# 1 Scientific Justification

The ubiquitous dust in outer space is an indicator for a tremendous amount of physical processes. For instance, it reveals places of high star formation and it indicates the location of molecular gas. Research on cosmic dust will improve our knowledge about the interstellar medium and molecular clouds. Apart from that, dust influences the amount of light being received by a telescope. In scientific research, you have to take into account the amount of extinction by dust, since it can influence luminosity measurements significally. So, our research will also be important for our fellow researchers, who will also be looking at the luminosity of galaxies.

In our research, our aim is to determine the range of the outer dust layer of a symmetrical galaxy. This will give us insight in the location of dust in galaxies, and to what radial extent the dust layer reaches. In order to do this, we will observe occulting galaxies.

The hypothesis is that the amount of dust decreases exponentially, radially outward of the center of the galaxy. The method used to measure the amount of dust is described below. We will observe at least two different pairs of occuling galaxies. We distinguish between occulting galaxies that are far apart, and those that have a small distance to each other. The second type will consist of a pair of merging galaxies, of which one is in front of the other from our point of view. In this way we can determine whether there is a difference in the range of the outer dust layer between the two types of occulting galaxies.

The reason why we will be looking at occulting galaxies, is that dust in galaxies is only observable when there is a luminous background source. We will need a bright background galaxy and a smaller, low-luminosity foreground galaxy. Optical imaging reveals the outer dust distribution in absorption against the light of the background galaxy. To map the extinction in the foreground galaxy, we assume that the foreground and the background galaxies are rotationally symmetric around their centers. This is why we will look at early stage mergers, as the merging process will affect the symmetry.

There are three methods that are relevant for our research [1]. We will only be using method A and B. Method A can be applied when the luminosity of the foreground galaxy is not negligible compared to the background galaxy. We are going to measure the optical depth in the overlap region, by using the flux from this region. We will construct an extinction map. If the assumption that both galaxies are symmetrical is correct and there is no dust extinction, the result will have zero flux. In order to create this map, we will divide the image into two different objects. Then, we rotate both galaxies 180 degrees around their centers and subtract them from the original image. The result is an indicator for the amount of dust extinction. Method B is used for a very luminous background source. In this case, the luminosity of the foreground galaxy is negligible. We expect this to be true for the non-merging galaxies. Therefore, only the background galaxy has to be rotated and subtracted from the original image.

## 2 Technical Justification

We selected 2 sets, each consisting of 3 targets for our research. The first set contains occulting galaxies that have a relatively large distance to each other. The second set consists of three pairs of merging galaxies, which were selected by the fact that the redshift of both galaxies was almost the same [2]. We will make observations between the 2nd and the 6th of May. As can be seen in the Staralt images, the selected targets are visible during these days. The exact positions at the sky of the galaxies will not significally change in the course of the week, but the period at which the moon is visible does shift to later times.

Different filters have different (dis)advantages. Dust is best visible in the blue side of the spectrum, but in this filter the galaxies are less rotationally symmetrical. On the other hand, using a red filter would result in more symmetrical galaxies, but the dust is less visible. As a concensus, we choose a filter that lies in between; a V- (WFCHARV) or G- (WFCSloanG) band filter. In the best case scenario, we will take extra exposures, in order to be able to compare the differences between the B- (WFCHARB) and R- (WFCHARR) band filters.

We used Signal to get an indication of the needed exposure times. The objects are extended, and we need to observe an overlap in the galaxies. Depending on the specific occulting galaxy pair, we need a certain amount of magnitudes arcsec$^{-2}$. In order to get the best results, we will first focus on the occulting pairs that have the most overlap. Then, we can assume that a result of 23 mag arcsec$^{-2}$ will be enough. Assuming an airmass of 1.2 and bright sky brightness, we would have to integrate for 20 minutes to get a S/N of at least 5. We will split this in three observations of 7 minutes each, as to filter for cosmic particles and to keep the exposures below the saturation limit.

The absolute minimal amount of data to be obtained is two exposures: one for a target of each set in a V- or G-band filter. However, the observations of more targets from both sets would lead to a more reliable result.

## References

[1] Holwerda, B.W., Keel, W.C., Williams, B., et al. 2009, ApJ, 137, 2

[2] Lumbreras, A., & Holwerda, B.W. 2015, Astronomy & Astrophysics

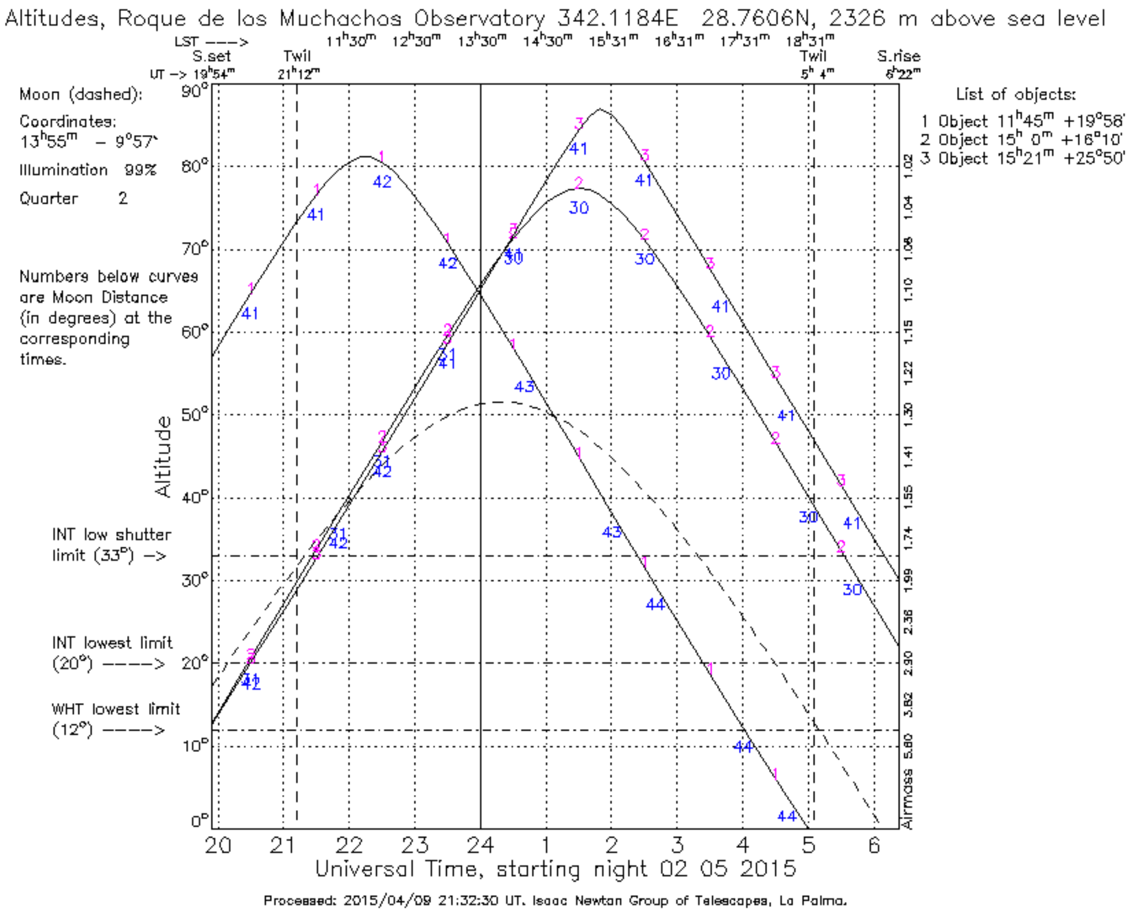


**Figure 1:** *The visibility of three targets of occulting galaxies. Each pair of galaxies lie on a relatively large distance. As can be seen in figure 2, the moon will shift to a later time, whereas the postition of the galaxies will remain about the same. So in the first few nights, we will focus on the 2nd and 3rd object.*

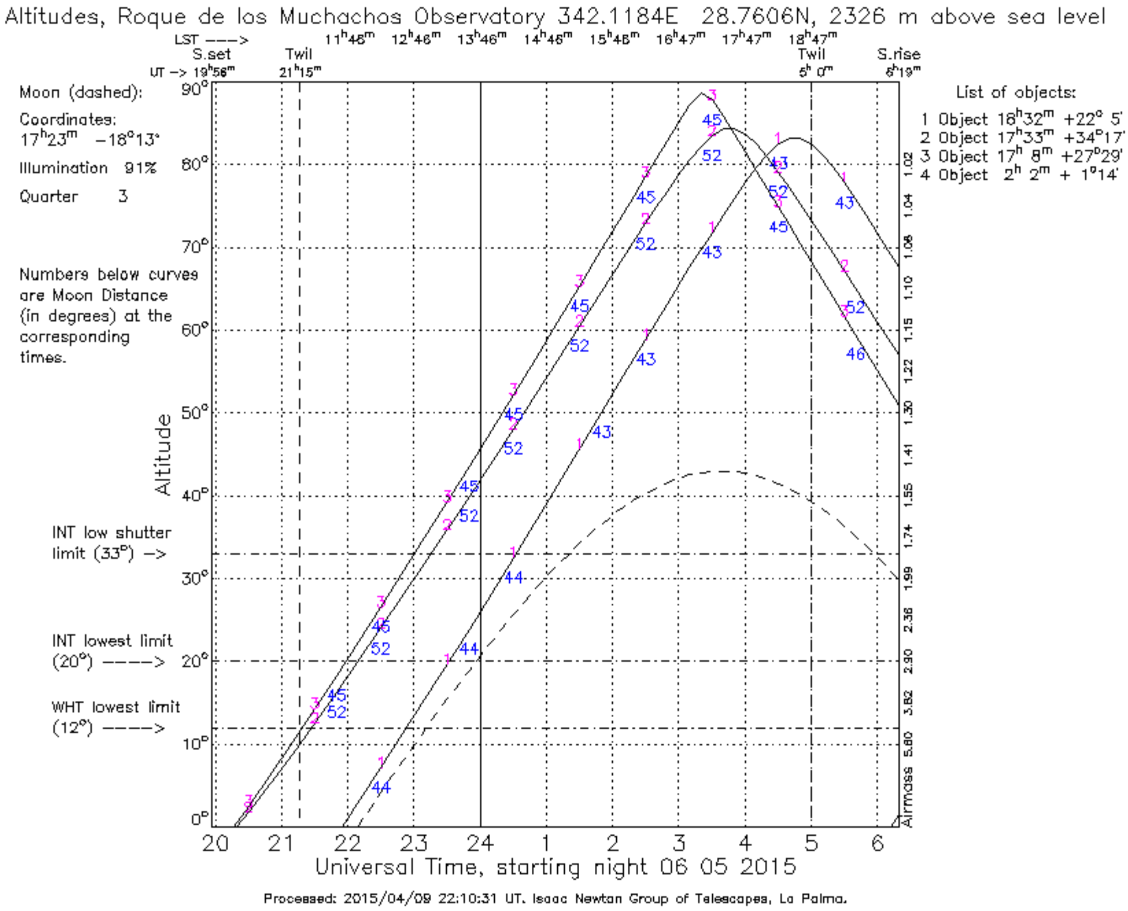


**Figure 2:** *The visibility of another three targets of occulting galaxies. The redshift of both galaxies in each pair is almost the same, so these galaxies have a high probability of being mergers. As all three targets rise at late times, the best days of observing will be the first few. Object 3 rises the highest and the longest time before twilight, so it will have priority over the other 2.*