

LIGHTCURVE OF 423 DIOTIMA

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Lightcurve observations of 423 Diotima result in a period and amplitude estimate: 4.825 ± 0.150 hours and 0.19 ± 0.02 mag.

Lightcurve observations of asteroid 423 Diotima are reported from Hampshire, England. My observatory is located in my back garden approximately 10 miles north of the city of Portsmouth on the south coast of England. My telescope is a 25-cm Orion Optics (UK) Newtonian reflector, equipped with a Starlight Xpress MX516 CCD camera, on an equatorial mount. The telescope is operated by a laptop connected to a Skysensor hand controller. Once set up the telescope can be operated via a wireless network between a PC in my study and the laptop in the observatory.

423 Diotima was chosen as a target from the list of asteroids on the ALPO Photometry and Shape Modeling web page. Discovered on 7th December 1896 by A. Charlois at Nice. Its rotational properties suggest it belongs to the Large Amplitude Short Period Asteroid (LASPA) class. This asteroid was well placed for a lengthy observing session (high in the south east) and of a magnitude (12.1) that enabled a high signal-to-noise ratio. The short predicted period (4.8 hours) allowed that I should be able to observe a complete rotation in a single night weather permitting.

Observatory set up procedure is; switch on laptop, GPS receiver (for timing purposes) and CCD camera, polar and three point align telescope, load asteroid elements in to Megastar and plot predicted path of asteroid and locate target. Test images are then taken (using Astroart) and checked to ensure that the maximum pixel intensity is of the order of 50%. In this instance the exposure time was set at 30 secs but subsequently reduced to 20 secs. All images were obtained unfiltered.

Imaging commenced at 19:35 UT on 12th January and ended at 02:16 UT the following morning. Calibration frames (5 darks, 5 flatdarks and 5 flats) were then taken, all images saved to CD and the observatory closed down at 02:45 UT. Images were processed on 13th January using Canopus. This program has taken a little getting used to, but I now find it and excellent tool for creating light curves. Brain Warner's book 'A Practical Guide to Lightcurve Photometry and Analysis' has also proven helpful. From analysis of the 337 unfiltered images obtained the period was estimated to be 4.825 ± 0.150 hours and the amplitude 0.19 ± 0.02 mag. These agree reasonably well with those listed in the *Asteroid Lightcurve Data Files* referenced below. The lightcurve is shown in Figure 1. Lightcurve and data were sent to Richard Kowalski for inclusion in the ALPO Photometry and Shape Modeling Program.

Acknowledgments

My thanks to Richard Miles of the British Astronomical Association and to Petr Pravec of Ondrejov Observatory for their guidance with this particular aspect of astronomy.

Epilogue

For those of you reading this article and who have not yet tried their hand at photometry please give it a go. If I had believed those who said "If you aren't doing all-sky photometry to a precision of 0.001 mag it isn't worth the effort" I would never have got started. Differential photometry isn't hard but you do have to be quite methodical and, once you have devised a procedure that works, write it down and follow it faithfully.

More information, which I hope will be of use to those new to both photometry and NEO imaging, can be found on the Near Earth Object web site I run on behalf of the British Astronomical Association, referenced below.

References

ALPO Photometry and Shape Modeling Program.
<http://www.bitnik.com/mp/alpo/>

British Astronomical Association website,
<http://www.britastro.org/main/index.html>

BAA Near Earth Object website,
<http://homepage.ntlworld.com/roger.dymock/index.htm>

Canopus website,
<http://www.minorplanetobserver.com/htms/mpocanopus.htm>

Di Martino, M., Cacciatori, S. (1984). "Rotation periods and light curves of the large asteroid 409 Aspasia and 423 Diotima." *Astronomy and Astrophysics* **130**, 206-207.

Harris, A. *Asteroid Lightcurve Data Files revised 23 September 2003*.

Ondrejov Observatory. <http://sunk1.asu.cas.cz/~ppravec/neo.html>

Schrober, H.J. (1983). "The large C-type asteroid 423 Diotima: rotation period. Lightcurve and implications for a possible satellite." *Astronomy and Astrophysics* **127**, 301-303.

Warner, B. D. (2003). *A Practical Guide to Lightcurve Photometry and Analysis*. Bdw Publishing, Colorado Springs.

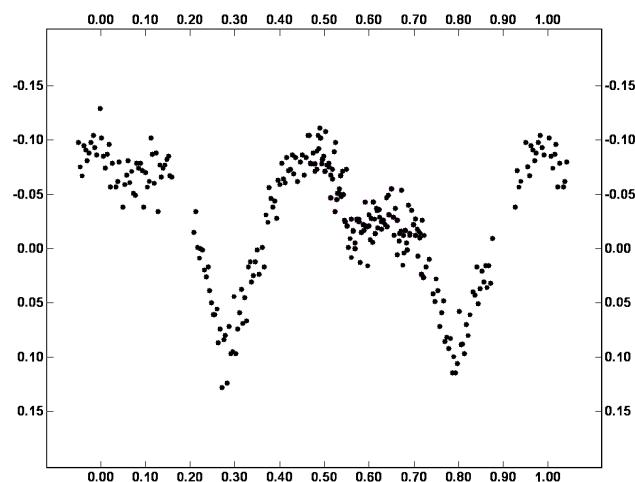


Figure 1: Lightcurve of 423 Diotima. The 0% Phase is equal to JD 2453383.426184 (corrected for light time).

THE SPACEWATCH VOLUNTEER SEARCH FOR FAST MOVING OBJECTS

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We describe a program in which we welcome amateur astronomers and the general public to participate in the search for fast moving near-Earth objects.

A condition of a grant from the Paul G. Allen Charitable Foundation was to make it possible for the general public to participate in the search for Near-Earth Objects (NEOs). Our solution to that challenge was to allow internet access to imagery from the 0.9m Spacewatch Telescope during the night they are taken. This allows anyone to discover closely approaching asteroids that leave trails during the time of the image exposure.

Most asteroids appear as point sources or only slightly trailed images and are spotted by software. However, trails more than a few pixels in length are more difficult for our software to recognize as single moving objects rather than edge-on galaxies or trails of cosmic ray secondary particles. Furthermore, our mosaic of CCDs produces images of too much sky area for one observer to examine for trails while also tending to other chores during the night. Nevertheless, such candidate objects are moving so fast that if found, they should be followed up on the same night.

Spacewatch imagery is well suited to spotting Fast-Moving Objects (FMOs) because the exposures are relatively long (2 minutes) and have a resolution of one arcsecond per pixel. Image pixel data are transmitted from Kitt Peak to the FMO website in Tucson in near realtime on every clear night that the mosaic of CCDs is operational. Applications Systems Analyst Miwa Block developed and maintains the web site for the volunteer program. Volunteers self-train on real FMO images as well as other features that can be confused with FMOs. Only fresh, previously unreviewed images are presented. Bandwidth limitations require the images on the web to be in jpeg format, so the observer on the mountain can see the candidate more clearly on the original display. Most of the candidates submitted are cosmic rays. If the candidate is real and seems to be recoverable, the observer provides the reviewer with Spacewatch's provisional designation. Using this, the volunteer can watch for the object to appear on the Minor Planet Center's NEO Confirmation Page. Some amateurs have made efforts to recover their own objects.

The average number of images that a volunteer inspects between discoveries is 940, amounting to about 180 square degrees of sky. However, the number of images reviewed to discover an FMO is a matter of luck. One reviewer found an FMO after reviewing only 25 images, while others have reviewed more than 5000 images before discovering one. As of 2005 March 30, 318 people had reviewed images. On an average clear night of observing, 35-40 reviewers are examining images. Currently, 25 volunteers have credit for detections or discoveries.

Recoverable FMOs seen by reviewers are illustrated at http://fmo.lpl.arizona.edu/FMO_home/news.cfm. The yield of this program to 2005 March 30 is 20 discoveries of fast-moving NEOs, 7 recoveries, 5 detections of artificial earth satellites, and 7 unconsolidated discoveries. Angular rates at the time of discovery range from 2.6 deg/day (2004 MV2) to 11.9 deg/day (2004 MO1). Absolute magnitudes H range from 29.3 (2004 YD5) to 23.2 (2004 MO1). 2004 YD5 passed Earth within 0.00023 AU, well inside the geosynchronous radius, on Dec. 19.86 UT. According to the "Close Approaches To The Earth by Minor Planets" page, this was the second closest approach by an FMO as of 2005 March 30, and is *the* closest approach with more than a 24 hour arc of observations. Six objects discovered by Spacewatch FMO reviewers have observations spanning only one day; the longest observed arc is 30 days for 2004 BV18.

While such small objects do not present a significant impact hazard, their numbers, spin rates and surface properties are of scientific interest. The smaller the asteroid, the more likely it is a single solid piece and not a loose aggregate of pieces. The spin rates of such objects revealed by their lightcurves can show whether they are solid. Closely approaching asteroids can also be studied closely by radar, which can reveal information about their sizes, shapes, spin rates, and dielectric constants. The smallest asteroids are also unlikely to have regoliths, the blanket of loose dust or dirt that obscures the bare rock surfaces of larger asteroids. Thus spectroscopic studies of the smallest asteroids, though difficult to do, can access the bulk material of the asteroids more directly. We hope that physical studies of a Spacewatch FMO will be made sometime soon. Finally, the orbits of the smallest asteroids are most affected by nongravitational effects on very long time scales, such as the thermal-radiation-driven Yarkovsky effect on rotating asteroids.

Those who discover new FMOs receive international recognition in the official discovery announcements. Some volunteers are students, some have full-time jobs, and some are retired. At least one reviewer is the operator of a large professional telescope who has free time during long integrations on targets. There are well-established amateur astronomers as well as those who have just begun to climb the learning curve. FMO discovery credits are held by people in five continents and over a dozen countries. We hope that this program helps fuel curiosity and participation in science in general, as well as provide a productive outlet for those eager to apply their skills. The web site for the volunteer program is http://fmo.lpl.arizona.edu/FMO_home/index.cfm.

Good hunting!

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