Scientific justification: Bridge between clusters

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Introduction

When groups of stars merge and their gravitational interaction is sufficiently strong, it is possible that stars will be pulled out of the cluster resulting in a flow of stars going from one cluster to the other. These stars form a bridge between the clusters.

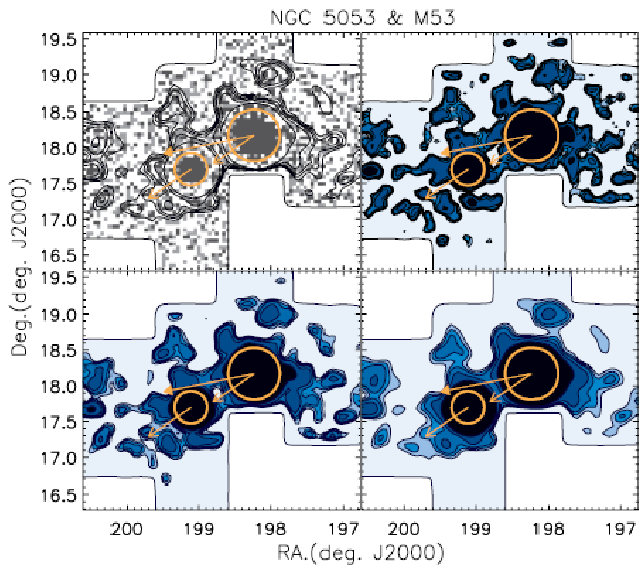

Figure 1: from Chun et al, 2010 figure 11. Density map of the clusters NGC 5053 and NGC 5024. An extratidal overdensity feature is visible between the clusters. This is consistent with a stellar bridge.

Similar dynamics can also be applied to galaxies: every galaxy is a result of many mergers with other galaxies. In order to study the evolution of galaxies and to find out how the Milky Way was formed, it is important to study the interaction of groups of stars on a small scale.

We want to observe the interaction between the globular clusters NGC5024 (also known as M53)and NGC5053. Previous studies suggest that there might be a stellar bridge between the clusters (Chun, 2010). We want to observe these particular clusters because of their near passage, and thus their strong interaction, is unique in our galaxy. Besides this, they are close to one another and because the Isaac Newton Telescope has a small field, this is fortunate: we can observe the whole system in a few images.

Methods

In Chun's research the possibility has been suggested that there are two bridges between those clusters. We want to confirm their data and acquire more data by using longer exposure times, which will enable us to spot fainter stars. This will give a higher certainty about the existence of the bridges. We are going to obtain the magnitudes of the stars of the cluster and the background by observing in two filters (g and r). With this data we can make a colour - magnitude diagram, just like the one in figure 2, which will give us the main sequence and turn-off point of the clusters.

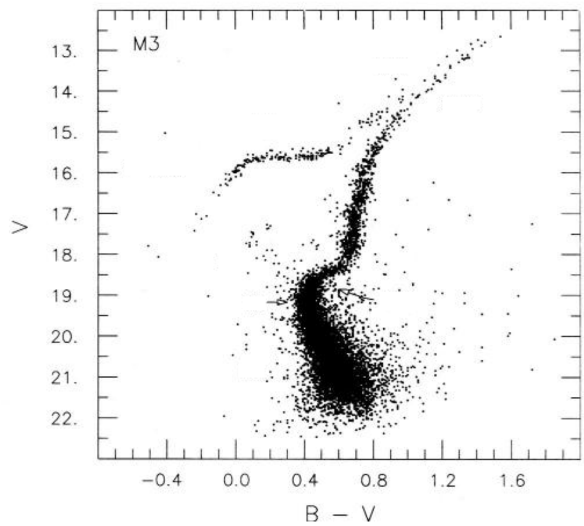

Figure 2: from Renzini et al., 1988. Colour-magnitude diagram of M3

In Chuns paper it was stated that both clusters are approximately the same age and have the same distance modulus. Because of this, we will see two very similar diagrams. With these two colour magnitude diagrams of the clusters, we will be able to distinguish between background stars and stars in the clusters. We will plot the stars of the clusters in order to get a density map of the clusters. We expect to see extratidal overdensity features in the form of two bridges between the clusters, as suggested in the paper of Chun et al. Because the clusters are very alike, we won't be able to tell from which cluster the stars in the bridge originate. This would be possible with spectrometry.

References

S. H. Chun, 2010, The Astronomical Journal, 139:606–625

A. Renzini and F Fusi Pecci, 1988, Annual review of astronomy and astrophysics, volume 26 (A89-14601 03-90)

Technical Justification

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The objects are best visible at 23.30h UT. We want to take these images in two different filters. The images we want to take are: an image of NGC 5024, an image of NGC 5053, two images of the bridge between them at different positions, and an image of the background. See table 3 and figure 2 for the properties of the objects.

One image covers a surface of approximately 20 by 11 arcminutes, so one cluster fits in one image and the bridge in two images. The magnitude of the brightest stars is approximately between 13 and 16 and of the background 19 [1], because it will be a bright night with a full moon. Therefore, in order to observe the fainter stars and make more precise observations than the previous research (Chun, 2010), we need to have a background image. We will use an background image to separate the bridge stars from the background stars. We will make this image a few arcminutes away from the system. We want to take at least four of the same images of the bridge in each different filter, that we want to add, so the fainter stars will be more visible and we will get better data.

The INT low shutter limit is at 33°. Our object is above 33° between 20.00h and 4.30h and at its peak at 23.30h (see Figure 2). However, there are a couple of obstacles that limit our scheduling. Firstly, twilight starts at 21.14h, therefore we want to start observing after 21.44h, in order to be able to observe the faintest stars in our field. Our object is then higher than 60°. Secondly, the moon crosses the path of the clusters at 02.40h, which can be seen in Figure 1 and it has a luminosity of 99%.

The average seeing at the La Palma Observatory is 1.2 arcsec[1].

We want to use the g and r filters. We want to use the r filter particularly because it is the same filter as they have used at Sloane Digital Sky Survey and if we get inconsistent data, we can use their data for comparison or backup.

The exposure time was calculated by setting a boundary of 40000 photons/pixel, to prevent saturation of the CCD, thus we tried to retrieve the highest signal to noise ratio. With the Exposure Time Calculator[3] we selected the B, V and R filters in order to calculate the exposure times for the g and r filters. The B and V, and the R filter resemble the g and r filter respectively: they have approximately the same maximum. The bandwidths can be found in the table from the website[2]. For the sky brightness we used the option 'Bright', which is equal to a magnitude of 20. We used an airmass of 1.0. From our calculations with the Exposure Time Calculator and from taking the highest possible Signal-to-Noise ratio, without over saturating the CCD (the limit was set at 40000 pixels[3], we concluded that the best exposure times are 6s for the g filter, 4s for the r filter and 600s respectively 450s for the background. See table 1 and 2.

Because we are making a colour-magnitude diagram we will only need the relative flux. This will work because the stars in a cluster and the bridge are approximately at the same distance.

Tables and Figures

Filter	Magnitude	Exposure time [s]	photon/pixel
B	21	600	38254.70
V	21	400	37124.01
R	21	450	36839.40

Table 1: Background images

Filter	Magnitude	Exposure time [s]	photon/pixel
B	14	5.0	36863.72
V	14	7.0	35957.39
R	13	4.0	37866.48

Table 2: Object images

	NGC5053	NGC4024
size	10 arcmin	13 arcmin
ra	$13^{h}16^{m}27.09^{s}$	$13^{h}12^{s}55.25^{s}$
dec	$17°42'00.9''$	$18°10'05.4''$

Table 3: Object properties

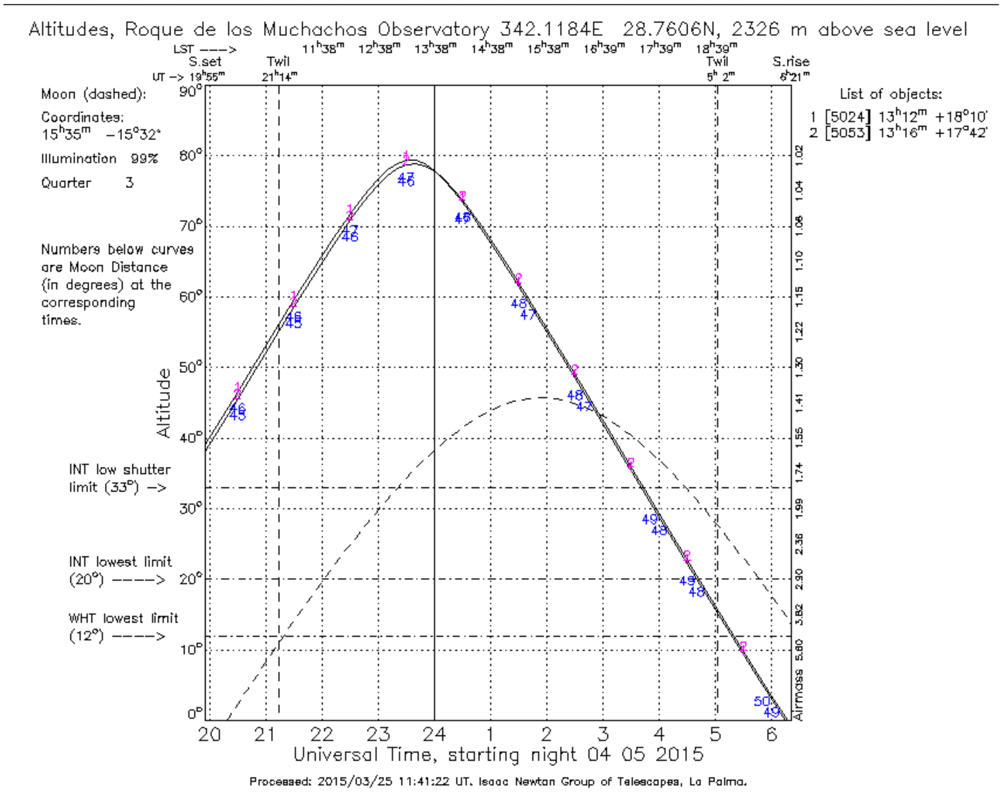

Figure 1: Visibility of objects

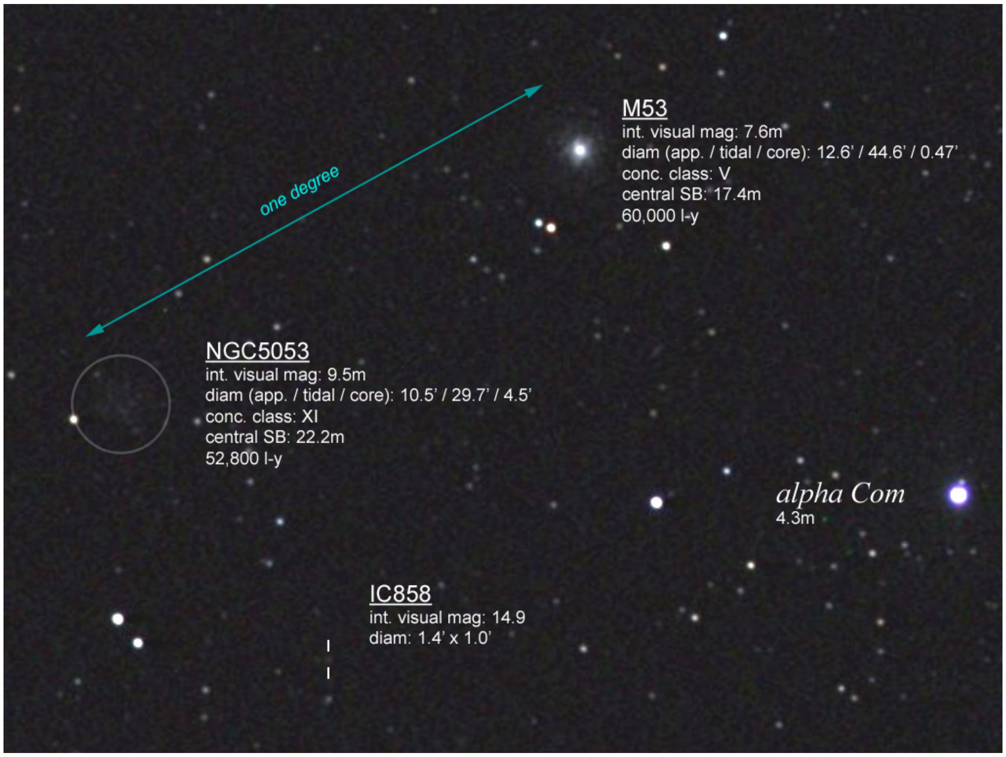

Figure 2: The finding chart

References

[1]http://catserver.ing.iac.es/signal/ http://www.ing.iac.es/astronomy/telescopes/int/
[2]http://catserver.ing.iac.es/filter/list.phpinstrument=WFC& filtersystem= BroadAndNarrowBand& availability=Yes
[3]http://catserver.ing.iac.es/signal/