OBSERVATIONS OF ASTEROIDS WITH CCD TELESCOPES ACCORDING TO THE PROGRAMME OF INTERNATIONAL CO–OPERATION BETWEEN MYKOLAIV ASTRONOMICAL OBSERVATORY (MAO), INSTITUTE OF APPLIED ASTRONOMY (IAA), AND BORDEAUX ASTRONOMICAL OBSERVATORY (BAO)

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INTRODUCTION

Observations in the MAO are carried out with the Zone astrograph (ZA) (objective aperture D = 160 mm with a 120 mm diaphragm, focal length F = 2044 mm) and the Axial meridian circle (AMC) (D = 180 mm, F = 2480 mm) equipped with similar CCD cameras (ISDO17, 1040×1160 pixels, pixel size 16×16 mkm). The observations in the BAO are carried out with the Bordeaux meridian circle (BMC) (D = 190 mm, F = 2370 mm) equipped with a CCD camera (1024×1024 pixels, pixel size 19×19 mkm).

I. LIST OF THE OBSERVED OBJECTS

The co-ordinated Programme includes observations of small Solar System bodies up to 16 magnitude in the following areas.

1. Uniform observation series of selected minor planets along all their visual tracks as far from the opposition as possible (IAA programme). The aims of the research are as follows: a) to compare the accuracy of the photographic observations with that of CCD and to estimate their possible systematic differences, b) to estimate the minimal Solar elongation angle at which minor planets yet can be observed, c) to use these observations for determination of the mutual orientation of the dynamical frame and ICRF, d) to select an adequate scattering law accounting for phase effect.

2. Observation of asteroids in order to determine the masses of some minor planets. The IAA programme list includes 30 sufficiently bright asteroids and the BAO programme includes 10 additional ones. The proposed observations during a 4–5 year period with an accuracy not worse than 60 mas will be used for improvement of the masses of Ceres (1), Vesta (4) and others.

3. The Programme includes also observations of near-Earth objects (NEO) for determining their positions and brightness. The list of objects compiled in IAA for 2000 includes more than 20 NEO up to 16 magnitude which encounter to the Earth at the distance less than 0.3 AU. Only five asteroids among them have minimum magnitudes less than 15.

II. OBSERVATIONS AT THE MYKOLAIV ASTRONOMICAL OBSERVATORY

1. Universal CCD camera

The camera with ISDO17 detector made by Optron-Electronic Corporation (Saint-Petersburg) was made at the MAO in 1999 [1]. It can work either in the drift-scan mode (exposure time $103/\cos\delta$ seconds, field of view (FOV) $23'\times26'$ for AMC) or in the drift-scan and stare mode (exposition from 1 ms to 30 min, limiting magnitude is about 15 min by a 5 min exposition and FOV $28'\times31'$ for ZA). The instrumental accuracy of coordinate determination with the CCD camera is presented in the Figure 1.

2. Observations of minor planets at the Zone astrograph

Trial CCD observations were carried out with ZA in autumn 1999 and the regular ones started in April 2000. More than 100 observations of 12 minor planets were performed. It was used such an observational procedure: there were taken series from 5 to 9 CCD frames for every planet during each night, exposition for a single CCD frame was from 2 till 4 minutes. Part of the observational data was preliminary reduced using the “Astrometrica

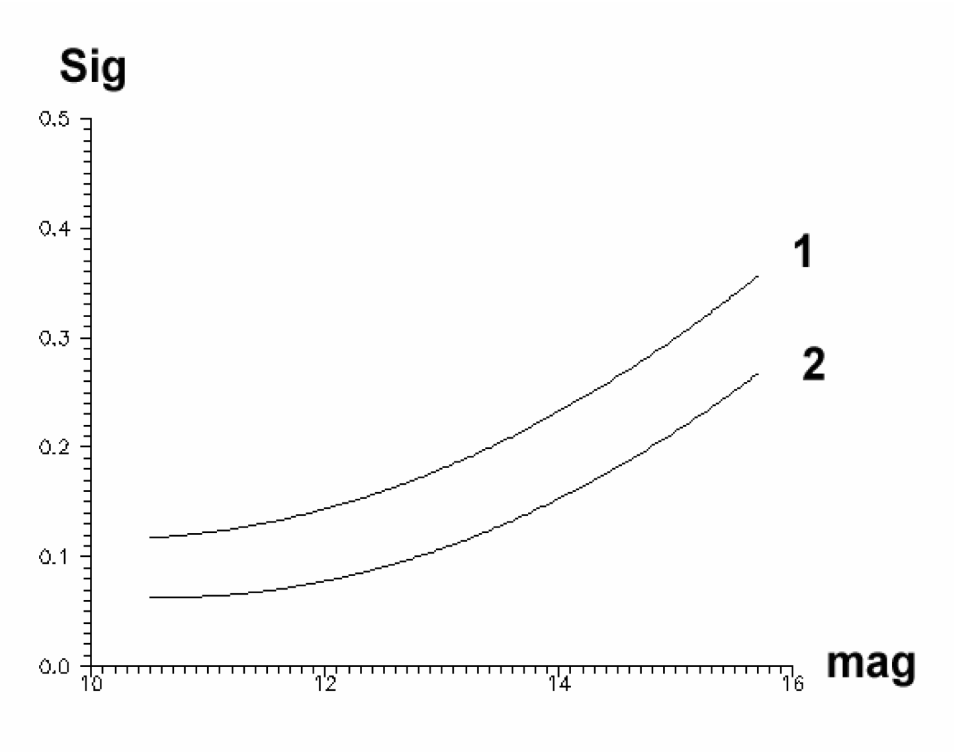

Figure 1: The instrumental accuracy of coordinate determination with CCD as a function of magnitude (in arcseconds)

programme" [2] in the system of USNO-A2.0 Catalogue. An internal accuracy for one minor planet position is of $0''.03 \div 0''.1$. The calculations of (O–C) were fulfilled for the series of observations of Thetis (17) and Vesta (4) only. The external error for one observation is about $0''.38$ in right ascension and $0''.51$ in declination. Our calculations were confirmed by similar ones which have been made O. P. Bykov (Pulkovo Observatory) using the "Epos" software. It is to be noted that observations of the planets have been carried out at a zenith distance $60^\circ - 70^\circ$.

3. Observations of minor planets with AMC in 1997-1998

First observations of minor planets with AMC were carried out using the previous CCD (288×256 pixels, pixel size 24×32 mkm). According to the list of selected minor planets by the IAA programme, 136 observations of 27 minor planets were fulfilled. A standard error for one determination of (O–C) in the GSC system was of $0''.22 \div 0''.51$. After modernization and installation of a new universal CCD camera the AMC will provide regular observations in 2001.

CONCLUSIONS

The first results of minor planets observations with MAO CCD telescopes show that these observations are to be perspective [3]. There are many appropriate methods to improve their accuracy. It permits to hope that the proposed Programme can be fulfilled during 4–5 years both by using of traditional methods and combining them with those developed for the complex of AMC and Zone astrograph of the MAO [4].

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