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X-ray spectral properties of bright Type 2 quasars

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Abstract. We present XMM-Newton observations of two bright QSO2s (3C 234 and IRAS 09104+4109). Our analysis suggests the likely possibility that the absorber along the line of sight to the nucleus of IRAS 09104+4109 is Compton-thin. The spectrum of the radio-loud quasar 3C 234 is heavily obscured ($N_H \sim 3.5 \times 10^{23}$ cm^{-2}) and closely resembles that typical of nearby Seyfert 2 galaxies. In particular, we reveal the presence of a soft X-ray excess dominated by intense emission lines. We also show how the imaging quality and throughput of Simbol-X in the 0.5-70 keV band will be crucial in the study of the spectral properties of QSO2s.

Key words. galaxies: individual (IRAS 09104+4109, 3C 234) – X-rays: galaxies

1. Introduction

IRAS 09104+4109 (I09104 hereafter) is a hyperluminous infrared galaxy at z=0.442, which harbors a dust-enshrouded QSO2 in its nucleus. The spectrum of I09104 at <10 keV is dominated by the thermal emission of the intracluster medium (ICM), with the QSO2 contributing ∼35% to the total 2-10 keV flux. A weak (2.5σ) 15-60 keV signal detected with the non-imaging *BeppoSaX*/PDS instrument was interpreted by Franceschini et al. (2000) as the nuclear continuum emission emerging from a Compton-thick (CT) obscuring screen. Iwasawa et al. (2001) reinforced the hypothesis of a *reflection-dominated* scenario extracting the *Chandra* spectrum of the central AGN embedded in the ICM emission. According to our analysis of the *XMM* data, the quasar emission can be equally well fitted either a transmission (through a Compton-thin absorber with $N_H \sim 5 \times 10^{23}$ cm^{-2}) or a *reflection-dominated* (implying a CT absorber) model. However we suggest that the latter case is disfavoured due to: (i) the relative weakness of the Fe Kα line (EW≈400±200 eV); (ii) the presence of a recently-discovered, bright CT source (NGC 2782) in the PDS field of view which likely heavily contributes to the 15-60 keV flux measured with this instrument; (iii) the good agreement between the value of $L_{2-10} \sim 8 \times 10^{44}$ erg s^{-1} measured by the transmission model and the corresponding value expected on the basis of the bolometric luminosity of I09104. The observed $L_{2-10} \sim 2 \times 10^{44}$ erg s^{-1} in reflection/CT scenario is not compatible with the bolometric luminosity, since it likely represents just a few percent of the intrinsic L_{2-10} of the quasar. A complete and detailed discussion of these results is reported in Piconcelli et al. (2007).

3C 234 is a radio galaxy with a FRII morphology at z=0.18. Optical spectropolarimetric

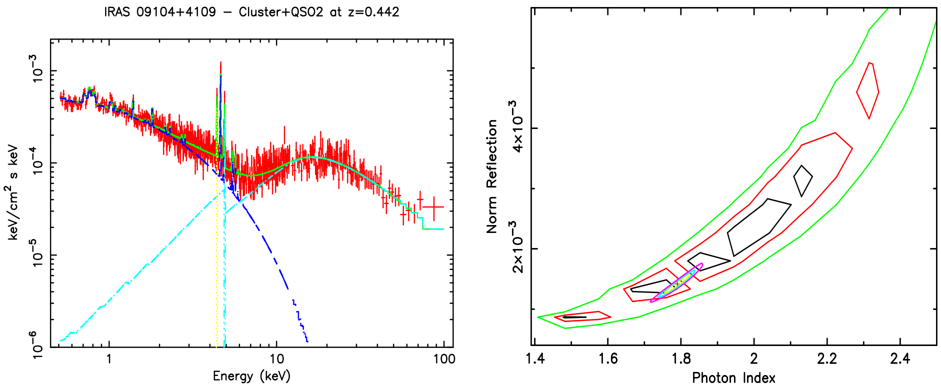

Fig. 1. Results of a 50 ks *Simbol–X* spectral simulation (e.g. Sect. 2). (a) *Left:* unfolded MPD+CZT simulated spectrum of I09104. (b) *Right:* Confidence contour levels (68%, 90% and 99%) for the continuum photon index and intensity of the reflection (in units of ph/keV/cm^2/s) using the *XMM* (broader region) and *Simbol–X* data.

data have demostrated the presence of a hidden QSO2 at its center. The *XMM* data allows us to tightly constrain for the first time the absorption column density ($N_H \sim 10^{23}$ cm^{-2}) and the overall shape of the continuum (Piconcelli et al. 2007b, submitted). This observation provides one of the best-ever X-ray spectroscopic data of a QSO2. Interestingly, the spectrum of this radio-loud QSO2 ($L_{2-10} \sim 3 \times 10^{44}$ erg s^{-1}) closely resembles that typical of nearby Compton-thin Seyfert 2 galaxies, i.e. an absorbed PL + an intense (EW~140 eV) Fe Kα line + a strong soft-excess. The latter is dominated by strong emission lines ruling out the hypothesis that the bulk of the soft X-rays in radio-loud (non-Blazar) AGN is due to non-thermal jet emission. Futhermore, given the high luminosity of this component ($\approx 10^{43}$ erg s^{-1}), an origin from starburst activity appears very unlikely. This soft-excess probably arises in a photoionized plasma as typically found in radio-quiet Seyfert-like AGNs.

2. The Simbol–X view of QSO2s

Thanks to its unprecedented throughput and angular resolution at >10 keV, the forthcoming *Simbol–X* observatory (Ferrando et al. 2006) can provide a unique tool to accurately investigate the physical properties of QSO2s. In Fig. 1a are reported the results for a 50 ks *Simbol–X* simulation of the 0.5–70 keV spectrum of I09104. Standard responses matrices (March 2007 release) were used. As input spectrum we applied a model consisting of a ICM thermal component + a narrow gaussian line at 6.4 keV and a reflection component (Γ=1.8). The expected data quality of this short exposure is excellent, especially in the hard band above ≈10 keV, for which only a poor PDS observation is available so far. Fig. 1b clearly shows the big improvement offered by *Simbol–X* for the study of the X-ray spectra of QSO2 by the comparison with present *XMM* results.

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