Study of the diffuse stellar structures in the nearby Universe in the era of the large scale surveys Euclid and LSST

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Whereas surveys of the Local Group based on stellar counts have been able to make a comprehensive study of the diffuse stellar structures there (collisional tidal debris, disrupted dwarf galaxy satellites), detecting them further out is much more complex and their census remains heterogeneous. This is worrisome as the frequency of these structures, their spatial distribution and properties provide strong constrains for the models and simulations of the structuration of the Universe, in particular those reconstructing the merging history of galaxies. Deep optical imaging surveys from the ground such as those carried out with the CFHT (MATLAS, CFIS, NGVS) have already given clues about the prevalence of LSB structures around specific galaxies (especially the massive ones) in specific environments (clusters, groups). The new generation of surveys covering very large areas of the sky (15 000 sq degree for the Euclid space mission and 20 000 sq degree for the LSST survey with the Rubin telescope in Chile) will soon for the first time provide a panoramic, global view of the Low Surface Brightness (LSB) Universe. The predictions of the achieved SB limit for both complementary surveys are very promising and unprecedented (Figure 1) provided that the pipelines preserve the LSB signal. The PhD thesis proposed will explore the LSB potential of these surveys and carry out their first scientific exploitation.

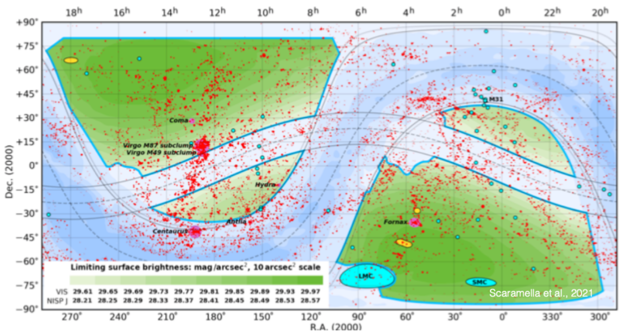

Figure 1 : The Euclid survey map of the limiting surface brightness in the VIS and NISP bands (Scaramella et al., 2021). LSST will achieve even fainter limits, but with worth image quality.

The PhD student will initially (1rst year) use available images from existing surveys as well as mock images from numerical simulations to create simulated Euclid and LSST images, that will be ingested in the standard pipeline which will be fine tuned to enhance the LSB signal. The first Euclid data from the science verification phase should already be available at the end of the first year. They consist of images of pre-selected nearby systems of particular interest for LSB studies. The first release of the data within the Euclid consortium will occur in the middle of the second year, at about the same time as the first data from Rubin/LSST. As part of the PhD work, a systematic study of a list of pre-defined targets will be carried out. Last year will be devoted to a more systematic blind analysis of specific regions (instead of targets), hopefully common between Euclid and LSST. The IA based tools developed as part of an on-going collaboration with a computer vision team will be adapted for this task.

The PhD director is an official member of both Euclid and LSST collaborations and has tickets for him and his team to access the unique data set provided by both missions. Within the collaborations, he is co-leading Work Packages devoted to the LSB science. In case both projects have strong delays, as backup solutions, the student will be invited to further explore the new data available from the CFHT CFIS + Unions surveys, which although not as deep as Euclid and LSST, remain competitive. Finally, a prototypal LSB optimized instrument (CASTLE) is soon to be installed at the Calar Alto observatory, and will provide additional data that may also be exploited as part of a B plan.