# COLLABORATIVE ASTEROID PHOTOMETRY FROM UAI: 2021 JANUARY-MARCH

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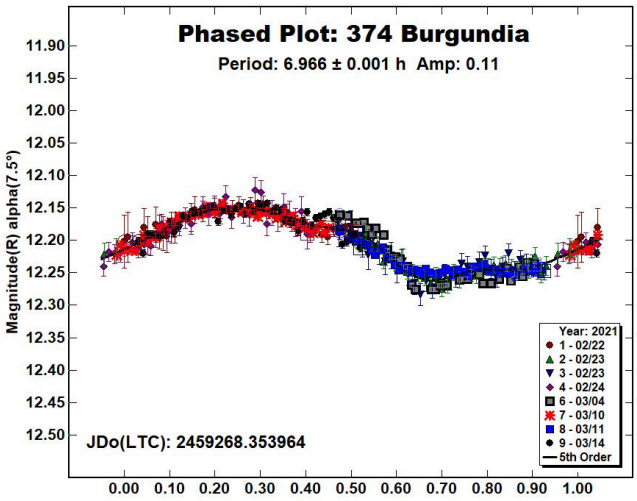
Photometric observations of six asteroids were made in order to acquire lightcurves for shape/spin axis modeling. The synodic period and lightcurve amplitude were found for 374 Burgundia, 472 Roma, 593 Titania, 1106 Cydonia, 1152 Pawona, and 3332 Raksha. We also found color index (V-R) for 472 Roma and 1152 Pawona along with H-G parameters for: 472 Roma and 3332 Raksha.

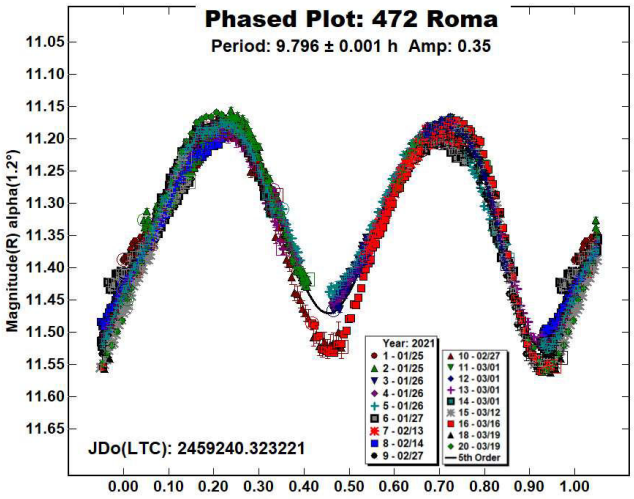
Collaborative asteroid photometry was done inside the Italian Amateur Astronomers Union (UAI; 2021) group. The targets were selected mainly in order to acquire lightcurves for shape/spin axis modeling. Table I shows the observing circumstances and results.

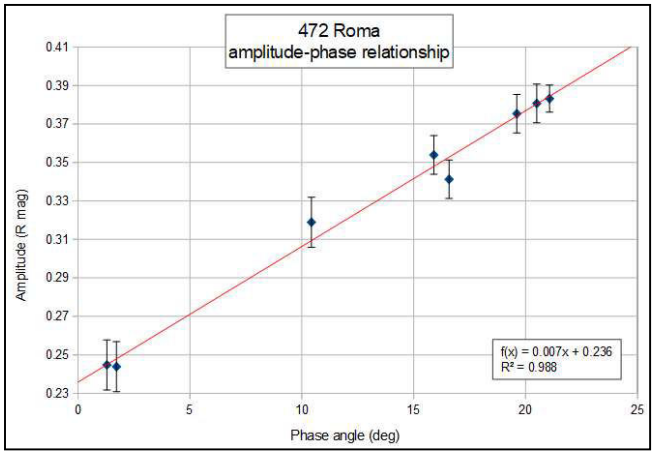
The CCD observations were made in 2021 January-March using the instrumentation described in the Table II. Lightcurve analysis was performed at the Balzaretto Observatory with *MPO Canopus* (Warner, 2019). All the images were calibrated with dark and flat frames and converted to R magnitudes using solar colored field stars from a version of the CMC15 catalogue distributed with *MPO Canopus*. For brevity, the following citations to the asteroid lightcurve database (LCDB; Warner et al., 2009) will be summarized only as "LCDB".

374 Burgundia is an S-type (Bus and Binzel, 2002) middle main-belt asteroid discovered on 1893 September 18 by A. Charlois at Nice. Collaborative observations were made over five nights. The period analysis shows a synodic period of $P = 6.966 \pm 0.001$ h with an amplitude $A = 0.11 \pm 0.02$ mag. The period is close to the previously published results in the LCDB.



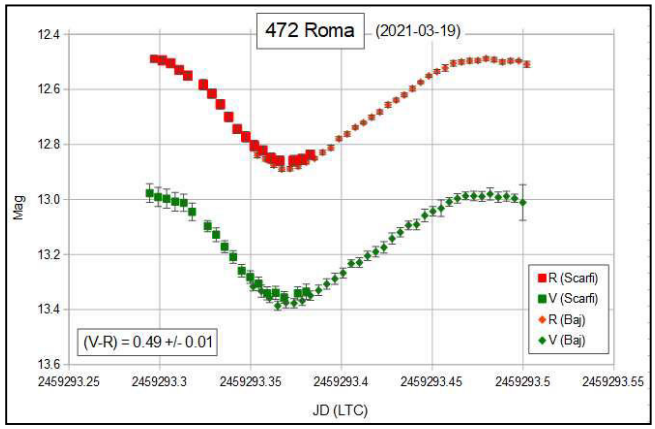

472 Roma is an S-type (Tholen, 1984) middle main-belt asteroid discovered on 1901 July 1 by L. Carnera at Heidelberg. Collaborative observations were made over eight nights. The period analysis shows a synodic period of $P = 9.796 \pm 0.001$ h with an amplitude $A = 0.35 \pm 0.04$ mag. The period is close to the previously published results in the LCDB.

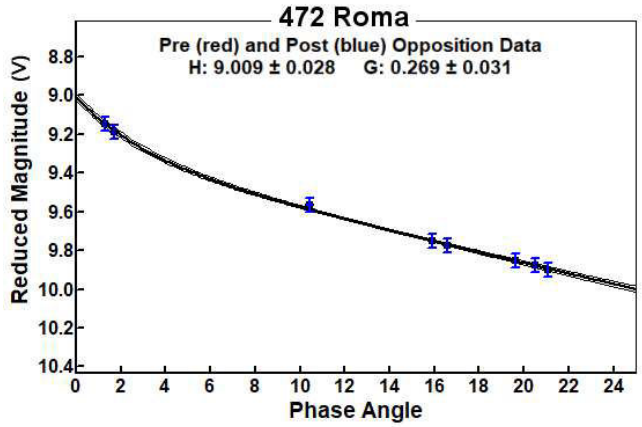


The measured amplitudes were related to the phase angle as shown by the amplitude-phase plot. By linear fit we obtained a slope $s$ = 0.007 ± 0.001 mag deg$^{-1}$ and intercept $A(0°)$ = 0.236 ± 0.021 mag. This gives $m = s/A(0°)$ = 0.030 ± 0.008 deg$^{-1}$. This result agrees with the empirical formula by Zappala et al. (1990): $A(\alpha) = A(0°)m\alpha+A(0°)$, where α is the solar phase angle and $m$ is a parameter (deg$^{-1}$) that varies according to the taxonomic type. Typical values are 0.030, 0.015, 0.013 respectively for S-type, C-type and M-type.

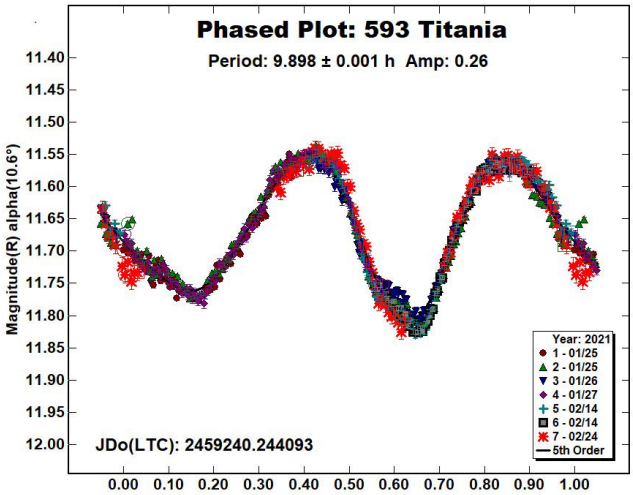
The nearly concurrent and independent sessions acquired by G. Scarfi and G. Baj on 2021 March 19 in the V and R bands allowed us to determine the color index (V-R) = 0.49 ± 0.01 mag. This value is consistent with a medium albedo S-type taxonomic class (Shevchenko and Lupishko, 1998).



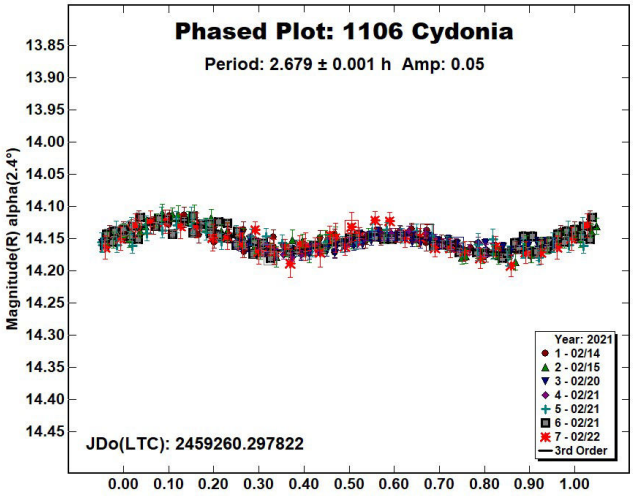




The H-G parameters were determined using the H-G calculator function implemented in *MPO Canopus*. For each lightcurve, the R mag were measured as half peak-to-peak and converted in V mag by adding the color index (V-R) previously determined. We derived $H$ = 9.01 ± 0.03 mag and $G$ = 0.27 ± 0.03. The $H$ value is close to result found in the LCDB and the $G$ value is consistent with a medium albedo S-type taxonomic class (Shevchenko and Lupishko, 1998).

593 Titania is a C-type (Tholen, 1984) middle main-belt asteroid discovered on 1906 March 20 by A. Kopff at Heidelberg. Collaborative observations were made over five nights. We found a synodic period of $P$ = 9.898 ± 0.001 h with an amplitude $A$ = 0.26 ± 0.03 mag. The period is close to the previously published results in the LCDB.

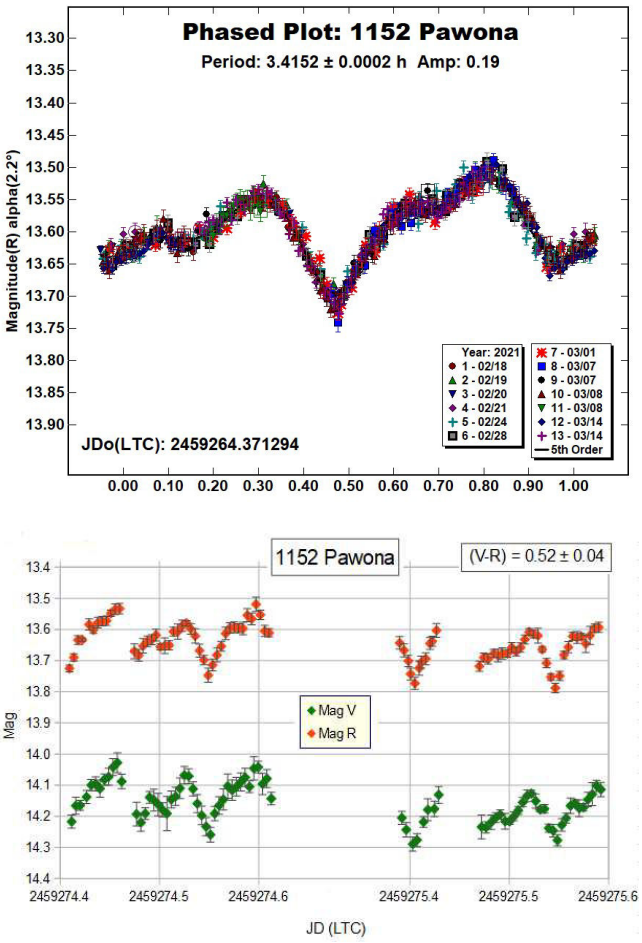



1106 Cydonia is an S-type (Bus and Binzel, 2002) middle main-belt asteroid discovered on 1929 February 5 by K. Reinmuth at Heidelberg. Collaborative observations were made over three nights. We found a synodic period of $P$ = 2.679 ± 0.001 h with an amplitude $A$ = 0.05 ± 0.02 mag. The period is close to the previously published results in the LCDB.

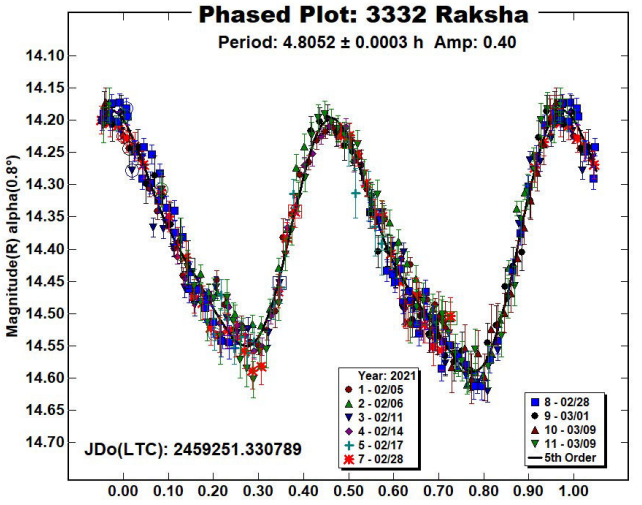



1152 Pawona is an Sl-type (Bus and Binzel, 2002) inner main-belt asteroid discovered on 1930 January 8 by K. Reinmuth at Heidelberg. Collaborative observations were made over eight nights. We found a synodic period of $P$ = 3.4152 ± 0.0002 h with an amplitude $A$ = 0.19 ± 0.03 mag. The period is close to the previously published results in the LCDB.

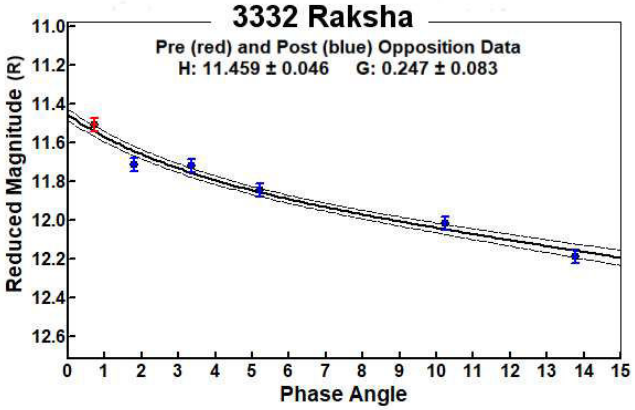
The sessions acquired by G. Baj on 2021 February 28 and March 1 in the V and R bands allowed us to determine the color index (V-R) = 0.52 ± 0.04 mag. This value is consistent with a medium albedo S-type taxonomic class (Shevchenko and Lupishko, 1998).




3332 Raksha is a medium-albedo inner main-belt asteroid discovered on 1978 July 4 by L. Chernykh at Nauchnyj. Collaborative observations were made over six nights. We found a synodic period of $P$ = 4.8052 ± 0.0003 h with an amplitude $A$ = 0.40 ± 0.03 mag. The period is close to the previously published results in the LCDB.




For each lightcurve were measured the half peak-to-peak R band magnitude, deriving $H_R$ = 11.46 ± 0.05 mag and G = 0.25 ± 0.08. The $G$ value is close to medium albedo S-type taxonomic class (Shevchenko and Lupishko, 1998).

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| Number | Name | 2021 mm/dd | Phase | $L_{PAB}$ | $B_{PAB}$ | Period(h) | P.E. | Amp | A.E. | Grp |
|---|---|---|---|---|---|---|---|---|---|---|
| 374 | Burgundia | 02/22-03/14 | *7.4,4.5 | 169 | -9 | 6.966 | 0.001 | 0.11 | 0.02 | MB-M |
| 472 | Roma | 01/25-03/19 | 1.2,21.0 | 124 | 1 | 9.796 | 0.001 | 0.35 | 0.04 | MB-M |
| 593 | Titania | 01/25-02/24 | 10.5,19.1 | 123 | 19 | 9.898 | 0.001 | 0.26 | 0.03 | MB-M |
| 1106 | Cydonia | 02/14-02/22 | *2.3,1.9 | 151 | -1 | 2.679 | 0.001 | 0.05 | 0.02 | MB-M |
| 1152 | Pawona | 02/18-03/14 | *2.2,10.1 | 155 | -1 | 3.4152 | 0.0002 | 0.19 | 0.03 | MB-I |
| 3332 | Raksha | 02/05-03/09 | *0.7,13.7 | 139 | 1 | 4.8052 | 0.0003 | 0.40 | 0.03 | MB-I |

Table I. Observing circumstances and results. The first line gives the results for the primary of a binary system. The second line gives the orbital period of the satellite and the maximum attenuation. The phase angle is given for the first and last date. If preceded by an asterisk, the phase angle reached an extremum during the period. $L_{PAB}$ and $B_{PAB}$ are the approximate phase angle bisector longitude/latitude at mid-date range (see Harris et al., 1984). Grp is the asteroid family/group (Warner et al., 2009).

| Observatory (MPC code) | Telescope | CCD | Filter | Observed Asteroids (#Sessions) |
|---|---|---|---|---|
| Astronomical Observatory of the University of Siena(K54) | 0.30-m MCT f/5.6 | SBIG STL-6303e (bin 2x2) | C,Rc | 374(3),472(3),593(1),1106(2),1152(2),3332(3) |
| M57 (K38) | 0.30-m RCT f/5.5 | SBIG STT-1603 | Rc,V | 472(5),593(3),1152(3),3332(2) |
| GiaGa Observatory (203) | 0.36-m SCT f/5.8 | Moravian G2-3200 | Rc | 472(3),1152(2) |
| Iota Scorpii(K78) | 0.40-m RCT f/8.0 | SBIG STXL-6303e (bin 2x2) | Rc,V | 472(2),592(1),3332(1) |
| Seveso Observatory (C24) | 0.30-m SCT f/6.3 | SBIG ST9 | Rc | 374(1),3332(1) |
| GAMP (104) | 0.60-m NRT f/4.0 | Apogee Alta | C | 1106(2) |
| Osservatorio Astronomico Margherita Hack (A57) | 0.35-m SCT f/8.3 | SBIG ST10XME (bin 2x2) | Rc | 1152(1) |
| GAV | 0.20-m SCT f/6.3 | SXV-H9 | Rc | 593(1) |
| Hypatia Observatory (L62) | 0.25-m RCT f/5.4 | SBIG ST8-XE | Rc | 374(1) |

Table II. Observing Instrumentations. MCT: Maksutov-Cassegrain, NRT: Newtonian Reflector, RCT: Ritchey-Chretien, SCT: Schmidt-Cassegrain

References


Bus, S.J.; Binzel, R.P. (2002). "Phase II of the Small Main-Belt Asteroid Spectroscopic Survey - A Feature-Based Taxonomy." *Icarus* **158**, 146-177.

Harris, A.W.; Young, J.W.; Scaltriti, F.; Zappala, V. (1984). "Lightcurves and phase relations of the asteroids 82 Alkmene and 444 Gyptis." *Icarus* **57**, 251-258.

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

Tholen, D.J. (1984). "Asteroid taxonomy from cluster analysis of Photometry." Doctoral Thesis. University Arizona, Tucson.

UAI (2021). "Unione Astrofili Italiani" web site. *https://www.uai.it*

Warner, B.D.; Harris, A.W.; Pravec, P. (2009). "The asteroid lightcurve database." *Icarus* **202**, 134-146. Updated 2020 Oct 22. *http://www.minorplanet.info/lightcurvedatabase.html*

Warner, B.D. (2019). MPO Software. *MPO Canopus* v10.8.1.1. Bdw Publishing. *http://minorplanetobserver.com*

Zappalà, V.; Cellino, A.; Barucci, A.M.; Fulchignoni, M.; Lupishko, D.F. (1990). "An analysis of the amplitude-phase relationship among asteroids." *Astron. Astrophys*. **231**, 548-560.