PbS AND CCD ARRAY AUTOCOLLIMATION MICROMETERS FOR THE INFRARED MERIDIAN CIRCLE

V. N. Yershov

Pulkovo Observatory

A new infrared meridian instrument is being developed at Pulkovo Observatory. The main purpose of the instrument is to extend the fundamental coordinate system to the K-infrared waveband and to faint stars at visual and I-wavebands. The instrument has a 30-cm primary mirror made from astrositall. An intermediate focal plane is used to introduce luminous reference marks. One can obtain autocollimated images of the marks at the intermediate focal plane with the use of a polished chamber located around the central hole of the primary mirror. The secondary mirror of the telescope forms images of the marks and of their autocollimated counterparts and passes them to the plane of a photodetector (Fig. 1.). The luminous marks give a reference frame for the measurements. These measurements are not affected by displacements of any optical unit placed after the intermediate focal plane or by displacements of the detector. The measurements are done relative to the coordinates of the average between positions of the luminous mark and its autocollimated image. Any small constant difference between the center of curvature and the optical axis position can be determined in the laboratory.

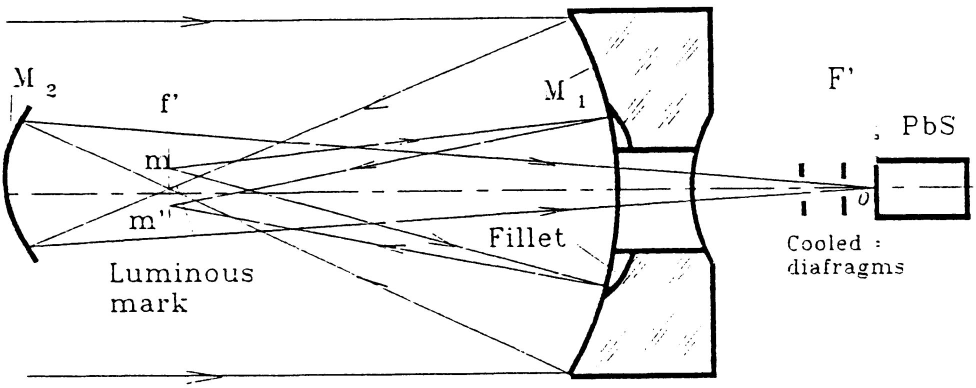

Fig. 1. The autocollimation micrometer with the intermediate focal plane.

A. G. Davis Philip et al. (eds.), New Developments in Array Technology and Applications, 337–338.

https://doi.org/10.1017/S0074180900056680 Published online by Cambridge University Press

The circle reading system of the instrument is rigidly connected to the optical unit. Two long-focus collimators measure the orientation of the sitallic unit relative to the unmovable optical axes by means of autocollimation from the lateral flat surfaces of the unit. So, both zenith distances and transit times of stars are determined relative to these fixed optical axes.

The intermediate focal plane allows one to use conventional construction for the infrared detector with its liquid nitrogen cryostat and cooled diaphragms and filters. Moreover, one may create additional focal planes in the micrometer by splitting the light beams into different colors. Two wavebands are planned to be used in the micrometer to obtain parameters of the atmosphere to be taken into account during the observations.

The visual and the near infrared wavebands (I) will be covered by the front illuminated CCD array with its 768 x 580 pixel array with square 27 micron pixels. The device will be cooled by Peltier thermoelectric elements. The sensitive area of the CCD is 21 x 16 square mm, and the total registration time will be 60 seconds. With the use of a "time delay and shift"" mode of signal accumulation one may expect the limiting magnitude of about I = 16 - 18.

The infrared K-waveband will be registered by a PbS 64 x 64 array (developed by the Electron Research Institute, St. Petersburg). The detector is in a coordinate addressing mode with a continuous layer of thin lead sulfide film. It is made by a process of chemical precipitation of poly-crystal, lead sulfide, onto a silicon substrate having the address bus.

Information is read by switching on part of the photoresistant layer, at the intersection of the selected column on the row, and by registration of the current passing through this part of the layer. For the PbS detector the time delay is a few dozens of milliseconds. The detector is working in a frame integration mode. Such a construction gives high sensitivity to the detector and a wide dynamic range (60 db). The spectral range of the detector is 1.0 to 3.0 micron and the working temperature is 90 K. The quantum efficiency is about 30%. The threshold level of the detectable signal is $(0.5 - 1.0)E^{-13}$ W/pixel (under the assumption of a S/N ratio of about one, and an integration time of 10 ms). The pixel size is about 50 x 50 micron and the pixel period is 60 microns. The total registration time is about ten seconds for these parameters of the detector and the telescope focal length is 5 m. The limiting K magnitude is estimated to be K = 5 - 10, depending on the star's spectral class (S/N = 3 is assumed).

This work was supported by the Russian Fund of Fundamental Investigations (92-02-17095)