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Galaxy Evolution in Hot Dense Plasma of Abell 3581 and Abell 400

Turgay Çağlar[1]⋆, Murat Hüdaverdi[1]

[1] *Yıldız Teknik Üniversitesi, Fizik Bölümü, Istanbul*

Özet

In this work we have selected two clusters of galaxies Abell 400 and Abell 3581 clusters of galaxies with moderate distant (z<0.025∼105 Mpc) in order to understand possible mutual interactions of extend intra cluster medium and galaxies within the clusters itself. Since each galaxy has different physical properties, we have applied a multi-band source detection technique to identify all types of point like sources within the field of view. We detect 80 X-ray point sources by EPIC-PN camera of XMM-Newton satellite of ESA. The detected sources are compared with Lockman-Hole field galaxies. The luminosity range is faint (39.3<log(L_X)<41.7 ergs s-1), which is probably polluted by low-mass X-ray binaries (LMXBs), hot halo, and low luminous active nuclei. X-ray to optical luminosity relations studied to understand distribution of galaxies. Based on our results, we observe an enhanced X-ray emission from galaxies from the cluster fields; in other words they are significantly brighter in X-rays.

Anahtar Kelimeler: X-rays: galaxies: clusters, Sıkı Nesneler

1 Introduction

Clusters of galaxies are the largest entities of the universe that have great gravitational potential. They are formed from the gravitational collapse of field galaxies.

The relative fraction of active galaxies in rich clusters was considerably lower than in the field.(Dressler & Gunn 1983, Dressler et al. 1999). Traditional optical studies overlook these sources and arrive at a fraction of %1 of all cluster galaxies harboring an AGN (e.g., Dressler et al. 1999). Including these X-ray selected AGNs, however, yields a fraction of %5 , consistent with the fraction of field galaxies hosting an AGN on the basis of optical studies. (Barger et al., 2002) X-ray selected AGN fraction in clusters is much higher than the optically selected AGN fraction (Martini et al. 2002). Then AGN populations in low redshift clusters (0.05≤z≤0.31) has been confirmed (Martini et al. 2006).

In this paper, we present X-ray point sources observed in the field of two nearby clusters A3581 (z=0.023) and A400. (z=0.0244). Luminosity values of A3581 and A400 are 0.6×10^{44} erg s^{-1}(de Plaa, J. et al. 2007) and 0.4×10^{44} erg s^{-1} (Ebeling, H. et al. 1998). Abell 3581 has a cd galaxy (IC 4374) that is a strong radio source and is brighter than Abell 400. Its ICM temperature is 2.0 keV (K. A. Frank et al., 2013). Abell 400 dominated by pair of giant ellipticals (NGC 1128) that also are radio jets. NGC 1128 contains two supermassive black holes spiraling towards merger. (3C 75). ICM temperature of A400 is 2.48 keV (K. A. Frank et al., 2013). We adopt WMAP standart cosmological parameters $H_0 = 70 \mathrm{km\,s^{-1} Mpc^{-1}}$, Ω_M=0.27 and Ω_Λ=0.73 in a flat Universe with a resulting luminosity distance 103 Mpc for A400 and 104 Mpc for A3581

2 Analysis

We applied The SAS source detection algorithms to the data. Source detection is performed with SAS Task, namely EDETECT_CHAIN. We used 3 different EPIC Images in the soft band of 0.3-1.0 keV, in the medium band of 1.0-1.6 keV and in the hard band of 1.6-10 keV to for source detection. Source detections were accepted with likelihood values above 10 (about 4 σ) and inside an off-axis angle of 12.5 arcminute. We selected minimum likelihood ml=10 and a 4 σ Gaussian of the signal-to-noise ratio. Detection routine has been applied for both MOS and PN cameras and the final list has been prepared with SAS task 'SRCMATCH'. After detecting point-like sources, spectral and background files are produced by using SAS task 'evselect'. Background spectrum is extracted from an annulus surrounding the circular source extraction region. Area of these spectral files are calculated by using 'backscale'. the Redistribution Matrix Files and Ancillary Response Files are produced by using SAS tasks 'rmfgen' and 'arfgen' respectively. All files are grouped by considering to their spectral shapes. Almost all sources are modelled with a single power law with intrinsic absorption model (pow*zwabs). But spectrum of several sources have thermal emission lines which, cause fitting them infeasible by using single power law. In that situation, we added a thermal model to fit them properly. The average galactic value of metal abundance (0.3) is fixed in our simulations.

The number of sources per unit sky area with flux higher than S, N ($> S$), is defined as the cumulative number per square degree. Integral Source count;

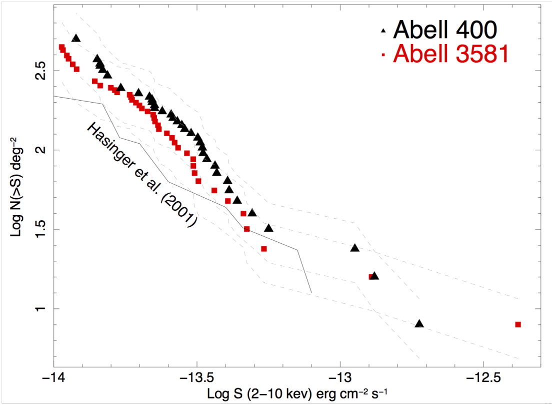
$$N(>S) = \sum_{i=1}^{n} = \frac{1}{\Omega_i} deg^{-2} \qquad (1)$$

where n is the detected source number, Ω_i = sky coverage for the flux of the i-th source. Figure '3' shows Log N - Log S relations for Abell 3581 and Abell 400. Lockman hole result is measured by Hasinger et al. (2001). Hard energy band is much susceptible to cosmic variance than soft energy band (Hasinger et al. 2005), (Nandra et al. 2009). We used 2-10 keV flux values at our Log N - Log S calculations.

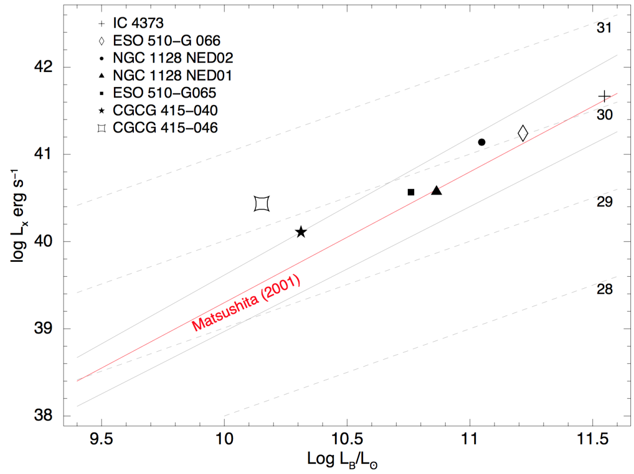
3 Discussion

We analyzed XMM Newton observation of Abell 3581 and Abell 400. 38 sources are detected for Abell 3581 and 36 sources de-

⋆ turgaycaglar88@yahoo.com



Şekil 1. Logarithmic cumulative source number vs logarithmic flux (2-10 keV) for Abell 3581 (box) and Abell 400 (triangle). Dashed lines represents 4σ gaussian error.



Şekil 2. Logarithmic L_X / L_B relation for bright elliptical and spiral galaxies. Red line represent average distribution of early-type galaxies. Grey straight lines indicates %90 confidence limit.

tected for Abell 400. We used cumulative source number per degree square method to calculate LogN - LogS plot. According to Log N - Log S plot, our source density values correspond to 346 $\pm$ 67 soures deg^{-2} for Abell 3581 372 $\pm$ 72 soures deg^{-2} for Abell 400 around logarithmic flux limit of 13.9. At this flux level, density of 199 $\pm$ 30 soures deg^{-2} from Lockman Hole are calculated by Hasinger (2001). If we use minimum possible source density level for our samples and maximum source density of Lockman hole, excess emission from clusters can be seen. A comparison of the cluster source density with both non-cluster fields implies an elevated AGN activity in the cluster environment. Close encounters and possible collisions of galaxies are highly possible in cluster environments. When a galaxy fall into cluster environments under the influence of gravitational potential, surrounding gas powers AGN, therefore, the source becomes brighter. In addition, Most of galaxies host an Black hole at its center. Most of them are inactive. Possible ICM fuelling may activate the inactive Black Hole, which increases X-ray source density in clusters.

The hard band (2-10 keV) X-ray values are plotted against optical blue luminosity in Figure. Apparent blue magnitudes (m_B) are taken from ned archive. The absolute blue magnitudes (M_B) are determined with following equation $M_B = m_B + 5$ - 5log(d), where d is distance in parsec. Blue luminosity are calculated by using $\log L_B = 0.4(M_B - 5.41)$.Matsushita studied average distribution of X-ray compact early-type galaxies with %90 confidence limit. Most of individual X-ray sources of our samples obey Matsushita's distribution. CGCG 415-040 has slightly higher L_X / $L_B$value that can be explained with contribution from unresolved sources. According to our L_X / L_B results, CGCG 415 - 046 is the only source that does not obey average distribution of early type galaxies. It has lowest L_X / L_B result. CGCG 415-046 has either faint LLAGN or there is no active nuclei. The brightest source in our survey is IC 4373, which is cd galaxy of Abell 3581. It is really bright in both X-ray and optic, yet we don't get any peculiarity.

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