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ART. XXXIV.—*Physical Aspects of the Comet II*, 1861; by
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THE comet was first noticed on the evening of the 30th of June at 10 $\frac{1}{2}$ o'clock. At that time a bank of clouds obscured the nucleus, and its lengthened coma of pulsating light extending towards the zenith caused it to be mistaken for an auroral beam. This opinion of its nature was apparently confirmed by a number of luminous and vapory flocculi lying eastward of the meridian, and near the prime vertical. The following evening at about the same hour or a little later, it was again remarked, and under somewhat similar circumstances; but whilst the change of place was evident, there was no reason to suspect it a celestial body. At a later hour its character was no longer doubtful.

On the night of the 2d of July, the nucleus of the comet was near the small star δ Ursæ Majoris, from which point the tail proceeded in two branches. The first one slightly curving towards the star α Ursæ Majoris, was only 8° or at most 10° in length. The other, eastern or main branch, was straight and narrow, and passed in nearly a vertical direction closely parallel with the stars λ and κ Draconis, near the latter of which it was the most attenuated, and not more than 1 $\frac{1}{2}$ ° in width. Thence, spreading gradually, it could be followed by the eye to a point in the neighborhood of 68 and 72 Herculis, or to a distance of some 80° or 85° from the nucleus. During the night it seemed to move slowly westward, finally enveloping the two stars of Draco mentioned above.

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Its light was neither uniform nor constant. For the first 8° or 10° from the nucleus the tail was remarkably brilliant, and then its light rapidly diminished in intensity until reaching its narrowest point, beyond which the gradation was almost insensible. The constancy of the light near the nucleus was interrupted at intervals by flashings or pulsations, closely resembling those of the aurora, and at these times it was remarked that the upper portion of the tail was perceptibly fainter, though this may have been simply the optical effect of contrast.

When viewed with a telescope of low power, the nucleus appeared as a small planetary disc of only a few seconds diameter. From this there emanated towards the sun a luminous sector, or fan-shaped head, terminated by a well-defined convex line. The matter proceeding from the nucleus toward the sun and forming the head, was at this line sharply repelled, and falling back on either side, formed the branches of the tail. The whole appearance of this sector, at first brilliant and well-defined, underwent various modifications as the night progressed. When first observed, it was nearly symmetrical with respect to the comet's axis. The eastern wing was perhaps a little the longer of the two. There was a dark oval spot near the middle of the fan and a little to the east of the axis: then a faint curved line or lines, concentric with the outer convex boundary, divided the mass into upper and lower strata, each with a cusp on either side. Afterwards the lines appeared broken, giving a mottled appearance to the central zone of the sector, and finally the western cusps seemed to break, and the fan-shape was transformed into a spiral whose centre was in the nucleus. Meanwhile, during the hours of observation, the dimensions of the whole mass had increased to at least double of the original size, while the outlines had become so indistinct that it was only with difficulty the general shape could be recognized.

July 3.—The nucleus was distinctly visible to the unassisted eye as early as 8 P. M., and as late as $4^h 10^m$ on the following morning. It might have been seen at even a later hour.

In the field of the telescope used last night, (the comet seeker), by 9 o'clock it was a brilliant stellar point just north of β Ursæ Majoris. In the equatorial it was enlarged to $11''\cdot 2$, and was evidently elongated in a line perpendicular to the direction of its motion.

The luminous sector, or fan-shaped head preceding it had greatly changed. Four measurements placed its outer boundary line at $101''$ from the nucleus. This line was parabolic rather than elliptical, but there was in its western half an irregularity as though a segment had been cut from that wing. In the early part of the evening, the posterior boundary was curved on each wing of the sector, its eastern half terminating in a sharp cusp,

whilst the western one was not only irregular, as has been said, but its extremity was not as well defined, and the volume of that half was sensibly less. That boundary had notably flattened by 11^h 45^m.

The surface of the sector was much less mottled than during the night of the 2d, and was at no time so vivid as then. The dark oval spot could not be recognized. Beyond the sector there was a dark space, and concentric with and at the distance of 396'' (measured by Mr. Ferguson) from the nucleus, a faint outer envelope was traceable. This last was a narrow band of dusky white hue, densest directly in front of the nucleus, at which point it was 12'' or 14'' broad, and from thence diminished towards the extremities of the wings both in volume and luminosity until its form was that of a slender crescent.

The coma continued much as last night, and requires comment under two heads. The lower, or main portion, extending from the nucleus to half-way between $\star$ and λ Draconis, was markedly the brighter, and the upper part of it slightly turned to the westward. Its eastern edge, bordering close on $\star$, and passing to the left of λ , was best defined; its western more fringe-like and spreading from the axis. It was not, at any time, as brilliant as during last night, nor was the dark central line near the axis as marked, but was, as then, subject to fitful pulsations, at which periods the increase of light sometimes seemed wholly confined to within 12° or 14° of the nucleus, at others to flash to the utmost extremity of the coma almost instantly, and again at others, the whole volume appeared to be bent to the westward as a willow branch by the wind. The most remarkable of these pulsations occurred at 10^h 50^m, during which the coma became extremely faint between $\star$ and α Draconis, though it continued quite distinct above the latter star. Its greatest breadth did not exceed 4°.

α Draconis was near the axis of the longer and narrower portion. This was nowhere more than 1½° broad; was always faintest between $\star$ and α Draconis, above which it was brighter, and could be followed in its gradually diminishing lustre to the eastward of α Ophiuchi where it was lost in the light of the milky way.

July 4.—The gazing observations of this night continued from 7^h 50^m until 11^h 30^m, P. M.

At 7^h 55^m the cometary nature of the body was readily distinguishable, and the light of the nucleus had become visible before that of α Ursæ Majoris. When seen at a later hour it was more condensed than last night, and appeared in the comet seeker as a brilliant elongated star.

At 10^h 50^m the general form of the sector-shaped head preceding the nucleus was parabolic. It was less distinctly marked

than during the last night. Its greatest extent from the nucleus by a mean of five measures in the direction of the axis of the comet was $140''$, and in a line perpendicular thereto—the extremity of the east wing—about one-third greater, or $180''$. The outline of the western half was broken as it was last night, and the surface of that wing was much mottled. 10° or 12° to the westward of the axis, and forming an angle of 45° with it, there emanated a narrow brush of light which was traceable in the field of the equatorial for $30''$. The posterior edge of the sector was again curved as on the night of the 2d, that of the eastern half being an unbroken line, whilst the western one was quite irregular. Moreover, there was a fan-shaped bundle of rays to the latter, which shot from the nucleus to a distance of $18''$ or $20''$ in a line perpendicular to the axis of the sector.

The outer envelope so well seen on the night of the 3d could not be traced in the equatorial, and was perceptible in the field of the comet-seeker only at intervals and by indirect vision. It preserved its slender crescent outline and was concentric with the sector, but separated from it by a dark space of about $70''$.

At $9^h 7^m$ the coma was plainly divisible into two branches of which the bifurcation was just above α Draconis. The angle at which the western branch curved from the longer one was from 3° to 4° . The great volume of the light was of a delicate cream color, and was within 8° of the nucleus, from which it gradually diminished in brilliancy. The eastern edge was the best defined, but neither of them was sharp, and the western one was more brushy, and curved outwardly more than heretofore. Above the point of separation of the two branches, the western one spread into quite a broad fan-shape whose outer borders rapidly diminished in light as far as the line joining α Draconis and ζ Ursæ Majoris; and except during the occasional pulsations, it wholly faded from sight within five degrees upward from that line. During these periods, the curve could be traced to the cluster of stars near θ Bootis. The great bend of the curve was on or near the line joining δ Ursæ Majoris and α Draconis. A dark space intervened between its eastern line and the eastern branch of the coma.

α and ι Draconis and τ , σ , η and ϵ Herculis were all within that branch. This nowhere above α Draconis exceeded $1\frac{1}{2}^\circ$ in breadth. It gradually diminished and again increased in brightness between the last named star and ι of the same constellation, and could be followed to the scattered light of the milky way east of α Ophiuchi. The periodical fluctuations in its brightness were not so remarkable as on either of the other evenings.

July 6.—Clouds broke away and the comet was found with the unassisted eye at $8^h 15^m$; it was obscured with occasional interruptions by clouds until 10^h when the sky became hopelessly overcast.

The comet was much fainter to-night. The tail was not more than 25° in length, and curved very nearly the same as on previous nights, but was broader, being nowhere less than $3'$ in width. The western and the main branches seemed both subdivided continually.

The luminosity surrounding the head was more extended than before, but with no perceptible outline.

The sector was much smaller and fainter, and for the greater part of the time could scarcely be discerned at all as distinct from the general mass of light. The vertex of its upper, convex side was some 5° or 10° to the right of the comet's axis, corresponding very nearly to the position of the line or brush of light seen on the 3d inst. The inner edge of the eastern cusp was better defined than that of the western,—it was concave as usual, while the western, when it could be seen at all, was quite straight. There was no trace whatever of any dark spots or lines, except that by occasional glimpses a shade could be suspected separating the outer luminosity from the sector, but even this was very doubtful.

July 7.—Although there were thin cirri extending over all that portion of the sky, the cometary nature of the body was recognizable as early as 8^h 5^m. An hour later, the thin clouds had all disappeared.

At 10^h P. M. the light of the nucleus was brighter than that of ϵ Ursæ Majoris. With a power of 70, and the full aperture of the equatorial, it was, in comparison with the night of the 5th, condensed and brilliant, but not stellar.

The head, or what has hitherto been called the sector was not unlike an arrow-head in form.

The anterior boundary of the sector was more flattened than on previous evenings, and was not unlike an arrow-head greatly expanded perpendicular to the axis of length. A brush of luminous fibres extended from the nucleus across it, inclined to the west at an angle of 8° or 10° , and perceptible $20''$ beyond the boundary. That wing was the smaller, and much the less regular in outline. The curve of the posterior boundary also was more flattened, but neither of them was well-defined, although the night had become perfectly clear.

The western branch of the coma could be traced from the nucleus to near θ Bootis, the eastern one to about a degree beyond ν and ϕ Herculis, and the latter stars were precisely in its line. At 8° from the nucleus the two were not more than $1\frac{1}{2}^\circ$ to 2° broad. The great volume of light was within 10° of the nucleus, and at 20° the brilliancy of the coma did not exceed that of the milky way, west of γ Aquilæ. But its intensity was subject to great changes, when it seemed to flow from the nucleus in a stream steadily increasing for some minutes, and again as

slowly fading away. At these times the dark space between the two branches of the coma became more distinct, and the optical illusion of a curve in the line of the axis more apparent. The most noteworthy of these changes was just at 11 o'clock, shortly after which hour the observations ceased.

July 8.—The nucleus was more planetary than during last evening, and was approximately of the same degree of brightness, or produced the same effect upon the eye as ζ Ursæ Majoris. It became visible soon after 8^h P. M.

In the equatorial, and with power 70 as used then, the sector head was much more distinct, and its anterior boundary quite circular. The posterior line was a caustic, of which the nucleus occupied one of the cusps. The eastern cusp was sharp, whilst the western continued as irregular as on previous evenings.

The marked brush or rays of light diverging from the nucleus extended across the general mottled surface of the sector at the angle observed last night.

The coma continued in two distinct branches, of which the western one was curved, and constantly traceable to within a degree of θ Bootis. During the pulsations it could be seen a degree or two beyond that point. Its western outline was markedly brushy from the nucleus to extreme visibility. The eastern branch extended to and covered ν and ϕ Herculis. The great volume of light was within 8° of the nucleus, and its eastern line was the sharpest. Above the point mentioned, the coma diminished in brightness uniformly, until it was no longer distinguishable beyond ϕ Herculis. As heretofore the dark space between the two branches was most notable during the outward emissions of light from the nucleus through them.

Upon attempting to compute an orbit for the comet, Prof. Hubbard found it impossible to represent the observed path by a parabola, and then obtained by the Gaussian method the following hyperbolic elements, based upon the places obtained by Mr. Ferguson on the 2d, 8th, and 17th of July. They give for the middle date the values $\Delta l = -0''\cdot33$, $\Delta b = -0''\cdot16$.

Time of perihelion passage, 1861, June 11.85294.	Wash. M. T.
Long. of perihelion,	$249^\circ 44' 44''\cdot58$ } M. equinox,
“ “ node,	$278\ 59\ 49\ \cdot72$ } 1861.0
Inclination,	$85\ 56\ 8\ \cdot86$
Excentricity,	$1\cdot0265470$
Perihelion distance,	$0\cdot7453901$

The following is the list of observations, as far as reduced and compared with the above elements:

Wash. M. T.		α			c.—o.	δ			c.—o.
d		$^{\circ}$	$'$	$''$		$^{\circ}$	$'$	$''$	
July	241250	130	48	6.8	+ 2.4	63	12	48.5	+ 1.3
	336480	147	56	52.0	+17.9	66	10	2.4	- 0.6
	38102	148	14	43.1	- 9.5	66	11	49.9	- 4.7
	63908	152	46	48.8	+24.8	66	34	17.6	- 2.5
	436786	164	40	26.8	+18.6	66	54	21.2	- 5.5
	637421	187	49	0.3	+ 2.5	64	51	1.7	- 5.8
	836769	200	12	23.3	- 0.5	61	50	2.0	- 0.8
	1053104	207	46	0.2	- 1.4	58	58	55.8	- 9.4
	1145260	209	59	3.0	+ 2.3	57	56	58.2	-10.2
	1242192	211	54	9.1	+ 8.9	56	58	12.1	- 7.8
	1443062	214	56	37.2	+ 7.5	55	14	25.5	- 6.1
	1637969	217	6	9.6	-13.4	53	52	5.4	+ 5.2
	1735071	217	58	33.0	- 4.8	53	16	37.0	+ 1.5
	42154	218	1	58.8	+ 4.2	53	14	13.7	- 3.8
	2040982	220	9	34.0	+16.7	51	42	28.5	- 3.8
	2337224	221	44	40.7	+19.5	50	30	17.2	- 9.1
	2435193	222	11	27.8	+28.1	50	9	26.8	- 9.8
	2536437	222	37	26.0	+32.5	49	49	15.3	-13.2
	2737080	223	24	38.3	+36.0	49	12	25.8	- 8.9

From these residuals it is evident that the orbit requires yet some correction, not sufficient, however, it is believed, to change its decided hyperbolic nature.