VI. On the annular eclipse of the sun which will happen on the 15th of May 1836; being the principal results of calculations for Greenwich and Edinburgh

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In all ruminating animals and birds of prey, there is a lucid tapetum at the bottom of the eye.

The owl, that never sees the sun, has no nigrum pigmentum.

The mackarel has the bottom of the eye lucid as quicksilver.

The *coup de soleil*, met with in the West Indies, the effects of which I have seen, I attribute to the scorching effect of the sun's rays upon the scalp.

The Egyptian ophthalmia I consider to be the effect of the sun's rays, and the glare of reflected light.

I have stated the fact of the scorching power of the sun's rays being destroyed when they are applied to black surfaces, but have not gone further. Sir Humphry Davy, to whom I showed these observations, immediately explained it. He said the radiant heat in the sun's rays was absorbed by the black surface, and converted into sensible heat.

VI. *On the annular Eclipse of the Sun which will happen on the 15th of May 1836; being the principal Results of Calculations for Greenwich and Edinburgh. By Mr. GEORGE INNES.*

Aberdeen, May 15, 1821.

SIR, — **T**HE great solar eclipse of April 1, 1764, after four *Chaldean* periods, will return again on the 15th of May 1836. It will then be very great to all Europe, and in Great Britain it will be more interesting than any that has happened since 1793, as also than any that will happen before it. Like the eclipse of 1793, it will be annular in Scotland, but not at Greenwich.

The calculation of the general eclipse, the track of the central path of the annulus, its boundaries and extent, I shall reserve for a future communication. In the mean time, I send you the elements for projection and calculation, as also the results of the principal steps of calculations for Greenwich and Edinburgh.

I once intended to send you the calculations at large, but after collecting the whole process into a quarto manuscript, I find that it could not be conveniently printed in octavo.

In making a projection of this eclipse for any particular place, it will be found that the times and digits eclipsed may be determined with almost as great accuracy as the method of projection admits of; the path of the moon, and those of the parallels of latitude, being nearly parallel to one another about the time of greatest obscuration; whereas in that of September last, they formed nearly the greatest angle possible.

The following elements are obtained from the Solar Tables of Delambre, and the Lunar Tables both of Burckhardt and Burg. In calculating for Greenwich and Edinburgh, I have used the Tables of Burckhardt.

The

which will happen on the 15th of May 1836.

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The Elements as obtained by using DELAMBRE'S Tables along with those of BURCKHARDT.				But by using those of Bürg.	
			h	h	
Mean time of ecliptic conjunction at Greenwich, May 15th, at	..	..	2 6 44,40 P.M.	2 6 59,98 P.M.	
Equation of <i>mean</i> to <i>apparent</i> time, +3' 56",77. Hence the <i>apparent</i> time is	..	..	2 10 41,17	2 10 56,75	
Horary decrease of the equation of time	..	..	54° 42 19,61	54° 42 20,69	
Longitude of the Sun and Moon, each from the true equinox	..	..	52 20 33,66	52 20 34,48	
Sun's right ascension	..	..	18 57 47,95		
declination north	..	..	8,70		
horizontal parallax	..	..	2 24,45		
horary motion in longitude	..	..	2 28,12		
in right ascension,	..	..	35,13		
in declination, increasing,	..	..	15 50,31		
semidiameter,	..	..	23 27 44,14		
Obliquity of the ecliptic,	..	..	54 24,03		54 25,05
Moon's equatorial horizontal parallax,	..	..	25 41,49		25 47,77
latitude north, increasing,	..	..	30 0,01		29 59,98
horary motion in longitude at the instant of conjunction,	..	..	30 0,36		30 0,33
for the hour preceding,	..	..	29 59,66		29 59,63
for the hour following,	..	..	2 46,48		2 46,05
horary motion in latitude at the instant of conjunction,	..	..	2 46,55		2 46,11
for the hour preceding,	..	..	2 46,42		2 45,99
for the hour following,	..	..	14 49,52		14 51,24
horizontal semidiameter,	..	..	5 44 32,1		
Angle of the relative orbit with the ecliptic,	..	..	27 43,9		
Horary motion of the Moon from the Sun in the relative orbit,	..	..			

From the preceding Elements, as calculated from the Tables of Delambre and Burckhardt, the following *data* are obtained.

Apparent time.	D's hor. mot. in long.	D's $\frac{1}{2}$ hor. mot. in long.	D's longitude.
h			
0 10 41,226	30 5,61	15 2,805	53 42 14,34
0 40 41,212	30 3,16	15 1,58	53 57 17,145
1 10 41,198	30 1,41	15 0,705	54 12 18,725
1 40 41,184	30 0,36	15 0,18	54 27 19,43
Conj. 2 10 41,17	30 0,01	15 0,005	54 42 19,61
2 40 41,156	29 59,66	14 59,83	54 57 19,44
3 10 41,142	29 58,61	14 59,305	55 12 18,745
3 40 41,128	29 56,86	14 58,43	55 27 17,175
4 10 41,114	29 54,41	14 57,205	55 42 14,38
4 40 41,1	29 51,26	14 55,63	55 57 10,01
5 10 41,086	29 47,41	14 53,705	56 12 3,715

Apparent time.	D's hor. mot. in lat.	D's $\frac{1}{2}$ hor. mot. in lat.	D's latitude.
h			
0 10 41,226	2 47,44	1 28,72	20 7,63
0 40 41,212	2 47,02	1 23,51	21 31,35
1 10 41,198	2 46,72	1 23,36	22 54,86
1 40 41,184	2 46,54	1 23,27	24 18,22
Conj. 2 10 41,17	2 46,48	1 23,24	25 41,49
2 40 41,156	2 46,42	1 23,21	27 4,7
3 10 41,142	2 46,24	1 23,12	28 27,82
3 40 41,128	2 45,94	1 22,97	29 50,79
4 10 41,114	2 45,52	1 22,76	31 13,55
4 40 41,1	2 44,98	1 22,49	32 36,04
5 10 41,086	2 44,32	1 22,16	33 58,2

Apparent time.	Sun's longitude.	Sun's $\mathcal{R}$.
h		
0 10 41,226	54 37 30,71	52 15 37,42
0 40 41,212	54 38 42,935	52 16 51,48
1 10 41,198	54 39 55,16	52 18 5,54
1 40 41,184	54 41 7,385	52 19 19,6
Conj. 2 10 41,17	54 42 19,61	52 20 33,66
2 40 41,156	54 43 31,835	52 21 47,72
3 10 41,142	54 44 44,06	52 23 1,78
3 40 41,128	54 45 56,285	52 24 15,84
4 10 41,114	54 47 8,51	52 25 29,9
4 40 41,1	54 48 20,735	52 26 43,96
5 10 41,086	54 49 32,96	52 27 58,02

Sun's half hourly motion in longitude, .. 1' 12",225
in $\mathcal{R}$. .. 1 14,06

In

In procuring the preceding table of general *data*, I have used the method given by Professor Vince in his *Astronomy*, vol. iii. p. 52, for finding the horary motions in longitude and latitude, before and after the time for which the places are calculated. Mr. Vince remarks that this method is not perfectly correct, but sufficiently so for the longest eclipse. I am inclined to think it far from probable, that in any case, even when the moon is in her perigee, the half hourly change of her motion can vary in four hours in the ratio of 3, 5, 7, 9. In the example given by Mr. Vince, the equation of the second order in longitude is $1''\cdot24$; from which, applying the arithmetical progression, we find that the horary motion at two hours preceding, is increased by $11''\cdot16$, and, at two hours following, diminished by the same quantity. Now, suppose the instant for which the places are calculated from the tables, to be an hour before the moon is in perigee; the horary motion will in this case increase for the first hour which follows, and then, having arrived at its maximum, it will begin to decrease. In such a case, therefore, I am at a loss to see how the above method could hold good.

I have been induced to solicit the attention of your valuable correspondents to this point, from a hope that some of them will have the goodness to give, through the medium of your Magazine, some easy, and at the same time more accurate method of applying the equation of the second order, both in longitude and latitude.

The following table exhibits the results of the principal steps of the calculations for Greenwich and Edinburgh. The times marked on the tops of the columns are the instants assumed.

The line marked ☉ contains the Sun's longitude.	
_____ A _____	the Sun's right ascension.
_____ ☾ _____	the Moon's true longitude.
_____ L _____	the Moon's true latitude.
_____ R _____	the right ascension of the meridian.
_____ H _____	the altitude of the nonagesimal.
_____ N _____	the longitude of the nonagesimal.
_____ P _____	the parallax in longitude.
_____ p _____	the parallax in latitude.
_____ D _____	the appar. diff. of long. of the ☉ and ☾.
_____ a _____	the Moon's apparent latitude.
_____ S _____	the Moon's apparent semidiameter.
_____ m _____	the Moon's apparent motion in 60' of time.
_____ e _____	the errors from the instants assumed, where — shows the inst. too early, and + too late.

The Calculation for Greenwich.

For the beginning.				For the apparent conjunction.				For the end.				
	h	'	''	h	'	''	h	'	''	h	'	''
☉	1	53	41,178	3	22	41,136	3	23	41,136	4	43	41,097
A	54°	41	38,682	54°	45	12,95	54°	45	15,357	54°	48	30,365
D	52	19	51,693	52	23	31,404	52	23	33,873	52	26	53,835
L	54	33	40,464	55	18	18,327	55	18	48,292	55	58	39,544
R	24	54,299	24	57,075	29	1,044	29	3,813	32	44,283	32	47,031
H	80	45	9,4	103	3	48,4	103	18	50,9	123	37	10,3
N	62	1	1,1	61	48	30,3	61	47	32,0	59	31	53,1
P	83	27	27,5	99	14	24,1	99	25	1,9	113	43	36,7
P	-23	22,41	-23	29,42	-33	25,51	-33	31,31	-39	39,32	39	42,67
D	25	23,76	25	23,16	25	31,76	25	32,56	27	24,03	27	25,99
a	31	11,63	30	50,96	20,13	3	29,28N.	1,62	30	32,26	30	56,36
S	29,46S.		26,08S		14	58,43	3	31,25N.	5	20,25N.	5	21,04N.
m	15	0,43			21,75				14	55,91		
e	20,71				-20,13				23,87			
	-21,12		-0,41						+13,82			+37,69
Hence, the Eclipse begins at 1h. 54' 42",37				Apparent Conj. at 3h. 23' 36",67.				End of the Eclipse at 4h. 43' 6",36.				

The Calculation for Edinburgh; observed Lat. $55^{\circ} 56' 42''$, and Long. in Time $12^{\circ} 49' W.$ by requisite Tables.

which will happen on the 15th of May 1836.

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For the beginning.						For the apparent conjunction, &c. using 3 instants.						For the end.					
	h	'	"	'''	h		h	'	"	'''	h		h	'	"	'''	h
☉	1 35	52,179	1 36	52,179	3 1	52,138	3 2	52,139	3 3	52,139	4 2	52,102	3 23	52,102	3 23	52,102	
A	54° 41	26,645	54° 41	29,052	54° 44	53,69	54° 44	56,097	54° 44	58,505	54° 48	8,697	54° 48	11,105	54° 48	11,105	
D	52 19	30,349	52 19	41,818	52 23	11,655	52 23	14,123	52 23	16,592	52 26	31,62	52 26	34,085	52 26	34,085	
L	54 31	19,462	54 31	49,406	55 14	18,637	55 14	48,605	55 15	18,573	55 54	40,957	55 55	10,821	55 55	10,821	
R	24 40	4,23	24 40	4,23	28 38,9	28 38,9	28 41,66	28 41,66	28 41,66	28 44,42	32 22,333	32 22,333	32 22,333	32 22,333	32 22,333	32 22,333	
H	76 17	42,0	76 32	44,5	97 51	13,7	98 6	16,2	98 21	18,7	118 9	33,2	118 24	35,6	118 24	35,6	
N	57 18	47,9	57 19	46,4	57 36	15,6	57 35	42,3	57 35	6,4	55 55	48,3	55 55	52,4	55 53	52,4	
P	80 52	33,5	81 2	25,0	95 13	49,4	95 23	50,3	95 33	49,5	108 43	10,6	108 43	4,9	108 53	4,9	
P	-20 27,13		-20 34,37		-29 39,32		-29 44,95		-29 50,62		-35 58,65		-36 2,28		-36 2,28		
D	29 15,95		29 15,17		28 59,04		28 59,46		28 59,92		30 17,19		30 18,69		30 18,69		
a	30 34,32		30 13,95		14,37		7,55		29,45		30 33,61		30 57,43		30 57,43		
S	4 35,53 S.		4 31,97 S.		20,14 S		17,8 S.		15,5 S.		2 5,14 N.		2 6,4 N.		2 6,4 N.		
m	15 0,17				14 58,56				21,9		14 55,96		23,85		23,85		
e	20,67				21,92		+7,55		+29,45		-8,4		-8,4		-8,4		
	-4,42				-14,37												

Hence, the Eclipse begins at 1h. 36' 5'', 01.
Apparent Conjunction at 3h. 2' 31'', 47.
End of the Eclipse at 4h. 23' 13'', 23.

40 *Remarks on Mr. Riddle's Claim to the Invention*

The other results may now be readily obtained, and in one view they are as follows, *apparent time* :

At GREENWICH

The eclipse begins at	.. .. .	1 ^h 54' 42",37 P.M.
Greatest obscuration,	.. .. .	3 22 44,15
Apparent conjunction,	.. .. .	3 23 36,67
End of the eclipse,	.. .. .	4 43 6,36
Digits eclipsed at greatest obscuration,		10° 28 58,45
on the north part of the sun's disc.		

The moon will make the first impression on the sun's disc at 131° 39' from his vertex on the right hand.

At EDINBURGH

The eclipse begins at	.. .. .	1 ^h 36' 5,01 P.M.
Beginning of the annulus,	.. .. .	3 0 19,35
Apparent conjunction,	.. .. .	3 2 31,47
End of the annulus,	.. .. .	3 4 43,72
End of the eclipse,	.. .. .	4 23 13,23
Digits eclipsed during the annulus,	.. .. .	11° 33 20,74
Breadth of the annulus on the sun's north limb,		1 10,36
	on the sun's south limb,	33,14

Proportion of the sun's disc obscured during the annulus ,89405

The moon will make the first impression on the sun's disc at 132° 22½' from his vertex on the right hand.

As I am anxious to determine the error of the Astronomical Tables by means of the observations made on the late solar eclipse, I should be much obliged to you, or Dr. Burney, to communicate, through your Magazine, the latitude and longitude of Dr. Burney's Observatory at Gosport.

I am, dear sir, yours respectfully,

To Dr. Tilloch.

GEO. INNES.

VII. *Remarks on Mr. RIDDLE's Claim to the Invention of a new Method of determining the Latitude.*

Edinburgh, June 8, 1821.

SIR, — As an article by Mr. Edward Riddle has been inserted in the Philosophical Magazine for May 1821, which appears to me to contain insinuations totally unfounded, I beg leave to say a few words in reply.

General Brisbane having been abroad for some time expresses himself as follows, in his *Memoir on the Repeating Circle*, Edinburgh Philosophical Transactions, vol. ix. Part I. page 97, &c. and read in February 1819.

“ Having

Projection for Edinburgh of the Annular Eclipse of the Sun, which will happen on May the 15, 1836.