Data Collection	VMC_CAT
Release Number	2
Data Provider	Maria-Rosa Cioni
Date	02.09.2014 (updated on 22.10.14)

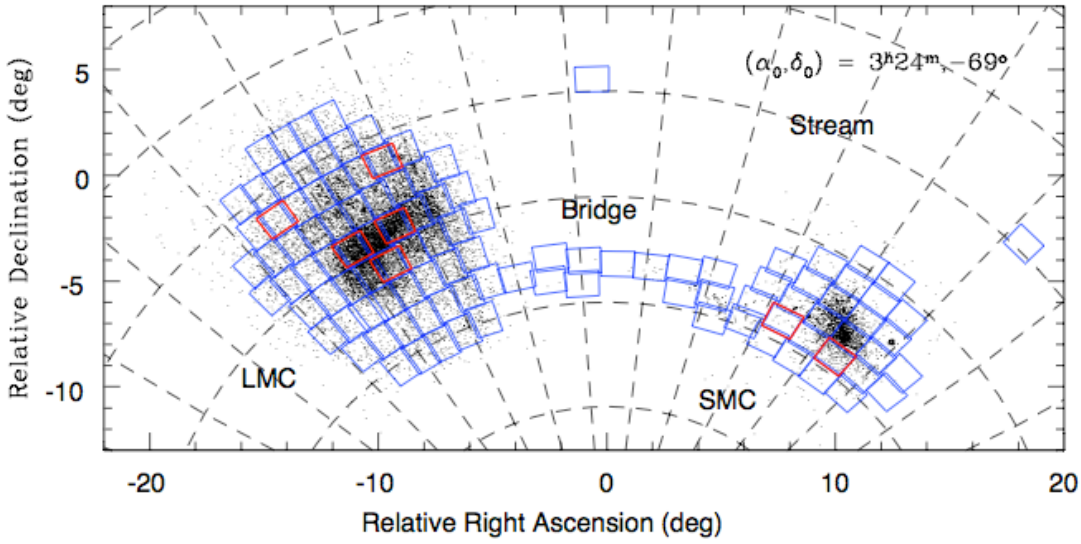
Abstract

Observations were obtained with the VISTA telescope as part of the VISTA survey of the Magellanic Cloud system (VMC; ESO program 179.B-2003) in three filters: Y, J and K_s. The main goals of the VMC survey are the determination of the spatially resolved star formation history and the three-dimensional geometry of the Magellanic system. The sensitivity of the data is designed to reach sources below the oldest main-sequence turn off point of the stellar population and the multi-epochs to measure accurate K_s mean magnitudes for pulsating variable stars, e.g. RR Lyrae stars and Cepheids.

This catalogue data release refers to five new tile images for VMC tiles completed by October 2012 (tiles LMC 5_5, 6_4, 8_3, and tiles SMC 3_3, 3_5) and the two re-processed tiles LMC 6_6 and 8_8. The total sky coverage of this release is ~7.5 deg^2 in the LMC and ~3 deg^2 in the SMC.

Overview of Observations

The figure below shows the Magellanic system as tiled by the VMC survey (blue) and tiles for which catalogues are released (red). Underlying small dots indicate the distribution of carbon stars, stellar clusters and associations.



Tile numbering begins from the bottom right corner, increasing from right to left and from bottom to right. The first LMC tile is 2_3, the first SMC tile is 2_2, the first Bridge tile is 1_2 and Stream tile 1_1 is right above the Bridge while 2_1 is to the right of the SMC.

Release Content

This catalogue release covers five tiles in the Large Magellanic Cloud: LMC 5_5, 6_4, 6_6, 8_3 and 8_8, as well as two tiles in the Small Magellanic Cloud: SMC 3_3 and 3_5.

LMC tiles were oriented with the Y axis more or less along the declination direction while for SMC tiles the Y axis is along the right ascension direction. Each tile covers about 1.771 deg^2 where the central (1.475 x 1.017)=1.501 deg^2 corresponds to the nominal depth of the survey and the remaining area to half the exposure time in each band.

Tile identification, number of records, size in Mby, limiting magnitude (MAGAPER3) in Y, J and K_s corresponding to sources with photometric errors APERMAG3ERR<0.1 mag are listed below.

Tile	Records	Mby	Y	J	Ks
SMC 3_3	694003	285	20.6261	20.3549	19.7121
SMC 3_5	374022	154	21.0939	20.9643	19.8743
LMC 5_5	1025523	422	20.8837	20.3507	19.7097
LMC 6_4	1212057	498	19.2571	18.9633	18.5661
LMC 6_6	1181089	486	19.9209	19.6221	19.1218
LMC 8_3	1076352	443	19.9141	19.4987	18.9629
LMC 8_8	761421	313	21.0893	20.7604	19.8342

Release Notes

The data for this release were prepared by the Wide Field Astronomy Unit (WFAU) and the VMC team from images initially processed by the Cambridge Astronomy Survey Unit (CASU).

The main processing steps are described in Cross et al. (2012, A&A 548, A119) and Cross et al. (2009, MNRAS 399, 1730). Epoch-merged and band-merged catalogues were extracted from deep tiles using the software suite provided by CASU (v1.3) and outgested from the VISTA Science Archive. Deep tiles are produced only from data that meet the observing criteria for the VMC survey.

Sources are unique within each tile. Where PRIORSEC>0 signifies that a source is located in a region of overlap with an adjacent tile that is not yet part of the current release.

The tile area over which the variability analysis is performed (VMC_CAT.VARFLAG) is 1.38 deg^2. The ears of tiles are excluded because of their lower exposure time compared to the tile centre and the region covered by detector #16 is also excluded because of the variable quantum efficiency.

Data Reduction and Calibration

The procedures to reduce and calibrate the data are described in detail at: http://casu.ast.cam.ac.uk/surveys-projects/vista/technical/data-processing.

In particular, catalogues were created from images that were filtered for nebulosity with size of the order of 30 arcsec (Irwin 2010, UKIRT Newsletter 26, 14).

Individual pass-band detections are merged into multi-colour lists. The band-merging procedure is outlines in detail at http://horus.roe.ac.uk/vsa/dboverview.html. It is based on matching pairs of frames from short to long wavelength, and early to late epochs. The pairing tolerance for the VMC survey is of 1.0 arcsec. This radius is larger than the typical astrometric errors and may induce some level of spurious matchings. Matching objects in the overlap regions of detectors are ranked according to their filter coverage, then their quality error flags and finally their proximity

to a detector edge. The final band-merged catalogue includes only sources that do not have duplicate measurements.

The magnitudes were not corrected for reddening.

Data Quality

The astrometric and photometric quality of the data is described in detail at *http://casu.ast.cam.ac.uk/surveys-projects/vista/technical*.

In addition, the quality error bit flags assigned during post processing are listed at *http://horus.roe.ac.uk/vsa/ppErrBits.html*. These flags refer to quality issues of varying severity. For each pass-band nine quality issues are implemented as follows, where the corresponding value of the ppErrBit is given in parenthesis. Source is deblended (16), has bad pixel(s) in default aperture (64), has low confidence in default aperture (128), lies within detector #16 region of a tile (4096), is close to saturation (65536), has photometric calibration probably subject to systemtic errors (131072), lies within a dither offset of the stacked frame boundary (4194304), lies within the underexposed strip of a tile (8388606), and lies within an underexposed region of a tile due to missing detector (16777216).
To select only sources without quality issues the user can filter on ppErrBits = 0, but note that the majority of the sources will have at least ppErrBits=16 due to the dense stellar field, and to include only sources with minor quality issues use ppErrBits < 256.

The completeness of the catalogues was evaluated from artificial star tests and PSF photometry.

Tile	Filter	95%	90%	75%	50%
SMC 3_3	Y	18.5	19.6	20.9	21.6
	J	18.4	19.5	20.8	21.5
	Ks	17.9	19.1	20.4	20.8
SMC 3_5	Y	21.1	21.6	21.9	22.3
	J	20.6	21.4	21.8	22.1
	Ks	19.8	20.4	20.7	20.8
LMC 5_5	Y	17.3	18.0	19.4	20.6
	J	16.9	17.6	19.1	20.3
	Ks	16.3	17.1	18.7	19.9
LMC 6_4	Y	17.0	17.6	18.8	20.0
	J	16.5	17.1	18.4	19.6
	Ks	15.8	16.5	17.9	19.3
LMC 6_6	Y	17.4	18.1	19.4	20.5
	J	16.9	17.6	19.0	20.2
	Ks	16.4	17.2	18.8	20.0
LMC 8_3	Y	19.3	20.2	21.2	21.9
	J	19.2	20.0	21.0	21.6
	Ks	18.5	19.5	20.3	20.5
LMC 8_8	Y	19.3	20.2	21.3	22.1
	J	19.2	20.0	21.1	21.7
	Ks	18.5	19.5	20.3	20.6

Known issues

These VISTA data may present the following issues, for which a full description is given in http://casu.ast.cam.ac.uk/surveys-projects/vista/technical/known-issues. A variable depth due to bad pixels in detectors #1, #4 and #16 as well as some bad rows. Point-like objects residuals of flatfielding, variable vignetting and spurious detections around bright stars. Some of these issues are recorded in the quality error bits flags assigned during post processing.

The magnitudes in these VISTA catalogues may present offsets of 0.02 mag compared to previous

analysis of the data due to problems in the zero-point calculation. More details are given at http://horus.roe.ac.uk/vsa/knownIssues.html#vmczp.

The astrometry in these deep tiles suffer from a complex 10-20 mas systematic pattern due to residual WCS errors from the component pawprints of individual tiles and prior to 01.08.2012 to an inconsistent use of the ZPN projection, which results in a complex residual radial distorsion of up to +/- 100 mas.

The pairing radius for associating sources among the three bands is of 2 arcsec (this will be reduced to 1 arcsec in further releases). After deblending a bright red source from a faint blue source the pairing in the band-merged catalogues may be wrong or not present because the search radius is sufficiently large and pairing proceeds from Y to Ks as follows.
Source Y1's closest J is J1, source J1's closest Y is Y1, source Y1's closest K is K2, source K2's closest Y is Y1. The result is a Y1, J1, K2 source and a J2 source while instead the correct result would be a Y1, J1 source and a J1, K2 source. This issue affects only a fraction of a percent of the sources in each catalogue.

Previous Releases

The previous Data Release (2) referred to catalogues extracted from the reduced images available in VMC Data Release 2. The present Data Release (3) refers to catalogues extracted from the reduced images available in VMC Data Release 3.

Data Format

Files Types

Seven epoch-merged and band-merged master source catalogues in YJKs, one per tile, are released:

vmc_er3_00h44-074d12_yjks_finalSourceCat_558345748487.fits
vmc_er3_01h27-074d00_yjks_finalSourceCat_558345748486.fits
vmc_er3_05h04-066d15_yjks_finalSourceCat_558345748481.fits
vmc_er3_05h12-069d16_yjks_finalSourceCat_558345748483.fits
vmc_er3_05h24-070d48_yjks_finalSourceCat_558345748485.fits
vmc_er3_05h37-069d22_yjks_finalSourceCat_558345748484.fits
vmc_er3_05h59-066d20_yjks_finalSourceCat_558345748482.fits

where the name is constructed as project_release_ra/dec_bands_typeofCat_framesetID.fits and framesetID uniquely identifies the tile as follows:

558345748487 SMC 3_3
558345748486 SMC 3_5
558345748481 LMC 8_3
558345748483 LMC 6_4
558345748485 LMC 5_5
558345748484 LMC 6_6
558345748482 LMC 8_8.

A MetaData file, vmc_er3_yjks_catMetaData.fits, accompanies the release. Its name refers to project_release_bands_typeofCat.fits.

Catalogue Columns

Each epoch-merged and band-merged catalogue contains 96 columns listed below of which the 15 most relevant to guide user selections are: IAUNAME, sourceID, ra2000, dec2000, merged-

Class, yAperMag3, yAperMag3Err, yErrBits, jAperMag, jAperMag3Err, jErrBits, ksAperMag3, ksAperMag3Err, ksErrBits, VARFLAG.

Number; name; format; description

1; IAUNAME; 36A; Unique identifier in IAU naming convention
2; SOURCEID; K; UID (unique over entire VSA via programme ID prefix) of this merged detection as assigned by merge algorithm
3; CUEVENTID; J; UID of curation event giving rise to this record
4; FRAMESETID; K; UID of the set of frames that this merged source comes from
5; RA2000; D; Celestial Right Ascension
6; DEC2000; D; Celestial Declination
7; L; D; Galactic longitude
8; B; D; Galactic latitude
9; LAMBDA; D; SDSS system spherical co-ordinate 1
10; ETA; D; SDSS system spherical co-ordinate 2
11; PRIORSEC; K; Seam code for a unique (=0) or duplicated (!=0) source (eg. flags overlap duplicates).
12; YMJPNT; E; Point source colour Y-J (using aperMag3)
13; YMJPNTERR; E; Error on point source colour Y-J
14; JMKSPNT; E; Point source colour J-Ks (using aperMag3)
15; JMKSPNTERR; E; Error on point source colour J-Ks
16; YMJEXT; E; Extended source colour Y-J (using aperMagNoAperCorr3)
17; YMJEXTERR; E; Error on extended source colour Y-J
18; JMKSEXT; E; Extended source colour J-Ks (using aperMagNoAperCorr3)
19; JMKSEXTERR; E; Error on extended source colour J-Ks
20; MERGEDCLASSSTAT; E; Merged N(0,1) stellarness-of-profile statistic
21; MERGEDCLASS; I; Class flag from available measurements (1|0|-1|-2|-3|-9=galaxy|noise|stellar|probableStar|probableGalaxy|saturated)
22; PSTAR; E; Probability that the source is a star
23; PGALAXY; E; Probability that the source is a galaxy
24; PNOISE; E; Probability that the source is noise
25; PSATURATED; E; Probability that the source is saturated
26; YPETROMAG; E; Extended source Y mag (Petrosian)
27; YPETROMAGERR; E; Error in extended source Y mag (Petrosian)
28; YAPERMAG3; E; Default point source Y aperture corrected mag (2.0 arcsec aperture diameter)
29; YAPERMAG3ERR; E; Error in default point/extended source Y mag (2.0 arcsec aperture diameter)
30; YAPERMAG4; E; Point source Y aperture corrected mag (2.8 arcsec aperture diameter)
31; YAPERMAG4ERR; E; Error in point/extended source Y mag (2.8 arcsec aperture diameter)
32; YAPERMAG6; E; Point source Y aperture corrected mag (5.7 arcsec aperture diameter)
33; YAPERMAG6ERR; E; Error in point/extended source Y mag (5.7 arcsec aperture diameter)
34; YAPERMAGNOAPERCORR3; E; Default extended source Y aperture mag (2.0 arcsec aperture diamter)
35; YAPERMAGNOAPERCORR4; E; Extended source Y aperture mag (2.8 arcsec aperture diameter)
36; YAPERMAGNOAPERCORR6; E; Extended source Y aperture mag (5.7 arcsec aperture diameter)
37; YGAUSIG; E; RMS of axes of ellipse fit in Y
38; YELL; E; 1-b/a, where a/b=semi-major/minor axes in Y
39; YPA; E; ellipse fit celestial orientation in Y
40; YERRBITS; J; processing warning/error bitwise flags in Y
41; YAVERAGECONF; E; average confidence in 2 arcsec diameter default aperture (aper3) Y
42; YCLASS; I; discrete image classification flag in Y
43; YCLASSSTAT; E; N(0,1) stellarness-of-profile statistic in Y
44; YPPERRBITS; J; additional WFAU post-processing error bits in Y
45; YSEQNUM; J; the running number of the Y detection
46; YXI; E; Offset of Y detection from master position (+east/-west)

47; YETA; E; Offset of Y detection from master position (+north/-south)
48; JPETROMAG; E; Extended source J mag (Petrosian)
49; JPETROMAGERR; E; Error in extended source J mag (Petrosian)
50; JAPERMAG3; E; Default point source J aperture corrected mag (2.0 arcsec aperture diameter)
51; JAPERMAG3ERR; E; Error in default point/extended source J mag (2.0 arcsec aperture diameter)
52; JAPERMAG4; E; Point source J aperture corrected mag (2.8 arcsec aperture diameter)
53; JAPERMAG4ERR; E; Error in point/extended source J mag (2.8 arcsec aperture diameter)
54; JAPERMAG6; E; Point source J aperture corrected mag (5.7 arcsec aperture diameter)
55; JAPERMAG6ERR; E; Error in point/extended source J mag (5.7 arcsec aperture diameter)
56; JAPERMAGNOAPERCORR3; E; Default extended source J aperture mag (2.0 arcsec aperture diameter)
57; JAPERMAGNOAPERCORR4; E; Extended source J aperture mag (2.8 arcsec aperture diameter)
58; JAPERMAGNOAPERCORR6; E; Extended source J aperture mag (5.7 arcsec aperture diameter)
59; JGAUSIG; E; RMS of axes of ellipse fit in J
60; JELL; E; 1-b/a, where a/b=semi-major/minor axes in J
61; JPA; E; ellipse fit celestial orientation in J
62; JERRBITS; J; processing warning/error bitwise flags in J
63; JAVERAGECONF; E; average confidence in 2 arcsec diameter default aperture (aper3) J
64; JCLASS; I; discrete image classification flag in J
65; JCLASSSTAT; E; N(0,1) stellarness-of-profile statistic in J
66; JPPERRBITS; J; additional WFAU post-processing error bits in J
67; JSEQNUM; J; the running number of the J detection
68; JXI; E; Offset of J detection from master position (+east/-west)
69; JETA; E; Offset of J detection from master position (+north/-south)
70; KSPETROMAG; E; Extended source Ks mag (Petrosian)
71; KSPETROMAGERR; E; Error in extended source Ks mag (Petrosian)
72; KSAPERMAG3; E; Default point source Ks aperture corrected mag (2.0 arcsec aperture diameter)
73; KSAPERMAG3ERR; E; Error in default point/extended source Ks mag (2.0 arcsec aperture diameter)
74; KSAPERMAG4; E; Point source Ks aperture corrected mag (2.8 arcsec aperture diameter)
75; KSAPERMAG4ERR; E; Error in point/extended source Ks mag (2.8 arcsec aperture diameter)
76; KSAPERMAG6; E; Point source Ks aperture corrected mag (5.7 arcsec aperture diameter)
77; KSAPERMAG6ERR; E; Error in point/extended source Ks mag (5.7 arcsec aperture diameter)
78; KSAPERMAGNOAPERCORR3; E; Default extended source Ks aperture mag (2.0 arcsec aperture diameter)
79; KSAPERMAGNOAPERCORR4; E; Extended source Ks aperture mag (2.8 arcsec aperture diameter)
80; KSAPERMAGNOAPERCORR6; E; Extended source Ks aperture mag (5.7 arcsec aperture diameter)
81; KSGAUSIG; E; RMS of axes of ellipse fit in Ks
82; KSELL; E; 1-b/a, where a/b=semi-major/minor axes in Ks
83; KSPA; E; ellipse fit celestial orientation in Ks
84; KSERRBITS; J; processing warning/error bitwise flags in Ks
85; KSAVERAGECONF; E; average confidence in 2 arcsec diameter default aperture (aper3) Ks
86; KSCLASS; I; discrete image classification flag in Ks
87; KSCLASSSTAT; E; N(0,1) stellarness-of-profile statistic in Ks
88; KSPPERRBITS; J; additional WFAU post-processing error bits in Ks
89; KSSEQNUM; J; the running number of the Ks detection
90; KSXI; E; Offset of Ks detection from master position (+east/-west)
91; KSETA; E; Offset of Ks detection from master position (+north/-south)
92; VARFLAG; J; Classification of objects across all bands.

The format refers to the fits notation as follows:
A - string 32 characters; D - double floating point (8 bytes); E - real floating point (4 bytes); I - short integer (2 bytes); J - integer (4 bytes); K - long integer (8 bytes).

The variability flag is described in detail in Cross et al. (2009, MNRAS, 399, 1730). It is set to true (1) or false (0) using the sum of the weighted ratios of the intrinsic standard deviation to the expected noise. The weighting in each filter depends on the number of observations in each filter. At least five observations in one filter are needed for an object to be counted as variable. Thus, for the VMC data this is driven by observations in the K_s band only.

Acknowledgements

Please reference Cioni et al. 2011, A&A, 527, A116 and use the following statement in your articles when using these data: Based on data products from observations made with ESO Telescopes at the La Silla Paranal Observatory under programme ID 179.B-2003.