THE MAO NASU PLATE ARCHIVE: "OBSERVATIONS IN THE PAST" OF MINOR PLANETS

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The Plate Archive of the Main Astronomical Observatory of the National Academy of Sciences of Ukraine (MAO NASU) includes 20 thousands of direct sky area plates, which have been taken for various astronomical projects during the period of about 50 years. Those plates contain more then hundred thousand images of minor planets with magnitude up to 16.7^m. About 10% of minor planets, which may be found on our archive plates were firstly discovered after the time when plates have been taken. So, we can rediscovery them due to the so-called "observations in the past". In the paper the criteria for choose of objects and methods of their search, identification, and determination of their position are discussed. First results of the search for potentially hazardous asteroids in the MAO plate archive are presented.

INTRODUCTION

The Plate Archive of the Main Astronomical Observatory of the National Academy of Sciences of Ukraine (MAO NASU) includes about 85 thousands plates which have been taken in frames of various astronomical observational projects over a period of more than 50 years. Among them there are 20 thousands of direct sky area plates which could be useful by search for and rediscovery of asteroids, comets, and other Solar System bodies. For an effective use of the MAO plates collection, we developed a system to provide a quick search of astronomical objects (SQSAPA) on basis of digital "clones" of plates. Principles of its organization, its aims and purposes were presented in [1]. One of the scientific applications of SQSAPA is the so-called "observations in the past" of asteroids. Over 24 millions of observations were collected in the list of the Minor Planet Center (MPC) for more than 250 000 objects. Only 85 117 of them have been numbered till now. In Fig. 1 we can see how the amount of unnumbered asteroids has increased during last five years. So, it is necessary to observe them not only "in the future" with modern telescopes but "in the past" with the help of plate archives.

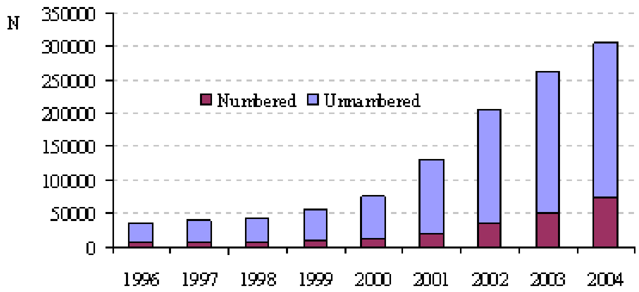

Figure 1. The growth increase of minor planets number in the MPC catalogue during 1996–2004

SEARCH OF MAIN-BELT ASTEROIDS IN THE MAO PLATES ARCHIVE

1. 122 of the MAO archive photographic plates in a zone from $-3°$ to $+3°$, which have been obtained during 1981–1994 within the framework of the Photographic Survey of the Northern Sky (FON), were looked through.
2. 876 asteroids with V magnitude up to 16.7^m, which potentially can be found on these plates, were picked up from the MPC catalogue. There were over 20 asteroids on several plates.
3. 63 of them were firstly discovered after the time of taking the plates on which they have been found; so, we can rediscover them and determine their coordinates on moments of time that precede to their discovery.
4. Two minor planets were measured on the plate No. 1 obtained during the FON program in 1981: 105 Artemis ($B = 12.5^m$, discovered in 1868) and 4816 Connelly ($B = 15.7^m$, discovered in 1981). The random error of measurements is 1–2 mkm.
5. The classic method of six constants as well as the ACT catalogue as a reference one were used to calculate the equatorial topocentric coordinates. Obtained topocentric coordinates of asteroids were compared with their ephemeris from JPL. Results confirm that the glass collection of MAO NASU is suitable the discovery of asteroids and determination of their coordinates.

   This research has been presented in [2, 3].

DIRECTION OF FURTHER INVESTIGATIONS

Our research is aimed to discovery, measurements and improvement of orbital elements for such objects:

1. “Rediscovered” asteroids;
2. Asteroids with out-of-truth orbits;
3. Specific objects, such as 719 Albert and 2000 JW8;
4. Near-Earth asteroids.

SEARCH FOR POTENTIALLY HAZARDOUS ASTEROIDS ON PLATES OF THE MAO ARCHIVE

Approximately a one fifth part of near-Earth asteroids can potentially be hazardous (PHA). Minimum orbital intersection distances of these asteroids are less than 0.05 AU. There were about 563 of PHA in May 2004. Only 82 of them are numbered.

At the first we took into account only those asteroids from the MPC list, which were discovered in 2002–2004 and are not numbered yet. Ephemerides of 190 unnumbered asteroids were viewed in the MPC Ephemeris Service over 1950–1993. Ephemerides of 46 asteroids were selected for moments of the closest approach when their V magnitudes were brighter than 15.4^m. We obtain 81 approaches for those 46 asteroids. The most interesting case we have for the asteroid 2002 CE (Fig. 2).

The next step of our work is a searching for potentially hazardous asteroids on plates of the MAO NASU archive using these ephemerides. But in the case of unnumbered asteroids, the opportunity exists that their orbits were determined inaccurately, so, a problem of their identification can appear.

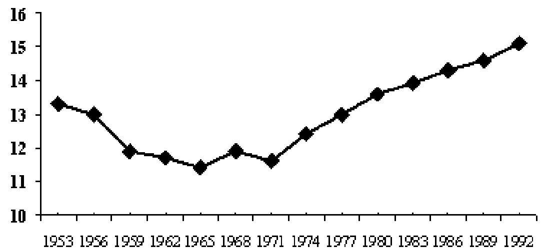

Figure 2. Approaches of potentially hazardous asteroid 2002 CE

CONCLUSIONS

1. The plate archive of the MAO NASU contains about 20 000 plates which are potentially useful for the binding of asteroids and improvement of their orbital elements.

2. To estimate this potential we selected 122 plates of the FON program in a zone from –3° to +3°. 876 asteroids from the list of MPC up to magnitude 16.7^m, which could be found on these plates, were picked up for sky proper areas.

3. Among them there were 63 asteroids which were firstly discovered in the year of appropriate plates observation or later.

4. The whole technological process (from the search for a plate in the database to the determination of coordinates of asteroids) was tested and tracks of two asteroids were measured. The result was that the MAO NASU collection of plates is suitable for the asteroids discovery and determination of their coordinates.

5. A technology for search for potentially hazardous asteroids was tested. To improve its efficiency it is necessary to use several plate archives that is possible within the framework of an virtual observatory and by applying of special methods for calculation of searching ephemeris.

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[3] *Sergeeva T. P., Sergeev A. V., Pakuliak L. K., Golovnya V. V.* Wide field plate archive of MAO NAS of Ukraine: electronic plate collection and first results of database application // Baltic Astronomy.–2004.–**13**, N 4.–P. 677–682.