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STREGA@VST: Structure and Evolution of the Galaxy

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Abstract. In this article we present the survey STREGA, that has been proposed as part of the VST GTO (VLT Survey Telescope Guarantee Time of Observation) that will be given to the INAF-OAC in exchange for the construction of the telescope (see Alcalà et al., this volume). This survey will cover an area of about 150 sq. deg., searching for the southern portion of the *Fornax stream*, also allowing to study the properties of Disk and Halo White Dwarfs and interacting binaries in different fields at increasing galactic latitudes and to provide an ideal database for star counts and for the comparison with Galactic model predictions. The final aim is to constrain the structure and the evolutionary properties of the Milky Way. For the Fornax Stream this proposal is coordinated with a LBT Science Verification Pilot Project (P.I.: G. Bono).

Key words. Stars: variables: RR Lyr – Stars: white dwarfs – Stars: cataclysmic variables – Galaxy: evolution – Galaxy: structure

1. Introduction

The main laboratory for investigating the galaxy formation, the evolutionary mechanisms and their dependence on the surrounding environment, is represented by the Milky Way and its satellite galaxies. The outer regions of the Galactic halo seem to be quite "clumpy" Vivas & Zinn (2003); Newberg et al. (2003),

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showing substructures that likely are relics of small satellite galaxies accreted and destroyed by the tidal interaction with the Milky Way. If this is the case, the stars (and the globular clusters) of disrupted galaxies should have formed a part (if not all) of the Galactic Halo. To quantify the importance of accretion mechanisms, if any, we need to find and study these relics, in particular stellar streams and tidal tails and/or extended halos. In this context, a recent paper Dinescu et al. (2004), based on the measurement of the absolute proper motion of Fornax, appears to confirm the existence of the long sought *Fornax Stream* Lynden-Bell (1982), mapping the tidal interaction of the galaxies Fornax, Sculptor, LeoI and LeoII (and possibly Sextans and Phoenix), and of the globular clusters Pal3, Pal4 and Pal12, with the galactic halo.

Further information on the "genesis" of the Milky Way can be inferred from the study of the White Dwarf (WD) populations. The disk WD Luminosity Function (WDLF) allows us to obtain an independent estimate of the age of the galactic disk Leggett et al. (1998). Modern surveys have recently found the first "ultracool" WDs, i.e. WDs with effective temperature below 4000 K Gates et al. (2004), which are probably the oldest stars of our galaxy and at least in part possible members of an halo WD population, that, according to the microlensing experiments Alcock et al. (2000), might partially contribute to the galactic dark matter.

Another important tool to derive information on the evolutionary properties of the Milky Way is to study Interacting Binaries (IBs) at various galactic latitudes. The recent discoveries of dim galactic X-ray (L$\sim 10^{31-33}$ erg/s) sources and optically faint binary systems has renewed the interest in the field of close binaries, especially under an evolutionary point of view. However, our current knowledge of the Disk and Halo populations of IBs is still very poor. A deep survey, combined with spectroscopic and proper motion follow-up observations, will allow us to make a systematic study of the properties of Disk and Halo systems and to derive a more reliable local density and scale height, improving our knowledge of binary population in our Galaxy.

2. Survey Goals

1) The Fornax Stream. To explore the existence of the *Fornax Stream*, we plan to investigate the extra-tidal star distributions around the galaxies Fornax and Sculptor and the globular clusters Pal3 and Pal12, by using RRLyrae, long period variables (LPVs) and turn-off (TO) stars (as tracers of the different populations). In particular, to test theoretical predictions of the existence of extended halos Mayer et al. (2002), we will observe each system in three directions up to 10 times its tidal radius. The project aims also at mapping the southern portion of the Fornax Stream with selected strips of 10 adiacent fields trasversal to the hypothetical Fornax orbit, including the region, close to the Galactic plane, where we expect that the southern stellar warp is showing its maximum extent (the effect of this warp can easily mimic stream-like stellar overdensities when we approach the Galactic plane; Momany et al. in preparation).

2) Disk and Halo White Dwarfs. The first goal is to improve the WD statistics. The limiting magnitude of $g = 24.5$ (which will be reached in the coadded images) will allow us to detect all the WDs down to $T_{\rm eff}\sim$4000 K within ∼500 pc (DA WDs) or ∼350 pc (DB WDs). These numbers translate into 10 to 50 disk WDs per sq. deg. (depending on the galactic latitude) and about 7 halo WDs per sq. deg. (if 5% of the galactic dark matter is given by halo WDs), in good agreement with SDSS Kleinman et al. (2004) and 2dF Vennes et al. (2002) findings. A powerful method to distinguish WDs from nondegenerate stars is to use the Strömgren v filter (vS), which is very sensitive to the surface gravity. The second goal is to find cool ($T_{\rm eff}\lesssim$6000 K) and ultracool ($T_{\rm eff}\lesssim$4000 K) WDs. Finally, the last goal is to separate Disk and Halo WD populations using a 2nd epoch measurement after 3-5 yrs (g-band only). This will provide a measure of the proper motions with an accuracy within few tenths arcsec per year.

3) Disk and Halo Accreting White Dwarfs. The limiting magnitudes set in the survey strategy will allow us to detect all IBs at any accretion level within 1.3 kpc, i.e. down to naked binary components, and further out for IBs at higher ($\geq 10^{14}$ g s^{-1}) accretion rates. This will provide also pre-CV candidates, i.e. close binaries at the beginning of the mass-transfer process. From the colours it will be possible to isolate candidates and determine the spectral energy distribution. New IB candidates will be isolated using colours while $H\alpha$ and vS will constrain the type of candidate. Repetitive observations will be used to determine the orbital periods and hence the type of binary.

4) Star Counts. The distribution of stars in fields located at different galactic coordinates will be used to get information on the star formation history (SFH) of the Milky Way. This study will be based on an updated and detailed Galactic model Castellani et al. (2002) which can generate different SFHs for each stellar galactic component (Halo, Disk, thick Disk), by combining a wide choice of star formation rates (SFRs), chemical enrichment laws, initial mass functions (IMFs) and binary fraction. For the purpose of an accurate comparison between these theoretical models and the observed star counts three filters are necessary because they allow us to discriminate different stellar populations in the colour-colour diagram.

3. Survey Strategy

We plan to obtain multi-epoch g and i band observations in order to detect and to get a reliable identification of variable stars and an accurate determination of their periods. In the r band, additional multiepoch exposures will be obtained only around galaxies and clusters, while for the remaining fields a single exposure will be sufficient to obtain colour-magnitude and colour-colour diagrams. For RR Lyrae, the comparison with theoretical relations Marconi et al. (2003); Di Criscienzo et al. (2004) will provide information on the individual distances and on the spatial distribution. In individual exposures we need to reach g = 21.7 mag, r = 21.5 mag and i = 21.5 mag (with S/N=30), whereas, the coaddition of multi-epoch exposures will allow us to reach g = 23.6 mag, r = 23.6 mag, i = 23.4 mag (with S/N=30) and TO stars at the distance of Fornax (with S/N$\sim$10). For the identification and study of WDs and IBs we will obtain also single epoch exposures (only for 20 sq. deg.) at a limiting magnitude u = 23.4, vS = 23.4 (with S/N=30) and, only for IBs, $H\alpha$ flux = 3x10$^{-16}erg/cm^2s$ with S/N=10. The observations can be performed in bright time for the $H\alpha$ filter and in gray time for all the other bands. The total estimated VST observing time is about 365 hours (including overheads) over 4 years. To complete the project, we need both spectroscopic observations at VLT (10 nights) and photometric follow up at VST for the measurements of proper motions.

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