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MOVIS catalog: near-infrared colors and taxonomy of asteroids observed by VISTA-VHS survey

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Abstract

We present the updated version of the MOVIS-C catalog based on VISTA-VHS DR5 release. The near-infrared colors - (Y-J), (H-Ks), (J-Ks) are provided for 53 447 Solar System objects, thus being the largest set of spectro-photometric data in the near-infrared region. Taxonomic classification based on a probablistic approach and machine-learning methods is provided for 9,097 asteroids included in this catalog.

1. Introduction

Spectro-photometric data in the near-infrared region provide the means to characterize the surface composition of Solar System objects. A large set of asteroid colors [1] in this wavelength region was obtained based on the VISTA-VHS (VISTA Hemisphere Survey) data. This survey used the Y, J, H, and Ks broad band filters which are centered at 1.021, 1.254, 1.646, and 2.149 microns and a 1.65 deg. field of view mosaic camera [2]. It imaged the entire southern sky hemisphere, about ~19000 square degrees. The observations were performed between November 4, 2009 and October 1, 2017. The last public data release, VHSDR5 (VHSv20161007), contains 141132 logs of stack-frames.

The taxonomic classification of asteroids imaged by these large surveys provides the opportunity to obtain large scale distribution for asteroidal population, to study the faint objects and to select targets for detailed spectral investigations.

We provide a description of the updated version of the MOVIS-C catalog. This includes the taxonomic classification. The color-color plots of the asteroids observed by this survey are compared with the equivalent colors of the meteorites spectra.

2. Methods

In order to recover the small bodies of the Solar System imaged by VISTA-VHS survey a dedicated pipeline was built [1]. This pipeline applied to VHSDR5 provides information for 53,447 Solar System objects, including 57 NEAs (near-Earth asteroids), 431 Mars Crossers, 612 Hungaria asteroids, 51,382 main-belt asteroids, 218 Cybele asteroids, 267 Hilda asteroids, 434 Trojans, and 29 Kuiper Belt objects [3]. Over this sample, there are about 9,097 asteroids having both (Y-J) and (J-Ks) colors measured and magnitude errors bellow $(Y-J)_{err}$ < 0.136 and $(J-Ks)_{err}$ < 0.136. These limits correspond to the second quartile of the errors.
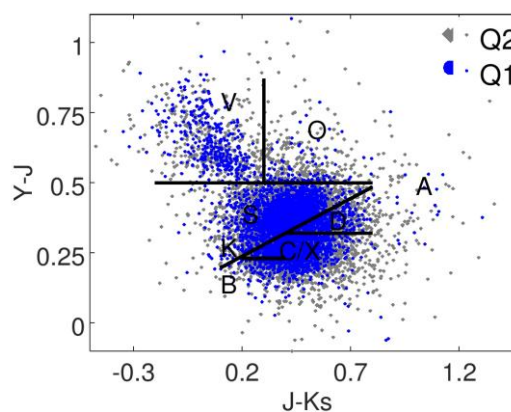

Figure 1: The (Y-J) versus (J-Ks) plot of asteroids reported in the updated version of MOVIS-C catalogue. The Q2 data corresponds to objects with $(Y-J)_{err}$ < 0.136 and $(J-Ks)_{err}$ < 0.136, and the Q1 data to $(Y-J)_{err}$ < 0.059 and $(J-Ks)_{err}$ < 0.073. A diagram corresponding to main taxonomic groups is shown.

A reliable taxonomic classification can be obtained for this sample. This was performed by applying a *probabilistic* approach and *k-nearest neighbor's*

algorithm. The asteroids spectrally classified by [4] were considered as a reference set. Because the information contained by colors provide less constraints than spectral data, the 24 classes were clustered in several groups: B_k^{ni}, C^{ni}, C_{gx}^{ni}, X_t^{ni}, D_s^{ni}, K_l^{ni}, A_d^{ni}, S^{ni}, and V^{ni}. The subscript denotes the interference with other groups.

For asteroid - meteorites comparison, we computed the synthetic colors of meteorites spectral data available in the RELAB database [5].

3. Results

The Solar System Objects found in VISTA-VHS DR5 release are reported in the updated version of the MOVIS-C catalogue. This contains both the NIR colors and the taxonomic classification for objects with (Y-J) and (J-Ks) observed colors [3]. The catalogs are available in electronic form at CDS.

The objects having the errors within the second quartile limits provide a reliable classification for statistical studies. The classification includes 143 bodies classified as B_k^{ni}, 612 as C^{ni}, 199 as C_{gx}^{ni}, 96 as X_t^{ni}, 434 as D_s^{ni}, 531 as K_l^{ni}, 246 as A_d^{ni}, 3303 as S^{ni}, and 807 as V^{ni}. This classification has a ~70% matching with the one provided by Sloan Digital Sky Survey [6].
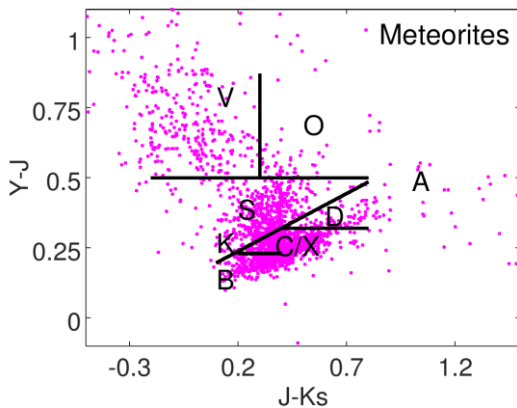

Figure 2: The colors computed from meteorite spectra available in RELAB database. A diagram corresponding to main taxonomic groups derived for asteroid population is overlapped with black color.

The color-color plots of asteroids reported in MOVIS-C catalogue show a broader distribution those computed from meteorite spectra available in the RELAB database. This finding outlines a wider compositional diversity of asteroids not sampled by our current meteorite records.

This large set of data also allows studying the compositional diversity of asteroid families based on their NIR colors [7] and the distribution of basaltic material across the Main Belt [8].

The NIR colors are efficient for identifying end-member classes such as V-types and A-types. By adding the albedo constraint we found that our V-type and A-type candidates have identical size-frequency distributions but a ratio of one to five in favor of V-types. This result adds additional constraints for the hypothesis of "missing mantle problem".

Acknowledgements

References

[1] Popescu, et al. 2016, A&A, 591, A115;

[2] Sutherland, et al. 2015, A&A, 575, A25;

[3] Popescu, et al. 2018, A&A, paper submitted;

[4] DeMeo, F. E., et al. 2009, Icarus, 202, 160;

[5] Pieters, C. M. & Hiroi, T. 2004, LPSC, Vol. 35, ed. S. Mackwell & E. Stansbery;

[6] Carvano, et al. 2010, A&A, 510, A43

[7] Morate, et al. 2018, A&A, forthcoming paper;

[8] Licandro, J., et al. 2017, A&A, 600, A126.