ZODIACAL LIGHT, GEGENSCHEIN AND SKY BACKGROUND

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ABSTRACT. Results from photometers on board the D2B satellite (1975) for the whole sky in ultraviolet and blue light, are combined to generate a very well defined empirical representation of the zodiacal light and Gegenschein. The sky background is then obtained by subtraction of this model from the data.

1. INSTRUMENTATION

The observations were obtained with two photometers on board the D2B satellite launched in september 1975. Its orbit had an altitude of 500 - 700 km, an inclination of 37° with respect to the equator and a period of 96 min. The satellite was pointed at the sun with an accuracy of ± 30' during the day and spin stabilized during the night. The spin rate was $1^\circ.5\ s^{-1}$ in the average (Cruvellier, 1970).

2. OBSERVATION OF THE ZODIACAL LIGHT

The data come from the ELZ photometer whose optical axis is pointed at a constant solar elongation of 90° and whose main characteristics are $\lambda = 3100$ Å, $\Delta\lambda = 500$ Å and field-of-view = 1° x 2°.8.

The photometric scans, in a plane perpendicular to the earth-sun direction, record the same sky field every six months.

In order to separate the sky background from the zodiacal light, we make use of a very sensitive zero method based on the residue:

$$R(\lambda,\beta) = S(\lambda,\beta,t + 6 \text{ months}) - S(\lambda,\beta,t)$$

as a function of λ and β.

This residue is non zero because of
1) the inclination of the zodiacal cloud with respect to the ecliptic plane and
2) the variation of the earth-sun distance; it is further unrelated to the skybackground (see figures 1 and 3).

The residue can be written in terms of the two components I_{sky} and I_{ZL}:

R. H. Giese and P. Lamy (eds.), Properties and Interactions of Interplanetary Dust, 27–30.

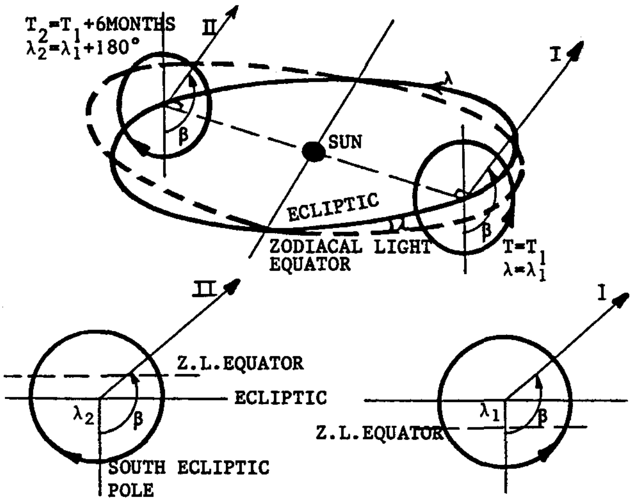

Figure 1. optical axis scans the same sky field every six months, whose planes are perpendicular to the anti-solar directions:
λ_I and $\lambda_{II}=\lambda_I+180°$

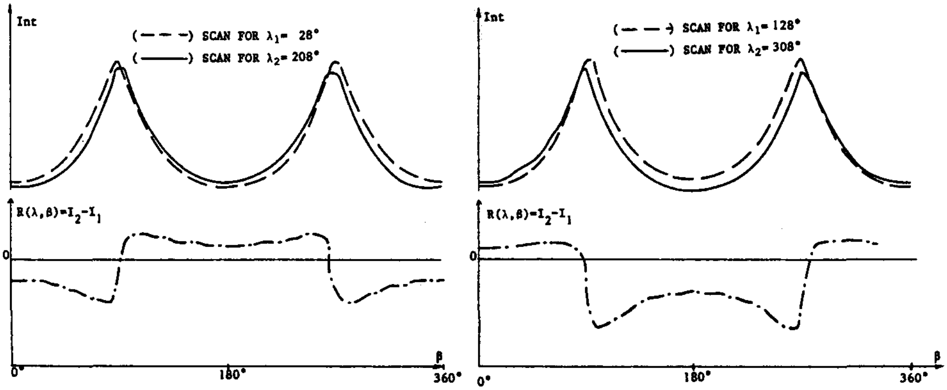

Figure 2. two examples of residues (—· —·) for two longitudes, computed with models. The south ecliptic pole direction gives the zero of β axis; 180° is the north ecliptic pole.

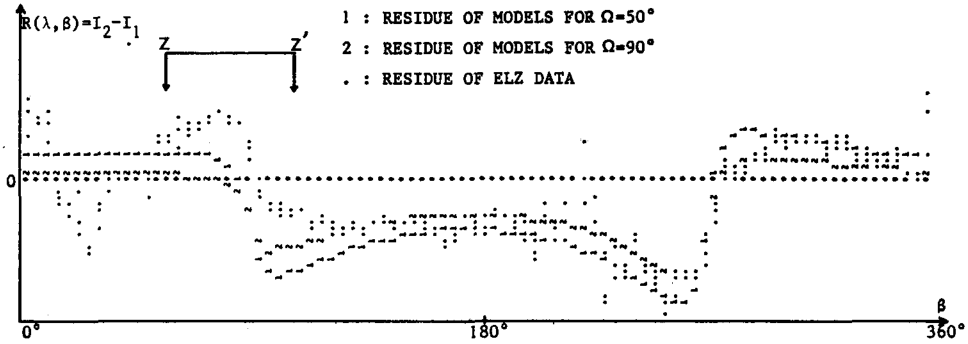

Figure 3. examples of residue for two models computed with two values of ascending nodes, compared with data, for λ_I=128° and λ_{II}=128°+180°=308°
ZZ'= zone where intensity of the zodiacal light is higher for λ_{II}=308° than for λ_I=128°

$$R(\lambda,\beta) = \underbrace{I_{sky}(\lambda,\beta) + I_{2ZL}(\lambda,\beta)}_{II} - \left[\underbrace{I_{sky}(\lambda,\beta) + I_{1ZL}(\lambda,\beta)}_{I}\right].$$

Residues obtained from the observational data were compared with calculated residues using various models proposed by Leinert et al. (1976).

The fan model of the form:

$$I = K\int_{0}^{\infty} \frac{r_1^{-\nu}}{r^2}\ \sigma_1(\Theta)\ \exp(\,-w\ |\sin^{u}\beta_{\odot}|)dx$$

was found to generate intensities and residues $R(\lambda,\beta)$ whose variations match exceedingly well those of the observational data and residues over the period 1975-1976.

We adopted a phase function $\sigma_1(\Theta)$ derived from the work of Mujica et al. (1979):

$$\sigma_1\ (\Theta) = 0.00021\ (\Theta - 90°.0)^2 + 1.$$

The nominal values of the parameters of the above model as well as the inclination i and the ascending node Ω of the plane of symmetry, and the corresponding error bars were determined by bracketing the observational residues within two extreme calculated residues.

Figure 3 shows an example of variation of the residue for two values of Ω.

We used skyfields where I is critically sensitive to ν, w, u, i and Ω separatly, and we obtained:

$\nu = 1.0 \pm 0.1$

$w = 4.0 \pm 0.2$

$u = 1.3 \pm 0.1$

$i = 2°.0 \pm 0°.5$

$\Omega = 70°.0 \pm 10°.0$

slightly different from values found by Leinert et al. (1976). We present in figure 4 the profile of the zodiacal cloud along an ecliptic meridian for $\lambda = 90°$

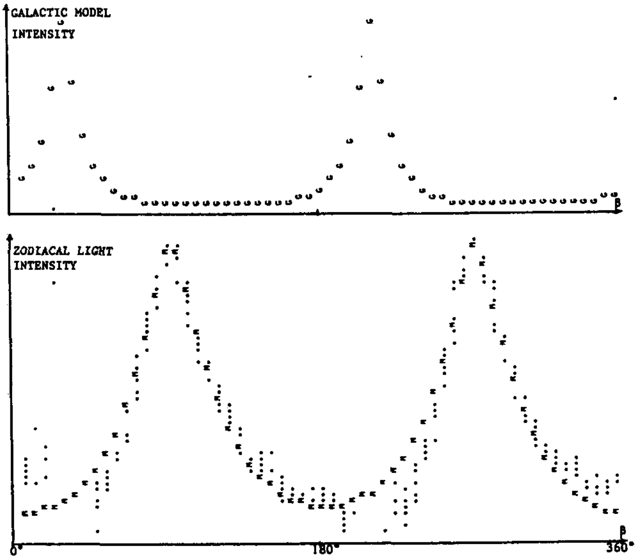

Figure 4. data for λ=90°, minus a galactic model, compared to the zodiacal light model (M). G is the galactic model for this scan.

3. GEGENSCHEIN

The data came from the ERC photometer which scanned the antisolar direction at $\lambda = 4500$ Å, $\Delta\lambda = 1000$ Å in a circle of 9° radius with a resolution of 1° x 1°.

Using the Pioneer 10 results for the sky background (Weinberg, 1981), we obtained nine gegenschein maps for nine ecliptic longitudes over the period 1975-1976.

By applying the zodiacal light model obtained perpendicular to the antisolar direction, with a new phase function: $\sigma_2\ (\Theta) = \sigma_1\ (\Theta) + \sigma'\ (\Theta)$

$$\sigma'\ (\Theta) = 0 \text{ for } \Theta < 177°$$

$$\sigma'\ (\Theta) = 0.02\ (\Theta - 90°.0)^2 - 3.49\ (\Theta - 90°.0) + 152.25 \text{ for } 177° < \Theta < 180°$$

we found that it is necessary to enhance the model in a 3° circle centered at the antisolar point as already suggested by Misconi (1981). The map for $\lambda = 185°$ is shown in figure 5.

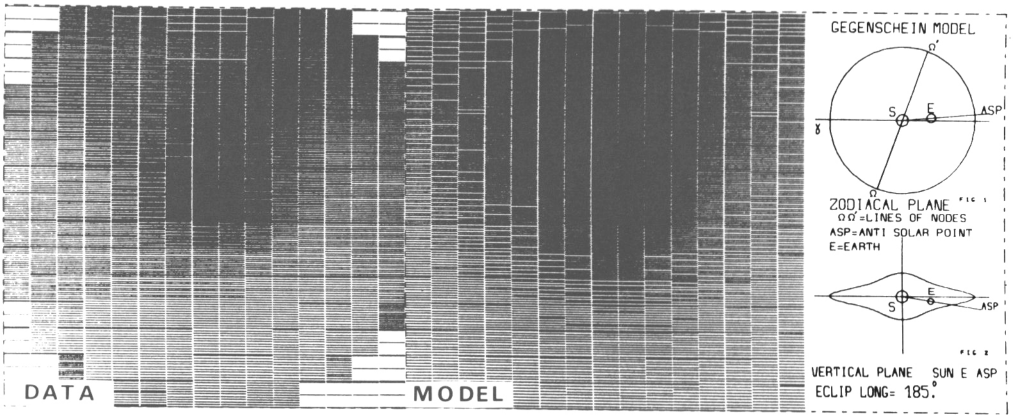

Figure 5. comparison of gegenschein map obtained for λ=185°, computed with ERC data, with the gegenschein model in the same conditions. The enhancement near antisolar direction is clearly visible.

REFERENCES

Cruvellier, P.: 1970, Proceedings of Summer School, Space Optics ed. A. Maréchal and G. Courtes, Gordon and Breach

Leinert, C., Link, H., Pitz, E., Giese, R.H.: 1976, Astron. Astrophys. 47 p. 221

Maucherat-Joubert, M., Cruvellier, P., Deharveng, J.M.: 1979, Astro. Astrophsy. 74 p. 218

Misconi, N.: 1981, Icarus, 47 p. 265

Mujica, A., Lopez, G., Sanchez, F.: 1980, Solid Particles in the Solar System (eds, J. Halliday and B.A. Mc Intosh) p. 75

Weinberg, J.L.: 1981, Sky and Telescope 61, p. 114