1 UVEX: The Southern Galactic Plane UV-Excess Survey

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1.1 Abstract:(10 lines max)

The Galactic Plane in blue colours is a vast unexplored region of the optical sky. Never has it been surveyed for UV-excess and/or high proper motion objects. It is, however, *the* region to make a quantum leap and obtain large samples of intrinsically faint, blue Galactic populations. These populations include single and binary white dwarfs, subdwarf B stars and interacting close binaries: all stellar remnants of single and binary star evolution. Obtaining a better, deeper and homogeneous sample of these populations is crucial to answer a number of astrophysical questions: *i)* how do close binaries evolve (e.g. in type Ia SNe) and what is the physics of common-envelope evolution, *ii)* what is the star formation history of our Galaxy as written in the population of white dwarfs, *iii)* what is the contribution of compact binaries to the gravitational wave background and which systems can be detected individually *iv)* what is the physics of accretion discs. We propose to obtain the *first ever*, full scale survey of the Galactic Plane for UV-excess and high proper motion objects: *UVEX*.

2 Description of the survey: (Text: 3 pages, Figures: 2 pages)

2.1 Scientific rationale:

2.1.1 Astrophysical Relevance

Stellar remnants form an essential ingredient to our understanding of (binary) stellar evolution, the formation and history of our Galaxy and the high energy and relativistic Universe. Populations of objects include single and binary white dwarfs, interacting close binaries (including neutron star and black hole binaries) and subdwarf B-stars. Our understanding is severely lacking on their space densities and population characteristics which are essential to answer crucial astrophysical questions such as:

•Binary Evolution & the Common Envelope.
A thorough understanding of binary evolution is crucial for our understanding of the Universe. The majority of all stars are located in a binary or multiple system and binaries are responsible for many of the high energy phenomena in the Universe, such as X-ray binaries, X-ray bursts, Supernovae type Ia, gamma-ray bursts and the sustained existence of globular clusters. Our understanding of single star evolution is thorough and advanced, but our understanding of binary evolution still contains large gaps. One such gap is the physics of the common-envelope. During its evolution to a compact binary a system must have experienced a phase of spiral-in (Paczyński 1976). In this phase the companion enters the envelope of the giant and spirals towards the giant's center to form a compact binary with the dense core of the giant (the future stellar remnant). Eventhough existing close binaries show that such a phase must have taken place, we do not understand the physics of this process: the energetics, time scales, role of rotation and the effect of luminosity of the components are not understood. One way of obtaining a better handle on the common-envelope physics is to obtain complete, homogeneous samples of possible common-envelope products and compare their relative and absolute numbers with population synthesis studies and detailed stellar evolution codes.

Apart from obtaining complete samples of white dwarf binaries, a UV-excess survey of the Plane will also uncover members of the rare class of neutron star and black hole binaries, specifically the quiescent low-mass X-ray binaries. The equation of state of neutron stars and the formation of jets in black hole binaries are two of the outstanding physical questions that these systems can solve. Current number statistics are so low that it is difficult to obtain any feel for population characteristics (level of remaining accretion, orbital period distribution, age etc.). A UV-excess survey of the Plane, correlated with e.g. the catalog of Chandra sources, is the way to obtain more examples of these rare objects.

• **Star Formation Record of our Galaxy.**
The formation and evolution of galaxies is one of the main topics of research in astrophysics today. Many lines of approach are taken to tackle this problem, and one of them is to better understand the structure and evolution of our own Galaxy. White dwarfs form an important key to unravel this Galactic history, since 86% (using a Kroupa et al.,1993, IMF) of all stars will end their lives as white dwarfs. In a large and homogeneous sample of these white dwarfs we can read the history of (medium-mass) star formation of our Galaxy because we can determine the age and mass of the white dwarf progenitors. White dwarf modeling is producing more and more accurate absolute luminosities such, from a combination of the models with observationally derived system parameters (log g and $T_{\rm eff}$) distances can be obtained. Combined with proper motion and radial velocity observations we can therefore build a complete 3D model of the white dwarf population in our Galaxy. However, current samples of white dwarfs are dominated by high Galactic latitude observations (in particular the Sloan Digital Sky Survey, but more in general almost all major surveys have been at high galactic latitude) which probe only a limited Galactic volume, typically one scale height ($\sim 200 - 500$ pc) in depth. No such study is currently available for the Plane, where we expect the vast majority of objects to be present. We propose to obtain this Plane sample of white dwarfs through the present proposal. The hotter stars will mainly be found through the UV-excess part of our proposal. The older, cooler and therefore fainter objects will be identified through the proper motion study of the *UVEX* survey.

• **The Gravitional Wave Sky**
With gravitational wave experiments such as *LIGO*, *TAMA* and *VIRGO* well underway and a satellite experiment such as *LISA* approved and under construction, the first direct detection of gravitational waves from astrophysical objects is a matter of time. Especially *LISA* will be a ground-breaking cluster of satellites that will open up this completely new window on the Universe. Studies of possible *LISA* sources show that the Galactic population of binary white dwarfs (detached as well as interacting systems) will be a major contributor to the *LISA* signal (e.g. Nelemans et al., 2001b, 2004). Although sometimes considered a background 'noise', a thorough understanding of this Galactic population of white dwarf binaries is crucial to the success of *LISA* to detect mergers of supermassive black holes in the centers of distant galaxies. And any detection of these white dwarf systems serves its own right in a number of ways: *i)* we will be able to detect *all* very short orbital period (< 10 min) systems in our Galaxy. We currently know of only three of these, but there is a predicted population of several 10^4 of these. These systems are possible candidates to form supernovae Type Ia through mergers (Piersanti et al., 2003; Belczynski et al., 2005), *ii) any* detection of an individual source of gravitational waves will be a major breakthrough in astrophysics. The *best, known* candidates for detection with *LISA* are three interacting white dwarf binaries of the AM CVn type: RXJ0806+15 ($P_{\rm orb}$=5.3 min), V407 Vul ($P_{\rm orb}$=9.5 min) and ES Ceti ($P_{\rm orb} = 10.3$ min). Since *LISA* will see all signals from the complete sky at the same time, it will be of immense help in confirming the detection of any system to have a thorough knowledge (i.e. numbers, positions and orbital periods) of the population of close compact white dwarf binaries *beforehand*. To obtain this population of objects we need to perform a UV-excess survey of the complete Galactic Plane to identify them. From the *LISA* observations themselves we will obtain the reduced mass of the binaries, the orbital inclination and in some cases individual masses and the distance. These populations of white dwarf binaries are intrinsically faint, Galactic and blue: a UV-excess survey of the Plane is therefore needed to obtain a complete sample of them.

• **Accretion Disk Physics** Accretion disks are prolific in the Universe, being encountered in many different settings. From young stellar objects to interacting close binaries to active galactic nuclei. Accretion is furthermore the powerhouse of the Universe, powering some of the most highly energetic phenomena. The physics of accretion disks is, however, still poorly understood, especially in more tenuous, thin disks. The source of viscosity in these disks, the role of magnetic fields in generating this viscosity, the equation of state of hot, inner disks in X-ray binaries and the formation of jets are open questions to this date. Interacting close binaries are one of the best places to study disks because of their abundance, convenient orbital periods and the possibility to study disks under different physical circumstances (e.g. X-ray irradation, high or low mass accretion rates within one system, He or H-dominance of the disk). This group of close binaries includes both the white dwarf systems such as Cataclysmic Variables and AM CVn stars, as well as the neutron star/black holes systems such as Low-mass X-ray binaries, accreting millisecond X-ray pulsars and soft X-ray transients. Within this group special attention is paid to the eclipsing systems. Through indirect imaging techniques (Doppler mapping, eclipse mapping) we can derive spatially resolved information on the brightness, temperature, density and velocity distribution of these disks: unique input for further theoretical and numerical modelling of these disks.

2.1.2 Populations of stellar remnants

As outlined above, the aim of our survey is to obtain complete and homogeneous samples of populations of stellar remnants in our Galaxy. The main populations we are aiming for are:

• **Single white dwarfs** The remnants of single star evolution or the product of a merger of two stellar remnants. They will be identified on their blue colour (T>7 000 K up to ∼1.5-2 Gyr after formation) and/or their proper motion. Obtaining this sample is important *i)* for determining the star formation history of our Galaxy, *ii)* for setting the absolute scale for the fraction and total number of sdB and white dwarf binaries in our Galaxy, *iii)* for providing the base sample to search for close, detached white dwarf binaries.

• **Binary white dwarfs** Detached binary white dwarfs will mainly be obtained from the sample of single white dwarfs from follow-up spectroscopy and photometry. They are *i)* a possible progenitor of type Ia Supernovae, *ii)* the main contributor to the *LISA* 'background' of gravitational waves, *iii)* the calibrator fraction to obtain the ratio of interacting to non-interacting white dwarf binaries.

• **Interacting white dwarfs** This population includes both the Cataclysmic Variables (with a low-mass main sequence companion) as well as the AM CVn stars (with a helium dominated (semi-)degenerate companion. They are: *i)* ideal for studying accretion disk physics, *ii)* the AM CVn class are possible progenitors of peculiar type Ia supernovae, *iii)* known short period AM CVn stars are the only known detectable targets for *LISA*.

• **Interacting neutron stars/black holes**. These rare populations are the main ingredient to the Galactic environment of high energy astrophysics. Ideal sources to study: *i)* the equation of state of neutron stars (especially when they are in their quiescent state), *ii)* the physics of accretion disks, *iii)* general relativistic effects such as frame dragging, *iv)* the formation of jets.

• **Subdwarf B-stars**. Subdwarf B stars dominate the sample of UV-excess sources at high galactic latitude in previous surveys. They are extreme horizontal branch stars that, in current scenario's (e.g. Han et al., 2002), are always the product of evolution in binaries. They are also a progenitor of white dwarfs. Understanding the evolution of sdB stars *and* their contribution to the general white dwarf population in a later stage of their evolution is essential for understanding binary evolution. They are also considered the main source of the UV upturn in elliptical galaxies and are proposed as an age indicator (Brown et al., 2003).

2.1.3 Why the Galactic Plane?

The reason to study the Galactic Plane in the UV for these sources is that they are all Galactic populations, and therefore show a strong concentration towards the Galactic Plane. Fig. 1 shows a simulation of the population of Galactic stars for three values of M_V. This sample is magnitude limited to g'=23: similar to the *UVEX* survey. A clear concentration of the population towards the Galactic Plane is seen, with 24%, 75% and 97% of all objects within 10° of the midplane for M_V=15, 10 and 5 respectively. In this situation we have incorporated extinction according to the Sandage model and used a Galactic model based on Boissier & Prantzos (1999). The M_V=5 case may be taken as an illustration of the population of sdB stars where we are sensitive to the full Galactic volume. The M_V=10 would be typical for our interacting binaries and brighter/hotter white dwarfs and the M_V=15 sample is illustrating our faintest targets: cooled-down white dwarfs and very low-luminosity interacting binaries.

2.1.4 Extinction: a mixed blessing

As shown above our expected populations show a strong concentration towards the Galactic Plane and we therefore have to worry about extinction and reddening. It is important to realise that our populations are *intrinsically faint and blue*. Compared with any main-sequence stars at the same distance they will therefore show a strong UV excess. Even in the case of reddening they will show up being bluer than the bulk of the

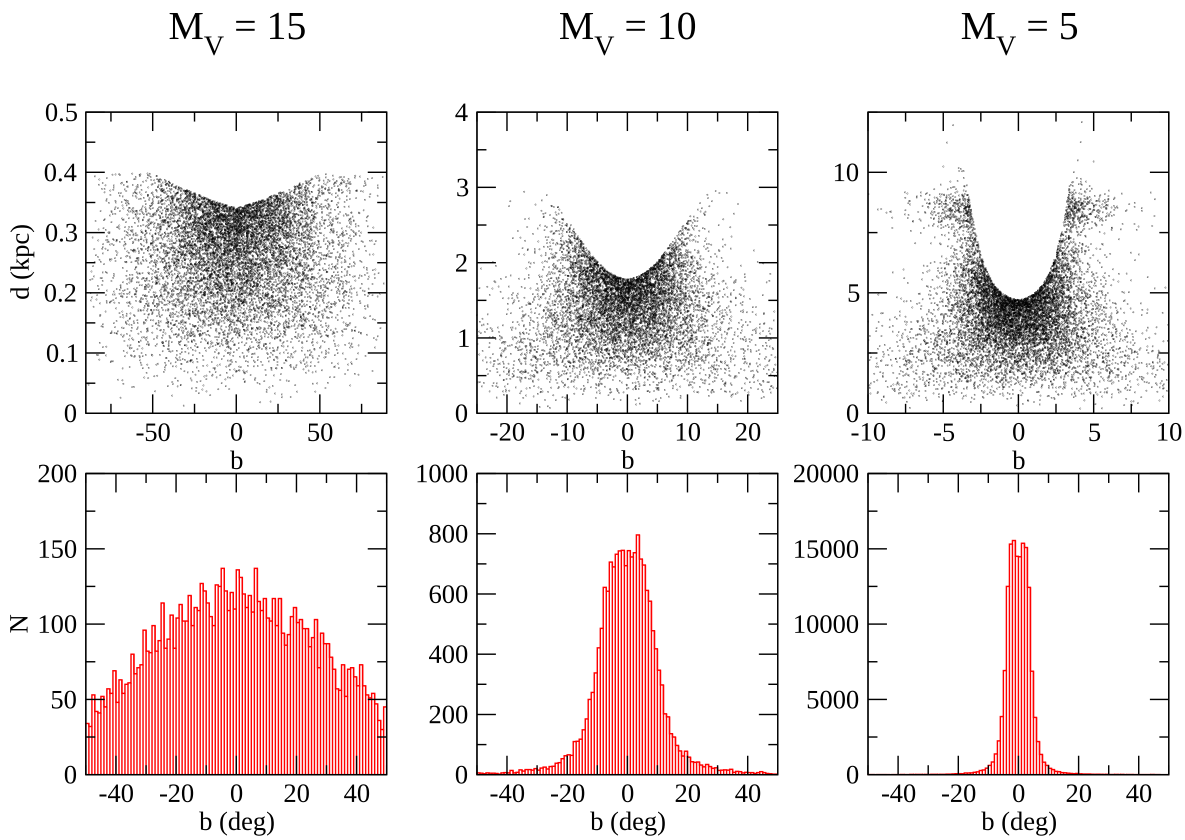

Figure 1: A simulated Galactic population of objects with indicated M_V in a magnitude limited sample down to g'=23, including a Sandage-type modeling of the Galactic extinction.

stellar population. Since they are also intrinsically fainter than the bulk of the stellar population, and therefore on average closer by, they will be less reddened than the stellar population, making them stand out even more. The strong extinction towards the Galactic plane will effectively screen out the non-stellar objects that we consider as 'interlopers' for our UV-excess selection, in particular quasars. In Fig. 2 we show the extinction (A_V) in the Galactic Plane. This shows that there is a strong fall-off of the extinction within the first 2 degrees of the Plane.

The *UVEX* survey will be a double pass UV-excess survey of the Galactic Plane ($|b| < 10°$) down to $u' = g' = r'$=23 with reobservations of the same area in g' after 3 and 10 years.

2.1.5 Additional scientific impact

• **Galactic structure; multiwavelength studies** Our dataset will be of general interest for studies of the structure of the Galaxy and the Bulge. We estimate to detect $\sim 10^9$ point sources, the vast majority of which will be main sequence stars. The *UVEX* database will be an excellent tool to constrain space densities of stellar populations, also in correlation with databases of surveys in different parts of the electromagnetic spectrum. The 2MASS and UKIDSS surveys will provide the near IR data, and the Spitzer Galactic Plane survey the 3.6 - 8.0 μm data. On the other side of the spectrum Chandra is providing thousands of point sources in the Galactic Plane. *UVEX* will be first, deep optical Galactic Plane survey ever.

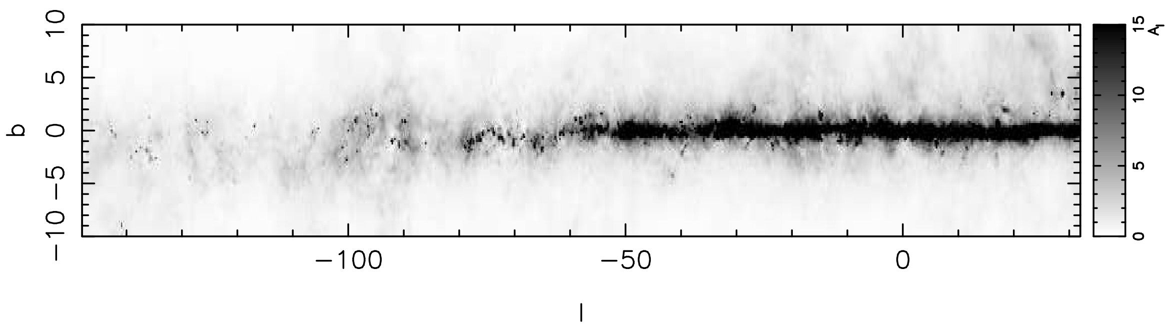

Figure 2: An extinction map of the Galactic Plane area proposed to be surveyed here based on the Schlegel et al. data. It is clear that there is a strong decrease of the extinction within the first 2 degrees from the midplane. However, the *full* area here has never been properly surveyed, despite the many areas of low extinction. This is what UVEX will remedy.

2.2 Immediate objective:

The immediate objective of this proposal is to enlarge the known sample of populations of stellar remnants in our Galaxy: single and binary white dwarfs, subdwarf B stars and compact interacting binaries. The means to achieve this is by *the first ever* survey of UV-excess objects in the Galactic plane. We wish to use the VST+Omegacam combination to survey a strip of 20×180 degrees along the Southern Galactic plane in the u', g' and r' bands down to 23rd magnitude. Candidates will be identified on the basis of their excess blue colour in a $u' - g'$ vs. $g' - r'$ colour-colour diagram with respect to the *local* population of Galactic disk stars. This strategy is based on the fact that our targets are bluer/hotter than the average turn-off mass of the Galactic disk population (located near $B-V$=0.38; $T_{\rm eff}$=7000 K, Fig. 3). The advantage to identify candidates with respect to the *local* population instead of setting an absolute requirement on colour excess is that even populations with moderate reddening can be detected as long as they have a blue excess compared with the background population. Since our targets are, on average, intrinsically fainter and bluer than main sequence stars, they have to be closer by and therefore suffer less reddening.

2.2.1 Expected numbers

From experience with wide field imagers at low galactic latitude we estimate the total number of objects in our survey to be $\sim 10^9$. Since our estimates of the target population lie at the $< 0.1\%$ level, it is crucially important to limit the number of 'false' candidates. This we wish to achieve by a double pass survey, as well as setting a limit on the seeing ($< 1''$). Note that crowding is not a problem, since we will have 3600×16400×16400 pixels to accomodate these objects, i.e. almost 1 000 pixels ($6''\times6''$) per object, i.e. . From observations at (l, b)=(-1°,2°) we estimate the density in the Galactic Center to be 1 object per 100 pixels (i.e $2''\times2''$).

Establishing the true space densities of our (binary) stellar remnants is exactly the main purpose of the *UVEX* survey. The exact number of candidates expected also depends on the luminosity distribution of the different populations (i.e. the effective Galactic volume probed). Here we will give estimated numbers on the basis of the current best (but often highly uncertain) estimates. To reach our science goals and do real population studies we need at least 500 candidates of each class to be able to accurately derive the population characteristics and compare with theory and models. This number is based on a subdivision per class in ~ 20 bins (whether they be over orbital period, luminosity, proper motion or distance etc.). This leaves $\sim$25 objects per bin, which already limits the accuracy per bin to 20%, which we consider as the bare minimum.

• **Single and binary white dwarfs**

The space density of white dwarfs is hotly debated with a wide range between theoretical predictions (of the order 2×10^{-2} pc^{-3}) and the observational limits ($\sim 5\times10^{-3}$ pc^{-3}, excluding white dwarfs around main sequence stars) (see e.g. Nelemans et al., 2001a and references therein). The main difference lies in the uncertainty on the luminosity function of white dwarfs, especially on the faint cool end (see e.g. the newly discovered system at 4(!) pc distance by Scholz et al., 2004). It is exactly these (with $M_V \sim$15 and a maximum distance of $d \sim$400 pc) that we will pick up in our proper motion survey. Taking the observational limit of 5×10^{-3} pc^{-3} and M_V=15 we estimate to find of the order 50 000 white dwarfs in our survey. From the SPY (Napiwotzki et al., 2003) and SDSS surveys we estimate the fraction of white dwarfs in close binaries to be 5-10% of the number of single white dwarfs. We therefore expect 2000-4000 white dwarfs in detached binaries.

•Subdwarf B-stars; extreme horizontal branch stars
The sdB stars are the most luminous of our target classes at $M_V \sim$4.5 (Thejll et al., 1997). We are therefore in the unique position to probe deeply into the disk *and* halo population. Using disk and halo densities of 3×10^{-7} pc^{-3} and 1×10^{-7} pc^{-3} respectively (Mitchell 1998), we will be able to detect sdB stars out to a distance of the LMC ($\sim$ 50 kpc). The total number found in *UVEX* will depend on the exact reddening and the fall-off in the halo. Assuming we cannot see beyond the Galactic Center in the disk we expect to find $\sim$1000 disk and $\sim$ 500 halo sdBs.

•Interacting compact binaries
Based on HST parallaxes for the five brightest members of the class of AM CVn stars, Groot et al. (2005) estimate a space density of AM CVns of 2×10^{-6} pc^{-3} (see also Warner 1995). The largest contribution will be from systems with periods $\sim$ 30 min., for which we estimate an M_V=11 (including an A_V of 3 magnitudes). The effective Galactic volume probed by *UVEX* is in this case set by the scale height of the population, for which we assume 500 pc. We estimate the total number of AM CVn stars present in this volume to be $\sim$1 000, compared with the currently known population of 13. Assuming a similar space density and brightness for Cataclysmic Variables, we find an expected number of $\sim$1 000 for these as well. For neutron and black hole binaries the estimated space density is $\sim 10^{-8}$ pc^{-3} (based on Romani 1988). The quiescent absolute magnitude is hard to estimate, but setting it to M_V=8 we expect $\sim$100 neutron star and black hole binaries.

The number estimates above show that to do a proper population study it is indeed necessary to do the full Galactic Plane down to the planned limit. Cutting down on either depth or width will severely limit the total number of objects found. A narrower strip will not allow the detection of any signature of a varying Galactic scale height (also in combination with high latitude surveys such as the SDSS). Cutting down on depth will mainly target the lowest luminosity systems or the most distant systems which are often the most interesting ones (e.g. in the single white dwarf case). We consider 23rd magnitude an appropriate depth limit since this will still allow spectroscopic and time-resolved photometric follow-up.

3 Are there ongoing or planned similar surveys? How will the proposed survey differ from those? (1 page max)

No UV-excess survey of the full Galactic Plane has ever been conducted. The deepest survey sofar is the survey by Lanning & Meakes (2004 and references therein), which is based on photographic plates taken over 30 years ago. This survey covers a total 1600 square degrees down to B=20. The *UVEX* survey will be a quantum leap forward in covering the full Galactic Plane, down to g'=23 and using modern CCD detectors on a telescope with superior optics. We plan to survey the full Southern Plane.

The recently announced low latitude SDSS data cover only a small part of the area proposed here: *UVEX* will go 7 times as wide as well as probing 2 magnitudes deeper than the SDSS data. *UVEX* will be an excellent complement to the SDSS e.g. in the study of white dwarfs, where the high galactic latitude surface densities will be provided by the SDSS and the low latitude numbers by *UVEX*. Together the two databases will allow a full characterisation of the Galactic population of white dwarfs (and many other stellar objects).

An Hα survey of the Southern Plane (VPHAS) is currently also proposed for the VST (PI Drew). The overlap between the two surveys is in the usage of the r' band and (largely) the sky region. Combined, the two surveys will image the Plane in all optical bands ($u' - i'$+Hα) and remedy the poor state of observational effort currently existing on the southern Plane.

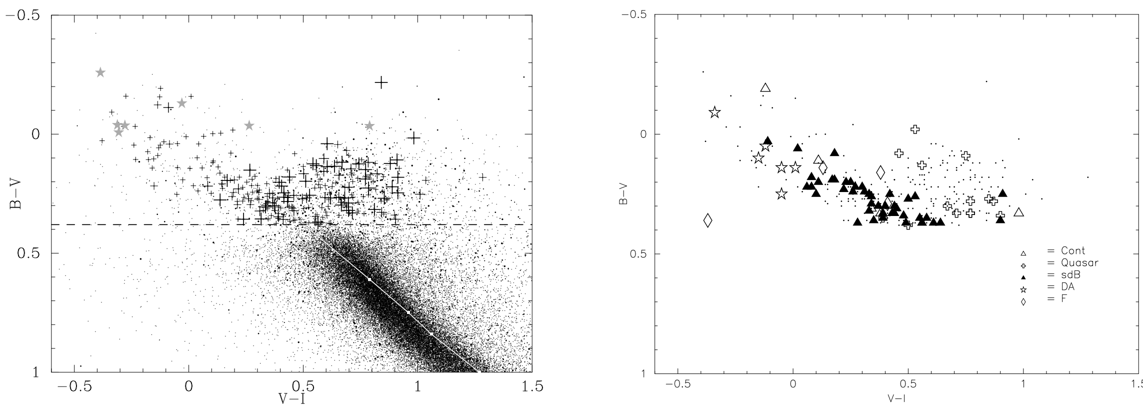

Figure 3: A cut-out of a $B - V$,$V - I$ colour-colour diagram from the FSVS (left panel, high galactic latitude; Groot et al., 2003), showing the blue edge of the Galactic disk population (dashed line) and the population of non-main sequence stars lying to the blue of this (identifications in the right panel). By using u', g' and r' we will be able to separate the stellar remnant population even better from the main sequence, plus the extinction in the Plane will effectively screen out the background quasars.

4 Observing strategy: (1 page max)

The *UVEX* observing strategy will consist of two parts: *i)* a double tiling of the Southern Galactic plane in u', g' and r' bands and *ii)* re-observations after 3 and 10 years in g' only to establish the proper motions of our candidates. We would like to cover an area of 20×180 degrees (from $212° \leq l \leq 32°$ and $-10° < b < +10°$). This translates to the RA range between 06h and 19h, i.e. Dec - July.

Initial survey
Experience with the FSVS (Groot et al., 2003) and IPHAS (Drew et al., 2005) has taught us that a large benefit is to be had if the area is surveyed in double pass. We will make two tiling sets where each field overlaps with a few arcminute offset. This double tiling is very effective in removing noise-peaks, CCD artefacts, cosmic ray hits, edge effects etc. from our UV candidate list. Even though this means an effective doubling of the observing time required this is more than saved in (spectroscopic) follow-up time for identification of possible candidates. The main objective of any wide field survey is to obtain a sample of candidate objects that is as free of artefacts and interlopers as possible before any follow-up is executed. We thus feel strongly about a double tiling strategy. Each square degree is observed twice in u', g' and r'. Using the Omegacam exposure time estimator[1] we need 25 minutes per (u', g', r') double tiled set per square degree to reach a S/N=10 at $u' = g' = r'$=23, including telescope overheads and CCD read-outs. To cover the full Southern plane we therefore need 3600×25 minutes (= 1500 hours).

Reobservations for proper motions
Since most of our objects will be relatively close by ($\leq$ 1 kpc) they will show measurable proper motions after 10 years of observations: e.g. for a star at 500 pc with a space velocity of 50 km s^{-1} transverse velocity the proper motion will be ∼100 milli-arcseconds after 10 years. This is well measurable with the VST+Omegacam. Spectroscopic studies will yield (a limit on) the radial component of the space velocity, allowing us to deduce the full space motion of our objects. Population membership of individual objects can thus be established

[1] http://www.astro.rug.nl/omegacam

(e.g. thin/thick disk, halo objects), which greatly enhances our understanding of these populations. A single-pass revisit after three years is also requested to identify the highest proper motion objects and to check for consistency with the 10-year results.

We request that the reobservations are done in g' only. This will require 360 hours in total for the full Southern plane for the combined 3 and the 10 year re-observations.

Since the data quality and consistency across the survey, and therefore our ability to establish different populations, vitally depends on the photometric homogeneity of the observations we do request that observations are obtained in photometric weather, and with seeing $< 1''$ to avoid severe blending since we do observe some of the most crowded regions in the sky. The u' and g' observations should be obtained during grey time (darkish preferentially for u'), and for the r' observations even some bright time can be used assuming a lunar distance $> 40°$. Overall we therefore request photometric grey time for our survey.

5 Estimated observing time:

Our observing time estimate of 25 minutes per double set is based on the overheads and exposure time estimates as given in the Omegacam User Manual (version 1.2, Koen Kuijken). To reach a S/N= 10 in grey time, we used a S/N=15 in dark time. Estimated integration times to reach AB=23 in the filters are: $u' = 180$ seconds, g'=60 seconds and r'=120 seconds. There is a 1 minute overhead per exposure for read-out and storage of the data. Assuming we will have to switch filters after each exposure, we have to add three minutes of filter exchange time per set of three exposures. We are assuming that telescope presets can be done while reading out the last exposure of a set on a field, and assume 2 minutes per offset (which are generally ∼1 degree). This comes to a total of 25 minutes per double set of three exposures on a given field.

The orientation on the sky of the Southern Galactic Plane splits our observing requests equally of all semesters, being concentrated to the end of the 'summer' semester and the start of the 'winter' semester (period Dec-July).

Period	Time (h)	Mean RA	Moon	Seeing	Transparency	Survey Part
P76	250	10h	grey	1.0	photometric	Initial
P77	250	16h	grey	1.0	photometric	Initial
P78	250	10h	grey	1.0	photometric	Initial
P79	250	16h	grey	1.0	photometric	Initial
P80	250	10h	grey	1.0	photometric	Initial
P81	250	16h	grey	1.0	photometric	Initial
P82	30	10h	grey	1.0	photometric	1. Reobservation P76
P83	30	16h	grey	1.0	photometric	1. Reobservation P77
P84	30	10h	grey	1.0	photometric	1. Reobservation P78
P85	30	16h	grey	1.0	photometric	1. Reobservation P79
P86	30	10h	grey	1.0	photometric	1. Reobservation P80
P87	30	16h	grey	1.0	photometric	1. Reobservation P81
P96	30	10h	grey	1.0	photometric	2. Reobservation P76
P97	30	16h	grey	1.0	photometric	2. Reobservation P77
P98	30	10h	grey	1.0	photometric	2. Reobservation P78
P99	30	16h	grey	1.0	photometric	2. Reobservation P79
P100	30	10h	grey	1.0	photometric	2. Reobservation P80
P101	30	16h	grey	1.0	photometric	2. Reobservation P81

5.1 Time justification: (1 page max)

Our time estimate is based on the Omegacam exposure time estimator of the OmegaWise consortium[2], which shows that a S/N=10 for point sources will be obtained after 180, 60, 120 seconds in u', g' and r' respectively. We have chose a S/N=10 limit to be able to accurately measure the profile of the object (in terms of photometric accuracy, extendedness, noise peaks on top of faint stars etc.) We therefore estimate that a double set of u', g', r' observations will take 25 minutes, taking into account telescope and camera overheads. The full area covered is 20×180 square degrees, i.e. 3600 square degrees or 1500 hours (equivalent of 150 ten-hour nights) for the initial survey. The re-observations after 3 and 10 years will require 3 minutes per square degree (single pass), i.e. 7200×3 min. = 360 hours (36 ten-hour additional nights). For the total survey we therefore request 186 nights.

6 Data management plan: (3 pages max)

6.1 Team members:

The *UVEX* team consists of astronomers spread over Europe and the US. Fifty percent of the team listed below has permanent positions, which ensures the continuity of the project as well as the opportunity to involve future new PhD student and postdocs.

Name	Function	Affiliation	Country
P.J. Groot	PI	Radboud University Nijmegen	NL
L. Morales-Rueda	Data reduction, analysis, sdB stars	RUN	NL
G. Nelemans	Analysis, population modelling	RUN	NL
E. van den Besselaar	Reduction/Analysis, RD+WD binaries	RUN	NL
G. Roelofs	Reduction/Analysis, AM CVn stars	RUN	NL
T. Marsh	Photometry, AM CVn stars	Warwick	UK
B. Gänsicke	Analysis, CVs	Warwick	UK
S. Barros	Analysis, AM CVns	Warwick	UK
T. Augusteijn	Photometry, WD binaries	NOT	S
D. Steeghs	Analysis, Spec. Follow-up, AM CVns, WD binaries	CfA	US
P. Jonker	Analysis, LMXBs	Utrecht/CfA	NL/US
U. Heber	Analysis, WDs	Bamberg	D
R. Napiwotzki	Spec. Follow-up, WDs	Leicester	UK
C. Knigge	Analysis, CVs	Southampton	UK
A. Witham	Photometry, CVs	Southampton	UK
M. Pretorius	Photometry, CVs	Southampton	UK
P. Woudt	Spec. Follow-up, CVs, AM CVn	Cape Town	SA
T. Naylor	Analysis, YSO	Exeter	UK
N. Mayne	Analysis,IR correlation, YSO	Exeter	UK

6.2 Detailed responsibilities of the team:

The main responsibility of the *UVEX* survey lies with the PI and his team at the Radboud University Nijmegen. These duties include: design of the survey, communication with ESO, data transport from VST/ESO to Groningen (see below) and to Nijmegen, quality control, astrometry and photometry and the generation of the general survey catalog. Further duties of team members, listed by science application of the *UVEX* database are as follows (subPI boldfaced):

[2] http://www.astro.rug.nl/omegacam

Science area	subPI	Members
AM CVn stars	**G. Roelofs**	D. Steeghs, T. Marsh, L. Morales-Rueda
		S. Barros, P. Groot, G. Nelemans, P. Woudt
sdB stars	**L. Morales-Rueda**	U. Heber, T. Marsh, C. Knigge
Single WDs	**U. Heber**	R. Napiwotzki, P. Groot, G. Roelofs
LMXBs	**P. Jonker**	G. Nelemans, P. Groot
WD binaries	**B. Gänsicke**	E. van den Besselaar, T. Augusteijn, R. Napiwotzki
CVs	**C. Knigge**	T. Augusteijn, A. Witham, P. Woudt, D. Steeghs, R. Pretorius
Modelling	**G. Nelemans**	U. Heber, R. Napiwotzki, T. Marsh
YSOs	**T. Naylor**	N. Mayne

6.3 Data reduction plan:

All data will be reduced and processed by the OmegaCen/OmegaWise data reduction pipeline and storage facility as already designed and operated by the Omegacam consortium and run at the Kapteyn Institute in Groningen. Agreements with Koen Kuijken and Edwin Valentijn are already in place for the processing and archiving of this data. Data storage and final archiving as well as the analysis of the data will take place in Nijmegen, under the responsibility of the PI.

6.4 Expected data products:

The expected data product is a photometrically and astrometrically calibrated u', g' and r' catalog of all point sources within our survey area. After completion of the second epoch of reobservations after 10 years the proper motions of all point sources in the field will be included in the data catalog.

6.5 General schedule of the project:

The general schedule for the observations is outlined in Section 5 above. The initial part of the survey will take six semesters, where we have assumed that observations will start in the summer of 2005/6. This is followed by two sets of reobservations on a 3 and 10 year delay with respect to the initial fields.

After processing through the OmegaCen pipeline source catalogs will be available on a time scale of 12 months after the initial observations. We will provide a convenient web-based user interface such that general users can access this database. This initial catalog will contain astrometrically and photometrically calibrated source lists of all point sources in our survey area.

Follow-up observations (initally for spectroscopic identification) will commence from one year on after the start of the initial survey and will initially be for spectroscopic identification only. We consider the 'follow-up of the follow-up' (e.g. time resolved photometry or spectroscopy) not to be part of the survey and this will be requested for seperately.

7 Envisaged follow-up: (1 page max)

The *UVEX* survey will generate UV-excess objects in the Galactic Plane. We foresee that most of these objects will require spectroscopic identification to establish their nature. We expect to find candidates at a surface density of 1-20 per square degree, at the limit of the efficiency break for using multi-object spectrographs over single-slit spectrographs. In the total survey area of 3600 sq. degrees we expect to find ∼50 000 UV-excess and high proper motion sources. For spectroscopic identification we will use a suite of telescopes available to the *UVEX* consortium partners, also outside ESO (Magellan, SALT, MMT). However, the main identification effort will be done using ESO telescopes, specifically the NTT and the VLT. To start the spectroscopic identification effort and to ensure that we will be complete in identification down to $g' = 20$ shortly after the completion of the main survey we request 25 NTT (+EMMI) and 10 VLT(+FORS/X-Shooter/VIMOS) nights (based on average integration time of 10 minutes per source for 2000 objects/MOS-pointing).

The follow-up of the spectroscopic identification will take many years and a combined effort on a large number of telescopes. Even though this may delay some of the results, the *UVEX* database is the essential first step in this process.

8 Other remarks, if any: (1 page max)

The *UVEX* survey partly overlaps in target area and observing strategy with the *OmegaBulge* proposal as submitted by G. Nelemans. We feel that the science case for both surveys is sufficiently different to warrant two separate proposals. However, the two surveys may be merged with small additional effort (i.e. deeper integrations on the Galactic Bulge and the addition of the i' band for this region).

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