HII Regions and Supernova Remnants: A Comparative Study

The H II Regions Aspect

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Abstract:

Our group used the PROMPT telescopes in Cerro Tollolo via SkyNet, SkyView, and SIMBAD to gather our astronomical data. We then found the star type, temperature, and brightness of three stars from each of the four nebulae. We found five type K stars and one type F star in the supernova remnants. In the HII regions, we found Two K types, two O3 type stars and a peculiar O type star. We were unable to get an accurate temperature for the star HD93129B. We recommend that further studies be done concerning this possible link between the two types of nebulae and their respective stars.

Introduction:

The goal of our research was to find any correlation between stars in supernova remnants and H-II regions. We studied four nebulae, two HII and two supernova remnants. In each of the nebulae, we then studied three stars for a total of twelve stars studied. We gathered the V and J filter images and gathered the rest of our data from those images. Our goal was to find the magnitude, temperature, and types of three of the brightest stars in each of the nebulae, in our case, being the H II regions.

Also known as emission nebulae, H II regions are hot, ionized hydrogen gas clouds in which stellar formation often occurs. In these regions, there is a central star with a surface temperature of at least 20,000 K, producing the energy to ionize and heat the hydrogen atoms. One of the most conspicuous emission nebulae is the Orion nebula. In this study, the H II regions we are studying are the Eagle and the Carina nebulae.

7,000 light years away, the Eagle nebula (IC 4703) is situated in the Sagittarius arm of our own Milky Way Galaxy. It can be located within the tail of the constellation Serpens, with the right ascension of 18h 18m 48s and declination –13°49'. The Eagle nebula is responsible for the open cluster, Messier 16, which was created approximately 5.5 million years ago. The Eagle nebula is well known for "The Pillars of Creation," a photo of dark gas columns taken by the Hubble Space Telescope. At the end of each column are several EGGs, or evaporating gaseous globules. These EGGs are compact, dense pockets of gasses that are responsible for the creation of stars within the nebula. In fact, our very own Sun may come from a structure such as an EGG. There is no doubt that the Eagle nebula is an important center of stellar formation.

The Carina Nebula is a giant star forming region discovered by Nicolas Louis de Lacaille in 1751. There is more than meets the eye to this cloud of dust, as it boasts many impressive features. These include massive H II Regions, many O-Type stars, and open star clusters. In fact, O-Type stars were first identified in Carina, which is home to so many enormous stellar formations. One particularly massive star, Eta Carinae, formed the smaller Homunculus Nebula in 1841 when it suffered a near supernova explosion. Located in the southern hemisphere portion of the Milky Way, the diffuse nebula has a visual magnitude of 1.0, making it is one of the largest diffuse nebulas that can be seen with the naked eye. Approximately eight thousand light years away from Earth, and with diameter over two hundred light-years across, Carina is four times larger and brighter than the Orion Nebula. The Carina Nebula is a good example of how very massive stars rip apart the molecular clouds that give birth to them. The bright star near the center of the image is Eta Carinae, which is one of the most massive and luminous stars known.

Observations:

Three pictures the Eagle nebula were obtained from NASA's digital sky survey in Skyview: a normal optical picture, a J-band picture, and one with a blue filter. We were not able to obtain pictures from Skynet. From the normal optical picture and the program Stellarium, we chose three of the brightest stars and recorded their true apparent magnitudes. Then we measured the magnitudes of the stars in blue and J pictures using Iris's aperture photometry and used the measurements to help determine the temperature and type of each star by using V-J.

For the Carina Nebula, we incorporated various internet sources as well as SkyView images to study our stellar formations. In addition, ImageJ and Iris aided in finding the magnitude of our selected stars.

We also assembled histograms of the intensities of the stars in each nebula, excluding stars below intensity 63,095 (above apparent magnitude –12). First, a 10x10 grid was placed on a 600x600 pixel picture of a 1x1 degree picture of the nebula, and each square plot from the grid was numbered from 1 to 100. Using a random number generator, 5 plots were selected, and the intensities of each star in the selected plots were measured using the aperture photometry in Iris and recorded.

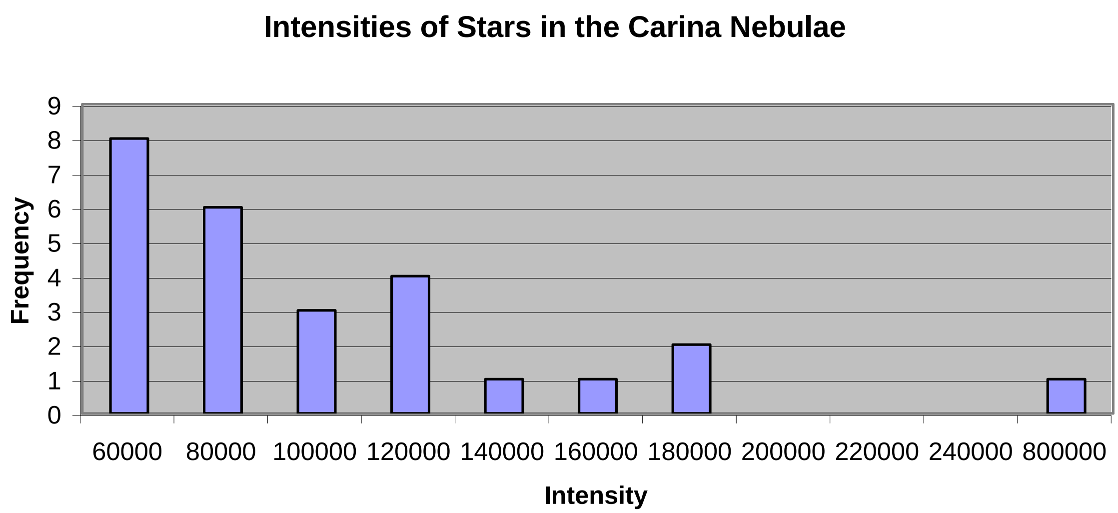
Results:

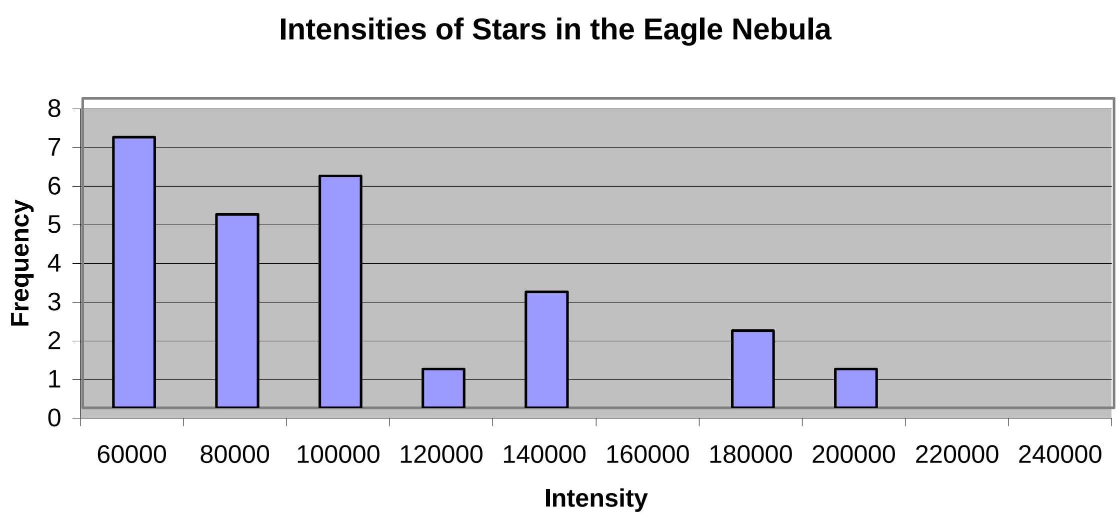
Brightest Stars in the Eagle Nebula			
	Alpha Eagle	Beta Eagle	Gamma Eagle
Right Ascension	18h 18m 36.4s	18h 18m 37.5s	18h 18m 36.05s
Declination	-13° 48’ 02.4”	-13° 58’ 38.5”	-13° 47’ 36.5”
Apparent Magnitude	8.20	8.25	8.80
Temperature	4560.37 K	5495.41 K	4677.35 K
Spectral Type	K	G	K

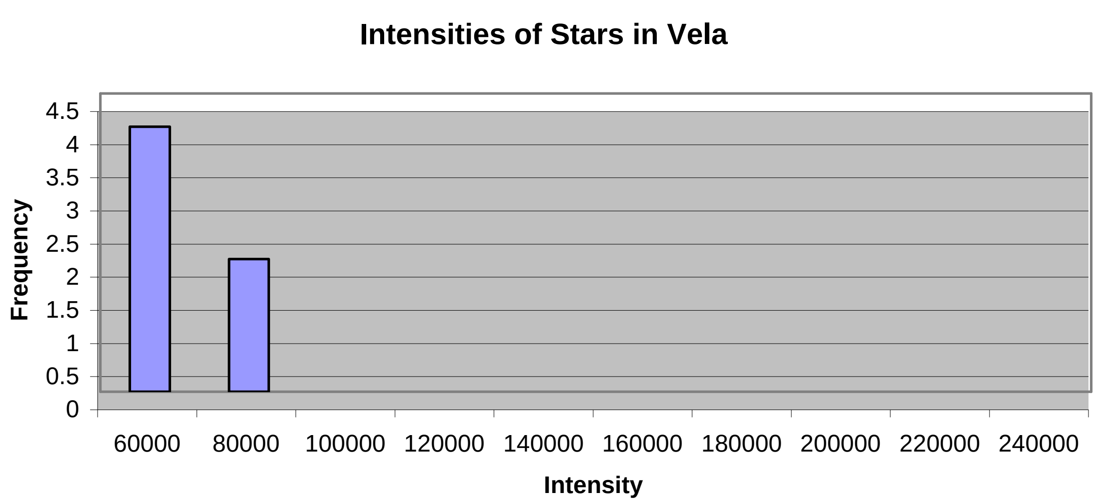
* The stars were named by us and are not in any catalogs under these names.

Brightest Stars in the Carina Nebula			
	Eta Carinae	HD 93129 A	HD 93129 B
Right Ascension	10h 45m 03.591s	10h 43m 57.5s	N/A
Declination	- 59° 41' 04.26?	- 59° 32' 51.3"	N/A
Apparent Magnitude	6.21	7.3	8.8
Temperature	36–40,000 K	51,000 K	N/A
Spectral Type	O / Peculiar	O3	O3

In comparison to the stars found in the supernova remnants, the temperatures and types are approximately the same, except for those of the Carina nebula.


Intensities of Stars in the Carina Nebulae
Frequency
0
1
2
3
4
5
6
7
8
9
60000
80000
100000
120000
140000
160000
180000
200000
220000
240000
800000
Intensity


Intensities of Stars in the Eagle Nebula
Frequency
0
1
2
3
4
5
6
7
8
60000
80000
100000
120000
140000
160000
180000
200000
220000
240000
Intensity


Intensities of Stars in Vela
Frequency
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
60000
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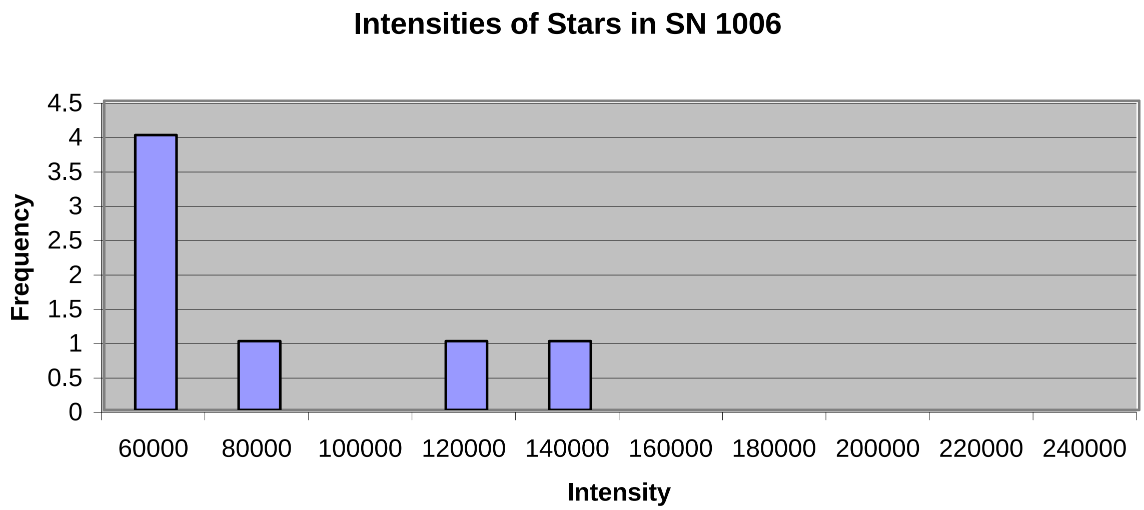
100000
120000
140000
160000
180000
200000
220000
240000
Intensity



Statistics on Intensities				
	Carina	Eagle	SN 1006	Vela
Mean	130594	109912	91435	78109
Mean W/o Outlier	103603	N/A	N/A	N/A
Standard Deviation	14528	41367	30216	12452
Std. Dev. W/o Outlier	37808	N/A	N/A	N/A

Because stars with intensities lower than 63,095 were excluded from this study, most inferences about the distribution of the intensities of the stars in the Eagle, Carina, Vela, and SN 1006 regions have to be used cautiously. Excluding these stars would drastically change the means, standard deviations, and shapes of each distribution.

Still, the histograms show that stars in supernova remnants tend to have lower intensities than those of H II regions. The data sets of the Carina and Eagle nebulae had higher mean intensities than those of SN 1006 and the Vela nebula. Also, only 13 stars total in the supernova remnants were found to have intensities greater than 63,905, while 51 high intensity stars were found in the H II regions. The standard deviations of H II were also higher than those of supernova remnants. However, if stars of all intensities were included, then the standard deviations may have differed; therefore, the standard deviation is an ineffective measure in this observational study. Both distributions are skewed to the right. According to this data, there is reasonable belief that stars in H II regions are more intense than those in supernova remnants.

Discussion:

From the data we were able to obtain, it appears that the stars in supernova remnants are cooler than the stars in HII regions. This could be caused by a great deal of factors such as the composition of the stars, the age of the respective nebulae, and even the location in the galaxy. Also, it appears that the stars in HII regions are more intense than that of supernova remnants. We recommend that there is a need to get a wider assortment of data such as spectral imaging, more accurate optical images and even radio observation of the stars.

Possible errors will come from various sources. First of all, the aperture photometry in Iris was giving unreasonable values for the magnitude, going as extreme as –14. Therefore, the intensities were also extreme, and might also affect calculations such as the temperature of the stars. However, the data is still relative to each other and therefore comparable.

Also, there may be bias in selecting the nebulae, since we did not choose the nebulae randomly but actually chose the more convenient and well-known nebulae. In further studies, a multistage sampling would be preferred, in which the nebulae are randomly chosen, along with the stars within them. A stratified sampling would also work well. Also, in continuation of this study, it would be better not to exclude the stars that we did in our sample, so that more tests and inferences can be performed, such as two-sample significance tests or confidence intervals.

A continuation of this research project might also involve exploring other questions, such as discovering what causes the differences in stellar formation. As a result of our data, there are several questions we asked. For example, since H II regions are older than supernova remnants, does age play a factor in the star formation? Does the presence of heavier elements cause stars to change temperature when they form? These are questions that would need to be answered with further research and studies so one could help gain a better understanding of the nebulae.

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Acknowledgements:

We would like to thank Duke TIP, PARI, and our parents for giving us the opportunity to learn and research to our fullest extent. Dr. Mike, Christie, and Justin - you have all been a tremendous help with our research projects!