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New physical models of asteroids derived from sparse and dense photometry

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Abstract

We present 78 new physical models of asteroids, namely their spin vectors and rotation periods. The models were derived from the photometric data using the lightcurve inversion method. With the new models, the total number of asteroid models derived from photometry has increased to ~ 300. The new models confirm the clustering of spin vectors of small asteroids towards the ecliptic poles [1].

1. Introduction

The lightcurve inversion method developed by [2] and [3] has led to more than 200 physical models of asteroids derived during the past decade. The models were derived mainly from classical dense lightcurves. In recent years, models from combined sparse and dense photometry significantly enlarged the sample of asteroids with know shape and rotational state. The knowledge of the shape, the rotation period, and the spin vector of individual objects is important for revealing the distribution of spin vectors orientation in the whole asteroid population.

2. Methods and results

We used the same approach as [1] – we used archived lightcurves from the Uppsala Asteroid Photometric Catalogue [4], recent lightcurves provided by the observers via the Asteroid Lightcurve Data Exchange Format[1], and sparse photometry from selected observatories downloaded from the AstDys web site.[2] We used the lightcurve inversion method to derive unique physical models of asteroids that fit the data.

We derived 78 new models that are listed in Table 1. The table lists the direction of the spin vector in ecliptic coordinates (λ, β) and the sidereal rotation period P. In most cases, there are two pole solutions for one asteroid with roughly the same value of β and the difference in λ of about $180°$. The typical accuracy of the pole direction is $10 - 20°$, depending on the number of observations. The accuracy of the rotation period depends on the time-span of observations and is of the order of the last decimal place of P given in Table 1.

The lightcurve inversion method is capable of deriving the spin axis direction and rotation period for synchronous binaries (1089 Tama, for example). From the modelling point of view, a fully synchronous binary behaves like a single body that can be approximated by a convex shape.

The spin-axis distribution of new models confirm the results of [1], namely the concentration of spin directions of small asteroids (< 30 km) towards the high absolute ecliptic latitudes. This concentration can be explained by the YORP evolution of spin states of small asteroids.

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[1] http://www.minorplanet.info/alcdef.html
[2] http://hamilton.dm.unipi.it/astdys/

References

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Table 1: List of new models.

Asteroid	λ_1	β_1	λ_2	β_2	P
	[deg]	[deg]	[deg]	[deg]	[hr]
72 Feronia	291	−24	110	−37	8.09067
79 Eurynome	228	30	54	24	5.97772
147 Protogeneia	270	15	91	13	7.85229
149 Medusa	333	−73	156	−76	26.0454
157 Dejanira	314	−64	143	−33	15.8287
166 Rhodope	346	−25	174	−5	4.714791
176 Iduna	178	80	81	17	11.2878
178 Belisana	77	14	260	19	12.32142
183 Istria	84	21			11.76898
210 Isabella	103	−13	281	−20	6.67191
220 Stephania	26	−50	223	−62	18.2087
257 Silesia	358	−45	172	−38	15.7096
260 Huberta	22	−29	206	−22	8.29051
265 Anna	108	−52			11.6903
272 Antonia	291	−82	49	−63	3.85480
290 Bruna	286	−80	37	−74	13.8055
352 Gisela	205	−26	23	−20	7.48007
390 Alma	54	−48	263	−73	3.74117
403 Cyane	62	36	228	30	12.2700
406 Erna	166	−55	356	−45	8.79078
474 Prudentia	160	−72	274	−59	8.57227
507 Laodica	102	−55	312	−49	4.70657
509 Iolanda	245	65	98	38	12.2907
512 Taurinensis	326	52			5.58203
528 Rezia	176	−60	48	−65	7.33797
543 Charlotte	337	52	174	43	10.7184
572 Rebekka	2	55	158	40	5.65009
669 Kypria	31	38	190	50	14.2789
708 Raphaela	37	27	217	22	20.8894
731 Sorga	83	40	275	21	8.18633
787 Moskva	330	60	122	19	6.05580
796 Sarita	17	76	276	28	8.17428
807 Ceraskia	325	23	132	26	7.37390
816 Juliana	120	0	303	9	10.5628
852 Wladilena	218	−41	57	−16	4.613302
857 Glasenappia	227	47	39	38	8.20756
867 Kovacia	198	−51	37	−52	8.67808
875 Nymphe	42	31	196	42	12.6213
900 Rosalinde	270	70	90	39	16.6868
958 Asplinda	41	48	226	35	25.3050
1056 Azalea	243	61	45	50	15.0276
1089 Tama	7	28	191	34	16.4460
1098 Hakone	58	70	233	19	7.14339
1126 Otero	44	75	240	56	3.64800
1130 Skuld	24	36	200	35	4.80764
1241 Dysona	125	−68	20	−19	8.60738
1386 Storeria	324	−64			8.67791
1432 Ethiopia	41	44	225	54	9.84425
1450 Raimonda	237	−55	66	−54	12.6344
1472 Muonio	249	61	42	62	8.70543
1490 Limpopo	142	−2	318	23	6.65164
1518 Rovaniemi	62	60	265	45	5.25047
1528 Conrada	250	−51	93	−66	6.32154
1554 Yugoslavia	281	−34	78	−64	3.88766
1607 Mavis	0	59	222	70	6.14775
1630 Milet	307	27	124	42	32.485
1719 Jens	305	−90	74	−45	5.87017
1785 Wurm	11	57	192	47	3.26934
1927 Suvanto	90	40	276	5	8.16151
1963 Bezovec	218	20			18.1653
2094 Magnitka	106	55	274	44	6.11219
2384 Schulhof	196	−60	45	−42	3.29367
2510 Shandong	256	27	71	27	5.94639
2606 Odessa	25	−81	283	−88	8.2444
2709 Sagan	308	−8	124	−16	5.25640
2839 Annette	341	−49	154	−36	10.4609
2957 Tatsuo	88	57	246	37	6.82043
2962 Otto	249	−37			2.67813
2991 Bilbo	277	54	90	51	4.06175
3170 Dzhanibekov	217	60	21	64	6.07168
3722 Urata	79	−16	259	−1	5.5671
4507 1990 FV	143	55	323	49	6.57933
4954 Eric	86	−54			12.05207
5647 1990 TZ	253	77	119	−19	6.13867
8132 Vitginzburg	33	−66	193	−48	7.27529
16403 1984 WJ1	216	30	13	48	7.53748
18042 1999 RF27	86	−71	252	−58	7.3017
19848 Yeungchuchiu	190	−68			3.45104