Draft version March 24, 2020
Typeset using LATEX default style in AASTeX63

Galaxy Colors In The NDWFSJ1428p3346

B. Comia, M. Theel, P. Toro, and M. Witek

ABSTRACT

Key Words Galaxy: Photometry - surveys - catalogues - radio continuum: galaxies - program: SExtractor

The J1428p3346 region of space was analyzed using a 0.675° area of the regions K-band and the R-band to identify any stellar objects that exist within the region. All identified objects had their coördinates recorded and compared between bands to find if they were real. Each object located also had their stellarity determined as well as a value calculated for their R-K color band. These values were used to determine any patterns that might exists between the objects magnitudes and their R-K values.

INTRODUCTION

Understanding sources found in the K-band and R-band wavelengths and whether they represent real objects in the night sky, or are simply consequences of our instrumentation and technological limitations was among our primary goals. The goal of finding 10 such objects in each the k and r-band was accomplished by a process outlined in the methodology section of this paper. By comparing said images we were able to decide multiple objects, likely galaxies, that do exist in the night sky, as well there relative magnitudes and stellarity (see results). Graphical representations were utilized but clear patterns were unlikely to emerge due to the limited data set. Other such studies have examined the similar sources and complied optical identifications (Jannuzi & Dey (1999)). Ideally, We would like to study a larger grouping of images and examine their magnitudes to determine the prevalence of any patterns that emerge. It would be interesting for our any future forays into Astronomy for us to have a sense of whether or not the magnitudes of various objects that we observe are typical of stars and galaxies of these kinds. In this paper, we discuss the properties and relationships that exist with our two optical K and R band image counterparts taken from the NOAO Deep-Wide Field Survey (NDWFS). The NDWFS data covers a 0.675° Right Ascension (RA) of the K-band near-infrared range. In the first section of the paper we briefly describe the methodology used to complete the aforementioned objectives. In the second section of the paper we discuss the results of our findings, and in the third section, we summarize our results and understanding.

METHODOLOGY

We were required to download the R-Band and K-Band images of the JM28p3346 field within the NOAO Deep Wide-Field Survey database. We were also required to download and run SExtractor on the K-Band and R-Band images in detection mode to generate their catalog of band sources. Initially, our group removed artifacts from both the R-Band and K-Band by increasing the detection threshold just enough to remove the unnecessary objects that were in the image. In order to do this, we opened up terminal and ran two commands "$ sex NDWFSJ1428p3346_K_01_sci.fits -CHECKIMAGE_TYPE OBJECTS" and "$ sex NDWFSJ1428p3346_R_03_sci.fits -CHECKIMAGE_TYPE OBJECTS". After this, we created three different catalogs in which each one had the sole purpose of locating the ten brightest K-Band sources and then locating each of those objects in the R-Band image. The first catalog was "test.cat" which consisted of the x-coordinate, y-coordinate, and magnitude value as parameters of K-band image. The second catalog was "test2.cat" which consisted of only the magnitude of the K-Band image. Last but not least, the third catalog was "testr.cat" which consisted of the x-coordinate, y-coordinate, and magnitude value as parameters of R-band image.

Once we have acquired the respective R-Band sources, we collected its x and y coördinate as well as manually find its magnitude in the "testr.cat" catalog. We were able to do this by matching the K-Band and R-Band coordinates using the "world coordinates system" in DS9. We also had both R-Band and K-Band images loaded in two separate frames. When selecting the frame that the K-Band image was in, we manually had to go into our "test2.cat" catalog to search and find the largest magnitude, which resulted in the largest negative value. Once we retrieved that magnitude, we went into our “test.cat” catalog where we located that specific magnitude’s x and y coordinate by using its line number from the “test2.cat” catalog. Next, we located the coordinates in the K-Band image then used

```
Frame>Match>Frame>WCS
```

in order to locate that specific location in the R-Band image. Finally, we recorded its x and y coordinate then used “testr.cat” catalog to search for those coordinates and took down the respective magnitude. Our group repeated this same methodology when we were required to find the ten brightest R-Band sources.

For our detection of galaxies we were able to use the “CLASS_STAR” command in the SExtractor output parameters along with a neural network provided by Astromatic.net (2009) to determine the stellarity index of an object. The result is that every objects had a stellarity index from 0 to 1 associated with it. For our measure of figure: 1 we considered a galaxy to be anything under 0.2 stellarity index, since we wanted to be reasonably certain we had identified a galaxy since a stellarity closer to 0 indicates a higher confidence an object is a galaxy. for figure: 2 we considered anything less than 0.5 to be galaxy like and anything over 0.5 to be star like. To reduce the number of artifacts we detected we doubled the “DETECTION_THRESHOLD” and “ANALYSIS_THRESHOLD” parameters from 1.5 to 3 which seemed to do the job well enough. We were afraid to increase it much further for fear of removing faint but legitimate objects. Artifacts had little impact on our brightest objects, since we manually verified their validity. Using the “-CHECKIMAGE_TYPE OBJECTS” command was useful for checking what specifically was detected.

RESULTS

Using S-extractor to identify galaxies we were able to create a plot depicting the number of galaxies vs their measured K-band magnitudes (see figure: 1). For this part we considered everything under 0.2 on the stellarity index to be considered a galaxy. These galaxies represent majority of the objects that we detected and a pattern does show most of these galaxies are between magnitudes are 15 to 17. We can note that these findings seem to hold up with other studies done on the NOAO Deep Wide-Field survey like El Bouchefry & Cress (2007), in that most of the galaxies detected in are between brightness magnitudes of 10 to 20 in the K-Band. The sum total of our galaxies are between magnitudes 11 and 19 which are consistent with the aforementioned studies. There are a few things that should be

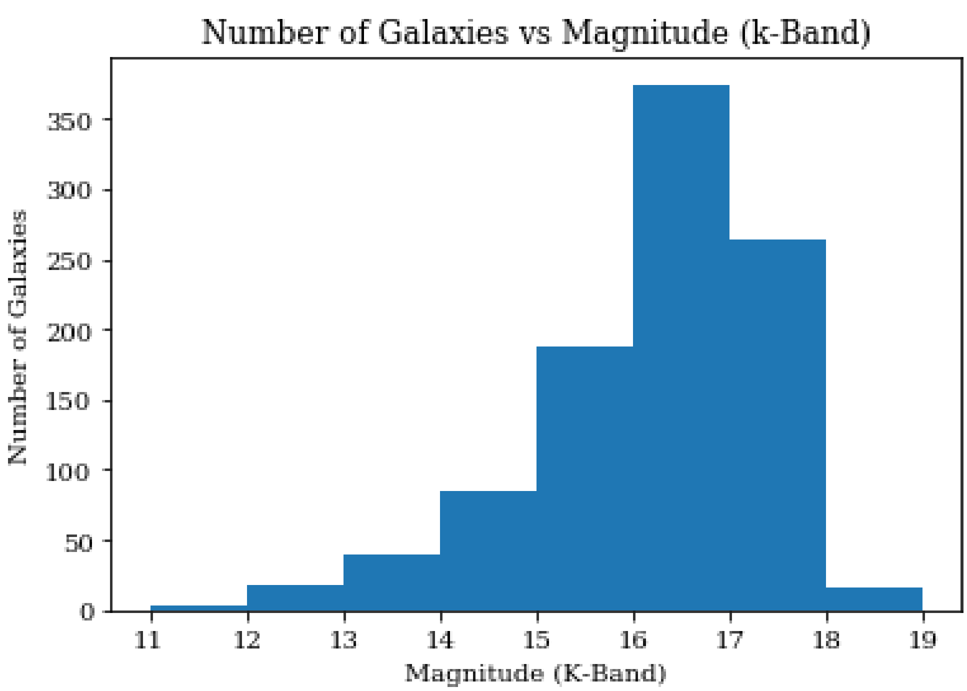

Figure 1. The number of galaxies VS. Magnitude (K-band) in 1 magnitude bins. There are 988 galaxies with their K-Band magnitudes identified. The region represented is: 0.675° Right Ascension. Most of the galaxies are between 15 to 18 magnitudes which is supported by El Bouchefry & Cress (2007).

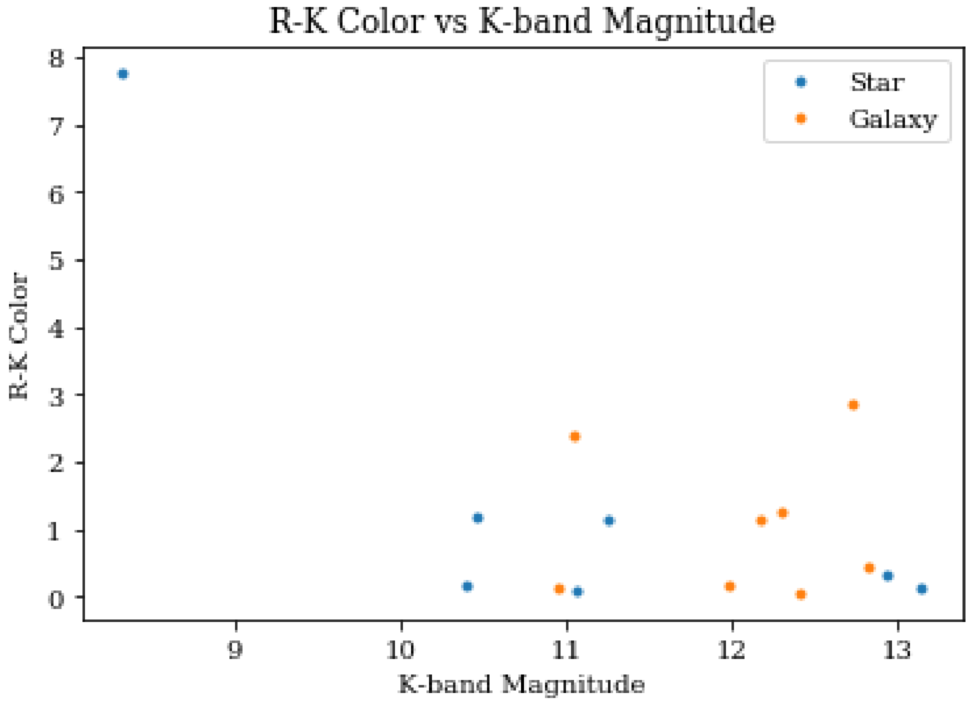

Figure 2. The R-K values for the top 15 brightest objects from the R and K Bands vs their K-Band magnitudes. The region represented is: 0.675° Right Ascension. Most of the objects in question are between R-K colors of 0 to 3 and K-band Magnitudes of 10 to 13.5. The raw numbers and their positions are provided in table: 1.

noted however. Despite our best efforts to reduce the number of artifacts that would be detected by S-extractor, it seems almost a certainty that some small number will have slipped through the cracks. However, even when we made the detection parameters absurdly strict, the pattern remained. Any artifacts that did get through only seem to amplify the peak but the general trend and scale remain the same.

When we found our 10 brightest K-band objects and 10 brightest R-band objects, 5 of them overlapped which left us with a total of 15 distinct objects of interest. From there we created a plot of their R-K Color vs K-band Magnitude which is shown by figure: 2. There are 8 galaxy-like objects and 7 star-like objects, which with one exception are clustered around R-K Color 0 to 3 and K-band Magnitude 10 to 13.5. These brighter objects make up a clear minority compared to the rest of the objects that we detected with these 15 brightest objects containing a good number of the total stars we found (97% of the objects we detected are galaxies). No clear pattern emerges from the R-K Color vs K-Band Magnitude, but this may be due to the limited scope of the number of objects to plot. A more clear pattern for example may emerge if objects with K-band magnitudes around 15 to 17, around which most of the typical objects reside, were included. This leaves room for further research. The outlying object around the R-K color of 8, upon further inspection appears to have been detected as a grouping of several objects in the R-band and should not be seen as indicative of any pattern or trend.

K-band X	K-band Y	K-band Magnitude	R-band X	R-band Y	R-band Magnitude	Object
3129.798	390.958	8.3189	3916.765	5426.082	16.1056	Star
4139.423	378.786	10.4007	5254.92	5333.074	10.6068	Star
3407.079	2639.193	10.4563	4273.932	8311.532	11.6782	Star
2956.991	2848.46	10.9554	3689.943	8587.383	11.1154	Galaxy
5565.623	1679.603	11.0465	7122.403	7047.085	13.4651	Galaxy
3203.631	2872.212	11.0591	4014.046	7299.346	11.1668	Star
1918.298	2951.67	11.2606	2320.493	8723.539	12.4378	Star
2846.143	240.50	11.982	3544.301	5150.127	12.1945	Galaxy
5967.734	2196.889	12.1697	7653.768	7729.822	13.335	Galaxy
1370.838	2381.243	12.4108	1580.648	7971.779	13.6015	Galaxy
1348.542	432.542	12.3065	1569.372	5404.519	12.4988	Galaxy
2500.895	571.746	12.7207	3087.292	5587.145	15.6084	Galaxy
474.028	760.592	12.8284	415.564	5836.397	13.025	Galaxy
2188.752	352.892	12.9267	2677.885	5298.922	13.2715	Star
480.028	558.120	13.1452	423.545	5569.561	13.3029	Star

Table 1. This table represents the Pixel X Y coordinates of our 15 brightest objects. All the objects are at 0.675° Right Ascension (RA) of the K-band and R-band since to get r-k values for both they had to be present in both measured bands. The pixel scales are 0.340 arcsec/pixel for both axis in the K-band coordinates and 0.258 arcsec/pixel for both axis in the R-band coordinates.

CONCLUSION

Upon setting out to find the 15-20 brightest sources in the J1428p3346 region of space taken from the NOAO Deep Wide-Field Survey database, we were tasked with locating ten of the brightest sources in the K-band image, as well as the ten brightest sources in the R-band image which were then analyzed to determine which were galaxies or stars. With both images being freed of any unwanted and insignificant artifacts, catalogs of bright sources were created upon running these images through SExtractor. With the use of these catalogs and DS9, we sifted through these sources, locating the brightest within each catalog, taking down each bright source's coördinates to then locate within the respective R-band or K-band image. Going through these sources one at a time, we would locate the source with its respective coördinates, and then find that same source in its opposing image; meaning that if we were working in K-band, we would find that source in the R-band image, and vice versa to then take down its coordinates and locate its magnitude in order to see if it too was a bright source in the opposing image. With a total of 15 sources found which were bright sources in both the K-band and R-band images, the next step was to calculate the R-K value. With the R-K value, all that was done was that the R-band magnitude was subtracted from its respective K-band magnitude. The R-K color value allowed us to see the if the object was more red, or more blue. Once the R-K color was determined, we used a neural network to calculate each sources stellarity index. With the stellarity index calculated for each source, we were then finally able to decide which of the 15 sources found were galaxies or stars. We were able to find that a stellarity index less than 0.5 indicates a source as galaxy-like, and stellarity index greater than 0.5 indicates a source as star-like. Our final results indicated that we found 8 galaxy like objects, and 7 star like objects. No patterns, trends, or similarities were found.

Upon coming across these final results, we found that maybe more could have been done and began to wonder what we could find with looking at a larger portion of the sky. Would a pattern or trend emerge? Would finding more sources lead to there being more star-like or galaxy-like objects? This of course could be answered with more research and testing of a larger region of J1428p3346 images of the sky.

CITATIONS AND REFERENCES

REFERENCES

Astromatic.net. 2009, Neural Network Weights for the SEXtractor star/galaxy classifier Kernal Description. https://astromatic.net/redmine/projects/sextractor/repository/revisions/227/entry/config/default.nnw

El Bouchefry, K., & Cress, C. M. 2007, Astronomische Nachrichten, 328, 577, doi: 10.1002/asna.200610717

Jannuzi, B. T., & Dey, A. 1999, Astronomical Society of the Pacific Conference Series, Vol. 191, The NOAO Deep Wide-Field Survey, ed. R. Weymann, L. Storrie-Lombardi, M. Sawicki, & R. Brunner, 111