VISTA PUBLIC SURVEY STATUS REPORT (87th OPC MEETING)

This report has to be returned to the Observing Programmes Office of the European Southern Observatory (<u>opo@eso.org</u>) before October 31, 2010.

PROPOSAL ESO No.: 179.B-2003 **TITLE:** The near-infrared YJKs survey of the Magellanic Clouds system (VMC) **PRINCIPAL INVESTIGATOR:** Maria-Rosa Cioni

1. Scientific Aims (brief description)

The aims of the VMC survey are the determination of the spatially resolved star formation history and the three-dimensional (3D) geometry of the Magellanic system. These main goals drive the observing strategy with respect to multi-epochs and depth.

The SFH requires data as deep as the oldest main sequence turn-off point of the stellar population and multi-filters to sample variations in age and metallicity. The SFH will be recovered from the analysis of colour-magnitude diagrams and simulations of the observed stellar population, accounting for foreground stars and reddening.

The 3D geometry will be derived using different density and distance indicators like the Cepheid and RR Lyrae period-luminosity relation, period-luminosity Wesenheit relations and the luminosity of red clump stars. The different indicators will probe the structure of the system as a function of time.

The VMC survey science addresses many other issues in the field of star and galaxy formation and evolution, such as: stellar clusters and streams, extended sources, proper motion, star formation, distance scale, models of Magellanic system evolution, extinction mapping.

2. Detailed progress report with respect to initial estimate from the Survey Management Plan (including preliminary results, whether published or not).

2.1. Progress report

The acquired VMC data meet expectations from the Survey Management Plan (SMP). Accounting for the late start of the Public surveys (P84 actual versus P81 expected) and the larger than expected instrument overheads, the VMC survey will be completed within 5 years (see Sect. 4).

The quality of the data with respect to the expected sensitivity and crowding as well as requested observing conditions has proved successful.

Contrary to the SMP an integration time of 5 sec was adopted in the Ks band following the revision of the Exposure Time Calculator prior the start of the survey. Further tests confirming this choice were done during the science verification period.

Following the recommendation of the Publich Suvery Panel, the Mid-term goal as written in the SMP no longer applies. The current VMC strategy aims to complete a given field within 1 year. This means that the Magellanic system will be progressively covered field by field year by year. The distribution of the fields to cover in a given year optimizes the available survey time with respect to RA and DEC with the result that fields observed in a given year are not necessarily adjacent to previous fields, at least at the beginning of the survey. Priority is also given to specific fields of particular interest for the astronomical community, e.g. the 30 Dor field and the Gaia field.

The first VMC paper (see below) will be provided as complementary information to this report after submission.

2.2. Publications

The first VMC paper is due for submission within the next few days. This is Paper I that describes the survey strategy and presents the first data. The main aim of this paper is to inform the community about the survey, provide the coordinates of the observed fields, and the details of how the observations are performed and analyzed. The data quality is presented and science topics are addressed to show that the data meet expectations and bear a great potential for different studies.

There are also five papers in preparation that deal respectively with:

- the star formation history (SFH) of the Gaia field (Rubele et al.)
- RR Lyrae and Cepheid stars in the Gaia and 30 Dor fields (Moretti et al.)
- Planetary Nebulae (PNe) in the VMC survey (Miszalski et al.)
- Stellar clusters in the Gaia field (Guandalini et al.)
- The Spectral Energy Distribution (SED) of Asymptotic Giant Branch (AGB) stars (Gullieuszik et al.)

A taste of these results is given in Paper I. In particular, a description of the distribution of stars in the VMC colour-magnitude and colour-colour diagrams. Completeness is derived for both single and deep tiles using artificial star tests. The light-curve of two RR Lyrae stars and of two Cepheid stars are shown in the Gaia and 30 Dor fields respectively. They show excellent periodicities that identify the radial pulsation.

A cross-correlation between existing PNe and the VMC data show that their halo is well detected in the Ks band, thanks to Brackett gamma emission, and that the VMC data provide the distinction between HII regions and true PNe. This cleans up previous samples and influences the PNe luminosity function.

Many stellar clusters have unknown parameters, like metallicity and age, and the quality of the VMC data provides a means to derive these parameters by fitting stellar evolution models. This study will provide both a set of results to compare the cluster and field population and a training set to identify new stellar clusters within VMC.

The VMC data are used in combination with the Spitzer data as well as data at other wavelengths to show the SED of AGB stars. A fit with SED models provides the bolometric magnitude of the stars.

An image press release appeared in <u>http://www.eso.org/public/news/eso1033/</u> the main image is also the front cover of the current ESO Messenger.

3. Quality Control and Advanced Data Products. The advanced data product submission plan should be described here. In addition the PI should comment on Quality Control on the acquired data. In particular, do the acquired data meet the survey requirements including image quality, target limiting flux, sky subtraction filters?

Since recently, CASU is making available data on a monthly basis. These data include tiles and their catalogues. On the other hand, WFAU has just started implementing the VISTA software based on tiles, so far it was working just with pawprints, this is necessary to obtain deep stacked tiles and linked epochs and wavebands.

The latest important addition to the WFAU side of the VISTA pipeline was the flux correction for stars close to saturation. This shows that magnitudes as bright as Ks=10 are well recovered in the VMC data. This provides an excellent overlap with 2MASS but also multi-epoch information for the AGB population that dominates the range Ks=10-12 mag.

While waiting for WFAU tiles, the VMC team is producing temporary deep tiles using a different software and PSF photometry. The latter will allow VMC members to test those science topics that require deep data. The tiles created in this way are those from which the SFH and the completeness are obtained.

Tiles are not needed to study Cepheids that are sufficiently bright to have accurate photometry in single pawprints. On the other hand, RR Lyrae stars require epochs based on tiles for obtaining a sufficiently small error bar on their magnitudes. Deep tiles are also needed to characterize the SFH, stellar clusters and PNe. The latter hardly show up in single tiles while outflows can be see in deep tiles.

Following the quality control procedures some VMC observations were repeated because of: too large seeing and/or ellipticity, incomplete concatenation sequences.

The average tile image quality of the VMC data obtained in P84 that passed quality control, regardless of the different requirements for crowded and un-crowded fields, are listed in the table below:

Filter	FWHM	Ellipticity	Zero-Point	Magnitude Limit
Y	1.03 (0.13)	0.065 (0.011)	23.520 (0.070)	21.111 (0.395)
J	1.00 (0.10)	0.064 (0.011)	23.702 (0.206)	20.527 (0.382)
Ks	0.93 (0.08)	0.051 (0.009)	22.978 (0.245)	19.220 (0.340)

The submission of advanced data products is linked to the availability of a fully working data set, based on tiles, from WFAU.

Current expectations suggest that the processed data will be made public within the six months that follow the moment the last epoch is obtained for a given VMC field. This accounts for 1-3 months for the data to be processed at CASU and WFAU and 1-3 months for the VMC team to complete the quality control steps, compare the multi-epochs, derive the completeness, etc.

For example, the last epoch for the 30 Dor and Gaia field is due to be obtained this autumn and the entire data set in these two fields is expected to be released to the astronomical community in the spring.

4. Are any changes proposed with respect to the Survey Management Plan in P87 (e.g., in strategy, targets, exposure time and/or other settings)? If yes, please provide a clear and detailed justification.

Based on what is described below the VMC team requests 82 h of allocation in P87.

During P84 100 h were allocated of which 79 h were observed, of these 11 hours were repeated. The same numbers for P85 are: 30 h, 29 h, and 5 h. This brings the observed VMC time to (29 h + 79 h) = 108 h which, on average, corresponds to the completion of 6 full fields, or a 5% completion of the VMC survey. This assumes that all data acquired in September 2010 are of good quality. The quality of the VMC data has been checked only until August 2010 included because these are the data available to the VMC team at present. The VMC allocated time during P86 is 300 h. Assuming that all this time will be successfully observed then the survey completion rate will rise to 22%.

This means that the VMC survey can be completed during the subsequent 4 years (by end of P94). In order to do that the allocation time would be ~320 h in even periods and ~80 h in odd periods. In particular, each odd period (including P87) would target 2 fields in the Magellanic Bridge and 5 fields in the Small Magellanic Cloud. Note that the observation of the Magellanic Stream fields will be completed during P87. This time accounts for the visibility of the VMC fields within the range of airmass specified for the homogeneity of the survey and the time distribution of Ks epochs.

No other change is foreseen for strategy, exposure time and other settings.

5. Observing Plan for Period 87.

Specify which part of the Survey Management Plan (SMP) the survey will focus on in P87 in the 1st column. If changes are foreseen in P87, please specify details of the observing strategy in the table and provide a full justification in Section 4 above.

SMP Period	Field name/ mean RA	Filter	Time (h)	Seeing	Moon	Transpar ency	Comments / strategy (e.g., no. of epochs)
P87	2 Bridge	YJKs	23	1.0-1.2	all	thin	YJ all + 6 Ks
P87	5 SMC	YJKs	57	0.8-1.2	all	thin	YJ all + 6 Ks
P87	2 Stream	Ks	2	1.0	all	thin	1 Ks