

ROTATION PERIODS FOR ASTEROIDS FROM CARL SAGAN OBSERVATORY: 2021 NOVEMBER - 2022 MAY

P. A. Loera-González, L. Olguín, J. C. Saucedo, M.E. Contreras
Departamento de Investigación en Física, Universidad de Sonora
pabloloera@tutanota.com

R. Nuñez-López
Departamento de Física, Matemáticas e Ingeniería,
Universidad de Sonora,
Caborca, Sonora, MEXICO

Rafael Domínguez-González
Hermosillo, Sonora, México

O. E. Angulo, S. D. Chapetti, D. E. Córdova, R. A. Cortez,
M. A. Ramírez, P. S. Vázquez
Departamento de Física, Universidad de Sonora
Hermosillo, Sonora, MEXICO

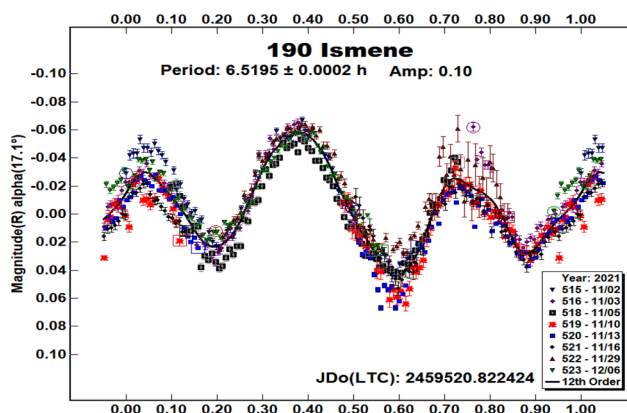
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We present photometric visible wavelength lightcurves and derive rotation periods for a sample of four asteroids: 190 Ismene (6.5195 ± 0.0002 h), 5009 Sethos (2.688 ± 0.001 h), (7335) 1989 JA (2.590 ± 0.002 h) and (11512) 1991 AB2 (2.93275 ± 0.00025 h). Observations were carried out at the Observatorio Astronómico Carl Sagan (OACS) of the Universidad de Sonora in Hermosillo, México.

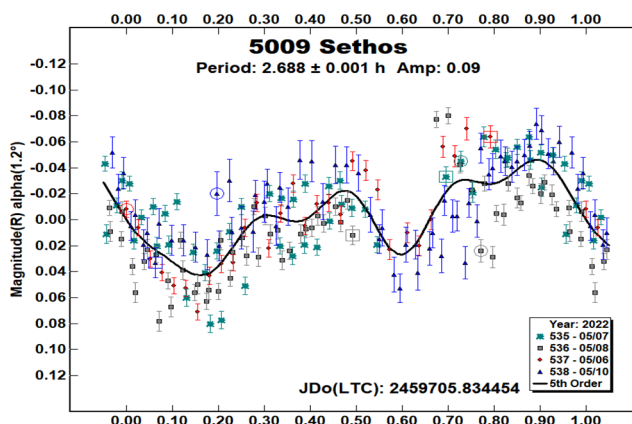
As part of our permanent campaign of asteroid observation at the Carl Sagan Astronomical Observatory, we obtained photometric data for three main-belt asteroids (190 Ismene, 5009 Sethos and 1991 AB2) and one Near Earth Asteroid (1989 JA). Asteroid observation provides an excellent opportunity to prepare students in observational techniques and data reduction as well as obtaining results such as lightcurves and rotation periods, and a way to fully take advantage of nearby astronomical facilities. This campaign was aimed to accomplish the above-mentioned objectives.

The equipment used at the OACS was a $512 \times 512 \times 20$ μm SBIG ST-9 CCD camera mounted on a Meade LX-200GPS 0.41-m $f/10$ telescope. Images yielding a final plate scale of 1.03 arcsec/pix and an effective 9×9 arcmin FOV. Data reduction was made with *IRAF* or *MaximDL* following standard procedures to correct for bias, dark current and flat-field effects. Photometry and lightcurve analysis were made using *MPO Canopus* (V.9.5.0.14, Warner, 2017) software package, which allowed us to obtain the synodic period for each object.

190 Ismene was discovered in 1878 Sep 22 by C.H.F. Peters at the Litchfield Observatory in Clinton, NY, (Schmadel, 2003). Ismene is a member of the Hilda family and has a size of 159 km, absolute magnitude $H=7.71$ and albedo of 0.066. We observed Ismene for 8 nights during 2021 November and December. A period of $P = 6.5195 \pm 0.0002$ h was obtained with a lightcurve amplitude of $A = 0.1$ mag. These values are similar to those reported earlier by Warner et al. (2021), $P=6.5198 \pm 0.0003$ h with $A=0.15$ mag; Warner and Stephens (2020), $P=6.521 \pm 0.0008$ h. with $A=0.16$; Shevchenko et al. (2008), $P=6.5192 \pm 0.0002$ h with $A=0.1$ mag; and Dahlgren et al. (1998), $P=6.52$ h. Changes in lightcurve shape and amplitude among different authors/epochs can be appreciated, presumably due to different viewing angles.



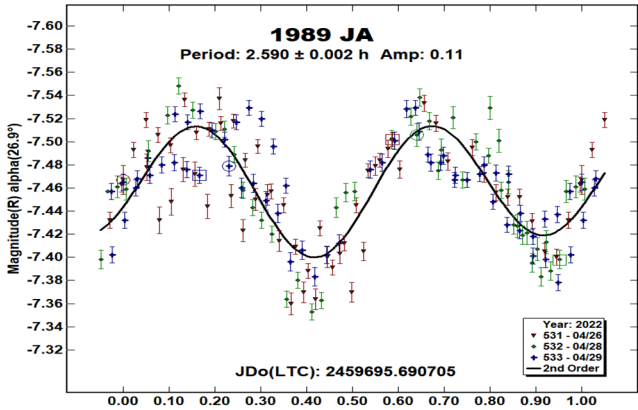
5009 Sethos. Discovered by C.J. van Houten and I. van Houten-Groeneveld at Palomar Observatory on 1960 Sep 24 (Schmadel, 2003). This Hilda asteroid has an estimated size of 4.3 km, an absolute magnitude $H=14.03$ and a geometric albedo of 0.455. We observed Sethos during 4 nights in 2022 May. A period of $P = 2.688 \pm 0.001$ h was obtained with a lightcurve amplitude of $A = 0.09$ mag. Similar results, $P = 2.6907 \pm 0.0003$ h with $A=0.08$, were obtained by Waszczak et al. (2015) from an incomplete lightcurve.



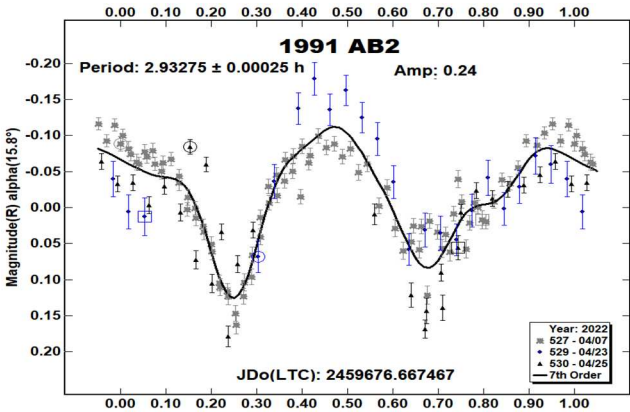
(7335) 1989 JA is an Apollo-type NEO and PHA discovered by E.F. Helin in 1989 May 1 at Palomar (Schmadel, 2003). It is 1.8 km in size, with an absolute magnitude $H=17.61$ and a geometric albedo of 0.448. We observed 1989 JA during late 2022 April and obtained a period of $P = 2.59 \pm 0.002$ h and a lightcurve amplitude of $A=0.11$ mag. The only published result for this asteroid is given by Mahapatra et al. (2002) where an upper limit of $P=12$ h was obtained from radar observations. The period of 1989 JA is marked as inconclusive at the JPL Horizons Small-Body Database.

Number	Name	yyyy mm/dd	Phase	L _{PAB}	B _{PAB}	Period(h)	P.E.	Amp	A.E.	Grp
190	Ismene	2021 11/02-12/06	17.1, 13.1	116.1	-6.2	6.5195	0.0002	0.10	0.05	MB-H
5009	Sethos	2022 05/07-05/10	0.9, 2.7	224.7	0	2.688	0.001	0.09	0.04	MB-H
7335	1989 JA	2022 04/26-04/29	26.8	220.6	19.3	2.59	0.0002	0.11	0.05	NEO
11512	1991 AB2	2022 04/07-04/25	15.6, 22.6	172.9	0.6	2.93275	0.00025	0.24	0.05	MB-I

Table I. Observing circumstances and results. The phase angle is given for the first and last date. If preceded by an asterisk, the phase angle reached an extrema 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).



(11512) 1991 AB2 is an inner-main-belt asteroid with an estimated size of 4.3 km, an absolute magnitude H=13.89 and a geometric albedo of 0.373. We observed 1991 AB2 during three nights in 2022 April. A period of $P = 2.93275 \pm 0.00025$ h was derived with a lightcurve amplitude $A = 0.24$ mag. This result is in close agreement with the reported value by Hess and Ditteon (2016) who obtained a period of $P = 2.933 \pm 0.002$ h.



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