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Absolute magnitudes of trans-neptunian objects

R. Duffard (1), A. Alvarez-Candal (2), N. Pinilla-Alonso (3), J.L. Ortiz (1), N. Morales (1), P. Santos-Sanz (1) and A. Thirouin (4)
(1) Instituto de Astrofísica de Andalucía, CSIC, Apt 3004, 18080, Granada, Spain. duffard@iaa.es (2) Observatório Nacional / MCTI, Rua General José Cristino 77, Rio de Janeiro, RJ, 20921-400, Brazil. (3) Department of Earth and Planetary Sciences, University of Tennessee, Knoxville, TN, 37996, United States (4) Lowell Observatory, 1400 W Mars Hill Rd, Flagsta_ff, 86001 Arizona, USA

Abstract

Accurate measurements of diameters of trans-Neptunian objects are extremely complicated to obtain. Radiomatric techniques applied to thermal measurements can provide good results, but precise absolute magnitudes are needed to constrain diameters and albedos. Our objective is to measure accurate absolute magnitudes for a sample of trans-Neptunian objects, many of which have been observed, and modelled, by the "TNOs are cool" team, one of Herschel Space Observatory key projects grantes with ~ 400 hours of observing time. We observed 56 objects in filters V and R, if possible. These data, along with data available in the literature, was used to obtain phase curves and to measure absolute magnitudes by assuming a linear trend of the phase curves and considering magnitude variability due to rotational light-curve. In total we obtained 234 new magnitudes for the 56 objects, 6 of them with no reported previous measurements. Including the data from the literature we report a total of 109 absolute magnitudes.

1. Introduction

Until recently most of the known phase curves belonged to main belt asteroids. Nevertheless, since the discovery of the trans-Neptunian objects (TNOs), some effort has been done to measure their phase curves. One critical problem for these objects is the low values of the phase angle (α) that can be reached from ground-based facilities. For comparison, a typical main belt asteroid can be observed up to 20^o or 30^o, while a typical TNO can reach only up to 3^o.

Besides providing information about surface properties, phase curves are also important because they provide the absolute magnitude, H, of an airless body. H is the reduced magnitude of an object at α = 0^o. Moreover, H is related to the diameter of the body, D, and its albedo p. If we are considering magnitudes in V-filter, then:

$$D[km] = 1.324 \ . \ 10^{(3-Hv/5)} . \ (p_v)^{-1/2}$$

Many of the physical characteristic of the trans-Neptunian population are still hidden from us due to the limited high-quality information we can currently obtain: visible and near-infrared spectroscopy of about 100 objects [1], colours of about 300 [2] drawn from a known population of more than 1,600 objects.

2. Observations and data reduction

The data presented in this work were collected during several observing runs spanning between September 2011 and May 2014 for well over 40 nights, some of which could not be used due to bad weather conditions. The instruments and facilities used were CAFOS at the 2.2-m, CAHA2.2, and MOSCA at the 3.5-m, CAHA3.5, telescopes of the Calar Alto Observatory sited at Sierra de Los Filabres (Spain), WFC at the 2.5-m Isaac Newton Telescope, INT, sited at the Roque de los Muchachos Observatory (Spain), the direct camera at the 1.5-m telescope, OSN, of the Sierra Nevada Observatory (Spain), the SOI at the 4.1-m SOAR telescope sited at Cerro Pachón (Chile), and the direct camera at the 1-m telescope of the Observatório Astronômico do Sertão de Itaparica, OASI, Brazil.

3. Results

In total we obtained 234 new magnitudes for 56 objects, 6 of which did not have any magnitude reported before to the best of our knowledge. Alongside our own data we made an extensive, although not complete and still on-going, search in the literature of other published V and R magnitudes. We used as our primary reference database the MBOSS 2 article by [2], but we did not take the data directly from their catalogue. Instead we carefully took the data from each referenced article to complete our list. In total we finished with over 1800 individual measurements for over 100 objects.

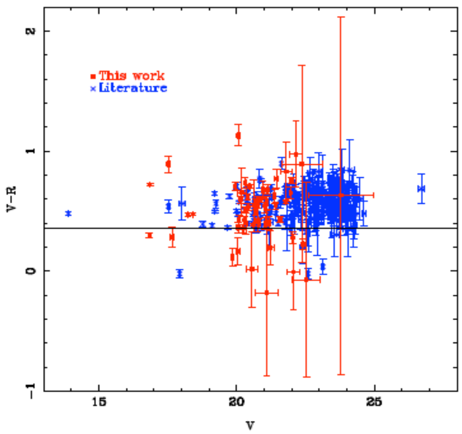

Figure 1: Color - magnitude for the objects in our database. In red are shown the objects that have at least one color measured by us, while in blue appear those whose data comes from the literature only. The $(V-R)_{\odot}$ is shown for reference as a horizontal line.

6. Summary and Conclusions

We have observed 55 objects, 6 of which with no reported magnitudes, to be the best of our knowledge, in the literature. We combined these new V and R magnitudes with an extensive bibliographic survey to compute absolute magnitudes. In total we report absolute magnitudes (H_V) for 109 objects. Some of these objects had already phase curves reported, nevertheless it is important to include new data, always keeping in mind that we are combining data from different apparitions for the same object and that surface conditions might have changed between observations.

This work represents the first release of data taken between late 2011 and early 2014 which represents a large effort of our group. It is important to mention that more observations are undergoing and that as any new work is published, and we get acquainted with, reporting new V or R magnitudes it will be included in our list, intending to have reliable H_V for all TNOs observable from 4-m class telescopes, improving at the same time the accuracy of diameters and albedos obtained via thermal data modelling.

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References

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