



Imaging of the Crab Nebula using the Great Basin Observatory

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Introduction

The Crab Nebula (Messier 1) is a planetary nebula located in the constellation Taurus. As a bright and famous object, it makes a good target for amateur astrophotography (Figure 1).

Using the Great Basin Observatory, we aimed to produce a color image of the Crab Nebula in addition to capturing the nebula in narrowband filters corresponding to wavelengths of 656 nm, 501 nm, and 672 nm.

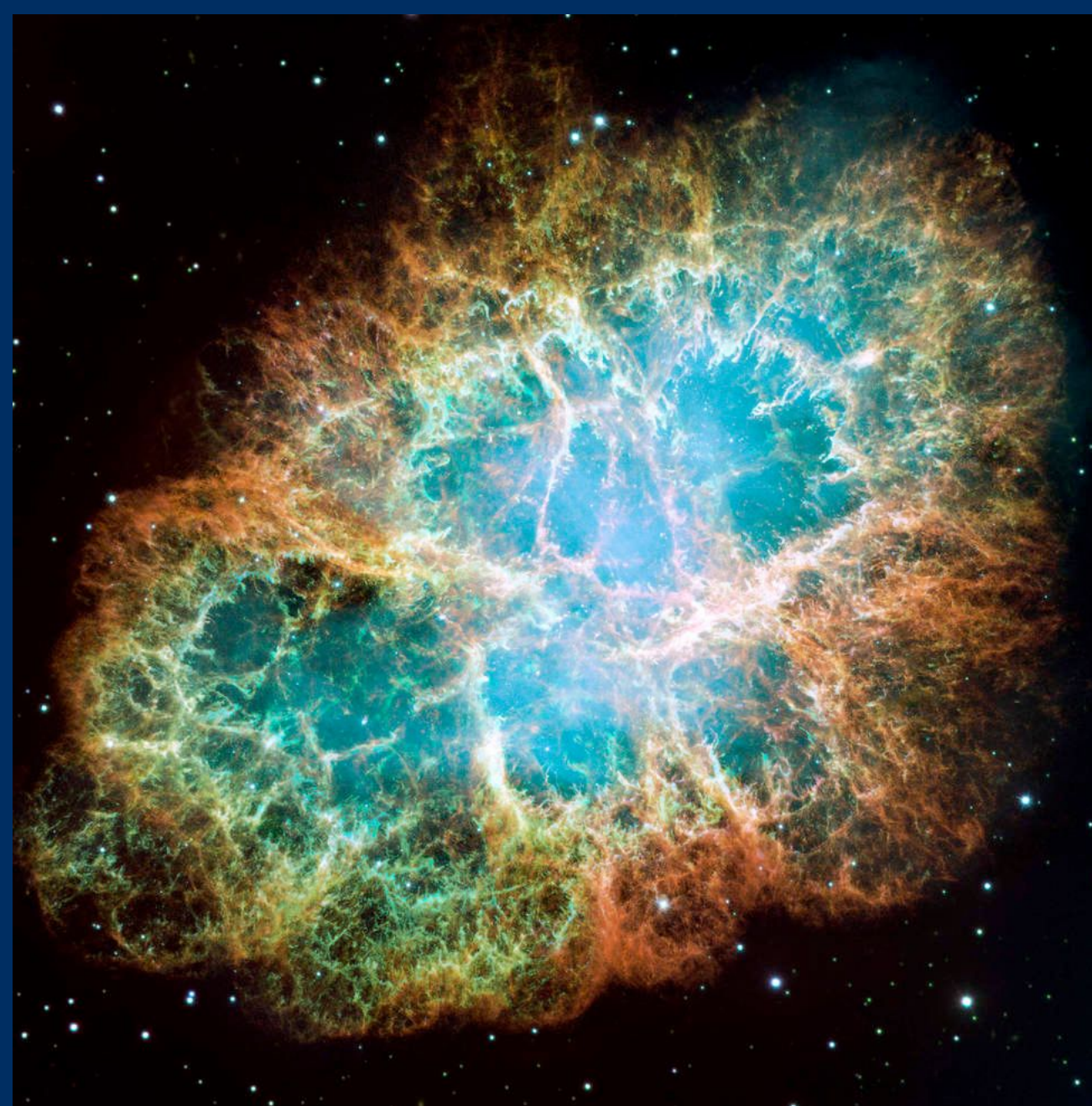


Figure 1: Crab nebula; Image Credit: [1]

Methodology

We obtained 5 raw images for each filter from the GBO resulting in 35 images. From here, we needed to reduce the data, which was done using AstrolmageJ. Data reduction includes subtracting bias and dark frames, and dividing out the flat fields. Bias and dark frames aim to remove noise and saturation caused by the charged coupled device itself, while flat fields reduce physical disturbances such as dust



Figure 3: Raw image from GBO red filter

on the lens of the camera. The 5 images in each filter were then stacked in photoshop and colored. Then, the final colorized image was created by stacking the red, green, and blue images. The images showing the narrowband filters were created using the same process, although we used arbitrary colors for contrast.

The Physics

- Light produced by recombination & electron transitions
- Crab Nebula contains Oxygen, Sulfur, and Hydrogen
- Can determine elements present by observed light

A schematic for these transitions in Hydrogen is shown in Figure 8. Due to its abundance in the Universe hydrogen is the most present element in the nebula.

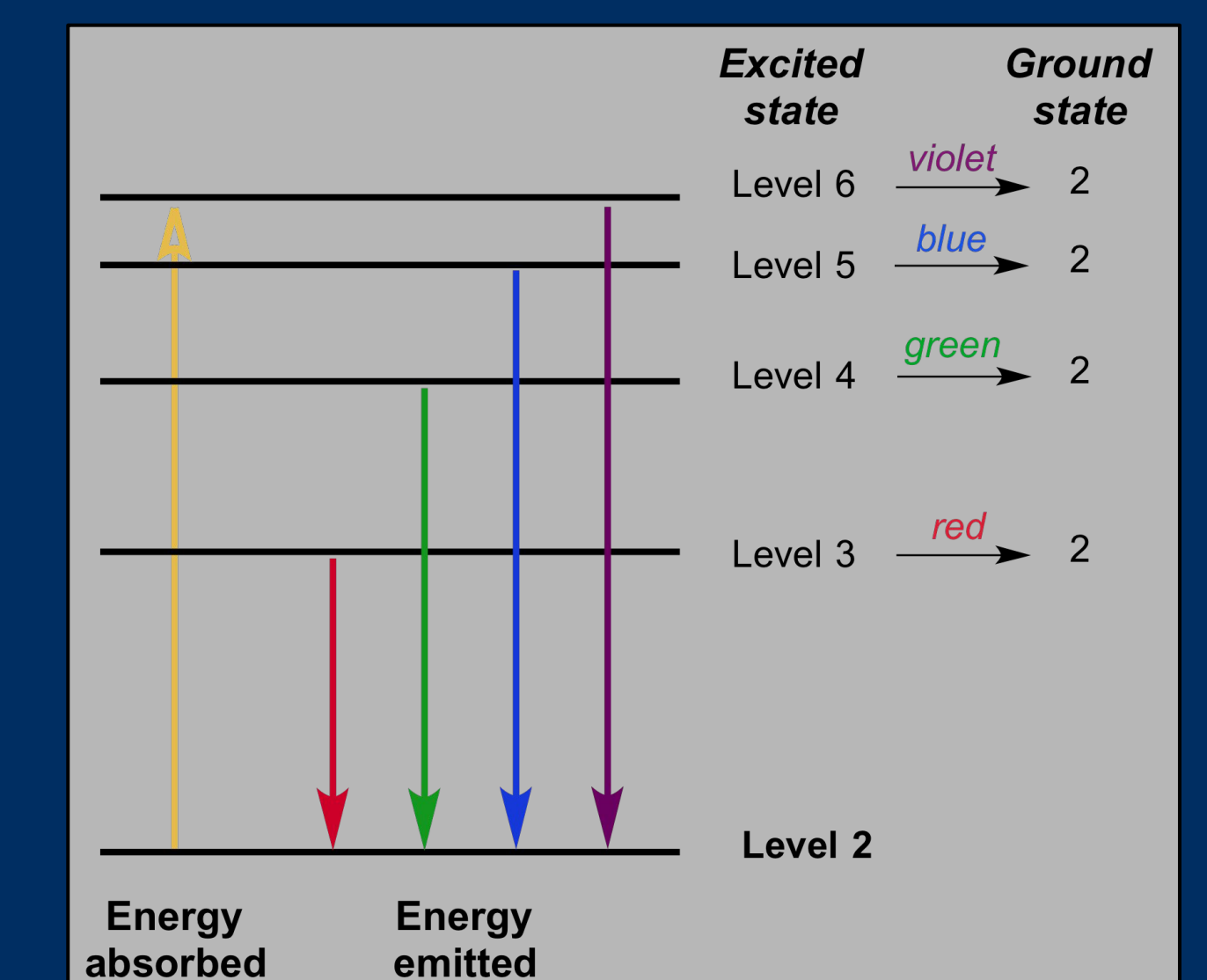


Figure 8: Hydrogen Spectrum; Image credit: [3]

Data and Observations

The Great Basin Observatory (GBO) (Figure 2) is a 0.7m reflecting telescope located in Great Basin National Park that is remotely operated and accessible to UNR students and faculty. Using the GBO, images of the Crab Nebula were taken in red, green, blue (RGB), and narrowband filters. The RGB images were used to create a base color image of the nebula. The narrowband images were layered on top of the base image to show the abundance of each element in the nebula.



Figure 2: Great Basin Observatory; Image Credit: [2]

Results



Figure 4: Full-Color Image

Figure 4 shows the final colorized image of the Crab Nebula that resulted from stacking and colorizing multiple red, green, and blue filters.



Figure 5: Sulfur (II) Filter



Figure 6: Oxygen (III) Filter

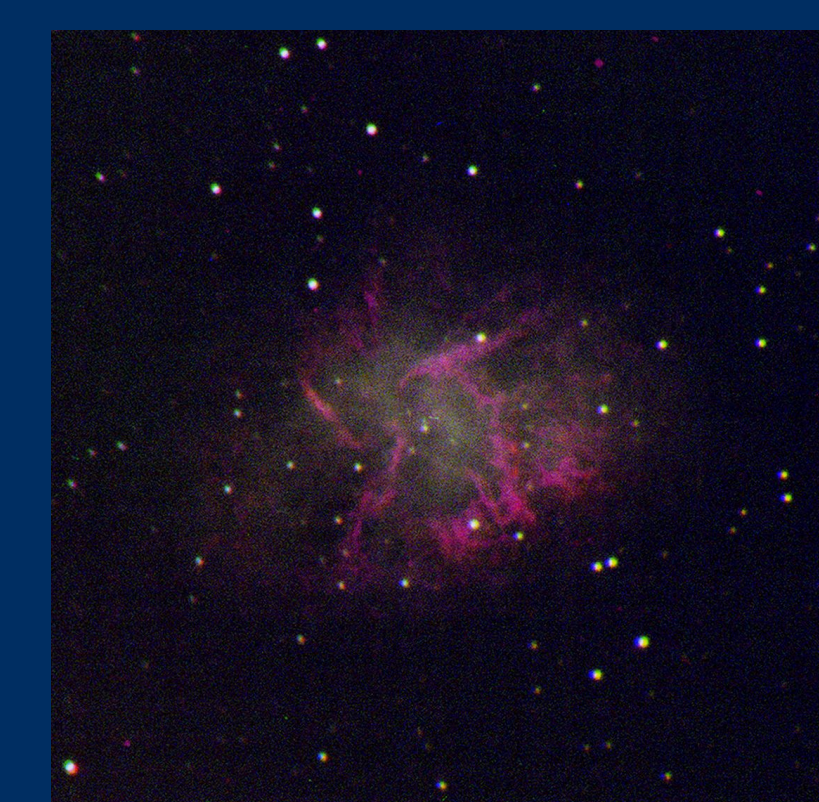


Figure 7: H- Alpha Filter

Conclusions

From our observations and resulting imagery we see that the Crab Nebula contains large amounts of sulfur, oxygen, and hydrogen. The experience using the GBO for this class will be carried over to the UNR Astronomy club for the purposes of scientific outreach and advertisement of the physics department Astronomy minor.

Acknowledgements

We would like to thank Dr. Plotkin, and Jeremiah Paul for their mentorship and advising. We would also like to thank the Great Basin Observatory.

References

- [1]<https://www.nasa.gov/feature/goddard/2017/messier-1-the-crab-nebula>
- [2]<http://www.greatbasinobservatory.org/about-observatory/virtual-tour>
- [3]<https://cdn.kastatic.org/ka-perseus-images/b8cb777559d81c6a6640187549bcd3907ebf0573.png>