CCD observations of planetary satellites and occultations and close approachments of stars by asteroids with 26-inch refractor of Pulkovo observatory

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ST–6 CCD camera has been used with 26–inch Refractor at Pulkovo for observations of satellites of Saturn (1–8) and Jupiter (1–4), occultations and close approachments of stars by asteroids and mutual events in satellites systems since 1995.

Observations have been made in series of CCD frames (10–100 and more frames per series). It made possible to estimate errors of relative positions within one series (internal errors). These estimates are ± 0.015 arcsec and ± 0.014 arcsec for X and Y correspondingly.

Original method of determination of centers of star (planet) images on CCD frame with high accuracy ($\sim$ 0.005 arcsec) had been worked out [3]. The orientation of each CCD frame is determined with the help of daily trail of stars or satellites. Mutual distances between objects are measured in CCD field. The "scale–trail" method is used for astrometric reduction of observations [1]. The calibration of CCD, necessary to obtain precise relative coordinates in "scale-trail" method, had been carried out.

Results of observations were compared with the ephemerides of Harper and Taylor, calculated by N. V. Emelianov (SAI). Standard deviations, calculated on the basis of (O–C), are equal to ± 0.146 arcsec and ± 0.069 arcsec for close pairs of satellites (distance < 50 arcsec) and ± 0.211 arcsec and ± 0.255 arcsec for wide pairs. Mean (O–C) differences are close to zero proving the absence of systematic errors in observations. The accuracy of the theory of motion of the saturnian satellites was estimated to be 0.1 arcsec.

Photometric observations of mutual events in the Galilean satellites of Jupiter have been made. Light curves, obtained from observations, make possible to determine the mutual distances with very high accuracy [2].

CCD observations of eight approachments and occultations of stars of Hipparcos, Tycho, GSC and ACT catalogues by asteroids had been carried out with 26–inch Refractor in 1998–2001 (see table below).

Mpl	Star	Date	Ev.[1]	Mpl	Star	Date	Ev.
39	H28954	21.03.98	A	454	GSC4960196	15.04.98	A
535	H44806	24.03.98	A	11	ACT303945	14.03.99	A
97	H63455	15.03.99	A	111	H2559	10.09.00	O
40	H46751	20.04.94	A	64	T18931422	02.04.01	O

[1] Kind of event (A — approachment, O — occultation)

Astrometric reduction of these observations had been performed using the "scale–trail" method. As a result of reduction the measured distances between objects in a small CCD field ($3' \times 2'$) are presented with high accuracy as functions of time. The errors of these measurements are ± 0.01 arcsec for minimum distances between objects (r_0) and $\pm(0.4 - 18)$ sec (depending on visual velocities of asteroids) for moments of events (t_0). Finally, relative positions and motions (V_0) of asteroids, and (O–C) have been calculated with errors not more than ± 0.025 arcsec. Also the variability of brightness of asteroid 454 has been revealed ($\Delta m \approx 0.15^m, P \approx 4h$).

Photographic observations of the saturnian satellites with 26–inch refractor at Pulkovo are continued now as well. The accuracy of photographic observations is also very high (± 0.06 arcsec — internal errors (for X and Y) and ± 0.12 arcsec — external errors), calculated with the help of (O–C). Totally over 100 relative positions of saturnian satellites have been obtained from CCD observations and over 500 relative positions — from photo observations. Each CCD position is a mean value in series of 10–100 frames.

References

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