LIGHTCURVE ANALYSIS OF NEA (190166) 2005 UP156: A NEW FULLY-SYNCHRONOUS BINARY

Brian D. Warner
Center for Solar System Studies–Palmer Divide Station
446 Sycamore Ave.
Eaton, CO 80615 USA
brian@MinorPlanetObserver.com

Alan W. Harris
MoreData!
La Cañada, CA USA

Amadeo Aznar Macías
APT Observatory Group
EURONEAR
SPAIN

Julian Oey
Blue Mountains Observatory (MPC Q68)
Leura, NSW, AUSTRALIA

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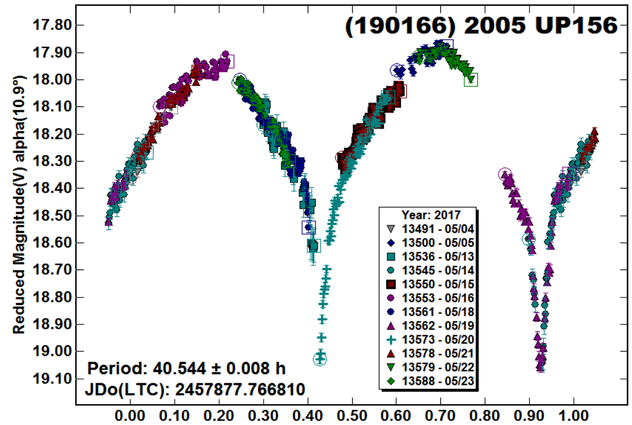
CCD photometric observations of the near-Earth asteroid (190166) 2005 UP156 in 2017 May show it to be a fully-synchronous binary with rotation and orbital period P = 40.542 ± 0.008 h. The estimated effective diameter ratio of the two bodies is 0.8 ± 0.1. However, the 0.5 mag out-of-eclipse lightcurve indicates quite elongated shapes and so the size ratio should be viewed with caution.

The near-Earth asteroid (190166) 2005 UP156 was observed by Warner in 2014 (Warner, 2015) who found a period of 40.5 h and amplitude of 0.79 mag. Based on a relatively sparse data set, there were no indications of the asteroid being other than a single, highly-elongated body. Those observations were made at about 43° solar phase angle and phase angle bisector longitude of 5° (see Harris et al., 1984).

Warner began observing the asteroid during the 2017 apparition on May 4. By May 19, there was clear evidence that the asteroid was a fully-synchronous binary, i.e., two bodies in close proximity with the rotation period of each body the same as the orbital period. After the observations on May 23, the lightcurve was sufficiently covered to determine the period and approximate size ratio of the bodies. At that time Warner and Harris (2017) submitted a CBET that was published shortly afterwards.

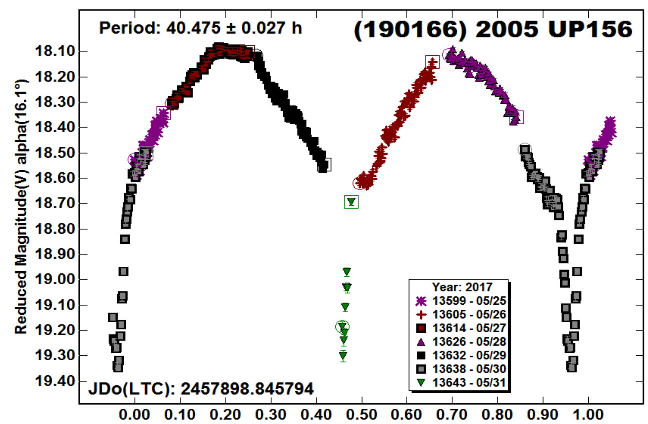
They reported an orbital/rotation period of 40.542 ± 0.008 h and total lightcurve amplitude of 1.1 mag. the out-of-eclipse lightcurve showed an amplitude of 0.5 mag with the eclipse events being about 0.6 mag. Using the latter value gives an effective diameter ratio of the two bodies of 0.8 ± 0.1. This should be considered only a first approximation since the large amplitude of the out-of-eclipse lightcurve indicates that the individual bodies are quite elongated.

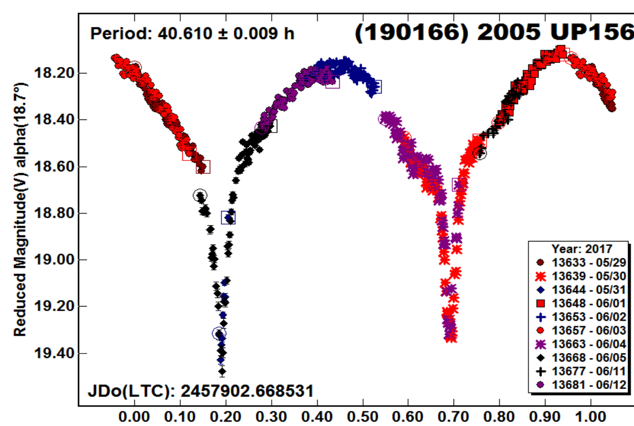


Soon after the discovery announcement, Aznar and Oey provided data to Warner to try to improve lightcurve and event coverage as well as the orbital/rotational period. Table II shows the instrumentation used during the campaign.

OBS	Telescope	Camera
Warner	0.30-m f/9.6 SCT	FLI ML-1001E
Aznar	0.35-m f/10 SCT	SBIG STL-1001E
Oey	0.35-m f/11 SCT	Apogee U6M

Table II. List of observers and equipment.





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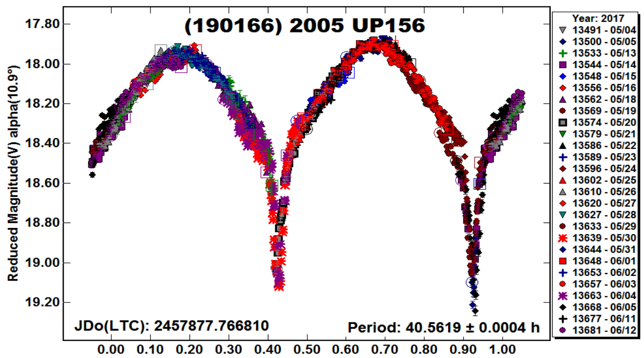
Additional observations by all observers provided the opportunity to follow changes in the lightcurve. For example, in the few days after the initial lightcurve, the "shoulders," sharp changes in the lightcurve slope, became more apparent. These gave further evidence of the binary nature of the asteroid. Note that the depths of the two events were almost identical.

A third lightcurve, including data from May 29 to June 12 also shows shoulders, more so at the second event around 0.7 rotation phase. More so, the depth of the two events was no longer symmetrical. The full effect of the lightcurve changes is seen when trying to find a single period using the entire data set.



Going Deeper into the Analysis

The 40.6 hour orbit period implies that the two components, if equal spheres of density ~2.5 gm/cm^3, would have an orbit radius about 9 times the radius of the two bodies. Since the non-eclipse amplitude of the lightcurve implies nearly 2:1 elongation of the bodies, the separation may be more like 6 times the long semi-axis, but the short semi-axis profiles would be closer to 1/12 of the separation (or full-width ratio about 1/6). This geometrical proportion is approximately confirmed by the width of the eclipse events, which are only about 0.05 rotation phase wide. A consequence of the narrowness of the events is that events will only be seen within about ten degrees of equatorial aspect, thus not seeing eclipse events at other apparitions is not surprising.

Acknowledgements

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LIGHTCURVE ANALYSIS OF THE NEAR-EARTH ASTEROID 6063 JASON

Brian D. Warner
Center for Solar System Studies–Palmer Divide Station
446 Sycamore Ave.
Eaton, CO 80615 USA
brian@MinorPlanetObserver.com

Amadeo Aznar Macías
APT Observatory Group
EURONEAR
SPAIN

Vladimir Benishek
Sopot Astronomical Observatory (K90)
Sopot, SERBIA

Julian Oey
Blue Mountains Observatory (MPC Q68)
Leura, NSW, AUSTRALIA

Roger Groom
Darling Range Observatory
Perth, WA, AUSTRALIA

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CCD photometric observations of the near-Earth asteroid 6063 Jason were made in 2017 June. A collaboration of five observers at widely-separated longitudes proved critical in finding a synodic period of 48.6 h, nearly commensurate with an Earth day, and confirming that the asteroid is most likely tumbling.

Previous data for near-Earth asteroid 6063 Jason indicated it may be a low amplitude non-principal axis rotation ("tumbler"; Petr Pravec, private communications, 2013). Using data from Warner (2014), Pravec found a strong signal for a period at about 51.3 h. He also found a secondary period of 238 h, but it was not possible to find a definitive answer.

Renewed CCD photometric observations of the asteroid were made by the authors in 2017 June. Table I gives the equipment used. The hope was to confirm and improve the earlier results.

OBS	Telescope	Camera
Warner	0.30-m *f*/9.6 SCT	FLI ML-1001E
Aznar	0.35-m f/10 SCT	SBIG STL-1001E
Benishek	0.35-m f/10 SCT	SBIG ST-8XME
Oey	0.35-m f/11 SCT	Apogee U6M
Groom	0.30-m f/7.2 SCT	SBIG ST-8XME

Table I. List of observers and equipment.

All observers used *MPO Canopus* to measure images, taking advantage of the Comp Star Selector utility to find near solar-color stars for ensemble differential photometry. The V magnitudes of stars from the APASS catalog (Henden *et al.*, 2009) were used for the reductions.

The initial observations by Warner (Jun 13-18) indicated the possibility of a longer period, just as was seen in the 2013 apparition. In that earlier work, it was obvious that data from a single station alone could not find an answer and so the collaboration of the five authors was formed.