EPSC Abstracts
Vol. 6, EPSC-DPS2011-1595-1, 2011
EPSC-DPS Joint Meeting 2011

Spectrophotometric trends within Main-Belt asteroid families using the SDSS Moving Object Catalog

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Abstract

Spectroscopy and spectrophotometry of asteroids allow us to study the composition of asteroids. However, over time a process known as space weathering can alter the spectral signal of a surface. We combine previously published asteroid family membership lists with photometry from the Sloan Digital Sky Survey Moving Object Catalog. This combination allows us to study spectral trends diagnostic of space weathering within individual asteroid families. This result will allow us to shed light on how space weathering trends vary with composition and on how space weathering rates vary with distance from the sun.

1. Introduction

Spectral changes due to space weathering should increase with time up to the point when saturation is reached and no further change occurs [5, 3]. Theories on collisional evolution of small bodies show that the expected lifetime of a body varies with the asteroid size [4]. A large object will have a longer collisional lifespan because it is less likely to be catastrophically disrupted. Smaller bodies will have far shorter survival times and will consequently have a younger age, on average, than their larger counterparts. For objects covered in regolith, the surface age need not date to the time the object was formed. Smaller impacts can seismically move regolith downslope and resurface the body [6]. Finally, the smallest objects may be unable to retain regolith due to their low surface gravity, and thus show unweathered, young-looking surfaces for very long times. Therefore, small bodies may display surfaces that are young enough to be unaltered by the space weathering process or may display surfaces that have not yet reached spectral maturity.

Models suggest that there is a transition size below which young surfaces are observable. Binzel et al. (2004) [1] identified this transition size (5 km) for S- and Q-types in near-Earth space by examining trends in spectral slope. To examine this transition in the Main Belt, Rivkin et al. (2011) [7] and Thomas et al. (2011) [8] performed a spectrophotometric survey of small Koronis family members. Those works identified potential Q-types and an observable transition size of 5 km between Q- and S-type slopes within the main-belt Koronis family.

The results of the Koronis survey showed that low resolution large spectrophotometric datasets hold a wealth of compositional information. Using the Sloan Digital Sky Survey (SDSS) Moving Object Catalog (MOC), we now examine several asteroid families to identify space weathering trends.

2. Procedure

We combine the SDSS Moving Object Catalog (release 3) with family membership lists determined by Mothé-Diniz et al. (2005) [2]. For each family we determine a data quality restriction based on the errors of the Sloan color indices. Final color indices for objects with multiple observations are determined by averaging all available color indices for each object. We convert the final color indices to reflectance values and use the SDSS filter center wavelengths to determine a spectrophotometric slope for each object. We display all results as a running box mean of slope values as a function of absolute magnitude (H).

3. Results

Results for the SDSS MOC investigation of the Koronis family (Figure 1) show a trend similar to that found in Thomas et al. (2011) [8]. In this sample the transition size is $\sim$4 km. We will continue this procedure for several other families within the SDSS MOC.

4. Implications

We are investigating other families to determine how space weathering trends vary with composition and

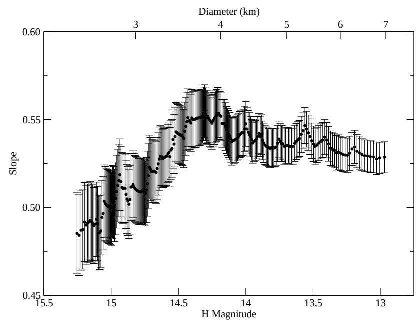

Figure 1: The results from the SDSS MOC investigation of the Koronis family. Our analysis contained observations of 376 individual Koronis family members. The figure shows a running box mean (N=140) of slope as a function of absolute magnitude and diameter. The trend is similar to that found in the previous Koronis family investigations [8].

how space weathering rates vary with distance from the sun. We expect different transition sizes and different slopes for the running box mean trend line for families at different locations in the Main Belt and with different family compositions. For example, we expect the S-type Flora family (a∼2.3 AU) to show a transition from Q- to S-type at a younger average surface age (smaller size) than seen in the Koronis family (a∼2.9 AU) due to the increased solar flux. These results will shed light on the collisional lifetimes within the families and therefore the collisional ages that corresponds to the transition sizes. This survey of SDSS MOC data shows that we can investigate complex problems with large scale photometric programs such as LSST.

Acknowledgements

T. Linder was supported by the NSF REU program at Northern Arizona University. This work is also supported in part by funding from NASA's Spitzer Science Center.

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