

THE APPROACH OF IMPROVEMENT TO STELLAR COORDINATE

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ABSTRACT

This article presents a new method for observing minor planets. The observation is operated with a photo-electronic imaging device CCD and a lower latitude meridian circle.

The CCD is mainly used except it is during the favourable opposition of the minor planet when the meridian circle is mainly used in this method. The method can improve precision of observation of planetary position and enlarge scope of observation of planetary orbit. Therefore, the measured precision of zero point of stellar coordinate could be increased. The key of succeeding is that more precise result is got using the CCD.

The experiment in this article indicates that this method is a good way: While a minor planet and calibration stars locate in the same image of the CCD, the measured precisions of the minor planet are

$$\sigma_{\alpha} = \pm 0''.03, \quad \sigma_{\delta} = \pm 0''.035;$$

While the minor planet and calibration stars are located in different images of the CCD, the precisions are

$$\sigma_{\alpha} = \pm 0''.06, \quad \sigma_{\delta} = \pm 0''.08.$$

1. INTRODUCTION

At present, the precision of the coordinate based on the stellar coordinate is affected because precision of observations on the celestial bodies in the solar system is not able to reach precision of observations on the stars. So raising precision of observations on the celestial bodies in the solar system is one of the important way to improve the stellar coordinate. Since 1986, we have been making a series of orientation observations on minor planets using CCD receiving system of 1M telescope in Yunnan Astronomical Observatory. The observations indicate^[1]: When the

tested minor planet and the calibration stars locate in the same image of CCD, the measured precision of the minor planet is: $\sigma_\alpha = \pm 0''.03$, $\sigma_\delta = \pm 0''.035$. On the other hand, when the measured minor planet is connected with calibration stars by means of overlap measurement, the precision becomes: $\sigma_\alpha = \pm 0''.06$, $\sigma_\delta = \pm 0''.08$. The increasing of observational frequency can no doubt improve the orientation precision of the minor planets. When we want to determine the orbits of those minor planets, we can adopt CCD. It has not only higher precision comparing with photograph, but also higher efficiency. On this basis, the author presents an idea to determine zero point of stellar coordinate, that is observing minor planets by using conjugation of CCD and the meridian circle^[1]. This paper discusses it in the concrete.

2. THE ADVANTAGES AND DISADVANTAGES OF DETERMINING ZERO POINT OF THE STAR CATALOGUE BY MEANS OF OBSERVING MINOR PLANETS.

In history, zero point of the star catalogue was determined by means of observing the sun and the planets. However, considering the observational conditions now, it is difficult to improve the observational precision of zero point of the star catalogue. The minor planets are near to point sources, and also they are observed at night. Theoretically, the position of the minor planets can be arrived with the stellar measured precision. So minor planets are the ideal celestial bodies to determine zero point of star catalogue. In the 20's of the 20th century, Dyson had presented a proposal to determine zero point of the coordinate through observing minor planets^[2]. For dozens of years, the precision of zero point of the star catalogue determined by minor planets is not high. The reason might be divided into three sides^[3-4].

(1). The adopted stars in the fundamental coordinate are mainly those stars absolutely and relatively measured through meridian circle. The minor planets are very dim, so not many of them can be observed by using meridian circle.

(2). In practice, photograph method is usually used. But the precision of the star catalogue adopted by this method is too low, the measured precision of the minor planets reduces.

(3). The minor planets are never observed systematically by using photograph or meridian circle, and the theory of movement of the minor planets are not perfect.

The conjugation of CCD and meridian circle to observe minor planets can improve the measured precision, and also enlarge the observed range. If the full use of the observational data of high precision of minor planets is made and the accurate orbits of the minor planets are determined, then the main disadvantages of the measurement of observing minor planets in the past can be overcome and the precision of zero point of the star catalogue determined by minor planets can be in-

creased, and also our aim of improving stellar coordinate will be realized.

3. CONJUGATION OF CCD AND MERIDIAN CIRCLE TO OBSERVE MINOR PLANETS

In this paper, the observational means is CCD receiving system of 1M telescope and low latitude meridian circle in Yunnan Astronomical Observatory. The meridian circle can observe celestial bodies of about 13^m ^[5].

During the opposition of minor planets, our main observational instrument is meridian circle, CCD helps it. They are used to observe for a period of time simultaneously. The aim is normalization calculation. When the minor planet's location is not good for meridian circle, CCD can be full used. In order to assure coincidence of the system and improve CCD orientating precision of minor planets, calibration stars in CCD observation should mainly be those stars observed by using low latitude meridian circle. CCD observation is an important assurance to get more observational points on the whole orbits of the minor planets.

The experiment indicates^[1]: Observing minor planets by using CCD have high precision and high efficiency. It can assure the orientating precision, enlarge the length of observational arcs for minor planets and reach high precision of zero point of the star catalogue.

4. SOME CONSIDERATIONS ON THE TREATMENT OF THE DATA

Conjugation of CCD and meridian circle realized the improvement on the observational means and methods. It is the important assurance of raising the measuring precision of the minor planets. Similarly, the improvement of the treating methods of the observational data can also reach the aim of raising precision.

(1). The measurement and correction of the systematic error

CCD receiving system and meridian circle are two different observational means. Their normalization calculation is very important. So it must be solved through experiments. According to the fact already known, number 1—4 minor planets can be selected as the observed celestial bodies. Even though, in the practice of observations on the minor planets, CCD and meridian circle must be simultaneously used for a period of time. Thus the high precision of measuring minor planets by using meridian circle can be assured.

(2). The improvement of the measuring precision of minor planets.

The experiments indicate: In order to raise the measuring precision of the minor planets' locations on the selected moment, it is necessary to increase CCD observational frequency around that moment as many as possible. Multinomial fitting is used for treating the data, and (α, δ) changing as time varies could be got from following function:

$$\alpha = \alpha_0 + at + bt^2 + ct^3 + \dots$$

$$\delta = \delta_0 + a't + b't^2 + c't^3 + \dots$$

where $a, b, c, d, \dots, a', b', c', d', \dots$ are coefficients to be determined. Such observational methods and data processing can assure the high precision of minor planets' locations on the selected moment^[1].

(3). The improvement of average orbital elements

Since the use of normalization calculation increases the precision of minor planets observed by meridian circle, and enlarges the length of observed arcs of minor planets, more observed values can be got on the enlarged arcs of minor planets' orbits. Making use of the observed values of high precision, the average orbital elements of minor planets will be improved, and the determination of accurate orbit of minor planets will be realized. Since the theory of minor planets' movement is not perfect, methods of the experiment are: make full use of the observed values that have high precision on the orbit of minor planets, take an envelope of osculating ellipses for approximations to minor planets' real orbits, realize the improvement of the minor planets' average orbital elements.

5. CONCLUDING REMARKS

As the transition from fundamental coordinate to dark stars, as the improvement of observational precision of zero point on the fundamental coordinate, it will have important significance to determine zero point of star catalogue by observing minor planets and have much more affection in practice. The method presented in this paper is a new way to determine zero point with minor planets.

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