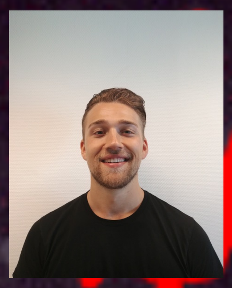
Dust lanes in Messier 101 shielding star-forming regions against central radiation

ANTON PANNEKOEK INSTITUTE

Rahul Silié

Ziggy Weesing



Daan de Jonge

VU VRIJE UNIVERSITEIT AMSTERDAM

Introduction

There are a plethora of processes that contribute to the shape and evolution of spiral galaxies. One of the most important of these is star-formation. So understanding what parameters influence star-formation on a galactic scale is of great importance.

In order for stars to form out of dense molecular clouds, the cores of these clouds have to be as cold as 10-20K. At these temperatures the thermal pressure is not strong enough to push against the gravity of the molecular cloud. As a result the cloud collapses into a protostar [1]. Radiation coming from the interstellar radiation field (ISRF) can ionize and thus heat up the molecular clouds, which would prevent stars from forming. Since there are still stars being formed, there must be a mechanism which prevents this. One possible explanation is that interstellar dust acts as a shield against this radiation [2].

In this research we quantify this mechanism in a simple way by determining the amount of star-forming regions shielded by dust lanes within the spiral galaxy Messier 101.

Method

Light in the visible spectrum is absorbed by the dust lanes. We used data from the L-filter to make concentric intensity plots (with the galactic core at the origin). We divided the galaxy in slices to get averages of the intensity values, Figure 1 shows an oversimplification of the processes. Then by finding the minima in these plots we were able to identify the locations of the dust lanes in M101.

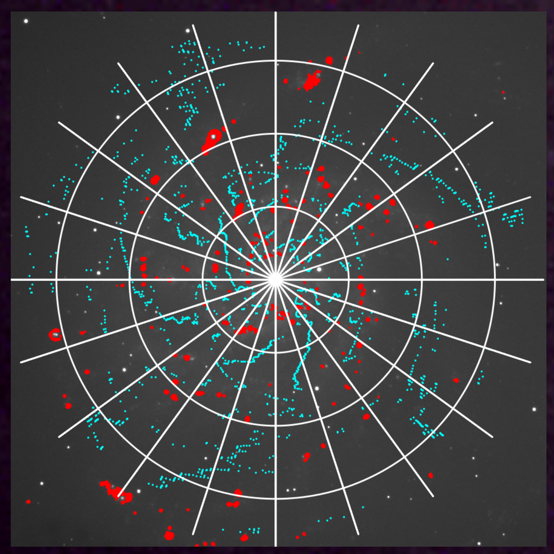


Figure 1: M101 divided in slices in the tangential and radial direction. The cyan dots represent the dust lanes and the red dots the Hα regions. This figure shows a lower amount of slices than the number that was actually used. All data for $r < 43.1$pc is ignored because it only shows the galactic core.

Stars are characterised by a strong Hα emission. To smoothen out the data we applied a Gaussian blur on the datasets. In order to isolate star-forming regions in M101, we removed the foreground stars from the data. Then we identified the stars with an algorithm on the V-filter. By removing these stars in the Hα filter and taking data points above a 2.2σ threshold, we were left with the isolated star-forming regions. Using these methods we were able to calculate an average distance between every individual star-forming region and the closest dust lane in the radial direction.

-Telescope: RCOS(Ritchey Chretien Optical Systems), specialized Cassegrain
-Diameter mirror = 50.8 cm (20")
-Total exposure time = 37 mins [L-filter], 60 mins[Hα-filter]
-CCD camera = FLI proline 16803

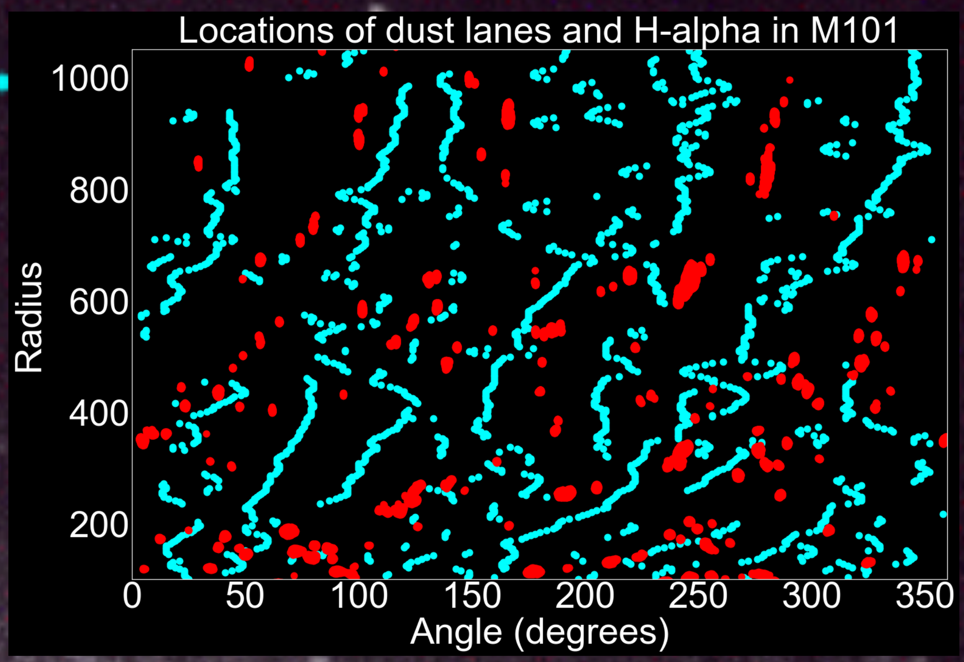


Figure 2: Radius plotted against the angle. The cyan dots represents dust lanes and the red dots are Hα regions.

Results

We have identified a total of 204 individual Hα regions in Messier 101. Of these regions, 86% (175 in total) are shielded by a dust lane in the radial direction, with the galactic core at the origin. The histogram in Figure 3 shows a distribution of the amount of Hα regions and their distance towards the closest radial dust lane. Figure 3 clearly shows that there is a higher amount of Hα regions close to the dust lanes.

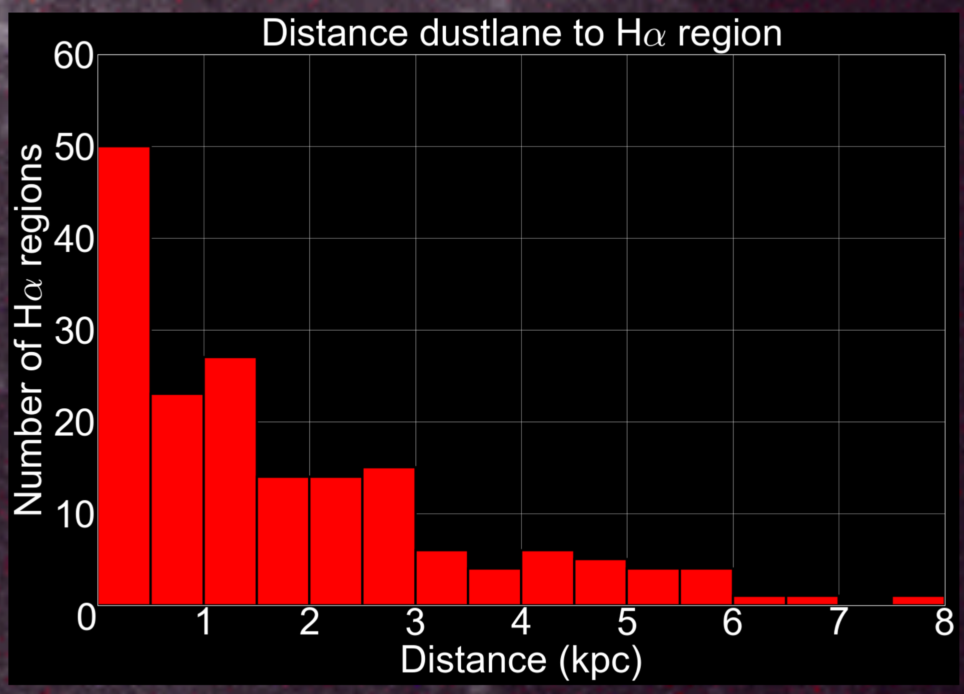


Figure 3: Histogram that shows the distribution of Hα in counts, against the distance towards the closest (radially) dust lane in kpc.

Conclusion and Discussion

Looking at the results we can conclude that dust shielding proves to be an important factor in the development of star-forming regions. In addition to this conclusion we have to take a couple of possible errors into account. One is the resolution of the telescope that was used (see bottom left). Higher resolution results in more detail, which makes the final results more reliable. Also the amount of Hα regions that were found might be a small underestimation. Since multiple nearby regions might only show up as a single region. Finally the σ threshold used on the Hα filter produces a small error.

References

[1] M. R. Krumholz, C. F. McKee, A general theory of turbulence-regulated star formation, from spirals to ultraluminous infrared galaxies, *The astrophysical journal* **630**, 250 (2005).

[2] M. R. Krumholz, C. F. McKee, J. Tumlinson, The atomic-to-molecular transition in galaxies. ii: Hi and h2 column densities, *The Astrophysical Journal* **693**, 216 (2009).