https://doi.org/10.15407/knit2023.05.079
UDC: 521.9 + 523.4, 520.338, 004.932

S. V. SHATOKHINA[1], Researcher
E-mail: svetash@mao.kiev.ua
H. RELKE[2], Ph.D. in Phys. & Math.
E-mail: helena_relke@yahoo.com
O. M. YIZHAKEVYCH[1], Researcher
E-mail: yizh_net@ukr.net
V. M. ANDRUK[1], Researcher
E-mail: andruk1058@ukr.net
A. SH. MULLO-ABDOLOV[3], Researcher (until 2021)
E-mail: aziz.sherzod@gmail.com

[1]Main Astronomical Observatory of the National Academy of Sciences of Ukraine
27 Akademik Zanolotny Str., Kyiv, 03143 Ukraine
[2]Walter Hohmann Observatory
159 Wallneyer Straße, Essen, 45133 Germany
[3]Institute of Astrophysics of the Academy of Sciences of the Republic of Tajikistan
299/5 Aini Ave, Dushanbe, 734063 Tajikistan

ASTEROID POSITIONS BASED ON THE DUSHANBE PART OF THE FON PROJECT OBSERVATIONS

We present the results of asteroid images' identification and creation of positional catalogs based on digitized photographic observations within the framework of the Northern Sky Survey (FON project). Namely, the cooperation between the Ukrainian Virtual Observatory and the Institute of Astrophysics of the Academy of Sciences of Tajikistan makes it possible to expand this work by involving numerous additional archives of digitized observations and processing services to obtain new original data about the small Solar system bodies.

The Dushanbe part of the FON project is represented by about 1570 photographic plates obtained in 1985—1992 at the Gissar Astronomical Observatory of the Institute of Astrophysics of the Academy of Sciences of Tajikistan. To the moment, their digitization and further scanning processing were completed, and a catalog of equatorial coordinates and stellar magnitudes for all registered objects on the plates was created.

In parallel with solving the main task of the project to create a catalog of stars and galaxies, we analyzed the results of processing the plates to search for images of asteroids and comets and to create a catalog of their coordinates and magnitudes. More than 2200 positions of asteroids and comets were obtained with visual magnitudes from 7^m to 16.5^m. All positions of the asteroids were compared with the ephemeris. A preliminary analysis of the O-C differences and their comparison with similar results obtained from the digitized observations of the Kyiv and Kitab parts of the FON project are conducted. The authors note some differences in the accuracy of the compared catalogs and also analyze the reasons for this and the possibilities of reducing their impact.

In addition, the catalog includes several positions of Pluto and comets that were also identified in the negatives.

Keywords: *data archives, digitized observations, catalog, asteroid positions.*

Цитування: Shatokhina S. V., Relke H., Yizhakevych O. M., Andruk V. M., Mullo-Abdolov A. Sh. Asteroid positions based on the Dushanbe part of the FON project observations. *Space Science and Technology.* 2023. **29**, № 5 (144). P. 79—87. https://doi.org/10.15407/knit2023.05.079

1. INTRODUCTION

At the end of the 20th century, six observatories took part in the implementation of the Nothern Sky Survey (FON) project, namely: the Main Astronomical Observatory of Ukraine, the Zvenigorod Observatory of Russia, the Zelenchuk Observatory of Russia, the Abastumani Observatory of Georgia, the Gissar Observatory of Tajikistan and the Kitab Observatory of Uzbekistan. Our predecessors I. G. Kolchinsky and A. B. Onegina were the founders of this project [6]. The most modern vision of the stages of project realization was presented by Pakuliak [10]. The main observations were carried out in 1981-1991, and later, separate processing of the observational material was carried out by Kislyuk [5] and Yatsenko [21]. However, their complete processing on a global scale seemed to be an unrealistic task due to various objective and subjective reasons. One of them was the huge amount of data and the large amount of time spent on calculations. Only with the development of digital technologies in the field of image processing and, most importantly, software for scientifically focused processing of such digitized data this unrealistic task became feasible [18—20]. As a result, it became possible to perform a complete digitization of all astroplates, their processing, and extracting data of all objects fixed on them.

All observations of the Main Astronomical Observatory (MAO), Kitab, and Gissar observatories, as the most numerous and continuous, were digitized in the same way and processed according to the methods and software developed at the MAO for processing of digitized images [1, 11, 12]. As a result, for each of the above three observational locations (or FON-Kyiv, FON-Kitab, and FON-Dushanbe parts of the project, respectively), three stellar catalogs of coordinates and magnitudes of stars and galaxies were compiled [2, 7, 23]. Together, they make up data for about 45 million stars, down to 16-17 stellar magnitude. Obtaining such a huge amount of data and, most importantly, its expansion to the region of faint stars would have been impossible within the framework of previous implementations of the project.

In parallel with the task of creating stellar catalogs, we continued to solve an additional task of searching for images of small bodies of the Solar system and separating their positional data from all data processing results. For the first two parts FON-Kiev and FON-Kitab, this work was done, and as a result, two catalogs were compiled, including more than 5000 positions and magnitudes of asteroids and comets [16, 17]. The results for the third part of FON-Dushanbe are presented below.

2. METHODS AND MATERIALS

Observations were carried out in 1985—1992 on the Zeiss-400 astrograph (Marsden code 190, $D/F =$ $= 400/2000$) at the Gissar Astronomical Observatory near Dushanbe. The collection of plates includes about 1570 negatives covering the northern hemisphere from –8° to +90°. Plate digitization began in 2017 using a commercial Microtek ScanMaker 1000XL Plus scanner. The digitizing options used a resolution of 1200 dpi with 16-bit gray levels. The first results of this work were published by Mullo-Abdolov [8, 9].

Images of all objects registered on plates were processed using the advanced software complex for CCD images processing MIDAS/ROMAFOT in the LINUX environment. Additional software modules developed and implemented in the Main Astronomical Observatory of the NAS of Ukraine provide both the digitized image processing and the final product as a catalog of equatorial coordinates α, δ, and magnitudes of all registered objects. The equatorial coordinates were obtained in the reference system of Tycho-2 at the epoch of the exposition of each plate. The photometry of stars was made on the principles implemented in processing the plates of the FON project by Andruk [3], using photoelectric measurements of stars to construct the characteristic curves of each plate described by Relke [13]. Photographic B-magnitudes of objects were calibrated with photoelectric standards.

All these processing results were directly used to identify asteroids and compile a catalog. Asteroids were identified by their coordinates and magnitudes. The diameter of the image and the maximum intensity of its central pixel were also taken into account. The asteroid identification process may be described in a few steps, such as:

1) software identification of the calculated coordinates of all registered objects on the plate with the

ephemeris coordinates of asteroids generated by the online services of the JPL website (https://ssd.jpl.nasa.gov/tools/sb_ident.html for a given moment of observation [4];

2) comparison of the identified coordinates of asteroids on the plate with the coordinates of the nearest stars from the Gaia DR3 catalog to eliminate ambiguous identifications of asteroids.

We used the last step to discard the positions of asteroids in cases where the asteroid coordinates are close or coincide with the coordinates of stars and their magnitudes are approximately the same, or the asteroid has a lower brightness. The radius of the neighborhood for the analysis of the degree of closeness of the coordinates was chosen experimentally and was usually 5 to 10 arcseconds.

This approach is empirical and approximate. We did not perform a more accurate analysis of close images using photometric sections. And since the goal of the work is not the identification itself (see, for example, other software by Savanevych [14, 15], but the determination of high-precision coordinates of asteroids, we do not expect to get good accuracy for the cases of poorly separated several images, one of which is not point-like due to the motion of the asteroid.

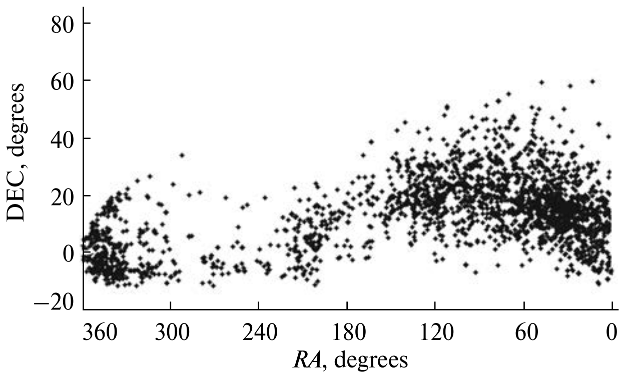

Figure 1. Distribution of equatorial coordinates of all 2269 identified asteroids

3. MAIN RESULTS

After identification and data analysis, 2269 positions and magnitudes of asteroids were compiled into a preliminary catalog based on the results of processing digitized photographic plates of the FON-Dushanbe project part. The catalog includes data mainly on Main belt asteroids, as well as isolated data on Mars-crosser asteroids, Jupiter Trojan asteroids, and 1+km Near-Earth Object. Separate data on 29P/Schwassmann-Wachmann and 192P/Shoemaker-Levy comets and Pluto positions are also present here.

The quantitative and qualitative characteristics of the catalog data were analyzed. Fig. 1 shows the distribution of the equatorial coordinates of all 2269 identified asteroids for FON-Dushanbe observations. The number of asteroid positions by years of observation and by each visual magnitude interval is presented in Fig. 2. Asteroids of visual magnitude down to 17.2 have been detected. To compare the results with the

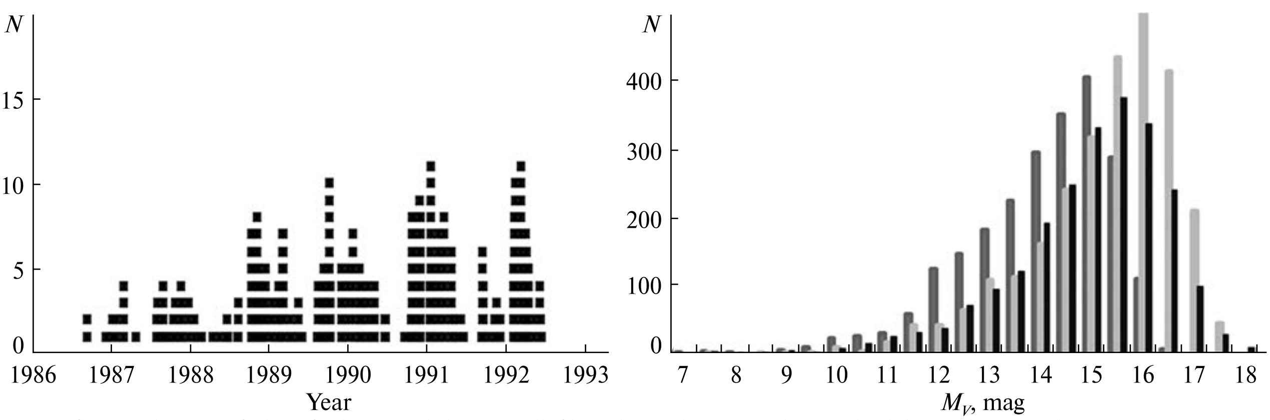

Figure 2. Distribution of identified asteroids by years (left) and visual magnitudes *Mv* (right). Dark gray columns — FON-Kyiv; light gray columns — FON-Kitab; black columns — FON- Dushanbe observations

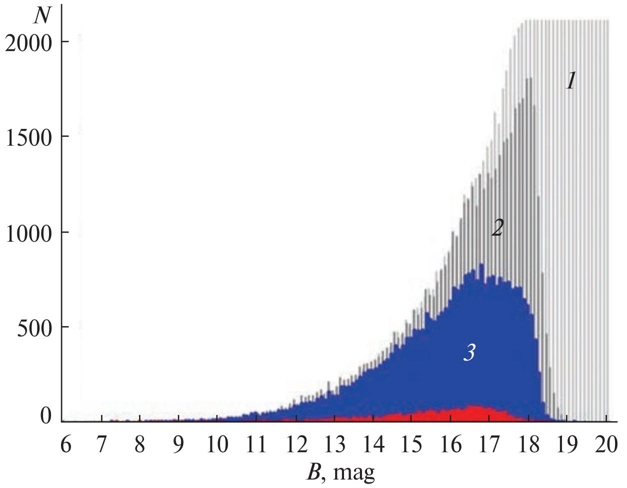

Figure 3. Celestial object numbers on individual plate № 713

other two parts of the project's observations, we note that asteroids of visual magnitude down to 16.2 were identified only in the FON-Kyiv observations. As for fainter asteroids down to 17—17.5, they were also detected in the FON-Kitab observations. This required a more thorough and rigorous approach to their identification on scans, especially under the conditions of closeness of the coordinates of faint stars.

To assess how real or unrealistic the positions of faint asteroids we obtained are, for a separate plate in Fig. 3, we showed three distributions of B magnitude for stars from the Gaia catalog selected for the plate area (*1*), all objects registered on the plate (*2*), and identified stars (*3*). The distribution of all identified asteroids from FON-Dushanbe observations is also schematically added here in red color. All data are presented by intervals of stellar magnitudes B. To match the scale of magnitudes, when constructing the figure, it was taken into account that the difference B-G(Gaia) is approximately equal to 1.

Based on this, we can conclude that the images of faint stars of the 17-th magnitude identified by us may be real, and not fake, on the plates of the best quality. However, this may be true for asteroids with a low rate of change in RA and DEC coordinates in the plane-of-the-sky.

All positions of asteroids were compared with the JPL DE431 ephemeris. The *O-C* differences in both coordinates for all asteroids are presented in Fig. 4. Additionally, this figure also shows similar results for all asteroid positions from the FON-Kyiv and FON-Kitab observations. The scatter of *O-C* values is greater in both coordinates for the FON-Dushanbe observations than for the FON-Kyiv and FON-Kitab observations. A systematic shift of *O-C* in the RA coordinate is also noticeable for all FON-Dushanbe positions of the asteroids.

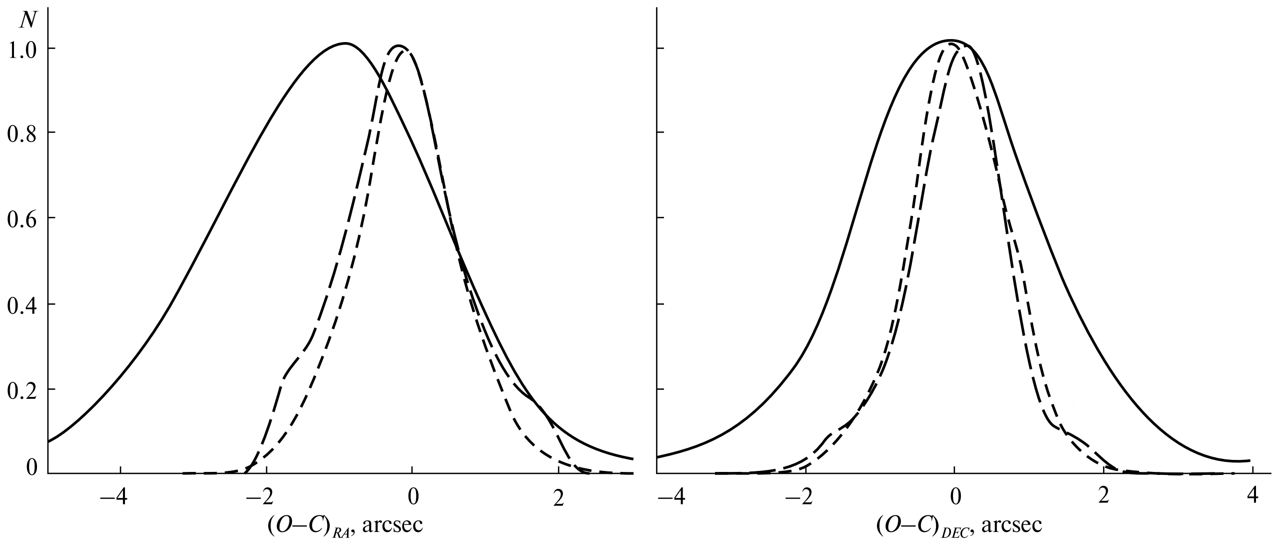

Figure 4. Histograms of the distribution of *O-C* differences on both coordinates for all asteroid positions (small dotted line — FON-Kyiv, dotted line — FON-Kitab, solid line — FON-Dushanbe observations)

4. DISCUSSION

The reasons for the appearance of systematic *O-C* shifts in the positions of asteroids required further analysis.

First, we selected several plates, where many asteroids with large values of *O-C* differences and a clear systematic shift were detected. The coordinates of all stars from these plates were obtained. For stars identified with those from the Gaia catalog, *O-C* differences were calculated for both RA and DEC coordinates (Fig. 5). From the analysis of the differences both separately in stellar magnitude intervals and as a whole, no systematic shifts, characteristic for the positions of asteroids, were found in stellar coordinates.

Secondly, the *O-C* differences of asteroids were analyzed depending on the rate of change of their coordinates RA and DEC in the plane-of-the-sky at the moments of observation. The results for all asteroid positions are shown in Fig. 6. A clear correlation of the *O-C* differences of asteroids with the values of their rate was found in the RA coordinate. For asteroids with higher rates, the largest values of the *O-C* differences and their significant shift are observed. Probably, this shift may be the result of a systemic underestimation of time in the asteroid positions, which is also noted by Yizhakevych [22]. According to the preliminary estimates, its value can reach several minutes.

As is known, the position of moving objects is characterized by two coordinates and the moment of observation time with which these coordinates are associated. If the coordinates are correctly determined, taking into account all the distorting influences, then the inaccurate moment of time can significantly change the position of the object to the impossibility of its further use.

In the case when the error due to inaccurate time moments has a systematic component, it can be determined by analyzing *O-C* arrays and artificially correcting time values. If individual errors in the observation time are random and chaotic, then it is unrealistic to improve such positions of asteroids.

Therefore, to determine the above systematic component in inaccurate time accounting, modeling of the differences of *O-C* was performed. The modeling results with a time shift of +1.5 or +3 minutes show a decrease in the systematic shift of the *O-C* differences. The changes obtained as a result of this are shown both in Fig. 6 and Fig. 7.

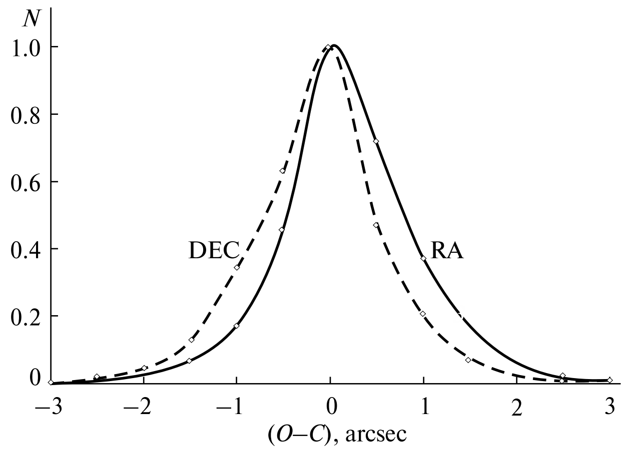

Figure 5. Distribution of *O-C* differences calculated between the coordinates determined from plate No. 1108 and identified from the Gaia DR2 catalog for 14103 stars

In 2020, due to communication with observers (A. Mullo-Abdolov, H. Relke. Personal messages, 11/19/2020), we learned that the original observation log was found, which was lost earlier due to insurmountable emergency circumstances. Note that for processing the observations, we used an electronic copy of the observational data, which is stored at the Gissar Observatory. Preliminary analysis of several records from this log showed the difference between the recorded original moments of observations from the log and the ones we used. This difference was systematic and amounted to 1.5 minutes. This value was used by us as a possible systematic time shift in modeling changes in the *O-C* of asteroids.

Fig. 7 presents the *O-C* distribution of asteroids, where there is a sufficient shift of the vertices and the histograms themselves as a whole along the RA coordinate after adding a correction equal to +1.5 or +3 minutes to each observation time. Similar smaller changes are also characteristic of the DEC coordinate. This indicates that the introduction of corrections of +1.5 or +3 minutes to all observation time moments leads to a systematic improvement of the results, while the most optimal solution is the addition of +3 minutes.

On the other hand, such a large value for correcting the time of observations is not confirmed by observers as possible. And the most likely correction is

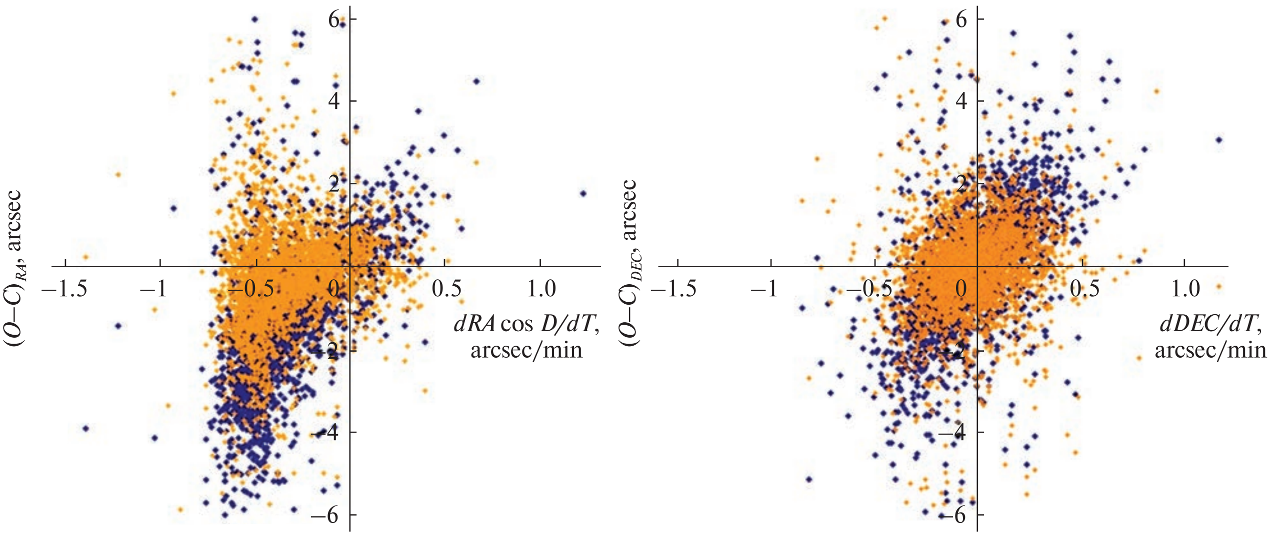

Figure 6. Dependence of *O-C* differences on the rates of RA, DEC coordinates changes for all asteroid positions (blue markers — time moment, yellow markers — time moment +3 minutes)

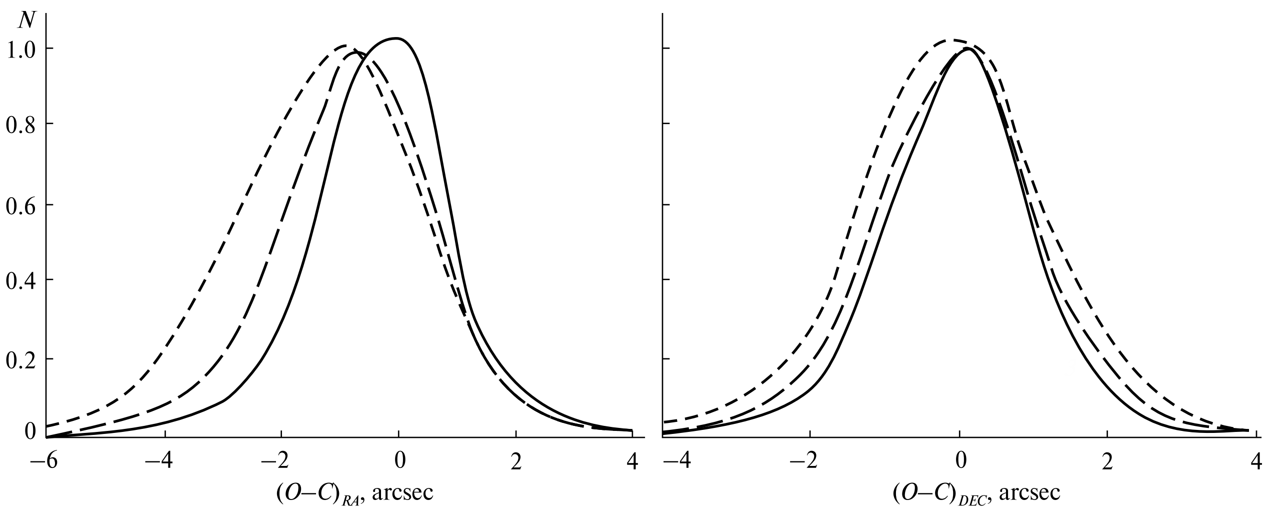

Figure 7. Histograms of the *O-C* distribution on both coordinates after correction of each observational time moment (small dotted line — time moment; dotted line — time moment + 1.5 min; solid line — time moment +3 min)

+1.5 minutes. Therefore, this issue is controversial and uncertain.

5. CONCLUSION

The search for images of small bodies of the Solar System based on digitized photographic observations of the Northern Sky Survey has been completed. A large-scale search was carried out using an analytical method and based on the results of full reduction processing of digitized negatives. Based on the materials of the third part of the FON project in Dushanbe, a catalog of more than 2200 positions and magnitudes of asteroids was obtained. In total, catalogs compiled for the three parts of the project comprise more than 7000 positions and magnitudes of asteroids and comets, including one position of Pluto. These catalogs are placed on the UkrVO website (http://gua.db.ukr-vo.org/starcatalogs.php) and in the Strasbourg Astronomical Data Center (http://cdsweb.u-strasbg.fr).

The precise timing of each exposure on the photographic plate, as it is required when observing moving celestial objects, was not a necessary requirement for observing stellar areas in the FON project implementation. Therefore, using these observations to determine the exact positions of asteroids may lead to some increase in error and a decrease in positional accuracy. However, the uniformity of observation tools, methods of data digitization and their processing lays the foundations for obtaining homogeneous series of asteroid positions. Although there are some differences in the accuracy of the asteroid coordinates between the three catalogs of the three parts of the project, they can be explained by random or sometimes systematic errors in the exact timing of the observations. Such errors can be analyzed and, if possible, taken into account.

The use of new digital observation processing technologies allows us to increase the total number of positions of small bodies of the Solar System in previous years, as well as to increase their accuracy. Dense coverage of asteroid orbits with missing high-precision position data can be useful not only for modern ephemeris calculations but also for studying the evolution of asteroid orbits over time, non-gravitational effects, etc.

These data can be obtained from the digitized observational archives of the UkrVO (Ukrainian Virtual Observatory) and IVOA (International Virtual Observing Alliance) databases. The magnitudes of asteroids, determined simultaneously with their coordinates, can be used to determine the photometric characteristics of asteroids and to construct light curves and phase dependences.

REFERENCES

1. Andruk V. N., Golovnya V. V., Ivanov G. A., Izhakevich E. M., Pakuliak L. K., Protsyuk Yu. I., Shatokhina S. V., Yatsenko A. I., Muminov M. M. (2014). Compilation of Catalog of Stellar Equatorial Coordinates and B-Magnitudes Using UKRVO Plate Database. *Odessa Astron. Publ.*, **27**, 53—54.
2. Andruk V. M., Pakuliak L. K., Golovnia V. V., Ivanov G. O., Yatsenko A. I., Shatokhina S. V., Yizhakevych O. M. (2016). Catalog of equatorial coordinates and B-magnitudes of stars of the FON project. *Kinemat. Phys. Celest. Bodies*, **32**, № 5, 260—263.
3. Andruk V. M., Pakuliak L. K., Golovnia V. V., Shatokhina S. V., Yizhakevych O. M., Protsyuk Yu. I., Eglitis I., Eglite M., Kazantseva L. V., Relke H., Yuldoshev Q. K., Muminov M. M. (2017). Star photometry on digitized astronegatives. *Sci. Innov.*, **13**, 17—27.
4. Giorgini J. D. (2015). Status of the JPL Horizons Ephemeris System. *IAU General Assembly*, Meeting #29, id.2256293.
5. Kislyuk V. S., Yatsenko, A. I., Ivanov G. A., Pakuliak L. K., Sergeeva T. P. (2000). Fonac: the astrographic catalogue of the FON project. *Kinemat. Phys. Celest. Bodies*, **16**, № 6, 483—496.
6. Kolchynskyi I. H., Onehyna, A. B. (1977). Plan fo photographing the sky on wide-angle astrographs. *Astrometriya i astrofisika*, 33, 11—16 [In Russian].
7. Kokhirova G., Relke H., Yuldoshev Q., Protsyuk Yu. I., Andruk V. M. (2021). FON Dushanbe Catalogue. Results of Processing in the Tycho-2 System. *Odessa Astron. Publ.*, **34**, 106—109.
8. Mullo-Abdolov A., Kokhirova G., Relke H., Yuldoshev Q., Protsyuk Yu., Andruk V. (2017). Investigation of the Microtek Scanmaker 1000XL Plus Scanner of the Institute of Astrophysics of the Academy of Sciences of the Republic of Tajikistan. *Odessa Astron. Publ.*, **30**, 186—189.
9. Mullo-Abdolov A., Relke H., Kokhirova G., Yuldoshev Q., Protsyuk Yu., Andruk V. (2018). Progress in the Realization of the Project FON-Dushanbe Catalogue. *Odessa Astron. Publ.*, **31**, 224—227.
10. Pakuliak L. K., Andruk V. M., Golovnia V. V., Shatokhina S. V., Yizhakevych O. M., Ivanov G. A., Yatsenko A. I., Sergeeva T. P. (2016). FON: from start to finish. *Odessa Astron. Publ.*, **29**, 132—135. DOI: 10.18524/1810-4215.2016.29.85140
11. Pakuliak L. K., Andruk V. M. (2020). Applications of Big Data in Astronomy and Geosciences: Algorithms for Photographic Images Processing and Error Elimination. Knowledge Discovery in Big Data from Astronomy and Earth Observation. Eds. P. Skoda, F. Adam. Elsevier, 325—330. ISBN: 978-0-128-19154-5 DOI: 10.1016/B978-0-12-819154-5.00029-1
12. Protsyuk Yu. I., Andruk V. N., Kazantseva L. V. (2014). Software for Processing of Digitized Astronegatives from Archives and Databases of Virtual Observatory. *Odessa Astron. Publ.*, **27**, 59—60.

13. Relke E., Protsyuk Yu. I., Andruk V. M. (2015). The Compiled Catalogue of Photoelectric UBVR Stellar Magnitudes in the TYCHO2 System. *Odessa Astron. Publ.*, **28**, 211—212.
14. Savanevych V. E., Briukhovetskyi O. B., Sokovikova N. S., Bezkrovny M. M., Vavilova I. B., Ivashchenko Yu. M., Elenin L. V., Khlamov S. V., Movsesian Ia. S., Dashkova A. M., Pogorelov A. V. (2015). A new method based on the subpixel Gaussian model for accurate estimation of asteroid coordinates. *Mon. Notic. Roy. Astron. Soc.*, **451**, № 3, 3287—3298.
15. Savanevych V. E., Khlamov S. V., Vavilova I. B., Briukhovetskyi A. B., Pohorelov A. V., Mkrtichian D. E., Kudak V. I., Pakuliak L. K., Dikov E. N., Melnik R. G., Vlasenko V. P, Reichart D. E. (2018). A method of immediate detection of objects with a near-zero apparent motion in series of CCD-frames. *Astron. and Astrophys.*, **609**, id.A54, 11 p.
16. Shatokhina S., Kazantseva L., Yizhakevych O., Andruk V. M. (2018). Catalogue of Asteroids from Digitized Photographic Plates of the FON Program. *Kinemat. Phys. Celest. Bodies,* **34**, 270—276.
17. Shatokhina S. V., Relke H., Yuldoshev Q. X., Andruk V. M., Protsyuk Yu. I., Muminov M. (2018). Asteroids Search Results in Digitized Observations of the Northern Sky Survey Project (KITAB Part). *Odessa Astron. Publ.*, **31**, 235—238.
18. Vavilova I. B., Pakuliak L. K., Protsyuk Yu. I., Virun N. V., Kashuba S. G., Pikhun A. I., Andrievsky S. M., Mazhaev A. E., Kazantseva L. V., Shlyapnikov A. A, Shulga A. V., Zolotukhina A. V., Sergeeva T. P., Miroshnichenko A. P., Andronov I. L., Breus V. V., Virnina N. A. (2011). Ukrainian Virtual Observatory: Current Status and Perspectives of Development of Joint Archives of Observations. *Space Science and Technology*, **17**, № 4, 74—91.
19. Vavilova I. B., Yatskiv Ya. S., Pakuliak L. K., Andronov I. L., Andruk V. M., Protsyuk Yu. I., Savanevych V. E., Savchenko D. O., Savchenko V. S. (2017). UkrVO Astroinformatics Software and Web-services. A*stroinformatics. Proc. Int. Astron. Union*, **325**, 361—366.
20. Vavilova I. B., Shatokhina S. V., Pakuliak L. K., Yizhakevych O. M., Eglitis I., Andruk V. M., Protsyuk Yu. I. (2022). Astrometry and photometry of asteroids from the UkrVO database of astroplates. *Proc. Int. Astron. Union*, **364**, 239—245.
21. Yatsenko A. I. (2016). Catalog of the Photographic Survey of the Northern Sky (FON-2.0) built up from the scanning of astroplates: a new version. *Kinemat. Phys. Celest. Bodies*, **32**, № 3, 153—156.
22. Yizhakevych O. M., Mullo-Abdolov A. Sh., Relke H. V., Kokhirova G. I., Pakuliak L. K., Andruk V. M. (2018). First Results of the Searching of Asteroids Based on the Data of FON-Dushanbe Processed Plates. *Odessa Astron. Publ.*, **31**, 247—250.
23. Yuldoshev Q. X., Ehgamberdiev Sh. A., Muminov M. M., Protsyuk Yu. I., Relke H., Andruk V. M. (2017). Catalog of equatorial coordinates and B-magnitudes of stars of the Kitab part of the FON project. *Kinemat. Phys. Celest. Bodies*, **33**, № 5, 250—253.

Стаття надійшладо редакції 14.08.2023
Після доопрацювання 12.09.2023
Прийнято до друку 14.09.2023

Received 14.08.2023
Revised 12.09.2023
Accepted 14.09.2023

С. В. Шатохіна[1], наук. співроб.
E-mail:svetash@mao.kiev.ua;
Е. Рельке[2], канд. фіз.-мат. наук
E-mail: helena_relke@yahoo.com;
О. М. Їжакевич[1], наук. співроб.
E-mail: yizh_net@ukr.net;
В. М. Андрук[1], наук. співроб.
E-mail: andruk1058@ukr.net;
А. Ш. Мулло-Абдолов[3], наук. співроб. (до 2021 р.)
E-mail: aziz.sherzod@gmail.com

[1] Головна астрономічна обсерваторія Національної академії наук України
вул. Академіка Заболотного 27, Київ, Україна, 03143
[2] Обсерваторія Walter Hohmann
Wallneyer Straße 159, Ессен, Німеччина, 45133
[3] Інститут астрофізики Академії наук Республіки Таджикистан
пр. Айні, 299/5, Душанбе, Таджикистан, 734063

ПОЛОЖЕННЯ АСТЕРОЇДІВ ІЗ СПОСТЕРЕЖЕНЬ ЗА ПРОЄКТОМ ФОН В ДУШАНБЕ

Наведено результати ідентифікації зображень астероїдів та робіт зі створення позиційних каталогів на основі оцифрованих фотографічних спостережень у рамках фотографічного огляду північного неба (проєкт ФОН). Співпраця між Українською віртуальною обсерваторією та Інститутом астрофізики Академії наук Таджикистану дозволяє розширити цю роботу через залучення численних додаткових архівів оцифрованих спостережень та сервісів обробки для отримання нових оригінальних даних про малі тіла Сонячної системи.

Душанбинська частина проєкту ФОН представлена приблизно 1570 фотопластинками, отриманими в 1985—1992 роках у Гіссарській астрономічній обсерваторії Інституту астрофізики Академії наук Республіки Таджикистан. На даний момент завершено їхнє оцифрування та обробка сканів, а також отримано каталог екваторіальних координат і зоряних величин для всіх зареєстрованих об'єктів на пластинках.

Паралельно з вирішенням основного завдання проєкту зі створення каталогу зірок і галактик за результатами обробки пластинок виконувався пошук зображень астероїдів і комет задля створення каталогу їхніх координат і зоряних величин. Було отримано більше 2000 положень астероїдів і комет з візуальними величинами від 7^m до 16.5^m. Усі положення астероїдів порівнювались з ефемеридами. Проведено попередній аналіз різниць *O-C* астероїдів та їхнє порівняння з аналогічними результатами, отриманими з оцифрованих спостережень Київської та Китабської частин проєкту ФОН. Автори відзначають деякі відмінності точностей порівнюваних каталогів, а також аналізують причини та можливості зменшення їхнього впливу.

Крім того, у каталог додано кілька положень Плутона і комет, які також були ідентифіковані на негативах.

Ключові слова: архіви даних, оцифровані спостереження, каталог, положення астероїдів.