ATTEMPTS TO OBSERVE THE ABSOLUTE INTENSITY AND THE CENTRE-TO-LIMB VARIATIONS OF THE SUN IN THE VACUUM ULTRAVIOLET REGION

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Abstract. Calibration for two rocket-borne spectrometers to observe the absolute intensity and the centre-to-limb variations of the Sun between 1500 Å and 2000 Å is described. The procedure of the calibration is divided into two parts, (a) the measurements of the transmission of the spectrometers, and (b) the absolute detector calibration.

The double dispersive spectrometer has been planned to be launched in September 1970, but it was postponed until the coming winter, and the single dispersive spectrometer will be launched in January 1971.

1. Introduction

The physical situation in the solar temperature minimum region between the upper photosphere and the low chromosphere may be deduced from the spectral intensity distribution and the centre-to-limb variations in the vacuum ultraviolet region (Keizo Nishi, 1967; Gingerich and de Jager, 1968). For this purpose, the observations have been done by some groups (Parkinson and Reeves, 1969; Widing *et al.*, 1970), but their results especially the absolute intensity do not coincide well each other. This is due to the difficulty in the absolute calibration.

At the Tokyo Astronomical Observatory we have prepared a vacuum chamber with a 50 cm Seya-Namioka type monochromator for the measurements of the efficiencies of concave gratings and mirrors which are to be used for the rocket-borne spectrometer, and for the absolute detector calibrations.

The method of measuring the efficiency of the optical devices is simply to compare the incident monochromatic light on to the test grating with the reflected light from the grating with the same detector without breaking the vacuum.

The principal process of the absolute detector calibration is to transfer the absolute value of the standard radiation source to the detectors of the flight spectrometer through a thermocouple and a 1P21 photomultiplier with a sodium salicylated glass window.

2. Calibration of Transmission of Spectrometers

The gratings and the parabolic mirror for the flight spectrometers were calibrated in a clean vacuum chamber (150 cm × 50 cm × 40 cm). A 50 cm Seya-Namioka type monochromator is set in the chamber. A hydrogen discharge tube with a thin quartz window was used as a light source. The pressure of hydrogen gas in the tube was 10 Torr, and it was operated under a constant discharge current of 300 mA. Thus the constancy of the light source can safely be maintained within 1% after running for 30 min. A detector which consists of a sodium salicylated glass window and a 1P21 photomultiplier can be

Labuhn and Lüst (eds.), New Techniques in Space Astronomy, 393–397.

moved along a Rowland circle of the test grating. The uniformity of the sodium salicylated glass window was carefully examined, and it was found to be better than 1%. The intensity of the incident monochromatic light to the test grating can be measured at the position of the exit slit of the Seya-Namioka monochromator, and the reflected light from the test grating can be measured on the Rowland circle with the same detector. The principle of the set up is shown in Figure 1.

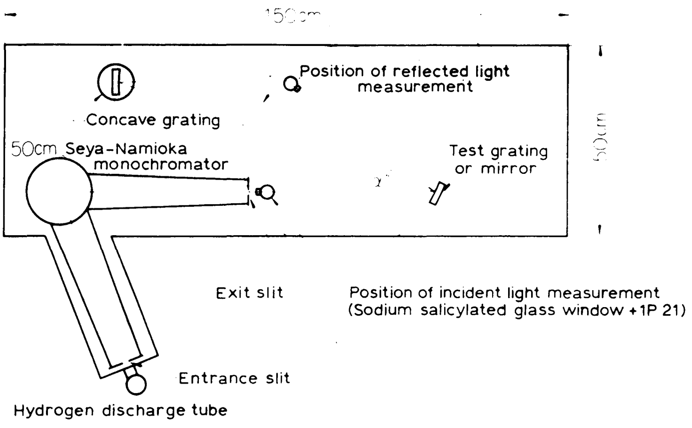

Fig. 1.

The measurements have been done by changing the incident angle α, and the orders on the blaze side, as well as on the non-blaze side of the gratings. In order to examine the polarization effect by the test grating, the detector system was rotated 90° around an axis which passes the concave grating, the exit slit of the Seya-Namioka monochromator and the test grating. Since the mounting of the flight spectrometer is nearly of normal incidence, the polarization effect was found to be almost negligible. The result is shown in Figure 2.

To measure the efficiencies of the parabolic mirror and the gratings in the Wadsworth mount, three concave mirrors were pre-calibrated. Two of them were set as a collimator and an imaging mirror, and after three measurements for three combinations of the mirrors efficiencies of individual mirrors were derived. Then the concave mirror was used as a collimator for the measurements of the parabolic mirror and the gratings in Wadsworth mount. One of the results is shown in Figure 3.

3. Absolute Calibration of Detectors

An iodine tungsten lamp, which was calibrated at the Electrotechnical Laboratory of the Agency of Industrial Science and Technology against the primary standard in the visual region, was used as a standard source. The current of the lamp was 6.6 A, and the constancies of the current and the supply voltage were kept within 0.5% and 0.01%.

respectively, and the colour temperature was about 3200 K. The calibration was done through a water filter to exclude the effect of the water vapour in the air. The absolute value of the source was transferred to a windowless thermocouple which was set in the vacuum chamber through the water filter. The flake of the thermocouple was 1 mm × × 4 mm in area and the sensitivity was 0.736 μV/μW for a 8 Hz chopping frequency. Then the intensities of emission lines at 2537 Å and 1849 Å of a low pressure mercury discharge tube, which was operated by a constant 100 V ac. keeping the constancy

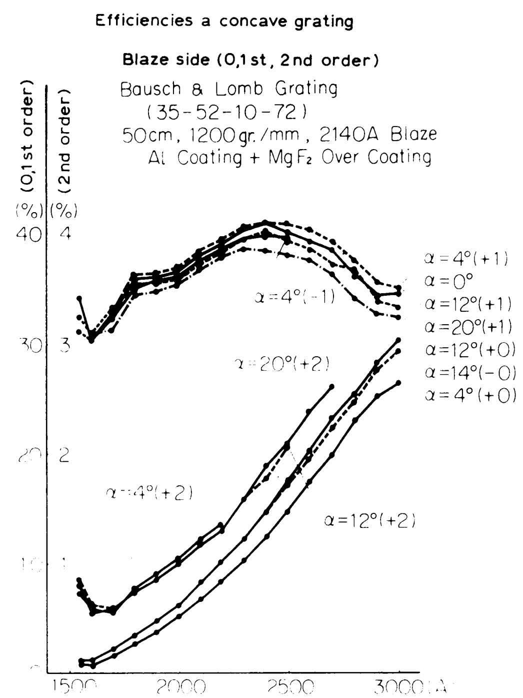

Fig. 2.

within 5% in the intensity, and 1608 Å of the hydrogen discharge tube were measured at the position of the exit slit of the Seya-Namioka monochromator by the thermocouple. Thus the intensities of the emission lines were absolutely calibrated, and their values were transferred to the detector of the combination of the sodium salicylated glass window and the 1P21 photomultiplier, and then to the flight detectors (HTV-R166, HTV-R190). The efficiency of the cathode of the photomultiplier is not uniform in general, therefore the flight detectors were calibrated in the same position as the flight situation. On the assumption that the thermocouple is really black, and the fluorescent quantum efficiency of sodium salicylate is flat among 2537 Å, 1849 Å, and 1608 Å, the flight detectors were absolutely calibrated. The result is shown in Figure 4.

In future we are planning to use a synchrotron radiation as a standard source.

4. Flight Schedule of the Spectrometers

A double dispersive spectrometer was planned to be launched on the 25th of September 1970. But it was postponed until coming winter because of the delay of the satellite M-4-S flight. The purpose of the observation is to measure the absolute intensity and

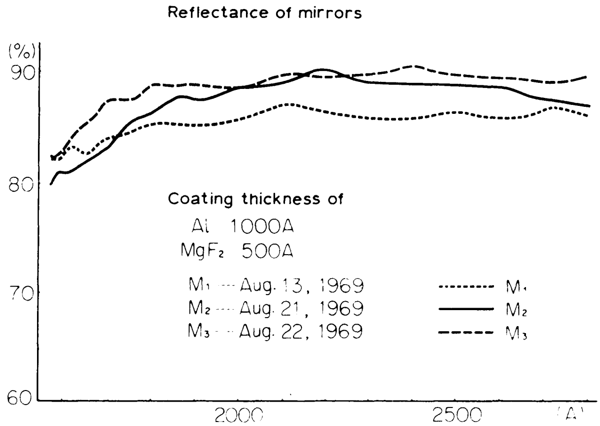

Fig. 3.

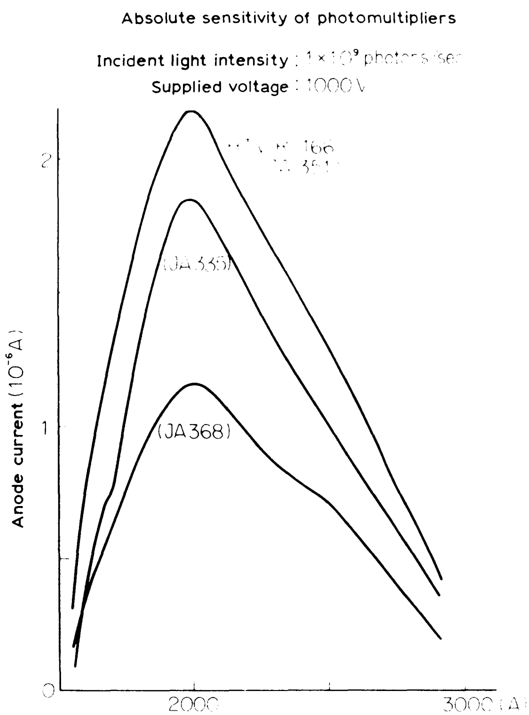

Fig. 4.

https://doi.org/10.1017/S0074180900103869 Published online by Cambridge University Press

the center to limb variations of the Sun around 1600 Å–1800 Å. The spatial resolution is 1 arc min and the spectral resolution is 2.5 Å. It is mounted in a nosecone of K-10-6 rocket, which is controlled by jet system.

Another single dispersive spectrometer will be launched on the 22nd of January 1971.

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