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Again, in gases considerably lighter or heavier than ammonia, as hydrogen or hydriodic acid, the lower the temperature of operation generally the less would be the influence of vapour; whilst in gases with about the specific gravity of '6 it may happen that diminishing the temperature would augment the error.

J. HERAPATH.

IV. *On the Solar Eclipse which took place on September 7, 1820.*

By F. BAILY, Esq. F.R.S. and L.S.*

THE solar eclipse of the 7th of September last having excited general attention throughout Europe, on account of its magnitude, I shall venture to lay before the Society such observations as I myself made relative thereto, and also the result of such observations as have been communicated to me by others, whose accuracy I have no reason to doubt. These latter however are at present neither so numerous nor important as I had reason to expect, considering the number of good observers, who must have witnessed this phenomenon: nevertheless I flatter myself that the observations of such persons will eventually be communicated to the public in some other manner.

My own observations were made at Kentish Town, near the bottom of Highgate Hill, in N. lat. $51^{\circ} 33' 34''$, and W. long. $35''.2$ in time, from Greenwich. The state of the clock was determined by several altitudes of the sun, taken on the morning and evening of the 6th, 7th, and 8th, with a Troughton's reflecting circle; the results of which agreed with each other to great exactness. The following are the times of the beginning and end of the eclipse.

Beginning	=	0	^h 21	['] 42	^{''} 4	}	mean time at the place.
End	=	3	13	41	.1		
Duration	=	2	51	58	.7		

In noting the time of the beginning of the eclipse, I have not made any allowance for the first second or two of time, which must (I think) in all cases elapse before the commencement of the eclipse can become visible to a spectator, even with the best telescopes. With respect to the termination of the eclipse, I do not consider any such allowance to be necessary, as the eye can follow the moon till it is completely off the sun's disc. The telescope, made use of, was a $3\frac{1}{2}$ feet refracting telescope by Tulley, with an object-glass of $3\frac{3}{4}$ inches diameter, and magnifying 38 times: but the object end was covered with a brass cap, which reduced the aperture to two inches. The eye was

* From Memoirs of the Astronomical Society of London.

protected from the rays of the sun by a dark glass of a *red colour*; a circumstance which I have thought proper to mention in this place, as it appears, from the remarks of M. Messier, that the *colour* of the glass is not immaterial in observations of this kind.

The sun was perfectly free from spots during the whole of the day; and had been so for the day or two previous thereto. Soon after the commencement of the eclipse, a succession of flying clouds prevented any correct measures being taken of the enlightened part of the sun's disc. Towards the middle of the eclipse however the clouds dispersed; and I had an excellent opportunity of measuring the diameter of the moon on the sun's disc, with one of Troughton's spider-line micrometers, attached to the telescope. By placing the two lines of the micrometer as tangents to the moon's disc, I found that the distance between them was 41.20 revolutions. But this was evidently too great by the thickness of one of the lines, which I found to be equal to five divisions: therefore the diameter of the moon was only 41.15 revolutions. The value of each revolution (by taking as a standard, the diameter of the sun on that day, as given by Delambre's tables,) was $42'',999$: therefore the apparent diameter of the moon, in the direction in which it was measured, was $29' 29'',4$. But this direction was inclined to the horizon about 75 degrees: which (on account of the refraction) diminished the true diameter in that direction exactly $1'',0$: so that its apparent diameter, measured horizontally, would be $29' 30'',4$; and consequently its semidiameter equal to $14' 45'',2$.

Now the horizontal semidiameter of the moon, at noon on that day was, according to Burckhardt's tables, $14' 41'',02$; to which must be added $8'',71$ for the augmentation at 2 o'clock (the hour of observation): thus making the apparent semidiameter at that time equal to $14' 49'',73$, or $4'',53$ more than the above observation. I would here remark that, according to Burgh's tables, the semidiameter of the moon was $14' 43'',13$: which, allowing for the augmentation, would make the apparent semidiameter $6'',64$ more than the above observation.

After the middle of the eclipse (the atmosphere remaining beautifully clear) I proceeded to measure the enlightened part of the sun's disc, or the distance of the borders of the sun and moon, with a telescope fitted up for the occasion by the Rev. Dr. Pearson, with a Rochon's prismatic micrometer. It was only 19 inches long, 1 inch diameter, and magnified about 30 times: but it was admirably adapted for the purpose intended. The prism moved through the whole length of the tube by means of a rack and pinion; and took in a scale of

36', divided into seconds by means of a vernier. The advantages attending an instrument of this kind, are its convenient size, and the ease and expedition with which the observations can be made. Nevertheless I think it right to remark that, in the present instance, it is probable there is a constant error of a few seconds affecting the results, arising from the indistinctness of the borders of the sun and moon, which prevented me from determining the exact point of contact. But as the junction was always made under the same apparent circumstances, the proportion between the results will not be affected thereby. This inconvenience may probably be overcome in any new telescope on this construction. The following are the observations which were made with this instrument.

Mean time at the place.	Distance of the borders.	Mean time at the place.	Distance of the borders.	Mean time at the place.	Distance of the borders.
h ' "	' "	h ' "	' "	h ' "	' "
2 17 18	11 8	2 33 14	17 4	2 45 11	21 22
21 3	12 27	34 44	17 30	48 36	22 37
24 13	13 41	36 34	18 11	50 58	23 30
26 10	14 25	39 7	19 4	52 47	24 10
28 2	15 5	40 47	19 43	54 0	24 38
31 22	16 20	43 20	20 40		

At 2^h 54' I left this instrument in order to prepare for observing the termination of the eclipse as above stated: and I cannot but consider it as extremely fortunate that the sun was entirely free from clouds both at the beginning and end of the eclipse.

All these observations were made from a large window; near which was suspended a barometer, with a thermometer attached: and I had also suspended another thermometer in the open air, in the shade. At noon these instruments stood as follow:

Barometer = 29·86
 Thermometer, within ... = 65°
 ————— without ... = 67°

During the progress of the eclipse, I watched the state of them, but *could not observe any alteration* in either of them. As soon as the eclipse was ended, I again noticed them more particularly, and they stood as follow:

Barometer = 29·87
 Thermometer, within ... = 66°
 ————— without ... = 68°

The diminution of light was very trifling, and would scarcely have been perceptible, had not my attention been called to it.

It by no means appeared so great as the diminution which took place in November 1816: although in that eclipse only $\cdot 78$ of the sun's disc was obscured, whereas in the present one $\cdot 87$ was obscured. But the former eclipse I observed through the dark atmosphere of London, where the abstraction of a small portion of light is easily perceptible. And I understand that, in the present eclipse, the diminution of light during the middle of the eclipse was very perceptible in the metropolis, and at places where the sun was obscured by clouds. Venus was seen by thousands of spectators with the naked eye: and I am informed that Mars also was visible to many.

Mr. Dollond informed me that he took the horizontal diameters of the sun and moon, at Greenwich, with one of his divided object-glass micrometers; and that they were in the proportion of 3.351 to 3.103. Therefore, assuming the semidiameter of the sun, as deduced from Delambre's tables, as a standard, the apparent semidiameter of the moon will be $14' 44''\cdot 14$; being about one second less than my own observation. The times at which Mr. Dollond and Mr. Taylor observed the commencement and end of the eclipse, at the Royal Observatory, were as follow:

	DOLLOND.	TAYLOR.	
Beginning	= $0^h 22' 37''$	$0^h 22' 33''\cdot 6$	} mean time at Greenwich.
End	= $3 14 40$	$3 14 44\cdot 5$	
Duration	= $2 52 3$	$2 52 10\cdot 9$	

Mr. Groombridge has favoured me with the following observations of the eclipse at Blackheath: N. lat. $51^\circ 28' 2''$, E. long. $0''\cdot 67$ in time from Greenwich. End of the eclipse at $3^h 14' 34''$ mean time at the place; the beginning not accurately observed.

Vertical distance of the Cusps.

Mean time at the place.	Rev. of Microm.	Mean time at the place.	Rev. of Microm.	Mean time at the place.	Rev. of Microm.
h ' "		h ' "		h ' "	
0 42 12	12.61	2 17 16	35.94	2 43 22	27.84
1 23 44	20.81	20 30	34.78	45 20	26.89
47 4	8.11	22 38	34.16	48 4	25.84
50 36	15.89	25 32	33.45	53 18	23.57
2 1 40	39.28	29 8	32.38	56 46	21.85
5 6	41.11	31 26	31.64	59 0	20.50
9 33	37.01	34 28	30.47	3 0 36	19.39
13 5	37.05	40 8	28.87	9 41	7.28

Each revolution of the micrometer was equal to $44''\cdot 982$.

The

The Rev. Dr. Pearson measured the diameters of the sun and moon not only with one of Dollond's divided object-glass micrometers, but also with one of Troughton's line-micrometers. By means of the former he made the moon's semidiameter equal to $14' 44''\cdot6$; and with the latter, equal to $14' 44''\cdot7$: the semidiameter of the sun being considered as the standard for the scale. These measures correspond with my own, prior to their reduction. Dr. Pearson also measured the luminous portion of the sun, when most obscured, by means of one of his compound prismatic eye-pieces with variable powers, attached to a $2\frac{1}{2}$ feet achromatic telescope, and found it to be $3' 58''\cdot24$. This measure would indicate an error in the lunar tables; as the eclipse ought not to have been of this magnitude even at Greenwich; and much less ought it to be so at the place where the observation was made. The distance between the cusps at $1^h 53'$ was $28' 53''\cdot8$ by Dollond's micrometer: and the distance of the cusps was exactly equal to the diameter of the moon, on its leaving the sun's disc at $2^h 2' 25''$. The end of the eclipse took place at $3^h 13' 20''$ mean time at the place: the beginning was not observed. Dr. Pearson's observatory is situated at East Sheen, in N. lat. $51^\circ 27' 35''\cdot7$, W. long. $1' 3'\cdot7$ in time from Greenwich.

Mr. William Allen observed the eclipse at Stoke Newington N. lat. $51^\circ 33' 40''$, W. long. $22''$ in time from Greenwich.

Beginning	=	$0^h 22' 31''$
End ...	=	$3 13 59$

Duration	=	$2 51 28$
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Mr. Isaac Wiseman wrote to me from Norwich (N. lat. $52^\circ 38'$, E. long. $5' 10''$ in time from Greenwich), stating that the eclipse began there at $0^h 28' 45''$, and ended at $3^h 21' 40''$, mean time at the place. The observation was made with a three feet reflecting telescope, with a power of 180; and the time was deduced from a meridian of his own construction. This gentleman has also sent me the result of some experiments on the power of the burning lens on different substances, during the time of the eclipse. Having procured a piece of pasteboard, he affixed thereto four equal pieces of different coloured cloths; viz. black, blue, yellow, and red; and placed them successively in the focus of a burning lens, *on the day preceding the eclipse*. The following are the periods at which they respectively took fire: viz.

Black	in	$7''$
Blue		7
Red		8
Yellow		16

He also on the same day submitted the bulb of a thermometer (which then stood at 66°) to the focus of the lens; and in $1\frac{1}{4}$ minute it rose to 94° , and probably would have risen higher, had he not been apprehensive that the glass would have been broken by the heat. These experiments were made at about two o'clock in the afternoon, in order that they might correspond with the time of the eclipse at its greatest obscuration. On the following day, about half an hour after the commencement of the eclipse, he applied the cloths in succession to the focus of the lens, and found the periods, at which they respectively took fire, to be as follow: viz.

Black	in	20''
Blue		20
Red		16
Yellow		40

At about half an hour before the end of the eclipse he again submitted them to the focus of the lens, and found their periods of ignition to be as under: viz.

Black	in	17''
Blue		18
Red		14
Yellow		24

But during the time of the greatest obscuration he could not produce any effect on them whatever. The thermometer at the commencement of the eclipse was at 66° ; and by two o'clock had fallen to $61\frac{3}{4}$. This was about the middle of the eclipse: and Mr. Wiseman assures me that at this time he *held the bulb in the focus of the burning lens for upwards of four minutes, but without producing any sensible effect.* At a quarter past two, he repeated the same experiment, and with the same result, although the sun was free from clouds. At the termination of the eclipse the thermometer rose to 64° . Mr. Wiseman also states, that he fitted up a prism in a darkened room, and that he made several observations on the coloured rays, which were thrown on a screen of white paper. He says that, during the continuance of the eclipse, the yellow and blue rays were generally increased in brilliancy, whilst the red became exceedingly faint, and did not occupy more than half their usual breadth. As I am not aware that any experiments of a similar kind were made during this eclipse, and as the results are somewhat singular, although anticipated by Mr. Wiseman, I have thought it right to state them here in order that the attention of the public may be excited thereto in any future eclipse.

Mr. Sloane of Belfast informs me that the eclipse commenced there at $11^{\text{h}} 47' 38''$ mean solar time: the observation was made with one of Dollond's achromatic telescopes, magnifying about 75 times, At

At Bury in Lancashire, the eclipse commenced at $0^h 9' 10'',5$ apparent time at that place, as observed with an achromatic telescope of five feet focus. The latitude of the place was $53^\circ 35' 30''$, and its longitude west of Greenwich $9' 8''$ in time.

Most of the letters which I have received from the country remark that the diminution of light was not so great as was expected. The fall of the thermometer towards the middle of the eclipse, was various in various places. I have already stated that, as far as my own observations extended, I could not perceive any diminution: the inspection of the instruments was made at intervals during the eclipse. In some places, I am informed, the fall was as much as 10° ; and, where the thermometer was placed in the sun, as much as 15° . It appears that the power of a lens to ignite gunpowder, was suspended from 10 to 15 minutes, during the middle of the eclipse: and it has been already stated, that for about the same period the lens was incapable of producing any effect on the thermometer:—an experiment which I believe is new, and which is certainly worthy of repetition, whenever another eclipse of any considerable magnitude may present itself.

From the continent I have received some communications, which tend to confirm the observations made by former astronomers on this singular and rare phenomenon.

At Frankfort on the Maine, Mr. J. V. Albert observed the eclipse, as follows:

Beginning	$1^h 14'',0$	}	Apparent time.
Do. of the annulus		$2 37,0$		
Middle of do.		$2 39,45$		
End of do.		$2 42,30$		

At the observatory of the Grand Duke of Baden at Mannheim, M. NICOLAI observed the eclipse as follows:

Beginning of the annulus	$2^h 37' 37'',8$	}	Apparent time.
End of do.	$2 42 32,0$		
End of the eclipse	$\dots 4 0 50,0$		

The actual formation of the annulus was very remarkable: for, about a second before it occurred, the fine curve of the moon's disc, then immediately in contact with the edge of the sun, appeared broken into several parts: and in a moment these parts flowed together like drops of water or quicksilver placed near each other. At the dissolution of the annulus, a similar appearance presented itself: for the delicate thread of light then formed by the annulus, instead of being broken in *one* place only, was in an instant divided in *several* places at once. The thermometer (reduced to Fahrenheit's scale) was at the commencement of the eclipse at $66\frac{1}{2}$, and fell towards the middle to 63, but afterwards rose again to $66\frac{1}{2}$. At

32 On preventing the injurious Effects resulting from the

At Augsburg, Professor Stark observed that the duration of the annulus was $5' 47'',5$; but neither the beginning nor end of the eclipse could be observed on account of the unfavourable state of the atmosphere: Reaumur's thermometer fell $3\frac{1}{2}$ degrees (equal to 8° of Fahrenheit).

At Spire, Professor Schwerd made the following observations:

Beginning of the annulus	$2^h 37' 55'',5$	}	Apparent time.
End of	do. $2 42 43,5$		
End of the eclipse	... $4 0 57,1$		

About six seconds before the formation of the annulus, a bright spot was seen on the point of one of the horns, which shortly after appeared to flow into it. About half a second before the complete junction of the two horns, there appeared a row of bright points. A similar appearance was observed at the dissolution of the annulus. The barometer stood at 28,1 inches: and the thermometer (reduced to Fahrenheit's scale) fell from $69\frac{1}{2}$ to 64. A burning-glass, six inches diameter, which immediately set wood in a flame, did not ignite tinder during the time of the middle of the eclipse; nor would it turn paper, in the least, brown.

At Munich (in the middle of the city) the formation of the annulus was observed at $2^h 53' 23''$ mean time. The barometer stood at 26,78 inches. And the thermometer (reduced to Fahrenheit's scale) fell about three degrees.

From the island of Zante I have received communications from two observers; differing in some trifling points from each other. But as the results are stated to the nearest *minute* only (omitting the seconds), I do not think it necessary to quote them in this place. It appears however that the atmosphere was not perceptibly darkened, till nearly the time of the formation of the annulus, which lasted about five minutes: and that the thermometer fell only $2\frac{1}{2}$ degrees during the whole time of the eclipse; viz. from $88\frac{1}{2}$ to 86.

V. Account of a successful Experiment to prevent the injurious Effects resulting from the Diffusion of arsenical Vapours from Copper-smelting Furnaces*.

THE injurious effects of the escape of arsenical and other deleterious vapours from the copper-smelting furnaces in the neighbourhood of Swansea have been long known. These condensing and falling on the surrounding country, have not only greatly injured, but almost totally destroyed, vegetable and

* Monthly Magazine for May 1822.