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OBSERVATIONAL DATA AND ORBITS OF THE ASTEROIDS DISCOVERED AT THE MOLĖTAI OBSERVATORY IN 2005–2007

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Abstract. The paper presents statistics of the asteroids observed and discovered at the Molėtai Observatory, Lithuania, in 2005–2007 within the project for astrometric observations of the near-Earth objects (NEOs), the main belt asteroids and comets. CCD observations of asteroids were obtained with the 35/51 cm Maksutov-type meniscus telescope and the 1.65 m Ritchey-Chretien reflector. In the Minor Planet Circulars and the Minor Planet Electronic Circulars (2005–2007) we published 17 003 astrometric positions of 2980 asteroids. Among them 112 were new normal asteroids and one NEO (2006 SF77) discovered at Molėtai; a few NEOs were found by our team independently. For the asteroids discovered at Molėtai their precise orbits were calculated. Because of short observational arc, a few asteroids have low-precision orbits and some asteroids have been lost. For three of them with low-precision orbital elements (NEO 2006 SF77 and two Mars crossers – 2006 SN368 and 2007 VM315), we present their ephemerides for 2016–2018.

Key words: minor planets, asteroids: search, near-Earth objects, astrometry, orbits

1. ASTROMETRIC OBSERVATIONS OF MINOR PLANETS

This is our third paper in a series of publications which review our contribution to discovery and follow-up observations of newly and previously discovered asteroids. The first paper (Černis et al. 2014) was devoted to the asteroids discovered at the Molėtai Observatory, Lithuania, in 2000–2004. In the second paper (Černis et al. 2015), we focus on statistics of the asteroids discovered at the Baldone Observatory in Latvia during the period from 2008 to 2013.

The aim of our project is the determination of more precise orbits of asteroids and comets and predictions of their Earth-impact threat. One of the main sites of observations is the Molėtai Astronomical Observatory (MAO) of Vilnius University, located at the longitude 25.5633 E, latitude 55.3166 N and altitude 210 m. Its IAU code is 152.

Most of the asteroids were discovered with the Maksutov telescope in the morning sky about 10–30 days before their opposition time at elongations 140–170°. The sky survey has been done close to the ecliptic (mostly not more than 15°

Table 1. Distribution of discoveries of asteroids and the numbers of astrometric observations of asteroids (both new and known) at the Molėtai Observatory in 2005–2007.

Year	Number of asteroid discoveries	Number of asteroid observations	Number of objects observed	References (MPC No.)
2005	45	3919	659	53631 54346 54967 55509
2006	44	8181	1379	56150 57112 57575 58099
2007	23	4903	942	58524 58766 59030 59306
				59582 59862 60087 60452
				60648 60908 61164 61423
Total	112	17003	2980	

from the ecliptic line), taking three CCD images on the same field, with 15–20 min time spans between the exposures. The MAO 1.65 m reflector with its new focal reducer gives much better astrometric precision, the scale is $0.9''$ per pixel. However this instrument was used for astrometry of asteroids only in October and November of 2005. For the measurements the Astrometrica software (Raab 2003) was applied. The catalogs USNO-A2.0, USNO-B1.0 and UCAC-2 were used for the selection of reference stars.

During 2005–2007, about 1960 CCD images for astrometry of asteroids were obtained by the three observers: K. Černis, J. Zdanavičius and K. Zdanavičius. We have measured positions of all asteroids appearing in the CCD frames. The 17 003 astrometric positions of 2980 asteroids, including 14 NEOs, were published in the Minor Planet Circulars (MPC) and Electronic Minor Planet Circulars (MPEC) (Černis & Zdanavičius 2005, 2006, 2007). During sky survey in the ecliptic regions and during the NEO asteroid follow-up observations, 112 new asteroids have been discovered.

Our contribution is about 0.07% of all 24 391 550 observations of asteroids done in the world in 2005–2007. The new discoveries (112) compose a similar part, 0.09%, of all 130 858 asteroids discovered during this period. Most of new asteroids have been discovered by the specialized projects: LINEAR, NEAT, Spacewatch, LONEOS and Catalina.

Table 1 presents the distribution of discoveries of asteroids and the numbers of their astrometric observations in 2005–2007. Table 2 lists the asteroids discovered at the Molėtai Observatory.

Table 2. List of asteroids discovered at the Molėtai Observatory in 2005–2007.

No.	Date of discovery	Designation	Number	Name	Discoverers	Status
1	2005 Mar 10	2005 EM200	168431			Id
2	2005 Mar 10	2005 EE220			KC, JZ	+
3	2005 Mar 10	2005 EV236			KC, JZ	Lost
4	2005 Mar 13	2005 ET249	198820	Iwanowska	KC, JZ	*
5	2005 Mar 13	2005 EU249	280686		KC, JZ	*
6	2005 Mar 13	2005 EV249	167960	Rudzikas	KC, JZ	*
7	2005 Mar 13	2005 EW249	296011			Id
8	2005 Mar 10	2005 EX282	231040		KC, JZ	*
9	2005 Mar 10	2005 EY282			KC, JZ	Lost

Table 2. Continued.

No.	Date of discovery	Designation	Number	Name	Discoverers	Status
10	2005 Mar 13	2005 ET285	257285			Id
11	2005 Mar 10	2005 EJ293			KC, JZ	Lost
12	2005 Mar 10	2005 EK293			KC, JZ	+
13	2005 Mar 13	2011 UP15			KC, JZ	+
14	2005 Oct 08	2005 TM48	187276	Meištas	KC, JZ	*
15	2005 Oct 07	2005 TN48	339854			Id
16	2005 Oct 07	2005 TO48				Id
17	2005 Oct 07	2005 TC49	339855		KC, JZ	*
18	2005 Oct 08	2005 TZ49	157534	Šiauliai	KC, JZ	*
19	2005 Oct 08	2005 TA50				Id
20	2005 Oct 08	2005 TB50	440486			Id
21	2005 Oct 08	2005 TC50				Id
22	2005 Oct 08	2005 TK52	261136		KC, JZ	*
23	2005 Oct 10	2005 TT52	229427		KC, JZ	*
24	2005 Oct 09	2005 TW52				Id
25	2005 Oct 08	2005 TE53	184786		KC, JZ	*
26	2005 Oct 08	2005 TG53	397013		KC, JZ	*
27	2005 Oct 08	2005 TH53	224278		KC, JZ	*
28	2005 Oct 08	2005 TJ53	290411		KC, JZ	*
29	2005 Oct 08	2005 TM53	261119			Id
30	2005 Oct 08	2005 TQ79				Id
31	2005 Oct 08	2005 TQ98				Id
32	2005 Oct 08	2005 TO105	189691			Id
33	2005 Oct 08	2005 TP105	391042		KC, JZ	*
34	2005 Oct 08	2005 TH154				Id
35	2005 Oct 08	2005 TJ154	186207			Id
36	2005 Oct 09	2005 TM169	155138	Pučinskas	KC, JZ	*
37	2005 Oct 08	2005 TJ173			KC, JZ	+
38	2005 Oct 08	2005 TR183			KC, JZ	+
39	2005 Oct 08	2005 TU183				Id
40	2005 Oct 08	2005 TJ184	354730			Id
41	2005 Oct 10	2005 TO186			KC, JZ	Lost
42	2005 Oct 10	2005 TP186	348511		KC, JZ	*
43	2005 Oct 08	2005 TC188				Id
44	2005 Oct 10	2005 UP488	319009		KC, JZ	*
45	2005 Oct 08	2013 HK51			KC, JZ	+
46	2006 Sep 02	2006 RE1	176451			Id
47	2006 Sep 01	2006 RT1				Id
48	2006 Sep 01	2006 RU1				Id
49	2006 Sep 23	2006 SF77			KC, JZ	+
50	2006 Sep 21	2006 SU77	210147	Žalgiris	KC, JZ	*
51	2006 Sep 23	2006 SM78	409849			Id
52	2006 Sep 23	2006 SP161	185150	Panevėžys	KC	*
53	2006 Sep 23	2006 SQ161	212587	Bartašiūtė	KC, JZ	*
54	2006 Sep 25	2006 SP197	319601		KC, JZ	*
55	2006 Sep 25	2006 SQ197	400072		KC, JZ	*

Table 2. Continued.

No.	Date of discovery	Designation	Number	Name	Discoverers	Status
56	2006 Sep 25	2006 SR197	214678		KC, JZ	*
57	2006 Sep 25	2006 SS197			KC, JZ	+
58	2006 Sep 25	2006 SF198	292343		KC, JZ	*
59	2006 Sep 25	2006 SG198	245983		KC, JZ	*
60	2006 Sep 21	2006 ST219			KC, JZ	+
61	2006 Sep 25	2006 SG281			KC, JZ	+
62	2006 Sep 25	2006 SH281			KC, JZ	Lost
63	2006 Sep 27	2006 SF285	212606	Janulis	KC, JZ	*
64	2006 Sep 27	2006 SG285	175548	Sūdžius	KC, JZ	*
65	2006 Sep 27	2006 SH285				Id
66	2006 Sep 26	2006 SR290			KC, JZ	+
67	2006 Sep 26	2006 SS290	324417		KC, JZ	*
68	2006 Sep 23	2006 SA368	406006		KC, JZ	*
69	2006 Sep 23	2006 SD368			KC, JZ	+
70	2006 Sep 23	2006 SE368	319636		KC, JZ	*
71	2006 Sep 23	2006 SN368			KC, JZ	Lost
72	2006 Sep 23	2006 SO368				Id
73	2006 Sep 25	2006 SP368	444562		KC, JZ	*
74	2006 Sep 25	2006 SQ368			KC, JZ	+
75	2006 Sep 24	2006 SA369	262284		KC, JZ	*
76	2006 Sep 24	2006 SB369			KC, JZ	+
77	2006 Sep 23	2006 SE369	299897		KC, JZ	*
78	2006 Sep 23	2006 SS372	361265		KC, JZ	*
79	2006 Sep 23	2006 ST372	335668		KC, JZ	*
80	2006 Sep 23	2006 SU372			KC, JZ	Lost
81	2006 Sep 25	2006 SV372	308934		KC, JZ	*
82	2006 Sep 23	2006 SG397			KC, JZ	+
83	2006 Sep 24	2006 SH406	292490		KC, JZ	*
84	2006 Sep 23	2006 SW406			KC, JZ	+
85	2006 Sep 25	2006 SX406			KC, JZ	Lost
86	2006 Sep 25	2006 SY406	248839		KC, JZ	*
87	2006 Sep 26	2014 LE10			KC, JZ	+
88	2006 Sep 25	2011 YS27	322539		KC, JZ	*
89	2006 Sep 25	2011 PR13	353404		KC, JZ	*
90	2007 Mar 23	2007 FS20			KC, JZ	+
91	2007 Mar 23	2007 FT20	212692	Lazauskaitė	KC, JZ	*
92	2007 Mar 23	2007 FU20	320153		KC, JZ	*
93	2007 Mar 23	2007 FV20				Id
94	2007 Mar 24	2007 FO34	327977		KC, JZ	*
95	2007 Mar 23	2007 FP34	319012			Id
96	2007 Mar 23	2007 FK35	325701			Id
97	2007 Mar 23	2007 FL35	346927			Id
98	2007 Mar 23	2007 FM35	225033		KC, JZ	*
99	2007 Mar 24	2007 FN35	361524		KC, JZ	*
100	2007 Mar 24	2007 FV35	386056		KC, JZ	*
101	2007 Mar 23	2013 GP36			KC, JZ	+

Table 2. Continued.

No.	Date of discovery	Designation	Number	Name	Discoverers	Status
102	2007 Apr 14	2007 GN6	202704	Utena	KC, JZ	*
103	2007 Apr 14	2007 GL28			KC, JZ	Lost
104	2007 Apr 14	2007 GM28	248993	Jonava	KC, JZ	*
105	2007 Apr 14	2007 GE32	309206		KC, JZ	*
106	2007 Apr 15	2007 GV51	281208		KC, JZ	*
107	2007 Apr 14	2007 GD52	450737		KC, JZ	*
108	2007 Apr 14	2007 GH71	381160			Id
109	2007 Apr 15	2007 GR75	324787		KC, JZ	*
110	2007 Apr 17	2007 HN97	341087		KC, JZ	*
111	2007 Nov 05	2007 VR302	305181	Donelaitis	KC, JZ	*
112	2007 Nov 05	2007 VM315			KC, JZ	Lost

Notes:

KC, JZ	Kazimieras Černis, Justas Zdanavičius
*	Credited for discoverers from MAO
Lost	The lost asteroid
Id	An independent discovery
+	Waiting for crediting MAO

Till now, 2016 January, the credits for discovery of 53 asteroids have been received by the Molėtai Observatory from the Minor Planet Center, 14 of them have been named. In the near future we expect to get numbers and credits for another 9 asteroids: 2005 EK293, 2005 TR183, 2005 EE220, 2006 SR290, 2006 SD368, 2006 SB369, 2006 SG397, 2006 SW406, 2007 FS20. The asteroids 2011 UP15, 2011 PR13, 2013 HK51, 2013 GP36, 2014 LE10 got designations only in 2011–2014, however, these objects were first spotted at the Molėtai Observatory.

2. ORBITS

To compute the orbits and ephemerides of asteroids the freely available OrbFit software v.4.2[1] has been used. In our computations we also used the JPL DE405 planetary and lunar ephemerides, the biased error model based on Chesley et al. (2010), and 25 perturbing asteroids. For weighting and selecting the observations, the method described in the NEODyS site (Wlodarczyk et al. 2014) has been used.

The masses of 25 perturbing asteroids were taken from Farnocchia et al. (2013). Starting positions of these asteroids and their perturbations were computed using the ASTDyS base of the initial orbital elements of asteroids[2] and the OrbFit software. The precision of orbital computation using the OrbFit software is described in Wlodarczyk (2009).

Table 3 lists the high precision orbital elements and their uncertainties for the asteroids discovered at the Molėtai Observatory in 2005–2007. They are presented in the order of the discovery date. For each asteroid the first line gives the following orbital elements: a – semimajor axis, e – eccentricity, i – inclination, Ω

[1] http://adams.dm.unipi.it/∼orbmaint/orbfit/

[2] http://hamilton.dm.unipi.it/astdy s/

– longitude of the ascending node, ω – argument of perihelion, and M – mean anomaly. The second line gives the rms errors of the elements and the third line gives the absolute magnitude H, the number of observations used and their time coverage. The orbital elements and their ephemerides are computed without any non-gravitational effects, i.e. in the computations only the gravitational model of the Solar System has been used.

The absolute magnitudes H given in Table 3 were calculated from the observed magnitudes R taking into account the computed orbit. Almost all asteroids have absolute magnitudes in the range $H = 15$–18 mag. The absolutely brightest in our sample is the asteroid (176451) with $H = 14.867$ mag which corresponds to the diameter from 3.2 km (for S-class with albedo = 0.20) to 7.1 km (for C-class with albedo = 0.04). The faintest asteroid is 2006 SF77 with $H = 21.691$ mag and the diameter from 0.14 km to 0.31 km if it belongs to S- or C-class.

One of the most important results of the project is the discovery of 2006 SF77, a high-inclination asteroid belonging to the NEO Aten group (Černis & Zdanavičius 2006). Discovery circumstances, astrometry, photometry and orbit calculations are described in Černis et al. (2008), where the orbit was computed using 192 observations. Now we have used 230 observations but orbital elements are still uncertain and further observations are needed, see Table 4.

It was impossible to compute orbits for the asteroids 2005 EV236, 2005 EY282, 2005 EJ293, 2005 TO186, 2006 SH281, 2006 SU372, 2006 SX406 and 2007 GL28, which had too short observational arcs. They are listed in Table 3 as the lost asteroids.

Because of short observational arcs the orbits for about a dozen asteroids are of lower accuracy. From them we selected three dynamically interesting asteroids which can be visible in the nearest future. In the next section (§3) the ephemerides of these asteroids for 2016–2018 will be given.

Table 3. High precision orbital elements of the asteroids discovered at the Molėtai Observatory in 2005–2007. The epoch JD2457200 = 2015 June 27.

a (au)	e	i (deg)	Ω (deg)	ω (deg)	M (deg)
		(168431)			
2.6515150573072	0.1546340198270	14.8569846341	17.3461227541	301.8287768684	359.6326677869
2.30656E-08	9.91161E-08	1.08429E-05	3.14155E-05	4.33250E-05	2.65195E-05
H = 15.629	rms=0.6208"	293 obs.	arc: 1998 09 26.29462 – 2015 11 14.12771		
		2005 EE220			
3.0467748663	0.2323397913	6.748982832	98.92638858	68.4163436	339.88759113
1.22019E-05	4.62135E-05	3.90219E-04	1.25073E-03	1.67254E-02	5.38486E-03
H = 17.023	rms=1.0112"	42 obs.	arc: 2005 03 10.83819 – 2010 04 17.42685		
		(198820)			
3.0822467842623	0.100182793040	12.3514782257	132.0080518630	306.719807952	46.7379249886
8.92545E-08	1.03436E-07	1.62843E-05	6.06391E-05	1.16833E-04	9.49504E-05
H =14.949	rms=0.6458"	186 obs.	arc: 2002 08 30.47103 – 2015 05 17.15423		
		(280686)			
3.0194339928679	0.088475480140	12.3291513331	139.8949656112	358.8382045276	15.1316031598
8.47993E-08	1.29396E-07	1.25414E-05	4.62613E-05	9.22676E-05	7.16962E-05
H =15.972	rms=0.5070"	163 obs.	arc: 1994 02 13.10426 – 2015 04 10.33127		
		(167960)			
3.0001628604507	0.0793400181897	9.7616354996	119.2491456593	214.9112878454	193.2351179123
8.83875E-08	9.89255E-08	1.00436E-05	5.31844E-05	9.52338E-05	8.82073E-05
H = 14.931	rms=0.6263"	301 obs.	arc: 2002 10 05.24509 – 2015 03 17.29039		
		(296011)			
2.7356663497308	0.1609201785413	8.4951180509	126.9732917960	97.0516126699	59.8056831107
4.36954E-08	6.84215E-08	1.13370E-05	5.35041E-05	6.73480E-05	3.85180E-05

Table 3. Continued.

a (au)	e	i (deg)	Ω (deg)	ω (deg)	M (deg)
H =16.474	rms=0.5767"	145 obs.	arc: 2001 06 30.24566 – 2015 10 08.25746		
		(231040)			
3.145957769590	0.031175701013	16.0029275005	142.3885449805	289.496084507	41.754152000
2.08149E-07	1.82490E-07	1.42561E-05	5.60205E-05	6.19797E-04	5.78318E-04
H = 15.314	rms=0.4710"	107 obs.	arc: 2005 03 10.83819 – 2015 01 17.39199		
		(257285)			
2.4481592167472	0.208213806205	11.0693842647	19.1215664746	219.1139159384	198.9846364964
7.06436E-08	2.04516E-07	2.37863E-05	4.57106E-05	6.02709E-05	4.28063E-05
H =16.926	rms=0.5991"	109 obs.	arc: 2005 03 13.83918 – 2014 11 11.14656		
		2005 EK293			
2.803879245974	0.10517333060	14.6434472363	144.331175667	135.563714144	333.245714260
4.32691E-07	4.12646E-06	3.38321E-05	1.76565E-04	4.92083E-04	3.96327E-04
H =16.244	rms=0.5324"	65 obs.	arc: 2005 03 10.84402 – 2015 07 06.32678		
		2011 UP15			
1.889514329250	0.03042684483	24.2527305511	4.7272700169	350.31832669	161.31767206
5.01881E-07	3.37446E-06	5.24372E-05	7.48373E-05	3.24029E-03	2.77863E-03
H =17.968	rms=0.6455"	32 obs.	arc: 2005 03 13.87648 – 2014 12 30.37841		
		(187276)			
2.7874062226424	0.1258107105510	4.25744439946	236.760277871	24.218752307	139.4758703479
6.04626E-08	8.44545E-08	9.53790E-06	1.49714E-04	1.60262E-04	5.48775E-05
H = 15.725	rms=0.5863"	227 obs.	arc: 2000 09 04.29466 – 2015 01 17.23362		
		(339854)			
2.3162309317727	0.134188037813	5.5228143362	2.834509838	355.003597236	289.4122578846
3.69988E-08	4.42071E-07	2.02693E-05	1.10405E-04	1.39043E-04	6.09671E-05
H = 17.359	rms=0.6213"	115 obs.	arc: 2005 09 24.36012 – 2014 04 28.20915		
		2005 TO48			
2.6082326948	0.2585770593	2.379176228	281.07217607	92.924062052	115.0842087
4.64954E-05	9.60308E-05	2.77958E-04	4.59498E-03	5.89258E-02	5.81132E-02
H = 18.342	rms=0.5649"	30 obs.	arc: 2005 09 30.29807 – 2015 01 16.56410		
		(339855)			
2.2589152781390	0.0790666598929	7.2929174059	216.7731574591	281.822946062	200.940065380
2.91298E-08	6.83606E-08	1.38259E-05	4.93751E-05	1.16867E-04	1.10548E-04
H = 17.043	rms=0.7109"	172 obs.	arc: 2005 09 25.30396 – 2015 11 06.28234		
		(157534)			
2.3198943014383	0.061179104304	6.4711416308	9.8202054067	116.450270591	177.204419648
2.69377E-08	1.26470E-07	2.21741E-05	6.11683E-05	2.80701E-04	2.65626E-04
H = 17.036	rms=0.7263"	171 obs.	arc: 2000 04 06.27293 – 2014 05 20.32407		
		2005 TA50			
2.2929746061239	0.14359863322	23.0887834181	209.9574599401	193.408398873	273.838707410
8.46774E-08	1.95403E-06	7.63667E-05	2.67042E-05	2.15860E-04	1.49514E-04
H = 17.422	rms=0.6728"	82 obs.	arc: 2005 09 30.37421 – 2014 04 24.30208		
		440486			
2.2569553409662	0.255035700453	2.3085423655	298.920302245	33.768378613	342.8730852801
3.26518E-08	2.04529E-07	1.06960E-05	2.76589E-04	2.79020E-04	2.34177E-05
H = 18.154	rms=0.5383"	143 obs.	arc: 2005 09 30.37421 – 2015 11 02.25544		
		2005 TC50			
2.332953304328	0.20793606697	5.2440816716	1.570361923	346.091799960	285.942781368
1.70299E-07	2.00939E-06	2.43916E-05	1.05598E-04	3.89128E-04	2.33548E-04
H = 17.814	rms=0.6705"	88 obs.	arc: 2005 09 29.44249 – 2012 11 14.12774		
		(261136)			
2.7035931716106	0.1673989697028	3.2144788078	275.418838161	189.765878172	6.5884775775
2.66166E-08	9.19170E-08	1.04988E-05	1.56391E-04	1.62476E-04	3.77653E-05
H =16.224	rms=0.5952"	214 obs.	arc: 2001 12 17.30685 – 2015 03 28.12694		
		2005 TT52			
2.2586407896435	0.1341121170108	5.56200242937	251.910631896	36.040348339	34.4373049246
2.09862E-08	6.87930E-08	7.42015E-06	1.00094E-04	1.09555E-04	4.43632E-05
H =16.512	rms=0.6112"	297 obs.	arc: 1998 08 27.39226 – 2015 11 06.27372		
		2005 TW52			
3.009535244	0.3832707683	15.987443290	43.141860125	353.30415513	303.0713286
2.37683E-04	3.53906E-05	9.57752E-04	7.77019E-04	5.19353E-03	7.88076E-02
H =17.970	rms=0.7763"	22 obs.	arc: 2005 10 01.32797 – 2005 12 02.17891		
		(184786)			
2.9211864337422	0.133742249650	1.2519326272	351.121531660	9.337174476	356.9153247833

Table 3. Continued.

a (au)	e	i (deg)	Ω (deg)	ω (deg)	M (deg)
4.26364E-08	2.85419E-07	1.34646E-05	4.55895E-04	4.57892E-04	3.90267E-05
H = 16.755	rms=0.6651"	160 obs.	arc: 1995 10 02.37657 – 2015 11 13.19067		
(397013)					
3.0027100380888	0.125559576786	10.1187338270	218.1213546219	151.8228254332	321.9792766384
9.49863E-08	3.16563E-07	1.37889E-05	6.80528E-05	8.79568E-05	4.50933E-05
H = 16.433	rms=0.4726"	76 obs.	arc: 2005 09 30.29807 – 2015 11 03.25113		
(224278)					
2.5238481190430	0.0473479803743	9.7786189091	217.5060345821	214.331834427	105.811496558
2.66784E-08	9.65750E-08	1.23034E-05	6.59501E-05	2.87620E-04	2.71559E-04
H = 16.846	rms=0.6397"	124 obs.	arc: 1993 10 15.26065 – 2015 04 09.34274		
(290411)					
2.4564983161406	0.192375591942	2.1081974332	348.274724232	60.835871791	168.2938301331
5.01696E-08	2.43855E-07	1.36151E-05	5.73934E-04	5.78193E-04	6.54512E-05
H = 17.995	rms=0.6632"	74 obs.	arc: 1995 02 04.19496 – 2013 12 28.28119		
(261119)					
2.7576313761827	0.046454104131	6.3966620403	15.5018820453	289.669077016	120.603891478
6.07120E-08	1.31706E-07	2.06836E-05	8.99720E-05	2.54349E-04	2.41168E-04
H = 16.261	rms=0.6991"	104 obs.	arc: 2000 08 20.37954 – 2014 11 12.33911		
2005 TQ79					
2.292226810491	0.236592866925	3.3710650706	345.63480189	356.92716585	313.98586703
7.03459E-07	3.32681E-05	7.44483E-05	1.53126E-03	4.84819E-03	1.72793E-03
H =18.235	rms=0.5983"	26 obs.	arc: 2005 09 29.44081 – 2012 12 05.20603		
2005 TQ98					
2.18693773	0.1887440195	1.54874908	268.7266751	116.772895	357.37476
1.39365E-03	2.18548E-05	1.58245E-03	3.25386E-02	1.22804E-01	1.07674E+00
H =19.448	rms=0.5061"	19 obs.	arc: 2005 09 29.30284 – 2005 10 27.17658		
(189691)					
2.3866549781210	0.087438290056	3.4745526376	273.522893106	276.488396740	69.5002092817
4.39393E-08	1.34030E-07	1.13137E-05	2.18661E-04	2.29214E-04	7.28448E-05
H = 16.437	rms=0.6472"	139 obs.	arc: 2000 05 11.28695 – 2014 01 10.33403		
(391042)					
3.144986086142	0.122085818256	9.9913771485	10.3592827727	330.5862545686	305.9382401927
1.65935E-07	3.14037E-07	2.83676E-05	6.85758E-05	9.61483E-05	7.43776E-05
H = 15.699	rms=0.6341"	76 obs.	arc: 1997 04 07.21463 – 2014 04 29.34559		
2005 TH154					
2.61580982645	0.1340540057	12.605710115	218.233643948	207.7016234	76.7162177
6.96092E-06	2.30056E-05	1.34881E-04	1.55005E-04	1.39180E-02	1.32113E-02
H = 17.084	rms=0.6031"	30 obs.	arc: 2005 09 30.37421 – 2014 11 25.59177		
(186207)					
2.5992379647155	0.102949625349	9.1899053287	222.0792874848	92.100499430	177.640470347
6.78041E-08	1.28579E-07	1.09936E-05	6.13195E-05	2.00775E-04	1.58631E-04
H = 16.430	rms=0.5168"	249 obs.	arc: 2001 11 17.28755 – 2013 11 06.50702		
(155138)					
2.7716303422478	0.100668119162	4.9166986307	9.6766621018	148.4913744543	276.2684273872
4.26720E-08	1.06818E-07	1.01973E-05	8.07886E-05	9.54984E-05	5.20151E-05
H = 15.931	rms=0.6534"	206 obs.	arc: 1991 10 10.31203 – 2015 11 14.40773		
2005 TJ173					
2.2200788	0.173417285	4.855131	214.4566763	183.10250	327.8859
1.72539E-02	5.05166E-04	1.34554E-01	7.21690E-02	3.39224	1.45200E+01
H = 18.574	rms=0.8856541"	13 obs.	arc: 2005 10 08.94124 – 2005 10 22.34105		
2005 TR183					
2.316117065975	0.1623371802	3.423076919	358.259742669	26.0491422	269.2558880
4.78969E-07	1.50091E-05	1.43536E-04	5.82616E-04	2.53600E-02	1.77814E-02
H = 18.630	rms=0.7242"	36 obs.	arc: 1998 10 16.45341 – 2012 10 09.387174		
2005 TU183					
2.755829256606	0.02677725440	6.5718536532	1.535409603	19.47657357	51.48564682
5.52007E-07	7.84031E-06	5.31075E-05	1.01343E-04	4.01683E-03	3.87663E-03
H =16.727	rms=0.5926"	76 obs.	arc: 2005 09 29.44081 – 2014 11 12.33993		
(354730)					
3.174027159017	0.021293059046	9.2225190632	16.3584354335	150.831780970	122.716393174
1.11357E-07	2.21639E-07	2.72942E-05	7.51135E-05	7.14288E-04	6.99053E-04
H =15.614	rms=0.5155"	93 obs.	arc: 2005 09 29.45570 – 2014 05 07.43138		

Table 3. Continued.

a (au)	e	i (deg)	Ω (deg)	ω (deg)	M (deg)
		(348511)			
2.2313083008057	0.116316221047	3.8655011504	306.284505759	170.709527294	252.7817282938
3.52284E-08	1.37875E-07	1.22408E-05	2.40064E-04	2.52779E-04	7.60055E-05
H = 17.508	rms=0.5674"	128 obs.	arc: 2005 10 10.05903 – 2015 11 19.27442		
		2013 PR47			
2.580215257289	0.19958719137	2.3974772732	311.208173626	29.576669308	156.114154314
5.88140E-07	3.80595E-06	3.01765E-05	3.68103E-04	8.26616E-04	5.34542E-04
H = 18.064	rms=0.5020"	44 obs.	arc: 2005 09 29.44081 – 2015 01 16.37633		
		2005 UP488			
2.7714435686393	0.083067441361	3.4516287422	306.858246500	32.466810478	80.2768897730
8.72372E-08	1.51685E-07	1.20126E-05	2.12177E-04	2.21849E-04	6.58645E-05
H = 16.630	rms=0.5176"	115 obs.	arc: 2005 10 10.06448 – 2014 12 12.24932		
		2013 HK51			
2.914652932620	0.076831669254	5.8810985681	350.598207785	32.420735222	347.789462638
1.09011E-07	1.48818E-07	1.33993E-05	1.46427E-04	1.87769E-04	1.07408E-04
H = 17.026	rms=0.5213"	70 obs.	arc: 2005 10 08.95609 – 2015 11 09.66261		
		(176451)			
3.046388632076	0.150478795099	9.41308563424	15.9871697298	5.3201625069	249.1627446180
6.16476E-08	1.12539E-07	9.86876E-06	4.53114E-05	5.40990E-05	3.23287E-05
H = 14.861	rms=0.5417"	303 obs.	arc: 2000 08 26.33527 – 2015 06 22.44455		
		2006 RT1			
2.300853826151	0.25358522049	3.2176021133	333.663803263	6.94225018	189.56086973
1.21749E-07	1.45737E-06	4.65987E-05	1.80277E-04	2.00034E-03	1.11696E-03
H =19.340	rms=0.5265"	103 obs.	arc: 1999 08 21.33365 – 2013 10 21.38123		
		2006 RU1			
2.27201594	0.214533456	1.35485518	310.8939834	35.120338	203.21682
6.86199E-03	2.54427E-04	7.81612E-03	9.18789E-02	2.88923E-01	4.00625E+00
H =18.622	rms=1.0949"	13 obs.	arc: 2006 08 25.02864 – 2006 09 23.80208		
		2006 SF77			
9.21989709E-01	0.3291317504	32.5035215	1.25698646	224.4014870	65.747792
1.24070E-04	8.67496E-05	2.21895E-02	1.08465E-03	2.25627E-02	7.90556E-01
H =21.691	rms=0.6595"	230 obs.	arc: 2006 09 23.02142 – 2006 10 16.12686		
		(210147)			
3.0663711482896	0.064149682490	4.1099362666	221.585382952	148.286477971	232.6847861564
7.66772E-08	1.23411E-07	1.26406E-05	1.36159E-04	1.62658E-04	9.46419E-05
H = 15.775	rms=0.6035"	155 obs.	arc: 2001 11 20.30299 – 2015 05 22.42325		
		(409849)			
2.539663625530	0.10649817875	2.2635319987	249.498719681	97.82848276	80.78307298
2.97148E-07	3.88670E-06	2.57514E-05	9.23759E-04	2.02980E-03	1.69022E-03
H =17.479	rms=0.6141"	90 obs.	arc: 1998 10 20.30280 – 2014 10 27.29817		
		(185150)			
2.5778936662552	0.148202750325	1.4305674815	233.549812508	176.025650363	15.308252882
6.56100E-08	2.02035E-07	1.25039E-05	6.07151E-04	6.20027E-04	1.35557E-04
H = 17.485	rms=0.5772"	166 obs.	arc: 2002 10 31.35145 – 2014 11 17.27562		
		(212587)			
2.6083538254088	0.166774744039	7.2373843160	359.0775629310	265.2518073243	121.0326342767
3.12134E-08	6.64857E-08	1.37509E-05	5.07436E-05	7.04012E-05	4.32111E-05
H = 15.988	rms=0.6176"	208 obs.	arc: 1971 03 25.33090 – 2015 11 19.43113		
		(319601)			
2.5812322421755	0.2282438942141	4.5463348728	103.642773653	333.696292569	347.5256694904
5.43203E-08	8.67119E-08	1.28262E-05	2.24619E-04	2.38111E-04	8.60018E-05
H = 17.176	rms=0.7676"	63 obs.	arc: 2002 10 29.21259 – 2015 11 08.60196		
		(400072)			
2.5787069399441	0.169005365951	3.5820982471	71.359267103	271.737814007	52.8736693485
7.65268E-08	3.42817E-07	1.01659E-05	2.38131E-04	2.50442E-04	6.59627E-05
H = 17.355	rms=0.6079"	93 obs.	arc: 2002 10 10.23277 – 2014 09 28.29064		
		(214678)			
2.7723000511016	0.043942484688	6.53621368690	37.6758795239	359.136859430	288.935398799
5.52622E-08	1.03488E-07	9.31103E-06	7.72518E-05	1.32665E-04	1.08230E-04
H =16.164	rms=0.5490"	150 obs.	arc: 1995 03 26.35489 – 2015 08 12.49132		
		2006 SS197			
2.673865374	0.3253457432	4.988899839	38.10828399	341.7567603	351.720381
2.95435E-04	7.69763E-05	3.53413E-04	1.63971E-03	2.03412E-02	1.24182E-01

Table 3. Continued.

a (au)	e	i (deg)	Ω (deg)	ω (deg)	M (deg)
H =18.289	rms=0.6770"	25 obs.	arc: 2006 09 25.91348 – 2006 11 17.17871		
		(292343)			
2.5418392798430	0.226367771376	11.6453044648	235.91211803522	21.692323072	144.6758546241
4.69862E-08	1.21380E-07	1.93534E-05	9.49813E-05	1.17944E-04	7.54898E-05
H =16.169	rms=0.7078"	128 obs.	arc: 1993 06 20.19848 – 2014 12 12.24789		
		(245983)			
3.1284039251864	0.107854233420	23.1017552729	211.3217486460	230.943995947	149.2054539671
6.00664E-08	1.07684E-07	1.22031E-05	2.31544E-05	6.08453E-05	6.09476E-05
H = 14.987	rms=0.6612"	143 obs.	arc: 1993 05 24.33243 – 2015 07 01.31363		
		2006 ST219			
3.197550216	0.261732550	11.2100298	5.7341188	346.8939845	202.141338
8.56866E-04	4.67838E-04	1.36818E-02	1.34066E-02	9.79492E-02	2.08660E-01
H =16.458	rms=0.8245"	29 obs.	arc: 2006 09 21.98581 – 2006 10 21.31853		
		2006 SG281			
3.018049682308	0.028761973801	8.4606050415	315.538864478	19.057153727	276.269049857
2.09292E-07	3.36141E-07	2.27771E-05	1.27941E-04	3.03865E-04	2.81397E-04
H =16.006	rms=0.4582"	51 obs.	arc: 2003 01 25.194260 – 2015 06 22.40579		
		2006 SG281			
3.232936	0.08230	27.1536	209.7336	313.394	34.585
3.20063E-01	1.56514E+00	5.37878E+01	2.98948E+01	7.56972E+02	9.19773E+02
H =14.740	rms=1.4825"	16 obs.	arc: 2006 09 24.85640 – 2006 09 26.90707		
		(212606)			
2.7403010393991	0.1274310724202	0.88328946026	325.810925960	353.877875236	24.7600957045
2.94925E-08	6.42029E-08	6.75805E-06	4.67754E-04	4.68443E-04	3.01789E-05
H =16.313	rms=0.5982"	299 obs.	arc: 1997 11 22.29063 – 2015 11 08.28181		
		(175548)			
2.6461118101434	0.070154368447	1.28589986453	229.10600760	123.350316826	37.8644374554
4.30862E-08	1.07724E-07	6.54635E-06	3.32354E-04	3.35455E-04	4.73479E-05
H = 16.396	rms=0.5894"	282 obs.	arc: 1995 02 03.18256 – 2014 10 25.13997		
		2006 SH285			
2.60768403018	0.26994697896	5.7314768993	199.972542895	188.28982967	22.76827113
2.47075E-06	4.96141E-06	5.13841E-05	1.24820E-04	1.31000E-03	1.77856E-03
H = 18.048	rms=0.5083"	56 obs.	arc: 2006 09 18.42097 – 2014 07 28.43405		
		2006 SR290			
2.4313355193411	0.215854323684	1.1844303320	283.292430274	127.503694232	90.7325899726
8.37441E-08	2.53686E-07	1.33780E-05	4.87203E-04	4.96746E-04	9.90246E-05
H = 18.095	rms=0.4342"	103 obs.	arc: 2002 08 28.45748 – 2015 02 22.28264		
		(324417)			
2.4057817588562	0.185202927330	1.65829306277	251.794475504	162.144657204	100.6185512556
4.26971E-08	1.85771E-07	8.17333E-06	3.34533E-04	3.36977E-04	3.45646E-05
H = 17.158	rms=0.6449"	193 obs.	arc: 1991 10 09.17884 – 2015 02 26.38009		
		(406006)			
2.548589720713	0.153471465228	15.2961569977	3.6381124182	324.861955824	90.183452468
1.13948E-07	7.94812E-07	3.88485E-05	2.80409E-05	3.70628E-04	3.08013E-04
H = 17.180	rms=0.5577"	122 obs.	arc: 2006 09 23.89237 – 2014 12 12.24712		
		2006 SD368			
3.13975760018	0.23941182577	25.0792242373	215.5201926491	109.893576638	241.6585759772
1.69875E-06	2.24998E-06	5.39837E-05	6.76367E-05	1.38373E-04	3.12081E-04
H =16.353	rms=0.5045"	37 obs.	arc: 2006 09 23.07274 – 2015 03 18.43386		
		(319636)			
2.6451133509603	0.167087624221	18.4974012180	6.6587184054	62.3098171845	339.5340115503
8.64543E-08	1.00412E-07	1.92809E-05	3.51615E-05	9.17306E-05	9.19061E-05
H =16.203	rms=0.6901"	107 obs.	arc: 2006 09 20.30032 – 2014 07 08.60572		
		2006 SN368			
2.577203	0.432314	3.66658	245.2191	84.9599	57.095
2.25377E-01	1.21763E-01	1.06011E+00	1.12530E+01	2.09923E+01	1.02733E+02
H =19.376	rms=0.9280"	12 obs.	arc: 2006 09 23.89993 – 2006 09 28.39733		
		(313511)			
2.6367080022622	0.117420687534	6.1664786682	326.9704375886	170.0665609489	269.6594822932
4.14474E-08	1.54074E-07	1.22053E-05	6.63860E-05	7.57145E-05	3.60514E-05
H =16.535	rms=0.5029"	132 obs.	arc: 2002 11 13.39303 – 2015 11 21.40995		
		2006 SP368			
2.7399142055644	0.207886167346	8.5588270787	223.7673081317	155.971524372	332.5709695782

Table 3. Continued.

a (au)	e	i (deg)	Ω (deg)	ω (deg)	M (deg)
5.51919E-08	9.73469E-07	1.70018E-05	5.61947E-05	1.69692E-04	8.73675E-05
H = 16.762	rms=0.6270"	174 obs.	arc: 2006 09 20.31495 – 2015 11 14.26511		
2006 SQ368					
3.075403013511	0.066583267963	7.5615158303	335.038815098	63.414700376	207.125774973
2.39163E-07	2.96009E-07	4.22749E-05	1.15753E-04	3.75409E-04	3.64317E-04
H =16.347	rms=0.5803"	50 obs.	arc: 2006 09 25.98282 – 2014 04 01.23684		
(262284)					
2.7622305360681	0.078241616862	7.8129986627	271.919192211	293.233904921	130.687348515
7.43851E-08	1.11562E-07	1.01870E-05	1.05222E-04	1.43248E-04	1.01327E-04
H =16.150	rms=0.5756"	112 obs.	arc: 2004 02 18.43982 – 2015 10 18.56885		
2006 SB369					
2.619866476791	0.09389769560	8.2216807421	242.928251549	83.86922028	59.86958102
8.35935E-07	2.31530E-06	2.06383E-05	1.72453E-04	1.66301E-03	1.25364E-03
H =17.076	rms=0.6002"	31 obs.	arc: 2006 09 24.85848 – 2014 08 16.45813		
(299897)					
3.080546636183	0.172604116322	3.8747512357	349.362373902	71.309655252	190.997155272
1.37329E-07	1.23333E-07	1.83200E-05	1.55665E-04	1.91025E-04	1.23421E-04
H = 16.031	rms=0.5503"	120 obs.	arc: 1996 12 14.31008 – 2014 04 28.33546		
(361265)					
2.6942508951192	0.140123970624	9.0888362860	344.3109868228	355.348799966	21.6400784990
5.66375E-08	2.53782E-07	1.58119E-05	8.89443E-05	1.09068E-04	8.05249E-05
H = 16.621	rms=0.7022"	114 obs.	arc: 2001 07 19.26722 – 2015 11 22.14455		
(335668)					
2.138029057785	0.12983623246	3.3514222076	302.076342951	52.630575976	302.451186887
3.60098E-07	1.70200E-06	1.42443E-05	1.73105E-04	2.67777E-04	3.40568E-04
H =18.591	rms=0.7938"	53 obs.	arc: 2003 11 16.27148 – 2015 07 07.45790		
2006 SU372					
2.3588837	0.09540533	6.097272	338.798797	70.2693	122.0745
1.35933E-02	5.16657E-03	1.25186E-01	6.04108E-01	1.95445E+01	1.62963E+01
H =17.476	rms=0.7029"	11 obs.	arc: 2006 09 23.92937 – 2006 09 30.31822		
(308934)					
2.7754284978504	0.1650134179091	8.8958376995	224.8986781593	226.4475737741	265.6343865801
3.84321E-08	8.91528E-08	1.34001E-05	6.84513E-05	8.13743E-05	4.46282E-05
H =16.449	rms=0.6556"	119 obs.	arc: 1997 11 28.37499 – 2015 11 06.29286		
2006 SG397					
2.22848144686	0.22497156451	5.0738478118	214.917322446	130.272969970	243.74231953
4.63482E-06	4.35506E-06	3.27468E-05	1.75975E-04	2.24281E-03	4.16447E-03
H = 18.356	rms=0.4031"	32 obs.	arc: 2006 09 23.88503 – 2012 05 21.4000		
(292490)					
2.6542932915166	0.172754589032	10.92536975284	358.9961634454	290.1613059149	83.3999977872
5.50460E-08	1.10121E-07	9.77227E-06	5.14302E-05	6.10476E-05	2.59719E-05
H =16.504	rms=0.5510"	148 obs.	arc: 1997 10 21.07529 – 2015 11 22.24588		
2006 SW406					
3.95136104883	0.3126650918	4.748625703	324.49239602	16.40076164	59.48951914
5.80757E-06	3.68279E-05	1.46269E-04	1.66039E-03	6.90268E-03	5.67205E-03
H = 16.136	rms=0.5494"	62 obs.	arc: 2006 09 23.89237 – 2014 11 30.09388		
2006 SX406					
2.5293914	0.3202091	5.575572	332.06523	8.0573	80.052
2.45582E-01	9.41276E-02	4.03517E-01	2.11843E+00	1.18602E+01	1.13677E+02
H = 18.422	rms=0.7629"	9 obs.	arc: 2006 09 23.89993 – 2006 09 26.03078		
(248839)					
2.6819734914963	0.173178907378	11.7026201913	349.3608826807	285.8009833613	80.6736305425
5.49731E-08	1.08838E-07	1.89245E-05	4.44904E-05	7.59790E-05	7.02611E-05
H =15.938	rms=0.6801"	129 obs.	arc: 1997 10 30.2636 – 2015 11 06.23676		
2014 LE10					
2.719400768573	0.143116089979	11.0004593303	222.7753154725	118.143065269	4.346803025
1.01685E-07	7.17343E-07	2.23965E-05	5.93297E-05	5.31145E-04	4.35694E-04
H = 17.231	rms=0.5417"	93 obs.	arc: 2006 09 26.88359 – 2015 11 18.24446		
2006 YS27					
2.6769750440329	0.156161695003	3.0699642943	268.228583821	171.377557722	311.6907748729
5.98364E-08	1.29977E-07	1.38092E-05	2.17196E-04	2.22889E-04	4.37654E-05
H = 17.256	rms=0.6841"	81 obs.	arc: 2002 12 28.14923 – 2015 11 21.33291		

Table 3. Continued.

a (au)	e	i (deg)	Ω (deg)	ω (deg)	M (deg)
		2011 PR13			
2.983750381596	0.092982074681	8.6144575642	313.6958637034	319.210422465	339.2936525867
1.78361E-07	1.34606E-07	1.24141E-05	9.83241E-05	1.43776E-04	9.38792E-05
H = 15.755	rms=0.5126"	89 obs.	arc: 2006 09 25.83692 – 2015 06 22.40643		
		2013 GP36			
3.155195910570	0.118966327745	21.1602449221	15.7371948355	167.966689173	155.9329538618
1.93281E-07	5.65312E-07	4.72223E-05	5.01786E-05	1.03370E-04	8.92934E-05
H = 16.325	rms=0.6979"	59 obs.	arc: 2001 02 22.169545 – 2015 10 18.38813		
		(212692)			
3.1139693714748	0.026669136892	10.37983152970	77.7838627467	160.587092839	113.043960508
7.45209E-08	1.02891E-07	9.43954E-06	4.72041E-05	1.75181E-04	1.65926E-04
H =15.420	rms=0.6669"	158 obs.	arc: 2002 03 13.44493 – 2015 11 06.37446		
		(320153)			
3.150515216780	0.046996561993	16.0470653754	130.1534653828	94.990603841	119.719770900
1.46765E-07	1.48872E-07	1.90476E-05	4.99117E-05	2.79686E-04	2.87403E-04
H =15.386	rms=0.7579"	79 obs.	arc: 2002 05 13.34247 – 2015 09 08.54076		
		2007 FV20			
2.549364208979	0.27639459157	12.4148013826	31.390863226	108.321036259	27.569097177
2.10942E-07	1.19946E-06	1.67030E-05	1.34109E-04	6.92383E-04	3.14010E-04
H =18.402	rms=0.5832"	62 obs.	arc: 2003 03 26.21121 – 2015 03 17.31857		
		(327977)			
2.708114192771	0.041167895122	6.4815584276	61.338620838	185.519416718	241.629965475
1.25681E-07	1.67792E-07	1.40398E-05	1.08192E-04	2.14604E-04	1.73085E-04
H = 16.196	rms=0.6655"	90 obs.	arc: 2005 12 02.13914 – 2014 12 29.28300		
		(319012)			
2.988259521451	0.228723883125	7.1243496547	108.433070076	340.948494709	276.4190067051
1.20614E-07	1.41151E-07	1.35341E-05	1.57872E-04	1.62926E-04	5.48139E-05
H =16.163	rms=0.5999"	72 obs.	arc: 2000 11 20.23034 – 2015 09 15.31481		
		(32570)			
2.747994431911	0.088819098191	11.5818247529	36.4970406496	261.680756628	178.956018805
1.15737E-07	1.15383E-07	1.99810E-05	6.35935E-05	1.51478E-04	1.27094E-04
H = 15.857	rms=0.6550"	91 obs.	arc: 2004 09 07.25168 – 2014 12 31.09710		
		(346927)			
2.2643152645728	0.050817227692	6.44627344079	87.947502796	64.876917446	174.893720848
9.38255E-08	1.72247E-07	8.82800E-06	1.06131E-04	2.47248E-04	2.34922E-04
H =17.450	rms=0.5946"	108 obs.	arc: 2003 01 06.09515 – 2015 11 04.30130		
		(225033)			
2.7959862629018	0.151095397548	10.2907109647	128.4636854337	180.2864071438	157.2282977729
5.75227E-08	1.03614E-07	1.07295E-05	5.47207E-05	6.39057E-05	3.33941E-05
H =15.600	rms=0.6013"	163 obs.	arc: 1997 02 10.34842 – 2015 01 14.23905		
		(361524)			
3.155157112904	0.039776793064	11.4015388312	131.4205651813	316.108020583	253.153112912
2.42980E-07	1.28297E-07	1.28972E-05	4.61622E-05	2.28091E-04	2.27825E-04
H =15.469	rms=0.6021"	149 obs.	arc: 2007 03 11.70744 – 2015 10 09.36480		
		(386056)			
2.3608051219202	0.1900022320044	2.3764858387	169.868459620	76.056902694	58.1011358561
3.82530E-08	9.44920E-08	1.71993E-05	1.99397E-04	2.08799E-04	7.00325E-05
H =17.479	rms=0.6258"	99 obs.	arc: 2000 05 27.31417 – 2015 09 12.42330		
		2013 GP36			
3.155195910570	0.118966327745	21.1602449221	15.7371948355	167.966689173	155.9329538618
1.93281E-07	5.65312E-07	4.72223E-05	5.01786E-05	1.03370E-04	8.92934E-05
H =16.325	rms=0.6979"	59 obs.	arc: 2001 02 22.169545 – 2015 10 18.38813		
		(202704)			
2.2126735605994	0.07047225488142	6.2427765597	104.9728311574	139.662737865	152.8093424316
3.61640E-08	9.00235E-08	1.15492E-05	7.83414E-05	1.24070E-04	9.30173E-05
H = 16.904	rms=0.6449"	160 obs.	arc: 2000 03 04.30569 – 2014 09 25.14156		
		(248993)			
2.4308988754312	0.201681394646	11.29917895224	77.3448502111	192.4202619899	22.1488463371
3.99995E-08	1.29002E-07	9.74236E-06	5.36863E-05	6.00582E-05	2.83376E-05
H =16.540	rms=0.6482"	121 obs.	arc: 2003 03 25.46889 – 2015 09 08.99392		
		(309206)			
1.9907124451412	0.138786041119	19.5129861052	23.7695990437	67.1185920278	49.5278373281
3.87301E-08	2.09799E-07	2.38171E-05	2.95947E-05	1.04243E-04	9.08102E-05

Table 3. Continued.

a (au)	e	i (deg)	Ω (deg)	ω (deg)	M (deg)
H =17.603	rms=0.6556"	116 obs.	arc: 2000 10 25.40082 – 2015 01 20.16042		
		(281208)			
2.3315679353698	0.076252788365	7.50125918948	60.9742754979	55.323725458	168.8216038949
4.66426E-08	1.48095E-07	9.74897E-06	9.06833E-05	1.17037E-04	8.24013E-05
H =16.849	rms=0.5913"	103 obs.	arc: 2005 09 03.369517 – 2015 07 24.41446		
		450737			
3.176643034675	0.208621856833	23.9238723330	203.6476954753	355.339710853	175.443224625
2.30297E-07	5.35493E-07	3.14498E-05	3.26788E-05	1.11980E-04	1.47404E-04
H =15.990	rms=0.6170"	56 obs.	arc: 2001 03 24.25313 – 2015 11 03.36898		
		(381160)			
2.4520487024282	0.168410785843	6.5160725506	113.165135668	82.824624436	41.314265756
9.76751E-08	3.93093E-07	1.31031E-05	1.62934E-04	2.00880E-04	1.25681E-04
H =17.400	rms=0.5607"	102 obs.	arc: 1999 01 08.18778 – 2015 06 24.36287		
		(324787)			
3.0774155224757	0.105779563113	17.1963967466	77.1703257252	258.955416999	81.5767051771
4.32997E-08	1.69328E-07	1.82058E-05	7.08817E-05	1.21738E-04	9.87370E-05
H =15.324	rms=0.6213"	125 obs.	arc: 1998 09 19.432011 – 2015 10 08.51591		
		(341087)			
2.5133087945077	0.034429227774	6.8910432111	113.998183517	19.803679978	98.704757095
4.99846E-08	1.06727E-07	1.01860E-05	1.27321E-04	3.27937E-04	2.94515E-04
H =16.483	rms=0.5556"	135 obs.	arc: 1995 04 26.41910 – 2015 05 26.36099		
		(305181)			
2.5735019204858	0.1585282838637	8.7644684951	14.7853787268	275.8993197092	52.5041966216
3.58152E-08	8.69013E-08	1.51047E-05	6.54909E-05	8.42193E-05	5.22026E-05
H =16.303	rms=0.6069"	160 obs.	arc: 1993 03 19.21875 – 2015 11 18.18925		
		2007VM315			
2.17966264	0.281626429	4.30473048	0.2734300	37.635631	140.58605
3.67252E-03	6.45181E-04	9.30835E-03	6.38092E-02	2.95676E-01	2.13805E+00
H =19.107	rms=0.5079"	10 obs.	arc: 2007 11 05.79071 – 2007 11 20.20985		

3. EPHEMERIDES FOR THE ASTEROIDS WITH ORBITS OF LOW ACCURACY

The ephemerides for 2016–2018 (geocentric observer) were computed for three asteroids with orbital elements of low accuracy when they will be brighter than 23.8 mag. We used the OrbFit software version 4.2 and JPL DE405 planetary and lunar ephemerides with 25 additional perturbing asteroids according to Farnocchia et al. (2013). The ephemerides are computed for the value of the non-gravitational parameter $A2 = 0$. Table 4 gives right ascensions (h, m, s) and declinations (deg, arcmin, arcsec), expected magnitudes, solar and lunar elongations (deg) and the sky plane errors in both axes (Err1 and Err2) in (deg, arcmin, arcsec) and the position angle (PA, deg). The magnitude errors are of the order of 0.5 mag. It is difficult to compute time evolution of these asteroids because of low accuracy of their orbital elements. We need additional observations to extend their observational arcs and to improve orbital elements.

4. RESULTS

During the years 2005–2007, at the Molėtai Observatory 112 asteroids have been discovered. For most of them we present orbits of high accuracy. For a few of the new asteroids the orbital elements are of low accuracy, thus they need additional astrometric observations. For three of these asteroids, having dynamically interesting orbits, the ephemerides for 2016–2018 are presented.

Table 4. Ephemerides for 2016–2018 of the asteroids with dynamically interesting orbits of low accuracy discovered at the Molėtai Observatory (for the geocentric observer).

Date	RA	DEC	Mag	Solar elong.	Lunar elong.	Sky plane error Err1	Err2	*PA*
			2006 SF77 - Aten					
2016 Nov 16	12 51 58.015	+32 14 28.25	23.8	62.9	–103.7	40.298’	0.018’	175.3
2016 Nov 26	13 29 22.782	+25 15 26.64	23.7	60.1	31.9	44.437’	0.017’	177.7
2016 Dec 6	14 04 54.608	+17 10 24.07	23.6	56.7	119.9	48.397’	0.015’	177.7
2016 Dec 16	14 40 21.963	+07 58 34.77	23.5	52.9	–103.5	51.560’	0.013’	175.3
2016 Dec 26	15 18 08.873	–02 11 41.61	23.4	48.6	14.7	52.989’	0.010’	170.1
2017 Jan 5	16 01 15.996	–12 49 19.68	23.3	44.3	123.3	51.742’	0.007’	161.3
			2006 SN368 - Mars Crosser					
2017 Nov 1	06 05 49.604	+21 23 29.41	21.9	127.1	–95.3	221.945°	0.325°	95.9
2017 Nov 11	06 02 55.723	+20 46 26.65	21.7	137.8	49.7	240.037°	0.385°	95.2
2017 Nov 21	05 56 06.739	+20 08 55.53	21.5	149.4	177.0	256.788°	0.447°	94.2
2017 Dec 1	05 46 11.050	+19 31 50.08	21.3	161.6	–54.8	268.879°	0.508°	93.2
2017 Dec 11	05 34 32.723	+18 56 40.61	21.1	173.3	93.3	273.274°	0.559°	92.1
2017 Dec 21	05 22 53.439	+18 25 43.88	21.2	–170.8	–142.6	268.626°	0.593°	91.2
2017 Dec 31	05 12 53.930	+18 01 44.51	21.6	–159.0	-9.3	256.012°	0.609°	90.6
			2007 VM315 - Mars Crosser					
2018 Jan 20	10 29 18.444	+14 48 32.98	22.0	145.7	176.0	4.445°	0.001°	117.4
2018 Jan 30	10 20 02.819	+15 32 36.69	21.8	158.1	–43.9	4.697°	0.001°	116.4
2018 Feb 9	10 08 31.250	+16 20 20.98	21.6	170.5	96.1	4.826°	0.001°	115.2
2018 Feb 19	09 56 14.843	+17 02 58.22	21.6	–173.7	–139.3	4.798°	0.003°	114.1

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