Mem. S.A.It. Suppl. Vol. 9, 204

Memorie della
Supplementi

The stellar VST-GTO surveys at the INAF-OA Capodimonte

J.M. Alcalá[1], M. Marconi[1], V. Ripepi[1], D. de Martino[1], I. Musella[1], R. Silvotti[1], M. Capaccioli[1,2], E. Cappellaro[1], M. Cignoni[1], E. Covino[1], M. Dall'Ora[1], M. Di Criscienzo[1,3], E. Iodice[1], S. Leccia[1], and A. Ruoppo[1,2]

[1] Istituto Nazionale di Astrofisica – Osservatorio Astronomico di Capodimonte, Via Moiariello 16, I-80131 Napoli, Italy e-mail: `alcala@na.astro.it`
[2] Università "Federico II" di Napoli, Italy
[3] Università "Tor Vergata" di Roma, Italy

Abstract. In this contribution we present the stellar projects that are planned to be carried out at the INAF- Osservatorio Astronomico di Capodimonte using the VLT Survey Telescope (VST) guaranteed observing time (GTO).

Key words. Stars: surveys – Stars: Variables: General – Stars: Pre-Main Sequence – – Galaxies: Magellanic Clouds – Galaxy: stellar content

1. Introduction

It is foreseen that the VLT Survey Telescope (VST) will start operations next year. In exchange for the construction of the telescope the INAF-OA Capodimonte will have guaranteed observing time with VST (VST-GTO). In this contribution we present the proposed stellar projects for the VST-GTO. We plan to investigate the formation and evolutionary mechanisms of the Milky Way and surrounding galaxies. In particular we will focus on the study of star formation regions and stellar populations, including variable stars as tracers, in different environments, from the Galactic plane to the outer halo and in some of its satellites. To this purpose we will focus on 4 different projects: 1) Structure and Evolution of the Galaxy; 2) The SMC in time: evolution of a prototype interacting dwarf galaxy; 3) a survey for pre-main sequence stars and young brown dwarfs and 4) a survey for extra-solar planets. We describe next each one of these projects.

2. STREGA - STructure and Evolution of the GAlaxy

This multipurpose project is a collaboration between INAF institutes (Naples, Rome, Teramo and Torino) and instruments (VST and LBT). Its first goal is to search for signatures of the tidal interaction of the Fornax and Sculptor galaxies, and of Pal3 and Pal12 GCs, with the Galactic Halo, by looking at the Southern part of the Fornax stream (Lynden-Bell 1982). To this purpose we plan to use RRLyrae, long period variables (LPVs) and turn-off (TO) stars as tracers of the different stellar populations. The survey is planned to cover a ∼150 sq. deg.

Send offprint requests to: J. M. Alcalá area (including the region of the Galactic Warp close to the Galactic Plane) using about 70 VST nights. The observations will also allow to study Disc and Halo White Dwarfs (WDs) in different fields, at increasing galactic latitudes, improving the statistics of these objects and providing the basis for the study (with the help of spectroscopic follow-up observations and proper motion measurements) of fundamental properties of the Milky Way (the age of the disk, the initial mass function, the star formation rate and the amount of dark matter). The observations also aim to search for interacting binaries (IBs) at different latitudes to help in solving the discrepancy between theoretical and observed space densities, to constrain the evolution of the disk binary population and to clarify the nature of high latitude systems and low luminosity X-ray sources. Finally, the systematic exploration of extended regions at varying Galactic latitude will provide an ideal database for Galactic counts and for the comparison with the predictions of accurate galactic models to constrain the structure and the evolutionary properties of the Milky Way. In particular, the core program of the survey (to be completed during the first two years) will be devoted to the exploration of extra-tidal star distributions (tails and/or halos) around the Fornax and Sculptor galaxies, the Pal3 and Pal12 clusters and the southern part of the hypothesized warp region. In the subsequent two years of the project, in order to extend the analysis to the northern part of the Galactic Warp close to the Galactic Plane and to more extensively map the southern portion of the stream and the WD and IB populations in Galactic latitude, we plan to observe additional strips (sequences of adjacent fields at constant latitude), transversal to the hypothesized Fornax Stream at various Galactic Latitudes. We plan to obtain multi-epoch g' and i' observations in order to detect and to get a reliable identification of variable stars and an accurate determination of their periods. Additional r' band exposures will be used to obtain color-magnitude and color-color 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 in turn on the spatial distribution. For these variable stars, we need to reach the limiting magnitudes g'=21.7 mag, r'=21.5 mag and i'=21.5 mag (with S/N=30), whereas, the co-addition 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 the limit magnitude for 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. degr.) in the u' and Strömgren v (vS) bands with limiting magnitudes u'=23.4, vS=23.4 (with S/N=30) and, only for IBs, Hα flux = 3x$10^{-16} erg/cm^2 s$ with S/N=10. The observations can be performed in bright time for the Hα filter and in gray time for all the other bands. Finally, 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. For more details on this project see Marconi et al. (2005)

3. STEP - the SMC in Time: Evolution of a Prototype interacting dwarf galaxy

This project is a collaboration between INAF (Naples, Bologna and Teramo) and foreign (STSCI, Univ. Wisconsin, Univ. Basel, ESO - Garching) institutes. The survey is devoted to the investigation of the Small Magellanic Cloud body and the Bridge (towards the LMC) in order to study the different stellar populations of these systems down to the turn-off of the oldest stars. In particular this project can be divided in two related surveys. The first is a deep survey (V $\approx$24.5 mag, S/N=10), aimed at studying the star formation history (SFH) of SMC and its stellar cluster component. The field SFH will be obtained from the comparison between deep color-mag diagrams (CMD) and proper population synthesis models. Cluster observations will be used to understand if clusters and field stars experienced the same SFH. The second is a shallow survey (V $\approx$19.5 mag, S/N=100, 30 phase points in V, 10 in B and i'), aimed at investigating, for the first time systematically, the SMC Wing and Bridge and most of the hosted clusters, which will be studied through the construction of homogeneous CM diagrams. The structure and spatial distribution of the inter-Cloud populations of the Bridge will be investigated also by variable stars as population tracers, in particular those still unexplored in the Bridge. The project is strictly interlaced with complementary observing runs foreseen or already carried out with HST (deep and spatially resolved photometry). Also 38 hours of VLT observing time will be used for multiobject spectroscopy of selected candidates. For more details on this project see Ripepi et al. (2005)

4. VISPO - VST Imaging Survey for Pre-Main Sequence Objects

An important issue for the understanding of the star and planet formation process is the determination of the Initial Mass Function (IMF), in particular in the very low-mass and sub-stellar regimes. Recent investigations give in fact controversial results. While in the Orion Nebula Cluster (ONC) the IMF appears to rise below $0.1\,M_{\odot}$, in T associations like Taurus-Auriga there is indication of a deficit of sub-stellar objects. A wide-field imaging survey in star forming regions with the VST is a very efficient means to gather a homogeneous sample of very low-mass objects in SFRs and to study the IMF in the sub-stellar regime.

In this project, which is a collaboration among the INAF-Observatories of Naples, Catania, Palermo, and Florence, and ESO (Garching) it is proposed to search for young Brown Dwarfs (BDs) in cometary clouds in Orion. The cometary clouds are regions in which star formation might have been triggered due to the strong impact of massive stars in the Orion OB association. We will study the IMF in the very low-mass and sub-stellar regimes using the capabilities of the VST, ie. good resolution in a wide field of view and completeness in the flux limits in broad photometric bands, specially in the r', i', z and Hα bands. The cometary cloud regions in Orion were selected from the literature as well as from our previous X-ray studies in Orion. The present study will allow us to determine the star formation history in the selected regions and to find out whether the IMF is rising or dropping in the very low-mass regime and if the environmental conditions have any impact on the IMF. The sensitivity and the large area covered in the proposed survey may also provide the possibility to single-out young free-floating planetary-mass objects.

The optical imaging data will be combined with IR data from the 2MASS and UKIDSS catalogs, as well as with X-ray data from XMM and Chandra observations in order to pre-select candidates to low-mass PMS stars, young BDs and possibly free-floating planets. Color-magnitude diagrams (CMDs) and theoretical isochrones (see also Alcalá et al. (2005) and Spezzi et al. (2005)) will be used for the candidates selection. The previously known PMS stars in the selected regions, many of which characterized by us, will be used to define the PMS locus in the i' vs. r'–i' or z vs. i'–z CMDs. These criteria will be combined with the Hα, near-IR and X-ray data in order to select emission line and X-ray emitting young BDs. The necessary observing time to perform the project will be 54 hours during one year, i.e. 23 and 31 hours for the broad-band and Hα filters respectively. In this way we will cover 15 square degrees. The depth of the survey will be about 24.3, 23.7, 23.0 and 22.5 in the r', i', z and Hα bands respectively at a significance level of 10σ. VLT will be also used for spectroscopic follow-ups of selected candidates.

5. OmegaTranS - OmegaCAM Transit Survey

This is a joint project of INAF (Naples and Padua) with the Max-Planck Institut für Extraterrestrische Physik (MPE, Garching) and the Leiden Observatory, aimed at searching for extra-solar planets using the transit method. Each country (Germany, Italy, and the Netherlands) shall provide one week per year of their own bright GTO, possibly during several years. In order to optimize the search strategy, additional observing time will be required as a poor-seeing back-up program. Targets are stars in the magnitude range R=13.5-17.0, in five OmegaCAM fields towards the Southern part of the Galactic disk. OmegaTranS shall

Table 1. Summary of the stellar VST GTO projects at the INAF-OA Capodimonte

Survey	Area [sq. deg.]	Filters and Depths	Obs. time [h]	Moon phase D	G	B	notes
STREGA	150	u'=23.4, g'=24.5, r'=21.5/24, i'=24.5, vS=23.4, Hα($3 \cdot 10^{-16}$)	365		90%	10%	(N1)
STEP	65	B=25, V=24.5, i'=23.8	169		50%	50%	(N2)
VISPO	15	r'=24.3, i'=23.7, z'=23.0 Hα=22.5	54		40%	60%	(N3)
OmegaTranS	5	r'=18	130			100%	(N4)

Notes to table:
(N1): Depths assume a point source with 1 arcsec seeing at airmass 1.5. S/N=30 on PSF for u', g', i' bands and for r'=21.5, S/N=10 on PSF for H_α and r'=24; (N2): Depths assume a point source with 1.2 arcsec seeing, airmass 1.7 and S/N=10 on PSF; (N3): Depths assume an aperture of 1.4 arc-sec, S/N=10 on PSF, seeing of 1.0 arc-sec and airmass of 1.5; (N4): Depth assume an aperture of 1.5 arc-sec, S/N=150 on PSF, seeing of 0.8 arc-sec and airmass of 1.2. The observing time refers to the first two years only.

improve the OGLE-III transit survey, which is arguably the most successful to date, by more than one order of magnitude. In the first year the survey will be sensitive to short-period planets, and next eventually to planets with orbital periods of some hundred days.

6. Conclusions

A summary of the stellar GTO VST projects at the INAF-OA Capodimonte is presented in Table 1. The exposure for the determination of the limiting magnitudes have been computed using the exposure time calculator VOCET (courtesy by A. Rifatto, www.na.astro.it/ rifatto/vst/vocet_2.htm). The total observing time includes an average of 25% overheads. The expected yearly dataflow will be as follows: 1 TByte for SGTREGA, 1 TByte for STEP, 0.5 TByte for VISPO and 1.3 TByte for OmegaTrans. This will require the use of an automatic pipeline like the one developed within the ASTRO-WISE (www.astro-wise.org) consortium for the data processing.

As can be seen from Table 1 all the stellar VST-GTO projects at the INAF-OA Capodimonte will be performed during grey or bright time and will use about 50% of the total VST-GTO. While the project STREGA is foreseen to be performed within the course of the first four years, VISPO and STEP are planned to be completed within the first and second years of VST operations respectively. For OmegaTranS it is foreseen to continue the observations after the first two years, but with a different observational strategy.

The stellar VST-GTO projects at the INAF-OA Capodimonte involve many astronomers at different observatories within Italy and abroad. As such they represent an important aggregation point within INAF.

Acknowledgements. We thank A. Rifatto for his help with VOCET. Financial support for this study was provided by MIUR, under the scientific project "On the evolution of stellar systems: fundamental step toward the scientific exploitation of VST" (P.I. Massimo Capaccioli).

References

Alcalá, J.M., Frasca, A., Spezzi, L., et al. 2005, Mem.S.A.I. 76, 241
Di Criscienzo M., Marconi, M., Caputo, F. 2004, ApJ, 612, 1092
Lynden-Bell, D., 1982, Obs 102 131
Marconi, M., Caputo, F., Di Criscienzo, M., Castellani, V., 2003, ApJ, 596, 299
Marconi, M., et al. 2005, this volume
Ripepi, V., et al. 2005, this volume
Spezzi, L., Alcalá, J.M., Frasca, A., Covino, E. 2005, this Volume