The Galaxy Cluster RXC J1504-024

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Abstract

The galaxy cluster RXC J1504-0248, located at z = 0.215, is a remarkable example of cool core cluster relatively close to us. We have studied this object with images and spectra obtained with the Gemini South Telescope. We have estimated the cluster mass through weak and strong gravitational lensing techniques, using a NFW-type profile and the analysis of a gravitational arc, respectively. We have obtained 1.5(5) x 10^{15} $h^{-1}M_{\odot}$ within a 3 h^{-1} Mpc (WL) and 3.74 (3) x 10^{13} $M_{\odot}$ inside a 62.9 h^{-1} kpc radius (SL). The latter, extrapolated to 3Mpc with a SIS model, gives 1.7 (3) x 10^{15} $M_{\odot}$. These results are consistent with previous estimations based in an X-ray analysis of this cluster, what is an indication that it is approximately in dynamic equilibrium. We also studied the nature of the BCG (Brightest Cluster Galaxy) emission lines with a BPT diagram, concluding that the nuclear emission is consistent with a LINER.

Introduction

● The cluster RX J1504-0248 is the most prominent "cool core" cluster known in the local universe (Ogrean et al. 2010);

● There are many filaments around the BCG, which are not still well understood (Fig. 1);

● Previous works using X-ray data have estimated a mass deposition rate of 1900 $M_{\odot}$/year, which is not observed (Borhinger et al. 2005);

● Radio data has shown a diffuse source in its center, classified as a minihalo (Giacintucci et al. 2010);

● In this work, we have studied the cluster dynamical state through the comparison between its mass obtained by gravitational lensing and by an X-rays analysis;

● We are also starting a study of the BCG, aiming to understand the nature of its filaments.

Data analysis

● For the weak lensing analysis, we have used GMOS images from the Gemini South Telescope, in the g, r ,i bands;

● The instrumental magnitudes were calibrated from *Sloan Digital Sky Survey* (SDSS) photometry of cluster galaxies in the same bands;

● We have used the combined analysis of color-color and color-magnitude diagrams to classify galaxies as cluster members, background and foreground galaxies;

● For the strong lensing analysis, we have used spectroscopic data obtained with the Gemini South Telescope;

● We have measured 36 redshifts of galaxies in the field, 27 of them cluster members, and we have determined the redshift of one of the gravitational arcs;

● In this work we adopt $\Omega_m = 0.3$, $\Omega_\Lambda = 0.7$ and $H_0 = 70\ h_{70}$ km s^{-1} Mpc^{-1}.

Results and Discussion

● We have estimated the cluster mass through a weak lensing analysis (WL) adopting two density profiles: a Singular Isothermal Sphere (SIS) and NFW; we have selected 365 background galaxies to perform this analysis. The mass was calculated in several radii, to enable a comparison with previous results from the X-ray analysis;

● For the strong lensing mass estimation, we have used the redshift of one of the gravitational arcs, z= 1.2. We have obtained a mass of 3.74 ± 0.3 x10^{13} $M_{\odot}$ inside 62.9 kpc;

● Mass estimation through X-rays analysis assumes dynamical equilibrium, while the lensing analysis is independent of this hypothesis. Since the results with both techniques are mutually consistent, we infer that the cluster is probably in dynamical equilibrium;

● We have examined the BCG nuclear emission with a BPT (Baldwin, Phillips & Terlevich 1981) diagram, shown in Fig. 3; the position of the BCG emission is consistent with a LINER emission.

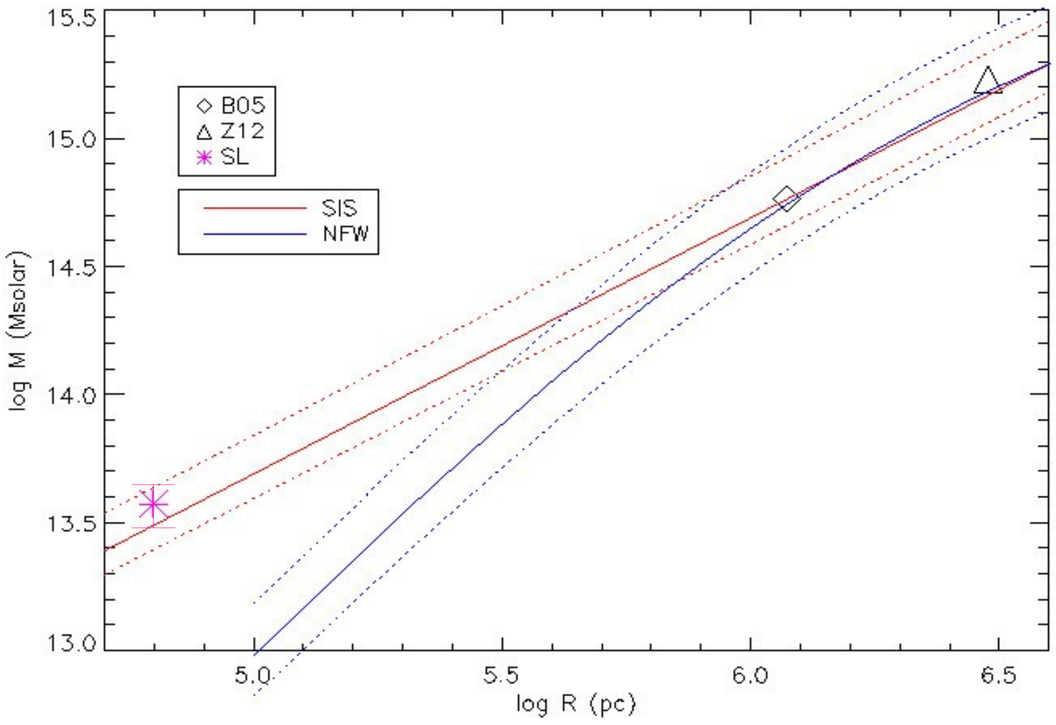

Fig. 2: SIS and NFW profiles (solid lines) obtained from WL analysis and their respective uncertainties (dashed lines). The pink cross shows the SL mass and the triangle and the diamond show the masses estimated by Borhinger et al. (2005) and Zhang et al. (2012), respectively.

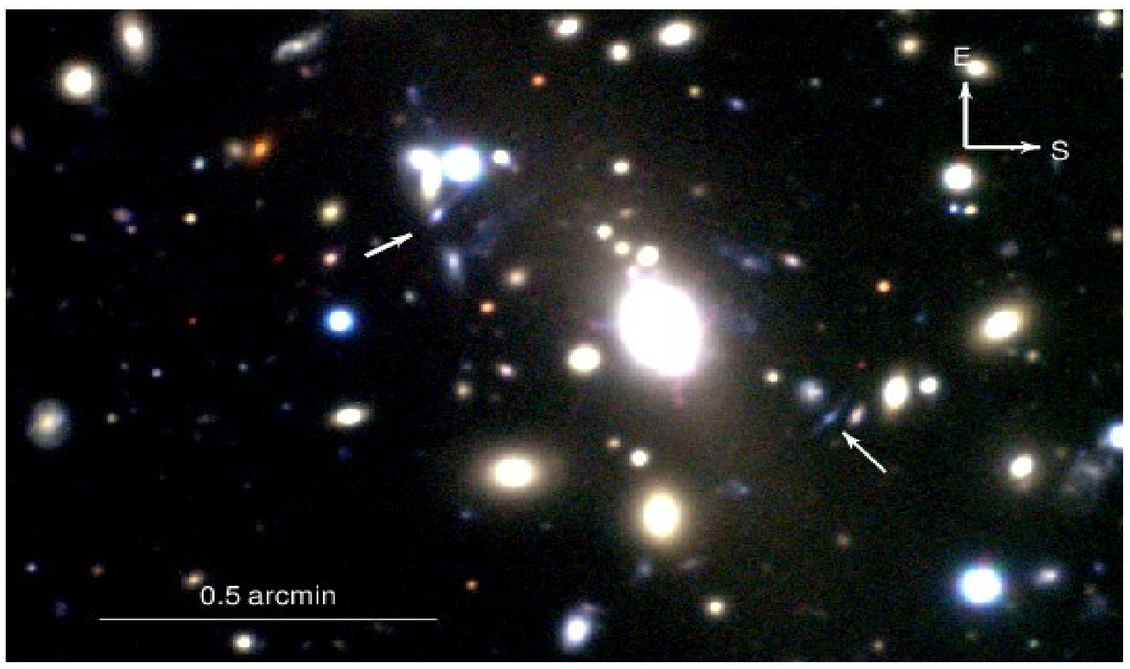

Fig. 1: Color image of the cluster obtained from the Gemini South images in g, r and i bands. The white arrows show two gravitational arcs close to the BCG. The southwest arc was used in the strong lensing analysis.

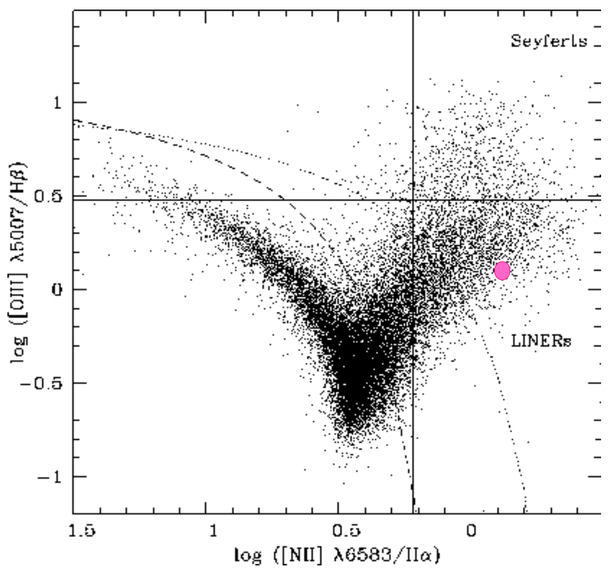

Fig. 3: BPT diagram from Kauffman et al. (2003); the pink point represents the BCG nuclear emission.

Radius (h^{-1}Mpc)	**SIS -WL (h^{-1} $M_{\odot}$)**	**NFW - WL (h^{-1} $M_{\odot}$)**	**SIS - SL (h^{-1} $M_{\odot}$)**	Previous Results (h^{-1} M⊙)
3	**1.4 ± 0.6 x 10^{15}**	**1.5 ± 0.5 x 10^{15}**	**1.7 ± 0.4 x 10^{15}**	1.7 ± 0.3 × 10^{15} Borhinger et al. (2005)
1.18	**5.6 ± 0.5 x 10^{14}**	**5.8 ± 0.7 x 10^{14}**	**7.1 ± 0.6 x 10^{15}**	5.81± 0.49 × 10^{14} Zhang et al. (2012)

Table 1: Comparison of the cluster mass obtained with different techniques.. Both Borhinger et al. (2005) and Zhang et al. (2012) have determined the matss from X-ray observations assuming the gas in hydrostatic equilibrium. For the mass estimation with the NFW density profile we assumed a concentration parameter c = 5.

References

Baldwin, Phillips & Terlevich 1981, PASP, vol. 93, Feb.-Mar. p. 5-19. ; Bohringer H., Matsushita K., Shurazov E., et al.: 2002, A&A 382,804 ; Giacintucci, S., M. Markevitch, and G. B. et al. 2011, AAP 525 ; Kauffmann, G., Heckman, T. M., Tremonti, C., et al. 2003, MNRAS, 346, 1055 ; Ogrean, G. A.; Böhringer, H. ; Yu-Ying Zhang et al. 2012, A&A...542A.106Z.