Probing Cluster Candidates within the CFHT-Deep Fields

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Özet Universe likes to form clusters around bright, massive galaxies. Falling into the gravitational potential brightest cluster galaxy (BCG), they form large scale structures which can extend several millions of light years across. In this study we systematically survey BCGs from CFHTLS Deep Field regions, in order to discover new cluster candidates. The CFHTLS *ugriz* filtered data is cross-correlated with X-ray archival data of Chandra and XMM-Newton. Based on the X-ray data, several candidates have been identified. Basic parameters such as flux, luminosity, temperature and gas profiles are studied. Our preliminary results suggest that these optical clusters are low-mass systems, with low X-ray temperatures and luminosities. We report that they are not yet completely virialized systems.

1 Introduction

Galaxies like to cluster together. Among all, brightest and massive galaxies are more likely to trigger such clustering in the crowded parts of the universe. The mutual gravity draw galaxies together into larger groups which can extend several millions of light years across. Since brightest cluster galaxy (hereafter BCG) settle to the cluster core as the galaxy distribution evolves, tracing cluster like entities in the vicinity of BGCs is very promising work for cluster hunting. In this proceeding, we report the preliminary results of our cluster survey from The Canada-France-Hawaii Telescope Legacy Survey (CFHTLS) Deep sky fields optical data with X-ray follow up detection of archival Chandra and XMM-Newton. Optical and X-ray identification of galaxy clusters have their advantages. Optical techniques are more evident to define cluster distance and member list

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of the system, and reduce the uncertainty introduced by the projectional effects. X-ray selection is convenience because we can directly recognize the hot intra-cluster medium (ICM) trapped into gravitational potential of the cluster. However, cluster evolution stages do not progress together in optical and X-ray. X-ray evolution is very significant from faint, regular to irregular clusters. While, optical evolution is moderate.

In this study, we attempt to initiate a parallel survey of optical and X-ray to detect and investigate clusters of galaxies. For this work we scale $H_0 = 100h$ km s^{-1} Mpc^{-1}, and the cosmological parameters as Ω_M=0.3, Ω_Λ=0.7 and h=0.7.

2 Observation and Analysis

CFHT is a 3.6 m telescope built at Mauna Kea, Hawaii. The telescope uses a big mosaic camera, called MegaCam, is dedicated to the Legacy Survey. CFHTLS deep field observations cover four $1^\circ \times 1^\circ$ sized regions through the whole filter set ($ugriz$) with integration times ranging from 33 to 132 hours depending on the filter (u':33 g':33, r':66, i':132, z':66). Field of view pointings:
CFHTLS - D1 → RA (2000) = 02h 26m 00s ; DEC (2000) = −04d 30m 00s
CFHTLS - D2 → RA (2000) = 10h 00m 29s ; DEC (2000) = +02d 12m 21s
CFHTLS - D3 → RA (2000) = 14h 19m 28s ; DEC (2000) = +52d 40m 41s
CFHTLS - D4 → RA (2000) = 22h 15m 31s ; DEC (2000) = −17d 44m 06s

CFHTLS-Deep fields coincides with several systematic multi-band surveys. Around 100 pointing is available in X-ray archival data including galactic sources in the field of view with a very short time of exposure. In order to reduce the ambiguity in the analysis we use the data only with exposures >10 ksec. Our project team have been performing a dedicated spectroscopic follow-up observational project (09BRTT150-474-0) of CFHTLS-D field sources with RTT-150 at Bakirlitepe, Antalya.

3 Source Identification

CFHTLS data is scanned for source detection in an automatic way with a fortran program due to its size and amount. In order to improve detection precision four criteria is applied to the galaxy catalogue extracted by SExtractor (Bertin & Arnouts 1996). These criteria are distance, i-magnitude, redshift and color as an indicator of evolutionary stage. Applying only one or two criteria may result a false detection as it was tested and explained by S. Aliş (2009). Above mentioned detection method gave us 158 BCGs. We employed archival X-ray data which was systematically observed as Extended Groth Strip (EGS) by P. Barmby et al. (2006), The All-Wavelength Extended Groth Strip Int. Survey (AEGIS) by M. Davis et. al. (2007), and Groth Westphal Field by T. Miyaji et al. (2004). The data were cleaned from solar flares by clipping

2.7σ deviation from average count rate at light curves. Since extend ICM emission more dominated in soft energies, we created 0.5-2 keV band images. Vignetting and exposure corrected images cross-correlated with the optical BCG locations. As the second part of our study we focus on X-ray emitting regions with 4σ S/N ratio and precisely explore galaxy population in optical band. In this letter, we focus on the second method and give two examples of galaxy clusters detected from D3 field with X-ray data, accompanied by an optical BCG.

3.1 BCG CFHTLS-J022531-041422

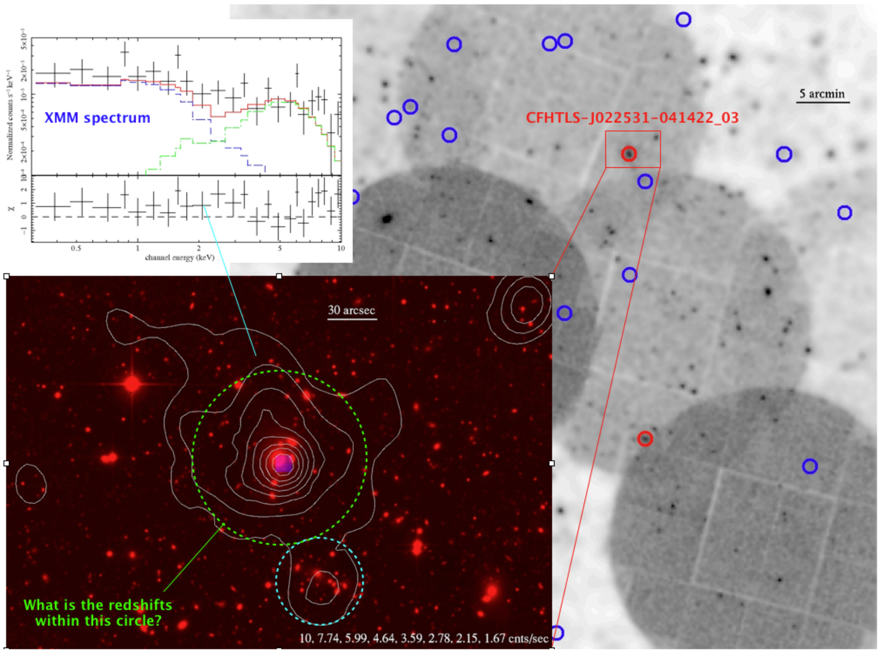
The source CFHTLS-J022531-041422 is one of the peculiar BCG source identified from D3 field. Figure-1 gray image shows soft-band [0.5-2 keV] mosaic XMM-*Newton* view of the field. The source location is indicated with a red-square. The optical red figure is CFHT *i*-band image with X-ray counters overlaid. The logarithmically scaled contour levels and image scale can be found in the image. The BGC and extend X-ray emission perfectly coincides. The spectrum in the top-right is MOS data fit with –mekal+power-law– plasma. ICM plasma temperature is estimated as kT=$1.51^{+0.94}_{-0.76}$ keV, with a luminosity of L_X=$1.24^{+1.35}_{-0.58}\times10^{43}$ergs/s. RTT-150 observations estimates a V_r=87645.4±376.5 km/sn, corresponding to a redshift of z=0.292. Our preliminary findings classify the CFHTLS-J022531-041422 as a low-mass regular cluster.

3.2 BGC CFHTLS-J022523-044049

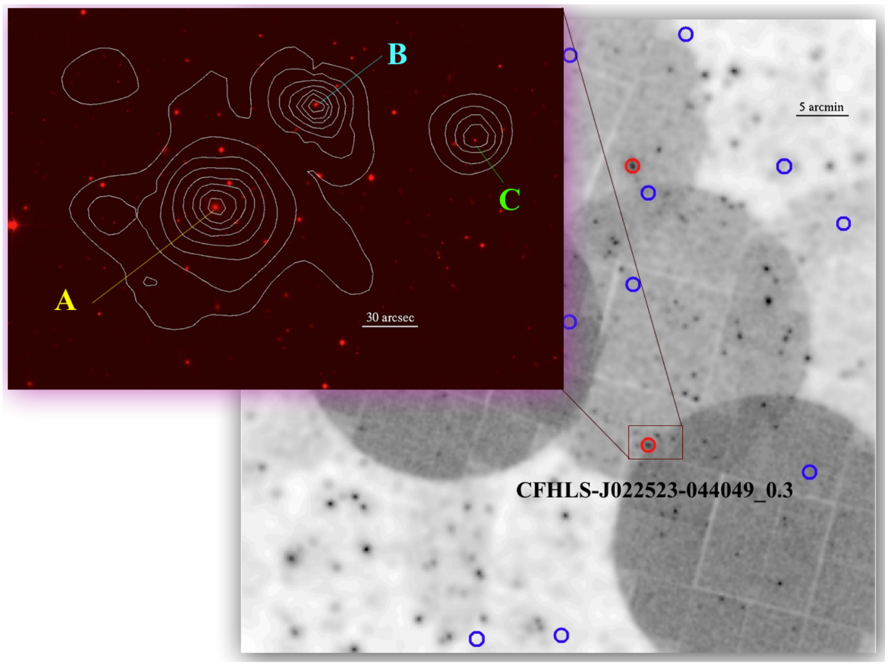
Our second source CFHTLS-J022523-044049 is also a bright optical source from D3, clearly identified as BCG and a good X-ray emitter. Figure-2 shows soft-band mosaic XMM-Newton image in gray and optical CFHT-LS *i*-filtered image in red overlaid with X-ray counters. The redshift information estimated with matched filter (z_{MF}=0.302) and photometric redshift (z_{ph}=0.314) by RTT-150 are consistent. The extend X-ray emission reveals a triad structure which is labeled as A, B and C in the figure. We extracted source counts from 30″ circular region peaking on A-point. The best fit parameters estimates an ICM temperature of kT=1.82±0.24 keV and metal abundance of 0.3 solar. The plasma have the luminosity of L_X=1.24±0.11×10^{43}ergs/s.

4 Conclusion

Basic theoretical models, which assume a hydrostatical equilibrium of gas, galaxy and dark-matter components yields $L_X \sim T^2$ (Arnaud & Evrard, 1999). Figure-3 shows the average local luminosity and temperature relation based on the study of Pacaud et al. (2007). We compare our results with that of local universe and plot the values in Figure-3 as red-triangles. Due to low photon counts and statistics, the error bars are relatively large. The two sources in this study having redshifts in the range [0.14-1.05] and fall on average the local L_X-T line. Based on preliminary results of this work, we suggest that the CFHTLS-J022531-041422

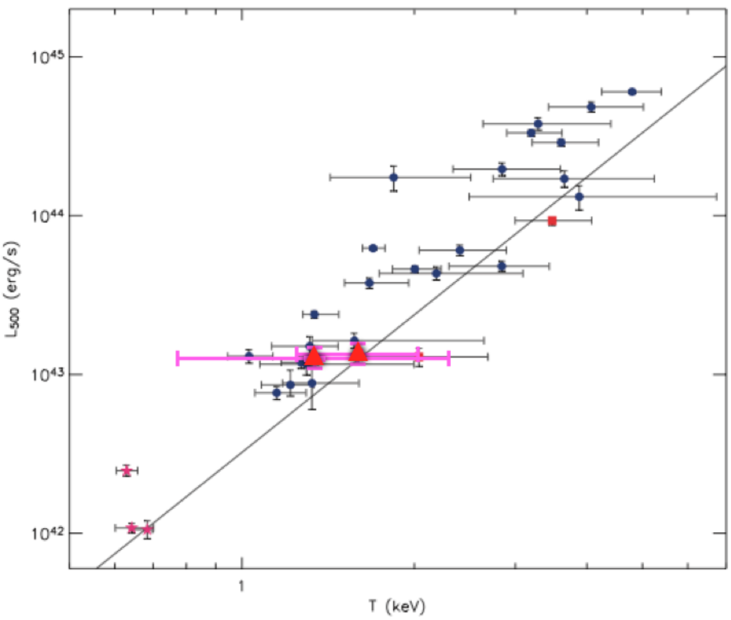


Şekil 1. CFHTLS-J022531-041422 optical image (CFHT) with X-ray counters overlaid.



Şekil 2. CFHTLS-J022523-044049 optical image (CFHT) with X-ray counters overlaid.

and CFHTLS-J022523-044049 show the properties of low temperature low mass clusters.



Şekil 3. L_X-T relation for the local [0.14-1.05] universe. The analysis results of this work are represented with red-squares

This work is supported by TÜBİTAK Scientific Project Contract #108T226 and #109T092. The project team acknowledges support and hospitality of TUG RTT-150 staff during our visits.

Kaynaklar

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