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Relationship between the environmental properties of the ICM and the central radio galaxy in the cluster of galaxies Abell 119

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Abstract. The galaxy cluster Abell 119 (z = 0.0441, richness class I) is a strong X-ray emitter although no cooling flows have been observed. The system has a disturbed morphology with evidence for the presence of groups of galaxies not yet fully relaxed. In this study we intend to describe in details the physical state of intra- cluster plasma, correlating with the properties of its central radio galaxies. We also intend to confirm - or not - the hypothesis that the system is in process of merging with neighboring system.

Resumo. O aglomerado de galáxias Abell 119 (z = 0.0441, classe de riqueza I) é forte emissor em raios-X embora nenhum fluxo de resfriamento tenha sido observados. O sistema tem morfologia pertubada com evidências da presença de grupos de galáxias ainda não totalmente relaxados. Neste estudo pretendemos descrever em detalhes o estado físico do plasma intra-aglomerado, correlacionando com as propriedades das radio-galáxias centrais. Pretendemos também confirmar - ou não - a hipótese que o sistema esteja em processo de fusão com os sistemas vizinhos

Keywords. Galaxies: clusters: intracluster medium, Galaxies: clusters: Abell 119

1. Introduction

Early X-ray observations of galaxy clusters suggested that the ICM had a cooling times shorter than the age of the Universe, leading to cooling flows toward the center of the clusters, which however are not observed (Fabian 1994) .

It is also found that most of these clusters host an AGN at their center, supporting the idea that feedback from AGNs helps suppress cooling. Jets may inflate lobes and bubbles of plasma, which can rise to the outermost parts of the cluster, heating and disrupting the ICM (MacNamara et al. 2007)

2. Methodology

For this analysis, we initially selected A119, which have public observations in X-rays (XMM-Newton and CHANDRA), in radio (153 MHz) and also in optical bands (SDSS).

Optical data for galaxies (magnitudes and redshifts) were obtained from the SDSS/DR18 database. We selected galaxies within a square of side $\sim 3 \times R_{200}$ centered at the cluster center and within a redshift range ±0.015 around the mean redshift of the cluster (z = 0.044). Member galaxies were selected using the shifting gapper algorithm.We estimated the mass and virial radius of the cluster by applying the caustic method (Diaferio and Geller 1997) and using the the Caustic-Mass code developed by Gifford (Gifford et al. 2013).

For the X-ray data, observations from the CHANDRA telescope (obsid = 4180 and 7918) were used. In order to obtain the maps, we used the ClusterPyXT automatic pipeline (Alden et al. 2019).

3. Results and Discussion

3.1. The Optical Data

Figure 1 shows the projected phase space distribution of galaxies in the region around A119. The blue curves are the caustics. Galaxies interior to the caustics curves (red dots: flag=1) are considered members of the cluster, in distinction from the other galaxies projected in the region (gray dots: flag=0). Figure 2 displays the velocity distribution of members galaxies showing it is highly symmetrical and well fitted by a Gaussian distribution. From the resulting caustics curves we estimated M_{200} = 5.03 $10^{14} M_{\odot}$ and R_{200} = $1.27 h^{-1}$ Mpc. Figure 3 shows the $SFR \times M_*$ diagram for the galaxies of our cluster. Data was obtained from the SDSS MPA/JHU (Brinchmann et al. 2004) value-added catalog. As it can be seen there is a much higher concentration in the region of passive galaxies, as expected for rich galaxy clusters such as A119.

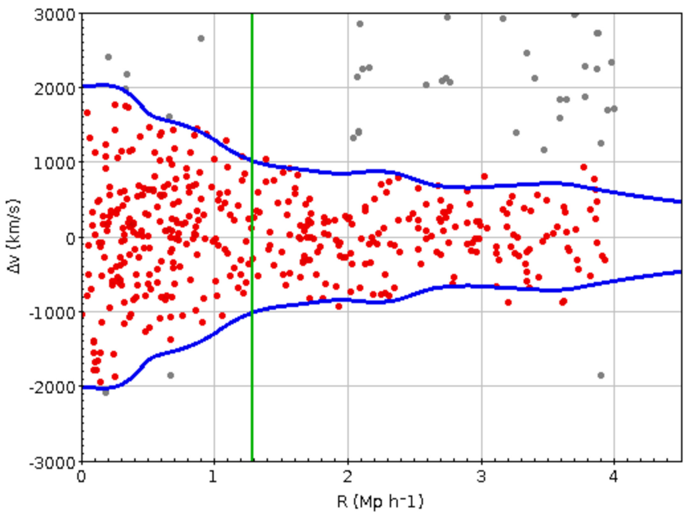

Figure 1. the Abell 119 galaxies phase space $R \times \upsilon$, where R is the radial distance of the galaxy to cluster center and υ its peculiar velocity. Red dots are the galaxies kinematically belonging to the cluster (flag=1). Gray dots are outliers detected by the shifting gapper algorithm (flag=0).

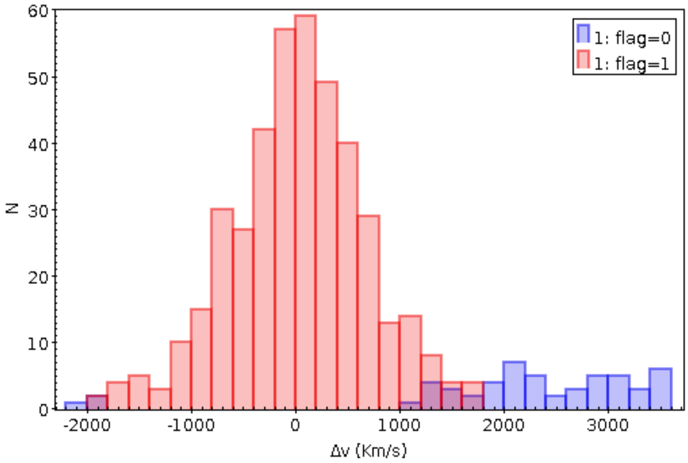

Figure 2. The Velocity Distribution of A119 galaxies. The blue boxes correspond to galaxies classified as outliers (flag=0) by the shifting gapper .

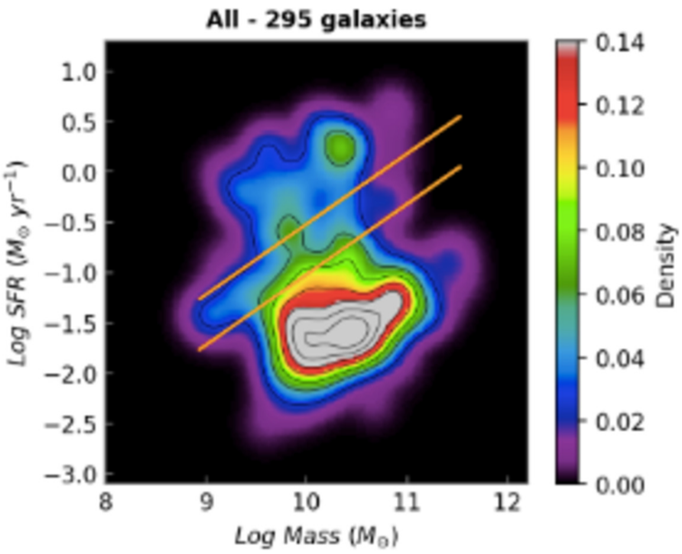

Figure 3. Density map of galaxies in the $SFR \times M_*$ plane. The fiducial lines separating the red cloud, with low SFR values, from the blue, high SFR, cloud (Trussler et al 2019) are the two paralel yellow lines

3.2. The X-ray Data

The maps shown in Figure 4 were obtained through the analysis of CHANDRA's X-ray observations using ClusterPyXT. The next steps of this work will include a more detailed discussion of these maps, as well as the study of possible correlations with radio data in order to understand the relationship between the AGN and the intra-cluster environment.

The X-ray surface brightness map (Figure 4, left) presents an asymmetric appearance with an elongation towards the northeast with irregular substructures.

Figure 4, right, shows the projected temperature map. As it can be seen, relatively cold gas ($\lesssim$ 4 keV) is distributed around the center of the cluster extending to the NE-SE direction and further to the NW from the cluster where it encounters an even colder region ($\approx$ 3keV). In the northern direction there is a gas cloud with a temperature of around 6 keV, while an arm of hot gas extends to the south of the nucleus with temperatures reaching up to 8 keV.

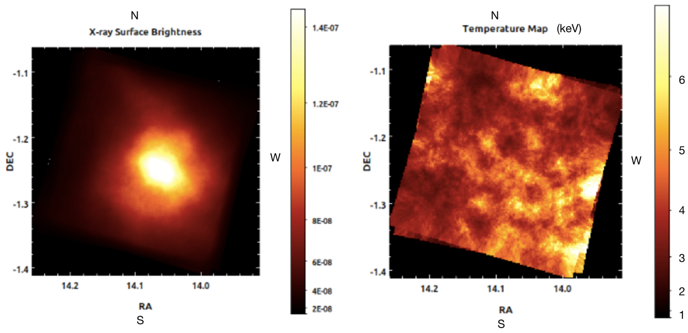

Figure 4. *Left*: X-ray surface brightness map. *Right*: Intra-cluster gas temperature (keV)

4. Conclusions

Although the results demonstrate some important features of the ICM and AGN relationship, an in-depth study also involving radio data will be necessary to understand whether in fact the observed phenomena can be attributed to the influence of AGN, and also to understand the physical processes that act behind this phenomenology.

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