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X-ray Bright Sources in the Field of Active Galactic Nuclei MKN 205

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ABSTRACT

Three bright X-ray non-target sources were detected in the field of the seyfert 1 galaxy MKN 205. These sources were classified as optically Early-type galaxy, BLAGN, and NELG (NED, SIMBAD, and AXIS). The spectrum analysis was made for these objects using thermal models and non-thermal models, modified by interstellar absorption. In some objects, we cannot distinguish between the thermal and non-thermal models of the hard components from the spectrum alone. The presence of intrinsic absorption was tested by photoelectric absorption at the redshift of the sources, and we assumed the flux distribution is affected by the intrinsic absorption in some sources. A black body component used to test the presence of soft excess in some spectra, which has been interpreted as primary emission from the accretion disc or as secondary radiation form the reprocessing of the hard X-ray in the surface layers of the disc.

1. Introduction

MKN 205 is a nearby (z = 0.071) low luminosity radio quiet quasar with an intriguing Fe Kα emission line complex. X-ray emission is an important tool for the investigation of the gravitational evolution of the cosmos. Most of the sources making up the cosmological X-ray background turn out to be different types of Active Galactic Nuclei, AGNs, where the X-ray emission is due to the accretion of matter onto a supermassive Black Hole, the remainder being due to radiation from the hot gas in the deep potential wells of galaxy clusters. Modeling of the X-ray spectrum of the background radiation in terms of these individual sources requires a mixture of objects, displaying different amounts of low energy absorption in their spectra. Highly absorbed objects will thus emit the bulk of their X-ray radiation at energies above 2 keV where the amount of available spectral data is limited. The high sensitivity at energies up to 10 keV, provided by XMM-Newton satellite, will offer the possibility to perform a comprehensive study of the soft and hard X-ray spectra of samples of serendipitous X-ray sources in deep extragalactic fields. This will allow the investigation of the spectral properties of objects, which due to their low flux or hard spectrum could not be observed by previous X-ray instruments. In this work, we study some non-target X-ray sources in MKN 205 which is a nearby

(z= 0.071) low luminosity radio quiet quasar with an intriguing Fe Kα emission line complex [1] field observed by XMM-Newton.

In the present paper, we report on the detection and spectral analysis of X-ray observation of the field of MKN205, taken by XMM-Newton observations. We organized the paper as follows: The X-Ray observations and data reduction are presented in section 2, section 3 is devoted to the spectral analysis, while the results are summarized and concluded in section 4.

2. Observations and Data Reduction

The identifications presented in this paper correspond to the X-ray sources found in XMM-Newton data of MKN 205. The observations with the EPIC MOS [2] and PN [3] detectors were split into 3 parts, each of which was exposed for 17 ksec duration, to test a variety of sub-window modes. Three observations each was made with the MOS 1 and 2 cameras, in Full Window, Partial Window 2 and Partial Window 3 modes. For the PN, two observations were made in Full Window mode and one in Large Window mode. The re-processed data were reduced with the SAS software, using EMCHAIN and EPCHAIN; further filtering was then performed using xmmselect. A light-curve for the observations (PN, MOS1, and MOS2) was created to check for flaring high background periods, which are best visible above 10 keV. Images were extracted in the energy bands 0.2-0.5, 0.5-2.0, 2.0-4.5, 4.5-7.5 and 7.5-12.0 keV with binsize 22 in cases of MOS1 and MOS2, and 82 in PN case. The edetect_chain task was used for the above five energy bands with likelihood threshold =8, and energy conversion factors in units 1011 count. cm^2 erg^{-1} . In order to utilize the χ2 technique, the X-ray spectra were rebinned to contain at least 20 counts in each spectral bin using grppha command and then simultaneously fitting the spectra from MOS1, MOS2 and PN detectors, with the response functions for each detector, using the XSPEC spectral fitting package. The value of the galactic absorption (NH) was found to be 3 × 1020 cm^{-2} obtained from FTOOLS NH task. For the search of discrete X-ray sources, the detection metatask edetect_chain is applied to the three EPIC cameras. The above five energy bands were used.

3. Spectral Analysis

To identify the X-ray sources detected in MKN 205 field, a search program was carried out to compare positions of objects in our field with X-ray source positions of objects in several catalogues and archives (eg. SIMBAD, NED, USNO, APM-North, etc.). To improve the reliability of the identifications, the optical magnitude (B and V) are used to calculate the ratio of X-ray flux (fx) to optical flux(fop), which is given by the following relation [4]:

$$log(\frac{f_x}{f_{op}}) = log\,(f_x) + 0.4\,m_{op} + 5.37, \quad (1)$$

where mop is the optical magnitude. The optical magnitudes are given from SIMBAD, USNO and APM-North catalogues.

A spectral analysis for three bright non-target sources in MKN 205 field are performed. These sources are classified as, early-type galaxies (at right ascension & declination 12.338&75.370 (named Obj_12.338_75.370)), broad-line active galactic nuclei (BLAGN) (at right ascension & declination 12.348&75.833 (named Obj_12.348_75.833)) and narrow emission line galaxies (NELG) (at right ascension & declination 12.368&75.438 (named Obj_12.368_75.438)).

In this spectral analysis, three sets of data points and model curves (one for PN and two for MOS) were used. For all in the following plots, the upper curves are for PN data and the lower curves are for the MOSs data.

For the object Obj_12.338_75.370 an X-ray spectrum with a single-temperature thermal plasma model [5] modified by interstellar

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absorption was fitted to all of the ranges from 0.2 keV to 10.0 keV. The parameters: the plasma temperature, the metal abundance and the normalization were free in the fitting, and the absorption column density is fixed at 3 ×1020 cm^{-2}.

This model failed to reproduce the observed spectrum; it fitted the data well up to 2 keV. The χ^2/odf is 345.5/211, KT is 0.72±0.015 keV and the abundance parameter is 0.16±0.02. By using this model, an excess emission found above the 2 keV (Fig1). A thermal bremsstrahlung model for the hard component to estimate the temperature variation above 2 keV was assumed. The bremsstrahlung model together with Raymond model were then fitted to the same band (0.2 keV - 10.0 keV). The assumption of thermal bremsstrahlung model to this spectrum provides an acceptable fit (Fig 2) the χ^2/odf is 217/209, the reduced chi-square is 1.042 and the null hypothesis probability is 0.323. The output thermal temperature from this fit is KT 0.41±0.01 keV, while the thermal temperature from the bremsstrahlung model is 5.39±1.6 keV. In this fit the abundance parameter is 0.21±0.03.

The broad band spectrum when fitted by Power-law with Raymond model, an acceptable fit was obtained, the χ^2/odf = 220/209 with reduced chi-square is 1.052 and the null hypothesis probability is 0.29, with photon index 1.82±0.19 keV. The thermal temperature from Raymond- Power-law model is 0.40±0.01 keV as from Raymond-Bremsstrahlung model (Fig. 3). Therefore, we cannot distinguish between the two possible thermal and non-thermal models of the hard component from the spectrum alone.

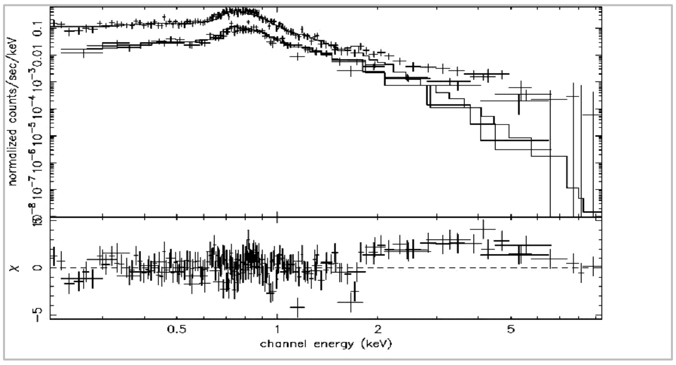

Figure 1: The PN, MOS1 and MOS2 spectra fitted using Raymond thermal model, with χ^2 test.

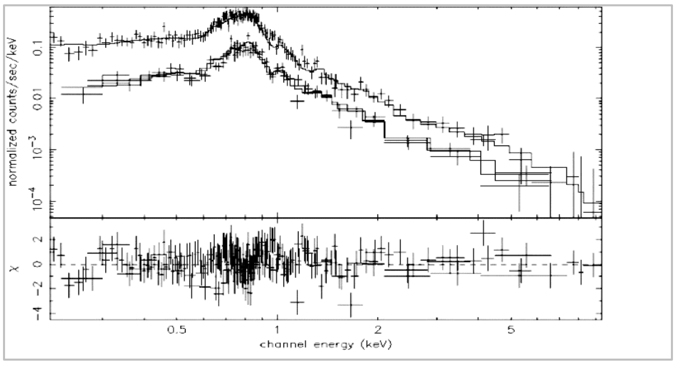

Figure 2: The PN, MOS1 and MOS2 spectra fitted using Raymond thermal model with thermal Bremsstrahlung, with χ^2 test.

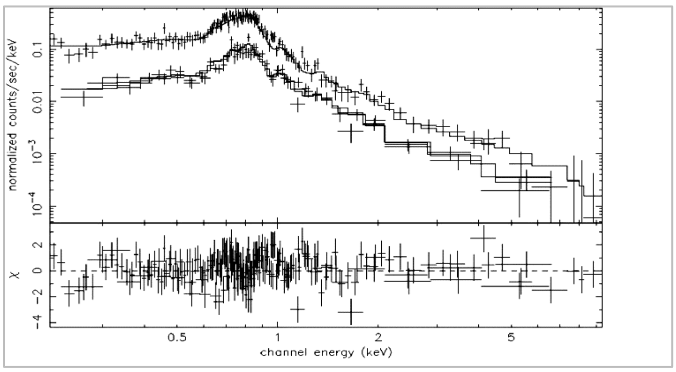

Figure 3: The PN, MOS1 and MOS2 spectra fitted using Raymond thermal model and Power-law model, with χ^2 test.

The two other objects Obj_12.348_75.833 and Obj_12.368_75.438 are classified as BLAGN and NELG respectively. The spectral analysis of these objects started with fitting a single power-law to the background-subtracted spectra. This model has two free parameters, the normalization, and the continuum slope Γ. A fixed photoelectric absorption component was included to account for the effect of the galactic absorption along the line of sight. Fitting this model gives a good reduced χ^2 for the two objects (Figs. 4 and 5) with photon index 1.7±0.04 keV and 1.5±0.03 keV respectively. The fitted parameters are summarized in Table (1).

Table 1: The fit parameters of the power-law model for the two objects

Parameter	Obj_12.348_75.833	Obj_12.368_75.438
Absorption column density (NH)	3×10^{20} cm^{-2} (fixed)	3×10^{20} cm^{-2} (fixed)
Γ	1.7±0.04 keV	1.5±0.03 keV
χ^2	87	153
odf	99	138
Norm	1×10^{-4}	8.3×10^{-5}

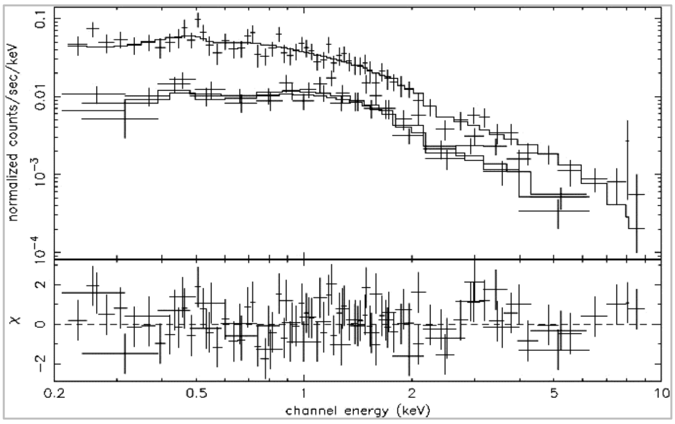

Figure 4: The PN, MOS1 and MOS2 spectra fitted using Power-law model with fixed photoelectric absorption component for Obj_12.348_75.833

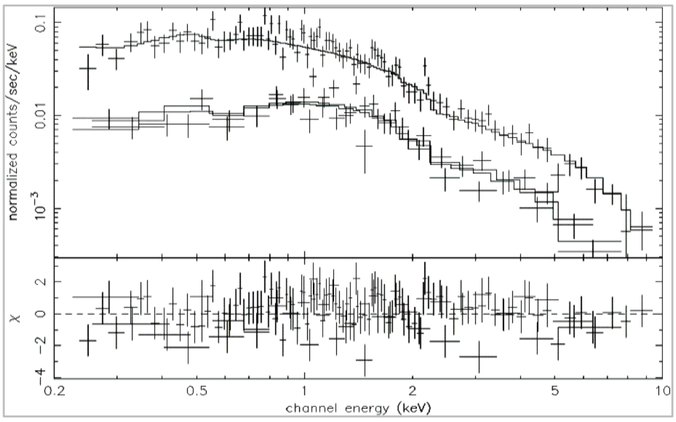

Figure 5: The PN, MOS1 and MOS2 spectra fitted using Power-law model with fixed photoelectric absorption component for Obj_12.368_75.438

In order to test whether intrinsic absorption is present, photoelectric absorption at the redshift of the source (0.65 and 0.24) is fitted, where the redshift was taken from Barcons, et al. (2002) [6]. In this case three parameters are free, the normalization, the photon index Γ, and the rest frame absorption. There is no significant improvement by adding this component, in the reduced χ^2 (0.89 and 1.07 respectively). The intrinsic absorption components (NH) from this fit are 1.13×10^{11} ±0.05 and 3.53×10^{11} ±0.015, this does not make sense. It is not possible to measure NH values much lower than 10^{20} cm^{-2} with XMM. This means that we need data with much better statistics to simultaneously fit the different contributions of intrinsic absorption for this object. The F-test (F = 5.8, F-probability = 1.73×10^{-2}) tells us that going from power-law model with fixed NH to a power-law model with intrinsic NH as additional fit parameter represents a significant improvement of the fit (Figs. 6-7). The agreement for this object is excellent so, one can assume that the flux distribution is affected by intrinsic absorption.

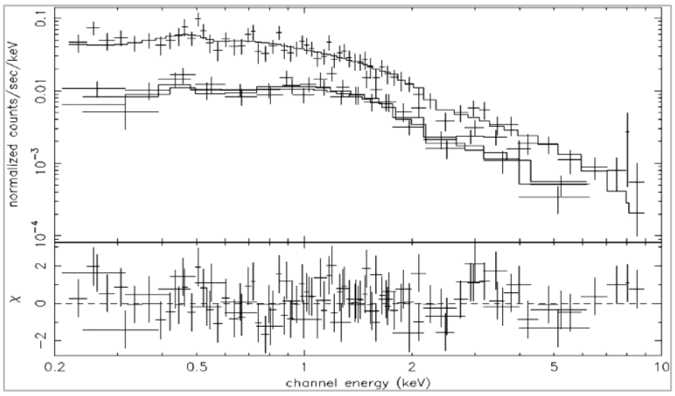

Figure 6: The PN, MOS1 and MOS2 spectra fitted using Power-law model with photoelectric absorption at the redshift for Obj_12.348_75.833

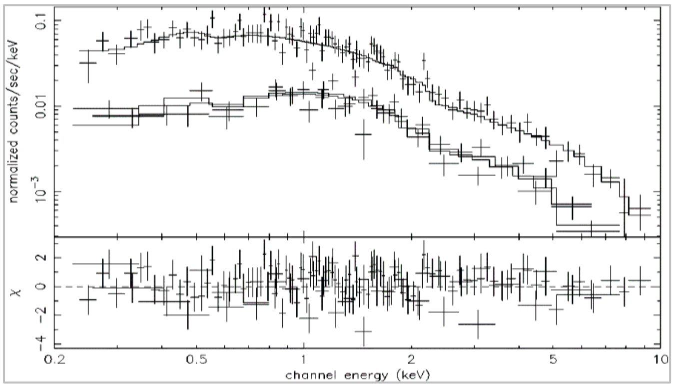

Figure 7: The PN, MOS1 and MOS2 spectra fitted using Power-law model with photoelectric absorption at the redshift for Obj_12.368_75.438

The determination of soft excess may depend on the knowledge of the shape of the power-law and the quantity of absorption. It has been interpreted as a primary emission from the accretion disc, the gravitation energy released by: the emission from the accretion disc, by the viscosity in the disc or as secondary radiation from the reprocessing of hard X-rays in the surface layers of the disc. We can provide a good fit to this soft excess by several models, such as: single black body, multiple black bodies, multicolor dick black body, blurred reaction from partially ionized material, smeared absorption, and thermal computerization in the optically thick medium [7]. To do this, the spectra were fitted with power-law and a low energy black body component (at the redshift of the source) taking into account absorption in our Galaxy. The χ^2/odf are 85.05/97 and 149/136, respectively for these fits. The photon indexes are changed to 1.42±0.04 keV and 1.42±0.05 keV and the thermal temperatures from the black body component (KT) are 0.39±0.17 and 0.38±0.17 keV (Table 2 summaries the fit parameters) as shown in Figures (8 and 9).

The F-test (F 1.01, 1.90 and F-probability 0.368, 0.153) tells us that going from power-law model to a power-law model with black body component, as an additional fit parameter does not represent a significant improvement of the fit. This means that we need more data with much better statistics to simultaneously fit the different contributions of the soft excess component.

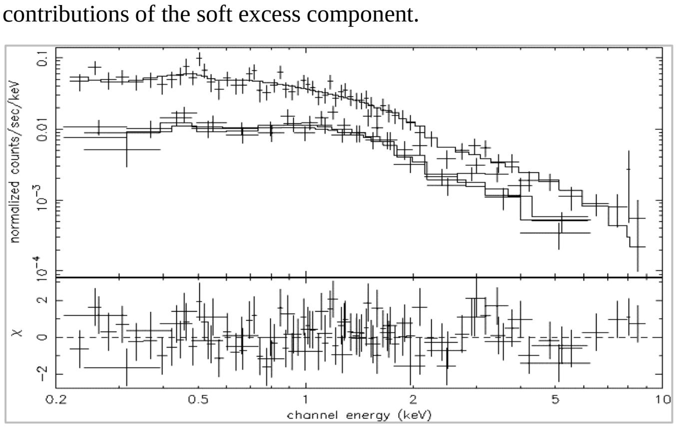

Figure 8: The PN, MOS1 and MOS2 spectra fitted using Power-law model with a black-body component for Obj_12.348_75.833.

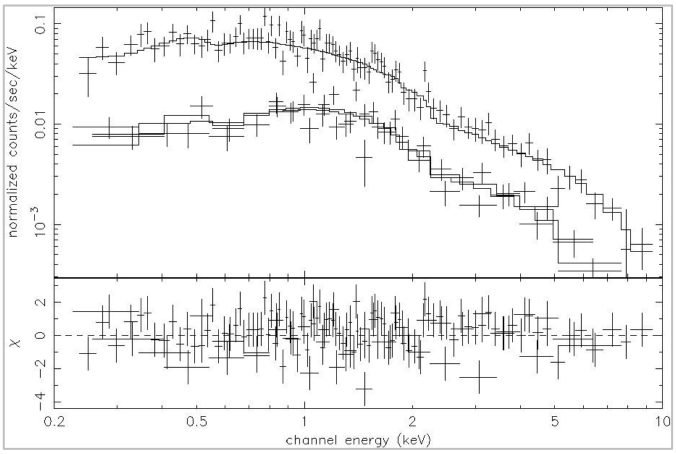

Figure 9: The PN, MOS1 and MOS2 spectra fitted using Power-law model with a black-body component for Obj_12.368_75.438

Table 2: The fit parameters of the power-law model with a black-body component for the two objects

Parameter	Obj_12.348_75.833	Obj_12.368_75.438
Absorption column density (N_H)	3×10^{20} cm^{-2} (fixed)	3×10^{20} cm^{-2} (fixed)
Γ	1.6±0.06	1.4±0.05
KT	0.39±0.17 keV	0.38±0.17 keV
χ^2	85	149
Odf	97	136
Norm	1.45×10^{-7}	4.68×10^{-7}

4. Discussion and Conclusion

The aim of the paper was to detect, classify and spectral analyze the possible bright X-ray non-target sources in MKN 205 field. We detected three bright objects in this field, these sources are located at right ascension & declination 12.338&75.370, 12.348&75.833 and 12.368&75.438 and classified optically as Early-type galaxy, BLAGN, and NELG, respectively.

The flaring high background periods checked by creating alight curves. For the first object an X-ray spectrum with a single-temperature thermal plasma model modified by interstellar absorption was fitted from 0.2 keV to 10.0 keV with a fixed the absorption column density at 3 × 1020 cm-2. The thermal temperature (KT) of this fit is 0.72±0.015 keV and the abundance parameter is 0.16±0.02. A thermal bremsstrahlung model for the hard component to estimate the temperature variation above 2 keV was assumed. The bremsstrahlung model, together with Raymond model, were then fitted to the same band. The assumption of thermal bremsstrahlung model to this spectrum provided an acceptable fit and the output thermal temperature from this fit is 0.41±0.01 keV, while the thermal temperature from the bremsstrahlung is 5.39±1.6 keV. In this fit the abundance parameter is 0.21±0.03. When the spectrum fitted by Power-law with Raymond model, an acceptable fit was obtained with a photon index 1.82±0.19, and the thermal temperature from Raymond- Power-law model is 0.40±0.01 keV as from Raymond-Bremsstrahlung model.

The two other objects fitted firstly by a single power-law to the background-subtracted spectra and a fixed photoelectric absorption component was included to account for the effect of the galactic absorption along the line of sight. A photoelectric absorption at the redshift of the source was fitted in order to test whether intrinsic absorption is present. There is no significant improvement by adding this component. The intrinsic absorption components (NH) from this fit were 1.13×10^{11} ±0.05 cm^{-2} and 3.53×10^{11} ±0.015 cm^{-2}. It is not possible to measure NH values much lower than 10^{20} cm^{-2} with XMM. The F-test tells us that going from power-law model with fixed NH to a power-law model with intrinsic NH as an additional fit parameter represents a significant improvement of the fit. The agreement for this object is excellent so, one can assume that the flux distribution is affected by intrinsic absorption. Finally, we tested the X-Ray soft excess by adding a black body component to the power law model, and the thermal temperatures from the black body component (KT) are 0.39±0.17 and 0.38±0.17 keV. But, the F-test tells us that going from power-law model to a power-law model with black body component as an additional fit parameter does not represent a significant improvement of the fit.

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