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Automatic galaxy detection and measurement in large astronomical photometric surveys

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In images from the Southern Photometric Local Universe Survey (S-PLUS, Mendes de Oliveira C. et al. 2019), we aimed to detect galaxies previously reported in the literature as spectroscopically confirmed or probable members of the Fornax Cluster. Our goal is to properly detect the position and apparent size of the galaxies, which can appear excessively deblended, or not even be detected, in the original S-PLUS DR3 and DR4 catalogs. This happens because the `SExtractor` input parameters used to obtain the released catalogs are intended to provide useful data for both galactic and extragalactic purposes.

To achieve our goal, we worked with three different sets of `SExtractor` parameters (RUN 1, RUN 2 and RUN 3), suitable to automatically detect and measure different types of astronomical objects. To perform the `SExtractor` runs, we developed a publicly available pipeline (MESSI)[1] that allows us to automate the entire process. From these runs, we obtained catalogs with homogeneous photometry in the direction of the Fornax, Antlia and Hydra clusters, and in the STRIPE-82 zone. Besides allowing for different analysis of the sources located in those sky regions, these catalogs are being used in the context of the S-PLUS Fornax Project (Smith Castelli et al., 2022) and to select targets in the Fornax and Antlia clusters for the CHANCES project of the 4MOST collaboration (Haines et al., 2023).

The results of our work can be summarized as follows. In nearby (D< 50 Mpc) environments, S-PLUS DR4 `SExtractor` parameters are useful to automatically detect and measure galaxies displaying smooth morphologies that are not placed in the vicinity of bright objects. However, they tend to miss faint galaxies and compact objects near bright galaxies and to over-deblend star-forming galaxies. RUN 1 `SExtractor` parameters recovers faint objects near bright galaxies but it is not capable to solve the over-deblending issue in star-forming galaxies. On the contrary, RUN 2 avoids the over-deblending of low and intermediate luminosity star-forming galaxies and make a good characterization of the sizes of large early-type galaxies. However, they do not solve the problem of over-deblending in large star-forming galaxies. RUN 3 parameters avoid the over-deblending of large star-forming galaxies and improve the characterization of the sizes of large early-type galaxies in comparison with RUN 2. We explored the catalogs released by other photometric surveys and found that a strong over-deblending of nearby star-forming galaxies is also present in DECaLS (Dey et al., 2019) and J-PLUS (Cenarro et al., 2019). We also found that RUN 1, RUN 2 and RUN 3 parameter sets display the same performance as on S-PLUS images when applyed on DECaLS, J-PLUS and MiniJPAS (Bonoli et al., 2021) images.

From our results we conclude that catalogues released by large photometric surveys that have both galactic and extragalactic goals should be used with caution, at least in nearby environments, and that our sets of `SExtractor`

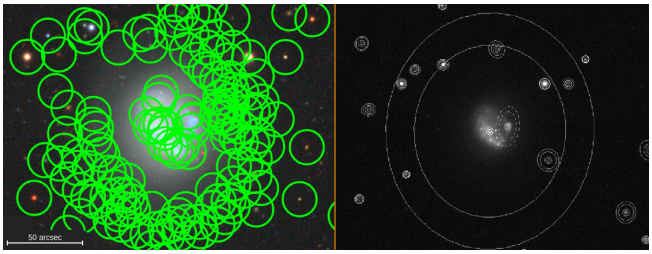

Figure 1. Example of an over-deblendend galaxy. In the left panel, the green circles indicate the multiple detections obtained by DECaLS. In the right panel we show the RUN 2 detections on the same galaxy.

[1] github.com/rodrihaack/MESSI

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parameters are useful to solve detection issues for different types of images.

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