EPSC Abstracts
Vol. 13, EPSC-DPS2019-365-2, 2019
EPSC-DPS Joint Meeting 2019

EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

Physical Characterization of Fast rotating NEOs

From Spectroscopy Back to Spectrophotometry

Jean-Baptiste Kikwaya Eluo (1), Carl Hergenrother (2), Richard Boyle (1)
(1) Vatican Observatory, V-00120 Vatican City of State, Vatican, (2) University of Arizona, Tucson, Arizona, USA (jbkikwaya@email.arizona.edu)

Abstract

With the introduction of spectroscopy, does it mean the end of spectrophotometry? Since 2012, we conducted a project of physical characterization of fast rotator near-Earth objects (NEOS) whose V magnitude ranges between 18.0 and 19.5 using a 2-meter class telescope (VATT) at Mt. Graham, Arizona. We used Johnson-Cousins broadband filters (B, V, R, and I) in order to collect enough light in each band. Spectrometers mounted on 2-meter class telescopes have a limiting V magnitude around 16. We focused on asteroids that were too faint for spectroscopy with the VATT. Nevertheless, after computing the relative reflectance of an object, we compared it using chi-square technique with actual spectra from spectroscopy projects like SMASS I and SMASS II.

1. Introduction

The first real taxonomy of asteroids goes back to CMZ taxonomy (Chapman, Morisson, and Zellner) (Chapman et al. 1975). Observing asteroids with a set of three broadband filters (U, B, and V), they were able to compute their color indexes (U-B, and B-V) and to make a two-color-axes plot (U-B versus B-V). Three distinct groups (C, S, and U) were detected: Type-C for dark objects, Type-S for bright objects, and Type-U (Unknown) for objects which are neither bright nor dark.

The second taxonomy was Tholen's (Zellner et al. 1984) based on 589 reflectance spectra produced with ECAS system (Eight-Color Asteroid Survey), a set of eight filter (u, b, v, w, x, p, z) covering the optical range of the electromagnetic spectrum. CMZ Type-C was enriched with C, G, B, F, Type-D was introduced, CMZ Type-C was maintained, and Unknown Type-U was broken into 8 different Types: R, A, M, P, Q, E, V (Vesta), and T.

SMASSI and SMASSII (Small Main-Belt Asteroid Spectroscopic Survey) are two projects run with the goal that is to reproduce ECAS reflectance spectra using spectroscopy. The later has these four advantages (single exposure for the entire spectrum, elimination of photometry variability due to the rotation of the asteroid, the measurement of the background is done at the same time as object observation, and does not require photometric conditions). With these two projects, a new taxonomy called Bus-DeMeo taxonomy became available with three main groups: S-complex (S, Sa, Sq, Sr, Sv), C-complex (B, C, Cb, Cg, Cgh, Ch), X-Complex (X, Xc, Xe, Xk). A fourth group called End Members has been added (D, K, L, T, A, O, Q, R, V) (see Bus and Binzel, 2002a; Bus and Binzel, 2002b; DeMeo et al. 2009, DeMeo et al, 2015 in Asteroids IV).

For each NEO, we produce its lightcurve, its color indices (B-V, V-R, and V-I), and relative reflectance spectrum. With the two-color-axes plots, we obtain the first idea of the color of the object. We connect the relative reflectance spectrum of the object with the actual spectra from SMASSI and SMASSII by performing a comparison by chi-squared using M4AST, modeling for asteroids from IMCCE (Popescu et al. 2012). With this method, the color from the first cut is confirmed. We also compare the relative reflectance spectrum with the lab spectra always using M4AST to have an idea about the composition of the surface of the object.

2. Observation, analysis

We observe only those NEOs with H (absolute magnitude > 22). In the first term of our research, we collected 11 NEOs (Kikwaya, 2018).

We computed the lightcurve of each of them. Example of lightcurve of NEO 2014 WF201 (fig1).

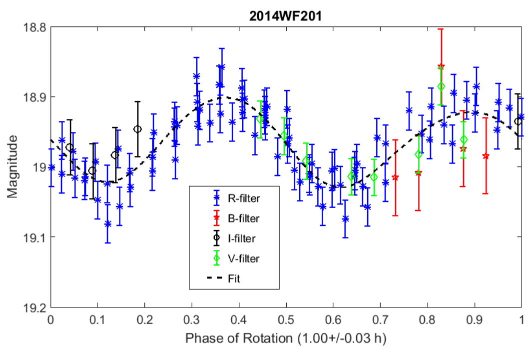

Figure 1. Lightcurve of NEO 2014 WF201.

We did the search in spectra database to see which ones would match the relative reflectance spectrum of NEO 2014 WF201 (fig2).

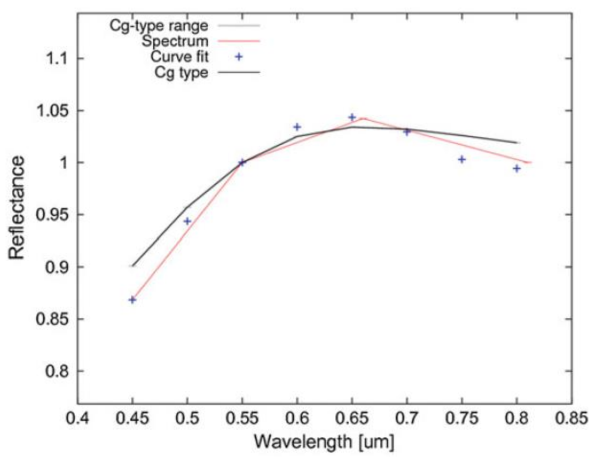

Figure 2. Neo 2014 WF201 matches Bus-DeMeo spectrum Type-Cg.

3. Results

Here are the results of all 11 NEOs. (table 1).

Asteroid	Classes	
	From Zeller et al. (1985)	From Popescu et al. (2012)
2014AY28	C	Cgh, Cg, O
2014EC	N/A	–
2014KS40	X	–
2014WF201	C	Cg, Cgh, O
2015FP	N/A	–
2015TB25	C	Cgh
2015VM64	C	Cgh, Ch
2015VT64	C	Cgh
2015XZ1	C	Cgh, C
2016EW1	C or S	O, Cg
2016GW221	C	Cgh

Table 1. NEOs classified using both the two-color-axes plots and the comparison with the observed spectra.

4. Conclusion

For the study of physical characterization of fast rotator NEOs, spectrophotometry remains a powerful technique particularly if observations are carried out with 2-meter class telescopes. Nevertheless, a connection has to be made with the spectra from SMASSI, SMASSII and different laboratories around the world. These spectra are available for instance in http://spectre.imcce.fr/m4ast/index.php/index/database, spectra database from IMCEE.

5. References

[1] Bus, S.J., Binzel, R.P. (2002a) Icarus, 158, 106

[2] Bus, S.J., Binzel, R.P. (2002b) Icarus, 158, 146

[3] DeMeo, F. E., Binzel, R.P., Silvan, S.M., Bus, S.J., (2009) Icarus, 202, 160

[4] DeMeo, F.E., et al. Asteroids IV (2015)

[5] Kikwaya Eluo, J.B. Springer (2018)

[6] Popescu, M., Birlan, M, and Nedelcu, D.A. (2012) A&A, 544, A130

[7] Zellner, B. Tholen, D, J, & Tedesco, E.F. (1985), Icarus, 61, 355.