The Vacuum Mires of the Transit Instrument at Nikolaev

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Summary:

At Nikolaev, in 1978, a system for the improvement in the stability of the light path between the transit instrument and the meridian mires was designed. Its purpose is to improve the accuracy of the azimuth determination and that of the collimation. This system consists of twelve sections of 8 mm thick steel tube with 160 mm diameter, each nine meters long. These tubes are lying in special steel cradles which rest on brick support columns spaced 8 meters apart, and these can be moved vertically and horizontally by 100 mm and 50 mm, respectively. Thus it is possible to align the axis of the tube exactly.

The ends of the tube are covered by 30 mm thick plane-parallel disks of optical glass. The glass in the mire house has a diameter of 50 mm, and the lens side of the mire a diameter of 150 mm. The air is removed from the tubes with a vacuum oil pump. Each tube has its own mercury manometer which monitors the pressure to 1 mm of mercury. Our experience shows that even during the day, the system produces a mires image which is close to ideal, a nucleus surrounded by diffraction rings; also, the system holds the vacuum very well. Over five years, the pressure in the South tube increased from 0 to 5 mm, and the presure in the North tube increased about 6-7 mm per year. After that, the air is again pumped out.

Unfortunately, our plane parallel glass plates formed a wedge (or were not parallel to each other) after they had been put into metal cells and pressed against the flanges of the tubes. This is evident from a change of the angle between the mires. This required an investigation of the influence of the air-pressure variation inside the tubes on the magnitude of the angle between the mires. For this purpose, we measured to the mires at two pressures: close to 0 and close to 90 mm Hg. This difference turned out to be $0^s.012 \pm 0.003$, and showed that a pressure increase to 10 mm can be tolerated before the vacuum has to be reestablished.

The influence of temperature and other factors on the behavior of the vacuum protection was studied from special series of measurments of half the

H. K. Eichhorn and R. J. Leacock (eds.), Astrometric Techniques, 529–531.

difference of the azimuth between the North and South mires. Their reduction demonstrates a slow change of the azimuth difference from one day to the next and also establishes the dependence of this azimuth difference on the temperature. We found out that a change of temperature by 1^{o} changes the value of the half-azimuth difference by 0.0091±.00015.

The dependence we found could be caused either by a change of the angle of the glass wedge (covering the tubes) or the movement of the foundations of the mires or the transit instrument, or both. To explore the influence of the glasses, we had similar measures of the half azimuth difference of the mires. These were mostly carried out by V. Lu. Brovenko in 1968, when there were no protective devices in place. We found out that the 1968 measurements showed exactly the same temperature dependence which we have found. We got a similar pattern on our instrument as well and in 1962 (Petrov 1964). We can therefore conclude that the glasses are not responsible for this phenomenon, and that the temperature dependence originates in relative motions of the foundations of the mires and the transit instrument. The temperature dependency of the half of the azimuth difference of the mires was noticed also on other instruments (Tursunov 1966) but unfortunately it did not receive much attention. The source of the problem is that the movement of the foundations can mimic the same temperature dependence in the half-sum of the azimuth of the mires which is used for monitoring the azimuth of the instrument with respect to the mires. The ability to make such checks is critical for the measurement of right ascensions and for other tasks. It therefore seems to us that if the suggested explanation turns out to be correct, it will be necessary to measure the movements of the foundations or to have the mires so widely separated that the shifts of their foundations can safely be neglected. The half-difference of the azimuths of the mires can be measured with the same precision as the collimation error from reading the instrument after reversing the transit instrument. With the vacuum pipes in place, we get an average quadratic error of 0.010 at night and 0.011 during the day. In 1968, these errors were 0.010 and 0.015, respectively. We could still improve the precision obtainable with vacuum pipes in place if we would enclose the tubes in the pavillion and lead them as close as possible to the instrument. In Nikolaev, this is impossible due to the peculiarities of the construction of the pavillion.

Conclusions

1. The glasses which seal the vacuum pipes are sensitive to changes of the air pressure within the pipes.

2. The use of vacuum pipes substantially increases the precision with which the azimuth of the instrument and the collimation error can be determined.

3. The presently existing distances between the mires and the transit instrument should be increased.

Acknowledgements

Finally, the authors express their thanks to Senior Engineer L. N. Pleshivtsev and his co-workers in the instrument shop of the Nikolaev department for carrying out the large task of constructing the protective system. The paper was translated from the Russian original by Eva Eichhorn.

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