EPSC Abstracts
Vol. 6, EPSC-DPS2011-1531, 2011
EPSC-DPS Joint Meeting 2011

ExploreNEOs: Average albedo by taxonomic complex in the near-Earth asteroid population

C.A. Thomas (1), D.E. Trilling (1), J.P. Emery (2), M. Mueller (3), J.L. Hora (4), L.A.M. Benner (5), B. Bhattacharya (6), W.F. Bottke (7), S. Chesley (5), M. Delbó (3), G. Fazio (4), A.W. Harris (8), A. Mainzer (5), M. Mommert (8), A. Morbidelli (3), B. Penprase (9), H.A. Smith (4), T.B. Spahr (4), J.A. Stansberry (10)

(1) Northern Arizona University, USA, (2) University of Tennessee, USA, (3) Observatoire de la Côte d'Azur, France, (4) Harvard-Smithsonian Center for Astrophysics, USA, (5) Jet Propulsion Laboratory, USA, (6) Claremont McKenna, Pitzer, and Scripps Colleges, USA, (7) Southwest Research Institute, USA, (8) DLR Institute of Planetary Research, Germany, (9) Pomona College, USA, (10) Steward Observatory, USA

Abstract

Understanding the albedo distribution of the Near-Earth Object (NEO) population allows for a better understanding of the relationship between absolute magnitude and size, which impacts calculations of size frequency distribution and impact hazards. Examining NEO albedos also sheds light on the differences between the NEO and Main Belt populations. We combine albedo results from the ExploreNEOs Warm Spitzer Exploration Science program [17] with taxonomic classifications from the literature, publicly available datasets, and new observations from our concurrent spectral survey to derive the average albedos for C-, D-, Q-, S-, V- and X-complex NEOs.

1. Introduction

Understanding the albedo distribution and the average albedos of certain populations, such as taxonomic classes, can inform our understanding of the NEO population as a whole. Conversions from absolute magnitude to size rely on albedo [7] and are frequently used in determinations of debiased size frequency distributions of near-Earth objects and the related impact risk [15, 11]. For many years, these calculations relied on albedo values obtained from studies of the Main Belt. However, several key differences exist between the Main Belt and near-Earth environments, such as space weathering rates and collisional evolution timescales. Additionally, NEOs are a biased sample of the Main Belt population and have different taxonomic class abundances than the Main Belt. Therefore, we do not expect the average albedos of the NEO population or of the individual taxonomic complexes to be identical to their Main Belt counterparts. Studies of NEO albedos [5, 15] are important to our understanding of the NEO population. The more accurate our relationship between H magnitude and object size, the more accurately we can examine the NEO size distribution and the progress towards meeting the congressional mandate of identifying 90% of NEOs larger than 140 m.

2. Data

The albedo values presented here were determined as part of the ExploreNEOs Warm Spitzer Exploration Science project. ExploreNEOs uses the post-cryogenic mode of the IRAC camera on the Spitzer Space Telescope. Thermal modeling using the IRAC fluxes and published H magnitudes for each asteroid yields an estimate of the diameter and albedo [17].

We obtained taxonomic classifications for objects in our ExploreNEOs target list via two sources: previously published work and new classifications. The literature classifications include papers defining taxonomic systems as well as other large spectroscopic surveys [16, 18, 1, 4, 2, 3, 15, 8, 9, 6, 12]. We classified objects within the Bus-DeMeo system using a combination of publicly available spectra [10, 13] and new observations made by our group.

3. Conclusions

Using a sample size of 118 NEOs, we calculate average albedos of $0.29^{+0.05}_{-0.04}$, $0.26^{+0.04}_{-0.03}$, and $0.42^{+0.13}_{-0.11}$ for the Q-, S-, and V-complexes, respectively. The averages for the C- and D-complexes are $0.13^{+0.06}_{-0.05}$ and $0.02^{+0.02}_{-0.01}$, but these averages are based on a small number of objects and will improve with additional observations. We also classify X-complex asteroids as E-, M-, or P-type. Our results demonstrate that the average albedos for the C-, S-, V-, and X-complexes are higher than those observed in the Main Belt.

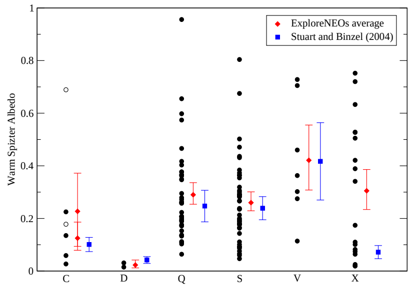

Figure 1: Average albedos of NEOs by taxonomic complex. The black circles indicate individual Warm Spitzer derived albedos compared to our class averages (red diamonds) and averages previously published by Stuart and Binzel (2004) [15] (blue squares).

4. Discussion

The C-, S-, V- and X-complexes show higher average albedos in the near-Earth population than in the Main Belt. Past work [15] has shown higher NEO albedos for the C- and S- complexes and for the overall NEO population. Our overall near-Earth asteroid population average albedo of 0.28 is much larger than that found in the Main Belt (0.08 [14]). [5] showed a similar average NEO albedo of 0.25. However, both samples are biased. Debiased NEO average albedos have been calculated as 0.14±0.02 [15] and 0.13 [11].

There are several potential reasons for the differences in albedos between the NEO and Main Belt populations. The discrepancy could be due to the different size regimes examined for each sample. The Main Belt albedos are from the IRAS catalog which primarily sampled objects with diameters larger than 10 km. In contrast, our albedo sample has only two objects with diameters larger than 10 km. When considering space weathering and collisional refreshing effects, the large difference in sizes between the NEO and Main Belt objects could result in fresher surfaces within the ExploreNEOs sample than within the IRAS sample.

We examine the contribution of the size discrepancy to the NEO-Main Belt average albedo mismatch by incorporating WISE and additional Spitzer data from other programs. This allows us to find the average albedos of various populations of small Main Belt asteroids in order to compare them to our NEO results.

Acknowledgements

This work is based in part on observations made with the Spitzer Space Telescope, which is operated by JPL/Caltech under a contract with NASA. Support for this work was provided by NASA through an award issued by JPL/Caltech.

References

[1] Binzel, R.P., Harris, A.W., Bus, S.J., & Burbine, T.H. 2001, Icarus, 151, 139

[2] Binzel, R.P., Perozzi, E., Rivkin, A.S., Rossi, A., Harris, A.W., Bus, S.J., Valsecchi, G.B., & Slivan, S.M. 2004, M&PS, 39, 351

[3] Binzel, R.P., Rivkin, A.S., Stuart, J.S., Harris, A.W., Bus, S.J., & Burbine, T.H. 2004, Icarus, 170, 259

[4] Bus, S.J. & Binzel, R.P. 2002, Icarus, 158, 146

[5] Delbó, M., Harris, A.W., Binzel, R.P., Pravec, P., & Davies, J.K.2003, Icarus, 166, 116

[6] DeMeo, F., Binzel, R.P., Slivan, S.M., & Bus, S.J. 2009, Icarus, 202, 160

[7] Harris, A.W. & Harris, A.W. 1997, Icarus, 126, 450

[8] Lazzarin, M., Marchi, S., Barucci, M.A., Di Martino, M., & Barbieri, C. 2004, Icarus, 169, 373

[9] Lazzaro, D., Angeli, C.A., Carvano, J.M., Mothé-Diniz, T., Duffard, R., & Florczak, M. 2004, Icarus, 172, 179

[10] MIT-UH-IRTF Joint Campaign for Spectral Reconnaissance, http://smass.mit.edu/minus.html

[11] Morbidelli, A., Jedicke, R., Bottke, W.F., Michel, P., & Tedesco, E.F. 2002, Icarus, 158, 329.

[12] Neese, C., Ed., 2010, NASA Planetary Data System, EAR-A-5-DDR-TAXONOMY-V6.0

[13] Reddy, V. 2010, NASA Planetary Data System, EAR-A-I0046-5-REDDYSPEC-V1.0

[14] Ryan, E.L. & Woodward, C.E. 2010, AJ, 140, 933

[15] Stuart, J.S. & Binzel, R.P. 2004, Icarus, 170, 295

[16] Tholen, D.J. 1989, in Asteroids II, eds. R.P. Binzel, T. Gehrels, M.S. Matthews (Tucson, AZ: Univ. Arizona Press), 1139

[17] Trilling, D.E. et al. 2010, AJ, 140, 770

[18] Xu, S., Binzel, R.P., Burbine, T.H., & Bus, S.J. 1995, Icarus, 115, 1