Article Report, Montes & Trujillo (2019)

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1 Main title

- **Name** $\Longrightarrow$ Intracluster light: a luminous tracer for dark matter in clusters of galaxies
- **Authors** $\Longrightarrow$ Mireia Montes and Ignacio Trujillo
- **Year of publication** $\Longrightarrow$ 2019
- **Source** $\Longrightarrow$ Monthly Notices of the Royal Astronomical Society
- **DOI** $\Longrightarrow$ 10.1093/mnras/sty2858

2 Introduction and overview

The main goal of the article was evaluate the effectiveness of the measurements of ICL (Intracumular Light) as a tester of DM (Dark Matter) for galactic clusters (six clusters analyzed). The authors tried to achieve it using measurements and observations of the HFF Initiative (The Hubble Space Telescope Frontier Fields) and some data of the Chandra X-Ray Observatory.

Inside the clusters many dynamical processes can occur, many of this processes can pull out star of galaxies. A small fraction of stars is expected, however, to follow the global dark matter shape of the cluster. These are the stars whose extended spatial distribution results from the merging activity of galaxies and form the intracluster light (ILC). The ILC is the light produced by stars out of galaxies inside of galactic clusters. These stars can be defined as "errant stars" inside the cluster although they have great chance to return to a nearby galaxy or follow the most strong gravitational path.

One of the best methods to estimate the gravitational influence of DM is through gravitational lensing. Despite gravitational lensing is an excellent method to do this estimations, it also represents very expensive costs of procedure including long exposure times, very large surveys, complex mathematical and computational models among others.

As mentioned before, the authors present the ILC method of DM estimation as a less expensive and faster method to do estimations. In order to do that, they used the data provided by the HFF Initiative. According to the authors *"The HFF Initiative appears as the perfect data set for exploring this as it not only provides the deepest images of six galaxy clusters ever observed with the Hubble Space Telescope (HST), but it also provides accurate gravitational lensing models of the clusters."*

3 Data and Photometry

I focused this section only to the HST observation products and the procedures concerning to photometry.

The primary data set used for the article was extracted from the HST images of the six HFF clusters (HFF webpage). ICL is characterized to be more prominent at redder bands so they use the HST F160W filter for each of the clusters.The used gadgets were the ACS/WFC (Advanced Camera for Surveys Wide Field Camera) and WFC3 (Wide Field Camera). The flats acquired were claimed to be accurate to better 1% across the detectors. The images taken with the F160W (those used to make the inferences) had a pixel size of 0.06".

The sky correction was obtained subtracting a constant measured in ~ 30 apertures of r= 25 pixels (1.5") separated from bias sources like diffuse light sources. An interesting process was made; they carried out a Kolmogorov-Smirnov test to the backgrounds with a 95% confidence interval ans thus confirm that there was not any kind of bias in the background data.

Once the images were corrected they tried to identify the ILC on the images. This step required subtract foreground and background data related to objects emitting light different to that of the ILC. It was mentioned that this step is highly non-trivial because the quality of this process would define the accuracy of the results. They tried to remove all the light that were not ILC or the brightest cluster galaxy (BGC).

Since galaxy clusters are very extended objects (and therefore its light), the process of cleaning the images was quite complicated. They performed intensive masking to the data with the goal of camouflage the sources that were not BCG or ILC.

Another consideration mentioned in the text was the ICL distribution. According to the authors the HFF clusters are in the process or have experienced recent merging. Identifying the BCG of three galaxy clusters was a very complicated task so much that the authors had to classify as a BGC the most massive galaxy cluster in the cluster. The difficulty is that it is not easy to distinguish between the real light from the ICL and the galaxies themselves as mentioned above. Finally, they smoothed the background-subtracted images using a Gaussian of $\sigma = 15$ pix(~ 0.9").

4 Results and conclusions

They tried to relate the positioning of the ICL measurements for each cluster and weak gravitational lens measurements in the same areas with low spatial margins of error.

Clusters analyzed:

- A2744
- M0416
- M0717
- M1149
- AS1063
- A370

According to the authors ICL represents a extraordinary method to trace the DM distribution in clusters. They used the Modified Hausdorff distance (MHD) metric that tries to approach shape matching. The MHD gave them the mean spatial difference between the sky distribution of the clusters and its ICL. So, the mean MHD difference the total mass distribution and the ICL is ~ 25 kpc.