ON THE ACCURACY OF CCD AND PHOTOGRAPHIC OBSERVATIONS OF ASTEROIDS AND THEIR CURRENT ORBIT DETERMINATIONS

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An application of the Classical Laplacian Method and new Pulkovo AMP-method for current asteroid orbit determinations is given. The CERES software package created at the Institute of Theoretical Astronomy (Russia) was applied to calculate (O-C)-differences for 200 numbered minor planets observed irregularly and quasisimultaneously in 1993 by CCD as well as by photographic techniques at 25 observatories (ESO, SERGA, Kitt Peak etc.). The accuracy of the observations was estimated by means of the standard error of the average (O-C) differences for each type of observation obtained by each telescope. As a whole the CCD-observations of the numbered minor planets are considerably more precise in comparison to the photographic ones. Some results are given in Table 1.

The efficiency and high accuracy of the CCD-observations allow one to solve the problem of orbit determination for any celestial object moving in the field of reference stars. We use the Classical Laplacian Method and the Pulkovo Method of Apparent Motion Parameters (Bykov 1989). All the calculations can be directly executed in real time during the CCD-observations. The author believes that the CERES software, developed by V. L'vov, V. Shor et al. at the Institute of Theoretical Astronomy (Russia) and the software (LAPLACE) made at the Pulkovo Observatory, are very useful for this purpose. Both software packages have been used for the current identification and classification of many asteroid orbits. An example of one orbit's calculation is given in the Table 2. The orbit obtained is not very good in comparison with the real orbit of the numbered minor planet 2699 but it is a single orbit which was obtained using the supershort arc of the positional observations. Gauss's and Laplace's methods cannot give precise orbital elements using these data only.

REFERENCE

Bykov, O. P. 1989 Opredelenie orbit nebesnikh tel pryamimi metodami, Problemi postroenia koordinatnikh sistem v astronomii, GAO, Leningrad, p. 328

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TABLE 1

Observations of minor planets

MPC-code and name of observatory		Telescope	Number of minor planets	nights	positions	Average error for a single observation of coordinates RA	DEC
			CCD observations				
691	Kitt Peak	0.9 Shm	6	14	42	0.38	0.18
801	Oak Ridge	1.5 rfl	7	17	33	0.30	0.23
689	Flagstaff	1.5 rfl	1	9	38	0.05	0.05
413	Sid.Spring	1.0 Shm	3	10	21	0.45	0.40
664		0.8 rfl	2	4	31	0.56	0.39
587	Sormano	0.5 rfl	3	5	12	0.54	0.36
657	Victoria	0.5 rfl	2	4	12	0.50	0.20
596	Collev.	0.3 Shm	4	9	19	1.02	1.04
107	Cavezzo	0.4 rfl	3	11	23	0.72	0.78
			Photographic observations				
809	ESO	0.4 Astr	30	86	256	0.77	0.56
675	Palomar	0.5 Shm	7	18	33	0.70	0.96
10	Caussols	0.9 Shm	7	18	43	0.92	0.96

TABLE 2

An Example of the orbit determination for Minor Planet 2699, Kalinin by the AMP-method

Positional observations by means of CERES, Nov, 1993

		RA	(O-C)	DEC	(O-C)		
1	16.22484	$3^h\,34^m\,47^s474$	0.36	14° 08′ 11″90	-0.28	801	CCD
2	16.23670	3 34 46.648	0.45	14 08 15.22	-0.13	801	CCD
3	16.80346	3 34 06.932	1.06	14 10 47.80	0.91	107	CCD
4	16.81871	3 34 05.809	0.29	14 10 51.51	0.53	107	CCD
5	17.22258	3 33 37.506	0.52	14 12 39.29	-0.02	801	CCD
6	17.23487	3 33 36.641	0.48	14 12 42.51	-0.10	801	CCD

CALCULATED PULKOVO ORBIT		CERES for NMP 2699 (ephemeris)
d =	1.0705	1.35202
r =	2.0574	2.338
a =	2.44598	2.63778
e =	0.18803	0.16925
i =	11.66548	16.1306
N =	67.040	64.4479
w =	308.658	294.2558
M =	26.574	40.6563

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