Lagerkvist, C.-I. (1978). "Photographic photometry of 110 main-belt asteroids." Astron. Astrophys. Suppl. Ser. 31, 361-381.

Shevchenko V.G., and Lupishko D.F. (1998). "Optical properties of Asteroids from Photometric Data", *Solar System Research* **32**, 220-232.

VizieR (2013). *http://vizier.u-strasbg.fr/viz-bin/VizieR*

Warner, B.D. (2013). MPO Software, Canopus version 10.4.1.9. Bdw Publishing, *http://minorplanetobserver.com/*

Warner, B.D., Harris, A.W., and Pravec, P. (2013). "Asteroid Lightcurve Data Files, Revised 2013 March 1." *http://www.minorplanet.info/lightcurvedatabase.html*

LIGHTCURVE ANALYSIS OF MAIN-BELT BINARY SYSTEM 3905 DOPPLER

Melissa N. Hayes-Gehrke, Michael Maroulis, Alec Bartek,
Eric Garcia, Robert Greenebaum, Terence Basile,
Seong Min Lee, Brady Bent, Nick Oliver, Kenneth Koester
Department of Astronomy, University of Maryland
College Park, Maryland 20742
mhayesge@umd.edu

Lorenzo Franco
Balzaretto Observatory, Rome, Italy

(Received: 13 December)

Photometric observations of the main-belt asteroid 3905 Doppler over eight nights in 2013 revealed for the first time that it is a synchronous binary system. A synodic period of 50.8 ± 0.1 hours was derived from the data.

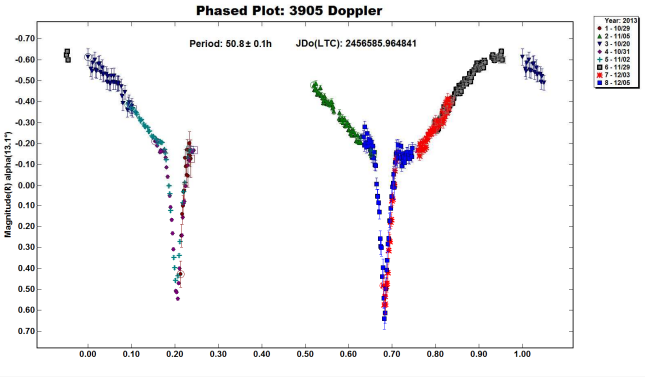
The main-belt asteroid 3905 Doppler was discovered on 1984 August 28 by Czech astronomer Antonin Mrkos. It was named after Austrian physicist Christian Andreas Doppler, who proposed that the measured frequency of a wave depends on the relative motion between the observer and source of emission. There are no prior period determinations for Doppler in the Asteroid Lightcurve Database (LCDB; Warner *et al.*, 2009; Warner, 2013). Doppler's orbit has an eccentricity of 0.258 and time-averaged mean orbital radius of 2.644 AU. It has an orbital period of 4.09 years, perihelion distance of 1.9 AU, and an inclination of 14.2° with respect to the ecliptic (JPL).

The asteroid was selected for observation due to consistently low zenith distances and no previously published period. In addition, it reached opposition on 2013 November 1, which was about the middle of the college semester in which the project took place.

The observations were made over the Internet using a robotic telescope in Spain (*iTelescope.net*; 2° 19' west, 39° 09' north; elevation 1650 m). The asteroid was observed using a 0.43-m PlaneWave CDK telescope and CCD camera with a Kodak Enhanced KAI-11000M chip (4008x2745, 9x9 micron pixels). All images were taken using a Baader UV/IR Luminance filter, which has a cutoff frequency of 420 nm at the lower limit and 680 nm at the upper limit. The camera was binned 1x1 with an exposure time of 300 seconds. Data were collected on four nights from 2013 October 20 through November 02, although a significant portion of the data collected on 2013 October 23 had to be discarded due to elongation as a result of guider error. The data collected on October 20 are noisier relative to other nights due to the moon's presence in the sky. Fourier analysis of calibrated images was carried out using *MPO Canopus* (Warner, 2013b).

We collaborated with Lorenzo Franco, who observed Doppler from Rome, Italy. He collected data over five nights from 2013 October 29 to December 05 using a 0.2-m Meade LX-200 Schmidt-Cassegrain telescope coupled to an SBIG ST7-XME CCD camera.

Preliminary analysis of the combined data set suggests that Doppler is a synchronous binary system with a period of 50.8 ± 0.1 hours. This is evidenced by the sharp attenuations in the lightcurve which are preceded and followed by less-steep attenuations on either side of maximum light.



Eight nights of observation of 3905 Doppler phased to an orbital period of 50.8 ± 0.1 hours.

Acknowledgments

Funding for observations was provided by the Astronomy Department at the University of Maryland. We would also like to thank *itelescope.net* for the use of their facilities and Dr. Petr Pravec for discussion of data.

References

iTelescope.net. *http://www.itelescope.net/*

JPL Small Body Database Search Engine. *http://ssd.jpl.nasa.gov/sbdb_query.cgi*

Warner, B.D., Harris, A.W., Pravec, P. (2009). "The asteroid lightcurve database." *Icarus* **202**, 134-149.

Warner, B.D. (2013a). MinorPlanet.info gateway, LCDB on-line query. *http://www.minorplanet.info/lightcurvedatabase.html*

Warner, B.D. (2013b). MPO Software, *MPO Canopus* version 10.4.3.12. Bdw Publishing. *http://minorplanetobserver.com/*