

EAO database of Solar System bodies observations

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Abstract

There is a large data bank of photographic observations of Solar System bodies at Engelhardt Astronomical Observatory (EAO). The brief description of the methods of observations and the accuracy of their reduction with the PPM and Tycho-2 catalogues is given. The photographic positions of the major planets, except Jupiter, are in the system of the Tycho-2 catalogue and their comparison with DE200 ephemeris coordinates are given.

1. Introduction

Modern technologies replace classical methods of observations in astronomy and in astrometry as well. At the same time many photographic plates have been gathered at astronomical observatories. It would be hard to overestimate how self-descriptive are these observations. Taking into account that observations of the past epochs have especially great value for astronomy and as times goes by their importance grows it is obvious that photographic astrometry will not lose its practical importance. This point was reflected in B3 XXIV IAU resolution by the General Assembly.

EAO has a large data bank with photographic observations of various celestial bodies including observations of solar system objects.

The results of reduction of observations of solar system bodies were published mainly in Proceeding of EAO and Transactions of Kazan City Astronomical Observatory, thus not available in English.

2. The photographic observations of the Solar System bodies at EAO and Zelenchuk station

The high altitude Zelenchuk station was built nearby the six-meter telescope in 1975 ($\lambda = 2^h 45^m 46,43^s$, $\varphi = 43^\circ 39' 10''$, $H = 2034\text{ m}$), where a Zeiss astrograph 400/2000 and Schmidt camera were installed to make photographic observations of celestial bodies. We obtained about three thousand observations at EAO and Zelenchuk station with the Zeiss telescope (D=400mm, f=2000mm), AFR-18 (photovisual, D=200, f=2000), 16" refractor (D=400mm, f=3450mm), Meniscus camera (D=340mm, f=1200mm), Schmidt camera (D=350mm, f=2000mm). The major planets with the exception of Pluto and Neptune were observed with a special cassette chamber equipped with a rotating disk which had an open sector to reduce the brightness of the planets. The dimension of the sector was chosen based on the brightness of the planets. The disk was placed in the centre of the astrograph's field. The stars' true brightness were preserved.

2. The Results of the Observations

A number of the catalogues were compiled by the end of the 20th century. We used PPM and Tycho-2 catalogues for reducing our observations. The PPM catalogue consists of two parts. The first one includes 181731 northern stars [1]. The average errors in the stellar positions and their proper motions are about 0.27 arcsec and 0.43 arcsec/century

accordingly. The second part has 197179 southern stars [1], the average errors in the stars' positions and their proper motions are 0.11 arcsec and 0.30 arcsec/century. The other catalogue Tycho-2 (Tycho-2 catalogue, 2000) includes 2539913 stars. The stars' proper motions given in the catalogue were obtained by comparing positions from Tycho-2 with positions from the Astrographic Catalogue. Therefore they are considered to be highly accurate. The accuracy of stellar positions in Tycho-2 is about 60 mas and the accuracy of their proper motions is 2.5 mas/yr.

The mean $(O-C)$ values for Pluto were calculated for observations taken between 1985 and 1991. However, if we look at the period of 1988-1991 in detail, the values of $(O-C)_\alpha$ for Pluto with the Tycho-2 catalogue increase from 1,32" to 2,25". The values of $(O-C)_\delta$ are in the limits of -0,41" to -0,57".

The large $(O-C)$ values for Pluto in both coordinates can be explained by the uncertainties of its ephemerides and maybe by the oscillations of the photometric centre of the Pluto-Charon system. Similar results were obtained earlier at EAO and Pulkovo observatory [3]. The values of $(O-C)$ for the other planets are within the accuracy of the photographic method of observation. Photographic positions of Venus, Mars, Saturn, Uranus, Neptune and Pluto in the system of the Tycho-2 catalogue were obtained. The coordinates of the planets are apparent with the exception of Pluto, which are astrometric.

3. Summary and conclusions

The accuracy of the reduction of our planet observations based on the Tycho-2 catalogue is higher than that of the reduction with the PPM catalogue especially in right ascension. This is not

surprising, since both the systematical and random errors are smaller in the Tycho-2 catalogue [2], [4]. We feel this demonstrates that rereduction of photographic observations with improved catalogues can significantly improve the accuracy, thus the value of old, and in the case of planets, unrepeatable observations.

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References

- [1] Bastian, U., Roeser, S., et al. 1993, PPM Star Catalogue, Positions and Proper Motion of 197179 Stars South of -2.5 degrees declination for Equinox and Epoch J2000 Spectrum Akademischer Verlag, Heidelberg, Berlin, New York)
- [2] Nefedjev, Y.,A., Rizvanov, N.G., Shaymukhametov, R.R. A comparative estimation of the accuracy of modern astrometric catalogues. 2003, Kinematics and physics celestial bodies, 19, 379 (in rus.)
- [3] Rilkov V.P., Dementjeva A.A., Narighnaj N.V., Kitkin V.N. Photographic positional observations of Pluto with telescope EAO Zeiss 400, 1995, Deponirovano in VINITI 03.05.95, No 1219-095, 7 p. (in rus.)
- [4] Schwan, H. Systematic relations between the Hipparcos catalogue and major (fundamental) catalogues of the 20th century (Paper I). 2000. A&A, 373, 1099