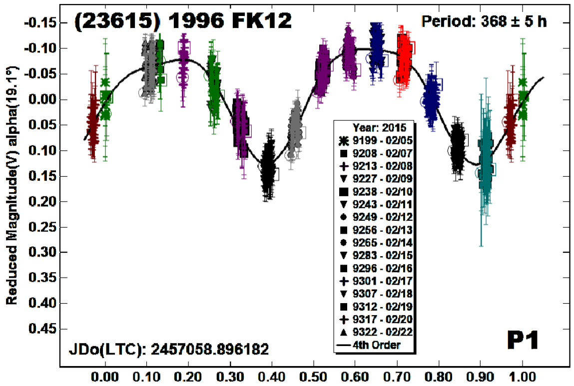

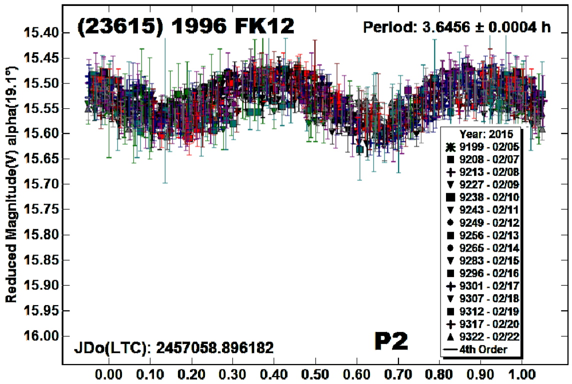

In the case of 1996 FK12, two of the sessions required zero point adjustments on the order of 0.1 mag to get a smooth fitting lightcurve. Given that the amplitude of the long period is only 0.20 mag, this is a significant adjustment. However, the remaining sessions required zero point changes of < 0.05 mag to obtain the best-fit solution shown in "P1". These were similar, if not more extreme, to the adjustments required when fitting the data in many of the previous results shown in Table II. Since observing *mutual events* is virtually unlikely, the best way to establish the validity of the results given in Table II will be to observe the asteroid at subsequent apparitions and, if possible, use data calibrated to at least an internal, if not standard, system with an accuracy and precision of 0.02 mag or better.

Acknowledgements

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LOW RESOLUTION VISIBLE REFLECTANCE SPECTRUM FOR NEA (357439) 2004 BL86

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Low resolution spectroscopic observations of the near-Earth asteroid (357439) 2004 BL86 were acquired during the flyby of 2015 January 26. The spectrum analysis shows that its taxonomic class is very close to that of 4 Vesta in the visible wavelength.

The near-Earth asteroid (357439) 2004 BL86 was observed in the visible spectrum during the flyby of 2015 January 26 at Balzaretto Observatory (A81) in Rome, Italy, using a 0.20-m Schmidt-Cassegrain (SCT) reduced to *f*/5.5 and an SBIG ST7-XME CCD camera equipped with a diffraction grating SA-200 (Paton Hawksley Education) mounted inside the filter wheel. With this simple slit-less configuration, it's possible to acquire low resolution spectra in the visible wavelength region of the relatively faint objects (up to 12-13 mag) with a spectral resolution R~100.

Due to the fast movement of the asteroid in the sky (147 arcsec/min), a sequence of 62 images, each with a 5 second exposure time, was acquired. The images were stacked with sigma-clip to increase the final signal-to-noise ratio and remove the weak spectra of faint field stars (Figure 1).

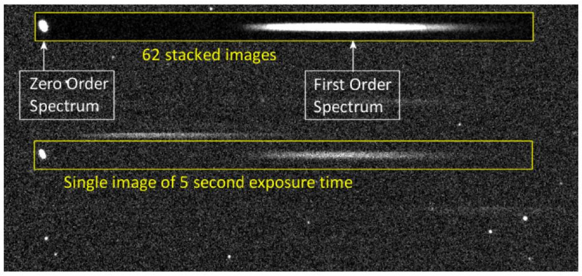

Figure 1. A single image of 5 second exposure compared with the stacked images, from which we can see the zero order and the first order spectra.

During the observations, the asteroid had a magnitude of V~9.7. For calibrating purposes, reference spectra of Sirius (A1V type) and HD 76151 (G2V type; solar analog) were acquired. Six images (0.1 sec) were taken of Sirius and three images (30 sec) of HD 76151. The spectrum of the G2V calibration star was acquired at about the same airmass of the asteroid. All CCD images were calibrated with dark and flat-field frames. Spectra reduction was done using *RSpec* (Field, 2013).

Linear wavelength calibration was performed using the A1V type star (Sirius), taking as reference two points: the zero order image (0 Å) and the H-beta Hydrogen Balmer absorption line (4861 Å), from which a dispersion of 17.0 Å/pixel was found. For low resolution work, the non-linearity effects in the wavelength calibration are negligible. In fact, in this case, the deviation from linearity was below the dispersion value. The wavelength calibration of the other spectra (HD 76151) was done using the zero order image as reference and the previously determined dispersion factor.

The reflectance spectrum of 2004 BL96 was obtained by dividing its calibrated spectrum in wavelength with the one for HD 76151 and then normalized to unity at the standard wavelength of 0.55 µm (center of the photometric V band). The acquired spectrum was in the spectral range from 0.4 µm to 0.85 µm. Errors are estimated to be lower than 0.05 in the range 0.45-0.70 µm, but significantly greater in the outer regions.

For taxonomy determination, the reflectance spectrum of 2004 BL86 was fitted with a 4th order polynomial and then compared with the typical relative reflectance spectra of single-letter taxonomy classes in the SMASS II catalog (Bus and Binzel, 2002) by computing the standard deviation of differences at the discrete wavelengths of 0.44, 0.50, 0.60, 0.65, 0.70, 0.75, 0.80, 0.85 µm. Lower standard deviation values were found for the taxonomy classes O, Q, T, V, and, in particular, for 4 Vesta (Figures 2, 3).

Data analysis shows that the taxonomy class of NEA (357439) 2004 BL86 is very close to that of 4 Vesta in the visible wavelength as judged by the lowest standard deviation as well as the tight-fitting overlap of the reflectance spectrum shown in Figure 4. This result is consistent with results reported on the JPL web site (2015).

This work shows the potential of low resolution spectroscopic observations made with small telescopes applied to the preliminary taxonomic classification of NEA during their close approaches to the Earth.

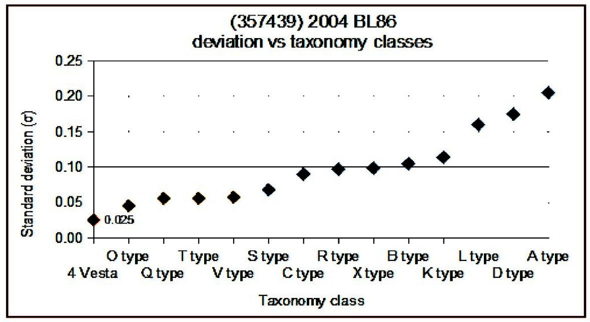

Figure 2. The standard deviation of 2004 BL86 with respect to the single-letter Bus taxonomy classes.

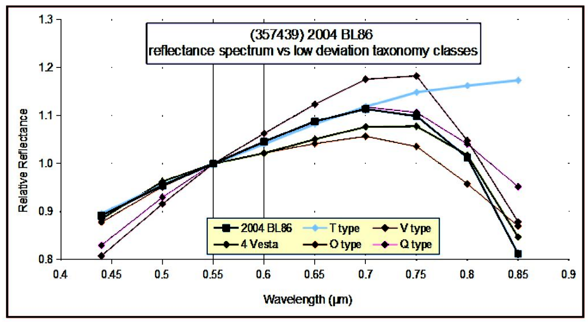

Figure 3. The reflectance spectrum of 2004 BL86 compared with the taxonomic classes with lower standard deviation.

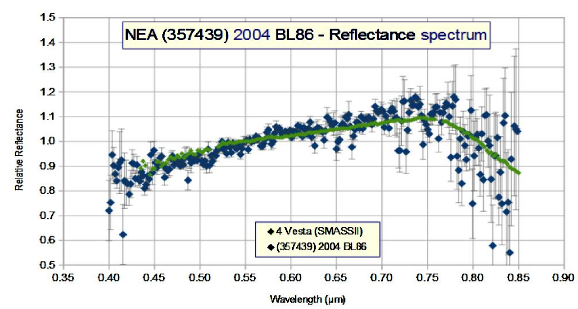

Figure 4. The reflectance spectrum of 2004 BL86 overlapped with that of 4 Vesta (SMASS II).

Acknowledgments

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