

Feb. 26. 00

Compliments of the Author.

## Photographs of the Zodiacal Light.

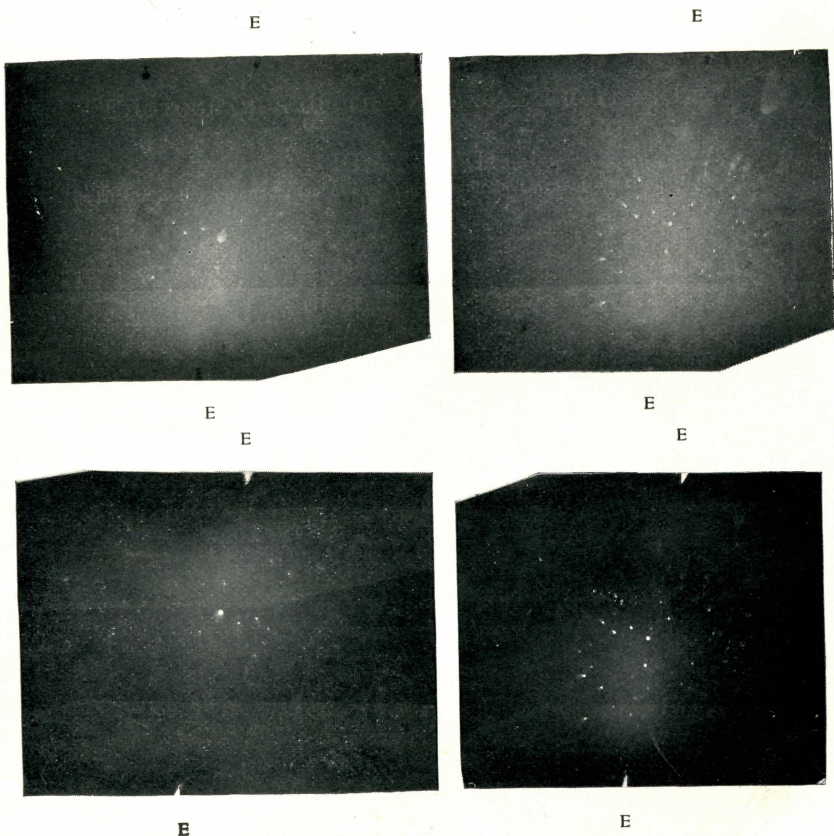
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A. E. DOUGLASS.

Reprint from POPULAR ASTRONOMY No. 74.



PLATE VIII.



October 7<sup>d</sup> 16<sup>h</sup> 20<sup>m</sup> — 17<sup>h</sup> 15<sup>m</sup>

October 14<sup>d</sup> 16<sup>h</sup> 15<sup>m</sup> — 17<sup>h</sup> 20<sup>m</sup>  
and October 15<sup>d</sup> 16<sup>h</sup> 16<sup>m</sup> — 17<sup>h</sup> 20<sup>m</sup>

PHOTOGRAPHS OF THE ZODIACAL LIGHT IN LEO.

The letter E at the top and bottom of each photograph indicates the direction of the Ecliptic.

## PHOTOGRAPHS OF THE ZODIACAL LIGHT.

A. E. DOUGLASS.

FOR POPULAR ASTRONOMY.

The experiments which resulted in the accompanying photographs of the zodiacal light were the outcome of long continued interest in the subject of the gegenschein and zodiacal light and a desire to render less fatiguing and more accurate the observation of those faint lights. Contours of the zodiacal light drawn by hand on about two hundred different nights had shown the defects and difficulties of that method of recording observations. Perhaps the chief of the defects was the almost invariable interference of stellar light; yet that was not the only important one, for the very first result of these photographs was to show that in estimating a visual contour one is apt to mistake ease in distinguishing the zodiacal cone at any given point for actual intensity at that point and therefore the contours of equal brightness are prolonged along the axis too far away from the Sun and horizon light. After seeing the photographs this erroneous tendency was actually found to exist.

The inherent difficulties in the old method lie in the long time required to get perfectly acquainted with standard reference stars and the advantage, that amounts almost to necessity, in making records in the dark. Even an old hand at this work will frequently be obliged to make use of some star whose name he does not know and will have to describe its place, as well as that of the zodiacal light, on paper which he can barely see resting in his hand.

The first effort to improve upon the method of observation consisted in designing a machine which could automatically record the contours directly on a star map, and a rough model of this contrivance gives entire promise of success. But as this was not put into actual practice attempts were made to succeed by photography. Many attempts have been in this line elsewhere, but without success. Of these one was by myself while in South America (in 1891, I think) and another has since then been made at that same station. The early work at Flagstaff was equally without result. But after repeated trials success was at once attained when the very simple idea of using ordinary positive visual eyepieces, which combine very short focus with relatively large aperture, occurred to me and was tested and from that time on



constantly improving results have been obtained. The most successful lens and the one by which the illustrations for this article were taken, is a combination lens, put together and mounted by Mr. Cogshall, who has done practically all of the photographic work. This lens seems to give a combination of flat and large field and very great light-transmission that surpasses any other apparatus that we have tried, and among those tried the one marked "Clark; Special" in the list below is a "solid" achromatic lens cut on the Fraunhofer curves. The following list describes briefly the various lenses tried by Mr. Cogshall and gives a summary of our experiments:

Make.	Focus.	Aperture.
St. Louis house; name unknown.....	16 inches	2 inches.
Same, with telescope lens to shorten focus.....	10 "	2 "
Rochester Optical Co. Rap. Rect.....	8 + "	$\frac{3}{4}$ "
H. & E. J. Dale, London. (A hand camera).....	5 + "	$\frac{3}{4}$ "
"W. A. C. Pinhole" Camera.....	3 "	$\frac{1}{4}$ "
Zeiss Planar Series Ia. By Bausch and Lomb.....	$1\frac{3}{8}$ "	$\frac{5}{16}$ "
Eyepiece; Brashear.....	1 "	$\frac{1}{2}$ "
" " .....	1 "	$\frac{1}{4}$ "
" " .....	1 "	$\frac{1}{8}$ "
" " .....	$\frac{1}{2}$ "	$\frac{1}{4}$ "
" " .....	$\frac{3}{8}$ "	$\frac{1}{8}$ "
" Clark.....	2 "	$\frac{1}{4}$ "
" " .....	2 "	$\frac{3}{8}$ "
" " .....	2 "	$\frac{1}{2}$ "
" " "Special".....	2 + "	$\frac{3}{8}$ "
"Combination;" part made in Paris and part by Clark; combined by W. A. C.....	1.3 "	$\frac{1}{2}$ " or 0.4 ( $\frac{3}{8}$ ) for best work.

After obtaining real photographs the first step was to make sure that there was no deception. Some of the views taken as long ago as May, 1899, were really exceedingly good but had some trifling defect, which threw a slight doubt on their genuineness. But they were repeated many times. Finally a very thorough test for ghosts or other concentration of light in the fields of the chief lenses used, was made by trial exposures on such objects as landscapes and ruled paper, by daylight, the side of a house by moonlight, and the sky, by day and by night. No genuine irregularity or concentration of light could be found in the fields over an area considerably greater than the entire portion of sky shown in our illustrations, and the photographs were therefore accepted as real. (Let me here explain that while taking the photograph of October 7, a pasteboard tube supporting the lens, projected too far inside the camera and cut down the field; this effect shows conspicuously in the original negative.)

The first conclusions drawn from these photographs are that the axis of greatest density is very indefinite and that the photo-



graphic contours of the apex of the zodiacal cone are far more rounded in form than the visual ones are usually represented; and, as stated above, I am inclined to think this same roundness is really true of the visual outlines.

Another conclusion and one of much interest to the experimenter, is one that cannot be derived from our illustrations but has been found to hold true on other photographs. It is that with this form of camera the zodiacal light makes an impression on the sensitive plate more readily than equally bright regions of the Milky Way.

The horizon light does not appear to effect these photographs. Of course they are not allowed to continue when the horizon light is very strong. Nor am I sure that the atmospheric absorption materially affects the intensity of the light near the horizon, since lessened exposure on the lower edges will account for the faintness in that region.

Finally in these photographs of the zodiacal light in Leo, at a distance of about  $8^{\circ}$  from the ecliptic, the intensity of the light fades much more rapidly on the southern side than on the northern. This effect may be partly due to atmospheric absorption but as the axis of the cone in this instance is inclined over  $70^{\circ}$  to the horizon, I am inclined to believe this a real effect due to the form and position of the great lenticular mass of particles which cause the zodiacal light.

LOWELL OBSERVATORY,  
February 26, 1900.