

ON THE PROGRAMME OF GROUND-BASED OBSERVATIONS OF BRIGHT SELECTED MINOR PLANETS FOR 1991–2000

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ABSTRACT. The programme of observations of 10 bright minor planets for 1991–2000 is proposed. One of the main aims of the programme is the determination of the orientation parameters and the systematic errors of star catalogues.

In 1976 during the IAU General Assembly in Grenoble, Commissions 8 and 20 approved the observational programme for 20 selected minor planets proposed by V.I. Orelskaya (1981). This programme was a significant broadening of the preceding ones proposed by D. Brouwer (1935) and by B.V. Numerov (1935) because it was aimed not only at determining the orientation parameters of the star catalogues, but at revealing the systematic errors of the latter as well. It was set up to 1990 and now it is near completion.

In the Institute of Theoretical Astronomy (ITA) there have been collected about 29000 observations of the 20 selected minor planets made at 35 observatories of the world within the framework of the programme mentioned and the earlier ones. Among these there are about 27000 observations of the 10 brightest minor planets covering the period 1949–1989. The error of unit weight of these observations when determining the orbital elements only is about 0".45. For the remaining 10 selected minor planets the number of observations is noticeably less, the O–C's are greater and the period of coverage, 1977–1989, is shorter.

The difference in accuracy owes partly to the fact that the minor planets of the second group are less bright, as a rule, as compared with those of the first group. To observe these minor planets one needs sufficiently long exposures. So their positions with respect to the reference stars are determined with rather large errors. At present the work is undertaken at the ITA for reducing the observations to the FK4 system and for determining the catalogue zero-point corrections and systematic errors which depend on the spherical coordinates.

When solving the problem two methods for processing observations are used. In the first one the usual normal places are formed within the areas of the celestial sphere. They are used to determine the orbital elements, the zero-point corrections and the systematic errors of the catalogue (Pierce 1971).

In the second one the generalized normal places are used (Batrakov et al 1987) to determine the same unknowns. Such a generalized normal place consists of the orbital parameters, the zero-point corrections, the systematic errors of the catalogue and their matrix of covariances determined from the restricted number of observations. To obtain these data the normal equations are subjected to regularization because of the bad conditioning. The method is quite correct as it gives the strict least squares solution based on all admissible observations and no information contained in them is lost. It is more laborious, of course, as compared with the first method, because for obtaining the generalized normal place the large dimension normal system must be solved. After completing the programme and collecting all the observations they will be checked and transferred to the Center of Stellar Data in Strassburg.

A question arises if the programme of observations of selected minor planets should be prolonged for the period after 1990. In our opinion, there are many reasons in favor of continuing it for 1991–2000, at least, though with some modifications. When using accurate observations the following problems can be solved:

- determining the minor planet masses,
- predicting the occultations of celestial bodies by minor planets,
- determining the star catalogue zero-point corrections and systematic errors,
- connecting the catalogues based on the ground-based observations with those obtained by astrometric satellites,
- connecting the coordinate frames based on ground-based optical observations with those based on VLBI observations of quasars, if radio-beacons are placed on some of the minor planets.

The limiting accuracy of 0".1 to 0".2 for ground-based observations can be reached when using telescopes of 5–10 m focal length (Duma 1985). With such instruments, however, it is difficult to have the required number of reference stars on the plate.

The smaller internal accuracy of 0".3 to 0".5 is attainable with telescopes of 3 m focal length which are more widely available. Many observatories have them and can take part in producing accurate positional observations. To obtain this accuracy short exposures must be used. So the minor planets observed must be as bright as possible.

Therefore, we propose to prolong the observation programme for the brightest minor planets only, namely numbers 1, 2, 3, 4, 6, 7, 11, 18, 39 and 40. The internal accuracy of individual observations in this programme must be 0".3 to 0".5. When observing the minor planets one must try to cover the widest possible arc of the planetary orbit, literally from quadrature to quadrature, in order to ensure good coverage of the star background and the separation of the unknowns. The most modern catalogues must be used. The observations and their dependences are to be published or delivered in a unified form.

The proposed programme for the 10 bright selected planets is a natural continuation of the preceding programmes mentioned above. The successful completion of it will give the proper base for solving many current scientific problems of importance.

References

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Discussion

CORBIN: I know that L. Morrison will agree when I say that meridian circle observers support this program because of the increasing role that minor planets are playing in the determination of the equinox correction. This program will help improve the orbital elements, which in turn will give better results in our programs.

MORANDO: I support the programme of observations of minor planets. Such a programme of bright minor planets exists in France at Bordeaux and in Spain at La Palma.

YATSKIV: Are there any techniques which give improved accuracy for observation of minor planets? What about the possible role of CCDs?

SEIDELMANN: VLA observations of minor planets are accurate to about 0.01 arcsec. The problem with CCD observations is the need for good reference star catalog positions. The CCD field is very small.

IVASHKIN: When you constructed your proposed observation list of minor planets, did you take into consideration the possible candidates for proposed space exploration of minor planets? Also, did you consider employing the results of spacecraft-observations of minor planets in your ephemeris development work?

BATNIKOV: Data from spacecraft-based measurements of minor planets were not considered.