HII Regions and Supernova Remnants: A Comparative Study

The Supernova Remnant 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 R filter images and gathered the rest of our data from those images.

Supernova Remnants

Our goal was to find the brightness, temperature and type of a selected number of stars in two different supernova remnants, the Vela Supernova remnant and SN 1006. We wondered if there would be any continuity or difference in the properties of these stars from each supernova remnant (SNR), and what we could deduct from the data and information we obtained.

Supernova remnants are the result of a supernova, the explosion of a massive star that is 10 times or more massive than our sun. When this massive star has reached the end of its life cycle, fusion ceases and the star begins to collapse under its own weight. There is a shock wave that is seen as the supernova, an extreme increase in the stars brightness and temperature. The outer layers of the star are violently blasted outwards and an expanding cloud is formed as the remnants of the exploded cloud. The neutron star that was created during the supernova explosion is sometimes still visible in the remnants of supernova. There are three types of supernova: shell like, composite, and a mixed morphology.

Observations

I. Method

We had to use telescopes located in the southern hemisphere because the nebulae we chose are only visible in the Southern hemisphere at nighttime since the sun blocks our view of them in northern hemisphere's summer. First, we scheduled images of our nebulae to be taken with Skynet's CTIO Prompt 4 and 5 telescopes, located in Cerro-Tollolo, Chile. For our images, we used the optical V (blue-colored) and R (red-colored) filters because that would help us find the temperature of the stars using the equation V-R. After a wave of concern that we would not receive the images of our nebulae due non-optimal weather in the mountains of Chile, we were fortunately able to identify the three brightest stars from our four images. We chose these brightest stars assuming that they are all in the supernova remnant nebulae, because they had similar right ascension and declination. With the IRIS application, we located a star (in both V and R filters) with aperture photometry and then found its calibrated magnitude. For each nebula, we made sure to use constant aperture and radius when locating a star with aperture photometry.

We used the equation V-R, which is the relative magnitude of the three stars in the V-filter minus the relative magnitude of the three in the R-filter. The relative magnitude was the magnitude that was given in our image. V-R found the color of the stars. A negative value in V-R indicates a blue colored star while a positive value in V-R indicates a red colored star. A value ranging in the zeroes indicates a balanced, white star. We used the online site, VIZIER, where a calibrated astronomical chart showing corresponding values of V-R and the logarithm of the effective temperature (in Kelvin) was available. We derived the straight temperature in Kelvin from the logarithm of the effective temperature:

Ex.) Log (T Effective) = 3.682 = 10 ^ 3.682 = 4,808.39 Kelvin

Once we found the temperature of the star in Kelvin, we were able to identify which spectral class (type of star) that the star belonged to with the following chart:

O (28,000 – 50,000)

B (10,000 – 28,000)

A (7,500 – 10,000)

F (6,000 – 7,500)

G (5,000 – 6,000)

K (3,500 – 5,000)

M (2,500 – 3,500)

We also assembled histograms of the intensities of the stars in all four nebulae, 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 in Iris and recorded. All images were taken from SkyView.

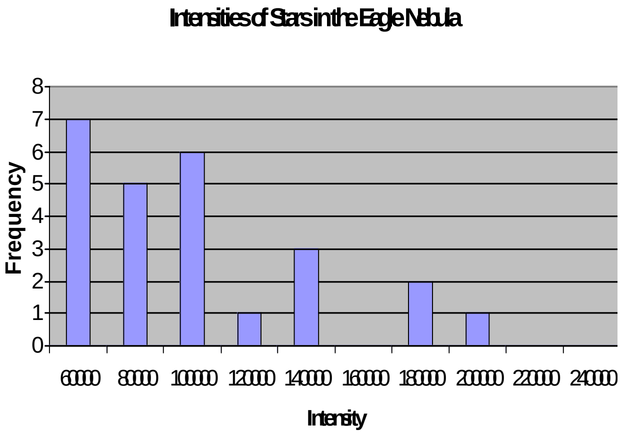
II. <u>Data</u>

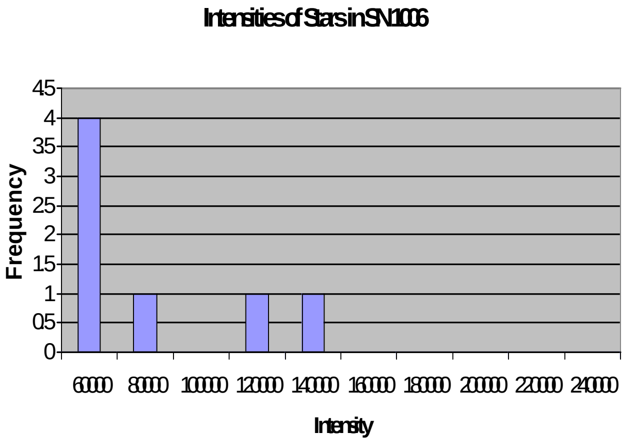
This is the data from SN 1006 for the three brightest stars we observed.

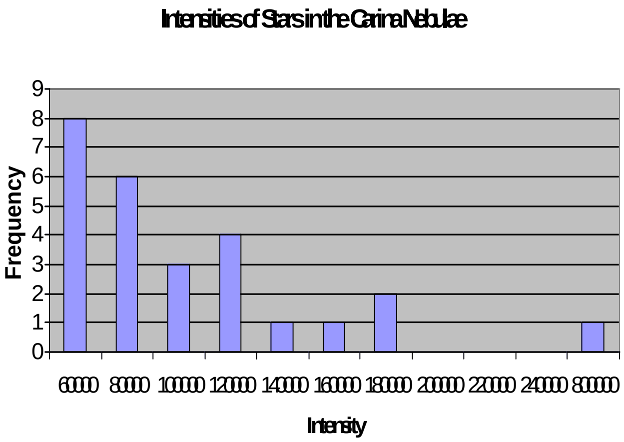
SN 1006	Star 1	Star 2	Star 3
V - R	0.55	0.53	0.71
Temperature (K, Kelvin)	4731.51	4808.39	4305.27
Type	K Star	K Star	K Star

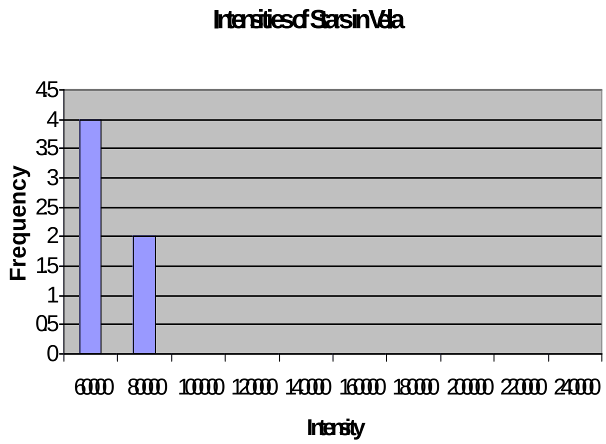
This is the data from the Vela Supernova Remnant for the three brightest stars we observed.

Vela	Star 1	Star 2	Star 3
V - R	0.25	0.56	0.53
Temperature (K, Kelvin)	6546.36	4688.13	4808.39
Type	F Star	K Star	K Star









The graphs above are histograms of the intensities of the stars. Since the 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.

Results

The data we obtained of the stars from the two different supernova remnants was very similar. Once we found the color of the stars using V-R, we found the temperature. The temperatures we found all indicated white stars. Once the temperatures of the stars were obtained, we were able to find the type of the stars using a temperature type chart. Five out of six of the stars were K stars, with one star as an F star. The temperatures ranged from 4,305.27 – 6,546.36 Kelvin. Although these stars were some of the brightest we observed, they were not hot enough to cause the supernova explosion.

Discussion

Although the stars we chose are brightest to the human eye, scientifically they are not hot or bright enough to cause a significant change in the nebulosity of a supernova remnant. Most stars that form the nebulosity, the glowing material in a supernova remnant, have temperatures of 10,000 Kelvin or greater. Since none of the stars we observed met this temperature, we believe that there may be another star or astronomical object showing the nebulosity in the supernova remnant.

I. Future Work

To further our research topic, we would obtain more information about the stars we observed as well as choose more stars for precise results. For example, we would have liked to verify the distance and actual location in each supernova remnant, because we did not have enough information to conclude that each star is in the supernova remnant. Although there is a big probability that the stars are in the supernova remnants, future researchers can test the Red shift or the Parallax to make sure. Also, further research can test if these stars are variable or subject to change in brightness. We would also look into what star or astronomical object that was forming the nebulosity of the two supernova remnants we chose to research.

Conclusion

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. 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. Along with a wider variety of data, there are several questions we asked as a result of our data. 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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