TWO-DIMENSIONAL PHOTOGRAPHIC PHOTOMETRY OF THE ZODIACAL LIGHT FROM SPATIAL OBSERVATIONS

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Abstract. Preliminary results for the photometry of a photograph of the inner zodiacal light taken aboard Saliout 6 are reported. The Very Wide Field Camera to be flown aboard Spacelab 1 is described and the program of observations of the zodiacal light is presented.

I. INTRODUCTION

Very few experiments appear to have been realized to obtain the photographic photometry of the zodiacal light (ZL) from space. MacQueen et al. (1973) reported the photometry of the F-Corona from 3 to 55 solar radii while Mercer et al. (1973) secured several photographs from 3° to 45° (solar elongation) but never published their photometry. Photographic photometry offers distinct advantages such as a large coverage, the geometry and the possibility to separate out various components (a property which may be useful in the ultraviolet).

II. PRELIMINARY RESULTS FROM THE SALIOUT 6 PHOTOGRAPH

The project was initiated through a collaboration beween S. Koutchmy and G. Nikolsky (Centre d'Etudes Cosmiques, Izmiran) and the photographs were taken by cosmonaut G. Gretchko from Saliout 6 at an altitude of 350 km. The optics (f/2, 58 mm of focal length) combined with the film (Kodak 2485 High Speed Recording) determine a large band pass centered at 5300 Å. The exposure time was 15 sec with the Sun 17° below Earth horizon. Calibrations were performed postflight using a step wedge. The photograph reveals the bright first ionospheric layer (D,E) at an altitude of 80-120 km and the star trails extending over ≃ 1° along the ecliptic direction (Saliout 6 uses the Earth and not the stars as reference).

The processing was performed with a PDS microdensitometer and a PDP 11/35 using a slit of 40 x 40 (micron)^2. Following digitization, the median bi-dimensional filtering as described by Huang et al. (1979) was applied with a window of 16 x 16 pixels in order to :

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i) reduce film grain noise,
ii) eliminate the stars,
iii) compress the data (sampling before storage).

Densities were then converted to intensities which were corrected for lens vignetting. Absolute photometry was realized using 6 stars of class G0 et G8. The resulting brightness along the ecliptic appears in good agreement with published results (e.g., Leinert et al., 1974). No deviation of the photometric axes from the projection of the ecliptic plane is observed (Figure 1). However, the ecliptic longitude of the Sun (349.5°) does not allow a large separation from either the orbital plane of Venus or the invariable plane according to the calculations of Misconi (1977).

Therefore, the conditions are quite unfavorable to confirm the result of Misconi and Weinberg (1978).

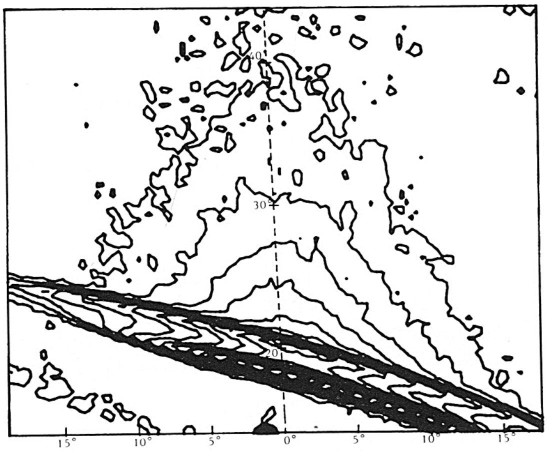

Figure 1. Brightness contours of the zodiacal light in ecliptic coordinates

Future processing will include checking these preliminary results, subtracting the ionospheric layers and removing the smear due to the motion of the spacecraft (deconvolution).

III. THE VERY WIDE FIELD CAMERA OF L.A.S.

(Scientific Team : G. Courtès, M. Viton, P. Lamy and J.P. Sivan)

The VWFC to be flown aboard Spaçelab 1 is an instrument of the Hyper-Schmidt type (FOV of 60°) having no vignetting, specifically designed to observe point sources and extended sources in the ultraviolet down to 1300 Å. It operates in two modes :

i) photometric mode : the hyperbolic mirror collects the light in a FOV of 60°. The Schmidt place is replaced by a mechanically deformed mirror. A Schmidt chamber (f/1.7) allows the image of the sky to be formed on the photocathode of an image intensifier (Ø 40 mm) and subsequently recorded on a 70 mm film.

Three band-passes, 250 Å wide, are available; they are centered at 1550, 1900 and 2500 Å. The expected sensitivity near 1500 Å is of the order of 5 x 10^{-8} erg cm^{-2} sec^{-1} $sterad^{-1}$ (Figure 2a).

ii) spectrographic mode : an additional concave mirror concentrates the light onto a slit (10° x 0.17°) and feeds a holographic toroïdal grating. A spectral resolution of 8 Å is obtained in the interval 1450-1950 Å (Figure 2b).

Besides stellar and extra-galactic observations, the program includes

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the inner (as close as possible to the Sun) and outer zodiacal light and the Gegenschein.

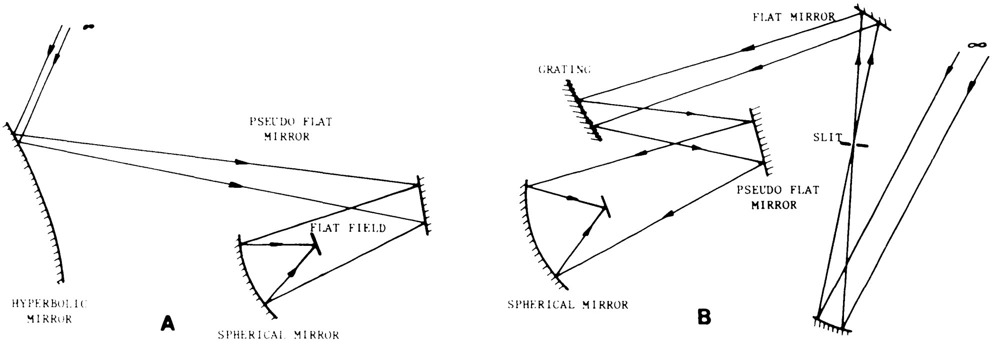

Figure 2. Optical lay-out of the two modes : a) photometric mode ; b) spectrographic mode.

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DISCUSSION

Roach: How will you evaluate the brightness of the zodiacal light?
Lamy: Photometry of the photographs as described above for the Saliout 6 photograph.

Keay: What emissions were detected from the D and E layers?
Lamy: The strong brightness of the D and E layers is produced by the oxygen green line.

Hughes: Could you explain how you are going to remove the luminosity of the D and E layer from your results?
Lamy: First, the layers have extremely sharp boundaries. They are seen in emission so their intensity is uniform throughout the field. We plan to measure it near the left edge of the field where the zodiacal light is probably negligible or requires only a small correction. The symmetry of the zodiacal light with respect to the ecliptic will help us to check if our subtraction is correct.

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