

In which  $m:1$ , as the greater axis of the generating ellipse is to the lesser.  $A$  is a circular arc, to the radius 1, whose tangent is  $\sqrt{m^2-1}$ , or its reciprocal, if  $m^2-1 \ll 1$ . And  $l$  is the natural logarithm of  $S$ ,  $S$  being the sine of the arc, whose co-sine is  $\frac{1}{m} \times \sqrt{m^2-1}$ , and  $V$  the versed sine of the same arc.

*Note*, The two first theorems, by substituting  $t$  for  $\sqrt{m^2-1}$ , coincide with those of Mr. Maclaurin for the oblate spheroid, in his dissertation on the tides.

III. *A Letter from the Rev. Mr. George Costard, Fellow of Wadham-College, Oxford, to Dr. Bevis, concerning the Year of the Eclipse foretold by Thales.*

Dear Sir,

Read Jan. 25, 1753. **I** THANK you greatly for the use of the Petersburg Acts, while in London, where Bayer supposeth the eclipse foretold by Thales to the Ionians fell out the year before Christ 603. Since my return home, upon looking over some papers, that I had formerly drawn up on that subject, I find, that I had determined it to have been the very same year. I will not trouble you with the chronological arguments, on which I founded that determination; and therefore shall only transcribe so much of those papers as relates to calculation.

C

Riccioli

Riccioli supposeth, that the eclipse foretold by Thales happened the year before Christ 585; and quotes both Theon and Cleomedes, in confirmation of the opinion. Theon, perhaps, had Cleomedes's words in view; but neither of these authors have circumstances enough to determine what eclipse in particular they meant. The passage of Theon is in his chapter concerning the moon's parallax, where he says, that Hipparchus, being in doubt whether the sun had any parallax at all, supposed, in the first book of his treatise concerning Magnitudes and Distances, that the earth, in respect of the sun, was only a point; from whence, by means of an eclipse there set down by him, he framed two distances of the sun, a less and a greater. *Εν γὰρ τῷ Α περὶ μεγεθῶν καὶ ἀποστημάτων λαμβάνει φαινόμενον τῷτο, Ἐκλείψιν Ἡλίου, ἐν μὲν τοῖς περὶ τὸν Ἑλλήσποντον τόποις ὅλη τῇ Ἡλίου ἀκρὸς γεγενεμένην, ὥστε μηδὲν αὐτῆς παραφαίνεσθαι ἐν Ἀλεξανδρείᾳ δὲ τῇ καὶ Αἰγυπτίῳ τὰ Δ μαλίστα πεμπτήμωρια τῆς διαμέτρου ἐκλειοιπτότα.*

All then that is here said is, that the eclipse made use of by Hipparchus was total at the Hellespont; but at Alexandria in Egypt a little more than 5 digits only. But he hath neither given us the æra of Nabonassar, the place of the luminaries, nor any one circumstance besides, by which we might form any conclusion what year this eclipse was in.

Cleomedes, who perhaps saw the same treatise of Hipparchus, is as uncircumstantial as Theon. He says only, that the diameter of the moon's shadow at the earth is something more than 4000 stadia. And to confirm this assertion, he says, *γεγόνε δὲ καὶ αὐτὴ τήρησις ἐπὶ τῆς κατὰ τὸν Ἡλίον Ἐκλείψεως, ὅς ὕλος ΠΟΤΕ*

ἐν Ἑλλάσσοντι ἐκλείπων, ἐτηρηθη ἐν Ἀλεξανδρείᾳ παρὰ τὸ πέμπτον τῆς ἰδίας ἐκλείπων διαμείρε' ὕπερ ἐστὶ καὶ τὴν φανήσασιν παρὰ δακτύλους δύο καὶ βραχύ.

By the quantity of obscuration here mentioned, this seems to have been the same eclipse with that quoted by Theon from Hipparchus; but as the place of observation in both these authors appears to have been Alexandria in Egypt, it must have been after that place was built. Consequently it was probably observed there by Hipparchus himself, and therefore could not have been the eclipse foretold by Thales. Besides, was this eclipse total upon the banks of the Hellespont, I know not what reason there is for supposing, that the battle between the Lydians and the Medes was fought there. It should rather seem, that the engagement was on the confines of the two kingdoms: consequently in a more southern latitude, and in a longitude more to the east of Alexandria, this eclipse could not have been total; nor therefore (as Herodotus said it did) turn day into night.

Sir Isaac Newton, in his chronology, likewise supposes the eclipse meant to have been that in May, the year before Christ 585. But in this, perhaps, he rather followed others, than adopted it after any examination of his own. That treatise never had the finishing hand of its great author, and it is well known now in what manner it came abroad.

According to Riccioli, this eclipse was at the Hellespont central, and at Sardes fell out at 6 of the clock in the afternoon; and therefore is rejected, you find, by Maier, in the Petersburg Acts, as being too late in the day. “ Quia ad littora Asiæ minoris

“ (says he) sub solis occasum appulit, in Natolia  
 “ nulla fuit eclipsis totalis, quin nec conspicua ob  
 “ instantem solis occasum.”

According to my computation, the apparent time  
 of the true conjunction was at Greenwich, May 28,  
 4<sup>h</sup> 35' 15".

|                                  | s | o  | '  | "  |
|----------------------------------|---|----|----|----|
| The place of the luminaries      | 1 | 29 | 0  | 24 |
| Moon's latitude north            |   |    | 20 | 54 |
| Semidiameter of the earth's disk |   | 61 | 14 |    |
| Semidiameter of the penumbra     |   | 32 | 40 |    |

|  | d  | h | '  | "  |
|--|----|---|----|----|
| Time of the greatest obscuration at<br>Greenwich | 28 | 4 | 32 | 33 |
| Beginning of the general eclipse                 |    | 2 | 3  | 20 |
| End of the general eclipse                       |    | 7 | 1  | 46 |
| Duration   |    | 4 | 58 | 26 |

|  | o  | '  | " |
|--|----|----|---|
| Longitude of Sardes east from London                 | 29 | 5  |   |
| Its longitude north                                  | 38 | 10 |   |
| Time of sun-set there May 28, 7 <sup>h</sup> 6' 54". |    |    |   |

The passage of the centre of the penumbra over  
 the earth's disk was at the following times, as rec-  
 koned at Greenwich, thus :

| Times |    |    | Longitudes |    |     | Latitudes |    |      |
|-------|----|----|------------|----|-----|-----------|----|------|
| h     | '  | "  | °          | '  | "   | °         | '  | "    |
| 3     | 22 | 33 | 115        | 5  | 10W | 22        | 10 | 40 N |
| 4     | 02 | 33 | 95         | 24 | 50  | 31        | 30 | 10   |
| 4     | 32 | 33 | 75         | 52 | 30  | 38        | 49 | 10   |
| 4     | 35 | 55 | 73         | 34 | 40  | 39        | 31 | 10   |
| 4     | 43 | 34 | 68         | 8  | 0   | 41        | 2  | 23   |
| 5     | 02 | 33 | 52         | 22 | 10  | 44        | 11 | 30   |
| 5     | 32 | 33 | 25         | 20 | 20  | 46        | 36 | 30   |

By this, I think, it pretty plainly appears, that the centre of the shadow passed so far from any place, where we can reasonably suppose the battle between the Lydians and Medes to have been fought, that this can hardly have been the eclipse mentioned by Herodotus.

Father Hardouin, in his chronology of the Old Testament, rejects this eclipse, as not happening, he says, in the reign of Cyaxares, but in that of Astyages; not on the fourth year of the Olympiad, but a month before it began; as falling out too late in the day; the greatest obscuration being (at Sardes, I suppose he means) scarce half an hour before sun-set; and not total, or central, or 12.56' digits, as Riccioli makes it, but almost 9. Tho' Pliny therefore says this eclipse was Olymp. XLVIII. 4. & A. V. C. CLX. yet six MSS. he observes, in the French king's library, have CLXX. and so most printed copies. He thinks therefore, that, instead of CLXX the number should be CLVII. which, he says, is Olympiad XLVIII. 4. and the year before Christ 597; when there was an eclipse of the sun, on Wednesday July the 9, at 6 of the clock in the morning.

This

This eclipse Petavius likewise prefers; tho' he makes the digits eclipsed only 9.22': Which is strange enough, as it could not have been by any means the cause of such a darkness, as is described by Herodotus. But F. Hardouin supposeth, that this battle was fought upon the banks of the river Halys in Cappadocia, and in latitude north  $40^{\circ}$ ; where, says he, this eclipse must have been central and annular.

According to Dr. Halley's tables, the year before Christ 597 the apparent time of the true conjunction at Greenwich was July 8<sup>d</sup> 21<sup>h</sup> 50' 9"; and

|   |    |   |     |    |
|---|----|---|-----|----|
|   | s  | o | '   | "  |
| The place of the luminaries                   | 3  | 9 | 17  | 0  |
| Moon's latitude north                         |    |   | 33  | 32 |
| Semidiameter of the earth's disk              |    |   | 54  | 38 |
| Semidiameter of the penumbra                  |    |   | 30  | 44 |
|   | d  | h | '   | "  |
| Beginning of the general eclipse              | 19 | 8 | 16  |    |
| End of the general eclipse                    | 9  | 0 | 49  | 2  |
| Duration                                      |    |   | 5   | 41 |
|   |    |   | 0   | '  |
| Sun rose centrally eclipsed, in longitude     |    |   |     |    |
| west from Greenwich                           |    |   | 83  | 33 |
| And in latitude north                         |    |   | 43  | 26 |
| Sun set centrally eclipsed, in longitude east |    |   |     |    |
| from Greenwich                                |    |   | 132 | 37 |
| And in latitude north                         |    |   | 26  | 25 |

The place of the centre of the penumbra was at the following times, as reckoned at Greenwich, thus :

Times

| Times |    |    | Longitudes |    |     | Latitudes |    |      |
|-------|----|----|------------|----|-----|-----------|----|------|
| h     | '  | "  | °          | '  | "   | °         | '  | "    |
| 21    | 46 | 15 | 30         | 21 | 0 E | 62        | 30 | 34 N |
| 21    | 58 | 39 | 42         | 53 | 30  | 60        | 53 | 0    |
| 22    | 13 | 39 | 56         | 32 | 40  | 58        | 8  | 20   |
| 22    | 28 | 39 | 68         | 58 | 0   | 54        | 41 | 40   |

This eclipse, therefore, at Sardes, or any-where else that we can well suppose this battle to have been fought, could not have been great enough to turn day into night; and therefore doth not answer Herodotus's description.

Archbishop Usher rejects both these eclipses, as inconsistent with his chronology; and supposes that intended to have been A. M. 4113. An. Nab. 147. before Christ 601. Olymp. XLIV. 4. Sunday July 20. 3<sup>h</sup> 25'. before noon, digits eclipsed 9. But this likewise is greatly defective as to quantity.

But tho' this is insufficient for the purpose, yet there was one two years before this, or the year before Christ 603, that will be found by good tables intirely satisfactory. Petavius, indeed, makes the digits eclipsed only 7.20'; but, according to Dr. Halley's tables, the apparent time of the true conjunction was at Greenwich, May 17<sup>d</sup> 20<sup>h</sup> 42' 19". The place of the luminaries 1<sup>st</sup>. 19° 12'. and the moon's latitude north 25' 17".

|                                  |       |
|----------------------------------|-------|
| Semidiameter of the sun          | 15 49 |
| Semidiameter of the moon         | 16 45 |
| Semidiameter of the penumbra     | 32 34 |
| Semidiameter of the earth's disk | 60 50 |
| Beginning                        |       |

|                                  | h  | '  | "  |
|----------------------------------|----|----|----|
| Beginning of the central eclipse | 19 | 13 | 27 |
| End of the central eclipse       | 22 | 3  | 47 |
| Duration                         | 2  | 50 | 20 |

|   |     |    |    |
|---|-----|----|----|
| Sun rose centrally eclipsed, in longitude | 0   | '  | "  |
| west from Greenwich                       | 43  | 46 | 10 |
| And in latitude north                     | 2   | 54 | 0  |
| Sun set centrally eclipsed, in longitude  |     |    |    |
| east from Greenwich                       | 155 | 56 | 20 |
| And in latitude north                     | 42  | 38 | 10 |

The place of the centre was at the following times, as reckoned there, thus :

| Times |    |    | Longitudes |    |      | Latitudes |    |     |
|-------|----|----|------------|----|------|-----------|----|-----|
| h     | '  | "  | 0          | '  | "    | 0         | '  | "   |
| 19    | 13 | 27 | 43         | 46 | 10 W | 2         | 54 | 0 N |
| 20    | 8  | 37 | 19         | 19 | 30 E | 31        | 33 | 0   |
| 20    | 23 | 37 | 28         | 28 | 10 E | 35        | 47 | 50  |
| 20    | 42 | 19 | 40         | 29 | 30 E | 40        | 41 | 20  |
| 22    | 3  | 47 | 155        | 56 | 20 E | 42        | 38 | 10  |

By this it appears, that, if modern maps and geographers may be depended upon, the center of the shadow passed over the kingdom of Barca and Africa, and crossed the Mediterranean between Candia and Cyprus, and then over Antiochetta and Erzroum, and a little to the south of Kars.

You will see, Sir, how this agrees with what is said in the Petersburg Acts, pag. 332. which, therefore, I shall not transcribe. I shall only add, that, if any allowance is to be made for the moon's acceleration,

for the moon's acceleration, or any other cause, the track here given, as you know, will be a little different. As I cannot make several ancient eclipses, that I have tried, succeed to my mind, without some such supposition, I have done the same with regard to this. What the quantity to be allowed is, I leave to you and others to determine: At present I make it 45'; at Mr. Whiston's rate of 1' in 54 years, or thereabouts. Then

|  |    |    |    |    |
|--|----|----|----|----|
|  | d  | h  | '  | "  |
| The apparent time of the true conjunction at Greenwich         | 17 | 20 | 42 | 19 |
| For the moon's acceleration                                    |    |    | 45 | 0  |
| Apparent time of the moon's conjunction at Greenwich corrected | 17 | 19 | 57 | 19 |

From hence I find the passage of the penumbra at the following times as reckon'd at Greenwich, thus:

| Times |    |    | Longitudes |    |      | Latitudes |    |     |
|-------|----|----|------------|----|------|-----------|----|-----|
| h     | '  | "  | °          | '  | "    | °         | '  | "   |
| 19    | 23 | 37 | 30         | 49 | 30 E | 31        | 33 | 0 N |
| 19    | 38 | 37 | 39         | 58 | 10   | 35        | 47 | 50  |
| 19    | 57 | 19 | 60         | 30 | 0    | 40        | 41 | 20  |

By this table it appears, that the center pass'd more to the south than the former, and went near Tripoli, Aracta, Nisabin, and Ardbil.

It is much to be wish'd, that Herodotus had told us where this battle was fought; that, by this means, we might have known, which of these two paths to have preferred. However, as he hath not, and there

is nothing in either of them, that is inconsistent with the history, I conclude, from a number of other circumstances besides, that this really was the eclipse foretold by Thales. I was not a little pleased, upon looking into my papers, to find, that Bayer and I agreed so exactly in the very year, as I was a stranger to what he had said upon that subject, till you brought me that volume of the *Petersburgh Acts*; and as the principles I proceeded upon were something different from his. This, however, is a presumption, that we are right, and confirms my opinion of some other articles in chronology, wherein I differ from some very great names. I am,

Dear Sir,

Islip, May 21,  
1752.

Your very faithful and

obliged humble servant,

G. Costard.

IV. *An Account of the Case of Anne Elizabeth Queriot, of Paris, whose Bones were distorted and softened; by Ambrose Hofty, M. D. of the Faculty of Paris.*

Read Jan, 25,  
1753.

**A**NNE Elizabeth Queriot\*, aged 35, native of Paris, was married in the year 1746 to a wool-carder. Tho' seemingly  
of

\* Her marriage-name was Supiot.