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METHODS AND INSTRUMENTS IN ASTRONOMY: FROM GALILEO TELESCOPES TO SPACE PROJECTS

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ABSTRACT BOOK

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made accurate measurement of large angles a million times more efficiently than could be done in about 1950 from the ground, and it will soon be followed by Gaia which is expected to be another one million times more efficient for optical astrometry.

ASTROMETRY AND PHOTOMETRY OF ASTEROIDS AT THE RTT150 TELESCOPE

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The space astrometric mission Gaia, a cornerstone of the European Space Agency, will be launched in the beginning of 2012 with the objective to make a 3D precise map of our Galaxy, http:// www.esa.int/science/gaia. Besides stars, the Gaia will observe asteroids with unprecedented precision from 0.5 to 3 mas, allowing the extremely fine orbit determinations. This precision has principal significance for the determination of small effects influencing the dynamics (relativistic, gravitational, non-gravitational, etc.) of Solar system bodies. The determination of masses of 150 asteroids is expected in 5 years of Gaia operation through the analysis of mutual perturbations between asteroids.

Considering the time length of the Gaia mission, there will be encounters between some asteroids occurring either at the beginning or the end of the mission, so the maximum of deflection angle pertained to the perturbation maximum will not be observed. The precision of mass determinations based solely on the Gaia observations will deteriorate in such cases.

The observational programme of Institut de Mécanique Céleste et de Calcul des Ephémérides (IMCCE, Paris) for astrometry of asteroids consists of the list of perturbed asteroids which positions are of a great value for being used in Gaia analysis, so these observations may be considered good for initial "unperturbed" orbit evaluation. Few asteroids of the dedicated list are regularly observed at the RTT150 within the framework of international cooperation between our institutions since 2006, e.g. in 2008, there have been observed 21 main belt asteroids which will be perturbed greatly by 11 different asteroids (not considering Ceres, Pallas, Vesta in this number) at about 2011-2012, the time of Gaia launch.

For the current analysis, we have chosen the series of 5 and more observations, made in 2006-2008. There are 2081 positions of 38 asteroids. The positions of asteroids (astrometric topocentric) were

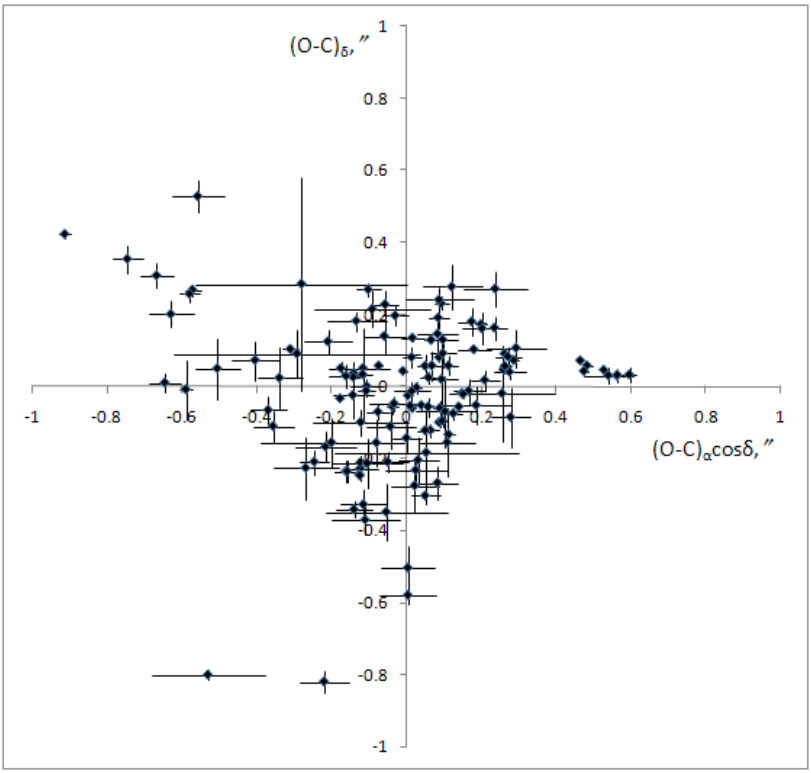

Fig. 1. (O–C) in right ascension and declination.

determined with the UCAC2 catalogue using Astrometrica software. The weighted standard error of a single measurement in right ascension is 0.15″ and 0.11″ in declination. The standard error was calculated as a standard deviation of a single position from the mean one in the series of observation images in one night, so it shouldn't depend upon the chosen reference catalogue. There is no sure positive evidence on the error dependence from asteroid magnitude, that is a good sign of observation homogeneity. This fact can be explained by the small values of visible speed of main belt asteroids. *(O–C)* for the subsequent analysis were calculated using ephemerides of the HORIZONS service, http://ssd.jpl.nasa.gov/?horizons. These values with their standard errors are given in Fig. 1. Considering standard errors of the *(O–C)*, one can make conclusion that the positions are useful for the improvement of present day orbital elements of observed asteroids.

The light curve of one of the observed NEAs (35107) 1991 VH belonging to Apollo group is given below, Fig. 2. Photometrical data consists of 550 points in R Cousins band representing observations from March 1 till July 5, 2008. The observations were made before an encounter with the Earth at 0.0457 a.u., which has occurred on August 15, 2008. The light curves show changes of brightness 1991 VH

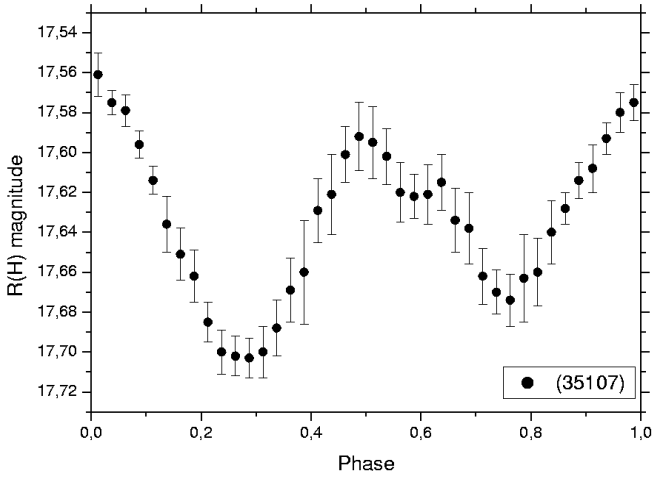

Fig. 2. Light curve of (35107) 1991 VH asteroid.

with the period of variability about 0.1 days and amplitude of 0.15 mag. Changes of the form of a curve of light curve in different nights of the observations are found out also. Light curves has shown the rotational changes and transition events from a satellite of the asteroid. Also processing of photometric data of few asteroids (15518, 5564, 6006) is made.

PROGRAMS OF OBSERVING SMALL CELESTIAL BODIES IN THE SOLAR SYSTEM BY SMALL TELESCOPES IN CHINA

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Several observing programs, including astrometric observations of the natural planetary satellites, astrometric and photometric observations of NEOs using small telescopes in China are reviewed. The observations of satellites with laser ranging system and GPS are briefly described. The important scientific results obtained from these observations are given. The research programs, including orbital determinations for binary and satellites, construction of planets/lunar ephemeris are introduced. The other projects including establishment of astrometric calibration regions, linkage between optical and radio reference frames through observations of the optical counterparts of radio sources and determinations of the precise proper motions of membership of star cluster are briefly described. A new program proposed by SHAO and Torino Astronomical Observatory, Italy, on the improvements for GSC2.3 such as eliminating systematic errors, (e.g. magnitude-dependent errors, spatial dependent errors, systematic proper motion error in the Southern hemisphere), and accidental errors, adding new observations as data at third epoch for POSS and SERC projects as well as deriving absolute proper motions referred extragalactic galaxies is presented.