1. INTRODUCTION

Recent XMM-Newton and Chandra observations of a number of active galactic nuclei (AGNs) have discovered complex spectral features (broad and/or narrow) redward of the well-known fluorescent Fe emission line(s) at 6.4–7 keV (Turner et al. 2002, 2005; Guainazzi 2003; Yaqoob et al. 2003; Porquet et al. 2004; Bianchi et al. 2004; McKernan & Yaqoob 2004; Gallo et al. 2004). These features are probably produced in the putative molecular torus. Although some of these properties have already been found in other type 1 AGNs (see Fabian et al. 2000), they are most likely due to illumination by local flares (e.g., Dovcˇiak et al. 2004). These features are probably produced in (or very close to) the supposed accretion disk, and, as such, their study provides primary information about the dynamics and physical processes that are taking place in the innermost part of the AGN (see Fabian et al. 2000 and Reynolds & Nowak 2003 for a review). Among the models invoked to explain these features, there are (1) a localized hot spot on the accretion disk surface due to illumination by local flares (e.g., Dovcˇiak et al. 2004), (2) reprocessed emission from narrow annuli on the surface of the accretion disk (Gallo et al. 2004), (3) inflow or outflow of material (e.g., the ejected blob model proposed by Turner et al. [2004] to explain the properties of the narrow lines observed in Mrk 766), and (4) destruction by energetic protons on the accretion disk surface of Fe into lower Z elements (mainly Cr and Mn), implying an enhancement of the line emission expected from elements of lower abundance (Skibo 1997).

In this paper we use XMM-Newton data to discuss the observed line properties of AX J0447–0627, a broad-line AGN at $z = 0.214$ discovered during the optical identification process of the X-ray sources of the ASCA (Advanced Satellite for Cosmology and Astrophysics) 2–10 keV Hard Serendipitous Survey (Cagnoni et al. 1998; Della Ceca et al. 1999). We assume $H_0 = 70$ km s$^{-1}$ Mpc$^{-1}$, $\Omega_M = 0.7$, and $\Omega_\Lambda = 0.3$.

2. OBSERVATIONS AND DATA REDUCTION

2.1. X-Ray Observations

AX J0447–0627 was detected with a signal-to-noise ratio (S/N) = 5.40 in the ASCA field pointed at NGC 1667 (ASCA sequence ID = 71032000) at the nominal ASCA position of R.A. = 04h47m48.6s, decl. = −06°27′50.8″ (J2000.0). The net ASCA GIS2 counts from the source are 54 ± 10 (2–10 keV), corresponding to a $f_{2–10} \sim 3 \times 10^{-13}$ ergs cm$^{-2}$ s$^{-1}$ (assuming a power-law [PL] photon index $\Gamma = 1.7$). The source attracted our attention because of its position in the hardness ratio diagram (see Della Ceca et al. 1999), indicative of a hard, presumably obscured, X-ray source (HR1 = 0.40 ± 0.15; HR2 = 0.32 ± 0.17).

We thus observed AX J0447–0627 with XMM-Newton on 2002 September 8 for a total of about 29 ks. The three EPIC cameras (MOS1, MOS2, and pn) were operating in full-frame mode with the thin filter applied. The XMM-Newton data have been cleaned and processed using the Science Analysis Software (SAS ver. 5.4) and analyzed using standard software packages (FTOOLS ver. 4.2, XSPEC ver. 11.2). Event files have thus been filtered for high-background time intervals, and only events corresponding to patterns 0–12 (MOS1, MOS2) and 0–4 (pn) have been used (see Ehle et al. 2001); the net exposure times at the source position after data cleaning are $\sim 21.4$ ks (MOS1, MOS2) and $\sim 17.5$ ks (pn).

The XMM-Newton MOS1, MOS2, and pn images in the 0.5–10 keV energy range reveal a high S/N (30–50 in the MOS and the pn, respectively) pointlike source within the ASCA 90% positional error circle ($\sim 2′$ radius) of AX J0447–0627. This is the only detected and visible X-ray source in the ASCA error circle; the X-ray position derived using the XMM-Newton data is R.A. = 04h47m48.62s, decl. = −06°28′12″ ($\sim 2′$ away from the nominal ASCA position).

Source counts were extracted from a circular region of radius $22′′$ for the MOS and $17′′$ for the pn (this smaller radius for the pn is due to the proximity of a CCD gap). Background counts were extracted from a nearby source-free circular region of...
Fig. 1.—Ratio between the 2–10 keV MOS (filled squares) and pn (open circles) data and the best-fit PL model (limited to the 0.8–3 keV energy range: $\Gamma = 2.24^{+0.06}_{-0.05}$). In the inset we report the change in fit statistic ($\Delta \chi^2$) as a function of the centroid energy position of a narrow Gaussian line model that was stepped across the data; the comparison model is the underlying power-law continuum.

\begin{table}[h]
\centering
\caption{Best-Fit Spectral Analysis (0.5–10.0 keV in the Observer Frame)
Parameters: Power Law plus Five Narrow Gaussian Lines}
\begin{tabular}{cccccc}
|     | $\Gamma$ | Norm   | $E_{\text{fit}}$ (keV) | Norm | EW (eV) | $\chi^2$/dof |
|-----|---------|--------|------------------------|------|---------|--------------|
|     | (1)    | (2)    | (3)                    | (4)  | (5)     | (6)          |
| 2.24$^{+0.06}_{-0.05}$ | 2.38$^{+0.13}_{-0.06}$ | 4.49$^{+0.13}_{-0.12}$ | 0.92$^{+0.71}_{-0.11}$ | 93$^{+72}_{-71}$ | 226.3/240 |
| 5.55$^{+0.06}_{-0.00}$ | 2.68$^{+0.84}_{-0.72}$ | 436$^{+152}_{-142}$ |
| 3.90$^{+0.00}_{-0.00}$ | 3.13$^{+0.00}_{-0.02}$ | 700$^{+299}_{-299}$ |
| 7.02$^{+0.20}_{-0.12}$ | 2.18$^{+0.07}_{-0.09}$ | 602$^{+251}_{-251}$ |
| 7.85$^{+0.76}_{-0.75}$ | 0.74$^{+0.04}_{-0.04}$ | 262$^{+331}_{-331}$ |
\end{tabular}
\end{table}

Notes.—Errors are quoted at the 90% confidence level for one parameter of interest ($\Delta \chi^2 = 2.71$); $\nu$: unconstrained parameter. Col. (1): Power-law photon index. Col. (2): Normalization of the power-law in units of $10^{-8}$ photons keV$^{-1}$ cm$^{-2}$ s$^{-1}$ at 1 keV. Col. (3): Rest-frame energy centroid of the narrow Gaussian line. Col.(4): Normalization in units of $10^{-8}$ photons keV$^{-1}$ cm$^{-2}$ s$^{-1}$ in the line. Col.(5): Equivalent width of the line. Col.(6): $\chi^2$/dof and number of degrees of freedom.

$\sim 42'' - 50''$ radius. The net count rates (0.5–10 keV energy range) are 0.051 $\pm$ 0.002, 0.054 $\pm$ 0.002, and 0.171 $\pm$ 0.004 counts s$^{-1}$ for MOS1, MOS2, and pn, respectively; the source counts represent about 85% of the total counts in the source extraction region. No statistically significant source variability has been detected during the XMM-Newton observation. To improve statistics, the MOS1 and MOS2 data have been combined together, and the MOS and pn spectra have been fitted simultaneously, keeping the relative normalization free. Source counts were binned so as to have at least 20 counts in each energy bin. We have also generated our own spectral response matrices at the source position using the SAS tasks arfgen and rmfgen. All the models discussed here have been filtered through the Galactic absorption column density along the line of sight ($N_{\text{H},\text{Gal}} = 5.6 \times 10^{20}$ cm$^{-2}$; Dickey & Lockman 1990). Unless otherwise stated, fit parameters are quoted in the rest frame of AX J0447–0627 ($z = 0.214$, see below), while the figures and the equivalent widths are in the observer frame.

2.2. Source Identification and Optical Spectroscopy
A bright (R.A. = 04h47m48.5, decl. = $-06^\circ 28\arcmin 13^\prime$; APM red magnitude = 17.7) optical source lies about 2" from the X-ray position derived using the XMM-Newton data. This object was observed spectroscopically at the Telescopio Nazionale Galileo on 2002 October 5. The optical spectrum (not reported here) covers the wavelength range $\sim 3500–8000$ Å (dispersion of 2.8 Å pixel$^{-1}$) and clearly shows broad (FWHM $>6000$ km s$^{-1}$) Mg II, H$\alpha$, and H$\beta$ lines, as well as narrow (FWHM $<1000$ km s$^{-1}$) [O III] 4959, 5007 Å lines. The optical line properties and position allow us to classify AX J0447–0627 as a classical broad-line AGN at $z = 0.214 \pm 0.001$. AX J0447–0627 also belongs to the ASC Medium Sensitivity Survey, so an independent confirmation of the redshift and the optical spectral classification comes from the work presented in Akiyama et al. (2003).

3. X-RAY SPECTRAL ANALYSIS
A single absorbed PL model is not a good description of the overall (0.5–10 keV) spectrum of AX J0447–0627 ($\Gamma =$ 2.18 $\pm$ 0.05; $N_{\text{H}}$ consistent with zero; $\chi^2$/dof = 280.3/250), since a very large discrepancy is present above 4 keV.

In Figure 1 we show the ratio between the best-fit PL model (obtained considering only the line-free region from $\sim 0.8$ to $\sim 3$ keV) and the data in the 2–10 keV energy range. The residuals show the presence of a possible "linelike" feature at $E \sim 3.5$ keV (observer frame) and a complex structure (several different lines?) in the energy range between $\sim 4.5$ and $\sim 7$ keV (observer frame). Splitting the total observation into two intervals of similar exposure times, we do not find convincing evidence of temporal variability of such structures.

We have been unable to reproduce the complex lines structure with a pure reflected continuum, either normal (PEXRAV model in XSPEC; see Magdziarz & Zdziarski 1995) or relativistic (REFSCH model; see Magdziarz & Zdziarski 1995; Fabian et al. 1989). A pure reflected continuum with associated emission lines from Ca, Cr, Fe, and Ni (see, e.g., the modeling of the Seyfert 2 galaxy NGC 6552 by Reynolds et al. 1994) is also unable to reproduce the observed structure since the relative abundances of the above elements differ from the expected ones. We also note that a pure reflected continuum, more typical of optical type 2 AGNs, is at odds with the optical spectral classification of AX J0447–0627.

To investigate the presence of linelike features and locate their energy centroid we slid a narrow ($\sigma = 0.1$ keV) Gaussian template across the data between 4 and 8 keV (rest frame), looking for an improvement to the fit with respect to the simple PL model. The results are shown in the inset of Figure 1, where we report the change in fit statistics ($\Delta \chi^2$) as a function of the centroid energy position of the narrow Gaussian line. This analysis points out the presence of a number of possible narrow lines, with rest-frame energy centroids at about 4.5, 5.6, 6.4, 7.0, and 7.9 keV (in the last case, the line centroid is not well constrained). Note that in the resulting fit statistics $\Delta \chi^2$ greater than 10.30 (5.25) represents a feature that is significant at more than 99% (90%) confidence level, so the lines at energies $\sim 4.5$ and at $\sim 7.9$ keV are of lower statistical significance with respect to those at $\sim 5.6$, $\sim 6.4$, and $\sim 7.0$ keV. Following these indications, we tried to reproduce the observed spectrum with a power law and five narrow Gaussian lines. The best-fit spectral parameters are reported in Table 1, while the ratio between the data and this possible best-fit model is shown in Figure 1a.
The line at 6.39^{+0.07}_{-0.06} keV (equivalent width [EW] $\sim$700 eV) is positionally consistent with the Fe i K\alpha emission line, while the line at 7.02^{+0.29}_{-0.12} keV (EW $\sim$600 eV) is positionally consistent with either the Fe i K\beta emission line (rest-frame energy $E = 7.058$ keV) or the Fe xxvi Ly\alpha emission line (rest-frame energy $E = 6.96$ keV). However, the association with the Fe i K\beta line is unlikely, since the measured flux from this line should be at a fixed ratio ($\sim$0.11) with the Fe i K\alpha emission flux, clearly in disagreement with the measured EWs. The association with Fe xxvi Ly\alpha seems to be more plausible given that this line could be very prominent (and sometimes with an EW comparable with the narrow Fe i K\alpha line) in type 1 AGNs (see, e.g., the case of the Seyfert 1 galaxy NGC 7314 discussed in Yaqoob et al. 2003). The line at 7.85^{+0.73}_{-0.76} keV is positionally consistent with the Ni K\alpha, while for the remaining two lines ($E = 4.49^{+0.13}_{-0.17}$ and 5.55^{+0.08}_{-0.05} keV) there are no clear associations with well-known and expected elements. The strongest expected lines in the spallation model are the Cr K\alpha at 5.4 keV and the Mn K\alpha at 5.9 keV (Skibo 1997). Both these lines are ruled out by the mismatch with the measured energy lines centroid. So unless an energy shift occurs (but we do not observe any energy shift for the Fe i K\alpha line), the spallation model is an unlikely explanation of the XMM-Newton data. We have also evaluated the upper limits for Fe xxv ($f$) at $E \sim 6.64$ keV and Fe xxvi ($r$) at $E \sim 6.70$ keV, since the strength of these lines, when combined with the strength of other ionized Fe lines, can constrain emission models (see Yaqoob & Padmanabhan 2004 and reference therein). These two lines are not required by the current data set, and the 90% upper limit on their EW is $\sim$400 eV.

The complex structure detected in the spectrum of AX J0447–0627 could suggest a profile of a Fe line produced by an accretion disk. We explored this interesting possibility using the DISKLINE model (Fabian et al. 1989), which assumes a non-rotating Schwarzschild black hole.\(^3\) The relativistic effects have also been introduced in the description of the reflected continuum, replacing the simple PL model with the XSPEC model REFSCHE.\(^4\)

We started the analysis using a model composed of the REFSCHE model plus a Fe i K\alpha disk line, fixing its energy position to 6.4 keV rest frame; since in AX J0447–0627 the observed lines seem to have a significantly larger EW than usual, we have also added the corresponding Fe i K\beta disk-line emission, fixing the Fe i K\beta/Fe i K\alpha ratio to that expected from the theory ($\sim$0.11). The best-fit spectral parameters are reported in Table 2, while the ratio between the data and the best-fit model is shown in Figure 2b. Although the overall fit is statistically acceptable ($\chi^2_r = 1.00$), the ratio in Figure 2b shows a linelike residual at an observed energy of $\sim$6 keV ($\sim$7.3 keV rest frame) that we were unable to reduce. We tried to consider disk lines also associated with Ni K\alpha at $\sim$7.5 keV or Fe xxvi Ly\alpha at $\sim$6.96 keV emission, and/or allowed the abundance of Fe i K\beta, Ni K\alpha, and Fe xxvi Ly\alpha to be a free parameter of the fit, but we were unable to take into account such linelike structure.

Thus, we tried the same model first used by Weaver et al. (1997) to describe the spectral properties of MCG –5-23-16: a narrow Fe i K\alpha component ($E_{\text{line}}$ fixed at 6.4 keV) plus a broad relativistic line component (DISKLINE model) along with the

\(^3\) We have also tried the LAOR model (Laor 1991), in which the black hole is maximally rotating, but because of the limited source count statistics we could not discriminate between the DISKLINE and LAOR models. Since the black hole spin parameter is clearly an overparameterization of the present data set, we report here only the results obtained applying the DISKLINE model. We note, however, that similar results have been obtained using the LAOR model.

\(^4\) This model is the sum of an e-folded power-law primary spectrum plus its reflected component from a ionized relativistic accretion disk.
The observed line position ($E_\text{c}$, disk temperature $T = 3 \times 10^4$ K; power-law index for reflection emssivity $\beta = -3$), and number of degrees of freedom.

a The following parameters have been fixed during all the fits: cutoff energy $E_\text{c}$, and number of degrees of freedom.

b Errors are quoted at the 90% confidence level for 1 parameter of interest ($\Delta \chi^2 = 2.71$). During the fit, the disk parameters of the different components were tied together; $f$: fixed parameter; $u$: unconstrained parameter. Col. (1): Power-law photon index. Col. (2): Inclination angle. Col. (3): Inner disk radius in units of $GM/c^2$. Col. (4): Outer disk radius in units of $GM/c^2$. Col. (5): Disk ionization parameter in units of ergs cm$^{-2}$ s$^{-1}$. Col. (6): Reflection scaling factor. Col. (7): Photon flux at 1 keV of the cutoff broken power law only (no reflection) in the observed frame in units of $10^{-4}$ photons keV$^{-1}$ cm$^{-2}$ s$^{-1}$. Col. (8): Rest-frame energy centroid of the line. Col. (9): Normalization in units of $10^{-6}$ photons cm$^{-2}$ s$^{-1}$ in the line. Col. (10): Equivalent width of the line. Col. (11): $\chi^2$ and number of degrees of freedom.

Notes—Errors are quoted at the 90% confidence level for 1 parameter of interest ($\Delta \chi^2 = 2.71$). During the fit, the disk parameters of the different components were tied together; $f$: fixed parameter; $u$: unconstrained parameter. Col. (1): Power-law photon index. Col. (2): Inclination angle. Col. (3): Inner disk radius in units of $GM/c^2$. Col. (4): Outer disk radius in units of $GM/c^2$. Col. (5): Disk ionization parameter in units of ergs cm$^{-2}$ s$^{-1}$. Col. (6): Reflection scaling factor. Col. (7): Photon flux at 1 keV of the cutoff broken power law only (no reflection) in the observed frame in units of $10^{-4}$ photons keV$^{-1}$ cm$^{-2}$ s$^{-1}$. Col. (8): Rest-frame energy centroid of the line. Col. (9): Normalization in units of $10^{-6}$ photons cm$^{-2}$ s$^{-1}$ in the line. Col. (10): Equivalent width of the line. Col. (11): $\chi^2$ and number of degrees of freedom.

a The following parameters have been fixed during all the fits: cutoff energy $E_\text{c}$, disk temperature $T = 3 \times 10^4$ K; power-law index for reflection emssivity $\beta = -3$.

b Equivalent widths are computed with respect to the REFSCH underlying continuum.

c Errors were calculated by fixing at the best-fit values $R_{\text{in}}, R_{\text{out}}$, and $\Gamma$ (relativistic line normalization); $R$ and Gaussian line normalization (disk ionization parameter).

d Errors have been evaluated performing a fit while stepping the value of $R_{\text{in}}$ ($R_{\text{out}}$) through the range 6.0–25.0 (20.0–200.0).

underlying continuum (REFSCH model). The best-fit spectral parameters are reported in Table 2, the ratio between the data and the best-fit model is shown in Figure 2c, while the folded model and the model itself are reported in Figure 3. The observed line position ($E = 6.61 \pm 0.11$ keV) of the broad relativistic line is inconsistent with the Fe Kα line from neutral material but strongly suggests that it is due to Fe Kα emission from ionized He-like material. Overall, this modeling provide a good description of the broadband spectral properties of AX J0447–0627. We have also tried to add a relativistic emission line from Fe xxvi Lyα to the best-fit model reported in Table 2; such a line can be accommodated within the present data set (with an EW of ~15 eV), but it is not statistically required. The observed flux and the intrinsic luminosity in the 0.5–10 keV energy range are ($6.5 \pm 0.4) \times 10^{33}$ ergs cm$^{-2}$ s$^{-1}$ and ($8.9 \pm 0.5) \times 10^{33}$ ergs s$^{-1}$, the errors reflecting the uncertainties on the best-fit model. We note that the 2–10 keV flux measured with XMM-Newton ($3.6 \pm 10^{-13}$ ergs cm$^{-2}$ s$^{-1}$) is in very good agreement with the 2–10 keV flux measured with ASCA.

4. DISCUSSION AND CONCLUSIONS

Using XMM-Newton data we have revealed that the optically type 1 AGN AX J0447–0627 at $z = 0.214$ is characterized by a complex, bright, and prominent set of lines in the 4.5–8.0 keV energy range (rest frame). We have shown that these lines can be reasonably well reproduced by a physical model comprising a power law, a reflected relativistic continuum, a narrow Fe Kα line from neutral material, and a Fe He-like Kα relativistic line from a ionized accretion disk. Although not well constrained, the best-fit ionization parameter ($\xi$ in Table 2) is consistent with the Fe ionization state, as deduced from the best-fit line position (see Matt et al. 1993). A similar modeling of the Fe line properties (a narrow plus a broad relativistic component) has been found to describe, for example, the spectral properties of the Seyfert 1.9 MCG –5.23-16 (Weaver et al. 1997), the radio-quiet quasar Mrk 205 (Reeves et al. 2001), and the Seyfert 1 NGC 3516 (Turner et al. 2002); the presence of the Fe relativistic line from a highly ionized accretion disk has been unambiguously reported in the case of Mrk 205. As already discussed by the aforementioned authors, the most likely origin of the narrow 6.4 keV component is from neutral matter distant from the black hole (e.g., the putative molecular torus).

The resulting best fit of the double-horned profile implies an inclination of the accretion disk of ~45°, as well as that the observed lines should be produced in a narrow region of the disk from $R_{\text{in}} \sim 19GM/c^2$ to $R_{\text{out}} \sim 30GM/c^2$. As, for example, in the case of ESO 198-G24 (Guainazzi 2003) and NAB 0205+024 (Gallo et al. 2004), a few alternative possibilities can be conjectured to explain why the inner radius is larger than the last stable orbit. The first possibility is that the disk is highly ionized in the inner part, so most of the Fe is completely stripped off and the production of the Fe lines is suppressed. Second, the accretion disk in AX J0447–0627 could be truncated at 10–15GM/c$^2$ (see Müller & Camenzind 2004).
Finally, the relativistic line can be produced by a localized hot spot on the accretion disk surface (e.g., Dovčiak et al. 2004). All the properties discussed above have also been observed in other AGNs and seem to be in agreement with the expectations from accretion disk theory. However, there is an observed property that is very unusual in AX J0447−0627 that makes this object unique: the very large EW observed, which is at least a factor of 5 greater than that usually measured in other type 1 AGNs (see, e.g., Yaqoob & Padmanabhan 2004 and references therein) or expected from an accretion disk around a Schwarzschild black hole (Matt et al. 1992, 1993). According to the modeling reported in Martocchia & Matt (1996) and Miniutti & Fabian (2004), a high EW could be explained if the primary X-ray source (illuminating both the observer and the accretion disk) is located very close to a central and maximally rotating Kerr black hole. However, such a combination should also imply a very high value of the reflection parameter $R$ and a reflection-dominated source, probably in disagreement with the best fit found here.

A way to solve part of these problems is to assume that the emission features appear much stronger than normal because the continuum is strongly absorbed. We have tested this possibility by adding a partial covering absorption model in front of the underlying continuum. Unless the primary AGN emission is heavily absorbed ($N_{HI} \sim 10^{25} \text{cm}^{-2}$) and therefore has signatures falling outside the XMM-Newton bandpass (but this is clearly at odds with the optical spectral classification of AX J0447−0627), the best-fit absorbing $N_{HI}$ and covering fraction ($\sim 9 \times 10^{21} \text{cm}^{-2}$ and $\sim 0.2$, respectively) imply that absorption effects cannot take into account the strong emission features observed.

That said, and with the caveat that the model proposed here could be not fully appropriate (e.g., we have already pointed out that a phenomenological description of the data can also be obtained by a simple PL model plus five narrow Gaussian lines at rest-frame energies of $4.49^{+0.13}_{-0.17}$, $5.55^{+0.06}_{-0.05}$, $6.39^{+0.07}_{-0.06}$, $7.02^{+0.29}_{-0.12}$, and $7.85^{+0.74}_{-0.76} \text{keV}$), we would like to note that the emission lines in AX J0447−0627 have a total EW of $\sim 2 \text{keV}$. This is an observational result and as such is model-independent. These lines deserve further attention and a deeper investigation since any model proposed to describe the X-ray spectral properties of AX J0447−0627 should be able to explain their large EW.

Finally, we would like to note that AX J0447−0627 was selected as a target for an XMM-Newton observation because of its observed ASCA hardness ratios, indicative of a hard, presumably obscured, X-ray source (see Della Ceca et al. 1999). The XMM-Newton observations reported here have shown that its hard X-ray colors are due to the strong line complex in the observed $4.5–8.0 \text{keV}$ energy range rather than to absorption effects. There have been many claims in recent years about a substantial fraction ($\sim 10\%$) of X-ray–absorbed, optically classified type 1 AGNs (with strong implications for AGN unification models and synthesis of the cosmic X-ray background) based mainly on poor-quality X-ray data (e.g., hardness ratios; see Willott et al. 2004). The result presented here indicates that a number of these sources, thought to be X-ray–absorbed type 1 AGNs on the basis of their hardness ratios, could instead be X-ray unabsorbed AGNs with substantial and complex X-ray line emission (see also Maccacaro et al. 2004).

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