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Synergies between the VVVX Survey and the S-PLUS Galactic Survey

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Abstract. Two new Galactic Surveys started activities in 2016: the ESO Public VISTA Variables in the Vía Láctea eXtended Survey (VVVX) and the Southern Photometric Local Universe Survey Galactic Survey (S-PLUS GS). VVVX is the extension of the ESO VVV Survey (Minniti *et al.* 2010) and will triple the observed area from 562 deg^2 to 1700 deg^2. The S-PLUS GS makes use of the T80-South robotic telescope in Cerro Tololo (Chile) to observe 1420 deg^2 of the Galactic disk and bulge in the optical. The S-PLUS GS will cover 800 deg^2 contemporaneously and overlapping with VVVX. Here we explore the synergy between these ongoing surveys and present illustrative examples combining the optical and infrared data.

Keywords. Galaxy: bulge, Galaxy: disk, Galaxy: stellar content, surveys

1. Two new Milky Way surveys

The ESO Public Survey VVVX will provide a deep JHK_s catalog ($K_s \sim 18$ mag) as well as K_s-band light-curves for about two billion point sources within 1700 deg^2 in the Galactic bulge and plane (Fig. 1). The VVVX area will cover the gaps left between the VVV and VHS areas (McMahon *et al.* 2013) and extend the VVV time-baseline from 6 to 10 years. Within the existing VVV data VVVX will produce a 5-D map combining positions, distances and proper motions of well-understood distance indicators such as red clump stars, RR Lyrae and Cepheid variables in order to unveil the inner structure of the Milky Way. The VVV+VVVX catalogues will complement those from the Gaia space mission and will feed spectroscopic targets for the forthcoming ESO high-multiplex spectrographs MOONS and 4MOST.

S-PLUS is an imaging survey that will image ∼8000 deg^2 of the Southern sky in twelve broad- and narrow-band optical filters (Sloan *ugriz*, plus filters centered on the [OII], Ca H+K, D4000, Hδ, Mgb, Hα and CaT spectral features) using the T80-S robotic telescope at Cerro Tololo (Mendes de Oliveira *et al.* 2017). This Galactic survey is unique in mapping the inner Milky Way with narrow-band filters, including multi-epoch observations in r, i and Hα. The observations will reach ∼18 mag with S/N = 50 in all filters (up to 21 mag with S/N = 3). The Survey covers an area of about 1420 deg^2 in the Milky Way plane, divided in bulge and disk (Fig. 1).

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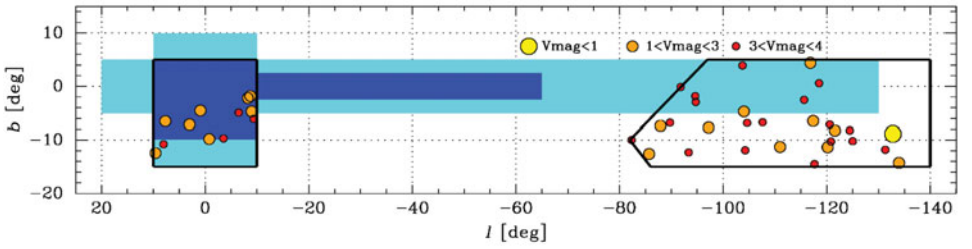

Figure 1. Areas being observed by the VVV/VVVX and S-PLUS GS surveys. The VVVX area is shown in light blue while the original VVV area is shown in dark blue. Thick lines mark the S-PLUS Galactic area, divided in bulge (400 deg^2) and disk (1020 deg^2). An overlapping area of 800 deg^2 will be observed contemporaneously by VVVX and S-PLUS GS. Stars brighter than $V = 4$ mag are marked in the figure. The region around these stars will be excluded from the S-PLUS GS observations.

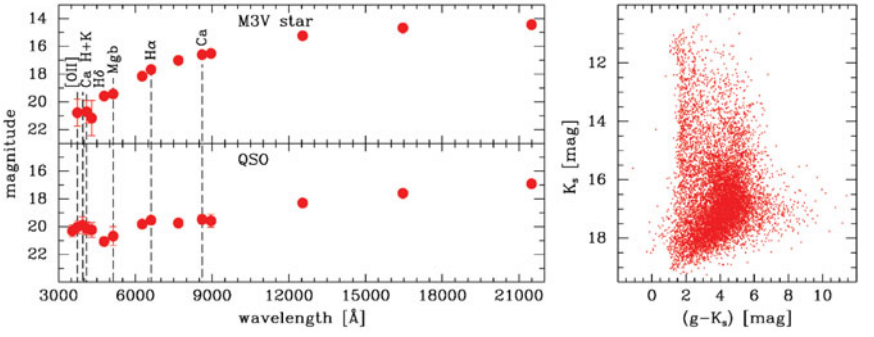

Figure 2. In the absence of S-PLUS GS data we present an illustrative dataset combining T80-S from the Main Survey with VISTA data from the VHS Survey (McMahon *et al.* 2013). Left: optical + near-IR photospectra combining the datasets for a M3V star (2MASS J01154245-0045092) and for a QSO (SDSS J011448.44-004148.3). Right: $K_s \times (g - K_s)$ color-magnitude diagram for a 2 deg^2 region around Stripe 82 (<RA,DEC>=01:13:20.3,−00:38:52.9, corresponding to l, b=135.0642,−63.0026). According to Schlafly & Finkbeiner (2011) the mean extinction for the region is A_V=0.094. In the inner Galactic plane extinction will play an important role.

2. Synergies between the VVVX and S-PLUS GS

S-PLUS observations will provide finer constraints on the targets found in the VVVX such as the colors of stars in microlensing events, stars harboring planet candidates as well as spectral classification of variable sources such as RR Lyrae and CVs. The optical and near-IR combination would be particularly useful for discriminating novae and other transients. Extinction maps will also benefit from additional narrow-bands to break the degeneracy between reddening and spectral type for large numbers of stars. Fig. 2 shows examples of photospectra for a M3V star and a QSO and a CMD combining VISTA and T80-S data. Besides the photospectra, r, i and Hα variability data from S-PLUS GS will be complementary to LSST that will saturate at these wavelengths.

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