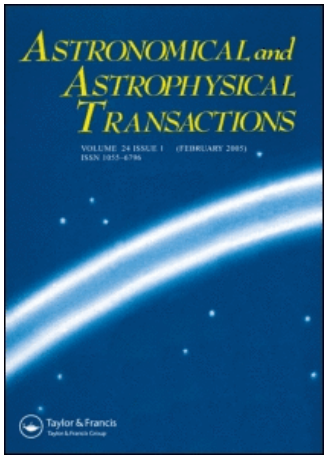

Astronomical & Astrophysical Transactions
The Journal of the Eurasian Astronomical Society
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713453505

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Online Publication Date: 01 July 1997
To cite this Article: Pinigin, G. and Gumerov, R. (1997) 'Advantages and peculiarities of the determination of stellar coordinates in antarctica with the automatic meridian telescope', Astronomical & Astrophysical Transactions, 13:1, 77 - 81
To link to this article: DOI: 10.1080/10556799708208116
URL: http://dx.doi.org/10.1080/10556799708208116

Astronomical and Astrophysical Transactions, 1997, Vol. 13, pp. 77–81
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ADVANTAGES AND PECULIARITIES OF THE DETERMINATION OF STELLAR COORDINATES IN ANTARCTICA WITH THE AUTOMATIC MERIDIAN TELESCOPE

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(Received November 14, 1995)

High-latitude observations in the southern hemisphere are suggested for the determination star positions to high-accuracy. The main advantages of the proposed method are high efficiency and small catalogue systematic errors. The peculiarities of the automatic meridian telescope for Antarctica are discussed.

KEY WORDS Astrometry, meridian circles, Antarctica

1 INTRODUCTION

There is large interest among astronomers in best sites on the surface of the Earth for the possibility of making more precise observations of celestial bodies. The XXI IAU approved the project of the international Antarctic Astronomical Observatory (AAO) on the high Antarctic Plateau with a latitude of about 89–90 degrees (Resolution A5, 1992). This project promises a very dry, tenuous and stable atmosphere, unique observing conditions, particularly in the infrared and submillimetre bands. Also, there is interest in the determination of position from northern and southern high latitudes during polar nights. In these conditions it is possible to observe stars for 24 hours and more with insignificant meteorological variations. The high position of the celestial pole over the horizon permits us to observe stars in two culminations along a very extended meridian arc. This allows us to relate exactly observed regions to the celestial pole and the sky meridian. The observations during polar nights must be free from systematic errors inevitable at other latitudes.

2 OBSERVATION IN THE ARCTIC (SPITZBERGEN)

In the 1970s polar night observations were made by the Mykolayiv and Pulkovo astronomical observatories on the island of West Spitzbergen ($F = +78°$) for the purpose of the determination of absolute positions of stars. These programs were headed by G. M. Petrov (right ascension-RA) and V. A. Naumov (declination-D).

The RA program was made with the photoelectric transit instrument of the Mykolayiv astronomical observatory during three polar nights in 1974–1977 (Petrov, 1981). The main part of the RA program (about 80%) was made during long-term and non-stop observations from 18 to 155 hours in which the small temperature variations do not exceed 1°C. Many star observations were received in two culminations for the reliable determination of the absolute orientation of the telescope. Finally, the absolute catalogue Nik (Spz)75 was compiled without large systematic errors and used for improvement of the FK4 RA system (Fifth Fundamental Catalogue, 1988).

The D program was made with the Bamberg zenith-telescope in 1977–1980 (Glebova *et al.*, 1991). Altogether 5.5 thousand values of instant latitudes were obtained in 18 months (three polar nights). Four values of the mean latitude of the telescope site have been found using four programs of Talcott pair observations in different zones of zenith distances. The standard deviation of the mean latitude determined from one program was equal to $\pm 0''.010$.

Take into account these observations, the program can detect some peculiarities of the determination of star position during polar nights. By the right ascensions:

(1) the variations of instrumental orientation parameters, mainly the azimuth of the meridian telescope are to be determined more carefully. For this purpose it needs to have stable azimuth marks;

(2) determination of collimation error is not so difficult when meteorological conditions are nearly stable during the period of observations. By the declinations: determination of the latitude and refraction errors using the Bessel method from star observations in two culminations is more reliable by the conditions of identical observation. Due to this the ultimate results must be free from systematic errors. On both occasions it takes more care to do a study of the influence of refraction on observations.

3 OBSERVATION IN ANTARCTICA

The astronomical observations on Spitzbergen underlie a new interest in high-latitude observations in connection with the establishment the international AAO in Antarctica (Petrov and Pinigin, 1992). The additional merits for positional astronomy in Antarctica are: (a) the unique observing conditions promise the possibility of the creation of an exact coordinate system on the southern sky with negligible errors; (b) the AAO will be an experimental observatory for the determination of

stellar coordinates before the future astronomical observatory on the Moon (Mission to the Moon, 1992).

3.1 Meridian Telescope for Antarctica

There are some requirements to the high latitude meridian telescope (HLMT), connected with the specific observing conditions on high latitudes (Pinigin, 1978, 1979). The main requirements are: the HLMT should be shown to be a stable and insignificant instrumental system, furnished with CCD registering devices, computer control and operating in low-temperature conditions during 24 hours and more long, continuous observations.

The available results are expected from the new Mykolayiv axial meridian circle (AMC) (Pinigin *et al.*, 1994, 1995). In 1995 the AMC was put into operation. The main components of the AMC are: (1) an ocular star micrometer with CCD format 288 × 256, a pixel size of 24 × 32 μ cooled down to −40° C has a mean error of the artificial mark reading $\pm 0''.01$, a magnitude limitation up to 13^m observation of a sky strip with a width of eight arcminutes up to 80 declination degrees and length four minutes (determined by the random-access memory (RAM) of the control computer, the strip may be longer by large RAM); (2) a divided glass circle (diameter 420 mm, division interval 5′) with a circle reading device including four reading microscopes with a mean error $\pm 0''.02$ and full reading time 16 s. There are two additional microscopes for automatic determination of graduation errors and checking their stability; (3) the telescope setting is made by means of a stepper motor; for visual checking it is equipped by the TV-microscope. The positioning accuracy of drives is $\pm 1'$, the rate is $1.5°s^{-1}$; (4) an autocollimator with CCD micrometer in prime vertical is set up to the AMC pentag. The mean error of artificial mark reading is $\pm 0''.1$. The collimator's tube is vacuumed for absence of anomalous refraction on the horizontal light path; (5) the time service is based on a Rb beam clock and used for the keeping of a time-scale during observations and has synchronization by short or long-wave receivers. The time scale is kept with the accuracy of ±0.5 mks/day; (6) meteorological data collection is provided for measurement of ambient temperature inside and outside the AMC pavilions, pressure and humidity. It is possible to measure the starting temperature for checking the AMC position. The accuracy of measuring of a temperature is ±0.05° C, pressure ±0.05 mm Hg and humidity ±1 mm Hg; (7) a Computer Control System (CCS) provides observation with the AMC in automatic and manual modes, a telescope setting, a divided circle reading and performance micrometers of tube and autocollimator, collection the meteorological data, preparation, handling and keeping data. The CCS includes control and master computers of type PC-486 connected on-line with information exchange rate of 1 Mbit s^{-1}. A Hard Disk memory 0.5 GB and operational system MS DOS 6.0 are used.

The preliminary investigations of the main parameters showed: the collimation was stable in time and with the temperature and described by the formula $C = C_0 + at$; where $t[C]$ is the environmental air temperature, $C_0 = 12''.705 \pm 0''.099$, $a = 0''.26 \pm 0''.008$ (Pinigin *et al.*, 1994). The horizontal flexure in temperature

range from +12 to +19°C was negligible and consisted of $-0''.037 \pm 0''.042$. The trial observations of the FK5 stars showed variations of the AMC instrumental system of not more than $0''.1$.

All the above mentioned allow us to propose such a telescope as the AMC for high-latitude observations.

3.2 Expected Advantages from the Antarctica Observations

The evaluation of the expected efficiency of star position determination from high-latitude observation was made in accordance with classic methods (Pinigin, 1978; Bagildinskii and Pinigin, 1979). Using the AMC parameters and large periods of clear sky in Antarctida (from 1500 hours in the US scientific station McMurdo to more then 3500 hours in the near of South Pole) it can be shown that the expected accuracy of a future star catalogue is about $0''.02$ compiled from observations during one or two polar nights. But using a method of global or parametric adjustment for the compilation of a star position catalogue obtained from high-latitude observations (Teixeira *et al.*, 1992; Gubanov, 1993) would be more promising. The consideration of employment of this method by high-latitude observations is being carried out at present.

4 CONCLUSIONS

Determination of stellar coordinates from Antarctica are very promising for the compilation of a south catalogue, free from systematic errors. The high accuracy of this catalogue will be provided by stability and the insignificant influence of atmosphere refraction. More important would be observation from north and south high latitudes for the creation of a homogeneous reference frame over all the celestial sphere.

High-latitude observation, especially from Antarctica, could be realized by using the Mykolayiv AMC, after some testing and preparation, as the high-latitude meridian telescope.

Acknowledgments

The research described in this publication was made possible in part by Grant No. 95–02–06013a from the Russian Science Foundation and by Grant No. USW 000 from the International Science Foundation.

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