Color Maps of the Interacting Galaxies NGC1512 and NGC1510

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Abstract

As humans, we only see a fraction of our universe. With new technologies such as CCD cameras, color filters, and computer programs for image analysis, we can get a glimpse into the unseen. Multiple images of the interacting galaxies NGC 1512 and NGC 1510 were taken using a robotic telescope in Australia. Using Python, the images taken with a specific filter are lined up and then added together to observe invisible details. Comparing the light from different colors can help us map out the possible history of the interactions between these galaxies.

Methods

The original images of NGC1512 and NGC1510 were taken using the iTelescope program and a telescope in the Siding Springs Observatory in Australia. Two of each image in the telescopic filters B, R, and V were taken in five-minute exposures using the T30 telescope (Figure 2). The telescopic filter B stands for blue and collects wavelengths of light within the range of blue (approx. 400nm-500nm). The R filter stands for red and collects wavelengths of light within the range of red (approx. 550nm-800nm). The V filter stands for visible and collects light within the range of human eyesight (approx. 500nm-700nm).[1] These images were then downloaded.

The Python program Jupyter Notebook with a variety of modules (imported and included) was used for the process of analyzation and image processing. Two such modules are Astropy, included in Python and used to analyze astronomical data; and Astroalign, imported into Python and used to align two astronomical images containing stellar data. Each of the four images in each telescopic filter were aligned and compiled using Astroalign; this is to ensure there is no blurriness and all images are contained within the same general coordinate system. Compiling these images together also allows more data per pixel of image. After the images were aligned, the data within the images are added together per filter. A total of three coadded images are produced from this method; one with the V filter, one with B and one with R.

The background noise presented within the coadded images is then subtracted out. Finding the average of the medians of the four corners of the images with no major stellar matter, gives the value as the average background "noise", which becomes the value subtracted from the coadded image values. Doing this reduces the noise, allowing focus on the galaxies.

The product is then produced from dividing the subtracted images. Dividing the images creates the colormaps.

Figure 1. Telescopes within the Siding Springs Observatory in Australia.[2]

Figure 2. The T30 telescope, a 30-500mm Reflector.[2]

Results

Every step of this research produced unique results, constantly evolving with every applied analyzation and process. Starting with the target image of each aligned transformation and comparing it to the added images of each filter, the importance of compiling data and exposure time can be shown. As the data shows in Figure 3, the difference can be shown
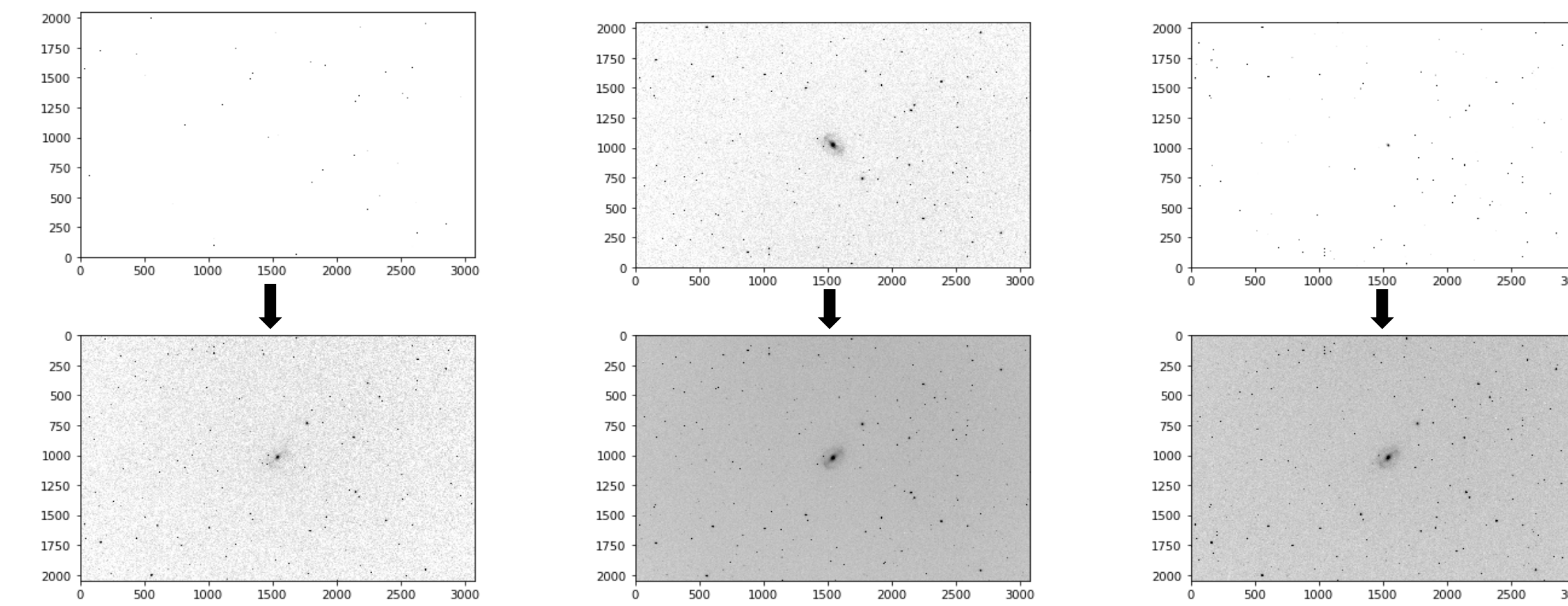

Figure 3. First image column (left): B filter images. Second image column (middle): R filter images. Third image column (right): V filter images.

just from adding all the images of a certain filter together. Each of the images in the top row are a singular image and by compiling the other three with it allows for the extra data per pixel, as discussed in the methods section and shown in the bottom row in Figure 3.

Finding the average of the median of each of the four corners of the added images gives the average sky background values which are then subtracted from the added images to produce an image with minimal background noise and more focus on the galactic halos of NGC1512, NGC1510 and some prominent surrounding stars. Figure 4 shows the background noise subtracted images from the bottom row of images in Figure 3.
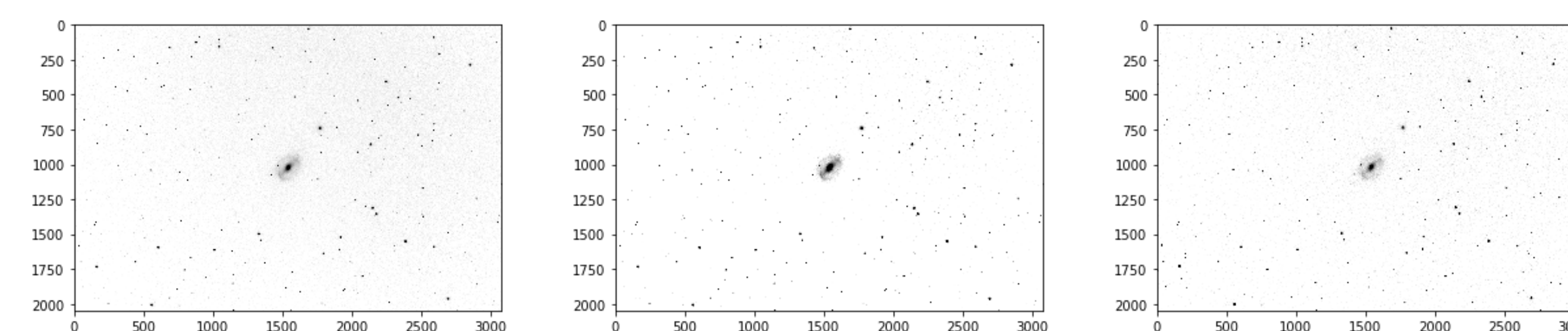

Figure 4. Background noise subtracted images. First image: B filter. Second image: R filter. Third image: V filter.

Since red wavelengths of light and blue wavelengths of light are on opposing ends of the visible section of the electromagnetic spectrum, using the added R images and the added B images for the division and the color mapping would produce the best results. A program was written to run through the added R and B images and produce the background sky subtraction, find the median, create the sky model and then produce a colormap using the filter 'rainbow' to aid in displaying differences within the pixels (Figure 5).[3]
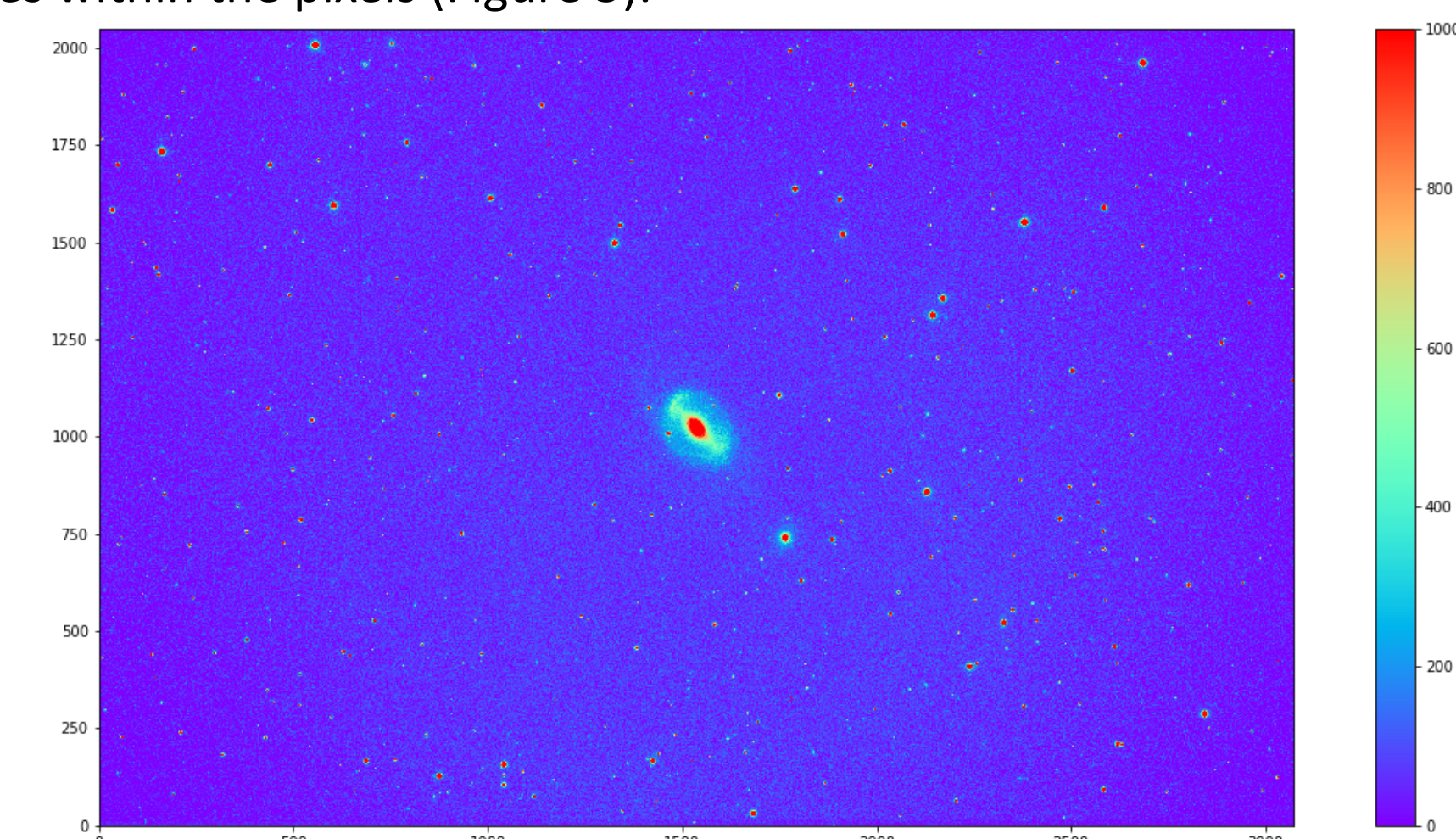

Figure 5. Colormap of NGC1512 and NGC1510 in B and R filter. Showing arms from halo.

The final image (Figure 6) created is an enlarged portion of Figure 5. Using the same program written and described above, but with a different task, it pulled out "median boxes" within a range of values to display a certain range of colors in a specific area.
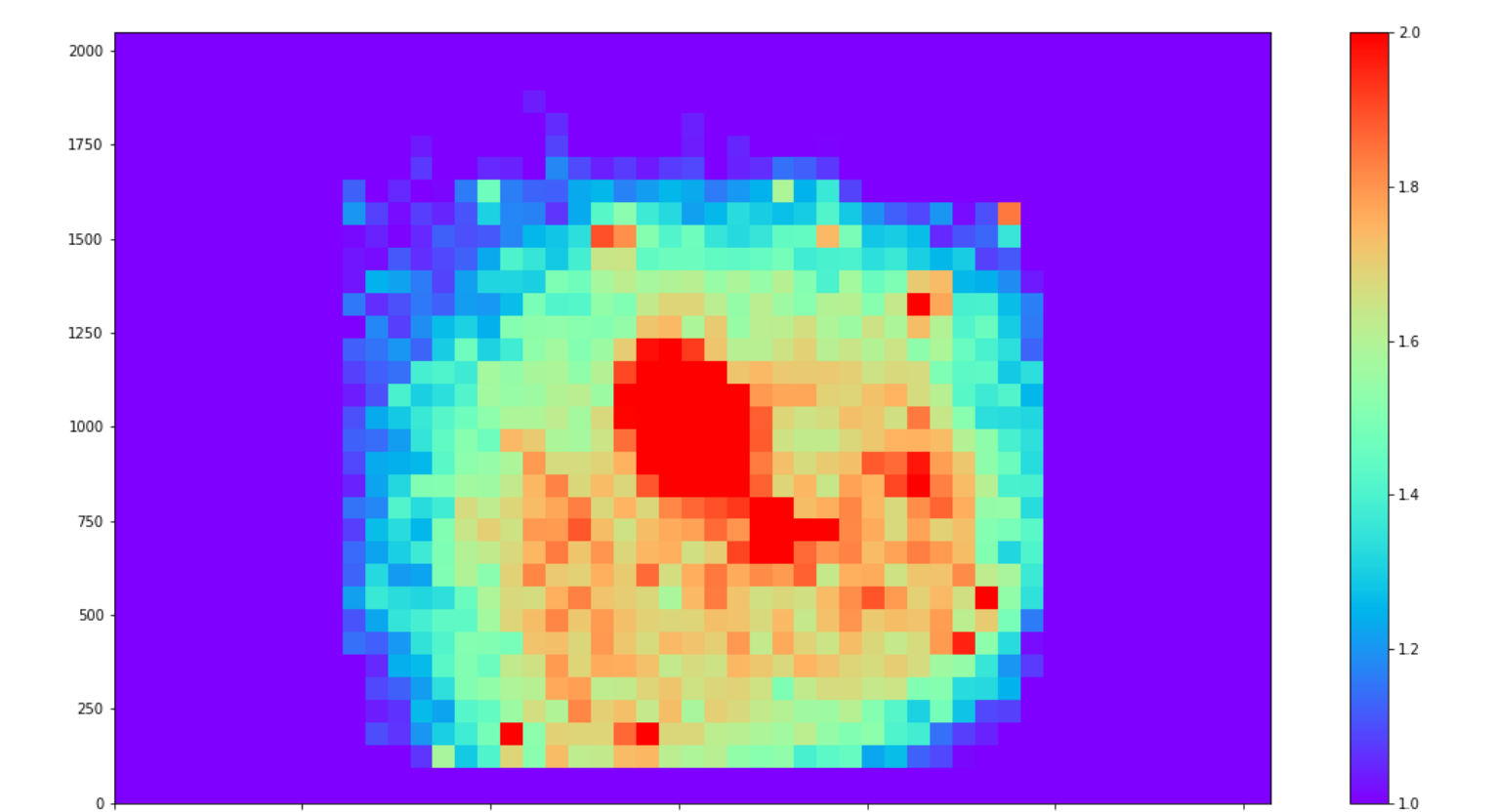

Figure 6. Enlarged portion of the above figure with a specific median value set.

Discussion

As displayed throughout the methods and results, a variety of factors and outcomes went into the production of this research. One of the biggest challenges to overcome was obtaining the amount of data needed per the collected amount of data. For example, to be able to see prominent extending arms from the galactic halo, more exposure time was needed, however, to obtain the data, requires time, that was not permitted for certain limits. To overcome this, the Astroalign module was used to compile the data and even though the results wanted were not exactly produced, a close second was as described via the results.

The images and results produced, partially fulfill the goal of this research. Through color mapping, provided the circumstances, it was shown that the interactions of collided galaxies such as NGC1512 and NGC1510 can be displayed through this method of studying the stellar matter within each galaxy, in relation to the parent.

Conclusions

In conclusion, this research provided an insight into using Python programs such as Astropy and Astroalign for astronomical image analysis. In using these programs, a variety of results that all lead to a broader confirmation, were concluded. Images included in the results section of this poster showed the outcomes of using these modules and more importantly the goal of this research. Displaying the step-by-step process of image analyzation and processing, the results shown, solidified the goal as described in the discussion section.

Future applications of more extensive research in the project can be done. If many images are taken of longer exposures in a multitude of sections in and around NGC1512 and NGC1510, then a more in-depth model of the interaction can be displayed. Taking in ideas that stars that form within a certain galaxy will contain only the elements abundant in the parent galaxy, colormaps much like the ones shown is the results can be created of the extending spiral arms. Upon close analysis, the stars that have been disrupted from either galaxy in those spiral arms, will possibly have slightly different colors or emit/absorb more of one wavelength of light more than the other due to the specific compositions. The direction and distribution of the stellar matter that have the certain colors and/or wavelengths of light, can be determined to model the future interaction and evolution of the galactic pair.

References

1. "UBVRI Filters." *UBVRI Filters | McDonald Observatory*, McDonald Observatory, 2020, mcdonaldobservatory.org/research/instruments/ubvri-filters.
2. Images from: ITelescope.Net.
3. Cederbloom, Steve (4-23-2020) NGC1512 Sky Model and Subtraction and Colormap. From/used in: http://localhost:8889/notebooks/NGC%201512%20sky%20model%20and%20subtraction%20and%20colormap.ipynb