SOURCE IDENTIFICATION IN THE IGR J17448-3232 FIELD: DISCOVERY OF THE SCORPIUS GALAXY CLUSTER

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ABSTRACT

We use a 43 ks XMM-Newton observation to investigate the nature of sources first distinguished by a follow-up Chandra observation of the field surrounding INTEGRAL source IGR J17448-3232, which includes extended emission and a bright point source previously classified as a blazar. We establish that the extended emission is a heretofore unknown massive galaxy cluster hidden behind the Galactic bulge. The emission-weighted temperature of the cluster within the field of view is 8.8 keV, with parts of the cluster reaching temperatures of up to 12 keV; no cool core is evident. At a redshift of 0.055, the cluster is somewhat under-luminous relative to the X-ray luminosity–temperature relation, which may be attributable to its dynamical state. We present a preliminary analysis of its properties in this paper. We also confirm that the bright point source is a blazar, and we propose that it is either a flat spectrum radio quasar or a low-frequency peaked BL Lac object. We find four other fainter sources in the field, which we study and tentatively identify. Only one, which we propose is a foreground Galactic X-ray binary, is hard enough to contribute to IGR J17448-3232, but it is too faint to be significant. We thus determine that IGR J17448-3232 is in fact the galaxy cluster up to ≈45 keV and the blazar beyond.

Key words: binaries: general – galaxies: active – galaxies: clusters: individual (CXOU J174453.4-323254) – X-rays: individual (CXOU J174437.3-323222, IGR J17448-3232)

1. INTRODUCTION

Since its launch in 2002, the INTErnational Gamma Ray Astrophysical Laboratory (INTEGRAL; Winkler et al. 2003) has been key to discovering non-thermal hard X-ray sources (“IGR” sources), thanks in particular to the large field of view that allows us to identify the extended emission and a bright point source previously classified as a blazar. We establish that the extended emission is a heretofore unknown massive galaxy cluster hidden behind the Galactic bulge. The emission-weighted temperature of the cluster within the field of view is 8.8 keV, with parts of the cluster reaching temperatures of up to 12 keV; no cool core is evident. At a redshift of 0.055, the cluster is somewhat under-luminous relative to the X-ray luminosity–temperature relation, which may be attributable to its dynamical state. We present a preliminary analysis of its properties in this paper. We also confirm that the bright point source is a blazar, and we propose that it is either a flat spectrum radio quasar or a low-frequency peaked BL Lac object. We find four other fainter sources in the field, which we study and tentatively identify. Only one, which we propose is a foreground Galactic X-ray binary, is hard enough to contribute to IGR J17448-3232, but it is too faint to be significant. We thus determine that IGR J17448-3232 is in fact the galaxy cluster up to ≈45 keV and the blazar beyond.

2. DATA SET AND ANALYSIS TOOLS

We use a 43.9 ks XMM-Newton observation that started on 2012 February 26, 03:59:17 UT (ID 0672260101). The data analysis is split between the point sources and the extended emission. The data for the point sources was reduced using XMM SAS v13.5.0, while the extended emission data was reduced using the Extended Source Analysis Software (XMM-ESAS4) package from SAS version 13.0.0. Snowden et al. (2008) introduced the analysis of galaxy clusters with ESAS, and it has then been expanded to include the EPIC pn data (e.g., Bulbul et al. 2012).

The spectral analysis is done with XSPEC (Arnaud 1996), using Verner et al. (1996) photoelectric cross-sections and Wilms et al. (2000) abundances, and \( \chi^2 \) statistics.

3. OVERVIEW OF THE FIELD: SOURCE DETECTION

Using the XMM-ESAS package, we first filtered out the flaring background events, and created a model of the quiescent particle background (QPB) for each camera over the 0.4–7.2 keV range. The three images were then background-subtracted and

4 http://heasarc.gsfc.nasa.gov/docs/xmm/xmmhp xmmesas.html
A new galaxy cluster (GC) was adaptively smoothed to reach 30 counts per circle (Figure 1). The extended source CXOU J174453.4-323254 is clearly visible in the center of the image, as well as a handful of point sources. The position derived from this analysis is used to search for counterparts in Section 6.

Table 1

| ID | Name                  | R.A.   | Decl.   | Err (") | Δpos (") |
|----|-----------------------|--------|---------|---------|----------|
| 0  | CXOU J174453.4-323254 | 17h44m49.73 | -32°32'25" | ...     | ...      |
| 1  | CXOU J174437.3-323222 | 17h44m37.44 | -32°32'22" | 0.37    | 1.33     |
| 2  | CXOU J174458.2-323940 | 17h44m58.32 | -32°39'41" | 1.25    | 1.25     |
| 3  | CXOU J174534.6-322917 | 17h45m34.56 | -32°29'17" | 4.15    | 4.15     |
| 4  | CXOU J174518.9-322655 | 17h45m11.04 | -32°26'56" | 0.75    | 1.06     |
| 5  | CXOU J174428.4-322828 | 17h44m28.32 | -32°28'28" | 2.04    | 1.28     |

Notes. The Err column gives the statistical error at the 95% confidence level of the Chandra position, calculated using Equation (5) of Hong et al. (2005). It does not account for the 0.64% (90% confidence level) systematic uncertainty on the Chandra position. The Δpos column gives the angular distance between the XMM-Newton position derived from this observation and the Chandra position (quoted in this table). Source 0 is the extended emission.
simply fix it during fits. It accounts for roughly 20% of the total observed 0.5–2 keV flux in our observation, but any fluctuations from around this value can easily be accommodated by the thermal Galactic components, which have free normalizations and temperatures. We fix the value of \( N_{\text{H}} \) to the LAB column density of \( 7 \times 10^{21} \) cm\(^{-2} \) (Kalberla et al. 2005).

### 4.2. Spectral Modeling

For the spectral modeling, we follow the method established by Snowden et al. (2008). The model \( M \) has two main components: \( M_{\text{resp}} \), which is folded through the nominal RMFs and ARFs, and \( M_{\text{diag}} \), which is only folded through a diagonal response. \( M_{\text{diag}} \) represents the residual soft proton contamination, and \( M_{\text{resp}} \) everything else: the instrumental lines \( I_{\text{lines}} \), the soft emission from the local hot bubble \( G_{\text{LHB}} \), the thermal Galactic disk emission and the GXRE \( G_{\text{halo}} \), the extragalactic cosmic X-ray background \( B_{\text{CXB}} \), and finally the intracluster medium emission \( S_{\text{cluster}} \).

In XSPEC, these components are made of the following models.

\[
I_{\text{lines}} = \sum \text{gauss} \\
G_{\text{LHB}} = \text{apec} \\
G_{\text{halo}} = \text{apec + apec + (apec + powerlaw)}_{\text{GRXE}} \\
B_{\text{CXB}} = \text{powerlaw} \\
S_{\text{cluster}} = \text{apec}.
\]

These components are modulated by total Galactic absorption \( N_{\text{H}2} \), foreground Galactic absorption \( N_{\text{H}1} \) (likely between us and the 3 kpc molecular ring), and normalization constants that account for imperfect cross-calibration between the three detectors \( (C_{\text{det}}) \) and the differences in solid angle between each annular region \( (C_{\text{area}}) \). Thus, \( M_{\text{resp}} \) can be developed as

\[
M_{\text{resp}} = I_{\text{lines}} + C_{\text{det}} C_{\text{area}} [G_{\text{LHB}} + N_{\text{H}1} G_{\text{halo}} + N_{\text{H}2} (B_{\text{CXB}} + S_{\text{cluster}})],
\]

which gives in pseudo-XSPEC format:

\[
M_{\text{resp}} = \text{gauss + gauss + gauss + gauss + gauss} + \text{gauss + const} \times \text{const} \times (\text{apec + wabs}) \times (\text{apec + apec + apec + po}) + \text{wabs} \times (\text{po + apec}).
\]

The normalization of the soft proton component is determined for each detector separately, tied together between the annuli. The normalization factor is composed of a constant scaling with the annuli areas multiplied by an additional constant to account for the non-uniform distribution across the detector plane. \( M_{\text{diag}} \) is expressed as

\[
M_{\text{diag}} = C_{\text{area}} I_{\text{SB}},
\]

which translates in pseudo-XSPEC format as

\[
M_{\text{diag}} = \text{const} \times \text{const} \times \text{powerlaw}.
\]

Because this observation is so near the Galactic plane, molecular hydrogen \( \text{H}_2 \) is likely to contribute significantly to the total absorption of the extragalactic CXB and cluster emission. The \( \text{H}_2 \) column density may also absorb some of the Galactic emission (GRXE and Galactic halo emission), but for simplicity we assume it lies in front of any \( \text{H}_2 \). This assumption might slightly bias our characterization of these components, but as long as the emission is accounted for the values of the model being used are unimportant since we are not studying diffuse Galactic X-ray emission and are not interested in modeling each component perfectly as long as the total flux is accurately accounted for. To estimate the \( \text{H}_2 \) column along our line of sight, we use the velocity-integrated CO brightness temperature \( W_{\text{CO}} \) and its conversion to \( \text{H}_2 \) column density \( N_{\text{H}_2} \) at this location in the Galaxy from Dame et al. (2001). The total Hydrogen column is then

\[
N_{\text{H}} = N_{\text{H}1} + 2 N_{\text{H}2} = N_{\text{H}1} + 2 (N_{\text{H}2}/W_{\text{CO}}) W_{\text{CO}}.
\]  

where \( N_{\text{H}2}/W_{\text{CO}} = 3 \times 10^{20} \text{ cm}^{-2} \text{ K}^{-1} \text{ (km s}^{-1})^{-1} \) and \( W_{\text{CO}} \sim 20 \text{ K km s}^{-1} \), or \( N_{\text{H}2} \sim 1.9 \times 10^{22} \text{ cm}^{-2} \). This column is nearly three times what would be expected from atomic Hydrogen alone but is in far better agreement with the data. In practice, we allow the \( N_{\text{H}} \) parameter operating on the cluster emission to be free since it is very well constrained by the data and find it to be only \( \approx 14\% \) higher than the estimated value from atomic and molecular Hydrogen.

### 4.3. Cluster Properties

To illustrate the effect of the high absorbing column, combined EPIC images in the 0.5–1.1 keV and 1.1–7.2 keV bands are shown in Figure 2. Essentially no cluster emission is visible in the soft band image (left panel) corresponding to where it is brightest in the hard band image, indicated by the gray contours in both panels that follow the hard band surface brightness. We extract spectra from the nine concentric annuli shown in the right panel of the figure and simultaneously fit them (along with a spectrum from the ROSAT all sky survey to further constrain the local hot bubble and Galactic foreground contributions) with the model defined above.

Grouping the spectra by at least 30 counts/bin, we obtain an excellent fit with \( \chi^2 = 1 \text{.00 (9576 degrees of freedom, dof).} \) The absorption \( (N_{\text{H}} = (2.24 \pm 0.03) \times 10^{22} \text{ cm}^{-2}) \) and Galactic emission are assumed to be uniform across the FOV. Based on constraints provided largely by the Fe–K line complex, we measure a redshift \( z = 0.055 \pm 0.001 \). The cluster properties within each annulus are given in Table 2. Although non-unitary cross-calibration constants between the three detector planes are not necessary to obtain a good fit, a slightly better fit results from allowing them to be free parameters; the MOS2 and pn data are found to be 1.4% brighter and 5.2% fainter than the MOS1 data, respectively. The spectral parameters evolve smoothly from the inner annulus to the outer one, so we only show the spectral fit for the inner, middle and outer ones in Figure 3.

Strikingly, the central region is very hot \( (kT \approx 10 \text{ keV}) \), implying a very massive \( (M_{\text{vir}} > 10^{15} M_\odot) \) galaxy cluster heretofore hidden by our Galaxy. The emission-weighted (2–10 keV) temperature, which we take as a proxy for the virial temperature, is \( kT_{\text{vir}} = 8.8 \text{ keV} \). However, the bolometric X-ray luminosity within the FOV is \( L_{\text{X,bol}} = 9.6 \times 10^{44} \text{ erg s}^{-1} \), or about three times less than the expected luminosity for a low redshift cluster with this temperature (e.g., Maughan et al. 2012), although still within the scatter of the relation for non-cool core clusters.

We estimate that 10%–20% of the total luminosity is lost beyond the XMM-Newton FOV (covering roughly out to \( R_{2500} \))

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5 The apec model produces an emission spectrum from collisionally ionized diffuse gas calculated using the ATOMDB code v2.0.2 http://atomdb.org/. In this model, the redshift is a free parameter. The Fe Kα lines are the brightest lines in this model and provide the main constraint to determine the redshift of the emitting plasma.

6 \( R_{2500} \) is defined as the radius enclosing mean overdensity of 2500, where \( \rho_c \) is the critical mean density of the universe, which can be defined in terms of the Hubble function \( H(z) \): \( \rho_c(z) = 3 H(z)^2/(8 \pi G) \).
Figure 2. Combined, foreground and background-subtracted, and exposure-corrected EPIC MOS and pn images in the 0.5–1.1 keV (left panel) and 1.1–7.2 keV (right panel) energy bands. Each image is scaled from 0 (white) to 120 (black) counts s\(^{-1}\) deg\(^{-2}\) and smoothed with a Gaussian kernel of 22\('\). The gray contours in both panels follow the surface brightness of the 1.1–7.2 keV image with a square-root scaling between 10 and 120 counts s\(^{-1}\) deg\(^{-2}\). In the right panel, circular annuli indicate the nine regions from which spectra are extracted. While essentially all of the cluster emission has been obscured by our Galaxy in the soft band image, at harder energies the cluster is detected out to the edge of the FOV.

Table 2

| Annulus | \(R_{\text{in}}\) (arcmin) | \(R_{\text{out}}\) (arcmin) | \(kT\) (keV) | abund. (rel. to solar) | Norm. \(^{\ast}\) (10\(^{-4}\) cm\(^{-2}\) arcmin\(^{-2}\)) |
|---------|----------------|----------------|-------------|------------------------|-----------------------------------|
| 1       | 0.0           | 1.0           | 11.0\(^{+1.5}_{-1.0}\) | 0.26\(^{+0.10}_{-0.09}\) | 7.96\(^{+0.24}_{-0.17}\) |
| 2       | 1.0           | 2.0           | 11.9\(^{+1.0}_{-0.9}\) | 0.34\(^{+0.07}_{-0.06}\) | 6.85 \pm 0.13 |
| 3       | 2.0           | 3.0           | 11.6\(^{+1.0}_{-0.8}\) | 0.31\(^{+0.06}_{-0.04}\) | 5.14\(^{+0.09}_{-0.10}\) |
| 4       | 3.0           | 4.0           | 10.1 \pm 0.7 | 0.27 \pm 0.05 | 3.41\(^{+0.08}_{-0.04}\) |
| 5       | 4.0           | 5.0           | 9.6\(^{+0.9}_{-0.8}\) | 0.24\(^{+0.06}_{-0.05}\) | 2.26\(^{+0.06}_{-0.05}\) |
| 6       | 5.0           | 6.5           | 7.8 \pm 0.5 | 0.23\(^{+0.05}_{-0.04}\) | 1.55\(^{+0.05}_{-0.04}\) |
| 7       | 6.5           | 8.0           | 6.7\(^{+0.9}_{-0.5}\) | 0.26 \pm 0.06 | 1.02 \pm 0.04 |
| 8       | 8.0           | 10.0          | 5.7 \pm 0.6 | 0.14\(^{+0.07}_{-0.06}\) | 0.69\(^{+0.04}_{-0.03}\) |
| 9       | 10.0          | 13.0          | 3.9\(^{+0.5}_{-0.4}\) | 0.20\(^{+0.12}_{-0.09}\) | 0.41 \pm 0.03 |

Note. \(^{\ast}\) Normalization of the apec thermal spectrum, which is given by \(10^{-14}/[4\pi (1 + z)^2 D_A^2] \int n_e n_H dV\), where \(z\) is the redshift, \(D_A\) is the angular diameter distance, \(n_e\) is the electron density, \(n_H\) is the ionized hydrogen density, and \(V\) is the volume of the cluster.

5. CXOU J174437.3-323222: A FSRQ OR BL LAC BLAZAR

In this section we focus on Source 1, which has been tentatively identified by Curran et al. (2011) as a blazar. We start by comparing the spectra measured by Chandra in 2008 and XMM-Newton in 2012. The spectra from the two instruments are independently fitted with an absorbed power-law model. Table 3 shows that the two spectra are similar within error, but we notice that the 2008 flux is 1.6 times higher than the one measured in 2012.

Figure 5 shows our XMM-Newton spectrum of the blazar candidate along with the Swift-BAT spectrum available publicly from the 70-month catalog\(^{7}\) (Baumgartner et al. 2013). The BAT’s angular resolution does not allow the separation between

\(^{7}\) http://swift.gsfc.nasa.gov/results/hs70mon/
The cluster component dominates the 2–6 keV range in all but annulus 9, and single temperature fits are largely adequate to describe this emission, although a small spread in temperature components distributed throughout an annulus would still allow a good fit with a single temperature model given the quality of these data.

Figure 4. Surface brightness profile of the cluster fit with an isothermal $\beta$-model profile. See the text for details.

Figure 5. Spectrum of Source 1. The black, red, and green points are from XMM-Newton MOS1, MOS2, and pn detectors, respectively, while the blue points are from Swift BAT. The solid lines show the models associated with each data set, and the bottom panel shows the residuals in units of standard deviation. The blue dotted line shows the decomposition of the model used for the BAT data: the apec (from the cluster, Source 0) dominates up to $\approx 45$ keV, and the power law (from the blazar, Source 1) beyond. The error bars show the $1\sigma$ confidence level.

Table 3
Spectral Modeling of the Chandra (2008) and XMM-Newton (2012) Data for Source 1

| Observatory | $N_{H}$ $(10^{22}$ cm$^{-2})$ | $\Gamma$ | $\chi^2$ (dof) | Flux $(10^{-12}$ erg cm$^{-2}$ s$^{-1}$) |
|-------------|------------------|--------|----------------|----------------------------------------|
| Chandra     | $3.03^{+0.91}_{-0.72}$ | $1.16^{+0.42}_{-0.38}$ | 1.32 (10 dof) | $2.60^{+0.41}_{-0.39}$ |
| XMM-Newton  | $2.51^{+0.25}_{-0.23}$ | $1.31 \pm 0.09$ | 0.89 (397 dof) | $1.65 \pm 0.07$ |

Note. The flux in the rightmost column is given for the 0.2–10 keV band, not corrected for absorption.
The column density is not affected by the addition of the Swift data, and is as quoted in Table 3. The power-law photon index is 1.31 ± 0.09, similar to what was found with the XMM-Newton data only (the BAT data alone provide a very poor constraint on the photon index). No cutoff is required by the data, but the points beyond 100 keV should be taken as upper limits. Source 1’s light curve (LC) does not reveal any significant variability (Figure 6): the LC can be fit with a constant rate of 0.20 ct/s, returning $\chi^2 = 0.76$ (83 dof).

Figure 7 shows the SED of Source 1. Although we are missing a critical part of the spectrum in the optical and UV, this SED matches that of either a flat spectrum radio quasar (FSRQ) or that of a low-frequency peaked BL Lac (LBL; Padovani & Giommi 1995), which are both described by a synchrotron peak in the $10^{13}$–$10^{14}$ Hz range and an inverse Compton peak around $10^{22}$–$10^{23}$ Hz. This differs from the analysis proposed by Curran et al. (2011) who modeled the IR and X-ray data as a single power law. Differentiating between an LBL and an FSRQ requires optical spectroscopy: FSRQs exhibit characteristic broad emission lines in the optical domain, while LBL do not. If this blazar was an FSRQ, the redshift of the emission lines could tell whether this object belongs to the galaxy cluster or if it lies in the background.

We note that change of flux between the Chandra and the XMM-Newton observations is compatible with the blazar scenario. The blazar could have been in outburst during the 2008 observation.

6. OTHER SOURCES IN THE FIELD

Here we focus on Sources 2–5 that are circled in Figure 1. The goal is to determine whether any of these sources contribute significantly to the flux seen by INTEGRAL for IGR J17448-3232, and whether any might be active galactic nucleus (AGN) associated with the cluster. The spectra are extracted from 30’’ radius regions, and they are grouped to yield 40 source + background counts and 3σ per bin (including the last bin), the upper energy limit of the last bin being set to maximize its significance. The three spectra are jointly fit with a cross-normalization constant fixed to 1 for pn, and free for MOS1 and MOS2. Figure 8 shows the spectra of these sources, and Table 4 presents the number of net counts that was detected in each camera and summarizes their spectral properties. For comparison, the integrated column density in the direction of IGR J17448-3232 is $\approx 7 \times 10^{21}$ cm$^{-2}$ (Kalberla et al. 2005). We found no significant variability in the 0.4–10 keV range for any of these sources.

Searching in VizieR8 at the Chandra positions reported in Table 1, we found optical and near infrared counterparts for each of the four sources (as compiled, for instance, in the Naval Observatory Merged Astrometric Data set, NOMAD; Zacharias et al. 2005). We dereddened their $B$, $V$, $J$, $H$, and $K_s$ magnitudes using our X-ray measurement of the column density (Güver & Özel 2009): $N_H$(cm$^{-2}$) = $(2.21 \pm 0.09) \times 10^{21}$ A$_v$ (mag), and using the relationship between extinction in the visual band $A_v$ and the other bands derived in (Cardelli et al. 1989). We then use tables (e.g., from Gelino 2001; Ducati et al. 2001; Pecaut & Mamajek 2013) to match the $B - V$, $V - J$, $V - H$, $V - K_s$ color indices (Table 5) with star spectral types.

CXOU J174458.2-323940 (no. 2). We limit the spectral analysis of this source to the 0.2–3.5 keV range, as it has almost no counts beyond 3.5 keV. A thermal model (absorbed black body) yields a good fit with $kT = 0.19 \pm 0.02$ keV ($\chi^2 = 1.28$, 71 dof). The very low column density ($N_H = 5.2_{-3.6}^{+4.9} \times 10^{20}$ cm$^{-2}$) places this source in the foreground. We find a good positional match ($\sim 6^\prime$) with 2MASS J17445825-3239407, for which the spectral type corresponds to a giant M3 star (Ducati et al. 2001). This source could be an active binary star (a binary with two main sequence stars).

CXOU J174534.6-322917 (no. 3). This source’s spectral analysis is done over the 0.4–5 keV and 0.4–10 keV for the MOS and the pn data, respectively. Its spectrum is acceptably fit by the sum of a soft thermal component (black body with $kT = 0.20_{-0.05}^{+0.06}$ keV) and a hard power-law tail with $\Gamma = -0.68_{-0.02}^{+0.02}$, yielding $\chi^2 = 1.69$ for 28 dof. The spectrum shows positive residuals around 1 keV, which could be well fit by a Gaussian emission line. Alternatively, replacing the black body by a thermal plasma component (apec) also improves the fit, although the physical interpretation is not straightforward in either case.

We find a good match with 2MASS J17453452-3229177: Although it is $\pm 76$ away, the inspection of the 2MASS

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8 http://vizier.u-strasbg.fr/viz-bin/VizieR

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Chandra images show that the Chandra error circle (4′′ radius for this source) nicely overlaps with the IR source without any possible confusion. The colors of this counterpart are not well matched by any type of main sequence star, however they coincide well with the supergiant type F0 (Ducati et al. 2001). Assuming that the blackbody + power-law model is correct for the XMM-Newton spectrum, Source 3 could be an X-ray binary.

CXOU J174510.9-322655 (no. 4). The spectral analysis of Source 4 is done over the 0.2–5 keV energy range. Its spectrum is best fit by an absorbed power law with $\Gamma = 4.66^{+1.14}_{-0.85}$ ($\chi^2 = 1.23$, 36 dof), however such a soft spectrum is physically better interpreted as thermal emission. Using an absorbed blackbody model, we find $N_H = 2.0^{+1.2}_{-1.1} \times 10^{21}$ cm$^{-2}$ and $kT = 0.24^{+0.05}_{-0.04}$ keV ($\chi^2 = 1.42$, 36 dof). We find a counterpart located 0′′42 away from the Chandra position, 2MASS J17451093-3226560, which color indices match well with an F8 supergiant (Ducati et al. 2001), or with an F–G main sequence star. Similarly to Source 2, this source could be an active binary star.

CXOU J174428.4-322828 (no. 5). The spectrum of Source 5 is very soft; we perform the spectral analysis over the 0.2–3 keV range. The model yielding the best fit is an absorbed blackbody, with $kT = 8.2^{+1.6}_{-1.8} \times 10^{-2}$ keV ($\chi^2 = 0.81$, 24 dof). 2MASS J17442842-3228286 is a robust counterpart, 0′′06 away from the Chandra position. The NIR and optical photometry indicate a spectrum rising toward shorter wavelength, possibly connecting with the tail of the black body spectrum observed in X-rays. This object might be an isolated neutron star, although one would need to build a SED of the source to confirm this hypothesis, which goes beyond the scope of this paper. In any case, it is not an AGN.

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**Table 4**

| ID No. | MOS1 (counts) | MOS2 (counts) | pn (counts) | $kT$ (keV) | $\Gamma$ | $N_H$ (10$^{21}$ cm$^{-2}$) | Flux (erg s$^{-1}$ cm$^{-2}$) |
|-------|---------------|---------------|----------|----------|------|----------------|----------------------------|
| 2     | 394.2 ± 29.1  | 334.1 ± 28.2  | 1231.2 ± 56.1 | 0.19 ± 0.02 | …    | 0.52^{+0.09}_{-0.36} | 7.1^{+0.63}_{-0.58} \times 10^{-14} |
| 3     | 239.4 ± 23.7  | 188.9 ± 21.3  | 803.9 ± 59.2  | 0.20^{+0.05}_{-0.05} | -0.68^{+0.99}_{-1.02} | 3.3^{+3.3}_{-2.1} | 2.3^{+0.9}_{-0.8} \times 10^{-13} |
| 4     | …             | 272.8 ± 25.0  | 864.3 ± 57.6  | 0.24^{+0.05}_{-0.05} | …    | 2.0^{+1.6}_{-1.2} | 5.3^{+0.5}_{-0.4} \times 10^{-14} |
| 5     | 154.0 ± 20.5  | 173.7 ± 21.6  | 578.5 ± 51.7  | 0.081 ± 0.017 | …    | 11.1^{+6.6}_{-2.8} | 3.0^{+0.41}_{-0.39} \times 10^{-14} |

Note. The flux in the rightmost column is given for the 0.2–10 keV band, not corrected for absorption.
With its hard power-law tail, Source 3 is the only one that is hard enough to contribute to IGR J17448-3232. However, with an order of magnitude lower flux than the blazar (Source 1), and no indication of variability, its contribution is not likely to be significant.

7. SUMMARY

This observation revealed that the extended object in the field of IGR J17448-3232 is a massive, nearby galaxy cluster heretofore hidden by the plane of the Galaxy, the Scorpius cluster. Since extragalactic surveys avoid the plane and nearly all the cluster emission within the ROSAT passbands has been absorbed by intervening cold gas, such a serendipitous discovery is not unexpected. The larger effective area, especially at harder energies, makes XMM-Newton the ideal X-ray observatory for revealing the nature of this cluster without supporting information at other wavelengths.

Although treated as a symmetric cluster to determine its gross properties, the surface brightness contours in Figure 2 illustrate asymmetric features that suggest a disturbed intracluster medium. If these features are due to a recent major merger, then we expect temperature variations to correlate with the surface brightness structures. Preliminary work suggests that this is indeed the case, but a more in-depth spatial-spectral analysis is beyond the scope of the current paper. Because slight spatial variations in Galactic foreground and absorption can bias local temperature estimates, the spatially flat values assumed here are insufficient to accurately determine the features of this new cluster. A more detailed analysis will be presented in a later paper (D. R. Wik et al. in preparation).

As illustrated in Figure 5 by the Swift-BAT data, IGR J17448-3232 is actually two sources: it is dominated in the 20–45 keV band by the galaxy cluster and in the 45–100 keV by the blazar. We confirmed the tentative identification by Curran et al. (2011) of CXOU J174437.3-323222 being a blazar (although we interpret its SED differently), and we propose that it is either an FSRQ or a low-frequency peaked BL Lac. We also analyzed four other sources present in the field of this XMM-Newton observation, but we concluded that they are most likely Galactic sources (foreground) that did not contribute to IGR J17448-3232.

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Facilities: XMM, INTEGRAL (IBIS), CXO (ACIS).

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Table 5

| Source | 2   | 3   | 4   | 5   |
|--------|-----|-----|-----|-----|
| B (mag) | 16.27 | 12.57 | 14.080 | 11.542 |
| V (mag) | 15.17 | 12.49 | 13.470 | 11.189 |
| J (mag) | 11.87 | 12.19 | 11.919 | 9.857 |
| H (mag) | 11.17 | 11.89 | 11.496 | 9.571 |
| K_(s) (mag) | 11.03 | 11.85 | 11.369 | 9.450 |
| B − V | 1.09 | 0.09 | 0.31 | −1.34 |
| V − J | 3.31 | 0.29 | 0.90 | −2.27 |
| V − H | 4.01 | 0.59 | 1.24 | −2.45 |
| V − K_(s) | 4.15 | 0.63 | 1.30 | −2.71 |

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