



GENESIS: Searching for the primordial structures of the Universe in the heart of the Galaxy - Photometry

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Scientific Case: High-redshift observations suggest that galaxy bulges may form through multiple mergers of massive clumps of gas and stars, and subsequently experience accretion events. Thus, a variety of relics tracing different phenomena are expected to populate galaxy bulges: the remnants of the primordial massive clumps that contributed to the bulge formation, in-situ formed and externally accreted globular clusters (GCs), and also nuclear star clusters of cannibalized galaxies. The signatures of different origins are imprinted in the photometric, chemical, and kinematic properties of these stellar systems. Being the only spheroid where individual stars can be observed, the Galactic bulge provides a unique opportunity for the exploration of the debris of those primordial and accreted structures, but no direct evidence has been found for decades because of the prohibitive observing conditions in this region of the Galaxy. Recent results, however, indicate that we likely reached a turning point: the discovery that two bulge stellar systems classified as GCs (Terzan5 and Liller1) host, instead, multi-age and multi-iron sub-populations strongly suggests that they could be the first exemplars of a variegated population of relics disguised under the false appearance of genuine GCs (Ferraro et al., 2009, *Nature*, 462, 483; Ferraro et al, 2021, *Nat. Astr.*, 5, 311). Thanks to an exceptional series of on-going observing programs with the top-level astronomical instrumentation, combined with tailored chemo-dynamical models and simulations, GENESIS proposes to perform a full “genetic screening” of the massive GCs in the MW bulge to unveil their true nature and origin, thus finally revealing unknown chapters of the Milky Way story.

Outline of the Project: This PhD thesis is aimed at assessing the presence and the number of different multi-age sub-populations cohabiting the same stellar system, by distinguishing multiple evolutionary sequences in the color-magnitude diagram (CMD), as the two separated red clumps found in Terzan5, or the blue plume detected in Liller1. This task, which is trivial and ordinary in halo GCs, is very complex in the bulge direction. In fact, the large contamination from Galactic field stars (that overlaps and mixes field and cluster sequences in the CMDs), combined with the extreme and differential reddening conditions (that severely distort and broaden the evolutionary sequences) make very challenging both the discrimination of the cluster population(s), and the correct reading of their properties (as the age). The PhD student will therefore use an unprecedented combination of high-resolution and multi-epoch optical and NIR observations (from HST, JWST and GEMINI), together with a set of innovative data analysis techniques, to finally construct multi-wavelength, high-quality CMDs, both selected for proper motions and corrected for differential reddening, which are the first indispensable ingredient for a solid photometric distinction between single-population and multi-age stellar systems. After the assessment of photometric completeness and blend contamination from artificial star experiments, the obtained CMDs will also be used to reconstruct the star formation history of each target from the comparison with synthetic CMDs (see, e.g., Dalessandro et al., 2022, *ApJ*, 940, 170; Crociati et al. 2024, *A&A*, 691, A311).

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