# AN ISOPHOTE MAP OF THE ZODIACAL LIGHT IN V

J. Pfleiderer and G. Leuprecht
Institute of Astronomy
University of Innsbruck
Austria

ABSTRACT: The reduction method and the results of a photoelectric surface photometry of the Zodiacal Light at a wavelength of 555 nm are presented. A comparison with published results is also given.

The data were obtained on Rockdale Mountain, South Africa, during 1961 and 1962 (for details see Pfleiderer and Mayer 1971). The instrument was a refractor (D = 125 mm, f = 750 mm) with a RCA 1P21 photomultiplier and a GG11 Schott filter (2 mm). The effective wavelength was about 555 nm, the field of view 1.1 square degrees. The data were recorded on strip charts and later on digitized with the semi-automatic digitizer of the Innsbruck computer centre. During the digitization, bright stars down to about $7^m$ were removed individually from the data.

Contributions to the observed brightnesses come from the Zodiacal Light (ZL), the Milky Way (MW), the airglow (AG), and from light scattered in the lower atmosphere (SL). We have assumed the AG and the SL both to depend on the zenith distance and time but to be independent of azimuth. They can be rather effectively removed by subtracting a background constant from each observed almucanteral scan. During the iteration process described below, the constants were adjusted to give a smooth function of zenith distance and time and also to give consistent results for repeated observations of the same sky areas.

This procedure leaves open, however, one constant for each of the four contributions to the observed brightness. For example, the minimum brightness, which we have observed and set arbitrarily to zero during the reduction, can be assumed to consist mainly of the minimum MW (far outside of the galactic plane), plus the minimum of the ZL, plus the minimum AG, plus the minimum SL (= Rayleigh scattering). These individual contributions cannot be found from our measurements alone but only from outside information.

After subtraction of the background, the remaining brightness -corrected for extinction- consists of MW plus ZL. These contributions can be separated by the relative motion of MW and ZL during the 7 months of observations.



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We used an iterational process: The ZL (or the MW) was found by subtracting the MW (or ZL) from the observed brightness (minus background) whereever the MW (or ZL) was estimated to be fainter than $S_o$. The result was used for the estimate of ZL (or MW) in the next iteration. Convergence of the iteration proved to be quite good. We choose $S_o$ = 100 S10V. We found however that the choice is rather uncritical.

The last step of the reduction is the choice of the constants mentioned above. Our best estimate is as follows: The minimum observed brightness was about 95 S10V (zenith distance 30$^o$). According to Landold-Börnstein, at least 30% of this should be AG (28 S10V). The average extraterrestrial brightness (MW + ZL) is about 100 S10V, the average extinction is about twice the zenith extinction , or 25%. About half the scattered light reaches the ground, or roughly 13 S10V. The zenith region being darker than the average, we estimate a SL contribution of about 9 S10V. Finally, Roach and Megill quoted about 28 S10V for the faintest parts of the MW, of which about 24 S10V reach the ground. The minimum ZL is therefore about 95 - 28 - 9 - 24 = 34 S10V observed or 39 S10V extraterrestrial.

The resulting map, averaged over 5×5 degrees, is given in table 1 and compared to other maps in table 2. The minimum at (180,50) is at lower latitudes than that found by LD, and also than the relative minimum at $|\varepsilon'|$= 180$^o$ found by Classen (1976) in B. A relative minimum occurs at (100-130, 45-65). It was not found by FHLT, and its presence is only marginally supported by the map of LD. Its position coincides, however, approximately with that of the absolute minimum found by Classen in B. It seems that the brightness distribution of the ZL in the darkest regions is still an unsettled question.

While our pole brightness and the brightness change along the ecliptic are in reasonable agreement with FHLT and LD, our intensities in the ecliptic plane are definitely lower. This cannot be solely due to a wrong choice of our zero point. However, part of the discrepancy can be removed by the assumption that our estimate of minimum AG and minimum MW were too high. This would mean that our pole brightness becomes higher than found by anybody else except Wolstencroft and Rose (1967).

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Table 1: Surface brightness of the Zodiacal Light in S10V

| \|ε'\| \ \|β\| | 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | | | | | | | | 58 | 54 | 64 |
| 5 | | | | | | | | | | | | | 125 | 83 | 53 | 54 | 63 |
| 10 | | | | | | | | | | | | | 108 | 75 | 59 | 58 | 63 |
| 15 | | | | | | | | | | | | 130 | 101 | 68 | 62 | 57 | 63 |
| 20 | | | | | | | | | | 147 | 128 | 97 | 84 | 64 | 60 | 58 | 62 |
| 25 | | | | | | | | | | 139 | 111 | 88 | 77 | 66 | 62 | 62 | 62 |
| 30 | | | | | | | | | 159 | 115 | 88 | 82 | 77 | 73 | 61 | 64 | 62 |
| 35 | | | | | | | | 155 | 134 | 117 | 81 | 81 | 81 | 67 | 63 | 62 | 62 |
| 40 | | | | | | | 168 | 147 | 128 | 96 | 86 | 83 | 76 | 67 | 61 | 59 | 63 |
| 45 | | | | | | 170 | 163 | 130 | 102 | 93 | 85 | 75 | 71 | 69 | 59 | 59 | 64 |
| 50 | 425 | 400 | 293 | 257 | 203 | 181 | 146 | 115 | 101 | 91 | 82 | 77 | 69 | 65 | 62 | 66 | 62 |
| 55 | 392 | 355 | 287 | 246 | 199 | 162 | 138 | 99 | 99 | 91 | 79 | 78 | 69 | 64 | 60 | 64 | 62 |
| 60 | 325 | 300 | 256 | 213 | 187 | 152 | 111 | 98 | 93 | 79 | 76 | 76 | 69 | 64 | 58 | 66 | 65 |
| 65 | 272 | 239 | 211 | 184 | 160 | 150 | 143 | 99 | 86 | 78 | 77 | 78 | 67 | 60 | 61 | 62 | 63 |
| 70 | 231 | 211 | 174 | 146 | 127 | 124 | 115 | 102 | 84 | 71 | 68 | 66 | 60 | 57 | 59 | 61 | 64 |
| 75 | 199 | 193 | 160 | 140 | 109 | 100 | 96 | 94 | 84 | 73 | 65 | 58 | 59 | 60 | 55 | 57 | 65 |
| 80 | 171 | 167 | 143 | 113 | 95 | 89 | 84 | 81 | 80 | 76 | 60 | 58 | 61 | 62 | 57 | 61 | 62 |
| 85 | 158 | 150 | 132 | 109 | 89 | 79 | 76 | 74 | 68 | 65 | 63 | 67 | 63 | 62 | 59 | 63 | 63 |
| 90 | 148 | 138 | 119 | 102 | 87 | 74 | 68 | 66 | 63 | 64 | 63 | 58 | 56 | 57 | 58 | 66 | 62 |
| 95 | 137 | 129 | 115 | 97 | 86 | 76 | 67 | 61 | 60 | 58 | 55 | 53 | 54 | 55 | 56 | 61 | 63 |
| 100 | 129 | 121 | 106 | 94 | 82 | 74 | 64 | 62 | 60 | 53 | 53 | 50 | 53 | 55 | 53 | 56 | 64 |
| 105 | 119 | 110 | 101 | 91 | 79 | 72 | 66 | 63 | 61 | 54 | 50 | 45 | 51 | 52 | 53 | 61 | 64 |
| 110 | 110 | 101 | 93 | 85 | 75 | 67 | 64 | 63 | 63 | 57 | 54 | 57 | 53 | 50 | 57 | 60 | 62 |
| 115 | 99 | 96 | 86 | 79 | 71 | 69 | 65 | 65 | 63 | 54 | 54 | 61 | 57 | 50 | 53 | 59 | 65 |
| 120 | 89 | 88 | 79 | 74 | 67 | 67 | 63 | 60 | 59 | 51 | 52 | 57 | 56 | 61 | 55 | 60 | 64 |
| 125 | 89 | 85 | 78 | 71 | 66 | 63 | 60 | 60 | 58 | 53 | 52 | 55 | 55 | 57 | 58 | 59 | 67 |
| 130 | 89 | 85 | 77 | 73 | 66 | 61 | 60 | 60 | 57 | 56 | 58 | 52 | 54 | 55 | 55 | 59 | 63 |
| 135 | 87 | 81 | 75 | 73 | 64 | 59 | 58 | 60 | 61 | 55 | 63 | 55 | 52 | 54 | 55 | 60 | 63 |
| 140 | 84 | 78 | 74 | 71 | 63 | 61 | 59 | 58 | 56 | 58 | 62 | 59 | 57 | 52 | 50 | 57 | 62 |
| 145 | 83 | 79 | 76 | 71 | 66 | 63 | 59 | 59 | 56 | 57 | 61 | 63 | 57 | 53 | 48 | 56 | 63 |
| 150 | 81 | 80 | 76 | 70 | 62 | 62 | 58 | 62 | 58 | 56 | 62 | 64 | 56 | 49 | 50 | 56 | 61 |
| 155 | 79 | 80 | 77 | 69 | 64 | 59 | 57 | 62 | 61 | 57 | 59 | 57 | 54 | 53 | 49 | 56 | 63 |
| 160 | 82 | 81 | 77 | 72 | 64 | 61 | 59 | 61 | 62 | 59 | 56 | 54 | 52 | 51 | 50 | 57 | 64 |
| 165 | 84 | 81 | 80 | 75 | 66 | 64 | 63 | 64 | 62 | 60 | 51 | 50 | 47 | 54 | 52 | 57 | 64 |
| 170 | 91 | 85 | 79 | 76 | 70 | 67 | 63 | 62 | 57 | 54 | 46 | 50 | 48 | 53 | 53 | 61 | 62 |
| 175 | 102 | 93 | 82 | 78 | 71 | 66 | 59 | 58 | 55 | 50 | 43 | 49 | 48 | 48 | 49 | 61 | 62 |
| 180 | 115 | 99 | 84 | 78 | 71 | 65 | 57 | 52 | 49 | 44 | 39 | 45 | 44 | 48 | 49 | 57 | 59 |

The surface brightness at an ecliptic latitude of 85 to 90 degree remains 63 S10V during all helioecliptic longitudes.

ε' ecliptic longitude with respect to the sun $(\lambda - \lambda_{\odot})$.

ß ecliptic latitude.

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Table 2: Comparison with other maps.

| Authors | FHLT | LD | P | R | PL |
|---|---|---|---|---|---|
| Measured from | balloon | ground | ground | | ground |
| Wavelength [nm] or spectral region | 500 | 502 | 542.5 | V | 555 |
| Surface Brightness $B(\|\varepsilon'\|,\|\beta\|)$ in S10V: | | | | | |
| Ecliptic pole | 60 | 63 | - | 78 | 63 |
| B( 60,0) | - | 394 | 392 | 500 | 325 |
| B(100,0) | 186 | 175 | 211 | 220 | 129 |
| B(140,0) | 130 | 139 | - | 164 | 84 |
| B(180,0) | 166 | 180 | - | 205 | 115 |
| B(180,0)-B(140,0) | 36 | 41 | - | 41 | 31 |
| B(100,0)-B(140,0) | 56 | 36 | - | 56 | 45 |
| B(100,0)-B(180,0) | 20 | -5 | - | 15 | 14 |
| Minimum ($\|\beta\|=0^{\circ}$) | 130 | 139 | - | 164 | 79 |
| $\|\varepsilon'\|$ of this minimum | 150° | 142° | - | 140° | 155° |

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