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Observations to determine the Refraction Effect of Comet 1899 I.

By C. D. Perrine.

Swift's comet of the present year, after its perihelion passage, seemed to fulfill the requirements for a satisfactory determination of the effect of refraction on a ray of light traversing it.

Its spectrum, observed by Mr. Wright, was practically all bright-line, with scarcely a trace of continuous spectrum, thus indicating a gaseous constitution.

It was large and bright. Its brightness increased towards the center more rapidly than it should in the case of a spherical mass of uniform density; from which, in the absence of any better criterion, it is to be assumed that the density also increased towards the center.

Finally, it was well placed for northern observers while very bright, and had a rapid motion, which made it possible to obtain a complete set of observations in a single night, all at comparatively small zenith distances.

Measures to determine the refraction were made on May 18th and June 9th with the 36 inch Refractor, using a

power of 270. This eyepiece gives a field of view about 6' in diameter. The observations of May 18th were not made under the best conditions, as the stars were too faint for the most accurate settings, and there was a disturbing wind. This series was sufficiently accurate, however, to make it certain that there was no considerable cometary refraction.

Following are the detailed results of the observations.

1899 May 18. Seeing 3-2.

Temperature of dry air 45° F. Barometer 25.76 inches.

Att. Thermometer 43° F.

Following are the position-angle and distance of two stars of 13.5 magnitude. The approximate coordinates of the stars were:

Star *a* $\alpha = 22^h 29^m 53^s$ $\delta = +44^\circ 21'$
Star *b* $= 22 \ 30 \ 5$ $= +44 \ 24$

Mt. H. Sid. T.	Angle	Apparent Distance	Corr. for Refract.	Corrected Distance	Probable Error	Nr. of Setts.
17 ^h 53 ^m 19 ^s	38°36	—	—	—	—	3
17 58 9	—	203"30	+0"10	203"40	±0"03	4
18 7 53	—	203.32	+0.09	203.41	±0.23	4
18 14 17	—	203.36	+0.09	203.45	±0.04	5
18 25 30	38.08	—	—	—	—	3
18 29 43	—	203.55	+0.08	203.63	±0.14	4
19 18 39	38.20	—	—	—	—	3
19 23 4	—	203.31	+0.06	203.37	±0.16	5

The position-angle and distance of the nucleus of the comet from star *a* were determined as follows:

Mt. Ham. Sid. T.	Angle	Distance
18 ^h 18 ^m 54 ^s	357°4	—
18 21 32	—	120"0

Following are the distances of the nucleus from the stars at 18^h 8^m the time of the comet's crossing the line joining the two stars:

Distance of nucleus from star <i>a</i>	78"
Distance of nucleus from star <i>b</i>	125"

The distance of the comet from the Earth was 60000000 miles. From a photograph of the comet obtained on the same night by Mr. H. K. Palmer with an exposure of an hour and a half the head is found to be 10' in dia-

meter. The diameter of the head of the comet was therefore about 174000 miles and the light of the stars traversed cometary matter as follows:

Star <i>a</i>	168000 miles
Star <i>b</i>	158000 "

At the time of the first measures the stars were involved in the nebosity. At the time of the last set of distance measures both stars were beyond any influence of the comet, the nucleus of the latter being 500" distant.

The greatest range of variation in the distance measures is 0"26, a difference which is in all probability purely accidental.

Following are the detailed results of the observations of June 9.

1899 June 9.

Conditions good, seeing 4.

Temperature of dry air 66° F. Barometer 25.87 inches.

Att. Thermometer 68° F.

Following are the position-angle and distance of two stars of 10th magnitude. The approximate coordinates of the stars were:

Star *a* $\alpha = 15^h 46^m 45^s$ $\delta = +44^\circ 13'$
 Star *b* $= 15 \ 46 \ 46$ $= +44 \ 9$

Mt. H. Sid. T.	Angle	Apparent Distance	Corr. for Refract.	Corrected Distance	Probable Error	Nr. of Setts.
17 ^h 3 ^m	178° 95	—	—	—	—	4
17 8 6 ^s	—	219".82	+0".05	219".87	±0".05	10
17 22 53	—	220.02	+0.05	220.07	±0.04	10
17 37 6	—	219.98	+0.05	220.03	±0.05	10
17 53 6	—	219.98	+0.05	220.03	±0.04	11
18 50 6	—	220.01	+0.05	220.06	±0.06	10

The position-angle and distance of the comet from star *a* was:

Mt. Ham. Sid. T.	Angle	Distance
17 ^h 13 ^m 14 ^s	99° 0	—
17 16 11	—	115".8

Position-angle and distance of the comet from star *b*:

18 ^h 34 ^m 23 ^s	241° 2	—
18 37 8	—	284".1

The nucleus of the comet transited a line joining the two stars at 17^h 41^m at the following distances from

Star <i>a</i>	130".1
Star <i>b</i>	89.9

A negative taken on the same night by Mr. H. K. Palmer, with an exposure of 2^h 5^m shows that the diameter of the head was 8'. The nebulosity about the nucleus was

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**) Astr. Nachr. No. 3072.

relatively fainter than on May 18th. In the center was a brighter condensation 2' or 3' in diameter.

The distance of the comet from the Earth at this time was 62000000 miles. The diameter of the head was therefore 145000 miles. The light from the stars traversed cometary matter as follows:

Star <i>a</i>	122000 miles
Star <i>b</i>	134000 "

At the time of the first set of measures the northern star (*a*) was slightly immersed in the nebulosity of the comet but in such a way that any effect of refraction would be at right angles to the line joining the stars. At this time star *b* was immersed in the outer nebulosity to a distance of 1' and in such a way that refraction would have some slight effect on the apparent distance between the stars.

At the time of the last measures the stars were entirely free from any effect from the comet.

The greatest observed variation in distance of the stars is 0".20. In neither case is there any systematic variation indicating refraction.

The pair of stars, for accurate measurement, should not be too bright. I have found stars of 9th to 11th magnitude most satisfactory for medium and large apertures.

Dr. M. W. Meyer made observations at Geneva of the comet 1881 III by measuring the position-angle and distance of the comet's nucleus from a star before, during, and after its closest approach. From these observations, he considers that he obtains evidences of refraction. *)

In 1891 Professors Burnham and Barnard observed Wolf's comet for this purpose. **) They measured the distance of two stars as the comet passed over one of them. Professor Burnham's measures, made with the 36 inch Refractor, show a slight systematic deviation, but in the opposite direction from what we should expect, upon the most probable assumption as to the physical state of the comet. Professor Barnard's measures made with the 12 inch Equatorial show no such systematic deviations.

A Correction to Watson's „Theoretical Astronomy“ and Oppolzer's „Lehrbuch zur Bahnbestimmung der Cometen und Planeten“.

By *C. D. Perrine.*

On page 253 of Watson's „Theoretical Astronomy“ is the following:

„The equation

$$\left\{ \eta' = \frac{s'^2(s' - 1)}{s' + \frac{1}{9}} \right\}$$

is of the third degree, and has therefore, three roots. Since s' is always positive and cannot be less than 1, it follows from this equation that η' is always a positive quantity. The equation may be written thus:

$$s'^3 - s'^2 - \eta' s' - \frac{1}{9} \eta' = 0,$$

and there being only one variation of sign, there can be only one positive root, which is the one to be adopted, the negative roots being excluded by the nature of the problem. «

On page 87 of volume I of Oppolzer's „Lehrbuch zur Bahnbestimmung der Cometen und Planeten“ occurs the following:

„Wäre ξ bekannt, so würde der Werth von h völlig bestimmt und η durch die cubische Gleichung: