

VEXAS: the VISTA EXtension to Auxiliary Surveys Data Release 1. The Southern Galactic Hemisphere

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Abstract

This document describes the first public data release of the VISTA EXtension to Auxiliary Surveys (VEXAS: Spiniello & Agnello, 2019, A&A, 630, hereafter S19), comprising seven cross-matched multi-wavelength photometric catalogues, where each object has a match in at least two different surveys.

The final aim of VEXAS is to build a uniform, large spatial coverage in the multi-wavelength sky (from X-ray to radio) and thus to provide the astronomical community with reference magnitudes and colours for various scientific uses: object classification (e.g. quasars, galaxies, and stars; high- z galaxies, white dwarfs); photometric redshifts of large galaxy samples; searches of exotic objects (e.g. extremely red objects and lensed quasars).

As of October 2019, the VEXAS catalogue is the widest and deepest public optical-to-IR photometric and spectroscopic database in the Southern Hemisphere.

Overview of Observations

In this first data release, covering the Southern Galactic Hemisphere (SGH), we cross-matched the two main extragalactic surveys on the Visible and Infrared Survey Telescope for Astronomy (VISTA, Emerson et al., 2006): the VISTA Hemisphere Survey (VHS, McMahon et al., 2013) and the VISTA Kilo Degree Infrared Galaxy Survey (VIKING, Sutherland et al., 2012), with many of the most successful wide-sky photometric surveys in the optical (the Dark Energy Survey, DES, Abbott et al., 2018; the Panoramic Survey Telescope & Rapid Response System DR1, PanSTARRS1, Chambers et al., 2016; and SkyMapper Southern Sky Survey, Wolf et al., 2018), in the infrared (the Wide-Infrared Survey Explorer, WISE, Wright et al., 2010), in the X-ray (ROSAT All Sky Survey, Boller et al., 2014, 2016; The XMM-Newton Serendipitous Survey, Watson et al., 2001) and in the radio domain (SUMSS, Bock et al., 1999). We also provide a match with spectroscopic data from the Sloan Digital Sky Survey Data Release 14 (Abolfathi et al., 2018) and the 6 degrees Field Galaxy Survey, 6dFGS Data Release 3 (Jones et al., 2009)

The core requirement is a reliable photometry in more than one band. This condition, together with the detection in at least two surveys (via cross-match), should minimize, if not completely eliminate, the number of spurious detections in the final catalogues. Finally, for this VEXAS-DR1 we only consider objects below the Galactic plane, $b < -20$ deg. This is the area where wide-field weak-lensing cosmological experiments overlap; it covers a hemisphere with narrower previous coverage, and also includes the well-studied Stripe-82 area of the SDSS. Comparable operations at $b > 20$ deg are planned for the second release of VEXAS.

Queries on the VISTA Surveys

The baseline near-IR tables were built by querying the VIKING-DR3 and the VHS-DR6 from the VISTA Science Archive [website](#) directly. To ensure that only objects with reliable photometry in at least one band are retrieved, we imposed the following criteria on the Petrosian magnitudes and their uncertainties:

$$\begin{aligned}
 (\Delta K_s < 0.3 \text{ AND } 8 < K_s) & \quad \text{OR} \\
 (\Delta H < 0.3 \text{ AND } 8 < H) & \quad \text{OR} \\
 (\Delta J < 0.3 \text{ AND } 8 < J) & \quad \quad \quad (1)
 \end{aligned}$$

The target depths (in Vega magnitudes) are $J=20.6$, $H=19.8$, $K_s=18.5$ on the 120-second integrations and somewhat shallower (~ 0.4 - 0.6 dex) for the images of 60 seconds integration time per band.

We note that the VHS-DR6, from the VSA database, differs from the latest release through the ESO archive (VHS-DR4), as visible from Figure 1, which also provides the total number of objects retrieved for each band and in total.

The VEXAS catalog tables assembled based on this master near-IR table.

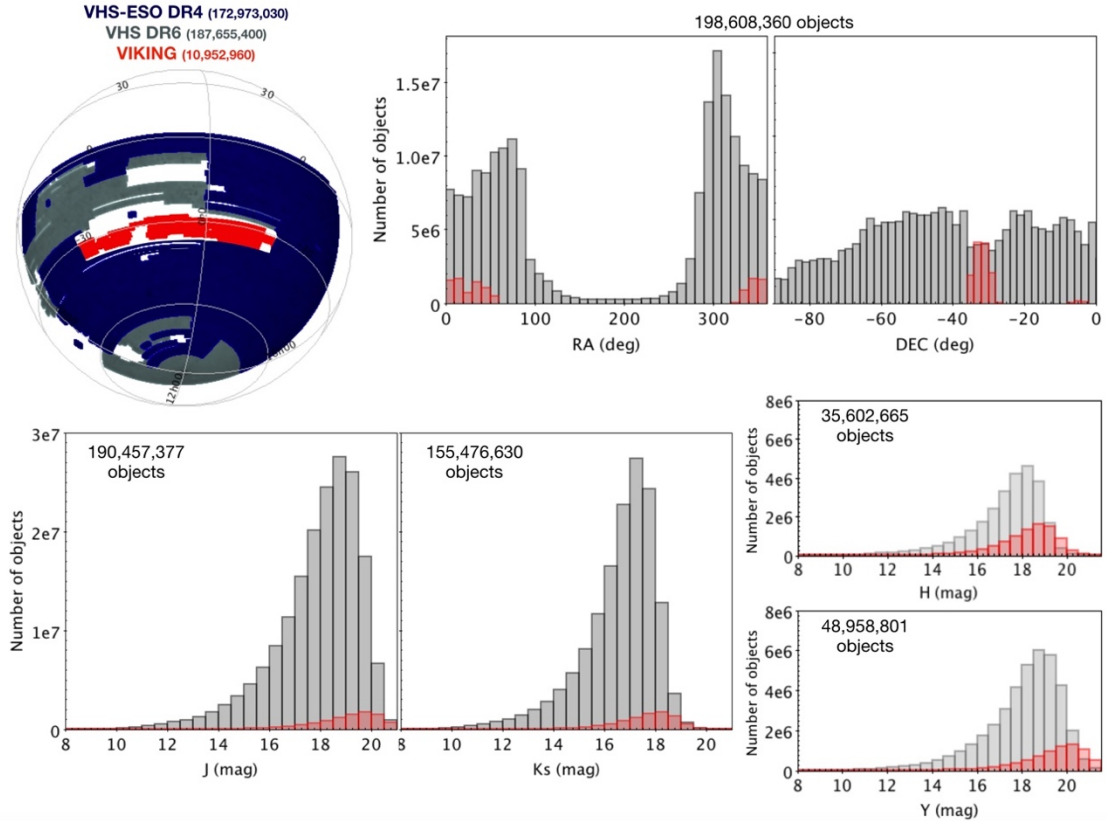


Figure 1: Left: Sky view of the VISTA footprint (VHS in grey and VIKING in red) compared to the VHS-ESO DR4 (blue). Right: Histograms of RA and DEC for the VISTA Surveys that we used for this VEXAS-DR1. The total number of objects (unique sources from the VISTA Surveys) in the catalogue is shown above each histogram. Bottom: Distribution of K_s , J , H , and Y magnitudes of the input VISTA table (in the Vega reference system), with number of objects within the magnitude ranges of Eq.1 given in the top left corner of each panel. The VSH has a very broad coverage in J and K_s , but only observed H and Y in a few fields.

Release Content

In this VEXAS-DR1, we release seven tables. They are listed below, with the total number of unique sources from the VISTA Surveys contained in each of them. Their file format and structure are given in the [Data Format](#) section. We note that the uniqueness of the objects in the matched surveys is not a requirement. In fact, given the different image resolutions of the different surveys, it might likely happen that a single object in e.g. WISE or in the spectroscopic survey result in multiple matches with VISTA.

| TABLE NAME | Number of unique sources in VISTA |
|----------------|-----------------------------------|
| VEXAS-AllWISE3 | 126'372'293 |
| VEXAS-DESW | 37'615'619 |
| VEXAS-PS1W | 24'693'386 |
| VEXAS-SMW | 20'331'041 |
| VEXAS-SPEC | 347'076 |
| VEXAS-21cm | 77'338 |
| VEXAS-XRAY | 2'871 |

The [VISTA+AllWISE3](#) main table

The AllWISE Source Catalogue (Cutri et al., 2013), used for this VEXAS release, includes ~747 million objects over the whole sky, with median angular resolution of 6.1, 6.4, 6.5, and 12.0 arcseconds respectively for the four bands 3.4 μm (hereafter W1), 4.6 μm (W2), 12 μm (W3) and 22 μm (W4).

Firstly, we cross-matched the master VISTA table (split in VHS and VIKING) with AllWISE, requiring a match within 10 arcsec directly from the VISTA science Archive, and retrieving the SLAVEOBJID to identify the WISE corresponding source. Secondly, we perform a further match with a smaller matching radius of 3 arcsec, retrieving this time also the WISE magnitudes and their associated errors. The result of such a match is provided in this data release (table: [VEXAS-AllWISE3](#)). The choice of 3 arcsec is a compromise between the resolution of WISE (~6 arcsec) and minimizing as much as possible the presence of spurious cross-matches between different sources with ghosts and artefacts.

We note that a single object in WISE can be associated to multiple SOURCEID_VISTA, since the image resolution of WISE is much worse of that of VISTA. This is, for instance, the case for strong gravitationally lensed quasars. When a quasar is strongly lensed by a galaxy, it results in multiple images of the same source, often separated only by few arcseconds. In this case, depending on the resolution of the survey, all the multiple quasar images and the deflector can be blended together and result in only one source in the catalogue or each component of the system can be associated to a different catalogue source (see S19 for more details).

For all the further cross-matches that will be described in the following, we use the VEXAS-AllWISE3 table as a starting point, unless otherwise specified.

Finally, in this table, we also include 2MASS magnitudes (J, H, Ks) when available. These were queried directly from the [NASA/IPAC Infrared Science Archive](#), together with the AllWISE catalogue.

Match with optical surveys

In order to maximize wavelength coverage and reach a wide mapping of the Southern Sky, we selected three of the most successful wide-field, multi-band optical photometric surveys: the Dark Energy Survey (hereafter DES), the Panoramic Survey Telescope and Rapid Response System 1 (hereafter PS1) and the SkyMapper Southern Sky Survey (hereafter SM).

For this work we retrieved the latest public releases (DES-DR1, PS1-DR2, SkyMapper-DR1) and cross-matched them onto the final VEXAS-ALLWISE3 table introduced in Section 1.2. The only requirement is a lower limit on the i -band magnitude ($i > 8.0$). For the DES and SkyMapper tables, we also required that a matching AllWISE source exists, without any further criteria on AllWISE magnitudes.

Three tables have been created, one for each optical survey, and are described in detail in the [Release Content](#) and [Data Format](#) Sections. Their sky footprint is shown in Figure 2 below, also including the coverage of the VISTA and AllWISE catalogues.

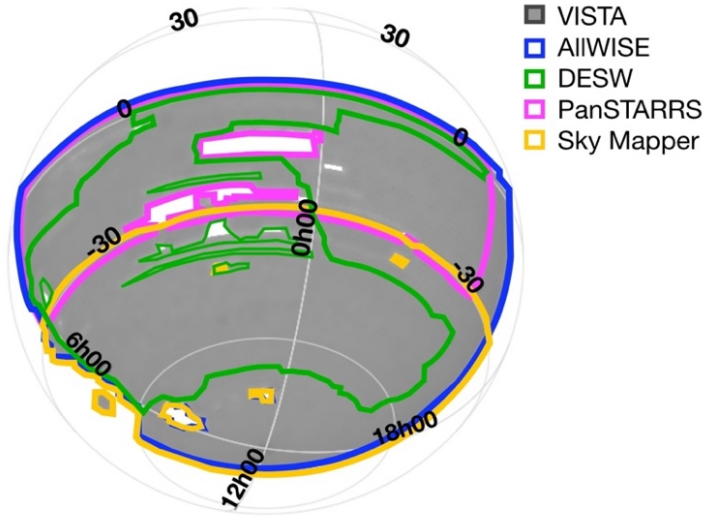


Figure 2: Sky view of the VEXAS plus optical table footprints, plotted over the VISTA catalogue footprint (grey)

Extragalactic objects

As an ancillary by-product, in S19, we also produced a table of objects with extragalactic colours in the VISTA footprint.

We do so by requiring:

$$W1 - W2 > 0.2 + \sqrt{\delta W1^2 + \delta W2^2} \quad (2)$$

on the WISE magnitudes (in the Vega system). This colour-cut excludes most stellar objects, which have $W1 - W2 \sim 0$. It generalizes the exponential cut-offs proposed by Assef et al. (2013) to isolate AGN candidates, which had a more demanding threshold ($W1 - W2 > 0.7$) and was incomplete with respect to quasars at redshifts $z > 2$. Our colour cut also retains most galaxies at $z < 2$ (which have $W1 - W2 \sim 0.35$). We note that we consider only the first two WISE bands since the sensitivity in W3 and W4 is signifi-

cantly impacted by Earth-shine noise. A fraction of contaminants includes brown dwarfs and white dwarfs with an IR excess, which can be further skimmed if optical and NIR magnitudes from ground-based surveys are used. In general, more refined separations of galaxies, stars, and quasars can be performed if multi-band coverage is available (e.g. through optical-to-NIR colours). However, this is currently possible only for a part of the SGH.

This table, although not directly contained in this ESO-DR1, can be reproduced starting from the [VEXAS-AllWISE](#) table and applying the cuts described by Equation 2.

Spectroscopic matches

In multi-band objects classification and discovery, the lack of spectroscopic information is a common issue. This holds especially in the SGH, where (at present) spectroscopic surveys are affected by depth, footprint, and preselection effects. However, part of the existing spectroscopic surveys does overlap with our VEXAS footprint. For this reason, in S19, we performed a spectroscopic cross-match between the final VISTA table and two of the most used all-sky spectroscopic surveys, the SDSS DR14 (Abolfathi et al., 2018) and the 6dFGS DR3 (Jones et al., 2009). We then join these tables together, releasing the [VEXAS-SPEC](#) table which contains all the objects identified in [VEXAS-AllWISE3](#) that have also a spectroscopic match from one or both of the above cited spectroscopic sample.

Finally, in the spectroscopic table we provide the ID of the objects targeted by SuperCosmos, BOSS, EBOSS and ELODIE to facilitate further, more specific cross-matches. As an additional service to the stellar community, we also provide for all the ELODIE targets, useful physical quantities such as surface gravity, effective temperature, Fe/H and metallicity. A detailed description of each column contained in the table is provided in the [Data Format](#) Section.

Match at other wavelengths

To further extend the wavelength coverage of VEXAS, we also performed a cross-match with surveys in the radio and X-ray domains. In this case as well we required the existence of a match in the AllWISE catalogue for each object in order to eliminate spurious detections. However, we note that, given the poorer resolution of the matched surveys at these wavelengths, we kept the WISE matching radius to 10 arcsec rather than restricting it to 3 arcsec (as done in the optical).

In the radio domain, we retrieved 21cm detection data from the Sydney University Molonglo Sky Survey (SUMSS) and performed the matches with AllWISE and VISTA ourselves.

For the X-rays, instead, we retrieved the catalogues presented by Salvato et al. (2018), who performed a match of sources from the ROSAT all-sky survey (RASS) and the XMM-Newton with the AllWISE Source Catalogue, taking into account magnitudes and number densities of the sources. In fact, given the large uncertainties in the positional errors of ROSAT/2RXS and XMM (see Fig.1 in Salvato et al., 2018), they avoided making a too simplistic cross-match using coordinates only, and identified counterparts using a Bayesian approach, also based on the W1 and W2 magnitudes from AllWISE.

Release Notes

All matches were performed with the “*Tool for Operations on Catalogues And Tables*” ([TOPCAT](#), Taylor, 2005) using the ‘Join - Pair Match’. Unless otherwise specified, we used the ‘Sky’ Matching algorithm with a maximum tolerance of 3 arcsec. We note that all the magnitudes in the tables are provided in their native system of reference (AB for the optical surveys and Vega for VISTA and AllWISE).

Known Issues

Footprints of the VEXAS-AllWISE tiles

Given the uneven sky coverage of the full VEXAS-AllWISE catalogue and the way the single-tile tables are built, the sky coverage (SKYQDEG) and the footprint provided in the header using the four vertices of a geodesic convex polygon (FPRAi, FPDEi) have to be interpreted as a good approximation of the actual real footprint covered by the data. We ensure however that 90% of the catalogue sources are indeed contained into the defined polygon.

Chromatic effects

We warn that the offset values between VISTA Source detections and those in optical surveys are computed directly from the catalog tables, and therefore do not account for chromatic effects, such as Atmospheric Differential Refraction, which are non-negligible (Agnello & Spiniello 2019). DR2 will provide ADR-corrected offsets.

Surveys depth

This DR1 relies on matches with AllWISE, which can affect the survey depth except for SkyMapper. Forced photometry on unWISE is planned for future releases.

Negative magnitudes in the Y and J VISTA bands

We caution the users that few thousand objects have negative (values that range between -30 and -1) Y and J magnitudes in the VISTA tables. We are not sure what exactly can cause this not physical numbers, but since we notice that the coordinates of such systems are spread over a small patch on the sky, we speculate that this might be a single tile-problem with the zero-point calibration. However, since the other magnitudes for these objects are reliable, we did not remove them from the final catalog.

Data Format

Files Types

This release contains seven multi-band catalogues, all given in the FITS format. The VEXAS-AllWISE table is released as multi-tile table made of 120 catalogue files, while all the other tables are instead released as single-file catalogue (monolithic).

In general, each table contains always the source ID from one or more surveys, FK5 J2000.0 coordinates and magnitudes in various bands with associated errors. The tables are linked together using the SOURCEID_VISTA (unique identifier of the merged detection in VHS or VIKING) to identify the same objects in different tables (UCD: meta.id;meta.main)

Catalogue Columns

The following tables list the columns that are present in each of the catalogue, with their unit and a short description of the content they represent.

TABLE 1: VEXAS-ALLWISE3

| NAME | UNIT | DESCRIPTION |
|-----------------|------------|---|
| SOURCEID_VISTA | | UID of this merged detection as assigned by merge algorithm |
| RA2000 | degrees | FK5 J2000.0 Right Ascension |
| DEC2000 | degrees | FK5 J2000.0 Declination |
| SLAVEOBJID_WISE | | The unique ID of the neighbour in calSource (=sourceID) for the 10arcsec match |
| ID_WISE | | AllWISE ID for the 3 arcsec match |
| RA_WISE | degrees | Celestial Right Ascension for AllWISE |
| DEC_WISE | degrees | Celestial Declination for AllWISE |
| Y_VISTA | mag (Vega) | Magnitude in Y-band from VISTA |
| EY_VISTA | mag (Vega) | Magnitude error in Y-band from VISTA |
| J_VISTA | mag (Vega) | Magnitude in J-band from VISTA |
| EJ_VISTA | mag (Vega) | Magnitude error in J-band from VISTA |
| H_VISTA | mag (Vega) | Magnitude in H-band from VISTA |
| EH_VISTA | mag (Vega) | Magnitude error in H-band from VISTA |
| Ks_VISTA | mag (Vega) | Magnitude in Ks-band from VISTA |
| EKs_VISTA | mag (Vega) | Magnitude error in Ks-band from VISTA |
| PSTAR_VISTA | | Probability that the source is a star from VISTA |
| EVb_VISTA | | The galactic dust extinction value measured from the Schlegel maps (Schlegel et al. 1998) |
| W1mag | mag (Vega) | Magnitude w1mpro from AllWISE (3.4 μ m) |
| E_W1mag | mag (Vega) | Magnitude error w1sigmpro from AllWISE |
| W2mag | mag (Vega) | Magnitude w2mpro from AllWISE (4.6 μ m) |
| E_W2mag | mag (Vega) | Magnitude error w2sigmpro from AllWISE |
| W3mag | mag (Vega) | Magnitude w3mpro from AllWISE (12 μ m) |
| E_W3mag | mag (Vega) | Magnitude error w3sigmpro from AllWISE |
| W4mag | mag (Vega) | Magnitude w4mpro from AllWISE (22 μ m) |
| E_W4mag | mag (Vega) | Magnitude error w4sigmpro from AllWISE |
| Jmag | mag (Vega) | Magnitude in the J-band from 2MASS |
| E_Jmag | mag (Vega) | Magnitude error in the J-band from 2MASS |
| Hmag | mag (Vega) | Magnitude in the H-band from 2MASS |
| E_Hmag | mag (Vega) | Magnitude error in the H-band from 2MASS |
| Ksmag | mag (Vega) | Magnitude in the Ks-band from 2MASS |
| E_Ksmag | mag (Vega) | Magnitude error in the Ks-band from 2MASS |

TABLE 2: VEXAS-DESW

| NAME | UNIT | DESCRIPTION |
|---------------------|---------|--|
| SOURCEID_VISTA | | UID of the merged detection in VISTA |
| Coadd_object_id_DES | | Unique ID in DES |
| SLAVEOBJID_WISE | | The unique ID of the neighbour in calSource (=sourceID) for the 10arcsec match |
| ID_WISE | | AllWISE ID for the 3 arcsec match |
| RA_DES | degrees | FK5 J2000.0 Right Ascension in DES |
| DEC_DES | degrees | FK5 J2000.0 Declination in DES |

| | | |
|-----------------------|----------|---|
| Mag_auto_g_DES | mag (AB) | Magnitude in the <i>g</i> -band from DES |
| Magerr_auto_g_DES | mag (AB) | Magnitude error in the <i>g</i> -band from DES |
| Mag_auto_r_DES | mag (AB) | Magnitude in the <i>r</i> -band from DES |
| Magerr_auto_r_DES | mag (AB) | Magnitude error in the <i>r</i> -band from DES |
| Mag_auto_i_DES | mag (AB) | Magnitude in the <i>i</i> -band from DES |
| Magerr_auto_i_DES | mag (AB) | Magnitude error in the <i>i</i> -band from DES |
| Mag_auto_z_DES | mag (AB) | Magnitude in the <i>z</i> -band from DES |
| Magerr_auto_z_DES | mag (AB) | Magnitude error in the <i>z</i> -band from DES |
| Mag_auto_y_DES | mag (AB) | Magnitude in the <i>y</i> -band from DES |
| Magerr_auto_y_DES | mag (AB) | Magnitude error in the <i>y</i> -band from DES |
| spread_model_i_DES | | Stellarity indicator in the <i>i</i> -band as defined by the Dark Energy Survey collaboration |
| spreaderr_model_i_DES | | Error on the stellarity indicator |
| wavg_mag_psf_i_DES | mag (AB) | Weighted-average of PSF magnitude in <i>i</i> -band |
| wavg_magerr_psf_i_DES | mag (AB) | Error on wavg_mag_psf_i_DES |

TABLE 3: VEXAS-PS1W

| NAME | UNIT | DESCRIPTION |
|---------------------|----------|--|
| SOURCEID_VISTA | | UID of the merged detection in VISTA |
| objID_PS | | Unique ID PanSTARRS1 (PS) |
| SLAVEOBJID_WISE | | The unique ID of the neighbour in calSource (=sourceID) for the 10arcsec match |
| ID_WISE | | AllWISE ID for the 3 arcsec match |
| RA_PS | degrees | FK5 J2000.0 Right Ascension in PS |
| DEC_PS | degrees | FK5 J2000.0 Declination in PS |
| gpetMag_PS | mag (AB) | Petrosian magnitude in the <i>g</i> -band |
| gpetMagErr_PS | mag (AB) | Error on the Petrosian magnitude in the <i>g</i> -band |
| rpetMag_PS | mag (AB) | Petrosian magnitude in the <i>r</i> -band |
| rpetMagErr_PS | mag (AB) | Error on the Petrosian magnitude in the <i>r</i> -band |
| ipetMag_PS | mag (AB) | Petrosian magnitude in the <i>i</i> -band |
| ipetMagErr_PS | mag (AB) | Error on the Petrosian magnitude in the <i>i</i> -band |
| zpetMag_PS | mag (AB) | Petrosian magnitude in the <i>z</i> -band |
| zpetMagErr_PS | mag (AB) | Error on the Petrosian magnitude in the <i>z</i> -band |
| ypetMag_PS | mag (AB) | Petrosian magnitude in the <i>y</i> -band |
| ypetMagErr_PS | mag (AB) | Error on the Petrosian magnitude in the <i>y</i> -band |
| iPSFMag_PS | mag (AB) | PSF magnitude in the <i>i</i> -band |
| iPSFMagErr_PS | mag (AB) | Error on the PSF magnitude in <i>i</i> -band |
| ipsfLikelihood_PS | | Likelihood that the <i>i</i> -band stack detection is best fit by a PSF (stellarity indicator) |
| Separation-VISTA-PS | arcsec | Distance between matched objects in VISTA and PS |

TABLE 4: VEXAS-SMW

| NAME | UNIT | DESCRIPTION |
|---------------------|----------|--|
| SOURCEID_VISTA | | UID of the merged detection in VISTA |
| Object_ID_SM | | Unique ID in Sky Mapper (SM) |
| SLAVEOBJID_WISE | | The unique ID of the neighbour in calSource (=sourceID) for the 10arcsec match |
| ID_WISE | | AllWISE ID for the 3 arcsec match |
| RA_SM | degrees | FK5 J2000.0 Right Ascension in SM |
| DEC_SM | degrees | FK5 J2000.0 Declination in SM |
| u_petro_SM | mag (AB) | Petrosian magnitude in the u -band |
| E_u_petro_SM | mag (AB) | Error on the Petrosian magnitude in the u -band |
| v_petro_SM | mag (AB) | Petrosian magnitude in the v -band |
| E_v_petro_SM | mag (AB) | Error on the Petrosian magnitude in the v -band |
| g_petro_SM | mag (AB) | Petrosian magnitude in the g -band |
| E_g_petro_SM | mag (AB) | Error on the Petrosian magnitude in the g -band |
| r_petro_SM | mag (AB) | Petrosian magnitude in the r -band |
| E_r_petro_SM | mag (AB) | Error on the Petrosian magnitude in the r -band |
| i_petro_SM | mag (AB) | Petrosian magnitude in the i -band |
| E_i_petro_SM | mag (AB) | Error on the Petrosian magnitude in the i -band |
| z_petro_SM | mag (AB) | Petrosian magnitude in the z -band |
| E_z_petro_SM | mag (AB) | Error on the Petrosian magnitude in the z -band |
| Class_star_SM | | Stellarity indicator from SkyMapper |
| ebmv_sfd_SM | | The galactic extinction value $E(B-V)$ measured from the Schlegel maps |
| Separation-VISTA-SM | arcsec | Distance between matched objects in VISTA and SM |

TABLE 5: VEXAS-SPEC

| NAME | UNIT | DESCRIPTION |
|-----------------|---------|---|
| SOURCEID_VISTA | | UID of the merged detection in VISTA |
| ID_WISE | | AllWISE ID for the 3 arcsec match |
| SPECOBJID_SDSS | | ID of the SDSS Spectral table |
| SPECID_6dFGS | | Spectroscopic ID from 6dFGS |
| TARGETID_6dFGS | | Target ID from 6dFGS |
| BOSS_SPECOBJ_ID | | ID of the BOSS Targets |
| EBOSS_TARGET_ID | | ID of the EBOSS Targets |
| SURVEY | | Survey where the object has been detected |
| RA_SDSS | degrees | FK5 J2000.0 Right Ascension in SDSS |
| DEC_SDSS | degrees | FK5 J2000.0 Declination in SDSS |
| RA_6dFGS | degrees | FK5 J2000.0 Right Ascension in 6dFGS |
| DEC_6dFGS | degrees | FK5 J2000.0 Declination in 6dFGS |
| Z_SDSS | | Redshift measurement from SDSS |
| Z_ERR_SDSS | | Error on the redshift measurement from SDSS |
| ZWARNING_SDSS | | Warning on the redshift measurement from SDSS |
| Z_6dFGS | | Redshift estimation from 6dFGS |
| Z_HELIO_6dFGS | | Redshift estimation from 6dFGS with Helio- |

| | | |
|-------------------|-------------|---|
| | | centric correction |
| QUALITY_6dFGS | | redshift measurement quality: 4=good 1=bad (6=star) |
| CLASS_SDSS | | Object classification from SDSS |
| SUBCLASS_SDSS | | Object sub-classification from SDSS |
| SuperCOSMOS_class | | Object classification from SuperCOSMOS |
| ELODIE_FILENAME | | FILENAME of the ELODIE sources |
| ELODIE_OBJECT | | Targets of ELODIE |
| TARGETTYPE | | Type of target (science or standard) |
| ELODIE_SPTYPE | | Stellar spectra type for ELODIE |
| ELODIE_BV | | B-V for ELODIE stars |
| ELODIE_TEFF | deg.Celsius | Teff for ELODIE stars |
| ELODIE_LOGG | | Log(gravity) for ELODIE stars |
| ELODIE_FEH | | Fe/H for ELODIE stars |
| ELODIE_Z | | Metallicity for ELODIE stars |
| ELODIE_Z_ERR | | Error on metallicity for ELODIE stars |

TABLE 6: VEXAS-21

| NAME | UNIT | DESCRIPTION |
|-----------------|---------|--|
| SOURCEID_VISTA | | UID of the merged detection in VISTA |
| SLAVEOBJID_WISE | | The unique ID of the neighbour in calSource (=sourceID) for the 10arcsec match |
| ID_WISE | | AllWISE ID for the 10 arcsec match |
| RA_SUMSS | degrees | Right Ascension for SUMSS |
| DEC_SUMSS | degrees | Celestial Declination for SUMSS |
| Sp | mJy | Peak brightness at 843MHz (in mJy.beam-1) |
| e_Sp | mJy | Uncertainty on the peak brightness at 843MHz |
| St | mJy | Total flux density at 843MHz |
| e_St | mJy | Uncertainty on the total flux density at 843MHz |
| MajAxis | arcsec | Fitted major axis |
| MinAxis | arcsec | Fitted minor axis |
| PA | degrees | Fitted major axis position angle (N to E) |
| dMajAxis | arcsec | Fitted major axis after deconvolution |
| dMinAxis | arcsec | Fitted minor axis after deconvolution |
| dPA | degrees | Fitted major axis position angle |
| Mosaic | | Mosaic in which the source appears |
| Nm | | Number of mosaics with the source |
| Xpos | pixel | X-Position of the source on quoted mosaic |
| Ypos | pixel | Y-Position of the source on quoted mosaic |

TABLE 7: VEXAS-XRAY

| NAME | UNIT | DESCRIPTION |
|-----------------|------|--|
| SOURCEID_VISTA | | UID of the merged detection in VISTA |
| SLAVEOBJID_WISE | | The unique ID of the neighbour in calSource (=sourceID) for the 10arcsec match |
| ID XMMSL2/2RXS | | Unique ID Xray |

| | | |
|-----------------|-------------------|---|
| ID_WISE | | AllWISE ID for the 10 arcsec match |
| RA_Xray | degrees | Celestial Right Ascension for XRay Surveys |
| DEC_Xray | degrees | Celestial Declination for XRay Surveys |
| pany_Xray | | Probability that there is a counterpart (p_any) |
| pi_Xray | | Relative probability of the match (p_i) |
| FluxB8_XMMSL2 | mW/m ² | XMMSL2 flux in band 8 |
| FluxB7_XMMSL2 | mW/m ² | XMMSL2 flux in band 7 |
| FluxB6_XMMSL2 | mW/m ² | XMMSL2 flux in band 6 |
| e_FluxB8_XMMSL2 | mW/m ² | XMMSL2 flux error in band 8 |
| e_FluxB7_XMMSL2 | mW/m ² | XMMSL2 flux error in band 7 |
| e_FluxB6_XMMSL2 | mW/m ² | XMMSL2 flux error in band 6 |
| SrcFlux_2RXS | mW/m ² | 2RXS flux computed as in Dwelly et al. (2017) |

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