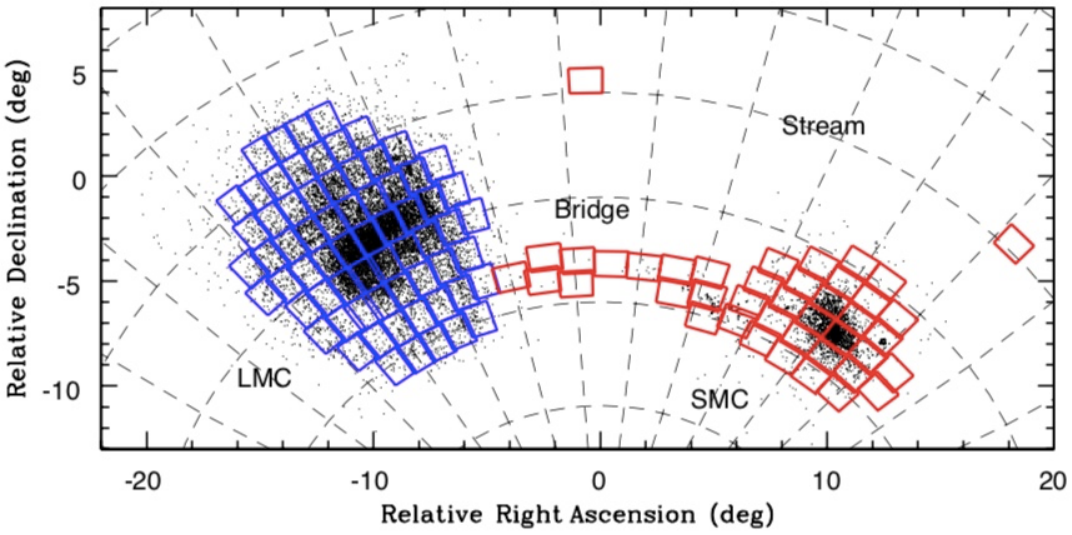
VISTA survey of the Magellanic Clouds system

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 data release is based on the complete observations for the VMC survey and data from twelve additional programmes, which add multi-epoch observations to the VMC foot-print. There are 68 VISTA tiles encompassing the Large Magellanic Cloud (LMC), 28 over the Small Magellanic Cloud (SMC), 13 across the Bridge and 2 on the Stream. Observations were acquired between October 2009 and January 2023. This release provides reduced and calibrated tile images belonging to individual observations ('single OBs'), in addition to the corresponding papwrints (6 per tile), deep co-added images, and source lists (separately for each filter). In addition, also deep co-added tile images and catalogues (separately for each filter), for both individual tiles and combined, as well as band-merged catalogues and catalogues with PSF magnitudes, are provided. This release supersedes all previous data releases of the VMC survey for the combined (deepstacked) data products, whilst providing additional (complementary) images and catalogues of single observations per filter. Overall, it includes about 64 million detections, split nearly evenly between sources with stellar of galaxy profiles. There are at least 4 tiles in Y and J filters and 14 tiles in K_s filter per field. The total sky coverage of this release is ~170 deg^2.



Overview of Observations

The figure above shows the Magellanic system as tiled by the VMC survey. 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 top. The first LMC tile is 2_3 whereas 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 Stream tile 2_1 is to the right of the SMC. Each survey tile has at least 2 OBs in Y and J filters, respectively (providing 800 s exposure time per pixel each) and 11 OBs in K_s with 750 s exposure time per pixel each. There are also pairs (YJ, JK_s, and YK_s) of shallow observations corresponding to half the exposure times.
Tiles SMC 5_4 and LMC 7_5 have a double number of epochs at both J and K_s resulting from programmes 099.C-0773 and 0100.C-0248. These programmes were designed to study the variability of young stars. The remaining tiles have an additional K_s-band epoch obtained from programmes 0103.B-0783, 105.2043, 106.2107, 108.222A, 109.231H and 110.259F with the goal to increase the time baseline and improve the measurement of proper motions. There are also additional observations of tile LMC 4_4, from programme 108.223E, in order to compensate for a shift in the central coordinates of original YJ-deep and YJK_S-shallow images compared to the K_s-deep images. Finally, the observations of tile SMC-gap, acquired from programmes 099.D-0194, 0103.D-0161, 105.2042 and 109.230A, fill a gap left by VMC observations between tiles SMC 5_3 and 5_4.

Release Content

This release comprises of new data for 111 tiles processed with v1.5 of the pipeline.

LMC tiles were oriented with the Y axis along the declination direction whereas SMC, Bridge (BRI) and Stream (STR) were oriented with the Y axis along the right-ascension direction. Each tile covers about 1.771 deg^2 where the central (1.017 x 1.475)=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 centres given in Right Ascension (RA), Declination (DEC) and the telescope position angle (TL_OFFAN) are listed in the DR6 data-release description file for the LMC tiles and in the DR5/5.1 for the SMC, BRI and STR tiles. The SMC-gap tile centre is at (00:54:58, -72:00:45) with an angle of 0 deg.

Individual tile catalogues and co-added tile images, with associated confidence maps and catalogues, are released per band per field. Preview images in JPEG format are associated to each FITS image. Each tile is uniquely identified by a FRAMESETID, which allows to trace the provenance of the set of frames (images) contributing to a merged source (with different filters and/or different epochs of observation).

The FRAMESETIDs for the catalogues released in DR5/5.1/6 have also been updated such that they are self-consistent within the entire survey area. In particular, this is necessary to guarantee that the SOURCEID, the main identifier, is unique. It also takes properly into account, using the priORSec flagging, of the overlapping areas between the LMC (DR6), the Bridge products (DR5) as well as between the SMC (DR5) and the SMC-gap tile. All VMC tiles released were regenerated to include data obtained via complementary open-time programmes. All data in this release refer 111 FRAMESETIDs.

Data Quality

Source lists and catalogues were created from images that were filtered for nebulosity with size of the order of 30 arcsec, but to the images released here the filtering process was not applied.

See Irwin (2010, UKIRT Newsletter 26, 14). Good-quality images are those that meet (within a small tolerance) the requested observational criteria for seeing, sky transparency (THIN or better) and airmass (<1.7). The seeing request varied with waveband and tile location from 1.0 arcsec to 1.2 arcsec with incremental steps of 0.1 arcsec from the Y and J to the Ks band. The majority of the tiles follow this request, but for 24 tiles covering the densest regions of the galaxies the seeing request was reduced by 0.2 arcsec in each band. These tiles are: LMC 4_5, LMC 4_7, LMC 5_2, LMC 5_3, LMC 5_4, LMC 5_5, LMC 5_6, LMC 5_7, LMC 6_2, LMC 6_3, LMC 6_4, LMC 6_5, LMC 6_6, LMC 6_7, LMC 7_2 and LMC 7_4, SMC 3_5, SMC 3_6, SMC 4_3, SMC 4_4, SMC 4_5, SMC 5_3, SMC 5_4, and SMC 5_5.

Tiles observed outside the above constraints (except for some observations carried out down to airmass ~2 for which all other criteria were satisfied), tiles for which the corresponding pawprints show zero-point differences of at least 0.1 mag, pawprints that are not associated to any tile (of which some may be of good quality), and problematic images are excluded from co-added tiles. In total 569 tile images and their corresponding pawprints are affected. The sensitivity of tile images is by construction higher than that of pawprint images and that of co-added tile images is higher than that of single tile images. For co-added tiles the sensitivity is usually equal to the sum of the times indicated for single tiles, but times may be larger in case of extra good quality images (those that meet the VMC observing constraints) or smaller due to the exclusion of problematic images. Observed pawprints that are not associated to any tile, because they refer to interrupted observations due to bad weather or technical reasons, are not included in the data release. There are in total 258.

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 ten 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 regions of a tile (4096), is close to saturation (65536), has photometric calibration probably subject to systematic errors (131072), lies within a dither offset of the stacked frame boundary (4194304), lies within an underexposed strip of a tile (8388606) or within an underexposed region of a tile due to missing detector (16777216), and corresponds to a bright tile detection, but no detection in pawprints (67108864). 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 SHARP and STAR_PROB parameters, listed in the PSF catalogues, could be used to disentangle point-like sources. For example, for stellar objects use STAR_PROB>0.77 and SHARP<0.5. The efficiency of these parameters depends on the FWHM and S/N ratio of the image. Compared to aperture photometry, the PSF photometry reaches sources on average 3 magnitudes fainter with uncertainties <0.1 mag. The magnitude difference may be larger in crowded stellar fields, especially in the Y band, or smaller in less crowded fields and in the K_s band. The completeness of the catalogue was evaluated from artificial star tests and PSF photometry. The mean completeness and standard deviation among all of the tiles included in this release is listed below. Note that the PSF catalogues and the completeness results were produced using only the original VMC-survey data (i.e., without the data from the additional programmes). However, the addition of one Ks-tile observation would likely produce similar results. The PSF catalogue for tile SMC-gap does not contain the completeness information, but this tile largely overlaps with the adjacent tiles for which the completeness is available; the sources within the gap will have similar values.

Band	Mean 80%	Uncertainty 80%	Mean 50%	Uncertainty 50%
Y	21.34	1.21	22.24	0.97
J	21.07	1.17	21.86	1.03

K_s	20.31	1.05	20.87	0.91

Release Notes

The data for this release were prepared by the Cambridge Astronomy Survey Unit (CASU), the Wide Field Astronomy Unit (WFAU), and the VMC team. Images were reduced and source lists extracted from individual tile images using the software suite provided by CASU (v1.5).

The main processing steps are described in Cross et al. (2012, A&A 548, A119) and Cross et al. (2009, MNRAS 399, 1730). Co-added images were outgested from the VISTA Science Archive and were produced only from good-quality data. Epoch-merged and band-merged catalogues were extracted from deep tiles using the same software. Sources are unique within each tile where PRIORSEC>0 signifies that a source is located in a region of overlap with an adjacent tile. The information about the variability of sources was derived using only data from the current release (see Cross et al. 2009 for details).

The PSF detection (Rubele et al. 2015, MNRAS, 449, 639) was made separately in each Y, J and K_s band, then the catalogues were correlated using a radial distance threshold of 1 arcsec. The uniformity of limiting magnitude on the final deep tile is intrinsically dependent on differences in the detector sensitivity and stellar crowding. The PSF magnitudes, originally adjusted to aperture magnitudes from previous releases (performed with v1.3 or earlier of the CASU software), have been aligned to the aperture magnitudes of this release (obtained with v1.5 of the CASU software) by adding the median shifts obtained from the cross-correlation between aperture catalogues, taking only sources detected in all three bands, with minor quality issues and with photometric uncertainties <0.1 mag, and PSF catalogues of each tile separately. The average values of the magnitude and colour shifts are indicated in the table that follows. The IAUNAME of sources in the PSF catalogues may not be unique. At this stage, sources in the overlap of tiles will appear with the same IAUNAME. Furthermore, the IAUNAME is rounded to two decimal points in arcsec, hence, it may be possible that two sufficiently close extractions result in two sources with the same IAUNAME.

Magnitude	Mean	Error	Colour	Mean	Error
Y	-0.010	0.130	Y-J	−0.045	0.044
J	0.035	0.116	Y-K_s	0.003	0.030
K_s	0.011	0.105	J-K_s	−0.006	0.043

The catalogues contain parameters that link the sources, extracted with PSF photometry, with those extracted with aperture photometry as in the VISTA Data Flow System pipeline. The SOURCEID parameter identifies sources in VMC_CAT that correspond to sources in VMC_PSF. Note that there can be more PSFIDs corresponding to the same SOURCEID. The DISTANCEMINS parameter indicates the distance in arcmin between the RA2000 and DEC2000 coordinates of a VMC_CAT source and similar coordinates for a VMC_PSF source. The catalogue contains also the SHARP parameter for each band. SHARP is a measure of the difference between the observed width of the object and the width of the PSF model. Stars should have a sharpness value ~0.0, resolved objects sharpness values >0.0, and cosmic rays and similar blemishes sharpness values <0.0.

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.

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

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

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 such as it is a deblended source or it contains bad pixels in the default aperture. They also indicate if a source is located in the under-exposed area of a tile or in detector #16. They appear as ppErrBits in the catalogues and can be used to refine object samples.

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 outlined in detail at *http://horus.roe.ac.uk/vsa/dboverview.html*. It is based on matching pairs of frames from long (K_s) to short (Y) wavelengths, and early to late epochs. The pairing tolerance for the VMC survey is of 1 arcsec. This radius is larger than the typical astrometric errors and may induce some level of spurious matches. 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 single sources and no duplicate measurements.

The calibrated pawprint images were combined using SWARP to generate a uniform sky subtracted final deep tile image. Artifacts in the pawprint images were removed masking contaminated regions during the co-addition. The PSF in each detector on each pawprint image was normalized to a constant PSF reference model using a Fourier deconvolution technique before to combine them. The deep multi-filter YJK_s PSF catalogues were generated correlating the three filters PSF catalogues using a 1 arcsec maximum radius.

Magnitudes are given in the Vega system and are not corrected for reddening.

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. Note also that 15% of each tile, corresponding to two edges, has only half the total effective exposure time.

Previous Releases

The DR1 (2011) covered only two tiles LMC 6_6 (containing the star forming region 30 Dorados) and LMC 8_8 (containing the South Ecliptic Pole) with complete VMC-survey data processed with an early version of the VDFS. Only VDFS products from both CASU and WFAU were released at that time. In DR2 the images were replaced with those reduced using a newer version of the VDFS and the catalogues were re-produced accordingly. DR3 and DR4 replaced the products for the two tiles above and added 5 and 12 tiles, respectively. The VMC data for these tiles were processed with version 1.3 of the VDFS; catalogues with PSF photometry and the parameters of classical Cepheids, Eclipsing Binaries and RR Lyrae stars across the SMC were also released. Subsequently, all VISTA data were reprocessed with version 1.5 of VDFS. This data was used in DR5 which included only VMC data products from CASU across the

SMC, Bridge and Stream tiles and in DR5.1 which, for the same tiles, released the corresponding WFAU products and the PSF photometry. DR6 provided both CASU and WFAU data products for all LMC tiles, catalogues with PSF photometry and parameters of RR Lyrae stars.

The DR7 corresponds to the same CASU products released in DR5 and DR6 for the VMC programme. The CASU products for the additional programmes are newly added. The WFAU data products have been reprocessed, combining the VMC-survey data with data from the additional programmes and including revised image-quality criteria. Tables with the parameters of different types of sources (e.g., stellar proper motions and redshifts of background galaxies) are also newly added. Only the tables with the PSF photometry and for the variable stars previously published remain unchanged (except for a few problematic sources which have been removed). Details about the different versions of the software are given in the CASU web pages.

The photometric calibration uses colour equations for the transformation of 2MASS calibrators into the VISTA system and the precision achieved in the VMC filters is better than 2%. Details about the calibration process are described in Gonzalez-Fernandez et al. (2018).

Data Format

Files Types

There are 240 individual tile images, each with six corresponding pawprints, and associated confidence maps and source lists with the adopted naming convention:

Pawprint images: v????????_?????_st.fits.fz
Associated confidence map: v????????_?????_st_conf.fits.fz
Source list per pawprint: v????????_?????_st_cat.fits
where the name is constructed as observing-date_number_type.fits(.fz)

Tile images: v????????_?????_st_tl.fits.fz
Associated confidence map: v????????_?????_st_tl_conf.fits.fz
Source list per tile: v????????_?????_st_tl_cat.fits
where the name is constructed as observing-date_number_type.fits(.fz)

There are 672 co-added tile images/confidence maps, where the name is constructed as project_release_ra/dec_tile_band_type_multiframeID.fits and multiframeID uniquely identifies each FITS image. These have 672 associated JPEG images and refer to the 111 main fields and 2 fields around the LMC gap. Then, there are (112x3x12)=4032 associated deep pawprints and their confidence maps. One field around the LMC gap refers only to a single band. Finally, there are (112x3)=336 individual deep tile base lists.

There are 113 epoch-merged and band-merged master source catalogues in YJKs, one per tile, where the name is constructed as project_release_ra/dec_bands_typeofCat_FRAMESETID.fits and FRAMESETID uniquely identifies the tile as follows. The complete list of FRAMESETIDs in this release begins with 558345748481 and ends with 558345748593 (there are 113, with no gaps) as listed below.

558345748481 SMC 2_3
558345748482 SMC 2_4
558345748483 LMC 2_6
558345748484 SMC 2_2
558345748485 LMC 2_5

558345748486 LMC 2_7
558345748487 SMC 2_5
558345748488 BRI 1_3
558345748489 LMC 2_4
558345748490 LMC 2_3
558345748491 BRI 1_2
558345748492 BRI 2_4
558345748493 SMC 3_3
558345748494 SMC 3_4
558345748495 SMC 3_2
558345748496 BRI 2_7
558345748497 SMC 3_5
558345748498 BRI 2_3
558345748499 SMC 3_1
558345748500 BRI 2_8
558345748501 LMC 3_6
558345748502 SMC 3_6
558345748503 LMC 3_5
558345748504 LMC 3_7
558345748505 LMC 3_4
558345748506 LMC 3_8
558345748507 LMC 3_3
558345748508 BRI 2_9
558345748509 LMC 3_2
558345748510 BRI 3_5
558345748511 BRI 3_6
558345748512 BRI 3_4
558345748513 SMC 4_3
558345748514 SMC 4_4
558345748515 SMC 4_2
558345748516 BRI 3_7
558345748517 BRI 3_3
558345748518 SMC 4_5
558345748519 SMC 4_1
558345748520 BRI 3_8
558345748521 SMC 4_6
558345748522 LMC 4_6
558345748523 LMC 4_7
558345748524 LMC 4_5
558345748525 LMC 1_1 (LMC gap – Y only)
558345748526 LMC 4_8
558345748527 LMC 4_4
558345748528 LMC 4_4 (different centre from above)
558345748529 LMC 4_3
558345748530 SMC 5_3
558345748531 LMC 4_9
558345748532 SMC gap
558345748533 SMC 5_4
558345748534 SMC 5_2
558345748535 SMC 5_5
558345748536 LMC 4_2
558345748537 SMC 5_6
558345748538 SMC 6_3
558345748539 SMC 6_4
558345748540 SMC 6_2

558345748541 LMC 5_6
558345748542 LMC 5_5
558345748543 LMC 5_7
558345748544 SMC 6_5
558345748545 LMC 5_4
558345748546 LMC 5_8
558345748547 LMC 5_3
558345748548 LMC 5_9
558345748549 LMC 5_2
558345748550 LMC 5_1
558345748551 SMC 7_3
558345748552 SMC 7_4
558345748553 LMC 6_6
558345748554 LMC 6_5
558345748555 LMC 6_7
558345748556 LMC 6_4
558345748557 LMC 6_8
558345748558 LMC 6_3
558345748559 LMC 6_9
558345748560 LMC 6_2
558345748561 LMC 6_10
558345748562 LMC 6_1
558345748563 LMC 7_6
558345748564 LMC 7_5
558345748565 LMC 7_7
558345748566 LMC 7_4
558345748567 LMC 7_8
558345748568 LMC 7_3
558345748569 LMC 7_9
558345748570 LMC 7_2
558345748571 LMC 7_10
558345748572 LMC 7_1
558345748573 LMC 8_6
558345748574 LMC 8_5
558345748575 LMC 8_7
558345748576 LMC 8_4
558345748577 LMC 8_8
558345748578 LMC 8_3
558345748579 LMC 8_9
558345748580 LMC 8_2
558345748581 LMC 9_6
558345748582 LMC 9_5
558345748583 LMC 9_7
558345748584 LMC 9_4
558345748585 LMC 9_8
558345748586 LMC 9_3
558345748587 LMC 9_9
558345748588 STR 2_1
558345748589 STR 1_1
558345748590 LMC 10_6
558345748591 LMC 10_5
558345748592 LMC 10_7
558345748593 LMC 10_4

A MetaData file, vmc_er7_ksjy_catMetaData.fits, accompanies the release. Its name refers to project_release_bands_typeofCat.fits.

There are 113 multi-epoch source catalogues per band, one per tile. Their name is constructed as project_relase_ra/dec_band_typeofCat_FRAMESETID.fits and FRAMESETID uniquely identify the tile as above. MetaData files, vmc_er7_y(j)(ks)_mPhotMetaData.fits, accompany the release. Their names refer to project_release_band_typeofCat.fits.

There are 113 catalogues for variable stars. Their name is constructed as project_release_ra/dec_bands_typeofCat_FRAMESETID.fits and FRAMESETID uniquely identifies the tiles as above. A MetaData file, vmc_er7_yjks_varCatMetaData.fits, accompanies the release. Its name refers to project_release_bands_typeofCat.fits.

There are 111 PSF catalogues in YJK_s, one per tile. Their name is constructed a project_release_ra/dec_bands_typeofCat_FRAMESETID.fits and FRAMESETID uniquely identifies the tile as above. A MetaData file, vmc_er7_yjks_psfSrcMetaData.fits, accompanies the release. Its name refers to project_release_bands_typeofCat.fits.

There are 111 catalogues with stellar proper motions, one per tile. Their name is constructed a project_release_ra/dec_bands_typeofCat_FRAMESETID.fits and FRAMESETID uniquely identifies the tile as above. A MetaData file, vmc_er7_yjks_pmCatMetaData.fits, accompanies the release. Its name refers to project_release_bands_typeofCat.fits.

There are 6 catalogues of variable stars for specific sources. Their name is constructed as project_release_bands_typeofVarCat.fits and MetaData files, vmc_er7_yjks_typeofVarMetaData.fits, accompany the release; typeof can take the following names: agb (for asymptotic giant branch stars), ceph (for Cepheids), eclBin (for eclipsing binaries), lpv (for long period variables), rrl (for RR Lyrae stars), and yso (for young stellar objects).

There are 2 catalogues of background sources and 1 with source classifications based on machine learning. Their name is constructed as project_release_bands_typeofCat.fits and MetaData files, vmc_er7_yjks_typeofCatMetaData.fits accompany the release; typeof can take the following names: back (for background galaxies) and qso (for quasars).

There is 1 catalogue with source classifications. Its name is constructed as project_release_bands_typeofCat.fits and a MetaData file, vmc_er7_yjks_typeofCatMetaData.fits accompanies the release; typeof takes the name MlClass.

There are 2 catalogues with reddening information. Their name is constructed as project_release_bands_typeofCat.fits and MetaData files, vmc_er7_yjks_typeofCatMetaData.fits accompany the release; typeof can take the following names: extJKs or extYKs.

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

Name; format; description
1; IAUNAME; 29A; IAU Name (not unique)
2; SOURCEID; K; UID (unique over entire VSA via programme ID prefix) of this merged 3; 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; ksMjd; D; Modified Julian Day in Ks band
27; ksPetroMag; E; Extended source Ks mag (Petrosian)
28; ksPetroMagErr; E; Error in extended source Ks mag (Petrosian)
29; ksAperMag3; E; Default point source Ks aperture corrected mag (2.0 arcsec aperture diameter)
30; ksAperMag3Err; E; Error in default point/extended source Ks mag (2.0 arcsec aperture diameter)
31; ksAperMag4; E; Point source Ks aperture corrected mag (2.8 arcsec aperture diameter)
32; ksAperMag4Err; E; Error in point/extended source Ks mag (2.8 arcsec aperture diameter)
33; ksAperMag6; E; Point source Ks aperture corrected mag (5.7 arcsec aperture diameter)
34; ksAperMag6Err; E; Error in point/extended source Ks mag (5.7 arcsec aperture diameter)
35; ksAperMagNoAperCorr3; E; Default extended source Ks aperture mag (2.0 arcsec aperture diameter)
36; ksAperMagNoAperCorr4; E; Extended source Ks aperture mag (2.8 arcsec aperture diameter)
37; ksAperMagNoAperCorr6; E; Extended source Ks aperture mag (5.7 arcsec aperture diameter)
38; ksGausig; E; RMS of axes of ellipse fit in Ks
39; ksEll; E; 1-b/a, where a/b=semi-major/minor axes in Ks
40; ksPA; E; ellipse fit celestial orientation in Ks
41; ksErrBits; J; processing warning/error bitwise flags in Ks
42; ksAverageConf; E; average confidence in 2 arcsec diameter default aperture (aper3) Ks
43; ksClass; I; discrete image classification flag in Ks
44; ksClassStat; E; N(0,1) stellarness-of-profile statistic in Ks
45; ksppErrBits; J; additional WFAU post-processing error bits in Ks
46; ksSeqNum; J; the running number of the Ks detection
47; ksXi; E; Offset of Ks detection from master position (+east/-west)
48; ksEta; E; Offset of Ks detection from master position (+north/-south)
49; jMjd; D; Modified Julian Day in J band
50; jPetroMag; E; Extended source J mag (Petrosian)

51; jPetroMagErr; E; Error in extended source J mag (Petrosian)
52; jAperMag3; E; Default point source J aperture corrected mag (2.0 arcsec aperture diameter)
53; jAperMag3Err; E; Error in default point/extended source J mag (2.0 arcsec aperture diameter)
54; jAperMag4; E; Point source J aperture corrected mag (2.8 arcsec aperture diameter)
55; jAperMag4Err; E; Error in point/extended source J mag (2.8 arcsec aperture diameter)
56; jAperMag6; E; Point source J aperture corrected mag (5.7 arcsec aperture diameter)
57; jAperMag6Err; E; Error in point/extended source J mag (5.7 arcsec aperture diameter)
58; jAperMagNoAperCorr3; E; Default extended source J aperture mag (2.0 arcsec aperture diameter)
59; jAperMagNoAperCorr4; E; Extended source J aperture mag (2.8 arcsec aperture diameter)
60; jAperMagNoAperCorr6; E; Extended source J aperture mag (5.7 arcsec aperture diameter)
61; jGausig; E; RMS of axes of ellipse fit in J
62; jEll; E; 1-b/a, where a/b=semi-major/minor axes in J
63; jPA; E; ellipse fit celestial orientation in J
64; jErrBits; J; processing warning/error bitwise flags in J
65; jAverageConf; E; average confidence in 2 arcsec diameter default aperture (aper3) J
66; jClass; I; discrete image classification flag in J
67; jClassStat; E; N(0,1) stellarness-of-profile statistic in J
68; jppErrBits; J; additional WFAU post-processing error bits in J
69; jSeqNum; J; the running number of the J detection
70; jXi; E; Offset of J detection from master position (+east/-west)
71; jEta; E; Offset of J detection from master position (+north/-south)
72; yMjd; D; Modified Julian Day in Y band
73; yPetroMag; E; Extended source Y mag (Petrosian)
74; yPetroMagErr; E; Error in extended source Y mag (Petrosian)
75; yAperMag3; E; Default point source Y aperture corrected mag (2.0 arcsec aperture diameter)
76; yAperMag3Err; E; Error in default point/extended source Y mag (2.0 arcsec aperture diameter)
77; yAperMag4; E; Point source Y aperture corrected mag (2.8 arcsec aperture diameter)
78; yAperMag4Err; E; Error in point/extended source Y mag (2.8 arcsec aperture diameter)
79; yAperMag6; E; Point source Y aperture corrected mag (5.7 arcsec aperture diameter)
80; yAperMag6Err; E; Error in point/extended source Y mag (5.7 arcsec aperture diameter)
81; yAperMagNoAperCorr3; E; Default extended source Y aperture mag (2.0 arcsec aperture diameter)
82; yAperMagNoAperCorr4; E; Extended source Y aperture mag (2.8 arcsec aperture diameter)
83; yAperMagNoAperCorr6; E; Extended source Y aperture mag (5.7 arcsec aperture diameter)
84; yGausig; E; RMS of axes of ellipse fit in Y
85; yEll; E; 1-b/a, where a/b=semi-major/minor axes in Y
86; yPA; E; ellipse fit celestial orientation in Y
87; yErrBits; J; processing warning/error bitwise flags in Y
88; yAverageConf; E; average confidence in 2 arcsec diameter default aperture (aper3) Y
89; yClass; I; discrete image classification flag in Y
90; yClassStat; E; N(0,1) stellarness-of-profile statistic in Y
91; yppErrBits; J; additional WFAU post-processing error bits in Y
92; ySeqNum; J; the running number of the Y detection
93; yXi; E; Offset of Y detection from master position (+east/-west)
94; yEta; E; Offset of Y detection from master position (+north/-south)
95; VARFLAG; I; Classification of objects across all bands.

96; PRIMARY_SOURCE; B; Primary source 1; secondary source 0

The format refers to the fits notation as follows:
A - string 29 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.

Each multi-epoch source catalogue contains 7 columns. The example below is for the Y band. In the J and K_s bands the name and description, for magnitude, error and post-processing flag, will change accordingly.

Name; format; description
1; PHOT_ID; K; UID for observation.
2; IAUNAME; 29A; IAU Name (not unique)
3; SOURCEID; K; UID (unique over entire VSA via programme ID prefix) of this merged detection as assigned by merge algorithm
4; MJD; D; Modified Julian Day in Y band
5; YMAG; E; Default point/extended source Y aperture corrected mag (2.0 arcsec aperture diameter)
6; YERR; E; Error in default point/extended source Y mag (2.0 arcsec aperture diameter)
7; yppErrBits; J; additional WFAU post-processing error bits in Y

PSF catalogues contain 47 columns as follows.

Number; name; format; description

1; IAUNAME; 29A; IAU Name (not unique)
2; SOURCEID; K; UID (unique over entire VSA via programme ID prefix) of this merged detection as assigned by merge algorithm
3; DISTANCEMINS; E; Angular separation between neighbours
4; PSFSOURCEID; K; UID of VMC PSF extracted objects
5; FIELDNAME; 8A; ID of field
6; FRAMESETID; K; frame set ID, linked to vmcMergeLog, assigned by merging procedure
7; CUEVENTID; J; UID of curation event giving rise to this record
8; RAY; D; PSF fit RA centre Y filter
9; DECY; D; PSF fit Dec centre Y filter
10; YPSFMAG; E; 3 pixels PSF fitting magnitude Y filter
11; YSFMAGERR; E; PSF error Y filter
12; YSHARP; E; PSF fitting shape parameter Y filter
13; RAJ; D; PSF fit RA centre J filter
14; DECJ; D; PSF fit Dec centre J filter
15; JPSFMAG; E; 3 pixels PSF fitting magnitude J filter
16; JPSFMAGERR; E; PSF error J filter
17; JSHARP; E; PSF fitting shape parameter J filter
18; RAKS; D; PSF fit RA centre Ks filter
19; DECKS; D; PSF fit Dec centre Ks filter
20; KSPSFMAG; E; 3 pixels PSF fitting magnitude Ks filter
21; KSPSFMAGERR; E; PSF error Ks filter
22; KSSHARP; E; PSF fitting shape parameter Ks filter
23; RA2000; D; PSF Y,J,Ks average RA centre

24; DEC2000; D; PSF Y,J,Ks average Dec centre
25; CX; D; unit vector of spherical co-ordinates
26; CY; D; unit vector of spherical co-ordinates
27; CZ; D; unit vector of spherical co-ordinates
28; HTMID; K; Hierarchival Triangular Mesh (HTM) index, 20 deep, for equatoial co-ordinates
29; L; D; Galactic longitude
30; B; D; Galactic latitude
31; PRIORSEC; K; Seam code for a unique (=0) or duplicated (!=0) source (eg. Flags overlap duplicates)
32; LCOMPY; E; Local completeness in Y calculated on bins of +/-0.05 [magnitude] on a ring of radius 0.025 [degrees]
33; LCOMPJ; E; Local completeness in J calculated on bins of +/-0.05 [magnitude] on a ring of radius 0.025 [degrees]
34; LCOMPKS; E; Local completeness in Ks calculated on bins of +/-0.05 [magnitude] on a ring of radius 0.025 [degrees]
35; SYSERRY; E; Local photometric systematic error in Y, calculated on bins of +/-0.05 magnitude on a ring of radius 0.025 [degrees]
36; SYSERRJ; E; Local photometric systematic error in J, calculated on bins of +/-0.05 magnitude on a ring of radius 0.025 [degrees]
37; SYSERRKS; E; Local photometric systematic error in Ks, calculated on bins of +/-0.05 magnitude on a ring of radius 0.025 [degrees]
38; STARPROB; E; Discrete star probability 1=100% to be a star, 0.0% probability to be a star
39; NY; J; Number of stars used to calculate the completeness in Y
40; NJ; J; Number of stars used to calculate the completeness in J
41; NKS; J; Number of stars used to calculate the completeness in Ks
42; YMJPSF; E; Y-J 3 pixels PSF fitting colour
43; YMJPSFERR; E; Error on Y-J 3 pixels PSF fitting colour
44; JMKSPSF; E; J-Ks 3 pixels PSF fitting colour
45; JMKSPSFERR; E; Error on J-Ks 3 pixels PSF fitting colour
46; YMKPSF; E; Y-Ks 3 pixels PSF fitting colour
47; YMKPSFERR; E; Error on Y-Ks 3 pixels PSF fitting colour

Variability catalogues contain 11 columns as follows.

Name; format; description
1; IAUNAME; 29A; IAU Name (not unique)
2; SOURCEID; K; UID (unique over entire VSA via programme ID prefix) of this merged detection as assigned by merge algorithm
3; ymeanMag; E; Mean Y magnitude
4; yAmpl; E; Amplitude of variable in y-band
5; yprobVar; E; Probability of variable from chi-square (and other data)
6; jmeanMag; E; Mean J magnitude
7; jAmpl; E; Amplitude of variable in j-band
8; jprobVar; E; Probability of variable from chi-square (and other data)
9; ksmeanMag; E; Mean Ks magnitude
10; ksAmpl; E; Amplitude of variable in ks-band
11; ksprobVar; E; Probability of variable from chi-square (and other data)

Catalogues for asymptotic giant branch stars contain 13 columns as follows.

Name; format; description
1; IAUNAME; 29A; IAU Name (not unique)

2; SOURCEID; K; UID (unique over entire VSA via programme ID prefix) of this merged detection as assigned by merge algorithm
3; uniqueID; K; UID of star in the AGB catalogue
4; ra2000; D; RA in degrees (J2000) from the VMC catalogue
5; dec2000; D; DEC in degrees (J2000) from the VMC catalogue
6; chi2r; E; Reduced chi-squared
7; ksMag; E; Mean Ks-band magnitude
8; ksMagErr; E; Error on the Mean K-band magnitude
9; period; E; Pulsation period
10; periodErr; E; Error on the Pulsation period
11; ksAmpl; E; Ks-band amplitude of the period
12; ksAmplErr; E; Errorr on the Ks-band amplitude of the period
13; cuEventID; J; UID of curation event giving rise to this record

Catalogues for Cepheids contain 23 columns as follows.

Name; format; description
1; IAUNAME; 29A; IAU Name (not unique)
2; SOURCEID; K; UID (unique over entire VSA via programme ID prefix) of this merged detection as assigned by merge algorithm
3; uniqueID; K; UID of VMC variables
4; cuEventID; J; UID of curation event giving rise to this record
5; ra2000; D; Celestial Right Ascension
6; dec2000; D; Celestial Declination
7; cephType; 16A; Type of Cepheid, e.g. DCEP
8; cephMode; 16A; Mode of Cepheid e.g. F0
9; vMeanMag; E; Mean V band magnitude
10; period; E; Period of first mode of oscillation
11; yMeanMag; E; Intensity-averaged Y band magnitude
12; yMagErr; E; Error in intensity-averaged Y band magnitude
13; yAmpl; E; Peak-to-Peak amplitude in Y band
14; yAmplErr; E; Error in Peak-to-Peak amplitude in Y band
15; jMeanMag; E; Intensity-averaged J band magnitude
16; jMagErr; E; Error in intensity-averaged J band magnitude
17; jAmpl; E; Peak-to-Peak amplitude in J band
18; jAmplErr; E; Error in Peak-to-Peak amplitude in J band
19; ksMeanMag; E; Intensity-averaged Ks band magnitude
20; ksMagErr; E; Error in intensity-averaged Ks band magnitude
21; ksAmpl; E; Peak-to-Peak amplitude in Ks band
22; ksAmplErr; E; Error in Peak-to-Peak amplitude in Ks band
evi; E; The dust extinction value E(V-I)
23; externalID; 32A; EROS-2/OGLE III ID: Identification from the EROS-2 or OGLE III catalogues.

Catalogues for eclipsing binaries contain 17 columns as follows.

Name; format; description
1; IAUNAME; 29A; IAU Name (not unique)
2; SOURCEID; K; UID (unique over entire VSA via programme ID prefix) of this merged detection as assigned by merge algorithm
3; uniqueID; K; UID of VMC variables
4; fieldID; 8A; ID of field
5; cuEventID; J; UID of curation event giving rise to this record
6; catalogue; 16A; Name of the catalogue containing the counterparts of the VMC 7 EBs: OGLE III, EROS-2 or both OGLE III /EROS-2

7; externalID; 32A; EROS-2/OGLE III ID: Identification from the EROS-2 or OGLE III catalogues.
8; ra2000; D; Celestial Right Ascension
9; dec2000; D; Celestial Declination
10; nEpochs; J; Number of epochs in the Ks-band
11; ksMax; E; Ks magnitude at maximum light, determined by fitting with GRATIS
12; ksMaxErr; E; Error on Ks magnitude at maximum light
13; period; E; Period from the EROS/OGLE catalogues. Periods of some stars (marked *, in externalID) were recalculated using GRATIS
14; epochMin; E; Epoch of minimum light; EROS, (HJD-2,400,000) determined by GRATIS in EROS R passband; OGLE (JD-2,400,000) from the OGLE III catalogue.
15; notes; 16A; More details from EROS-2 ("cont.-like", "non-contact") or OGLEIII (checked by GRATIS "ch" or not "n/c")
16; origVSArel; 16A; VSA release from which Ks data was used
17; origVSASOURCEID; K; VSA SOURCEID in VSA release from which Ks data was used

Catalogues for long period variables contain 9 columns as follows.

Name; format; description
1; IAUNAME; 29A; IAU Name (not unique)
2; SOURCEID; K; UID (unique over entire VSA via programme ID prefix) of this merged detection as assigned by merge algorithm
3; uniqueID; K; UID of star in the LPV catalogue
4; catalogueID; B; CatalogueID 1=Gullieuszik et al. 2012; 2=Groenewegen et al. 2020;
5; ra2000; D; RA in degrees (J2000) from the VMC catalogue
6; dec2000; D; DEC in degrees (J2000) from the VMC catalogue
7; massLossRate; E; log10 Mass-loss rate calculated
8; luminosity; E; Luminosity
9; cuEventID; J; UID of curation event giving rise to this record

Catalogues for RR Lyrae stars contain 17 columns as follows.

Name; format; description
1; IAUNAME; 29A; IAU Name (not unique)
2; SOURCEID; K; UID (unique over entire VSA via programme ID prefix) of this merged detection as assigned by merge algorithm
3; uniqueID; K; UID of VMC Variables
4; galaxy; 8A; Galaxy that the variable is in LMC/SMC
5; origVmcID; K; UID: VMC source ID from release VMCv20181120
6; ra2000; D; Celestial Right Ascension from VMC
7; dec2000; D; Celestial Declination from VMC
8; rrLyrType; 16A; RR Lyrae type (ab,c,etc)
9; period; E; Period
10; vMeanMag; E; Mean V band magnitude
11; ksMeanMag; E; Mean K_s band magnitude
12; ksMeanMagErr; E; Error on mean K_s band magnitude
13; ksAmpl; E; Peak-to-Peak amplitude in Ks band
14; metallicity; E; Metallicity [Fe/H]
15; metalErr; E; Error on metallicity [Fe/H]
16; evi; E; The dust extinction value E(V-I)
17; cuEventID; J; UID of curation event giving rise to this record

Catalogues for young stellar objects contain 13 columns as follows.

Name; format; description

1; IAUNAME; 29A; IAU Name (not unique)
2; SOURCEID; K; UID (unique over entire VSA via programme ID prefix) of this merged detection as assigned by merge algorithm
3; uniqueID; K; UID of VMC Variables
4; ra2000; D; Celestial Right Ascension from VMC
5; dec2000; D; Celestial Declination from VMC
6; varBands; 8A; Band(s) in which variability was indentified
7; yMag; E; Apparent Y band magnitude from VMC deep stack
8; jMag; E; Apparent J band magnitude from VMC deep stack
9; ksMag; E; Apparent Ks band magnitude from VMC deep stack
10; jAmpl; E; Peak-to-Peak amplitude in J band
11; ksAmpl; E; Peak-to-Peak amplitude in Ks band
12; varType; 16A; Type of variable according to OGLE database
13; cuEventID; J; UID of curation event giving rise to this record

Catalogues with stellar proper motions contain 20 columns as follows.

Name; format; description
1; IAUNAME; 29A; IAU Name (not unique)
2; SOURCEID; K; UID (unique over entire VSA via programme ID prefix) of this merged detection as assigned by merge algorithm
3; distanceMins; E; Angular separation between neighbours
4; uniqueID; K; UID of star in the proper motion catalogue
5; fieldName; 8A; ID of field
6; FRAMESETID; K; frame set ID, linked to vmcMergeLog, assigned by merging procedure
7; cuEventID; J; UID of curation event giving rise to this record
8; ra2000; D; Average celestial Right Ascension of source from VMC PSF catalogue
9; dec2000; D; Average celestial Declination of source from VMC PSF catalogue
10; cx; D; unit vector of spherical co-ordinates
11; cy; D; unit vector of spherical co-ordinates
12; cz; D; unit vector of spherical co-ordinates
13; htmID; K; Hierarchical Triangular Mesh (HTM) index, 20 deep, for equatorial co-ordinates
14; l; D; Galactic longitude
15; b; D; Galactic latitude
16; pmXi; D; PM in Xi direction
17; pmEta; D; PM in Eta direction
18; rmsX; D; Rms of PM in Xi direction
19; rmsY; D; Rms of PM in Eta direction
20; epoch; D; Epoch of position in PM calculation

Catalogues for background galaxies contain 22 columns as follows.

Name; format; description
1; IAUNAME; 29A; IAU Name (not unique)
2; SOURCEID; K; UID (unique over entire VSA via programme ID prefix) of this merged detection as assigned by merge algorithm
3; uniqueID; K; UID of background source catalogue
4; tableID; 32A; Table name - paper, table no
5; tableRow; K; UID of background source catalogue
6; ra2000; D; RA in degrees (J2000) from the VMC catalogue
7; dec2000; D; DEC in degrees (J2000) from the VMC catalogue
8; zBest; E; Best fitting photometric redshift
9; zBestLow; E; Lower error on zBEST (1 sigma)
10; zBestHigh; E; Upper error on zBEST (1 sigma)

11; zMl; E; Maximum likelihood photometric redshift
12; zMlLow; E; Lower error on zML (1 sigma)
13; zMlHigh; E; Upper error on zML (1 sigma)
14; Template_GQ; I; Best fitting galaxy/QSO template
15; Chi2_GQ; D; Chi-squared for the best fitting galaxy/QSO template
16; EBV; E; Best fitting reddening E(B-V)
17; DistMod; E; Best fitting distance modulus
18; NumberBands; I; Number of photometric bands in the SED
19; Context; I; Combination of phtometric bands in the SED
20; Template_S; I; Best fitting stellar template
21; Chi2_S; D; Chi-squared for the best fitting stellar template
22; cuEventID; J; UID of curation event giving rise to this record

Catalogues for quasars contain 15 columns as follows.

Name; format; description
1; IAUNAME; 29A; IAU Name (not unique)
2; SOURCEID; K; UID (unique over entire VSA via programme ID prefix) of this merged detection as assigned by merge algorithm
3; uniqueID; K; UID of QSO
4; externIauName; 32A; IAU format name from VMC or otherwise
5; cuEventID; J; UID of curation event giving rise to this record
6; ra2000; D; RA in degrees (J2000) from the VMC catalogue
7; dec2000; D; DEC in degrees (J2000) from the VMC catalogue
8; yMag; E; Y band magnitude from VMC
9; yMagErr; E; Error on Y band magnitude
10; jMag; E; J band magnitude from VMC
11; jMagErr; E; Error on J band magnitude
12; ksMag; E; Ks band magnitude from VMC
13; ksMagErr; E; Error on Ks band magnitude
14; class; B; VMC source object class -1 (point), 1 (extended)
15; zSpec; E; Spectroscopic redshift from VLT/SAAO observations

Catalogues with source classification using machine learning contain 41 columns as follows.

Name; format; description
1; IAUNAME; 29A; IAU Name (not unique)
2; SOURCEID; K; UID (unique over entire VSA via programme ID prefix) of this merged detection as assigned by merge algorithm
3; distanceMins; E; Angular separation between neighbours
4; uniqueID; K; UID of star in the ML classification catalogue
5; ra2000; D; RA in degrees (J2000) from the VMC catalogue
6; dec2000; D; DEC in degrees (J2000) from the VMC catalogue
7; cx; D; unit vector of spherical co-ordinates
8; cy; D; unit vector of spherical co-ordinates
9; cz; D; unit vector of spherical co-ordinates
10; htmID; K; Hierarchical Triangular Mesh (HTM) index, 20 deep, for equatorial co-ordinates
11; l; D; Galactic longitude
12; b; D; Galactic latitude
13; pAGN; D; Probability of the source being an AGN.
14; pAGNErr; D; Error on probability of the source being an AGN.
15; pGalaxy; D; Probability of the source being an Galaxy.
16; pGalaxyErr; D; Error on probability of the source being an Galaxy.
17; pOB; D; Probability of the source being a star of type O or B.

18; pOBErr; D; Error on probability of the source being a star of type O or B.
19; pRGB; D; Probability of the source being an RGB star.
20; pRGBErr; D; Error on probability of the source being an RGB star.
21; pAGB; D; Probability of the source being an AGB star.
22; pAGBErr; D; Error on probability of the source being an AGB star.
23; pHIIorYSO; D; Probability of the source being a compact HII region or a YSO.
24; pHIIorYSOErr; D; Error on probability of the source being a compact HII region or a YSO.
25; pPNe; D; Probability of the source being an PNe.
26; pPNeErr; D; Error on probability of the source being an PNe.
27; pAGBorRGB; D; Probability of the source being a post-AGB or post-RGB star.
28; pAGBorRGBErr; D; Error on probability of the source being a post-AGB or post-RGB star.
29; pRSG; D; Probability of the source being an RSG star.
30; pRSGErr; D; Error on probability of the source being an RSG star.
31; pHighPM; D; Probability of the source being a foreground (high proper-motion) star.
32; pHighPMErr; D; Error on probability of the source being a foreground star.
33; pUnk; D; Probability of the source being classed as Unknown.
34; pUnkErr; D; Error on probability of the source being classed as Unknown.
35; prfClass; 16A; Class predicted by the PRF. The class with the highest probability.
36; pPrfClass; D; Probability of the source being the predicted class.
37; pPrfExGal; D; Probability of the source being extragalactic.
38; catFlag; 1A; Flag indicating which catalogue the source belongs to. 'H' = High-confidence (>80%), 'M' = Mid-confidence (>60%, <80%) and 'L' = Low-confidence (<60%).
39; isXRayRadio; 1A; States whether there is an X-ray or Radio detected source within the positional error indicated by 'N" (neither), ‘X’ X-Ray, 'R' radio, 'B', both.
40; cuEventID; J; UID of curation event giving rise to this record
41; fieldName; 8A; ID of field

Catalogues with extinction values based on JKs photometry have 28 columns as follows.

Name; format; description
1; IAUNAME; 29A; IAU Name (not unique)
2; SOURCEID; K; UID (unique over entire VSA via programme ID prefix) of this merged detection as assigned by merge algorithm
3; uniqueID; K; UID of QSO
4; ra2000; D; RA in degrees (J2000) from the VMC catalogue
5; dec2000; D; DEC in degrees (J2000) from the VMC catalogue
6; cx; D; unit vector of spherical co-ordinates
7; cy; D; unit vector of spherical co-ordinates
8; cz; D; unit vector of spherical co-ordinates
9; htmID; K; Hierarchical Triangular Mesh (HTM) index, 20 deep, for equatorial co-ordinates
10; l; D; Galactic longitude
11; b; D; Galactic latitude
12; ejks; E; E(J-Ks) reddening value.
13; n30as; I; Number of sources within 30 arcsec
14; sig30as; E; Standard deviation of sources within 30" (1)
15; mean30as; E; Average extinction of sources within 30" (1)
16; med30as; E; Median extinction of sources within 30" (1)
17; max30as; E; Maximum extinction of sources within 30" (1)
18; n1am; I; Number of sources within 1 arcmin
19; sig1am; E; Standard deviation of sources within 1' (1)
20; mean1am; E; Average extinction of sources within 1' (1)
21; med1am; E; Median extinction of sources within 1' (1)
22; max1am; E; Maximum extinction of sources within 1' (1)

23; n5am; I; Number of sources within 5 arcmin
24; sig5am; E; Standard deviation of sources within 5' (1)
25; mean5am; E; Average extinction of sources within 5' (1)
26; med5am; E; Median extinction of sources within 5' (1)
27; max5am; E; Maximum extinction of sources within 5' (1)
28; cuEventID; J; UID of curation event giving rise to this record

Catalogues with extinction values based on YKs photometry have 15 columns as follows.

Name; format; description
1; IAUNAME; 29A; IAU Name (not unique)
2; SOURCEID; K; UID (unique over entire VSA via programme ID prefix) of this merged detection as assigned by merge algorithm
3; uniqueID; K; UID of QSO
4; galaxy; 8A; Galaxy, LMC/SMC
5; ra2000; D; RA in degrees (J2000) from the VMC catalogue
6; dec2000; D; DEC in degrees (J2000) from the VMC catalogue
7; cx; D; unit vector of spherical co-ordinates
8; cy; D; unit vector of spherical co-ordinates
9; cz; D; unit vector of spherical co-ordinates
10; htmID; K; Hierarchical Triangular Mesh (HTM) index, 20 deep, for equatorial co-ordinates
11; l; D; Galactic longitude
12; b; D; Galactic latitude
13; eyks; E; E(Y-Ks) reddening value.
14; eyksSmth; E; E(Y-Ks) smoothed reddening value.
15; cuEventID; J; UID of curation event giving rise to this record

Acknowledgements

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If you use the VMC data in general please reference Cioni et al. (2025, A&A, 699, A300) for the specific DR7 products and Cioni et al. (2011, A&A, 527, A116) for the original survey paper.

If you specifically use the PSF catalogues please reference Rubele et al. (2018, MNRAS 478, 5017).

If you specifically use any of the additional data products (proper motion tables, parameters of variable stars, background sources, and reddening) please refer also to the original papers as reported in Section 4.2 of Cioni et al. (2025, A&A 699, A300).