
Center for Space Debris Data Collection, Processing and Analysis
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High Geocentric Orbit Space Debris Circular No.1

Coverage period ends on Jan 31, 2007

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Introduction

This circular opens new series of publications devoted to periodical summarizing of worldwide scientific activity in observations of space debris objects on high geocentric orbits (GEO, HEO and high near-circular non-GEO). Objects considered to be included into this publication are fragments (operational by nature, created in fragmentation events or in result of larger objects surface and construction deterioration due to environment conditions) having brightness fainter than 15th visual magnitude during most part of their observation time. This limit corresponds to equivalent approximately 1 m size object on geostationary orbit. It is possible that sometimes these objects can be brighter than 15th magnitude due to combination of their specific properties (surface reflectivity and attitude) and favorable observation conditions (good phase angle, high elevation etc.).

The goal of this publication is to give world scientific community imagination about the status of high geocentric orbit space debris researches and to provide most recent data for each discovered object including orbital parameters, estimated standard magnitude and estimated area-to-mass ratio value. Those data can be included into existed space debris models as well as can be used for study of long-term orbital evolution and possible origin of the objects. The Circular will also serve as some reference document for scientists and amateurs involved into those objects observations and data analysis. Operators of spacecrafts on high geocentric orbits (mainly in GEO) can use this publication in order to obtain more real description of situation around their orbital assets.

Observation planning, ephemeris support, processing and analysis of obtained data are made by researchers from Keldysh Institute of Applied Mathematics (KIAM) (Vladimir Agapov, Igor Molotov, Viktor Stepanyants, Vladimir Titenko) with invaluable help of Zakhariy Khutorovskiy (Vympel Corporation) and Vasiliy Yurasov (Scientific and Research Institute of Precise Instrument Engineering, IPIE).

All questions regarding cooperation in the joint research program for high geocentric orbit space debris studies should be sent to Prof. E. L. Akim, KIAM Deputy Director. All questions regarding observation schedule, required formats, ephemeris support, observations and orbital data processing, analysis and usage should be sent to Dr. V. M. Agapov. All questions regarding requirements for observation instruments, CCD-frames processing software, possible help in the instrument's upgrade in order to make possible participation in the research program should be sent to Dr. I. Ye. Molotov.

List of sensors

This list includes all sensors participating to the date in a joint program of observation and analysis of space debris objects on high geocentric orbits. Each sensor has own identification

number assigned to it in the KIAM space objects database. Most of sensors are involved into minor planet observations as well thus having the MPC assigned identification code. But for purposes of this research program it was decided to maintain separate ID system permitting to describe all participating sensors regardless of their other research programs involvement. Coordinates of sensors are given for reference purposes only and shouldn't be used in real observation processing. In the column "Instrument" common name, aperture (d, mm) and focal length (f, mm) of each instrument are given.

The list will be updated each time new sensor will send observations for studied objects.

Table 1. List of participating sensors

Ref. ID	Longitude, °	Latitude, °	Height, km	Observatory/ Facility	Instrument
10003	100.919 E	51.622 N	1.998	Mondy	AZT-14
10010	41.432 E	43.657 N	2.070	Arhyz	Zeiss-600 d600/f7500
10012	42.499 E	43.276 N	3.127	Terskol	Zeiss-2000 d2000/f16000
10016	30.273 E	46.397 N	0.010	Mayaki	RC-600 d600/f4800
10018	33.163 E	45.219 N	0.010	Yevpatoriya	AZT-8 d700/f2800
10019	33.997 E	44.403 N	0.340	CrAO/Simeiz	Zeiss-1000
10031	34.016 E	44.726 N	0.585	CrAO/Nauchnyi	AT-64 d640/f900
10041	66.896 E	38.673 N	2.593	Maidanak	Zeiss-600 d600/f7500
10042	41.443 E	43.649 N	2.059	SAO/Arhyz	Zeiss-1000 d1000
10071	64.624 W	21.596 S	1.865	Tarija	Zeiss-600 d600/f7500
10102	100.920 E	51.622 N	2.000	Mondy	Zeiss-600 d600/f7500
10103	100.919 E	51.617 N	2.025	Mondy	AZT-33IK d1500/f30000
10191	7.465 E	46.877 N	0.951	Zimmerwald	ZIMLAT-1000 d1000/f10500
10198	16.512 W	28.301 N	2.445	Teide/OGS	Zeiss-1000 d1000/f13300
10531	34.016 E	44.728 N	0.595	CrAO/Nauchnyi	ZTSh d2600/f10000
10532	34.017 E	44.730 N	0.595	GAISh/Nauchnyi	Zeiss-600 d600/f4680
10533	34.016 E	44.726 N	0.585	CrAO/Nauchnyi	PH-1 d220/f507

New objects

This section contains information on objects newly detected during period Jan 1 – Jan 31, 2007.

There are two lists. The first one contains information on objects which had been successfully recovered in follow-up observations after initial detection and one-night tracking and for which orbital data and area-to-mass ratio value had been determined with high level of confidence. The second one contains information on objects having only one night track of observations. Complete set of orbital data can't be determined for these objects. Only some orbital parameters (mainly inclination and RAAN) are determined relatively accurate. The AMR values can't be determined for these objects at all.

It should be noted that all one-night tracks had been probed to identify with all other one-night tracks and with all known objects in the KIAM database having well determined orbits (both bright and faint). It is possible that identification had negative results not only due to absence of other tracks of the same object but also due to uncertainty caused by unknown AMR value which can result in very significant orbital evolution that prevents proper correlation of one-night tracks.

Each object listed in this section has two identifiers. The first one is assigned by the observer discovered the object and the second one is assigned in the KIAM space objects database. Since widely agreed space debris identification system doesn't exist still then all

provided identifiers can be assumed as temporary ones. As soon as such the agreed system will appear, all objects will be assigned with the new identifiers.

Orbital elements are referring to True Equinox Mean Equator (TEME) coordinate system. Area-to-mass ratios are calculated assuming reflectivity coefficient equal to 1.3. Orbital elements for short tracks (Table 3) have obtained in two steps. At the first one attempt to construct orbit with fixed zero value eccentricity was made. In case of great (more than 3 expected sigma) residuals of measurements the second step was applied. At this step it was allowed eccentricity to vary as well.

Table 2. List of newly discovered and confirmed objects

ID1	ID2	Date/time, UTC	<i>a</i> , km	<i>e</i>	<i>i</i> , °	Ω , °	ω , °	<i>u</i> , °	AMR, sq.m/kg
4310 5	E07014 A	23.01.2007 20:37:42.2 6	42147.4 4	0.320500 2	17.45 1	328.97 9	322.66 1	146.50 7	12.85
4310 6	E07015 A	24.01.2007 06:37:55.2 6	41838.4 6	0.179072 4	14.32 8	297.02 4	346.42 3	312.59 4	8.30
4310 7	E07015 D	23.01.2007 21:41:34.9 5	41429.9 8	0.106181 0	10.37 4	337.50 8	313.89 0	137.30 6	3.44
4310 8	E07017B	20.01.2007 00:31:55.1 5	41737.4 2	0.065342 9	8.575	316.20 7	327.29 8	211.502	1.56
4310 9	E07020 A	24.01.2007 01:52:38.1 5	42008.1 4	0.016461 6	13.46 4	10.951	80.959	160.21 5	0.44
43110	E07020C	22.01.2007 03:25:12.1 6	20502.9 9	0.6654611	7.884	19.145	326.05 9	149.39 3	0.54
43111	E07020 D	23.01.2007 23:35:48.2 9	41846.8 1	0.090870 6	16.04 0	333.711	290.94 2	104.18 8	7.22
43112	E07021 A	23.01.2007 05:50:01.3 8	42224.7 5	0.072059 3	10.79 4	337.64 2	281.54 9	210.78 6	2.08
43113	E07021B	22.01.2007 23:16:41.3 5	25033.6 7	0.718179 1	7.665	94.815	221.89 2	54.970	-
43114	E07021 D	24.01.2007 00:58:55.2 5	24762.7 1	0.715323 4	4.948	84.361	253.66 3	65.898	7.88
43115	E07022 A	23.01.2007 21:02:47.0 6	43693.7 9	0.292389 3	1.639	183.23 1	96.209	237.42 0	7.77
9005 2	95306	24.01.2007 15:17:49.5 0	41052.2 0	0.007871 7	9.543	325.00 2	182.10 9	130.26 0	0.044

Table 3. List of newly discovered objects having only single one-night track of observations

ID1	ID2	Date/time, UTC	Track duration, hh:mm	T , min	a , km	e	i , °	Ω , °	ω , °
4615 3	g070115a	15.01.200 7	00:02	651.13	24885.2	0.3755	18.122	16.53	261.10
4615 4	g070115b	15.01.200 7	00:02	1357.03	40602.5	0	13.925	4.97	196.12
4615 5	g070116c	16.01.200 7	00:03	2243.03	56761.0	0.3828	10.665	55.14	139.51
4615 6	g070116d	17.01.200 7	00:08	1248.09	38399.4	0.0555	14.058	356.9 3	318.89
4615 7	g070116e	17.01.200 7	00:21	939.83	31782.9	0.4390	16.198	29.13	208.26
4615 8	g070117a	17.01.200 7	00:15	1469.46	42815.3	0.0052	14.926	9.83	6.43
4615 9	g070117b	17.01.200 7	00:06	1465.47	42737.8	0	13.849	7.51	246.67
4616 0	g070118a	18.01.200 7	00:47	1384.44	41147.5	0.0207	12.966	3.56	141.99
4616 1	g070118b	18.01.200 7	00:16	1289.01	39234.2	0.0693	13.866	7.98	317.14
4616 2	g070122	22.01.200 7	00:25	1481.45	43047.9	0.0422	14.716	358.9 2	32.58
4640 4	m070124	24.01.200 7	00:12	1451.62	42468.0	0	14.588	359.2 8	11.84

New identifications

This section contains information on successful identification of newly and previously obtained single one-night tracks with each other as well as with objects having well determined orbits.

Table 4. New identifications

ID_new	ID_old	Observation date	Observer
90052	065871577	14.10.2006	10533

Updated orbits

This section contains information on latest orbital updates for objects discovered prior to Jan 1, 2007 and observed at least once in Jan 2007.

Table 5. Updated orbital parameters for objects observed in Jan 2007.

ID1	ID2	Date/time, UTC	a , km	e	i , °	Ω , °	ω , °	u , °	AMR, sq.m/kg
4302 6	EGEO26	16.01.2007 16:59:29.5 1	41443.11	0.145658 5	9.575	335.76 1	315.87 3	114.410	4.20

ID1	ID2	Date/time, UTC	a , km	e	i , °	Ω , °	ω , °	u , °	AMR, sq.m/kg
4303 1	EGEO31	23.01.2007 03:46:29.3 7	40189.5 1	0.125973 7	12.07 9	337.64 6	319.49 2	161.17 7	1.32
4303 3	EGEO33	21.01.2007 02:00:36.1 7	33182.6 6	0.347162 6	8.128	72.193	244.89 0	53.525	3.49
4304 5	EGEO45	24.01.2007 06:54:33.8 5	42157.0 0	0.105998 0	9.670	330.92 3	59.104	256.57 6	1.84
4308 1	E06204 D	13.01.2007 04:20:20.9 0	46833.3 5	0.244836 5	9.655	129.76 5	320.72 5	19.718	8.21
4308 2	E06205C	21.01.2007 00:28:54.0 6	41416.5 3	0.046664 3	13.87 6	345.24 9	245.05 4	75.201	2.21
4308 4	E06207B	23.01.2007 01:15:12.3 7	38316.7 0	0.320776 9	10.77 3	333.05 9	298.76 2	108.44 5	21.52
4309 1	E06293 A	24.01.2007 07:02:15.8 5	40257.0 4	0.293930 5	4.784	126.25 5	184.56 2	28.512	11.29
4309 3	E06326 A	23.01.2007 01:05:53.4 6	43583.6 1	0.087976 2	9.233	333.24 9	305.90 7	187.76 1	3.32
4309 4	E06326C	23.01.2007 03:54:42.3 6	40825.9 5	0.2341611	8.038	301.16 3	2.015	189.211	10.49
4309 8	E06327F	17.01.2007 05:32:02.1 7	43309.2 0	0.073329 7	9.715	333.84 3	278.58 4	179.09 6	2.77
4310 0	E06327E	20.01.2007 22:52:50.4 6	39989.4 2	0.065514 2	12.54 1	344.99 1	253.20 8	69.697	0.41
4310 1	E06348C	16.01.2007 02:16:29.0 6	43315.9 0	0.248189 8	12.12 8	348.18 7	317.94 4	95.930	4.29
4310 3	E06349B	16.01.2007 19:32:50.6 0	41889.7 3	0.004758 9	13.89 7	103.69 9	6.552	133.47 3	0.029
9000 6	90006	28.01.2007 16:16:23.5 0	42190.0 2	0.0011732	14.46 5	352.53 2	13.457	128.25 8	0.017
9000 8	90008	19.01.2007 00:13:04.7 1	42148.3 0	0.004247 4	14.35 9	358.42 8	102.68 7	194.32 8	0.0062
9000 9	90009	17.01.2007 15:17:26.2 8	42275.0 1	0.003237 6	14.68 7	359.53 3	350.46 9	144.118	0.019

ID1	ID2	Date/time, UTC	a , km	e	i , °	Ω , °	ω , °	u , °	AMR, sq.m/kg
9001 4	90014	22.01.2007 19:15:10.2 7	42616.3 9	0.007880 2	14.98 8	354.06 1	113.923	114.758	0.043
9001 6	90016	14.01.2007 19:38:01.5 9	42240.2 4	0.016752 7	14.03 0	332.56 9	217.89 6	41.781	2.03
9001 9	90019	18.01.2007 00:03:04.0 2	42229.3 0	0.005284 3	14.82 1	359.93 6	19.760	179.46 6	0.12
9002 1	90021	22.01.2007 23:20:42.2 7	42699.4 2	0.0204119	14.91 9	0.077	342.98 3	169.02 6	0.38
9002 2	90022	17.01.2007 16:59:03.5 2	42156.1 7	0.005574 0	14.56 5	359.10 7	226.33 1	104.69 8	0.10
9002 3	90023	19.01.2007 14:51:08.5 0	40109.9 3	0.019206 7	12.37 7	355.79 4	18.208	74.872	1.64
9002 7	90027	17.01.2007 14:48:39.1 3	42005.9 2	0.020738 2	10.20 0	332.50 7	211.013	124.81 4	0.014
9002 8	90028	28.01.2007 16:34:47.5 0	42495.8 9	0.013010 2	14.61 3	359.19 5	61.629	112.501	0.0089
9003 1	90031	18.01.2007 23:55:07.8 7	42158.7 9	0.002053 1	13.80 6	7.910	203.32 9	156.97 0	0.0053
9003 2	90032	18.01.2007 23:31:05.3 0	42158.9 5	0.018788 4	14.28 8	359.31 2	235.24 9	158.48 9	0.0047
9003 3	90033	12.01.2007 16:34:43.4 6	20521.6 6	0.654678 9	2.022	9.705	179.42 7	57.458	-
9003 4	90034	15.01.2007 17:19:41.8 2	24638.1 9	0.715146 9	7.051	184.09 9	18.618	192.41 0	1.55
9004 1	90041	18.01.2007 02:52:55.5 6	41990.9 5	0.002688 0	11.398	29.763	0.027	121.44 9	0.086
9004 2	90042	17.01.2007 02:50:52.9 0	38705.8 5	0.044337 6	11.458	336.21 6	277.24 1	230.54 0	0.81
9004 8	90048	17.01.2007 17:50:37.8 7	41584.0 7	0.075341 4	13.94 6	347.01 4	277.28 3	130.09 9	1.32
9004 9	90049	19.01.2007 00:41:20.9 0	38797.0 8	0.0611525	17.73 4	349.59 4	219.21 5	164.14 3	1.79

ID1	ID2	Date/time, UTC	a , km	e	i , °	Ω , °	ω , °	u , °	AMR, sq.m/kg
9005 0	90050	22.01.2007 22:36:34.1 5	42223.4 6	0.073983 1	11.270	343.81 0	308.61 5	118.178	4.31
9005 1	90051	22.01.2007 22:53:25.1 5	42720.8 5	0.025796 2	14.67 2	10.342	268.71 6	103.29 3	0.23
9005 2	90052	24.01.2007 15:17:49.5 0	41052.1 9	0.007872 2	9.544	325.00 1	182.12 1	130.26 1	0.043

Master list of objects

The master list of objects includes all high altitude orbit faint objects discovered to the date with description of obstacles of discovery and last update of orbital information. Due to large volume of the master list it will be distributing in electronic form only.

Observation statistics

This section contains general statistics on obtained measurements.

Table 6. Distribution of measurements obtained by each facility by year of observation (as of Jan 31, 2007)

	2004	2005	2006	2007	TOTAL
Nauchnyi	1240	6478	12944	1806	22468
Zimmerwald	0	597	3355	64	4016
Teide	0	624	2279	640	3543
Maidanak	0	150	2166	778	3094
Mayaki	0	0	981	0	981
SAO	0	258	524	0	782
Terskol	0	0	475	0	475
Mondy	0	229	65	116	410
Yevpatoriya	0	0	272	0	272
Simeiz	0	0	213	0	213
Arhyz	0	0	115	11	126
Tarija	0	0	21	0	21
TOTAL	1240	8336	23410	3415	36401

Distribution of measurements obtained for faint high altitude objects during 2004-2007

