Identifying Galaxy Mergers in the Distant Universe Using the Hubble Space Telescope

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Abstract

By studying galaxy clusters we can better understand the evolution of galaxies and how interactions between galaxies can change their morphology. In clusters, galaxies evolve through close interactions and merging together. Here we present the results of finding mergers in the IRC0222A cluster with a look-back time of 9.2 billion years and the IR0222B cluster with a look-back time of 9.9 billion years. The Hubble Space Telescope (HST) imaged both clusters in three different filters. Grism observations were used to obtain the look-back time for galaxies in both clusters.

Galaxy mergers in both clusters were identified by measuring the flux of each individual object and using a search radius to constrain the distance between objects. The mergers were crosschecked with mergers that have previously been visually identified. We measure a merger fraction of approximately 39% for IRC0222A and 49% for IRC0222B.

Introduction

Images of the IRC0222A and IRC0222B were taken in the infrared using HST/WFC3 in three different filters: F105W, F125W, and F160W.

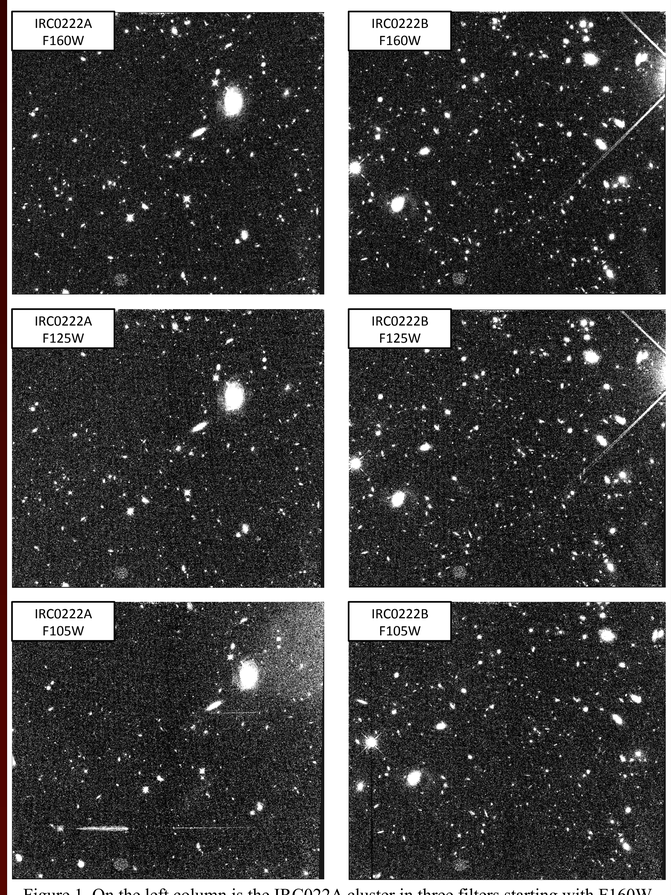

Figure 1. On the left column is the IRC022A cluster in three filters starting with F160W, F125W, and ending with F105W. On the right column is the IRC0222B cluster with the filters in the same order as on the left. These images are the raw images from HST.

Method

Cosmic rays and bad pixels were removed for each individual image using the AstroDrizzle package in Astroconda. After the initial drizzle run the images were aligned using the TweakBack package in Astroconda, drizzled one more time, and combined to form one image to represent each filter for each cluster.

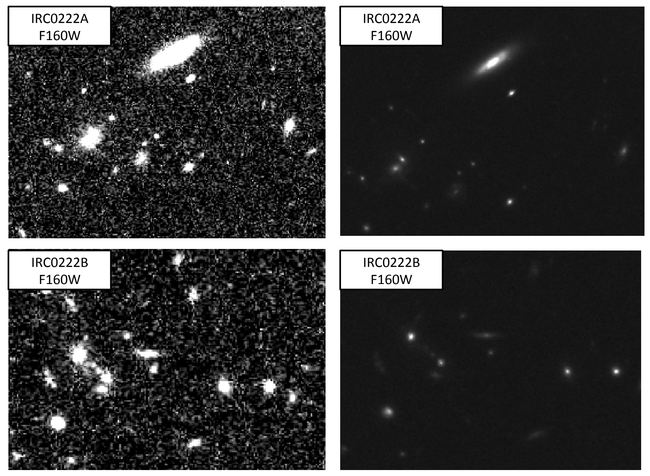

Figure 2. These images showcase the importance of drizzling and how it affects the quality of an image that we analyze to find possible mergers. All images were taken in the F160W filter. Top left panel is the final, drizzle, and combined image of a small portion of IRC0222A. Top right panel is a single undrizzled image of a small portion of IRC0222A. Bottom left panel is the final, drizzled, and combined image of a small portion of IRC0222B. Bottom right panel is a single undrizzled image of a small portion of IRC0222B.

Figure 3. On top is an RGB image of IRC0222A cluster and below is an RGB image IRC0222B cluster.

By combining the final drizzled images for each filter, we were able to create an RGB image of both clusters as seen above in Figure 3. A catalog of all the objects in both clusters was created by creating a stacked image using the F160W and F125W filter images for both clusters and using SExtractor to measure the flux of each individual object.

Results

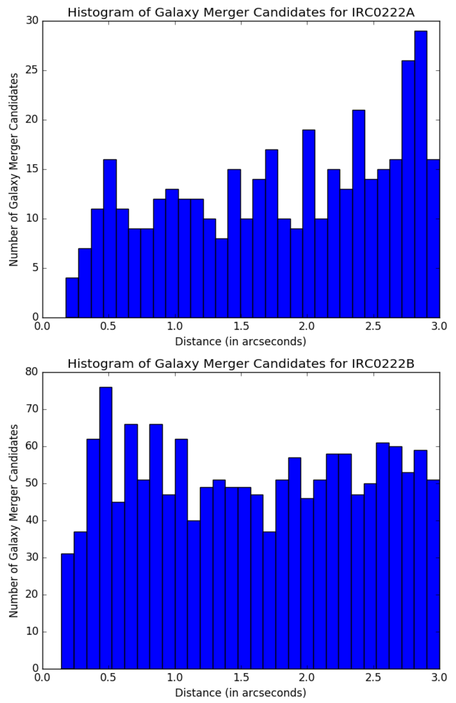

Figure 4. At the top is the histogram of the number of merger candidates for IRC0222A and at the bottom is the same histogram for IRC0222B.

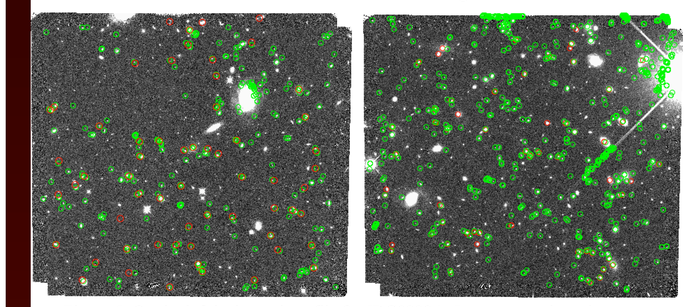

Figure 5. On the left is the regions file for IRC0222A. In green are the galaxy merger candidates found using the computational method and in red are the galaxy merger candidates that were visually identified. On the right is the regions file for IRC0222B. The coloring scheme is the same as IRC0222A regions file.

Conclusions

By comparing the results of finding galaxy mergers using a computational means versus visually identifying galaxy mergers, we find that using the computational method will yield more merger candidates. This computational method does require some careful fine-tuning such that we do not get candidates that are obviously not galaxy mergers. By using both results from the two methods we are able to better determine the galaxy mergers in both clusters thought, there still needs to be work done for visually and computationally identifying galaxy mergers for IRC022B. We measure a merger fraction of approximately 39% for IRC0222A and a 49% merger rate for IRC0222B.

References

Skelton et al. 2014, AJSS, 214, 2.
Momcheva et al. 2015, ApJS, 2106, 2.
Watson in prep.

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