Distribution of galaxy morphological types with redshift

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AUTHOR BIO

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ABSTRACT

This research focuses on the relationship of the redshift of the galaxy cluster and the amount of elliptical galaxies it contains. We looked for trends or patterns that could be drawn from the data collected of the galaxies and their redshifts. The purpose behind the research is scattered online conjecture that states the merging of two galaxies will create an elliptical galaxy. While not complete proof, the findings of this research do allow further exploration into this statement. Galaxy Clusters are large groups of galaxies that are bound together through gravitational forces and can range in size and other properties. Galaxies can take on different shapes, most notably elliptical and spiral, and the goal of this study is to find if there's a link between the redshift of a cluster and the morphological distribution of elliptical and spiral galaxies in a cluster. Using Galaxy Zoo, a morphological database, galaxies and their correlating morphology were gathered. Using a script, the data was matched to NASA's Extragalactic Database to obtain their redshifts. Each galaxy was grouped to a certain redshift to get the percentage of ellipticals at each redshift, which was graphed using a scatter plot. A line of best fit was drawn and with it we calculated a Pearson's Correlation Coefficient to get the correlation strength between percentage of ellipticals and redshift. This ended up as 0.9427, which signified a strong positive correlation between the two variables. Our correlation strength demonstrates that generally, higher redshifts mean higher percent of elliptical galaxies.

Keywords: *Galaxy, Redshifts, Distribution at different Redshifts, Elliptical Galaxy, Merging Galaxies, Galaxy Morphology, Galaxy Shape, Spiral Galaxy, Hubble's Law, Correlation between redshift and elliptical galaxy, Galaxy cluster, Extragalactic database*

INTRODUCTION

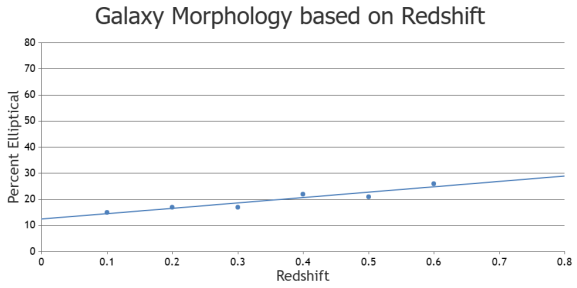
Galaxy Clusters are large groups of galaxies that are bound together through gravitational forces, and they can range in size, shape, and other properties. Galaxies can take on different morphological types, most notably elliptical and spiral, and the goal of this study is to find if there's a link between the redshift and the morphological distribution of elliptical galaxies in a cluster. Redshift is a property that relates to an increase in wavelength and decrease in frequency of electromagnetic radiation. Through Hubble's Law and the expansion of the Universe, it can be related to the age of observable objects, and thus provides a strong foundation to base our research on. Galaxies with higher redshifts are further away and generally older, meaning there's a higher probability for more galaxy mergers to have occurred. This theoretically would mean that there would be a higher percentage of elliptical galaxies at higher redshifts.

GATHERING AND ORGANIZING DATA

Galaxy clusters were the initial starting point due to the close proximity of the galaxies within them, allowing for more galaxy mergers to occur over time. A large amount of time was spent researching in order to look for the morphological data of known galaxy clusters. However, very limited morphological data is available for galaxies, and getting proper data to make a good conclusion and analysis is realistically speaking, not possible. Partial morphological data for the galaxies in a cluster would require large amounts of extrapolation for each cluster, diminishing the value of the analysis and conclusion. However with certain concessions made with regard to how data would be collected, a strong result can also be achieved by focusing on galaxies individually. Using Galaxy Zoo, galaxies with morphological data were selected. Afterwards, a database match was performed with NASA's Extragalactic Database to get and store the redshift of each galaxy. Each galaxy was grouped based on the redshift from 0 through 0.6, with an increment of 0.1. Finally, at each redshift increment, the percentage of elliptical galaxies was calculated.

GRAPHING THE DATA

With the different percentages of elliptical galaxies, the next step was to graph the data so it could be properly analyzed. A scatter plot is the best option as it is capable of showing patterns in this scenario much better than other methods. They also allow for a line of best fit to be drawn, which is necessary for determining the correlation strength between the two variables.



CORRELATION STRENGTH

The Pearson Correlation Coefficient is a method that allows you to assess the strength of the correlation between two sets of values. The closer the final result is to 1, the stronger the correlation, and the closer it gets to 0, the weaker the correlation. Calculating the Correlation Coefficient for the above scatter plot, we arrive at a value of 0.9427, which signifies a very strong positive correlation between a higher percentage of elliptical galaxies and higher redshifts.

CONCLUSION

Our correlation strength shows with a reasonable degree of certainty that the higher the redshift, the more elliptical galaxies there are. Looking back towards our initial purpose, the findings help support the idea that two galaxies merging will produce an elliptical galaxy. As discussed previously, redshift can help us determine the age of faraway objects. The further out you go in the universe, the more galaxy mergers there would be, leading to higher

percentages of elliptical galaxies. There is a lot of potential for further research in this area, especially towards a scientific explanation for why this happens. Another idea that could be explored more, especially with more complete morphological data, is involving the different types of elliptical galaxies so that we could make more complex observations and further our understanding behind the phenomenon of two galaxies merging to create an elliptical galaxy.

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