

Introduction

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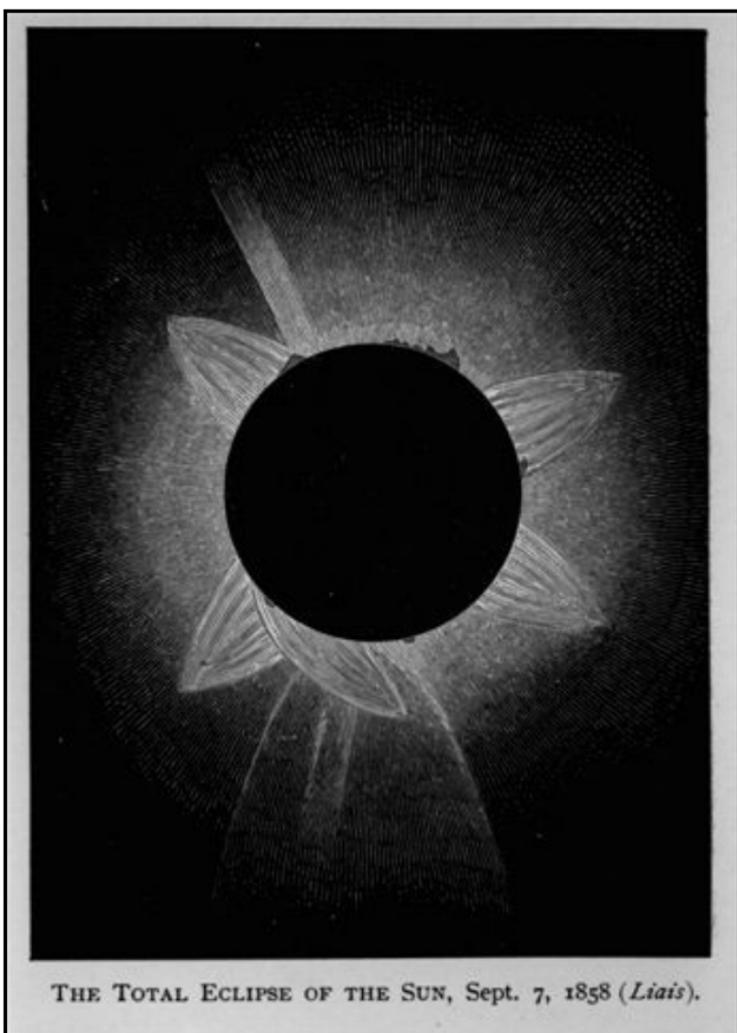
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STORY OF THE ECLIPSES
BY
GEORGE F. CHAMBERS F.R.A.S

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THE TOTAL ECLIPSE OF THE SUN, Sept. 7, 1858 (*Liais*).

THE STORY OF ECLIPSES

BY

GEORGE F. CHAMBERS, F. R. A. S.

OF THE INNER TEMPLE, BARRISTER-AT-LAW

AUTHOR OF THE STORY OF THE SOLAR SYSTEM,
THE STORY OF THE STARS,
A HANDBOOK OF DESCRIPTIVE ASTRONOMY, ETC.

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CHAPTER X.

ECLIPSES OF THE SUN MENTIONED IN HISTORY —
CLASSICAL.

IN this chapter we shall, for the most part, be on firmer ground than hitherto, because several of the most eminent Greek and Latin historians have left on record full and circumstantial accounts of eclipses which have come under their notice, and which have been more or less completely verified by the computations and researches of modern times. But these remarks do not, however, quite apply to the first eclipse which will be mentioned.

Plutarch, in his *Life of Romulus*, refers to some remarkable incident connected, in point of time at any rate, with his death :—" The air on that occasion was suddenly convulsed and altered in a wonderful manner, for the light of the Sun failed, and they were involved in an astonishing darkness, attended on every side with dreadful thunderings and tempestuous winds." This so-called darkness is considered to have been the same as that mentioned by Cicero.* There is so much myth about Romulus that it is not safe to write in confident language. Nevertheless it is a fact, according to Johnson, that there was a very large eclipse of the Sun visible at Rome in the afternoon of May 26, 715 B.C., and 715 B.C. is supposed to have been the year, or about the year, of the death of Romulus. Plutarch is also responsible for the statement that a great eclipse of the Sun took place sometime before the birth of Romulus; and if there is anything in this statement Johnson thinks that the annular eclipse of November 28, 771 B.C., might meet the circumstances of

De Republica, Lib. vi., cap. 22.

the case, but too much romance attaches to the history of Romulus for anyone to write with assurance respecting the circumstances of his career. Much of it is generally considered to be fabulous.

In one of the extant fragments of the Greek poet Archilochus (said to be the first who introduced iambics into his verses), the following sentence occurs:—"Zeus, the father of the Olympic Gods, turned mid-day into night, hiding the light of the dazzling Sun; an overwhelming dread fell upon men." The poet's language may evidently apply to a total eclipse of the Sun; and investigations by Oppolzer and Millosevich make it probable that the reference is to the total eclipse of the Sun which happened on April 6, 648 B.C. This was total at about 10 A.M. at Thasos and in the northern part of the Ægean Sea. The acceptance of this date displaces by about half a century the date commonly assigned for the poet's career, but this is not thought to be of much account having regard to the hazy character of Grecian chronology before the Persian wars.*

On May 28, 585 B.C. there occurred an eclipse the surrounding circumstances of which present several features of particular interest. One of the most celebrated of the astronomers of antiquity was Thales of Miletus, and his astronomical labours were said to have included a prediction of this eclipse, which moreover has the further interest to us that it has assisted chronologists and historians in fixing the precise date of an important event in ancient history. Herodotus,** describing a war which had been going on for some years between the Lydians and

* E. Millosevich, *Memorie della Societa Spettroscopisti Italiani*, vol. xxii. p. 70. 1893.

** *Herodotus*, Book i., chap. 74. This eclipse is also mentioned by Pliny (Nat. Hist., Book ii., chap. 9) and by Cicero (*De Divina-tione*, cap. 49).

the Medes, gives the following account of the circumstances which led to its premature termination :—" As the balance had not inclined in favour of either nation, another engagement took place in the sixth year of the war, in the course of which, just as the battle was growing warm, day was suddenly turned into night. This event had been foretold to the Ionians by Thales of Miletus, who predicted for it the very year in which it actually took place. When the Lydians and Medes observed the change they ceased fighting, and were alike anxious to conclude peace." Peace was accordingly agreed upon and cemented by a twofold marriage. " For (says the historian) without some strong bond, there is little security to be found in men's covenants." The exact date of this eclipse was long a matter of discussion, and eclipses which occurred in 610 B.C. and 593 B.C. were each thought at one time or another to have been the one referred to. The question was finally settled by the late Sir G. B. Airy, after an exhaustive inquiry, in favour of the eclipse of 585 B.C. This date has the further advantage of harmonising certain statements made by Cicero and Pliny as to its having happened in the 4th year of the 48th Olympiad.

Another word or two may be interesting as regards the share which Thales is supposed to have had in predicting this eclipse, the more so, that very high authorities in the domains of astronomy, and chronology, and antiquities take opposite sides in the matter. Sir G. C. Lewis, Bart., M.P., may be cited first as one of the unbelievers. He says* that Thales is " reported to have predicted it to the *Ionians*. If he had predicted it to the Lydians, in whose country the eclipse was to be total, his conduct would be intelligible, but it seems strange that he should have predicted it to the Ionians, who had no direct in-

* Astronomy of the Ancients, p. 88,

terest in the event." Bosanquet replies to this by pointing out that Miletus, in *Ionia*, was the birthplace of Thales, and also that a shadow, covering two degrees of latitude, passing through *Ionia*, would also necessarily cover *Lydia*.

Another dissentient is Sir H. C. Rawlinson,* who, remembering that Thales is said to have predicted a good olive crop, and Anaxagoras the fall of an aerolite, says:— " The prediction of this eclipse by Thales may fairly be classed with the prediction of a good olive crop, or the fall of an aerolite. Thales, indeed, could only have obtained the requisite knowledge for predicting eclipses from the Chaldeans; and that the science of these astronomers, although sufficient for the investigation of lunar eclipses, did not enable them to calculate solar eclipses—dependent as such a calculation is, not only on the determination of the period of recurrence, but on the true projection also of the track of the Sun's shadow along a particular line over the surface of the earth—may be inferred from our finding that in the astronomical canon of Ptolemy, which was compiled from the Chaldean registers, the observations of the Moon's eclipse are alone entered."

Airy ** replied to these observations as follows :—" I think it not at all improbable that the eclipse was so predicted, and there is one easy way, and only one of predicting it—namely, by the *Saros*, or period of 18 years, 10 days, 8 hours nearly. By use of this period an evening eclipse may be predicted from a morning eclipse, but a morning eclipse can rarely be predicted from an evening eclipse (as the interval of eight hours after an evening eclipse will generally throw the eclipse at the end of the *Saros* into the hours of night). The evening eclipse, therefore, of B.C. 585, May 28, which I adopt as being

* *Herodotus*, edited by Rev. G. Rawlinson, vol. i. p. 212.

** *Month. Not.*, R.A.S., vol. xviii. p. 148; March 1858.

most certainly the eclipse of Thales, might be predicted from the morning eclipse of B.C. 603, May 17. ... No other of the eclipses discussed by Baily and Oltmanns present the same facility for prediction."

Xenophon* mentions an eclipse as having led to the capture by the Persians of the Median city Larissa. In the retreat of the Greeks on the eastern side of the Tigris, they crossed the river Zapetes and also a ravine, and then reached the Tigris. According to Xenophon, they found at this place a large deserted city formerly inhabited by the Medes. Its wall was 25 feet thick and 100 feet high ; its circumference 2 parasangs [=7½ miles]. It was built of burnt brick on an under structure of stone 20 feet in height. Xenophon then proceeds to say that " when the Persians obtained the Empire from the Medes, the King of the Persians besieged the city, but was unable by any means to take it till a cloud having covered the Sun and caused it to disappear completely, the inhabitants withdrew in alarm, and thus the city was captured. Close to this city was a pyramid of stone, one plethrum in breadth, two plethra in height. . . . Thence the Greeks proceeded six parasangs to a great deserted castle by a city called Mespila formerly inhabited by the Medes; the substructure of its wall was of squared stone abounding in shells . . . the King of the Persians besieged it, but could not take it; Zeus terrified the inhabitants with thunderbolts, and so the city was taken."

The minute description here given by Xenophon enabled Sir A. H. Layard, Captain Felix Jones, and others, to identify Larissa with the modern Nimrud and Mespila with Mosul. A suspicion is thrown out in some editions of the *Anabasis* that the language cited might refer to an eclipse of the Sun. It is to be noted, however, that it is

* *Anabasis*, Lib. iii., cap. 4, sec. 7.

not included by Ricciolus in the list of eclipses mentioned in ancient writers which he gives in his *Almagestum Novum*. Sir G. B. Airy, having had his attention called to the matter, examined roughly all the eclipses which occurred during a period of 40 years, covering the supposed date implied by Xenophon. Having selected two, he computed them accurately but found them inapplicable. He then tried another (May 19, 557 B.C.) which he had previously passed over because he doubted its totality, and he had the great satisfaction of finding that the eclipse, though giving a small shadow, had been total, and that it had passed so near to Nimrud that there could be no doubt of its being the eclipse sought.

Sir G. B. Airy was such a very careful worker and investigator of eclipses that his conclusions in this matter have met with general acceptance. It must, however, in fairness be stated that a very competent American astronomer, Professor Newcomb, has expressed doubts as to whether after all Xenophon's allusion is to an eclipse, but, judging by his closing words, the learned American does not seem quite satisfied with his own scepticism, for he says—"Notwithstanding my want of confidence, I conceive the possibility of a real eclipse to be greater than in the eclipse of Thales, while we have the great advantages that the point of occurrence is well defined, the shadow narrow, and, if it was an eclipse at all, the circumstance of totality placed beyond serious doubt." *

In the same year as that in which, according to the common account, the battle of Salamis was fought (480 B.C.), there occurred a phenomenon which is thus adverted to by Herodotus **—" At the first approach of Spring the

* *Washington Observations*, 1875, Appendix II., p. 31.

** Book vii., chap. 37. See Rawlinson's *Herodotus*, vol. iv. P. 39-

army quitted Sardis and marched towards Abydos; at the moment of its departure the Sun suddenly quitted its place in the heavens and disappeared, though there were no clouds in sight and the day was quite clear; day was thus turned into night." We are told * that " As the king was going against Greece, and had come into the region of the Hellespont, there happened an eclipse of the Sun in the East; this sign portended to him his defeat, for the Sun was eclipsed in the region of its rising, and Xerxes was also marching from that quarter." So far as words go these accounts admirably befit a total eclipse of the Sun, but regarded as such it has given great trouble to chronologers, and the identification of the eclipse is still uncertain. Hind's theory is that the allusion is to an eclipse and in particular to the eclipse of February 17, 478 B.C. Though not total at Sardis yet the eclipse was very large, 94/100ths of the Sun being covered. If we accept this, it follows that the usually recognised date for the battle of Salamis must be altered by two years. Airy thought it " extremely probable " that the narrative related to the total eclipse of the *Moon*, which happened on March 13, 479 B.C., but this is difficult to accept, especially as Plutarch, in his *Life of Pelopidas*, says—" An army was soon got ready, but as the general was on the point of marching, the Sun began to be eclipsed, and the city was covered with darkness in the daytime." This seems explicit enough, assuming the record to be true and that the same incident is referred to by Plutarch as by Herodotus and Aristides.

Since the time when Airy and Hind examined this question, all the known facts have been again reviewed by Mr. W. T. Lynn, who pronounces, but with some hesitation, in favour of the eclipse of Oct. 2, 480 B.C., as the one associated with the battle of Salamis. He does this by refus-

* *Scholia*, in *Aristidis Orationes*, Ed. Frommel, p. 222.

ing to see in the above quotations from Herodotus any allusion to a solar eclipse at all, but invites us to consider a later statement in Herodotus * as relating to an eclipse, though the historian only calls it a prodigy.

After the battle of Thermopylae the Peloponnesian Greeks commenced to fortify the isthmus of Corinth with the view of defending it with their small army against the invading host of Xerxes. The Spartan troops were under the command of Cleombrotus, the brother of Leonidas, the hero of Thermopylae. He had been consulting the oracles at Sparta, and Herodotus states that "while he was offering sacrifice to know if he should march out against the Persian, the Sun was suddenly darkened in mid-sky." This occurrence so frightened Cleombrotus that he drew off his forces and returned home. It is uncertain from the narrative of Herodotus whether Cleombrotus returned to Sparta in the autumn of the year of the battle of Salamis, or in the spring of the next following year, which was that in which the battle of Plataea was fought. Bishop Thirlwall ** thinks that it was the latter, but Lynn pronounces for the former, adding that the date may well have been in October, and the solar eclipse of October 2, 480 B.C. may have been the phenomenon which attracted notice, particularly as the Sun would have been high in the heavens, the greatest phase ($\frac{6}{10}$ ths) occurring, according to Hind, at 50 minutes past noon. Here I must leave the matter, merely remarking that this alternative explanation obviates the necessity for disturbing the commonly received date of the battle of Salamis.

Thucydides states that during the Peloponnesian war "things formerly repeated on hearsay, but very rarely

* Book ix., chap. 10. See Rawlinson's *Herodotus*, 3rd ed. vol. iv. p. 379.

** *History of Greece*, vol. ii. p. 330.

confirmed by facts, became not incredible, both about earthquakes and eclipses of the Sun which came to pass more frequently than had been remembered in former times." One such eclipse he assigns to the first year of the war, and says * that " in the same summer, at the beginning of a new lunar month (at which time alone the phenomenon seems possible) the Sun was eclipsed after mid-day, and became full again after it had assumed a crescent form and after some of the stars had shone out." Aug. 3, 431 B.C. is generally recognised as the date of this event. The eclipse was not total, only three-fourths of the Sun's disc being obscured. Venus was 20° and Jupiter 43° distant from the Sun, so probably these were the " stars" that were seen. This eclipse nearly prevented the Athenian expedition against the Lacedaemonians. The sailors were frightened by it, but a happy thought occurred to Pericles, the commander of the Athenian forces. Plutarch, in his *Life of Pericles*, says :— " The whole fleet was in readiness, and Pericles on board his own galley, when there happened an Eclipse of the Sun. The sudden darkness was looked upon as an unfavourable omen, and threw the sailors into the greatest consternation. Pericles observing that the pilot was much astonished and perplexed, took his cloak, and having covered his eyes with it, asked him if he found anything terrible in that, or considered it as a bad presage? Upon his answering in the negative, he asked, ' Where is the difference, then, between this and the other, except that something bigger than my cloak causes the eclipse ? ' "

Another eclipse is mentioned by Thucydides ** in connection with an expedition of the Athenians against Cythera. He says :—" At the very commencement of the following summer there was an eclipse of the Sun at the

* Book ii., chap. 28. ** Book iv., chap. 52.

time of a new moon, and in the early part of the same month an earthquake." This has been identified with the annular eclipse of March 21, 424 B.C., the central line of which passed across Northern Europe. It is not quite clear whether the historian wishes to insinuate that the eclipse caused the earthquake or the earthquake the eclipse.

An eclipse known as that of Ennius is another of the eclipses antecedent to the Christian Era which has been the subject of full modern investigation, and the circumstances of which are such that, in the language of Professor Hansen, " it may be reckoned as one of the most certain and well-established eclipses of antiquity." The record of it has only been brought to light in modern times by the discovery of Cicero's Treatise, *De Republicâ*. According to Cicero,* Ennius the great Roman poet, who lived in the second century B.C., and who died of gout contracted, it is said, by frequent intoxication, recorded an interesting event in the following words:—*Nonis Junii soli luna obstetit et nox*, " On the Nones of June the Moon was in opposition to the Sun and night." This singular phrase has long been assumed to allude to an eclipse of the Sun, but the precise interpretation of the words was not for a long time realized. In Cicero's time the Nones of June fell on the 5th, but in the time of Ennius, who lived a century and a half before Cicero, the Nones of June fell between June 5 and July 4 on account of the lunar years and the intercalary month of the Roman Calendar. The date of this eclipse is distinctly known to be June 21, 400 B.C., but the hour was long in dispute. Professor Zech found that the Sun set at Rome eclipsed, and that the maximum phase took place after sun-set. Hansen, however, with his better Tables, found that the eclipse was total at Rome, and that the totality ended at

* *De Republicâ*, Lib. i. c. 16.

7.33 p.m., the Sun setting almost immediately afterwards at 7.36. This fact, Hansen considers, explains the otherwise unintelligible passage of Ennius quoted above: instead of saying *et nox*, he should have said *et simul nox*, "and immediately it was night." Newcomb questions the totality of this eclipse, but assigns no clear reasons for his doubts.*

On August 14, 394 B.C., there was a large eclipse of the Sun visible in the Mediterranean. It occurred in the forenoon, and is mentioned by Xenophon in connection with a naval engagement in which the Persians were defeated by Conon.

Plutarch, in his *Life of Pelopidas*, relates how one Alexander of Pheras had devastated several cities of Thessaly, and that as soon as the oppressed inhabitants had learned that Pelopidas had come back from an embassy on which he had been to the King of Persia, they sent deputies to him to Thebes to beg the favour of armed assistance, with Pelopidas as general. "The Thebans willingly granted their request, and an army was soon got ready, but as the general was on the point of marching, the Sun began to be eclipsed, and the city was covered with darkness in the day-time." This eclipse is generally identified with that of July 13, 364 B.C. If this is correct, Plutarch's language must be incorrect, or at least greatly exaggerated, for no more than about three-fourths of the Sun was obscured.

On February 29, 357 B.C. there happened an eclipse, also visible in or near the Mediterranean. This is supposed to have been the eclipse for the prediction of which Helicon, a friend of Plato, received from Dionysius, King of Syracuse, payment in the shape of a talent.

* *Washington Observations*, 1875, Appendix II., p. 33.

** *Hellenics*, Book iv., chap. 3, sec. 10.

We have now to consider another ancient eclipse which has a history of peculiar interest as regards the investigations to which it has been subjected. It is commonly known as the "Eclipse of Agathocles," and is recorded by two historians of antiquity in the words following. Diodorus Siculus * says:—

"Agathocles also, though closely pursued by the enemy, by the advantage of the night coming on (beyond all hope) got safe off from them. The next day there was such an eclipse of the Sun, that the stars appeared everywhere in the firmament, and the day was turned into night, upon which Agathocles's soldiers (conceiving that God thereby did foretell their destruction) fell into great perplexities and discontents concerning what was like to befall them."

Justin says **:—

"By the harangue the hearts of the soldiers were somewhat elevated, but an eclipse of the Sun that had happened during their voyage still possessed them with superstitious fears of a bad omen. The king was at no less pain to satisfy them about this affair than about the war, and therefore he told them that he should have thought this sign an ill presage for them, if it had happened before they set out, but having happened afterwards he could not but think it presaged ill to those against whom they marched. Besides, eclipses of the luminaries always signify a change of affairs, and therefore some change was certainly signified, either to Carthage, which was in such a flourishing condition, or to them, whose affairs were in a very ruinous state."

The substance of these statements is that in the year 310 B.C. Agathocles, Tyrant of Syracuse, while conduct-

* *Bibliothecæ Historicæ*, Lib. xx., cap. 1, sec. 5.

** *Historia*, Lib. xxii., cap. 6.

ing his fleet from Syracuse to the Coast of Africa, found himself enveloped in the shadow of an eclipse, which evidently, from the accounts, was total. His fleet had been chased by the Carthaginians on leaving Syracuse the preceding day, but got away under the cover of night. On the following morning about 8 or 9 a.m. a sudden darkness came on which greatly alarmed the sailors. So considerable was the darkness, that numerous stars appeared. It is not at the first easy to localize the position of the fleet, except that we may infer that it could hardly have got more than 80 or at the most 100 miles away from the harbour of Syracuse, where it had been closely blockaded by a Carthaginian fleet. Agathocles would not have got away at all but for the fact that a relieving fleet was expected, and the Carthaginians were obliged to relax their blockade in order to go in search of the relieving fleet. Thus it came about not only that Agathocles set himself free, but was able to retaliate on his enemies by landing on the coast of Africa at a point near the modern Cape Bon, and devastating the Carthaginian territories. The voyage thither occupied six days, and the eclipse occurred on the second day. Though we are not informed of the route followed by Agathocles, that is to say, whether he passed round the North or the South side of the island of Sicily, yet it has been made clear by astronomers that the southern side was that taken.

Baily, who was the first modern astronomer to investigate the circumstances of this eclipse, found that there was an irreconcilable difference between the path of the shadow found by himself and the historical statement, a gap of about 180 geographical miles seeming to intervene between the most southerly position which could be assigned to the fleet of Agathocles, and the most northerly possible limit of the path of the eclipse shadow. This was the condition of the problem when Sir G. B. Airy

took it up in 1853.* He, however, was able to throw an entirely new light upon the matter. The tables used by Baily were distinctly inferior to those now in use, and Sir G. B. Airy thought himself justified in saying that to obviate the discordance of 180 miles just referred to "it is only necessary to suppose an error of 3 minutes in the computed distances of the Sun and Moon at conjunction— a very inconsiderable correction for a date anterior to the epoch of the tables by more than twenty-one centuries."

It deserves to be mentioned, though the point cannot here be dwelt upon at much length, that these ancient eclipses all hang together in such a way that it is not sufficient for the man of Astronomy and the man of Chronology to agree on one eclipse, unless they can harmonise the facts of several.

For instance, the eclipse of Thales, the date of which was long and much disputed, has a material bearing on the eclipse of Agathocles, the date of which admits of no dispute; and one of the problems which had to be solved half a century ago was how best to use the eclipse of Agathocles to determine the date of that of Thales. If 610 B.C. were accepted for the Thales eclipse, so as to throw the zone of total darkness anywhere over Asia Minor (where for the sake of history it was essential to put it) the consequence would be that the shadow of the eclipse of 310 B.C. would have been thrown so far on to land, in Africa, as to make it out of the question for Agathocles and his fleet to have been in it; yet we know for a certainty that he was in it in that year, and no other year. Conversely, if 603 B.C. were accepted for the Thales eclipse, then to raise northwards the position of the shadow in that year from the line of the Red Sea and the Persian Gulf, that it might pass through Asia Minor,

**Phil. Trans.*, vol. cxliii. pp. 187-91, 1853.

would so raise the position of the shadow in 310 B.C. as to throw it far too much to the N. of Sicily for Agathocles, who we know must have gone southwards to Africa, to have entered it. But if we assume 585 B.C. as the date of the eclipse of Thales, we obtain a perfect reconciliation of everything that needs to be reconciled; the shadow of the eclipse of 585 B.C. will be found to have passed where ancient history tells us it did pass—namely, through Ionia, and therefore through the centre of Asia Minor, and on the direct route from Lydia to Media; while we also find that the shadow of the 310 B.C. eclipse, that is, the one in the time of Agathocles, passed within 100 miles of Syracuse, a fact which is stated almost in those very words by the two historians who have recorded the doings of Agathocles and his fleet in those years.

This is where the matter was left by Airy in 1853. Four years later the new solar and lunar tables of the German astronomer Hansen were published, and having been applied to the eclipse of 585 B.C. the conclusions just stated were amply confirmed. As if to make assurance doubly sure, Airy went over his ground again, testing his former conclusions with regard to the eclipse of Thales by the eclipse of Larissa in 557 B.C., already referred to, and bringing in the eclipse of Stiklastad in 1030 A.D., to be referred to presently. And as the final result, it may be stated that all the foregoing dates are now known to an absolute certainty, especially confirmed as they were in all essential points by a computer of the eminence of the late Mr. J. R. Hind,

On a date which corresponds to February 11, 218 or 217 B.C., an eclipse of the Sun, which was partial in Italy, is mentioned by Livy.* Newcomb found that the central line passed along way from Italy, to wit, " far down in Africa."

* *Hist. Rom.*, Lib. xxii., cap. 1.

An eclipse of the Sun is mentioned by Dion Cassius * as having happened when Caesar crossed the Rubicon, a celebrated event made use of by speakers, political and otherwise, on endless occasions in modern history. There seems no doubt that the passage of the Rubicon took place in 51 B.C., and that the eclipse must have been that of March 7, 51 B.C. The circumstances of this eclipse have been investigated by Hind, who found that the eclipse was an annular one, the annular phase lasting 6½-minutes in Northern Italy.

Arago associates the death of Julius Caesar in 44 B.C. with an annular eclipse of the Sun, but seemingly without sufficient warrant. The actual record is to the effect that about the time of the great warrior's death there was an extraordinary dimness of the Sun. Whatever it was that was noticed, clearly it could not have been an annular eclipse, because no such eclipse then happened, Johnson suggests that Arago confused the record of some meteorological interference with the Sun's light with the annular eclipse that happened seven years previously when Caesar passed the Rubicon, to which eclipse allusion has already been made. That there was for a long while a great deficiency of sunshine in Italy about the time of Caesar's death seems clear from remarks made by Pliny, Plutarch, and Tibullus, and the words of Suetonius seem to imply something of a meteorological character. I should not have mentioned this matter at all, but for Arago's high repute as an astronomer. According to Seneca ** during an eclipse a comet was also seen.

It is an interesting question to inquire whether any allusions to eclipses are to be found in Homer, and no very certain answer can be given. In the *Iliad* (book

* *Hist. Rome*, Book xli., chap. 14.

** *Naturalium Questionum*, Lib. vii.

xvii., lines 366-68) the following passage will be found :—
"Nor would you say that the Sun was safe, or the Moon, for they were wrapt in dark haze in the course of the combat."

In the *Odyssey* (book xx., lines 356-57) we find :—
"And the Sun has utterly perished from heaven and an evil gloom is overspread." This was considered by old commentators to be an allusion to an eclipse, and in the opinion of W. W. Merry * " this is not impossible, as they were celebrating the Festival of the New Moon."

Certainly this language has somewhat the savour of a total eclipse of the Sun, but it is difficult to say whether the allusion is historic, as of a fact that had happened, or only a vague generality. Perhaps the latter is the most justifiable surmise.

I have in the many preceding pages been citing ancient eclipses, for the reason, more or less plainly expressed, that they are of value to astronomers as assisting to define the theory of the Moon's motions in its orbit, and this they should do; but it is not unreasonable to bring this chapter to a close by giving the views of an eminent American astronomer as to the objections to placing too much reliance on ancient accounts of eclipses. Says Prof. S. Newcomb **:—" The first difficulty is to be reasonably sure that a total eclipse was really the phenomenon observed. Many of the statements supposed to refer to total eclipses are so vague that they may be referred to other less rare phenomena. It must never be forgotten that we are dealing with an age when accurate observations and descriptions of natural phenomena were unknown, and when mankind was subject to be imposed upon by imaginary wonders and prodigies. The circum-

* Homer, *Odyssey*, vol. ii. p. 328. Clarendon Press Series,

** *Washington Observations*, 1875, Appendix II., p. 18.

stance which we should regard as most unequivocally marking a total eclipse is the visibility of the stars during the darkness. But even this can scarcely be regarded as conclusive, because Venus may be seen when there is no eclipse, and may be quite conspicuous in an annular or a considerable partial eclipse. The exaggeration of a single object into a plural is in general very easy. Another difficulty is to be sure of the locality where the eclipse was total. It is commonly assumed that the description necessarily refers to something seen where the writer flourished, or where he locates his story. It seems to me that this cannot be safely done unless the statement is made in connection with some battle or military movement, in which case we may presume the phenomena to have been seen by the army.

CHAPTER XI.

ECLIPSES OF THE SUN MENTIONED IN HISTORY.— THE CHRISTIAN ERA TO THE NORMAN CONQUEST.

THE Christian Era is, for several reasons, a suitable point of time from which to take a new departure in speaking of historical eclipses, although the First Century, at least, might obviously be regarded as belonging to classical history—but let that pass.

Dion Cassius * relates that on a date corresponding to March 28, A.D. 5, the Sun was partly eclipsed. Johnson says that the central line passed over Norway and Sweden. It seems, perhaps, a little strange that a writer who lived in Bithynia in the 3rd Century of the Christian Era should have picked up any information about something that

* *Hist. Rome*, Book lv., chap. 22.

happened in the extreme North of Europe two centuries previously. But probably the eclipse must have been seen in Italy.

On November 24, A.D. 29, there happened an eclipse of the Sun which is sometimes spoken of as the "eclipse of Phlegon." Eusebius, the ecclesiastical historian, records Phlegon's testimony. Phlegon was a native of Tralles in Lydia, and one of the Emperor Adrian's freed-men. The eclipse in question happened at noon, and the stars were seen. It was total, and the line of totality, according to Hind,* passed across the Black Sea from near Odessa to Sinope, thence near the site of Nineveh to the Persian Gulf. A partial eclipse with four-fifths of the Sun's diameter covered was visible at Jerusalem. This is the only solar eclipse which was visible at Jerusalem during the period usually fixed for Christ's public ministry. This eclipse was for a long time, and by various writers, associated with the darkness which prevailed at Jerusalem on the day of our Lord's Crucifixion, but there seems no warrant whatever for associating the two events. The Crucifixion darkness was assuredly a supernatural phenomenon, and there is nothing supernatural in a total eclipse of the Sun. To this it may be added that both Tertullian at the beginning of the 3rd century and Lucian, the martyr of Nicomedia, who died in 312, appealed to the testimony of national archives then in existence, as witnessing to the fact that a supernatural darkness had prevailed at the time of Christ's death. Moreover, the generally recorded date of the Crucifixion, namely, April 3, A.D. 33, would coincide with a full Moon. As it happened, that full Moon suffered eclipse, but she emerged from the Earth's shadow about a quarter of an hour before she rose at Jerusalem (6 h. 36 m. p.m.): the

* Letter in the *Times*, July 19, 1872.

penumbra continued upon her disc for an hour afterwards.

Speaking of the Emperor Claudius, Dion Cassius* says:— "There was going to be an eclipse on his birthday. Claudius feared some disturbance, as there had been other prodigies, so he put forth a public notice, not only that the obscuration would take place and about the time and magnitude of it, but also about the causes which produce such events." This is an interesting statement, especially in view of what I have said on a previous page about the indifference of the Romans to Astronomy. It would, likewise, be interesting to know how Claudius acquired his knowledge, and who coached him up in the matter. This eclipse occurred on August 1, A.D. 45. Barely half the Sun's diameter was covered.

Philostratus ** states that " about this time while he was pursuing his studies in Greece such an omen was observable in the heavens. A crown resembling Iris surrounded the disc of the Sun and darkened its rays." " About this time " is to be understood as referring to some date shortly preceding the death of the Emperor Domitian, which occurred on September 18, A.D. 96. This has usually been regarded as the earliest allusion to what we now call the Sun's "Corona"; or, as an alternative idea, that the allusion is simply to an annular eclipse of the Sun. But both these theories have been called in question; by Johnson because he cannot find an eclipse which in his view of things will respond as regards date to the statement of Philostratus, and by Lynn on the same ground and on other grounds, *more suo*. The question of identification requires looking into more fully. There was a total eclipse on May 21, A.D. 95, but it was only

* *Hist. Rome*, Book lx., chap. 26.

** *Life of Apollonius of Tyana*, Book viii., c. 23.

visible as a partial eclipse in Western Asia and not visible at all in Greece. This is given as the conclusion arrived at by the German astronomer Ginzl. But it does not seem to me sufficient to overthrow, without further investigation, the fairly plain language of Philostratus, which is possibly confirmed by a passage in Plutarch* in which he discusses certain eclipse phenomena in the light of a recent eclipse. The date of Plutarch's "recent" eclipse is somewhat uncertain, but that fact does not necessarily militate against his testimony respecting the Corona or what is regarded to have been such. The statement of Philostratus, treated as a mention of a total solar eclipse, is accepted as sufficiently conclusive by Sir W. Huggins and the late Professor R. Grant Johnson, to meet the supposed difficulty of finding an eclipse to accord with the assertion of the historian, suggests that "perhaps some peculiar solar halo or mock Sun, or other meteorological formation" is referred to. But Stockwell has advanced very good reasons for the opinion that the eclipse of Sept. 3, A.D. 118, fully meets the circumstances of the case. Grant's opinion is given in these emphatic words :—"It appears to me that the words here quoted [from Apollonius] refer beyond all doubt to a total eclipse of the Sun, and thus the phenomenon seen encompassing the Sun's disc was, really as well as verbally, identical with the modern Corona." **

With the end of the first century of the Christian Era we may be said to quit the realms of classical history and to pass on to eclipse records of a different character, and, so far as regards European observations, of comparatively small scientific value or usefulness. Our information is largely derived from ecclesiastical historians and, later on,

* Plut. *Opera Mor. et Phil.*, vol. xix. p. 682. Ed. Lipsiæ, 1778.

** *Ast. Nach.*, No. 1838, vol. lxxvii. p. 223 : March 31, 1871.

from monkish chronicles, which as a rule are meagre in a surprising degree. Perhaps I ought not to say "surprising," because after the times of the Greek astronomers (who in their way may almost be regarded as professionals), and after the epoch of the famous Ptolemy, Astronomy well-nigh ceased to exist for many centuries in Europe, until, say, the 15th century, barring the labours of the Arabians and their kinsmen the Moors in Spain in the 9th and following centuries.

In examining therefore the records of eclipses which have been handed down to us from A.D. 100 forwards through more than 1000 years, I shall not offer my readers a long dry statement of eclipse dates, but only pick out here and there such particular eclipses as seem to present details of interest for some or other reason.

On April 12, 237 A.D., there was, according to Julius Capitolinus, an eclipse of the Sun, so great "that people thought it was night, and nothing could be done without lights." Ricciolus remarked that this' eclipse happened about the time of the Sixth Persecution of the Christians, and when the younger Gordian was proclaimed Emperor, after his father had declined the proffered dignity, being 80 years of age. The line of totality crossed Italy about 5 p.m. in the afternoon, to the N. of Rome, and embraced Bologna.

Calvisius records, on the authority of Cedrenus, an eclipse of the Sun on August 6, 324 A.D., which was sufficiently great for the stars to be seen at mid-day. The eclipse was associated with an earthquake, which shattered thirteen cities in Campania. Johnson remarks that no more than three-fourths of the Sun's disc would have been covered, as seen in Campania, but that elsewhere in Italy, at about 3 p.m., the eclipse was much larger, and perhaps one or two of the planets might have been visible.

On July 17, 334 A.D., there was an eclipse, which seems to have been total in Sicily, if we may judge from the description given by Julius Firmicus.*

Ammianus Marcellinus ** describes an eclipse, to which the date of August 28, 360 A.D., has been assigned. Humboldt, quoting this historian, says that the description is quite that of a solar eclipse, but its stated long duration (daybreak to noon), and the word *caligo* (fog or mist) are awkward factors. Moreover, the historian associates it with events which happened in the eastern provinces of the Roman Empire; but Johnson seems in effect to challenge Marcellinus's statement when he says, " It is true that there was an annular eclipse of the Sun in the early morning on the above date, but it could only be seen in countries E. of the Persian Gulf."

About the time that Alaric, King of the Visigoths appeared before Rome, there was a gloom so great that the stars appeared in the daytime. This narrative is considered to apply to an eclipse of the Sun, which occurred on June 18, 410 A.D. The eclipse was an annular one, but as the central line must have crossed far S. of Rome, the stars must have been seen not at Rome but somewhere else.

An eclipse occurred on July 19, 418 A.D., which is remarkable for a twofold reason. People had an opportunity not only of seeing an eclipse, but also a comet. We owe the account of the circumstances to Philostorgius,*** who tells us that—" On July 19, towards the 8th hour of the day, the Sun was so eclipsed, that even the stars were visible. But at the same time that the Sun was thus hid, a light, in the form of a cone, was seen in the sky ; some

* *Matheseos*, Lib. i., cap. 2, p. 5, Basileæ. 1533.

** *Historiæ*, Lib. xx., cap. 3, sec. 1.

*** *Epitome Historiæ Ecclesiasticæ*, Lib. xii., cap. 8.

ignorant people called it a comet, but in this light we saw nothing that announced a comet, for it was not terminated by a tail; it resembled the flame of a torch, subsisting by itself, without any star for its base. Its movement too was very different from that of a comet. It was first seen to the E. of the equinoxes; after that, having passed through the last star in the Bear's tail, it continued slowly its journey towards the W. Having thus traversed the heavens, it at length disappeared, having lasted more than four months. It first appeared about the middle of the summer, and remained visible until nearly the end of autumn."

Boillot, a French writer, has suggested that this description is that of the zodiacal light, but this seems out of the question in view of the details given by the Chinese of a comet having been visible in the autumn of this year for 11 weeks, and having passed through the square of Ursa Major. Reverting to the eclipse—Johnson finds that the greatest phase at Constantinople, which was probably the place of observation, occurred at about half an hour after noon, when a thin crescent of light might have been seen on the northern limb of the Sun. From this it would appear that the central line of eclipse must have passed somewhat to the south of Constantinople. To the same effect Hind, who found that $\frac{95}{100}$ ths of the Sun's diameter was covered at Constantinople.

An eclipse of the Sun seems to be referred to by Gregorius Turonensis, when he says * that:— " Then even the Sun appeared hideous, so that scarcely a third part of it gave light, I believe on account of such deeds of wickedness and shedding of innocent blood." This w^ould seem to have been the eclipse which occurred on February 24, 453 A.D., when Attila and the Huns were ravaging Italy,

* *Historia Francorum*, Lib. ii., cap. 3 (*ad fin.*).

and to them it was doubtless that the writer alluded. At Rome three-fourths of the Sun's disc would have been eclipsed at sunset, a finding which tallies fairly with the statement of Gregorius.

It is not till far into the 6th century that we come upon a native English record of an eclipse of the Sun as having been observed in England. This deficiency in our national annals is thus judiciously explained and commented on by our clever and talented American authoress.* Speaking of the eclipse of February 15, 538 A.D., she says :—" The accounts, however, are greatly confused and uncertain, as would perhaps be natural fully 60 years before the advent of St. Augustine, and when Britain was helplessly harassed with its continual struggle in the fierce hands of West Saxons and East Saxons, of Picts and conquering Angles. Men have little time to record celestial happenings clearly, much less to indulge in scientific comment and theorising upon natural phenomena, when the history of a nation sways to and fro with the tide of battle, and what is gained to-day may be fatally lost to-morrow. And so there is little said about this eclipse, and that little is more vague and uncertain even than the monotonous plaints of Gildas—the one writer whom Britain has left us, in his meagre accounts of the conquest of Kent, and the forsaken walls and violated shrines of this early epoch."

The well-known *Anglo-Saxon Chronicle*** is our authority for this eclipse having been noted in England, but the record is bare indeed:—" In this year the Sun was eclipsed 14 days before the Calends of March from early morning till 9 a.m." Tycho Brahe, borrowing from Calvisius, who borrowed from somebody else, says that the eclipse happened " in the 5th year of Henry, King of the

* Mrs. D. P. Todd, *Total Eclipses of the Sun*, p. 101.

** *The Anglo-Saxon Chronicle*, vol. ii. p. 14. Ed. B. Thorpe, 1861.

West Saxons, at the 1st hour of the day till nearly the 3rd, or immediately after sunrise." Johnson finds that at London nearly three-fourths of the Sun's disc was covered at 7.43 a.m.

The next eclipse recorded in the *Anglo-Saxon Chronicle* is somewhat difficult to explain. It is said that in 540 A.D. "The Sun was eclipsed on the 12th of the Calends of July [= June 20], and the stars appeared full nigh half an hour .after 9 a.m." Johnson's calculations make the middle of the eclipse to have occurred at about 7.37 a.m. at London, two-thirds of the Sun's diameter being covered. He notes that the Moon's semi-diameter was nearly at its maximum whilst the Sun's semi-diameter was nearly at its minimum—a favourable combination for a long totality. The visibility of the stars seems difficult to explain in connection with this eclipse, and therefore he suggests that the annalist has made a mistake of four years and meant to refer to the eclipse of September 1, 536 A.D., but this does not seem a satisfactory theory.

The year after Pope Martin held a Synod to condemn the Monothelite heresy, an eclipse of the Sun took place. It is mentioned by Tycho Brahe in his catalogue of eclipses as having been seen in England. Johnson gives the date as February 6, 650 A.D., and finds that the Sun was three-fourths obscured at London at 3.30 p.m.

The *Anglo-Saxon Chronicle* tells us under the year A.D. 664 that "In this year the Sun was eclipsed on the 5th of the Nones of May ; and Earcenbryht, King of the Kentish people died and Ecgbryht his son succeeded to the Kingdom." Kepler thought this eclipse had been total in England, and Johnson calculating for London found that on May 1, at 5 p.m., there would only have been a very thin crescent of the Sun left uncovered on the southern limb, so that the line of totality would have passed across the country some distance to the N. of London.

The eclipse of Dec. 7, A.D. 671, seems to be associated with a comic tragedy. The Caliph Moawiyah had a fancy to remove Mahomet's pulpit from Medina to his own residence at Damascus. " He said that the walking-stick and pulpit of the Apostle of God should not remain in the hands of the murderers of Othman. Great search was made for the walking-stick, and at last they found it. Then they went in obedience to his commands to remove the pulpit, when immediately, to their great surprise and astonishment, the Sun was eclipsed to that degree that the stars appeared." * Once again the question of visible stars is in some sense a source of difficulty. Hind found that the eclipse was annular on the central line. At Medina the greatest phase occurred at 10h. 43m. a.m. when 85/100ths of the Sun's diameter was obscured. Hind suggests that in the clear skies of that part of the world such a degree of eclipse might be sufficient to bring out the brighter planets or stars. At any rate no larger eclipse visible at Medina occurred about this epoch. Prof. Ockley seems to refer to this eclipse in making, on the authority of several Arabian writers, the mention he does of an eclipse in the quotation just given.

Perhaps this will be a convenient place to bring in some remarks on certain Arabian observations of eclipses only made known to the scientific world in modern times. That the Arabians were very capable practical astronomers has long been recognised as a well-established fact, and if it had not been for them there would have been a tremendous blank in the history of astronomy during at least six centuries from about the year A.D. 700 onwards. In the year 1804 there was published at Paris a French translation of an Arabian manuscript preserved at the

* Prof. S. Ockley, *History of the Saracens*, vol. ii. p. 110. Camb. 1757.

University of Leyden of which little was known until near the end of the last century. The manuscript was then sent to Paris on loan to the French Government which caused a translation to be made by " Citizen" Caussin, and this was published under the title of *Le Livre de la grande Table Hakénate** Caussin was Professor of Arabic at the College of France. Newcomb considers this to contain the earliest exact astronomical observations of eclipses which have reached us. He remarks that some of the data left us by Ptolemy, Theon, Albatagnius and others may be the results of actual observations, but in no case, so far as is known, have the figures of the actual observations been handed down. For example, we cannot regard " midnight " nor " the middle of an eclipse " as moments capable of direct observation without instruments of precision; but in the Arabian work under consideration we find definite statements of the altitudes of the heavenly bodies at the moments of the beginning and ending of eclipses—data not likely to be tampered with in order to agree with the results of calculation. The eclipses recorded are 28 in number, and usually the beginning and end of them were observed. The altitudes are given sometimes only in whole degrees, sometimes in coarse fractions of a degree. The most serious source of error to be confronted in turning these observations to account arises from the uncertainty as to how long after the first contact the eclipse was perceived and the altitude taken ; and how long before the true end was the eclipse lost sight of. Making the best use he could of the records available Newcomb found that they could

* It should be stated that prior to the publication of the work in a book form the greater part of the eclipse observations had been published in the *Memoires de L'Institut National des Sciences et Arts: Sciences Mathematiques et Physiques*, tome ii.

safely be employed in his investigations into the theory of the Moon.

The observations were taken, some at Bagdad and the remainder at Cairo. I do not propose to occupy space by transcribing the accounts in detail, but one extract may be offered as a sample of the rest—"Eclipse of the Sun observed at Bagdad, August 18, 928 A.D. The Sun rose about one-fourth eclipsed. We looked at the Sun on a surface of water and saw it distinctly. At the end when we found no part of the Sun was any longer eclipsed, and that its disc appeared in the water as a complete circle, its altitude was 12° in the E., less the one-third of a division of the instrument, which itself was divided to thirds of a degree. One must therefore reduce the stated altitude by one-ninth of a degree, leaving, therefore, the true altitude as $11^{\circ} 53' 20''$." The skill and care shown in this record shows that the Arab who observed this eclipse nearly a thousand years ago must have been a man of a different type from an ordinary resident at Bagdad in the year 1899. No description is given of the instrument used, but presumably it was some kind of a quadrant. It does not appear why some of the observations were made at Bagdad and some at Cairo. The Bagdad observations commence with an eclipse of the Sun on November 30, 829, and end with an eclipse of the Moon on November 5, 933. The Cairo observations begin with an eclipse of the Sun on December 12, 977, and end with an eclipse of the Sun on January 24, 1004. These statements apply to the 25 observations which Newcomb considered were trustworthy enough to be employed in his researches, but he rejected three as imperfect.

I have broken away from the strict thread of chronological sequence in order to keep together the notes respecting Arabian observations of eclipses. Let us now revert to the European eclipses.

Under the date of A.D. 733, the *Anglo-Saxon Chronicle* tells us that, " In this year Æthelbald captured Somerton ; and the Sun was eclipsed, and all the Sun's disc was like a black shield ; and Acca was driven from his bishopric." Johnson suggests that the reference is to an annular eclipse which he finds occurred on August 14, at about 8¼ h. in the morning. In Schnurrer's *Chronik der Seuchen* (pt. i., § 113, p. 164), it is stated that, " One year after the Arabs had been driven back across the Pyrenees after the battle of Tours, the Sun was so much darkened on the 19th of August as to excite universal terror." It may be that the English eclipse is here referred to, and a date wrong by five days assigned to it by Schnurrer. Humboldt (*Cosmos*, vol. iv. p. 384, Bohn's ed.) reports this eclipse in an enumeration he gives of instances of the Sun having been darkened.

On May 5, A.D. 840, there happened an eclipse of the Sun which, amongst other effects, is said to have so greatly frightened Louis Le Debonnaire (Charlemagne's son) that it contributed to his death. The Emperor was taken ill at Worms, and having been removed to Ingelheim, an island in the Rhine, near Mayence, died there on June 20. Hind * found that this was a total eclipse, and that the northern limit of totality passed about 100 miles south of Worms. The middle of the eclipse occurred at ih. 15m. p.m. at an altitude of 57°. The duration of the eclipse was unusually long, namely about 5½ minutes. With the Sun so high and the obscuration lasting so long, this eclipse must have been an unusually imposing one, and well calculated to inspire special alarm.

On Oct. 29, 878, in the reign of King Alfred, there was a total eclipse visible at London. The mention of it in the *Anglo-Saxon Chronicle* is as follows :—" The Sun

* Letter in the *Times*, July 19, 1872.

was eclipsed at 1 hour of the day." No month is given, and the year is said to have been 879, which is undoubtedly wrong. Hind found that the central line of the eclipse passed about 20 miles N. of London, and that the totality lasted 1m. 51s. Tycho Brahe, in his *Historia Cælestis*, quotes from the *Annales Fuldenses* a statement that the Sun was so much darkened after the 9th hour that the stars appeared in the heavens.

Thorpe in his edition of the *Anglo-Saxon Chronicle* quotes from Mr. Richard Price a note which assigns the date of March 14, 880, to this eclipse, and cites in confirmation a passage from the *Chronicle of Florence of Worcester*, anno 879. The 880 eclipse is mentioned by Asser in his *De Vitâ et Rebus gestis Alfredi* in the words following:—"In the same year [879] an eclipse of the Sun took place between three o'clock and the evening, but nearer three o'clock." The confusion of dates is remarkable.

In the *Chronicon Scotorum*, under the date of 885, we find:—"An eclipse of the Sun; and stars were seen in the heavens." The reference appears to be to the total eclipse of June 16, A.D. 885. The totality lasted more than four minutes, and as the stars are said to have been visible in the North of Ireland, doubtless that part of Ireland came within the eclipse limits.

On Dec. 22, 968, there was an eclipse of the Sun, which was almost total at London at about 8h. 33m. a.m., or soon after sunrise. The central line passed across the S.-W. of England, and thence through France to the Mediterranean. One Leon, a deacon at Corfu, observed this eclipse, and has left behind what probably is the first perfectly explicit mention of the Corona.*

On Aug. 30, 1030, there happened an eclipse visible in

* J. F. J. Schmidt, *Ast. Nach.* vol. lxxvii. p. 127, Feb. 1, 1871.

Norway, which has already been alluded to on a previous page under the name of the "eclipse of Stiklastad." This was one of those eclipses, the circumstances of which were examined many years ago in detail by Sir G. B. Airy,* because he thought that information of value might be obtained therefrom with respect to the motions of the Moon. Its availability for that purpose has, however, been seriously questioned by Professor Newcomb. Stiklastad is a place where a battle was fought, at which Olav, the King of Norway, is said to have been killed. While the battle was in progress the Sun was totally eclipsed, and a red light appeared around it. This is regarded as an early record of the Corona, though not the first.** Johnson found that the eclipse was nearly total at about 2h. 21 m. p.m.

In 1033 there happened on June 29 an eclipse of the Sun, which evidently had many observers, because it is mentioned by many contemporary writers. For instance, the French historian, Glaber,*** says that "on the 3rd of the Calends of July there was an eclipse from the sixth to the eighth hour of the day exceedingly terrible. For the Sun became of a sapphire colour; in its upper part having the likeness of a fourth part of the Moon." This sufficiently harmonises with Johnson's calculations that about four-fifths of the Sun on the lower side was covered at 10h. 50m. in the morning.

* *Memoirs*, R.A.S., vol. xxvi. p. 131. 1858.

** J. L. E. Dreyer, *Nature*, vol. xvi. p. 549, Oct. 25, 1877.

*** *Historiarum Sui Temporis*, Lib. iv., cap. 9.

CHAPTER XII.

ECLIPSES OF THE SUN MENTIONED IN HISTORY.---
MEDIAEVAL AND MODERN.

One of the most celebrated eclipses of mediaeval times was that of August 2, 1133, visible as a total eclipse in Scotland. It was considered a presage of misfortune to Henry I. and was thus referred to by William of Malmesbury * :-

" The elements manifested their sorrow at this great man's last departure from England. For the Sun on that day at the 6th hour shrouded his glorious face, as the poets say, in hideous darkness, agitating the hearts of men by an eclipse; and on the 6th day of the week early in the morning there was so great an earthquake that the ground appeared absolutely to sink down; an horrid noise being first heard beneath the surface."

This eclipse is also alluded to in the *Anglo-Saxon Chronicle* though the year is wrongly given as 1135 instead of 1133 as it certainly was. The *Chronicle* says:- "In this year King Henry went over sea at Lammas, and the second day as he lay and slept on the ship the day darkened over all lands; and the Sun became as it were a three-night-old Moon, and the stars about it at mid-day. Men were greatly wonder-stricken and affrighted, and said that a great thing should come hereafter. So it did, for the same year the king died on the following day after St. Andrew's Mass-day, Dec. 2, in Normandy." The king did die in 1135, but there was no eclipse of the August new Moon, and without doubt the writer has muddled up the year of the eclipse and of the king's departure from England (to which he never returned) and the year of his

**Historia Novella*, Lib. i., sec. 8.

death. Calvisius states that this eclipse was observed in Flanders and that the stars appeared.

Respecting the above-mentioned discrepancy Mrs. Todd aptly remarks:—" So Henry must have died in 1133, which he *did not*; or else there must have been an eclipse in 1135, which there *was not*. But this is not the only labyrinth into which chronology and old eclipses, imagination, and computation, lead the unwary searcher." Professor Freeman's explanation fairly clears up the difficulty : - "The fact that he never came back to England, together with the circumstances of his voyage, seems to have made a deep impression on men's minds. In popular belief the signs and wonders which marked his last voyage were transferred to the Lammas-tide before his death two years later." * The central line of this eclipse traversed Scotland from Ross to Forfar and the eclipse was of course large in every part of the country. The totality lasted 4m. 26s. in Forfarshire.

Hind has furnished some further information respecting this eclipse. It appears that during the existence of the Kingdom of Jerusalem created by the Crusaders an eclipse occurred which would appear to have been total at Jerusalem or in its immediate neighbourhood. No date is given and a date can only be guessed, and Hind guessed that the eclipse of 1133 was the one referred to. He found that after leaving Scotland and crossing Europe the central line of the 1133 eclipse entered Palestine near Jaffa and passed over Jerusalem where the Sun was hidden for $4\frac{1}{4}$ minutes at about 3h. p. m. From Nablous on the N. to Ascalon on the S. the country was in darkness for nearly the same period of time. The alternative eclipses to this one would be those of Sept. 4, 1187, magnitude at Jerusalem $\frac{9}{10}$ ths of the Sun's diameter; or June 23, 1191,

* *Norman Conquest*, vol. v. p. 239.

magnitude at the same place about $\frac{7}{10}$ ths; but these do not seem to harmonise so well with the accounts handed down to us as does the eclipse of 1133.

In 1140, on March 20, there happened a total eclipse of the Sun visible in England which is thus referred to by William of Malmesbury * : —

"During this year, in Lent, on the 13th of the Calends of April, at the 9th hour of the 4th day of the week, there was an eclipse, throughout England, as I have heard. With us, indeed, and with all our neighbours, the obscuration of the Sun also was so remarkable, that persons sitting at table, as it then happened almost everywhere, for it was Lent, at first feared that Chaos was come again : afterwards, learning the cause, they went out and beheld the stars around the Sun. It was thought and said by many not untruly, that the King [Stephen] would not continue a year in the government."

The same eclipse is also thus mentioned in the *Anglo-Saxon Chronicle*:—"Afterwards in Lent the Sun and the day darkened about the noontide of the day, when men were eating, and they lighted candles to eat by; and that was the 13th of the Calends of April, March 20. Men were greatly wonder-stricken." The greatest obscuration at London took place at 2h. 36m. p. m., but it is not quite clear whether the line of totality did actually pass over London.

It was long supposed that this eclipse was total at London, an idea which seems to have arisen from Halley having told the Royal Society anent the total eclipse of May 3, 1715, that he could not find that any total eclipse had been visible at London since March 20, 1140. In consequence of this statement of Halley's, Hind carefully investigated the circumstances of this eclipse, and found

* *Historia Novella, Lib. ii., sec. 35.*

that it had *not* been total at London. The central line entered our island at Aberystwith, and passing near Shrewsbury, Stafford, Derby, Nottingham, and Lincoln, reached the German Ocean, 10 miles S. of Saltfleet. The southern limit of the zone of totality passed through the South Midland counties, and the nearest point of approach to London was a point on the borders of Northamptonshire and Bedfordshire. For a position on the central line near Stafford, Hind found that the totality began at 2h. 36m. p. m. local mean time, the duration being 3m. 26s., and the Sun's altitude being more than 30°. The stars seen were probably the planets Mercury and Venus, then within a degree of each other, and 10° W. of the Sun, and perhaps the stars forming the well-known "Square of Pegasus." Mars and Saturn were also, at that time, within a degree of each other, but very near the western horizon. It is therefore necessary to look further back than 1140 to find a total solar eclipse visible in London.*

A solar eclipse seems to have been alluded to by certain historians as having happened in A.D. 1153. We have the obscure statement that "something singular happened to the Sun the day after the Conversion of St. Paul." A somewhat large eclipse having been visible at Augsburg in Germany, on January 26, this may have been the "something" referred to. It would seem that about 11/12ths of the Sun's diameter was covered.

On May 14, A.D. 1230, there happened a great eclipse of the Sun, thus described by Roger of Wendover **:—"On the 14th of May, which was the Tuesday in Rogation Week, an unusual eclipse of the Sun took place very early in the morning, immediately after sunrise; and it

* Letter in the Times, *July 28, 1871.*

** Rogerus de Wendover, *Flores Historiarum*, vol. ii. p. 535, *Bohn's ed.*

became so dark that the labourers, who had commenced their morning's work, were obliged to leave it, and returned again to their beds to sleep ; but in about an hour's time, to the astonishment of many, the Sun regained its usual brightness." This eclipse, as regards its total phase, is said by Johnson to have begun in the horizon, a little to the N. of London, in the early morning.

On June 3, A.D. 1239, and October 6, 1241, there occurred total eclipses of the Sun, which have been very carefully discussed by Professor Celoria of Milan, with the view of using them in investigations into the Moon's mean motion.* The second of these eclipses is mentioned by Tycho Brahe.** He states that "a few stars appeared about noonday, and the Sun was hidden from sight in a clear sky." The eclipse was total in Eastern Europe.

Dr. Lingard,*** the well-known Roman Catholic historian, speaking of the battle of Cressy, which was fought on August 26, 1346, says:—"Never, perhaps, were preparations for battle made under circumstances so truly awful. On that very day the Sun suffered a partial eclipse: birds in clouds, precursors of a storm, flew screaming over the two armies; and the rain fell in torrents, accompanied with incessant thunder and lightning. About 5 in the afternoon, the weather cleared up, the Sun in full splendour darted his rays in the eyes of the enemy; and the Genoese, setting up their shouts, discharged their quarrels." This was not an eclipse, for none was due to take place; and the phenomenon could only have been

* Sugli Eclissi Solari Totali del 3 Giugno 1239, e del 6 Ottobre 1241 in the Memorie del R. Istituto Lombardo di Scienze e Lettere, vol. xiii. p. 275.

** Historia Cælestis, vol. i. p. 38.

*** Hist. Engl., vol. iii. chap. xviii. p. 50, 4to. ed.

meteorological—dense clouds or something of that sort in the sky.

On June 16, 1406, there was a large eclipse of the Sun, $\frac{9}{10}$ ths of its diameter being covered at London; but on the Continent it seems to have been total. It is stated that the darkness was such that people could hardly recognise one another.

One of the most celebrated eclipses during the Middle Ages was undoubtedly that of June 17, 1433. This was long remembered in Scotland as the "Black Hour," and its circumstances were fully investigated some years ago by Hind. It was a remarkable eclipse in that the Moon was within 13° of perigee and the Sun only 2° from apogee. The central line traversed Scotland in a south-easterly direction from Ross to Forfar, passing near Inverness and Dundee. Maclaurin,* who lived in the early part of the last century mentions that in his time a manuscript account of this eclipse was preserved in the library of the University of Edinburgh wherein the darkness is said to have come on at about 3 p.m., and to have been very profound. The duration of the totality at Inverness was 4m. 32s.; at Edinburgh 3m. 41s. The central line passed from Britain to the N. of Frankfort-on-the-Maine, through Bavaria, to the Dardanelles, to the S. of Aleppo and thence nearly parallel to the river Euphrates to the N.-E. border of Arabia. In Turkey, according to Calvisius, "near evening the light of the Sun was so overpowered that darkness covered the land."

In 1544, on Jan. 24, there occurred an eclipse of the Sun which was nearly but not quite total. The chief interest arises from the fact that it was one of the first observed by professed astronomers: Gemma Frisius saw it at Louvain.

* Phil. Trans., vol. xl. p. 194. 1737

Kepler says* that the day became dark like the twilight of evening and that the birds which from the break of day had been singing became mute. The middle of the eclipse was at about 9 a.m.

In 1560 an eclipse of the Sun took place which was total in Spain and Portugal. Clavius who observed it at Coimbra says ** that "the Sun remained obscured for no little time : there was darkness greater than that of night, no one could see where he trod and the stars shone very brightly in the sky : the birds moreover, wonderful to say, fell down to the ground in fright at such startling darkness." Kepler is responsible for the statement that Tycho Brahe did not believe this, and wrote to Clavius to that effect 40 years afterwards.

In 1567 there was an annular eclipse visible at Rome on April 9. Clavius says *** that " the whole Sun was not eclipsed but that there was left a bright circle all round." This in set terms is a description of an annular eclipse, but Johnson who calculated that at Rome the greatest obscuration took place at 20m. past noon, points out that the augmentation of the Moon's semi-diameter would almost have produced totality. Tycho tells us that he saw this eclipse on the shores of the Baltic when a young man about 20 years of age.

The total eclipse of February 25, 1598, long left a special mark on the memories of the people of Scotland. The day was spoken of as " Black Saturday." Maclaurin states **** :—" There is a tradition that some persons in the

* *Astronomiæ Pars Optica*, c. viii. sec. 3 ; *Opera Omnia*, vol. ii. p.315. Ed. Frisch, 1859.

** Quoted by Kepler, as above, at p. 315.

*** *Commentarius in Sacroboscum*, cap. iv.; quoted in Kepler's *Astronomiæ Pars Optica*, c. viii. sec. 3; *Opera Omnia*, vol. ii. 316. Ed. Frisch, 1859.

**** *Phil. Trans.*, vol. xl. p. 193. 1737.

North lost their way in the time of this eclipse, and perished in the snow"—a statement which Hind discredits. The central line passed from near Stranraer, over Dalkeith, and therefore Edinburgh was within the zone of totality. Totality came on at Edinburgh at 10h. 15m. and lasted 1m. 30s. From the rapid motion of the Moon in declination, the course of the central line was a quickly ascending one in latitude on the Earth's surface, the totality passing off within the Arctic circle.

Kepler in his account of the new star in the constellation Ophiuchus * refers to the total eclipse of the Sun of October 12, 1605, as having been observed at Naples, and that the "Red Flames" were visible as a rim of red light round the Sun's disc: at least this seems to be the construction which may fairly be put upon the Latin of the original description.

The partial eclipse of the Sun of May 30, 1612, is recorded to have been seen "through a tube." No doubt this is an allusion to the newly-invented instrument which we now call the telescope. Seemingly this is the first eclipse of the Sun so observed, but it is on record that an eclipse of the Moon had been previously observed through a telescope. This was the lunar eclipse of July 6, 1610, though the observer's name has not been handed down to us.

The eclipse of April 8, 1652, is another of those Scotch eclipses, as we may call them, which left their mark on the people of that country. Maclaurin ** speaks of it in his time (he died in 1746) as one of the two central eclipses which are "still famous among the populace in this country" [Scotland], and "known amongst them by the appellation of Mirk Monday." The central line passed

* *De Stella Nova in Pede Serpentarii*, p. 115. *Pragæ*, 1606.

** *Phil. Trans.*, vol. xl. p. 193. 1737.

over the S.E. of Ireland, near Wexford and Wicklow, and reaching" Scotland near Burrow Head in Wigtownshire, and passing not far from Edinburgh, Montrose and Aberdeen, quitted Scotland at Peterhead, Greenock and Elgin, were near the northern limit of the zone of totality, and the Cheviots and Berwick upon the southern limit. The eclipse was observed at Carrickfergus by Dr. Wyberd.* Hind found that its duration there was but 44s. This short duration, he suggested, may partly explain the curious remark of Dr. Wyberd that when the Sun was reduced to " a very slender crescent of light, the Moon all at once threw herself within the margin of the solar disc with such agility that she seemed to revolve like an upper millstone, affording a pleasant spectacle of rotatory motion." Wyberd's further description clearly applies to the Corona. A Scotch account says that " the country people tilling, loosed their ploughs. The birds dropped to the ground."

The eclipse of November 4, 1668, visible as a partial one in England, was of no particular interest in itself, but deserves notice as having been observed by Flamsteed.** who gives a few diagrams of his observations at Derby. He states that the eclipse came on much earlier than had been predicted. It was well known at this time that the tables of the Sun and Moon then in use were very defective, and it was a recognition of this fact which eventually led to the foundation of the Greenwich Observatory in 1675.

On September 23, 1699, an eclipse of the Sun occurred which was total to the N. of Caithness for the very brief space of 10—15 sees. At Edinburgh, about 11/12ths of the Sun's diameter was obscured. In the Appendix to Pepys's *Diary**** there is a letter from Dr. Wallis mentioning that

* *V. Wing, Astronomia Britannica, p. 355.*

** *Historia Ccelestis, vol. i. pp. 7 and 21.*

*** *Diary of Samuel Fepys, vol. vi. p. 208 ; Ed. M. Bright, 1879.*

his daughter's attention was called to it by noticing " the light of the Sun look somewhat dim " at about 9 a.m., whilst she was writing a letter, she knowing nothing of the eclipse.

An eclipse of the Sun occurred on May 12, 1706, which was visible as a partial eclipse in England and was total on the Continent, especially in Switzerland. A certain Captain Stannyan who made observations at Berne, writes thus to Flamsteed * :—" That the Sun was totally darkened there for four and a half minutes of time ; that a fixed star and a planet appeared very bright; *and that his getting out of his eclipse was preceded by a blood-red streak of light from its left limb, which continued not longer than six or seven seconds of time;* then part of the Sun's disc appeared all of a sudden as bright as Venus was ever seen in the night; nay, brighter; and in that very instant gave a light and shadow to things as strong as the Moon uses to do."

On this communication Flamsteed remarks :—" The Captain is the first man I ever heard of that took notice of a red streak preceding the emersion of the Sun's body from a total eclipse, and I take notice of it to you [the Royal Society], because it infers that the Moon has an atmosphere; and its short continuance, if only six or seven seconds' time, tells us that its height was not more than five or six hundredths part of her diameter."

On the whole, perhaps, the most celebrated eclipse of the Sun ever recorded in England was that of May 3, 1715. The line of totality passed right across England from Cornwall to Norfolk, and the phenomenon was carefully observed and described by the most experienced astronomer of the time, Dr. Edmund Halley. The line of totality passed over London amongst other places, and as the

* *Phil. Trans*, vol. xxv. p. 2240. 1706.

maximum phase took place soon after 9 a.m. on a fine spring morning, the inhabitants of the Metropolis saw a sight which their successors will not see again till many generations have come and gone. Halley has left behind him an exceedingly interesting account of this event, some allusions to which have already been made.

He seems to have seen what we call the Corona, described by him however as a "luminous ring," "of a pale whiteness, or rather pearl colour, a little tinged with the colours of the Iris, and concentric with the Moon." He speaks also of a dusky but strong red light which seemed to colour the dark edge of the Moon just before the Sun emerged from totality. Jupiter, Mercury, Venus, and the stars Capella and Aldebaran were seen in London, whilst N. of London, more directly under the central line, as many as twenty stars were seen.

The inhabitants of England who lived in the reign of George I. were singularly fortunate in their chances of seeing total eclipses of the Sun, for only nine years after * the one just described, namely, on May 22, 1724, another total eclipse occurred. The central line crossed some of the southern countries, and the phenomenon was well seen and reported on by Dr. Stukeley,** who stationed himself on Haraden Hill, near Salisbury. The Doctor says of the darkness that he seemed to "feel it, as it were, drop upon us ... like a great dark mantle," and that during the totality the spectacle presented to his view "was beyond all that he had ever seen or could picture to his imagination the most solemn." He could with difficulty discern the faces of his companions which had a ghastly startling appearance. When the totality was ending there appeared a small lucid spot, and from it ran a rim of faint

* Being half a *Saros* period (see p. 19, *ante*).

** *Itinerarium Curiosum*, 2nd ed., vol. i. p. 180.

brightness. In about 3½ minutes from this appearance the hill-tops changed from black to blue, the horizon gave out the gray streaks previous to morning dawn, and the birds sprang joyously into the air.

This eclipse seems to have had royal observers. It was watched at Kensington apparently by the King or some of the royal family of England, and at Trianon (Paris) by the King of France,* under the competent guidance of Maraldi, Cassini and De Louville. It was the last which was visible as a total one in any part of England.

On May 2, 1733, there was an eclipse of the Sun, which was total in Sweden and partial in England. In Sweden the total obscuration lasted more than 3 minutes. Jupiter, the stars in Ursa Major, Capella, and several other stars were visible to the naked eye, as also was a luminous ring round the Sun. Three or four spots of reddish colour were also perceived near the limb of the Moon, but not in immediate contact with it. These so-called red " spots " were doubtless the Red Flames of the present century, and the luminous ring the Corona.

On March 1, 1737, a good annular eclipse was observed at Edinburgh by Maclaurin.** In his account he says:—" A little before the annulus was complete a remarkable point or speck of pale light appeared near the middle of the part of the Moon's circumference that was not yet come upon the disc of the Sun. . . . During the appearance of the annulus the direct light of the Sun was still very considerable, but the places that were shaded from his light appeared gloomy. There was a dusk in the atmosphere, especially towards the N. and E. In

* *Mem. de Mathematique et de Physique de V Acad. des Sciences*, 1724, p. 259.

** *Phil. Trans.*, vol. xl. pp. 181, 184. 1737.

those chambers which had not their lights westwards the obscurity was considerable. Venus appeared plainly, and continued visible long after the annulus was dissolved, and I am told that other stars were seen by some." Lord Aberdour mentions a narrow streak of dusky red light on the dark edge of the Moon immediately before the ring was completed, and after it was dissolved. No doubt this is a record of the " Red Flames."

In 1748 Scotland was again favoured with a central eclipse, but it was only annular. The Earl of Morton * and James Short, the optician, who observed the phenomenon at Aberdour Castle, 10 miles N.-W. of Edinburgh, just outside the line of annularity, saw a brown coloured light stretching along the circumference of the Moon from each of the cusps. A "star " (probably the planet Venus) was seen to the E. of the Sun.

The annular eclipse of April 1, 1764, visible as such in North Kent, was the subject of the following quaint letter by the Rev. Dr. Stukeley:—

“ To the Printer of *Whitehall Evening Post*,—

" In regard to the approaching solar eclipse of Sunday, April 1, I think it advisable to remark that, it happening in the time of divine service, it is desired you would insert this caution in your public paper. The eclipse begins soon after 9, the middle a little before 11, the end a little after 12. There will be no total darkness in the very middle, observable in this metropolis, but as people's curiosities will not be over with the middle of the eclipse, if the church service be ordered to begin a little before 12, it will properly be morning prayer, and an uniformity pre-

* *Phil. Trans.*, vol. xlv. p. 586. 1750. This is the man who under the designation of "Lord Aberdour" observed the eclipse of 1737 {ante}.

served in our duty to the Supreme Being, the author of these amazing celestial movements.—Yours,

" RECTOR OF ST. GEO., Q.S." * ,

The year 1766 furnishes the somewhat rare case of a total eclipse of the Sun observed on board ship on the high seas. The observers were officers of the French man-of-war the *Comte d'Artois*. Though the total obscuration lasted only 53 secs., there was seen a luminous ring about the Moon which had four remarkable expansions, situate at a distance of 90° from each other.** These expansions are doubtless those rays which we now speak of as " streamers " from the Corona.

Curiously enough the next important total eclipse deserving of notice was also observed at sea. This was the eclipse of June 24, 1778. The observer was the Spanish Admiral, Don Antonio Ulloa, who was passing from the Azores to Cape St. Vincent. The total obscuration lasted 4 minutes. The luminous ring presented a very beautiful appearance : out of it there issued forth rays of light which reached to the distance of a diameter of the Moon. Before it became very conspicuous stars of the 1st and 2nd magnitudes were distinctly visible, but when it attained its greatest brilliancy, only stars of the 1st magnitude could be perceived. "The darkness was such that persons who were asleep and happened to wake, thought that they had slept the whole evening and only waked when the night was pretty far advanced. The fowls, birds, and other animals on board took their usual position for sleeping, as if it had been night." ***

* Rev. W. Stukeley, Rector of St. George's, Queen's Square, London, *Diary*, vol. xx. p. 44, ed. " Surtees Soc.," vol. lxxvi. p. 384.

** Le Gentil, *Voyage dans les Mers de l'Inde*, vol. ii. p. 16. Paris 1769.

*** *Phil. Trans.*, vol. lxi. p. 105. 1779.

On Sept. 5, 1793, there happened an eclipse which, annular to the N. of Scotland, was seen and observed in England by Sir W. Herschel * as a partial eclipse. He made some important observations on the Moon on this occasion measuring the height of several of the lunar mountains. Considerations respecting the shape of one of the Moon's horns led him to form an opinion adverse to the idea that there the Moon had an atmosphere.

CHAPTER XIII.

ECLIPSES OF THE SUN DURING THE NINETEENTH CENTURY.

Observations of total solar eclipses during the 19th century have been, for the most part, carried on under circumstances so essentially different from everything that has gone before, that not only does a new chapter seem desirable but also new form of treatment. Up to the beginning of the 18th century the observations (even the best of them) may be said to have been made and recorded with but few exceptions by unskilled observers with no clear ideas as to what they should look for and what they might expect to see. Things improved a little during the 18th century and the observations by Halley, Maclaurin, Bradley, Don Antonio Ulloa, Sir W. Herschel, and others in particular rose to a much higher standard than any which had preceded them. However, it has only been during the 19th century, and especially during the latter half of it, that total eclipses of the Sun have been observed under circumstances calculated to

* *Phil. Trans.*, vol. lxxxiv. p. 39. 1794.

extract from them large and solid extensions of scientific knowledge. Inasmuch as it has been deemed convenient to sort out and classify our knowledge under particular heads in previous chapters, I shall in this chapter speak only of the leading facts of each eclipse in such an outline form as will avoid as far as possible unnecessary repetition.

In 1806 a total eclipse of the Sun occurred, visible in N. America. Observations made in the United States have been handed down to us. Don Joachin Ferrer, a Spanish astronomer, observed the eclipse at Kinderhook in the State of New York. The totality lasted more than $4\frac{1}{2}$ m. — a somewhat unusual length of time. One or two planets and a few 1st magnitude stars were seen. During the totality there was a slight fall of dew.

On Nov. 19, 1816, there occurred the first total eclipse of the Sun in the 19th century, the central line of which passed over Europe. There is only one known observation of the total phase, and this was by Hagen at Culm in Bohemia, but he appears to have seen only the beginning of the totality and not the whole of it.

A partial eclipse of the Sun visible as such in England but which was annular in the Shetland Isles took place on Sept. 7, 1820. The only reason why this is worth mention is for its political associations. The trial of Queen Caroline was going on in the House of Lords, and the House suspended its sitting for a short time for the sake of the eclipse.

On May 15, 1836, there occurred an annular eclipse of the Sun, which though it was nowhere total, may be looked upon as the first of the modern eclipses the observations of which have taken such a great development during recent years. The annularity of this eclipse was observed in the N. of England and in the S. of Scotland; and it was at Jedburgh in Roxburghshire that Mr. Francis

Baily * observed that feature of eclipses of the Sun now universally known as " Baily's Beads." Some indications of the Red Flames were also obtained at places where the eclipse was annular.

Probably it was the recognition of Baily's Beads as a regular concomitant of eclipses of the Sun, which helped to pave the way for the extensive preparations made in France, Italy, Austria, and Russia for observing the total eclipse of July 8, 1842. Many of the most eminent astronomers of Europe repaired to different stations on the central line in order to see the phenomenon. Amongst these may be named Arago, Valz, Airy, Carlini, Santini, and O. Struve. The eclipse was witnessed under favourable circumstances at all the various stations on the central line across Europe, from Perpignan in France in the West to Lipesk in Russia in the East.

Arago wrote ** such an exceedingly graphic account of this eclipse from what may be termed the standpoint of the general public, that I will quote it at some length, because, with an alteration of date, it might be re-written and applied to every total eclipse visible in much populated tracts of country.

" At Perpignan persons who were seriously unwell alone remained within doors. As soon as day began to break the population covered the terraces and battlements of the town, as well as all the little eminences in the neighbourhood, in hopes of obtaining a view of the Sun as he ascended above the horizon. At the citadel we had under our eyes, besides numerous groups of citizens established on the slopes, a body of soldiers about to be reviewed.

"The hour of the commencement of the eclipse drew nigh. More than twenty thousand persons, with smoked glasses in their hands, were examining the radiant globe

* *Memoirs*, R.A.S., vol. x. p. 5. ** *L'Annuaire*, 1846, p. 303.

projected upon an azure sky. Although armed with our powerful telescopes, we had hardly begun to discern the small notch on the western limb of the Sun, when an immense exclamation, formed by the blending together of twenty thousand different voices, announced to us that we had anticipated by only a few seconds the observation made with the unaided eye by twenty thousand astronomers equipped for the occasion, whose first essay this was. A lively curiosity, a spirit of emulation, the desire of not being outdone, had the privilege of giving to the natural vision an unusual power of penetration. During the interval that elapsed between this moment and the almost total disappearance of the Sun we remarked nothing worthy of relation in the countenances of so many spectators. But when the Sun, reduced to a very narrow filament, began to throw upon the horizon only a very feeble light, a sort of uneasiness seized upon all; every person felt a desire to communicate his impressions to those around him. Hence arose a deep murmur, resembling that sent forth by the distant ocean after a tempest. The hum of voices increased in intensity as the solar crescent grew more slender; at length the crescent disappeared, darkness suddenly succeeded light, and an absolute silence marked this phase of the eclipse with as great precision as did the pendulum of our astronomical clock. The phenomenon in its magnificence had triumphed over the petulance of youth, over the levity which certain persons assume as a sign of superiority, over the noisy indifference of which soldiers usually make profession. A profound stillness also reigned in the air; the birds had ceased to sing. After an interval of solemn expectation, which lasted about two minutes, transports of joy, shouts of enthusiastic applause, saluted with the same accord, the same spontaneous feeling, the first reappearance of the rays of the Sun. To a condition of melancholy produced by sentiments of an indefinable

nature there succeeded a lively and intelligible feeling of satisfaction which no one sought to escape from or moderate the impulses of. To the majority of the public the phenomenon had arrived at its term. The other phases of the eclipse had few attentive spectators beyond the persons devoted especially to astronomical pursuits."

The total eclipse of July 28, 1851, may be said to have been the first which was the subject of an "Eclipse Expedition," a phrase which of late years has become exceedingly familiar. The total phase was visible in Norway and Sweden, and great numbers of astronomers from all parts of Europe flocked to those countries. Amongst those who went from England were Sir G. B. Airy, the Astronomer Royal (then Mr. Airy), Mr. J. R. Hind and Mr. Lassell. The Red Flames were very much in evidence, and the fact that they belonged to the Sun and not to the Moon was clearly established. Hind mentions that "the aspect of Nature during the total eclipse was grand beyond description." This feature is dwelt upon with more than usual emphasis in many of the published accounts. I have never seen it suggested that the mountainous character of the country may have had something to do with it, but that idea would seem not improbable.

In the year 1858, two central eclipses of the Sun occurred, both presenting some features of interest. That of March 15 was annular, the central line passing across England from Lyme Regis in Dorsetshire to the Wash, traversing portions of Somersetshire, Wiltshire, Berkshire, Oxfordshire, Northamptonshire, Lincolnshire, and Norfolk. The weather generally was unfavourable and the annular phase was only observed at a few places, but important meteorological observations were made and yielded results, as regards the diminution of temperature, which were very

definite. All over the country rooks and pigeons were seen returning home during the greatest obscuration; starlings in many places took flight; at Oxford a thrush commenced its evening song; at Ventnor a fish in an aquarium, ordinarily visible in the evening only, was in full activity about the time of greatest gloom ; and generally, it was noted that the birds stopped singing and flew low⁷ from bush to bush. The darkness, though nowhere intense, was everywhere very appreciable and decided. The second central eclipse of 1858 took place on September 7 and was observed in Peru by Lieutenant Gilliss of the U. S. Navy. The totality only lasted one minute, and the general features of a total eclipse do not appear to have been very conspicuously visible. Gilliss remarks * :—" Two citizens of Olmos stood within a few feet of me, watching in silence, and with anxious countenances, the rapid and fearful decrease of light. They were wholly ignorant that any sudden effect would follow the total obscuration of the Sun. At that instant one exclaimed in terror '*La Gloria?*' and both, I believe, fell to their knees, filled with awe. They appreciated the resemblance of the Corona to the halos with which the old masters have encircled their ideals of the heads of our Saviour and the Madonna, and devoutly regarded this as a manifestation of the Divine Presence."

The year 1860 saw the departure from England of the first great Ship Expedition to see an eclipse. One was due to happen on July 18, and a large party went out from England to Spain in H.M.S. *Himalaya*. Mr. De La Rue took a very well-equipped photographic detachment, and his photographs were eminently successful. This eclipse settled for ever the doubt as to whether the Red Flames belonged to the Sun or the Moon, and in favour of the former view.

The years 1868, 1869, and 1870 were each marked by

**Month. Not.*, R.A.S.,, vol. xx. p. 301. May 1860.

total eclipses, which were observed to a greater or less extent. In the first-named year the eclipse occurred on August 18, the central line passing across India. The weather was not everywhere favourable, but several expeditions were dispatched to the East Indies. The spectroscope was largely brought into play with the immediate result of showing that the Corona was to be deemed a sort of atmosphere of the Sun, not self-luminous, but shining by reflected light. The eclipse of 1869 was observed by several well-equipped parties in the United States, and a very complete series of excellent photographs was obtained.

To view the eclipse of December 22, 1870, several expeditions were dispatched, the central line passing over some very accessible places in Spain, Sicily, and North Africa. The English observers went chiefly in H.M.S. *Urgent*, though some of them travelled overland to Sicily. The expenses, both of the sea and land parties, were to a large extent defrayed by Her Majesty's Government. It deserves to be noted that so great was the anxiety of the French astronomer Janssen to see this eclipse, that he determined to try and escape in a balloon from Paris (then besieged by the Germans) and succeeded, carrying his instruments with him. The weather seriously interfered with the work of all the observers who went out to see this eclipse, which was the more to be regretted because the preparations had been on a very extensive and costly scale. The chief result was that it was ascertained that the Red Flames (henceforward generally called "Prominences") are composed of hydrogen gas in an incandescent state.

The year 1871 saw, on December 12, another Indian eclipse, noteworthy for the numerous and excellent photographs which were obtained of the Corona, of the rifts in it, and of the general details, which were well recorded on the plates.

There was an eclipse visible in South Africa on April 16, 1874. Some useful naked eye views were obtained and recorded, but as no photographic work was done, this eclipse cannot be said to come into line with those which preceded or followed it.

In the following year, that is to say on April 6, 1875, there was a total eclipse of the Sun, visible in the far East, especially Siam ; but the distance from England, coupled with the very generally unfavourable weather, prevented this from being anything more than a second-class total eclipse, so to speak, although extensive preparations had been made, and the sum of £1000 had been granted by the British Government towards the expenses. A certain number of photographs were obtained, but none of any very great value.

Perhaps of the next eclipse which we have to consider, it may be said that the circumstances were more varied than those of any other during the second half of the 19th century. The eclipse in question occurred on July 29, 1878.

Several favourable circumstances occurred to make it a notable event. In the first place, the central line passed entirely across the United States; in other words, across a long stretch of inhabited and civilised territory, accessible from both sides to a nation well provided with the requisite scientific skill and material resources of every kind. But there was another special and rare facility available; the central line crossed the chain of the Rocky Mountains, an elevated locality, which an American writer speaks of as overhung by " skies of such limpid clearness, that on several evenings Jupiter's satellites were seen with the naked eye." On the summit of a certain peak, known as Pike's Peak, a party of skilled observers, headed by Professor Langley, observed the wonderful developments of the Corona, mentioned on a previous page. The

fact that such a display came under the eyes of man was no doubt mainly due to the superbly clear atmosphere through which the observations were made. That this is not a mere supposition may be inferred from the fact that at the lower elevation of only 8000 feet, instead of 14,000 feet, the Coronal streamers were seen by Professor Newcomb's party, far less extended than Langley saw them. Perhaps the best proof of the importance of a diaphanous sky is to be found in the fact that on the summit of Pike's Peak, the Corona remained visible for fully 4 minutes after the total phase had come to an end. A comparison of the descriptions shows that even at the elevation of 10,200 ft. the observers placed there, whilst they were better off than those at 8000 ft., assuredly did not see so much or so well as those at 14,000 ft.

There occurred a total eclipse on July 11, 1880, visible in California, but as the totality lasted only 32 sees, and the Sun's elevation was only 11° , not much was got out of this eclipse notwithstanding that it was observed in a cloudless sky at a station 6000 ft. above the sea.

The eclipse of May 17, 1882, yielded several interesting and important features although the totality was short —only about $1\frac{1}{4}$ minutes. Here again favourable local circumstances helped astronomers in more ways than one. It was in Egypt that the eclipse was visible, and Egypt is a country which it is exceedingly easy for travellers to reach, and it is also noted for its clear skies. These were doubtless two of the reasons which combined to inspire the elaborate preparations which were made for photographic and spectroscopic observations. The former resulted in a very unprecedented success. One of Dr. Schuster's photographs of the totality showed not only the expected Corona, but an unexpected comet.

Though on more than one previous occasion in history the darkness which is a special accompaniment of a total

eclipse had caused a comet to be seen, yet the 1882 eclipse was the first at which a comet had thrust itself upon the notice of astronomers by means of a photographic plate. It will be remembered that the political circumstances of Egypt in 1882 were of a somewhat strained character and probably this contributed to the development of an unusual amount of astronomical competition in connection with this eclipse. Not only did the Egyptian Government grant special facilities, but strong parties went out representing England, France, and Italy, although not perhaps in set terms at the direct instigation of their respective Governments.

The next eclipse, that of May 6, 1883, had some dramatic features about it. To begin with its duration was unusually long—nearly 5½ minutes, and Mrs. Todd in her genial American style remarks:—"After the frequent manner of its kind, the path lay where it would be least useful—across the wind-swept wastes of the Pacific. But fortunately one of a small group of coral islands lay quite in its line, and, nothing daunted, the brave scientific men set their faces toward this friendly cluster, in cheerful faith that they could locate there. Directed to take up their abode somewhere on a diminutive island about which nothing could be ascertained beforehand, save the bare fact of its existence at a known spot in mid-ocean, the American observers were absent from the United States more than three months, most of which time was spent in travelling, 15,000 miles in all, with ten full weeks at sea. Their tiny foothold in the Pacific was Caroline Island, a coral atoll on the outskirts of the Marquesas group."

In spite of the unattractive, not to say forbidding, character of the place to which they would have to go, parties of astronomers went out from England, France, Austria, and Italy, and although rain fell on the morning of the day the sky became quite clear by the time of

totality and the observations were completely successful. One of the pictures of the Corona obtained by Trouvelot, an observer of French descent, but belonging to the American party, has been often reproduced in books and exhibited the Corona in a striking form. How few were the attractions of Caroline Island as an eclipse station may be judged from the fact that the inhabitants consisted of only four native men, one woman, and two children who lived in three houses and two sheds.

On September 8, 1885, there occurred a total eclipse, which was seen as such in New Zealand, but the observations were few, and with one exception, unimportant and uninteresting. A certain Mr. Graydon, however, made a sketch which showed at one point a complete break in the Corona, so that from the very edge of the Moon outwards into space there was a long and narrow black space showing nothing but a vacuity. If this was really the condition of things, such a break in the Corona is apparently quite unprecedented.

In 1886, on August 29, there occurred a total eclipse, visible in the West Indies, which yielded various important results. It was unfortunate that for the greater part of its length, the zone of totality covered ocean and not land, the only land being the Island of Grenada and some adjacent parts of South America. The resulting restriction as regards choice of observing stations was the more to be regretted because the duration of the totality was so unusually long, and therefore favourable, being more than 6½ minutes in the middle of the Atlantic Ocean. Parties of English, American, and Italian astronomers assembled, however, at Grenada, and though the weather was not the best possible, some interesting photographs were obtained which exhibited an unusual development of hydrogen protuberances. The central line in this eclipse not only stretched right across the Atlantic, but entered Africa

on the West Coast where a missionary saw the eclipse as a mere spectator, and afterwards expressed his regret that no astronomers were within reach with instruments to record the remarkable Corona which was displayed to his gaze.

Though the unusual opportunities which, so far as the Sun and the Moon were concerned, were afforded by the eclipse of 1886 were lost, astronomers looked out hopefully for August 19, 1887, when another eclipse was due to happen which, weather permitting, would be observable over a very long stretch of land, from Berlin through Russia and Siberia to Japan. Unusually extensive preparations were made in Russia at one end and in Japan at the other, but clouds prevailed very generally, and the pictures of the Corona which were obtained fell far short in number and quality from what had been hoped for, having regard to the number and importance of the stations chosen, and of the astronomers who made their preparations thereat. An enthusiastic Russian, in the hopes of emancipating himself from the risks of terrestrial weather at the Earth's surface, went up in a balloon to an elevation of more than two miles. His enthusiasm was so far rewarded that he had a very clear view of a magnificent Corona; but as, owing to some mischance, the balloon rose, conveying only the astronomer and leaving behind his assistant who was to have managed the balloon, all his time was engrossed by the management of the balloon, and he could do very little in the way of purely astronomical work.

The year 1889 afforded two total eclipses of the Sun for which the usual preparations were made. The first occurred on New Year's Day, and the path of the shadow crossed the North American Continent from California to Manitoba. The weather was nearly everywhere very favourable, and an enormous number of observers and in-

struments were assembled along the central line. The consequence was that a very large number of photographs were obtained. It may be said generally of this eclipse, that as it coincided with a Sun-spot minimum, it left us in a position to learn very distinctly what are the characteristic features of a solar Corona at a period which is one of rest and repose on the Sun, at least, so far as regards visible Sun-spots.

The second eclipse of 1889 occurred on December 22, and should have been visible off the northern coast of South America and on the West Coast of Africa. Attempts were made to utilise the South American chances by English and American parties, whilst a small expedition comprising astronomers of both nations went to Cape Ledo in West Africa. The African efforts failed entirely owing to clouds, but the South American parties at Cayenne were successful. One very deplorable result, however, arising out of the expedition to Cayenne was the illness and subsequent death of the Rev. S. J. Perry, S. J., who was struck down by malaria and died at sea on the return journey. None who knew Mr. Perry personally could fail to realise what a loss he was both to astronomy generally and to his own circle of friends particularly.

On April 16, 1893, there happened a total eclipse of the Sun, which was successfully watched by a large number of skilled observers throughout its entire length. Indeed it is believed that only one party was unsuccessful. The line of totality started on the coast of Chili, passed over the highlands of that country, across the borders of Argentina and Paraguay, and over the vast plains and forests of Central Brazil, emerging at about noon of local time at a short distance to the N.-W. of Ceara on the North Atlantic seaboard. Crossing the Atlantic nearly at its narrowest part, it struck the coast of Africa N. of the river Gambia, and finally disappeared somewhere in

the Sahara. The South American observations were the most extensive and successful, the latter fact being due to the circumstance that the sky at many of the principal stations was pre-eminently favourable, owing to the cleanness and dryness of the atmosphere.

On Sept. 29, 1894, there was a total eclipse of the Sun, but as its duration was brief and the zone of totality lay chiefly over the Indian Ocean, practically nothing came of it.

Things seemed, however, much more promising for the total eclipse of Aug. 9, 1896, and a very large number of observers went out to the North of Norway hoping to catch the shadow at its European end, whilst a yacht party went to Nova Zembla in the Arctic Ocean, and a few observers travelled as far as Japan. So far as the very large number of would-be observers who went from England to Norway were concerned, the eclipse was a profound disappointment, for owing to bad weather practically nothing was seen in Norway, except on the West coast near Bodo, where the weather was beautifully fine, but where no adequate preparations had been made, because nobody believed that the coast would be free from fog. Exceptionally fine weather prevailed at Nova Zembla, and the small but select party who were kindly taken there by the late Sir G. B. Powell, M.P., in his yacht, were very fortunate, and an excellent series of photographs was secured. One important result obtained at Nova Zembla was a full confirmation by Mr. Shackleton of Prof. Young's discovery in 1870 of the "Reversing Layer," a discovery which was long and vehemently disputed by Sir Norman Lockyer. Fairly successful observations were made of this eclipse in Siberia and Japan.

The last total eclipse of the Sun which has to be noticed as an accomplished fact was the " Indian Eclipse " of Jan. 22, 1898, which was very successfully seen by large numbers of people who went to India from all parts

of the world. As usual in all total eclipses of the Sun nowadays, the photographers were very much to the front, and the photographs of the inner Corona, taken by the Astronomer Royal, are thought to have been probably the best that have yet been done. Amongst the miscellaneous observations made, it may be mentioned that more stars were seen during the second partial phases than during totality (a circumstance which had been noticed by Don A. Ulloa as far back as 1778). It is stated also that a mysterious object was seen between Mars and Venus by two officers of H.M.S. *Melpomene*, which was not put down on the published chart as a star to be looked for. The identity of this object has not been ascertained.

CHAPTER XIV.

THE ELECTRIC TELEGRAPH AS APPLIED TO ECLIPSES OF THE SUN.

AMONGST the auxiliary agencies which have been brought into use in recent years, to enable astronomers the better to carry out systematic observations of eclipses of the Sun, the electric telegraph occupies a place which may hereafter become prominent. As it is not likely that this little book will fall into the hands of any persons who would be able to make much use of telegraphy in connection with eclipse observations, it will not be necessary to give much space to the matter, but a few outlines will certainly be interesting. When the idea of utilising the telegraph wire first came into men's minds, it was with the object of enabling observers who saw the commencement of an eclipse at one end of the line of totality, to give cautionary notices to observers farther on, or towards the far end, of special points which had been seen at the

beginning of the totality, and as to which confirmatory observations, at a later hour, were evidently very desirable. It is obvious that a scheme of this kind depends for its success upon each end (or something like it) of the line of totality being in telegraphic communication with the other end, and this involves a combination of favourable circumstances not likely to exist at every occurrence of a total eclipse, and in general only likely to prevail in the case of eclipses visible over inhabited territory, such as the two Americas, Europe, and parts of Asia. This use of the telegraph was, I think, first proposed as far back as 1878, by an American astronomer, in connection with the total eclipse of that year. His proposal fell upon sympathetic ears, with the result that arrangements were concluded with the Western Union Telegraph Company of North America for the expeditious forwarding of messages from northern stations on the eclipse line to southern stations. Some attention was being given at that time to the question of Intra-Mercurial planets, and it was thought that if by good fortune any such objects were unexpectedly found at the northern station, and observers at a southern station could be advised of the fact, there might be a better chance of procuring an accurate and precise record of the discovery. As it happened, nothing came of it on that occasion, but the idea of utilising the telegraph having once taken possession of men's minds, it was soon seen what important possibilities were opened up.

The want of telegraph organisation curiously made itself felt in the Egyptian eclipse of 1882. It is stated in another chapter of this work that during the total phase a comet was unexpectedly discovered. Now comets sometimes move very rapidly (especially when they are near the Sun), and had it been possible to have warned some observer to the E. of Egypt to look out for this comet, and had he seen it even only a couple of hours...

This marks the end of the transcript