

ART. XXVIII.—*The Polarization of Light from Comet b, 1881 ;*
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POLARISCOPIC observations of the comet were made on the evenings of June 25 and 26, which gave faint indications of the existence of polarization, but with the instruments then used it was not possible to ascertain satisfactorily either its character or amount. The state of the sky was not very favorable for observation until the evening of June 29, when a method of observation was found which made it possible to determine the polarization, which was at once seen to be considerable, with comparative ease and a good degree of precision.

The instrument employed was the polarimeter constructed for observation of the solar corona in the eclipse of July 29, 1878, and described in the volume containing the reports upon this eclipse issued from the U. S. Naval Observatory.* A slight modification was made by substituting a Savart plate for the selenite, it being attached to the Nicol's prism in the eye-piece. This gave a rather narrow field which was nearly filled by the image of the comet, an arrangement very favorable for detection of the bands caused by polarization. The aperture of the telescope to which the polarimeter is attached is three inches.

The plane of polarization of the light was found to have such a direction as to pass through the sun's place. This was determined both by the disposition of the bands seen in the polarimeter, and also independently by means of a double-image prism placed before the ordinary eye-piece of the telescope when this was attached to the instrument. The two images of the comet as the prism was rotated were easily seen to have different intensities in certain positions corresponding to polarization in a plane situated as above described. As seen with this instrument the fainter of the images appeared considerably shorter than the other as if the light coming from toward the extremity of the tail were more strongly polarized than that from points near the nucleus. But this was possibly an illusion depending upon the fact that when the very faint light was diminished by the polarizing effect it became too feeble for perception, and this lessened the extent of the visible area. When examined with the polarimeter the light appeared to be slightly less strongly polarized as the instrument was directed to points more remote from the head of the comet, as would be the case if the proportion depended simply upon the angle of incidence of the light, which decreased with the distance from

* Reports on the Total Solar Eclipses of July 29, 1878, and January 11, 1880, pp. 264-267.

the nucleus. The second and third of the observations of July 1, in the list below, were made upon regions removed several degrees from the nucleus, but though the amount of polarization is somewhat less, and tends to confirm the above conclusion, the difference is hardly greater than would be accounted for by the errors of observation. Determinations of polarization at great distances from the nucleus were not possible, the light being too feeble.

In the use of the polarimeter, the latter was fitted so that a card could be attached to the slide moving the glass plates. The positions were pricked upon this with a needle point, and were read off by means of the graduated circle after the observations were finished. The latter were made in sets of ten, the plates being moved to the point of neutralization, or disappearance of the bands, first from below, then from above, alternately, until five had been made from each direction. The points upon the card thus fell into two groups separated by an interval which was greater or less according to the degree of polarization. The mean of the angles for each set of five being taken, the percentage of polarized light corresponding to each was determined from a curve constructed for the instrument. Two values were thus obtained the mean of which was the amount of polarization for the point observed. Each card was capable of containing two sets of points, and could be removed or replaced by another without the aid of a light, a necessary precaution in observations of such delicacy, as the proper sensitiveness of the eye could only be maintained by seclusion from the light.

The results of the observation are given in the following table. The date and local mean time for the series of each evening are given in column I. In column II are given the results derived from the sets of determinations arranged in their order as made, each result, as explained above, being obtained by ten measurements. The numbers express the proportion of polarized light to the total light reckoned as one hundred parts. The means of the percentages of the sets in column II for each evening are given in column III. Column IV gives the approximate angles of incidence of the light derived from the sun, referred to the nucleus or points very near it. It is obtained from the ephemeris of Peters,* combined with that of Oppenheim given in the *Dun Echt Circular* No. 24. The angles subtended at the comet by the earth's radius vector at the dates of the ephemeris were obtained by a simple graphic process. With these a curve was constructed from which the angles for the dates of the different observations were derived. These divided by two are the angles of incidence.

* *Astronomische Nachrichten*, No. 2381, p. 75.

I.	II.	III.	IV.
June 29, 1 ^h to 2 ^h , A. M.	24·7 23·8 21·3	23·3	60°·5
June 30, 1 ^h to 2 ^h , A. M.	18·1 17·6 18·6 17·1	17·8	58°
July 1, 11 ^h to 12 ^h 30 ^m P. M.	21·8 20·1 17·6 17·7	19·3	54°·5
July 2, 10 ^h 30 ^m to 11 ^h P. M.	16·9 16·9	16·9	52°·5
July 3, 10 ^h 30 ^m to 12 ^h P. M.	18·3 18·0 18·7	18·3	51°
July 21, 11 ^h 30 ^m P. M. to 1 ^h .	15·9 15·6	15·7	33°
July 22, 11 ^h 30 ^m P. M. to 1 ^h .	14·5 13·8	14·1	32°

The observation of July 2 was made under rather unfavorable atmospheric conditions, and the sky was somewhat luminous from auroral action. The amount of polarization found is undoubtedly less than the true value. The others were made when the sky was very clear, and during those of July 21 and 22 it was exceptionally fine. The time of the observations precluded the possibility of any influence from twilight or the light of the moon.

On comparing the percentage of light polarized and the angles of incidence it is seen that they decrease together. No definite maximum was made out, but the existence of one near or beyond 60° is perhaps indicated by the fact that polarization was less easily observed on the evenings previous to June 29, and by the more rapid variation in the percentages on this and the two succeeding evenings. At first sight the large percentages obtained in the earlier observations appeared to indicate reflection from a gaseous substance, but the numbers found later, and especially the relation of all the values to the angles of incidence, render an inference as to the character of the reflecting material more difficult. It is not improbable that the constitution and physical condition of the matter composing the tail were variable, and this circumstance would introduce changes in the proportion of polarized light, in addition to those produced by the alteration in the angle of the reflected rays. The fact of polarization shows that a large part, probably the greater part, of the light coming from the tail is reflected sunlight.

Yale College, July 25, 1881.