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Physical characterization of fast rotator NEOs

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Abstract

NEOs cannot only be studied dynamically to address their impact hazard, but also physically to undestand various properties important to constrain models of their potential hazard, and also to know what they can tell us about the origin of the solar system and its ongoing processes. But this can only efficiently be done if NEOs are observed with different instruments to cover as much as possible a large portion of the electromagnetic spectrum. Therefore setting up a network of telescopes to observe simultaneously Near-Earth Objects with different instruments in different bands will provide complemetary properties that will help to understand them.

1. Introduction

Our project is to take advantage of the two-meter-class telescopes around Tucson, in Arizona in USA to observe fast rotator NEOs (H $>$ 22) synoptically at three different locations: VATT (Vatican Advanced Technology Telescope) at Mount Graham (longitude: -109.8719, latitude: 32.7016, elevation: 10469 feet), Bok 2.3 m at Kitt Peak (longitude: -111.6004, latitude: 31.9629, elevation: 6795 feet) and Kuiper 1.5-m at Mount Bigelow (longitude: -110.7345, latitude: 32.4165, elevation: 8235 feet). All three telescopes will aim simultaneously at the same object, each with a different instrument. Since 2013, The VATT-4K, optical imager mounted on the VATT, is used for photometry. In the future we plan to utilize the BCSpec (Boller & Chivens Spectrograph) for visible spectroscopy on Bok 2.3 meter and a near-infrared instrument on Kuiper 1.5 meter.

2 Instrument and data

VATT (Vatican Advanced Technology Telescope) is a telescope operated by the Vatican Observatory. It has 1.8-m f/1.0 primary mirror, and 0.38-m f/0.9 Zerodur concave secondary mirror. VATT4k, an imager, is mounted on the VATT for photometry and astrometry. It has a field of view of 12.5 arcmin square with a scale of 0.375"/pixel. The resolution of images acquired with this instrument have a resolution of 2016x2016 pixels, covering 300 to 1000 nm with a quantum efficiency of 96% at 450 nm. Broadband BVRI filters are used for color estimation of NEOs. Data gathered are from April 2013 to March 2015.

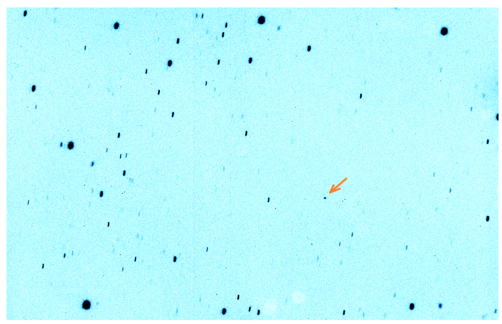

Figure 1: NEO 2011PT.

3 Reduction and Analysis

Iraf commands like ccdphot, digiphot, apphot are used to perform photometry reduction. Radii of the sky annulus are fixed. Imexam is used to estimate the object radius for each frame and twice the value is inserted as the object aperture. 3 BVRI photometric standard stars are used each night [1] at different magnitude and different airmass. For each standard star, total magnitude is given by catalog magnitude - Instrumental magnitude. Linear fit of total magnitude versus airmass gives zero point (intercept) and slope (extinction coefficient). Object magnitude on one frame is given by (zero point magnitude + Instrumental magnitude) - object air mass* extinction coeeficient. Asteroid Lightcurve Analysis program by Petr Pravec is used to estimate the rotation of the object [2] and also the color indexes B-V, V-R and I-R. Some NEOs with their different spinning rates are shown below.

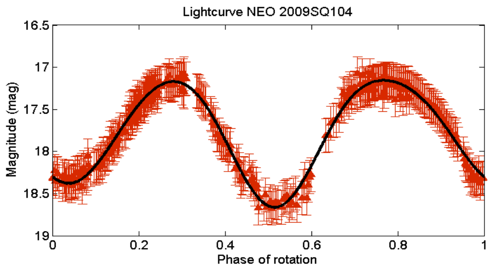

Figure 2: 2009 SQ104 (6.85 ± 0.03 h).

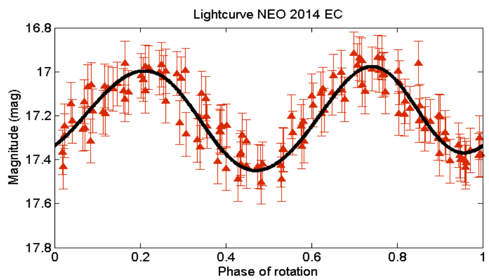

Figure 3: 2014 EC (0.54 ± 0.04 h).

4 Results and Conclusions

2009 SQ 4109, 2014 EC, 2014 FA44, 2014 KS40, 2014 SB145, 2014 AY28, 2011 PT, 2014 SC324, and 2014 WF201 showed clear spinning rate, but 2014 HM2 did not show any conclusive spinning rate. Using Figure 5 of F. Yoshida et al (2004) [3], seven objects are associated to different NEO groups. 2014 HM2, 2014 FA, 2014 SB145, 2011 PT fall among X-type asteroids; 2014 KS40, 2014 WF201 are likely to be C-type; and 2014 SC 324 is a D-type.

References

[1] LANDOLT, 1992, AJ, 104, 340

[2] Petr PRAVEC, Asteroid Lightcurve Analysis Program (Version 0.94.3)

[3] F. YOSHIDA, 2004, PASJ, 56, 1105

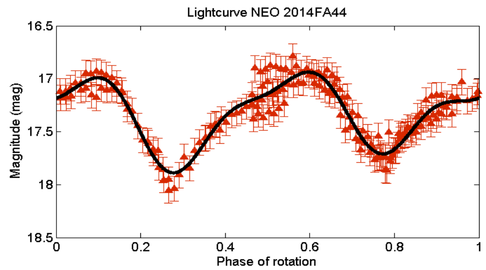

Figure 4: 2014 FA44 (3.45 ± 0.05 h).

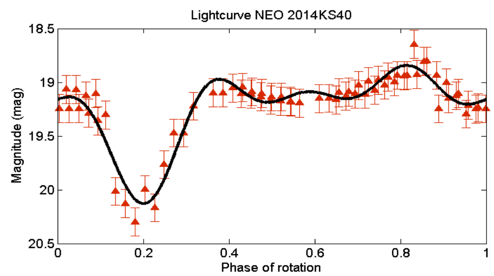

Figure 5: 2014 KS40 (1.11 ± 0.06 h).

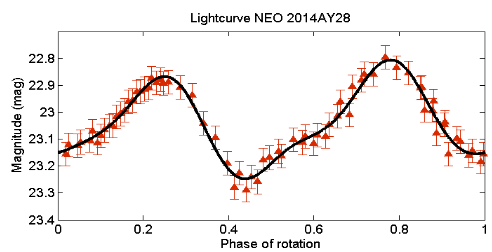

Figure 6: 2014 AY28 (0.91 ± 0.02 h).