The Master Catalogue of stars towards the Magellanic Clouds

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ABSTRACT

The Master Catalogue of stars towards the Magellanic Clouds (MC2) is a multi–wavelength reference catalogue. We present the first results of the MC2 project. We performed a systematic cross-matching of the DENIS[1] Catalogue towards the Magellanic Clouds (DCMC)[2] with 2MASS[3] and the optical (GSC-II[4], UCAC1[5]) catalogues. It provides an unprecedented wealth of data on the stellar populations of the Magellanic Clouds (MCs). New cross–matching procedures for very large catalogues have been developed and detailed results on the astrometric and photometric accuracy of the cross–identified catalogues were derived. The cross–matching of large surveys is an essential tool to improve our understanding of their specific contents in the Virtual Observatory context. This study has been partly supported by the AstroVirtel[6] Project that aims at improving access to astronomical archives as virtual telescopes.

1 Why cross–matching multispectral catalogues?

Cross–matching catalogues is highly relevant for:

- completing the spectral or spatial coverage when there are missing or unpublished data,
- searching for astrometric or magnitude shifts between surveys and check the internal accuracy of each catalogue,
- multiwavelength studies of astronomical objects.

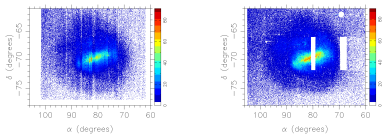
2 Data Overview

Each catalogue has its own characteristics. The observational strategy influences the homogeneity of the final data. The passbands, as well as the characterized stellar populations and the number of sources are different. These factors have a strong impact on the results of the cross–matching.

Density maps below: the pixel size is 3′ × 3′, except for UCAC1 which is 6′ × 6′.

DCMC - LMC
1,459,441 sources
IJK_s

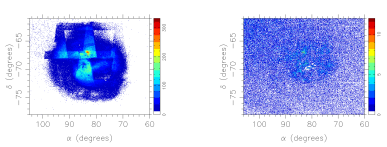
2MASS - LMC
1,996,745 sources
JHK_s



Inhomogeneities in the magnitude limit of some DENIS strips are visible on the DCMC map.
The 2MASS data are from the 2nd Incremental Release PSC. There are some cross-like gaps around bright stars. The circular gap on the upper right corner of the LMC map corresponds to the semi-regular pulsating star HD 29712, which is also the second brightest star in Ks (after Betelgeuse) with a magnitude lower than -4. White rectangular regions crossing the bar denote missing data due to observations not released yet.

GSC2.2 - LMC
6,032,614 sources
FJV

UCAC1 - LMC
267,103 sources
579–642nm, proper motions



The unusual patterns on the GSC2.2 map match the HTM (Hierarchical Triangular Mesch) partitioning of the data, which is a recursive spatial indexing scheme dividing the unit sphere into spherical triangles.
White regions in the UCAC map denote missing digitalization frames in the center of the bar, due to difficulties in extracting sources in overcrowded regions of the sky.

3 Accuracy of the cross–identified catalogues

3.1 Astrometric Shifts

Field distortions in the DCMC affect the quality of the astrometry. To detect them, we proceeded strip by strip. The relative shifts in R.A. and Dec. are a function of the pixel coordinates of the camera. More details can be found in Delmotte et al. (2002)[7].

3.2 Photometric Shifts

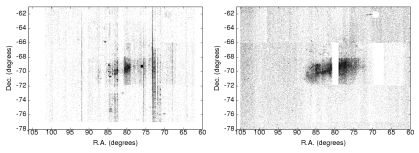
We considered the mean linear relation between DCMC and 2MASS magnitudes, restricting to the range [10, 14] in J and [8, 12] in K_s, avoiding the saturated bright stars as well as the faintest ones.
We find a systematic shift of the absolute calibration between the two catalogues. For each strip, we calculated the median of δJ and δK_s.
The derived mean relations between the two systems are as follow:

$$J_{\mathrm{DCMC}} = J_{\mathrm{2MASS}} - (0.11 \pm 0.06)$$
$$K_{\mathrm{1DCMC}} = K_{\mathrm{s2MASS}} - (0.14 \pm 0.05)$$

These relations have been computed in the case of the DCMC catalogue and may not be valid for the whole DENIS survey. This is quite different from the relations proposed by Carpenter (2001)[8], based on a limited preliminary sample of a few DENIS sources. Groenewegen (2000)[9] did the comparison for a few hundred Cepheids towards the Clouds and found no significant difference between DENIS and 2MASS in J, but found a 0.2 magnitude shift for the K_s band data.

3.3 Non–associations

It is of great astronomical interest to get as many wavelengths as possible for each star, but this should not lead to disregard sources detected only with one survey and not with the other ones. Keeping non–associations in the MC2 helps keeping track of the internal discrepancies of each catalogue, as seen below :



Spatial distribution of some cross–matched sources.
Left panel: Sources of the MC2 belonging to the DCMC catalogue only. The DENIS strip structure remains visible, because some of them suffer from field distortion all along the borders.
Right panel: Sources of the MC2 belonging to the 2MASS catalogue only. The 2MASS scanning strategy covered the sky with tiles 6 degrees long in Dec. and 8.5′ wide in R.A. These patterns remain visible on the plot, thus denoting different sensitivity limits.

4 Results of the Cross–matching

A *strip by strip* cross–matching strategy has been implemented to correct from the residual discrepancies in the catalogues. For each DCMC source of a given strip, we search the best 2MASS association using both position and magnitude criteria. Adding the GSC2.2 and UCAC1 catalogues is done with a cross–matching in position only.
Here is the distribution of the MC2 sources:, for the LMC:

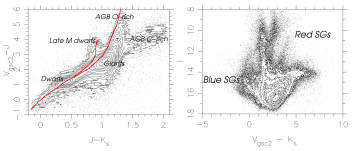
2MASS	DCMC	GSC2.2	Number of sources
X	X	X	1,161,734
X	X		54,584
X		X	629,624
X			151,215
	X		65,709
		X	4,064,181
	X	X	177,414
Total			6,304,461

99.9% of the UCAC1 catalogue is linked to the MC2 and 4.2% of the MC2 has a UCAC1 counterpart.

5 Multispectral Views of the MCs

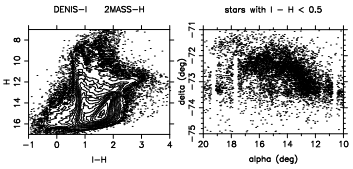
5.1 Large Magellanic Cloud

Combining IR with optical wavelength, as shown below, enables us to discriminate between dwarf and giant stars. Red and blue supergiants are also easy to trace.



Left panel: The colour/colour dwarf and giant tracks superimposed on the diagram are computed using Table 2 from Wainscoat et al. (1992)[10]. The sources involved in this diagram have photometric errors smaller than 0.06 magnitude.
Right panel: Colour–magnitude diagrams combining the magnitudes from the two near–infrared surveys (DCMC–I ; 2MASS–K_s) with one of the three optical magnitude provided by the GSC2.2.

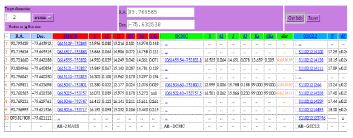
5.2 Small Magellanic Cloud



Left panel: Linking DENIS–I and 2MASS–H is a powerful tool to isolate the bluest stars.
Right panel: Spatial (clumpy) distribution of the young blue stars selected with $(I\text{-}H) \leq 0.5$ on the $(I\text{-}H\,,H)$ CMD.

6 Conclusions

- The MC2 is available on the web at CDS:
  `http://vizier.u-strasbg.fr/MC2/`
- Each line of data contains the name of the source for all the original catalogues, followed by the magnitudes. For each catalogue, the distance of the cross–identification is given, except for 2MASS which is taken as reference.
- Links for each source allow to access the complete data from the original catalogue through the VizieR search engine.
- Cross–identification of large multispectral surveys is an essential step towards the Virtual Observatory of the future.



References

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[6] `http://www.stecf.org/astrovirtel/`.
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[8] J. Carpenter *AJ* **121**, pp. 2851–2871, 2001.
[9] M. Groenewegen *A&A* **363**, p. 901, 2000.
[10] R. J. Wainscoat et al. *ApJS* **83**, p. 111, 1992.