# (35107) 1991 VH: AN APOLLO BINARY ASTEROID

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Lightcurves of (35107) 1991 VH, a known binary, revealed a primary orbital period $P_{prim}$ = 2.6239 ± 0.0001 h with amplitude 0.15 ± 0.03 mag and an orbital period $P_{orb}$ = 32.26 ± 0.01 h with primary and secondary minima of 0.16 ± 0.03 and 0.14 ± 0.03 mag. There were indications of a third period, possibly due to rotation of the secondary, but this was not confirmed.

During the 1997 apparition of the near-Earth Apollo-type binary asteroid (35107) 1991 VH, two intertwined lightcurves were reported (Pravec et al., 1998). Fourier analysis revealed a short-period lightcurve of period $P_{prim}$ = 2.62385 ± 0.000072 h with amplitude $A_{prim}$ = 0.09 mag and a long period $P_{orb}$ = 32.688 ± 0.024 h with a primary and secondary minima of $A_p$ = 0.19 ± 0.01 and $A_s$ = 0.16 ± 0.01 mag. The interpretation of these data assumed a model consisting of two gravitationally bound bodies with a non-synchronous primary rotating at period $P_{prim}$ and a secondary orbiting with the period $P_{orb}$. Occultations produced the long period lightcurve.

During the 2003 apparition the asteroid was found to have the same basic short and long period lightcurves with $P_{prim}$ = 2.6236 ± 0.0001 h, $A_{prim}$ = 0.08 mag, $P_{orb}$ = 32.63 ± 0.05 h, and minima depths $A_p$ = 0.17 ± 0.01 and $A_s$ = 0.14 ± 0.01 mag (Pravec et al., 2006). However, a third period of $P_{sec}$ = 12.836 ± 0.003 h and amplitude $A_{sec}$ = 0.06 mag was also seen. A recheck of the 1997 data showed no such component. The suggested explanation for this period was a non-synchronous rotation of the secondary.

During the 2008 apparition photometric data were collected on 35107 at Stonegate Observatory using a 36-cm Celestron C-14, SBIG ST-10XME CCD camera, and clear filter. The camera was binned 2x2 with an image scale of 1.3 arc-seconds per pixel. Image exposures were 120 seconds at –15C. All photometric data were obtained and analyzed using *MPO Canopus* (Warner, 2008).

Observations were made on 8 nights from 2008 July 2 through July 31, resulting in 770 data points. Analysis of the data using the *MPO Canopus* "Dual Period Search" indicated a primary orbital period $P_{prim}$ = 2.6239 ± 0.0001 h with amplitude $A_{prim}$ = 0.15 ± 0.03 mag. The period agrees well with previous results but the amplitude was 0.06 mag higher. The secondary orbital period $P_{orb}$ = 32.26 ± 0.01 h is 0.4 h shorter period than previously reported. The orbital amplitude $A_p$ = 0.16 ± 0.03 and $A_s$ = 0.14 ± 0.03 mag are within the error bars of the references. The residual period spectrum showed a low confidence periodicity at 14.30 ± 0.01 h but this is likely noise and does not correlate with the previous 2003 apparition secondary period, $P_{sec}$ = 12.836 h.

Acknowledgments

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References

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Pravec, P., Scheirich, P., Kušnirák, P., Šarounová, and 53 colleagues (2006). "Photometric Survey of Binary Near-Earth Asteroids." *Icarus* **181**, 63-93.

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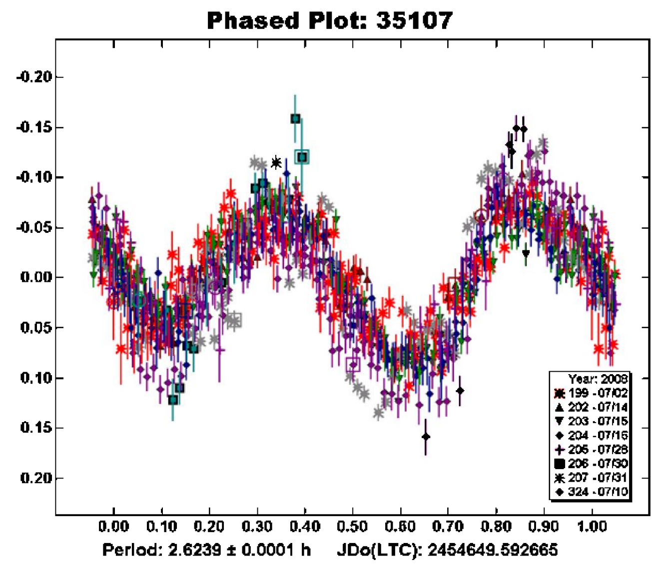


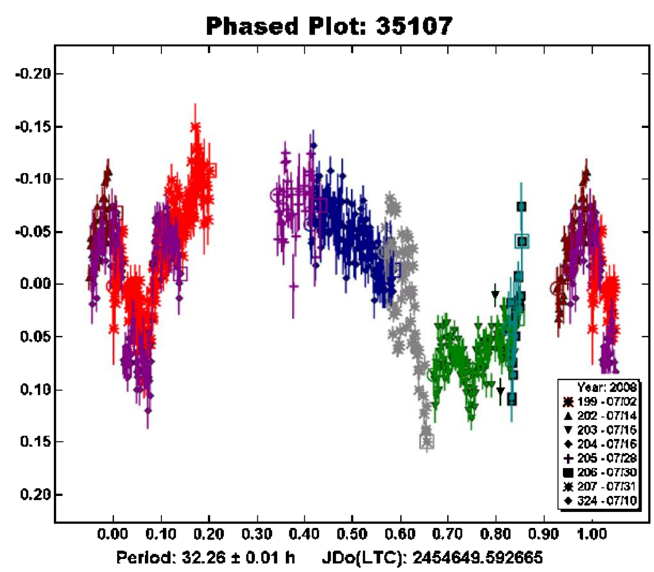

# LIGHTCURVE PHOTOMETRY OPPORTUNITIES: 2010 JANUARY – MARCH

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With a New Year come new things. For this regular article it means an "In Focus" section at the top that highlights particular topics or calls extra attention to listed targets so that they don't get overlooked. We have trimmed the material in the standard text, keeping the essential elements and Internet web sites. For more background on the program details for each list, refer to previous issues, e.g., *Minor Planet Bulletin* **36**, 188.

## In Focus

In the radar support list, we make particular mention of needed data to help with pole and shape modeling. Surprisingly, very few pole directions for near-Earth asteroids (NEAs) have been published – only 30 or so. There are hints that pole directions have preferred orientations, which can be evidence for drift due to the Yarkovsky effect (e.g., see Warner et al., *Icarus* **204**, 172-182). However, the lack of data prevents any definitive conclusions. Almost every lightcurve (those of sufficient quality) can help build the statistical pool for pole modeling. For many years, the lack of data prevented proper rotational rate studies. Now that we have rotational data on almost 3000 asteroids, the focus moves beyond (but not completely away from) rotation rates and onto pole orientations and, with even more data, shape modeling.

It is easy to bypass asteroids that have been well-observed over many apparitions. However, for NEAs and small asteroids in the inner main belt, "more data!" could be very important. As has been shown, some asteroids do not have a constant rotation rate (1862 Apollo, Kaasalainen et al., 2007. *Nature* **446**, 420-422; 54509 YORP, Taylor et al., 2007. *Science* **316**, 274-276). It's believed that the YORP effect, the thermal re-radiation from an asteroid, causes the rotation rate for some asteroids to change gradually, either slower or faster. This was determined by comparing precise data on at least three well-separated apparitions over many years. If an NEA or small, inner main belt asteroid becomes available, don't ignore it just because it's been well-worked. Your data could provide yet more evidence for the sunlight-induced spin up or down of asteroids. A potential target along these lines is 1627 Ivar, which will be available in February 2010 at V = 15.9, Dec +15°.

Note that 4486 Mithra in the radar targets list is a high priority. The radar observations have already been made, so the goal here is to obtain additional data to support those observations. Do try to coordinate efforts, either by working directly with Lance Benner or by messaging on the Minor Planet Mailing List: http://tech.groups.yahoo.com/group/mpml. The object has a long period and so collaboration among observers at different longitudes will be critical.

## The Opportunities Lists

We present four lists of "targets of opportunity" for the period 2010 January-March. In the first three sets of tables, Dec is the declination, U is the quality code of the lightcurve, and $\alpha$ is the solar phase angle. See the asteroid lightcurve data base (LCDB) documentation for an explanation of the U code:

*www.minorplanetobserver.com/astlc/LightcurveParameters.htm*

Note that the lightcurve amplitude in the tables could be more, or less, than what's given. Use the listing only as a guide.

Objects with no U rating or *U* = 1 should be given higher priority when possible. ***We strongly urge that you do not overlook asteroids with U = 2 on the assumption that the period is sufficiently established.*** Regardless, do not let the existing period influence your analysis since even high quality ratings have been proven wrong at times.

The first list is those asteroids reaching <15m at brightest during the period and have either no or poorly constrained lightcurve parameters. The goal for these asteroids is to find a well-determined rotation rate.

The Low Phase Angle list includes asteroids that reach very low phase angles. Getting accurate, calibrated measurements (usually V band) at or very near the day of opposition can provide important information for those studying the "opposition effect."

The third list is of those asteroids needing only a small number of lightcurves to allow shape and spin axis modeling. Those doing work for modeling should contact Josef Durech at the email address above and visit the Database of Asteroid Models from Inversion Techniques (DAMIT) web site for existing data and models: *http://astro.troja.mff.cuni.cz/projects/asteroids3D.*

The fourth list gives a brief ephemeris for planned radar targets. Supporting optical observations made to determine the lightcurve period, amplitude, and shape are needed to supplement the radar data. High-precision work, 0.01-0.03 mag, is preferred. Those obtaining lightcurves in support of radar observations should contact Dr. Benner directly at the email given above.

Future radar targets:
*http://echo.jpl.nasa.gov/~lance/future.radar.nea.periods.html*
Past radar targets:
*http://echo.jpl.nasa.gov/~lance/radar.nea.periods.html*
Arecibo targets:
*http://www.naic.edu/~pradar/sched.shtml*
Goldstone targets:
*http://echo.jpl.nasa.gov/asteroids/goldstone_asteroid_schedule.html*

Once you have analyzed your data, it's important that you publish your results. Papers appearing in the *Minor Planet Bulletin* are