1.1.18 PRESENTATION OF ZODIACAL LIGHT INSTRUMENT ABOARD

THE D2B ASTRONOMICAL SATELLITE

M. Maucherat and P. Cruvellier
Laboratoire d'Astronomie Spatiale, Marseille

Abstract. The french astronomical satellite D2B is to be launched on September 1975. During the dial of the orbit, one axis of the satellite points to the Sun, with an accuracy of ± 30 arcmin; during the night of the orbit, the satellite keeps this stabilization by gyroscopic effect. The perpendicular axes -one of them is the optical axis of the Z.L. (Zodiacal Light) instrument- roll around the Earth-Sun direction, once every 4 minutes. Because of the Earth's motion around the Sun, the celestrial sphere will be scanned along ecliptic meridians, every orbits; the complete exploration of the sky will be achieved after six months. The Z.L. instrument is a photometer analyzing galactic and zodiacal fluxes, in the range λλ 3100-750, in five spectral intervals 200-500 wide, with a field of 2.8°□. For a single scan, the limit of detection by the instrument will be the 6th visual magnitude for early-type stars (O-B).

1. Introduction

The french astronomical satellite D2B is to be launched from French Guyana, on September 1975. The orbit of the spacecraft is inclined 37° to the ecliptic plane, with a perigée of 500 km, an apogée about 700 km height, and a period of revolution of 96.5 min. The Zodiacal Light instrument is used only during the night eclipse behind the Earth. The satellite is stabilized in one axis: during the dial of its orbit, one axis points to the Sun, with an accuracy of ± 30 arcmin; during the night, it keeps its stabilization by gyroscopic effect. The perpendicular axes (one of them is the optical axis of the Zodiacal Light instrument) roll around the Earth-Sun direction, once every 4 minutes. Because of the Sun's motion on the ecliptic, each displaced by 4 arcmin, every orbit, the complete exploration of the sky will be achieved after six months, the presumed lifetime of the spacecraft.

Figure 1 presents the position of the Zodiacal Light instrument inside the spacecraft, and its scanning of the sky, at 90° elongation. The region of the north ecliptic pole will be analyzed every rotation of the vehicle.

2. Instrumental design

A scheme of the optical design of the instrument is presented in Figure 2. An objective grating, with an aperture ratio of F/3 analyses stellar fluxes in a field

https://doi.org/10.1017/S0252921100051472 Published online by Cambridge University Press

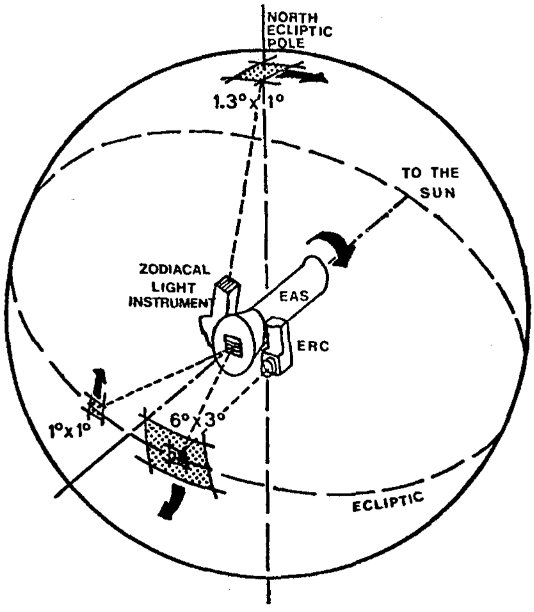

Fig. 1. Position of the instrument in the spacecraft

of 1.3° limited by a baffle; in order to observe faint emission while exposed to earthlight or moonlight, a diffraction baffle allows only components of second or higher order diffraction to enter the photometer. The spectrum is formed in the focal surface of the photometer with a dispersion of 68 Å mm^{-1}. Behind the exit slits, about 4 mm wide, set in a plane close to the focal surface is a pulse-counting photomultiplier detector. A change of the orientation of the grating makes possible an exploration of the spectrum in five passbands. The motion of the vehicle causes the spectrum image to move over the exit spectral slit, realizing a scanning without any mechanical need. The spectrum is analysed in the range λ750, Lyα, λ1650, λ2200, λ3100, with passbands 200-500 Å wide. The field of view is 2.8°□ due to the motion of the vehicle during an integration counting. Figure 3 presents the wavelength calibration curves obtained at the Laboratory in the range Lyα, λ3100. These are preliminary values of absolute instrumental efficiency.

3. Sensitivity of the instrument

The background consists of the diffuse UV sky background and of the dark background of the detector. The sky background on the far ultra-violet is 3 to $6 \cdot 10^{-12}$ erg s^{-1} cm^{-2} $Å^{-1}$ $°□^{-1}$ (Lillie, 1972; Henry, 1973). The dark background of the detector is equivalent to a diffuse emission of intensity less than $1 \cdot 10^{-13}$ erg s^{-1} cm^{-2} $Å^{-1}$ $°□^{-1}$, and may be negligible. The limit of the flux from the source is

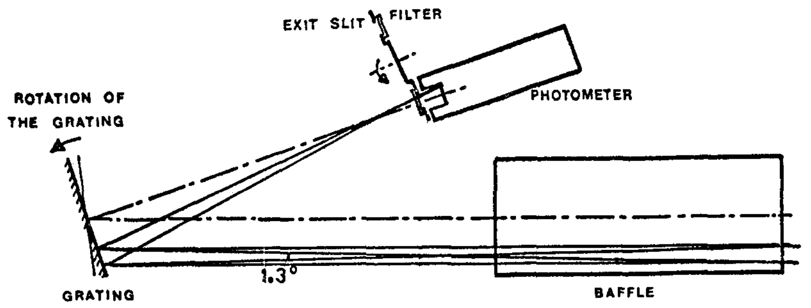

Fig. 2. Optical diagram of the instrument

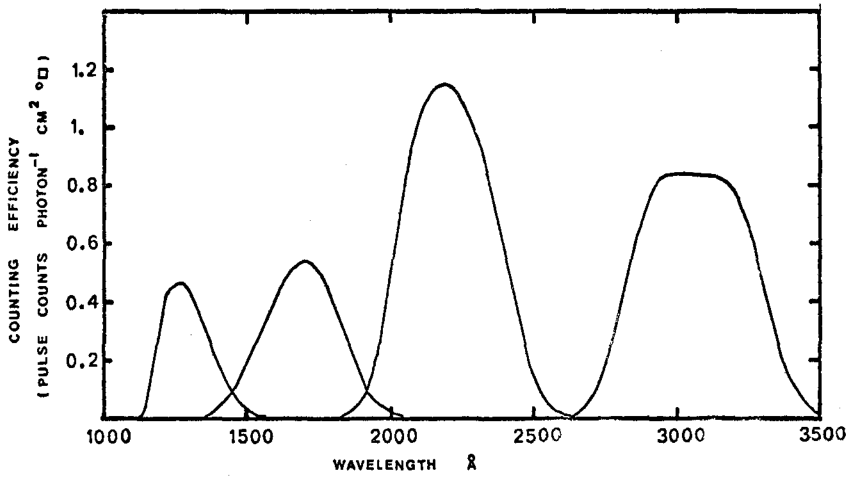

Fig. 3. Preliminary values of the instrumental efficiency

$1 \cdot 10^{-12}$ erg s^{-1} cm^{-2} $Å^{-1}$ $^{\circ}\square^{-1}$. So this instrument is capable of an essentially complete survey of the intensity of Zodiacal Light and of galactic light. As a matter of fact, knowing that the intensity of the Zodiacal Light is of the same order at λ4250 and at λ1680 (Lillie quoted by Davidsen et al, 1974) from the measurements of its intensity in the blue color (Dumont et al, 1966; 1973; Frey et al, 1974) its presumed flux at λ1650 at the north ecliptic pole is $8 \cdot 10^{-12}$ erg s^{-1} cm^{-2} $Å^{-1}$ $^{\circ}\square^{-1}$, on the ecliptic at 90° elongation $3 \cdot 10^{-11}$ erg s^{-1} cm^{-2} $Å^{-1}$ $^{\circ}\square^{-1}$.

Taking into account that the airglow intensity is of the same order than the limiting flux, the intensity of zodiacal light will be at least 8 times brighter than the limiting flux. Thus the sensitivity of the zodiacal light instrument is adequate to meet the objectives of this experiment. Moreover, the mean intensity of direct starlight in the solar neighbourhood at λ1400 is $3 \cdot 10^{-11}$ erg s^{-1} cm^{-2} $Å^{-1}$ $°\square^{-1}$ from the calculations of Habing (1968) making the galactic flux perfectly detectable. A complete survey of the diffuse galactic light intensity would perhaps be possible with this instrument, with an optimized field of view, small enough to eliminate a substantial contribution from hot stars, but large enough for a good sensitivity to diffuse radiation.

References

Davidsen,A., Bowyer,S., Lampton,M. 1974, Nature 247, 513.

Dumont,R., Sanchez-Martinez,F. 1966, Ann. Astrophys. 29, 113.

Dumont,R., Sanchez-Martinez,F. 1973, Astron. Astrophys. 22, 321.

Frey,A., Hofmann,W., Lemke,D., Thum,C. 1974, Astron. Astrophys. 36, 447.

Habing,H.J. 1968, Bull. Astr. Inst. Netherlands 19, 421.

Henry,R.C. 1973, Astrophys. J. 179, 97.

Lillie,C.F. 1972, Scientific Results from OAO-2, 95 (NASA, 1972).

https://doi.org/10.1017/S0252921100051472 Published online by Cambridge University Press