INCIDENCE AND LUMINOSITY OF ACTIVE GALACTIC NUCLEI IN CLUSTER ELLIPTICAL GALAXY

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ABSTRACT

Active Galactic Nuclei, or AGNs – contains a mechanism that heats up and disperses gas surrounding the supermassive black hole of a galaxy, giving an excess in radiation when compared to other regions of the same galaxy. In this study, we investigated the frequency and luminosity of AGNs in cluster elliptical galaxies. Spectral energy distributions (SEDs) were generated by plotting a graph of flux density of radiation from different regions of a galaxies against wavelengths. Ratio images were on the other hand, generated by dividing two images after homogenization. The results showed that AGNs exhibits an excess at optical wavelength radiation, representing possibly H-alpha line emission. We predict ratio images to give the distribution of AGNs from the center of the cluster and further out. The study of incidence and luminosity of AGNs has led to a better understanding of AGNs and the mechanism behind it.

INTRODUCTION

AGNs are thought to contain a supermassive black hole that produces radiation of optical wavelength to near-UV. The mechanism is predicted to heat the disk of gases by friction as they are pushed to the supermassive blackhole and dispersed out. The gas comprises the fuel for both stars formation and the central supermassive black hole, ejecting them ceases the growth of stars and central supermassive black hole. However, the process of pushing gases into the central supermassive black holes of galaxies remains poorly understood, not to mention the mechanism of ejecting gases. Ram pressure, galaxy interactions and galactic mergers (Marshall, 2017) are said to be causes for AGNs with evident reasons, but the true nature of the processes are still unsolved. Ram pressure refers to the pressure exerted on the gases in a galaxy as the galaxy moves in the cluster, thus pushing the gases into the center of the galaxy. Galaxy interactions describes the gravitational interaction between two galaxies while galaxy mergers describe the cannibalism of galaxies by the brightest central galaxy (BCG).

METHOD

We propose to study the incidence and luminosity of AGNs in elliptical galaxy of massive galaxy cluster A209 with the usage of data from the Cluster Lensing and Supernovae with Hubble (CLASH) Program. Spectral energy distributions (SEDs) and ratio images of galaxies are generated from the CLASH data. By fitting the galaxies with a Sersic function through IMFIT, a program for fitting galaxies photos, we get the central coordinates, ellipticity and position angle of the galaxies. We then draw the central region of 0.3″ from the center of the galaxy and a few annuli of 0.3″ outwards each. The SEDs were generated after flux density of each region is obtained at each wavelength. Masking has to be done in order to mask out the neighboring galaxies that affect the data. We expect to see excess at optical wavelengths likely produced by H-alpha line emission for the central region of the galaxy. Fig. 1 shows the masking of two nearby elliptical galaxies to the third brightest galaxy in cluster A209. On the other hand, ratio images are generated by homogenizing the images before dividing two images of different wavelength to look for the presence of AGNs. Fig. 2(a) shows the ratio image between an H-alpha line filter and a longest wavelength filter at the near-infrared after homogenization. A reddish point in the middle of the galaxy represents the presence of H-alpha line emission and AGN. The distribution and frequency of the presence of AGNs is studied to find whether frequency of AGNs is concentrated at the center of the cluster, where ram-pressure is predicted to be strong.

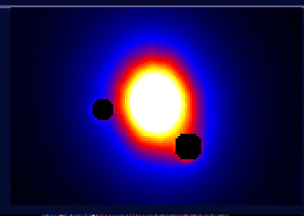

Figure 1. Masking of two neighbouring galaxies near the third brightest elliptical galaxy in the galaxy cluster A209

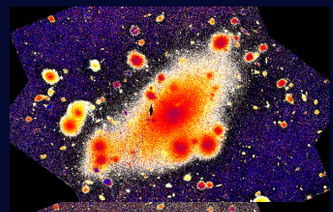

Figure 2(a). Cluster A209's ratio image of filter containing H-alpha line divided by the longest wavelength filter after homogenization. At the centre of elliptical galaxies is a reddish dot that represents an excess of H-alpha line emission, and gives evidence of an AGN.

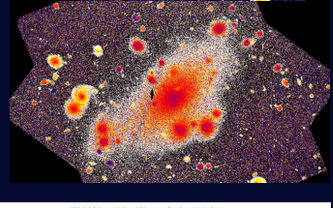

Figure 2(b). Cluster A209's ratio image of the same filters as Fig. 2(a), before homogenization. The regions of the vast universe has a significant amount of noise that obstruct the identification of small galaxies and fine details.

RESULT AND DISCUSSION

Fig. 3 shows the SED of the third brightest galaxy in galaxy cluster A209. Different color curves in each panel represents the SEDs at different radii from the centers of these galaxies (inner_UV, flux1, flux2, flux3, flux4). As shown in the plot, the SED of the central region of the galaxy is different - an excess at optical wavelength by H-alpha line emission could be recognized. Similarly, SEDs of other elliptical galaxies in the cluster were generated and all of them show similar characteristics. Refer to Fig. 3 again, the pattern of AGNs in the centers of the galaxies in the elliptical galaxies could be easily seen. The distribution of AGNs in the cluster is still a work in progress, therefore no result could be shown here. Our prediction is that moving towards the center of the cluster, galaxies experience a greater gravitational pull and accelerate faster. As a result, the effect of ram pressure is larger and the number of AGNs will appear to be higher towards the center of the cluster. One point to note about ratio image is that homogenization before division of images is inevitable because at small value of the vast universe, difference between ratio of two images could be extremely huge and thus make the ratio image dizzy, as shown in Fig. 2(b). Homogenization could diminish the fluctuations in dark parts of the images and reduce noise in the ratio images.

Figure 3. SED of the third brightest elliptical galaxy in galaxy cluster A209, normalised at 10000 A. Inner_UV region exhibits an excess at 6000-10000 A, which comprises H-alpha line emission.

REFERENCE

Marshall, M. A., Shabala, S. S., Krause, M. G., Pimbblet, K. A., Croton, D. J., & Owers, M. S. (2017, November 23). Triggering active galactic nuclei in galaxy clusters. Retrieved from https://academic.oup.com/mnras/article-abstract/474/3/3615/4655052