The influence of M51b on star forming regions within M51a

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Introduction

Messier 51a, also known as NGC 5194 or "The Whirlpool Galaxy", is a spiral galaxy. The majority of observed objects in the universe are spiral galaxies, but M51a has a unique trait: a small companion galaxy known as M51b or NGC 5195. This is a dwarf irregular galaxy.

This study looked at the influence of M51b on the star forming regions within the outer spiral arms of M51a.

Method

In order to take a look at the star forming regions within M51a, observations with different filters were used. Firstly, Hα was used to look at possible star forming regions: Hα often originates from regions with ionized hydrogen, which can be found in star forming regions [1].

However, Hα is also a part of the red spectrum, meaning that stars that emit light in this spectrum also emit Hα. Because of this, images taken with the R, V and B filters were also used. That way, if there's an increase in Hα emission, it can be determined whether or not it's caused by the presence of stars.

Ultimately, different areas within the spiral arms need to be compared: we want to compare the outer arm closest to M51b to the arm on the opposite side. For this, a program was written in Python that divides the spiral arms of M51a into 24 separate areas. Each area was then analyzed to determine the amount of emission in the Hα, R, V and B spectra.

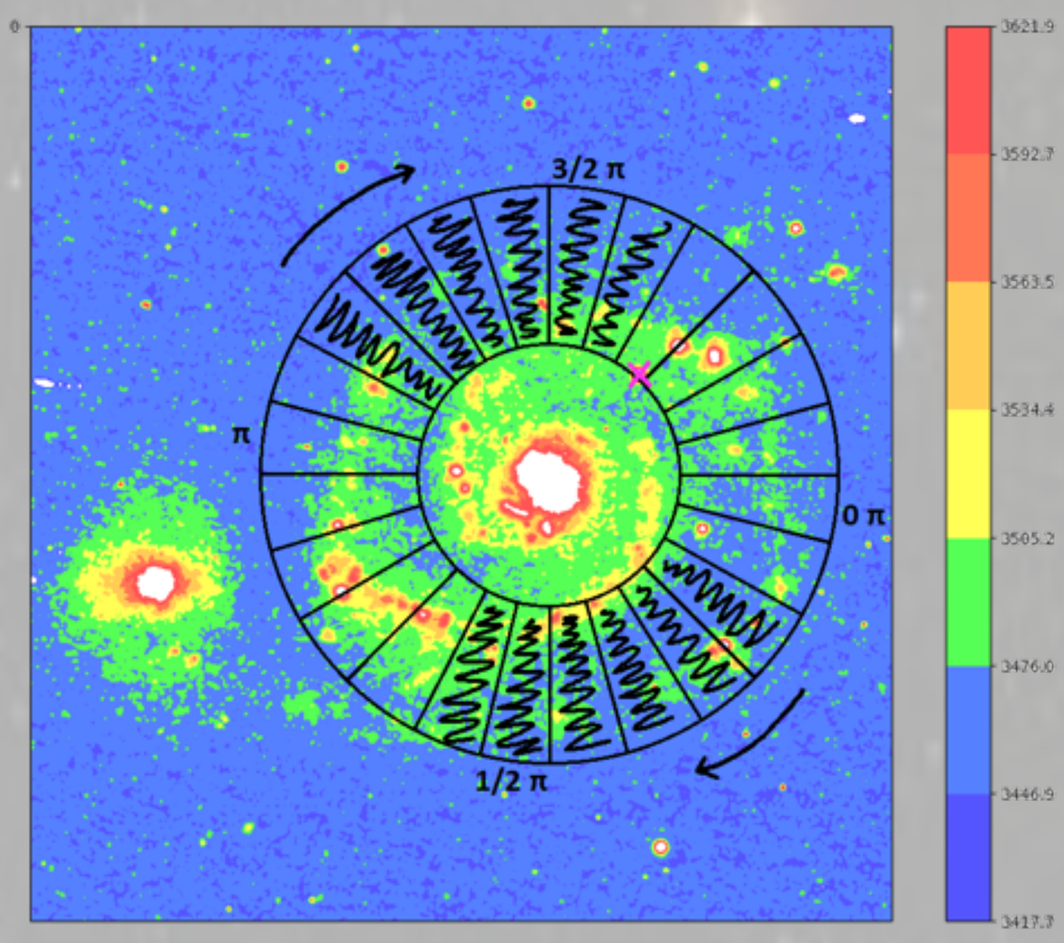

Figure 1: Hα contour plot of M51, with the used areas marked. The colors indicate the difference in pixel values in ADU. Each step on the color scale represents three times the standard deviation. From green upwards the data is at least three times the standard deviation above the background, deeming it useful. The unit circle has been vertically flipped, the arrows indicate its trigonometric direction. The total pixel values of the crossed out areas have been shown in figure 2, but have not been taken into account for the final comparison. One star in front of the galaxy has also been removed, which has been marked in this plot with a pink cross.

Results: Graph

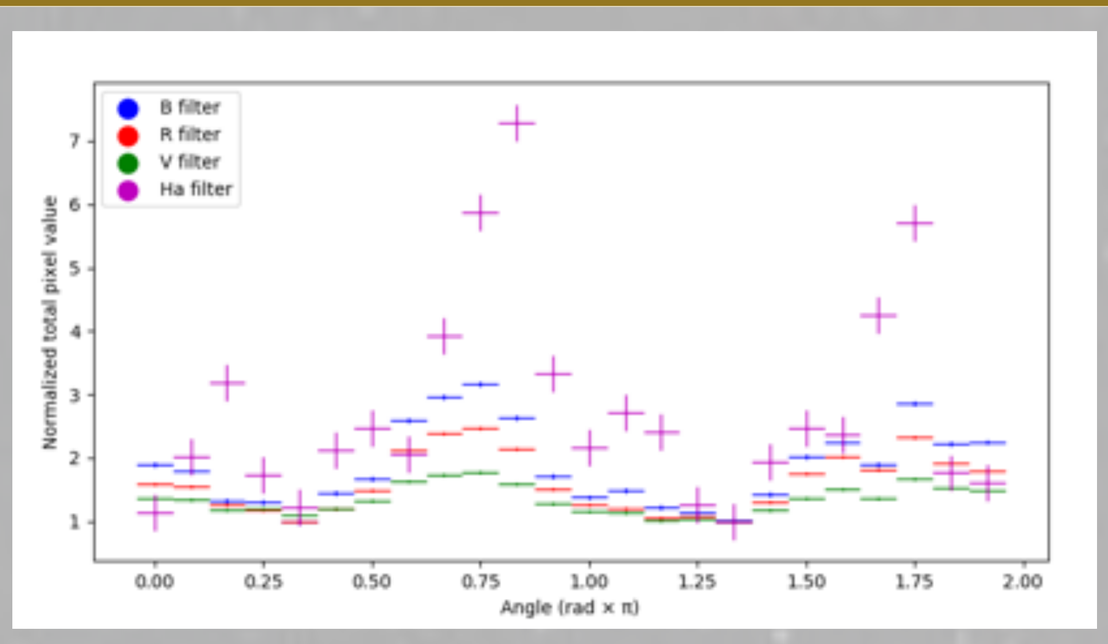

Figure 2: Plots of all normalized total pixel values per area per filter. Each value has been normalized using the minimum value of its corresponding filter.

Results: Percentages

For these results only the six areas closest to and farthest from M51b were used. The exact parts that were used are also shown in figure 1: the unused parts have been crossed out.

- R filter: 99.91 ($\pm$ 0.43) %
- V filter: 99.45 ($\pm$ 0.28) %
- B filter: 103.22 ($\pm$ 1.08) %
- Hα filter: 153.32 ($\pm$ 7.79) %

Conclusions

When comparing the areas of the spiral arm close to M51b to those on the opposite side, an increase of 53.32 ($\pm$ 7.79) % in Hα can be measured. In the R, V and B filters however, there's a relatively small difference, ranging between an increase of around 2% and a decrease of around 0.5%. This seems to be indicative of a larger amount of star forming regions on the side of M51b.

References

J. Moustakas *et al.*, Optical star formation rate indicators. *Astrophys. J.* **642**, 775-796 (2006).

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