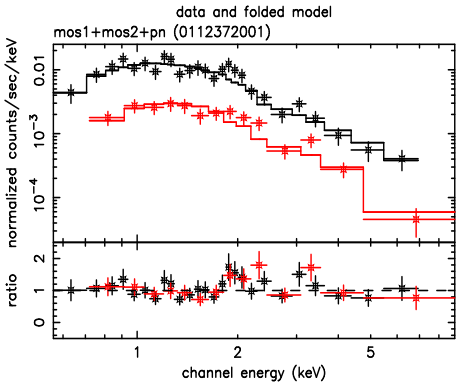

Figure 3. Mos+pn folded X–ray spectra of XBS J0216-0435 (upper panel, solid points) and the best–fit model (single absorbed power–law model at z=0.6, continuous lines). Ratio between data and model is plotted in the lower panel as a function of energy.

the emission at these wavelengths and that this QSO is heavily absorbed also in the optical band.

Our result suggests that relatively bright X-ray emitting EROs with high X-ray to optical and X–ray to near-infrared flux ratios are very good candidates to be QSO2. This scenario is also supported by the few examples already present in the literature of X-ray emitting EROs with high F(2-10 keV)/F(opt) ratios and with an estimate of the spectroscopic redshift (i.e. Severgnini et al. 2005, Maiolino et al. 2005).

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