Transit of Venus, December 6, 1882, from ingress to sunset.
See pp. 86, 110.

ECLIPSES,

PAST AND FUTURE;

WITH

GENERAL HINTS FOR OBSERVING THE HEAVENS.

BY THE

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VICAR OF MELPLASH, DORSET.

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PREFACE TO FIRST EDITION.

IT was originally my intention to bring out two works; one, a description of eclipses, past and future; the other, a cycle of celestial objects coming within the range of a 4-inch telescope, such an instrument being common with amateurs, and a very useful size, large enough to shew what is worth examining, and not too large to prevent portability. On after thoughts, my plan was to abridge both works, and publish them under the title of "Eclipses, Past and Future; with General Hints for Observing the Heavens."

With the solar eclipse of 1870 a considerable interest was kindled as to such phænomena, not a little correspondence passed on the subject in the scientific journals, and there were several inquiries about the next solar eclipse that would be total in this country. This led to certain communications to the "Times" by Mr. Hind in 1871 and 1872. In the first part of the following little work, notices of the eclipses are collected from the earliest days to the present time. A selection may be made from them by those who wish to compute from the tables of Leverrier and Hansen. All the eclipses in the "Saxon Chronicle"

are also stated, and the results of calculations I have made respecting them. No description of these eclipses seems, hitherto, to have been published. An account of the eclipses for the next forty years will be found, commencing on page 83, and of those of the sun for a long future period. The second part contains brief notes on the planets, meteorology, &c.; double-stars and nebulæ, within reach of small telescopes, such as many are possessed of, but use little, from disinclination to wade through Smyth's "Cycle," and similar long works. It is my hope that this little book may fall into the hands of such persons.

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Upton-Helions Rectory,
Crediton, Devon,
January 19, 1874.

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INTRODUCTION.

INTRODUCTION.

THE word 'eclipse' is derived from the Greek ἔκλειψις, a failing or fainting, as the moon, when she got immersed in the earth's shadow, was imagined by many of the ancients to be swooning away. Perhaps there is nothing in astronomy that affords to the generality of mankind such ocular demonstration of the truth of the science, as the agreement of the prediction of an eclipse of the sun or moon with its appearance in the heavens, as to time, degree of obscuration, and other circumstances connected with the phænomenon. Although the earth and the other planets perform their respective periods round the sun in nearly equal times, yet, from the elliptical figures of their orbits, and their mutual attractions, their motions are far from being equable; and when these bodies are viewed from the earth, the inequality becomes still more apparent, as, in that case, they are sometimes direct, sometimes stationary, and at other times retrograde. But, as regards our satellite the moon, her nearness to the earth renders the inequalities of her orbit more apparent than those of any other heavenly body: she has, besides, a considerable parallax, which causes her place in the heavens, as seen from the surface of the earth, to be very different from that in her orbit, or when viewed from the centre of our globe. For these reasons, the computations of

eclipses, especially solar ones, are attended with considerable labour and difficulty.

It has been ascertained, that if the latitude of the moon be less than 1° 23′ at the time of new moon, there will be an eclipse of the sun; and, if less than 51′ 57″ at the time of full moon, there will be an eclipse of the moon. There cannot be less than two eclipses in any year, or more than seven; and we are unable to mention any year in which this maximum number was attained. We suppose the reader to be acquainted, more or less, with the theory of eclipses. It is not our design to enter here into a description of the periodical equations and secular equations of the moon's motions, simply to give a brief description of eclipses on record in ancient and mediæval times, as such may prove of use to some for purposes of reference.

In astronomy, eclipses of the moon are of great use for ascertaining the periods of her motions; in geography, the longitudes of places are found by eclipses, especially by those of the moon, as they only are of equal size and duration at all places where they are seen. In chronology, both solar and lunar eclipses serve to determine the time of a past event; for there are so many particulars observable in each eclipse, with respect to its magnitude, the places where it is visible (if of the sun), and the time of day or night, that it is impossible there can be two solar eclipses, in the course of many ages, alike in all particulars. There is a degree of uncertainty attached to many early historical records. When, however, a historian has mentioned some fact as occurring coincidently with an eclipse, it is competent for astronomy to speak about

the date. For this purpose it is not necessary to employ the lengthened and intricate tables of the present day, unless we wish to ascertain the exact mile on the earth's surface where the limit of totality would pass. In the following calculations, the tables given in the *Encyclopædia Britannica,* 8th edit., have been used. After trying them on a great number of known eclipses, the author was convinced they would answer well for the object he had in view.

In less civilized ages, it is not to be wondered at that great solar eclipses should have caused considerable alarm. It is well they did so, as the accounts we have of them are of great use in the recovery of the dates of ancient events. At the present day, many of the Hindoos, Chinese, &c., beat gongs, and raise the most hideous sounds, to drive away the great monster they fancy is devouring the sun or moon, when they see its face gradually eaten away by an eclipse. Even among cultivated nations, the effects of consternation are sometimes great on the occasion of a total eclipse of the sun. To give only one instance, we may mention the death of a woman in Iowa from fright, at that which took place there in the summer of 1869. A total solar eclipse still remains the grandest and most appalling sight in nature. The bursting forth of the stars in the daytime, the apparent descending of the sky like a black mantle, the sun surrounded by its corona, combine in forming a scene that can never be effaced from the memory of the beholders. In the present day, such phænomena are of the greatest use, not merely for the correction or verification of our astronomical tables, but also for ascertaining the con-

stituents of the sun's atmosphere, and the nature of the gorgeous corona, with which he is surrounded during the total phase. When, therefore, a total solar eclipse takes place now, in any available or habitable part of the world, it is pretty sure to be observed with more or less care. In fact, we may say, that just what a grand review, or a great victory, the Derby-day, or a coronation, are to terrestrial folk, such is a great eclipse to the lover of astronomical lore. A few moments of total darkness are more precious to him than the most splendid illumination, or the most glorious fireworks which ever followed a royal marriage or an honourable peace. He leaves the limits of his observatory, and neglects all his ordinary duties, to be present at such an extraordinary occurrence. He then expects to see, during two or three minutes of total darkness, phænomena so interesting and so rare, that he takes his departure into distant lands, and runs the risk of cloudy skies and bad weather, so long as there is a chance of catching a glimpse of the sun and moon at the time of obscurity. The positions of the sun and moon are of the utmost consequence in the system of the world. The mariner depends on the latter body for information of his whereabouts, when far away from land and lighthouse. Apart, however, from this verification of theory, of which eclipses of the sun form the surest and simplest test, it may be added that the appearances which are observed when the moon is exactly between the sun and earth, and when it completely cuts off the light of the great central luminary, are of such a curious character, that they are found deserving of the most careful scrutiny. They give very

considerable information respecting the physical constitution of the sun, and of its atmosphere, of which we have gained much knowledge, within the last few years, by this means, and which phenomena, though not yet completely explained, may serve as data for future observers, exactly in the same manner as the observations of ancient eclipses, rudely given though they may be, serve as a test for the accuracy of the present tables of the sun and moon, and form a system of landmarks in all our chronological researches. The ancients used to foretell eclipses by means of the Chaldæan Saros, or period of 223 lunations, and by Meton's cycle of 19 years. By these means a good idea might be got of the lunar eclipses that were going to happen. As to solar ones, only the time in which they would take place in some part of the world could be mentioned; as the exact locality in which they fall cannot be foretold by cycles.

We may trace forward the progress to accuracy in the tables for this purpose. Even the Burmese, Chinese, and other Oriental nations, have their methods for ascertaining the eclipses of the heavenly bodies. In the author's possession is a curious old book by Cyprianus Leovitius, the Bohemian astronomer, who lived above three centuries ago. This gives drawings and descriptions of all the eclipses, for Augsburg, from 1554 to 1606. (It also contains a figure and description of the comet of 1556.) Leovitius mentions, at the commencement of his work, that he took the time of a total lunar eclipse on June 5, 1555, from the tables of George Purbach, and was "so deceived that it happened more than half-an-hour too late." In the rooms

of the Royal Astronomical Society in London there is a curious map of the path of the total eclipse of 1715, by Dr. Halley, in which he places London only just within the southern boundary of the total phase, and says it was not certain whether it would be total there. Observation proved it was total there for 3 min. 11 sec., so the limit must have gone a considerable distance south of London. Passing on about half-a-century, we come to 1764, when an annular eclipse took place on a Sunday morning in April, which excited considerable attention in England. A calculation from the best lunar tables then extant, gave the north-west limit of the annular appearance to pass a few miles to the south-west of Greenwich. At Oxford, where it was expected the eclipse would have been just annular, the least distance of the solar cusps was found to be about two-sevenths of the whole circumference of the sun. Mr. Murray, of Chatham, with a 12-foot telescope, found the eclipse barely annular at half-past ten, the light of the sun below the moon being but just visible, and scarcely the breadth of a hair in the telescope. It was hence inferred that the limit of the annulus passed over Rochester bridge. This will be sufficient to shew the progress that was made, as years rolled on, towards perfecting the tables of the sun's and moon's places.

Tycho Brahe had an idea that the diameter of the moon could never exceed that of the sun, and consequently that there could never be a really total eclipse of the sun. He need not, therefore, have been so proud of his instruments, as he appears to have been, if one may judge from his *Historia Celestis.*

This idea about the diameters, there are persons who do not understand astronomy hold persistently at the present day. But the semi-diameter of the moon may be greater than the semi-diameter of the sun by about a minute of arc, as seen by us.

CHAPTER I.

THE MOST ANCIENT ECLIPSES, INCLUDING THOSE OF PTOLEMY.

THE earliest eclipse spoken of, is one in the reign of Chou-kang, in the twenty-second century before Christ, to which three or four different dates has been assigned. B.C. 2169, 2158, and 2127, Oct. 13, have been given as the date. On the last mentioned, I find an eclipse visible in China did occur, but I have not looked into the circumstances of it [a].

The Chinese records make no mention of any other eclipse till we come down to the year 776 B.C., in the time of Yew-Wang, who is said to have reigned from 781 to 769 B.C. The tables I employed give a small eclipse on the sun, in the more northern parts of what is now called China, on Sept. 6, 776, about sunrise, but no other eclipse that year. An examination of the preceding and subsequent years did not seem to render a satisfactory result.

There is a statue in the British Museum of Assurnazirpal, king of Nineveh, pointing to the crescent moon, which is separated from a figure of the sun by

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[a] This eclipse has been made the subject of the following college rhyme, from the alleged discomfiture of the Mandarins Ho and Hi:—

"Here lie the bodies of Ho and Hi
Whose fate though sad was risible,
Being hanged because they could not spy
Th' eclipse which was invisible."

an emblem signifying fire. Mr. Hind has considered this to be an eclipse, and has mentioned the eclipses of 884 and 923 B.C. as answering for the purpose, especially the first-named. It seems doubtful, however, whether an eclipse is alluded to at all.

The first eclipse of which we have a clear record is one which happened at Nineveh in the year 763 B.C., which would be in the reign of Uzziah, king of Judah, and in the earlier part of the life of the prophet Isaiah. The record of this eclipse was discovered on the Assyrian tablets in the British Museum. It took place on June 15, and my computation makes it to have been almost total at Nineveh about 9h. 47m. a.m., corresponding as to size, and pretty nearly as to time, with the result Mr. Hind published in the "Times." It was evidently a startling phænomenon, and possibly total at Nineveh, as the inscription is underlined. This is, accordingly, a very important eclipse for the correction of the astronomical tables, as the result obtained places Nineveh a little out of the totality.

Till the discovery of this Nineveh eclipse of 763 B.C., the most ancient eclipses on record were obtained from Ptolemy. He mentions in his *Almagest* three of the moon, which were observed at Babylon by the Chaldæans. The first of these occurred in the first year of Mardokempadius, the 27th of the era of Nabonnassar, in the Egyptian month Thoth, 721 B.C., the date of the kingdom of Israel being extinguished by Shalmaneser. The eclipse was total. The next two took place in the following year, and were only partial. These ancient eclipses have been of the greatest value, as they indicate an acceleration or hastening of

the moon's motion round the earth; that is to say, the moon is in advance of the place it ought to occupy in the sky, in other words, her revolution round us is accomplished in a little shorter time now than in earlier ages. About this period, the shadow went back on the dial of Ahaz, fifteen years were added to the life of Hezekiah, and the Babylonians sent a message to him. Tycho Brahe, the Danish astronomer, considered this miracle to have caused the Chaldæans to observe eclipses more diligently; and he adds, very sagaciously, that "Hipparchus and Ptolemy would have had no reason to mention these eclipses, if they could have found any more ancient ones, happening at an earlier period, since from them the motions of the sun and moon could be more certainly deduced."

We may here mention that an attempt has been made to explain the retrogression of the shadow on the dial of Ahaz by an eclipse of the sun. It is true, we have no idea what was the particular construction of this dial, and so we are ignorant of the precise nature of the miracle. It is the first mention of the measure of time by a dial in Holy Writ. The first mention of an hour as a part of time, is when we read of Daniel (ch. iv. ver. 19) that he was "astonied for one hour, and his thoughts troubled him." Herodotus observes that the Greeks learned from the Egyptians the method of dividing the day into twelve parts; but whether the Hebrews learnt it from the Egyptians, or the Egyptians from the Hebrews, cannot now be known. It has been asked whether the miracle of the sun going back was wrought on the sun, or only on the dial. Some have observed that not a word is mentioned

of the sun going back, but only of the shadow on the dial; which might have been effected by the Almighty's power, by altering the position of the dial, so as to make the shadow retire, without changing the motion of the sun itself. The Jewish writers, however, and Archbishop Usher consider, on the other hand, that the sun and heavenly bodies went back. But conjectures about the celestial machinery employed in this case must be as futile, as in the case of Joshua calling on the sun and moon to stand still.

Returning to the eclipses of Ptolemy. According to the tables in the *Encyclopædia*, this one of 721 B.C. began at Babylon about 7h. 7m., totality came on 8h. 10m., and ceased 9h. 51m., and the shadow cleared off 10h. 54m.

Two others of those recorded by Ptolemy deserve attention, that of 383 B.C., Dec. 23, the occurrence of which he marks by saying that it was when Phanostrates was ruler at Athens, in the month of Possideon, in the 366th year of Nabonnassar; the other 201 B.C., Sept. 22. Ferguson has the following remarks on these: "There are two ancient eclipses of the moon recorded by Ptolemy from Hipparchus, which afford an undeniable proof of the moon's acceleration. The first of these was observed at Babylon, Dec. 23, 383 B.C., when the moon began to be eclipsed about half-an-hour before the sun rose, but by most of our tables, the moon was set at Babylon about half-an-hour before the eclipse began; in which case, there could be no possibility of observing it. The second eclipse was observed at Alexandria, Sept. 22, 201 B.C., where the moon rose so much eclipsed that it must have begun

half-an-hour before she rose; whereas by most of our tables, the beginning of this eclipse was not till about 10 min. after the moon rose at Alexandria. Had these eclipses begun and ended whilst the sun was beneath the horizon, we might have imagined, as the ancients had no certain way of measuring time, they might have been so far mistaken in the hours, that we could not have laid stress on the accounts given by them. But, as in the first eclipse the moon was set, and consequently the sun risen, before it was over; and in the second eclipse the sun was set, and the moon not risen till some time after it began; these are such circumstances as the observers could not possibly be mistaken in." Now, if we examine these eclipses by the tables in the *Encyclopædia*, we find on Dec. 23, 383 B.C., a very small obscuration on the moon, about $\frac{1}{4}$ to 7h. local time, so the moon did "begin to be eclipsed before the sun rose." The eclipse of 201 B.C. happened within a very few days of the September equinox. So the sun would set, and the moon would rise about 6h. or a little after. The tables give an eclipse on this evening, the middle at Alexandria about $\frac{1}{4}$ past 6h., magnitude between six and seven tenths on the lower limb. While, therefore, they indicate the phænomenon to have begun sooner than it probably did, they shew the moon considerably eclipsed at its rising, as Ptolemy records. The following is a list of the eclipses mentioned by Ptolemy, with the size expressed in digits or twelfth parts of the moon's diameter; M = morning, A = afternoon :—

B.C. 721, Mar. 19, A. total; B.C. 720, Mar. 8, A. 3 digits; same year Sept. 1, A. 6 dig.; B.C. 621, April 22,

M. 3 dig.; B.C. 523, July 16, A. 6 dig.; B.C. 502, Nov. 19, A. 3 dig.; B.C. 491, April 25, A. 2 dig.; B.C. 383, Dec. 23, M. very small; B.C. 382, June 15, A. very small; same year, Dec. 12, A. total; B.C. 201, Sept. 22, A. 8 dig.; B.C. 200, Mar. 19, A. total, and Sept 11, M. total; B.C. 174, April 30, A. 7 dig.; B.C. 141, Jan. 27, A. 3 dig.; A.D. 125, April 5, A. 2 dig.; A.D. 133, May 6, A. total; A.D. 134, Oct. 20, A. 10 dig.; A.D. 136, Mar. 6, M. 6 dig.

CHAPTER II.

THE MOST REMARKABLE ECLIPSES OF ANTIQUITY.

Thales' Eclipse, 585 B.C., May 28. — One of the most celebrated eclipses in ancient history is that said to have been foretold by Thales of Miletus. This he would be enabled to do by the Saros, or period of eighteen years, as there had been an eclipse in 603, eighteen years previously. Herodotus (i. 74), relates that this eclipse put an end to the war between the Medes and Lydians, that it happened as the battle was at its heat, the day was suddenly turned into night; *συνήνεικε ὥστε τῆς μάχης συνεστεώσης τὴν ἡμέρην ἐξαπίνης νύκτα γενέσθαι;* that the Medes and Lydians seeing this, ceased from fighting, and hastened to make peace, which they confirmed by a marriage. Now, the general inference from the description of Herodotus would be, that a total eclipse is here signified. But supposing a large partial one would answer, computation shews there is only one eclipse

about this time that will answer for that of Thales. It should here be mentioned that the precise spot where the battle was fought is uncertain. Some consider it was about the river Halys, others place it about the gulf of Issus. On May 28, 585 B.C., there was a notable eclipse of the sun in these parts. This has accordingly been given as the eclipse of Thales by Pliny, Scaliger, Ricciolus, Newton, Ferguson, and nearly every other astronomer. Certain chronologists, grounding their opinion on some merely historical evidence, have given other dates. Clinton and Hales have said 603 B.C., Prideaux 601 B.C. It has also been considered the eclipse of 610, Sept. 30, would answer. But when Hansen's lunar tables were published, this was found not to be the case. I find, by calculation, its magnitude at any point where the battle could have been fought was not sufficient to cause anything approaching the gloom described by the historian, and also that the eclipse of 603, May 18, would be of a much smaller magnitude, the totality passing a long way south of Asia Minor. As the eclipse of 585 B.C. comes out total in these parts a few minutes before six in the evening, and as there appears to have been no great eclipse in any approximate year, the reader is left to draw the inference.

Eclipse of Larissa.—Xenophon, in the third book of his *Anabasis*, chap. iv., speaks of a phænomenon, which was clearly an eclipse of the sun. He mentions a deserted city of considerable size called Larissa. It is now identified by the great Assyrian ruins called Nimrod, after the name of the mighty hunter men-

tioned in Scripture. Xenophon states that the Medes formerly inhabited this town, which must be, of course, after the end of the Assyrian empire; that "when the Persians got the empire from the Medes, their king besieged it, and could not take it, ἥλιον δὲ νεφέλη προκαλύψασα ἠφάνισε μέχρις οἱ ἄνθρωποι ἐξέλιπον, καὶ οὕτως ἑάλω; but gloom having covered the sun, made it disappear, until the inhabitants left (the city), or, perhaps, 'lost courage, and so it was taken.'" Sir G. B. Airy has found the eclipse occurred on May 19, 557 B.C.

Xerxes' Eclipse, 478 B.C., Feb. 17.—At the time of the great expedition of Xerxes against Greece, there was an important solar eclipse. Herodotus (lib. vii. cap. 37) refers it to the time when the Persian army set out in the spring from Sardis to Abydos. "As it was on the point of setting out, the sun, quitting his seat in the heavens, disappeared, though there were no clouds, and the air was perfectly serene, and, instead of day, it became night." The historian goes on to say that Xerxes was troubled about this, but the magi told him it only meant that they were going to eclipse the cities of the Greeks. Arago, in his "Popular Astronomy," (bk. xxii. ch. viii.,) remarks on it in these words: "Historians have mentioned a total eclipse of the sun, which happened in the year 480 before our era, and which almost created a revolt in the army of Xerxes." Tycho Brahe has also given 480 B.C., and he remarks in his *Historia Celestis:* "Xerxes crossed over into Greece this year, as spring drew on. At this time, Herodotus asserts the sun was darkened. But this must have happened without

an eclipse, as there was none in the spring of this year, or the former." Sir G. B. Airy sought to get over the difficulty by suggesting that the eclipse of the moon in 478 B.C. was signified. There was no eclipse of the sun in 480 B.C. In the former year, 481 B.C., April 19, M. Pingré has referred to one; but I find, on calculation, that the obscuration was but a small portion of the sun's south limb at Susa in the early morning. It has been considered that the eclipse must have taken place at the departure of Xerxes from Susa, and not from Sardis, for which Herodotus has mistaken it. But as there was an eclipse in 478, very large at Sardis, Hind has shewn, somewhat conclusively, that this must have been the phænomenon, and hence that the date of the battle of Salamis is two years more recent than commonly supposed. There was an eclipse of rather more than half the sun's disc on Oct. 2, 479 B.C., which Hind considers to be the one occurring at the time Cleombrotus consulted the oracles at Sparta.

Thucydides' three Eclipses, 431 or 433 B.C.; 424; 413.—(1.) It is said that Anaxagoras foretold the eclipse of the sun which was seen at Athens in the first year of the Peloponnesian war. Thucydides (bk. ii. ch. 28) says that it happened in the summer, after noon-day, that the sun assumed a crescent shape, and some of the stars shone out. From this account, a great obscurity would naturally be inferred. The eclipse of 431 B.C., Aug. 3, has always been pointed to as that here indicated. Many astronomers have asserted it was total. Even Sir J. Herschel, in a note in his "Outlines of Astronomy," has fallen into this

error; but he adds, "the eclipse deserves to be recomputed." A very slight examination would soon shew that it could nowhere be total; the moon's semidiameter not coming up to the sun's. I only obtain a magnitude of about seven-tenths of the sun's diameter for this eclipse of 431 B.C., and hence the difficulty arises, how are we to explain, *ἀστέρων τινῶν ἐκφανέντων*. Venus, no doubt, would come out. It would be seen sooner in an oriental sky than in an English. Ad. Smyth, at Bedford, saw it distinctly with the naked eye during the eclipse of 1836. Similar instances might be mentioned. The other eclipses taking place about this period, were, (1.) a small one on Nov. 4, 426 B.C., on the sun's south limb; (2.) one on March 30, 433 B.C., larger than that of 431 according to these tables, and happening two hours after noon, would better answer the description of Thucydides than that of 431 B.C., which was about 5h. Plutarch (*Vita Periclis*) refers to this eclipse, and says that Pericles, finding the pilot of his ship terrified, threw his cloak over him, and asked him what was the difference, except that something bigger than his cloak caused the eclipse. As both Plutarch and Thucydides refer to the darkness in so unmistakeable a manner, is it possible that the universally received date of 431 B.C. must be given up? If the eclipse of March 30, 433, is the larger eclipse, and the correct one, it need not be objected that it would hardly be summer, for Athens is not a northern climate; and, in the following eclipse, the historian distinctly says the time was the beginning of summer, while March 21 is the date that has been always given.

The only difficulty would be, that the second eclipse seems to have been in the eighth year of the war.

(2.) The second eclipse spoken of by Thucydides was at the time of an expedition of the Athenians against Cythera (bk. iv. ch. 52). "At the commencement of the subsequent summer there was somewhat of an eclipse of the sun, ἐκλιπές τι, about the new moon, and at the commencement of the month there was an earthquake." The expression is peculiar, and clearly indicates an eclipse only partial. Accordingly, for that on Mar. 21, 424 B.C., I obtain a magnitude that will coincide with the description of the historian.

(3.) The last one is of the moon, about the time of the defeat of Nicias and the Athenians at Syracuse. That on the evening of Aug. 27, 413 B.C., which appears to be signified here, was total. One on Sept. 8, 414 B.C., has also been brought forward as answering for the purpose, but the moon would scarcely be risen. Plutarch says this eclipse terrified Nicias very much, for though the people could understand a solar one, they could not make out "how the moon, when at the full, should suddenly lose her light and assume such a variety of colours." He mentions that Anaxagoras was the first to point out what overshadowed the moon, but that his treatise was not much known, as it had to be communicated with caution, from fear of the people.

Eclipse of Pelopidas, B.C. 364.—At the time when Pelopidas was starting on an expedition into Thessaly against Alexander of Pheræ, who had ruined certain cities there, Plutarch relates the sun was eclipsed, and the city of Thebes was covered with darkness in the

daytime. Arago has given 375 B.C. for the date, and calls it total, but a search through the new moons from 364 to 376 B.C., inclusive, shewed me there was no solar eclipse visible at Thebes in 375. The eclipse evidently occurred on the morning of July 13, 364 B.C., when upwards of three-fourths of the sun's diameter was under obscuration there about ¼ to 9h.

Eclipse of Arbela, 331 B.C., *Sept.* 20.—Eleven days before the victory of Alexander over Darius at Arbela, in Assyria, there was an eclipse of the moon, mentioned by Plutarch and Pliny. The moon became totally immersed in the earth's shadow, and the middle was about ¼ past 8h.

Eclipse of Agathocles, 310 B.C. (Referred to by Diodorus Siculus, lib. xx. cap. 1; Justin, lib. xxii. cap. 6).—On the second day of the voyage of Agathocles from the harbour of Syracuse to the coast of Africa, a notable eclipse of the sun is recorded to have taken place. Stars were visible on all sides. Most calculations have indicated the line of totality to have run a considerable distance south of Syracuse. I make the greatest phase to have occurred there 6h. 55m. morn., and with only a very thin crescent of light uncovered; according to which totality would pass but little to the southward of Syracuse, and Agathocles and his party would be completely involved in it.

Eclipse at Pydna, 167 B.C., *June* 10.—Livy mentions that Sulpitius Gallus, one of the Roman tribunes, foretold the eclipse on the eve of the battle of Pydna, when Perseus, king of Macedonia, was conquered by Paulus Æmilius, and Tycho Brahe says he was the first of the Romans who foretold such a phænomenon. Plu-

tarch thus relates the circumstance: "When the army had supped, and were thinking of nothing but going to rest, on a sudden the moon, which was then at full, and very high, began to be darkened, and after changing into various colours, was at length totally eclipsed." The Romans, upon this, made a noise with brazen vessels, and held up lighted torches in the air to recover the moon's light, "but the Macedonians were seized with horror." The eclipse on the afternoon of June 21, 168 B.C., has been stated by Ferguson and others as that on the eve of the battle of Pydna. I find it began at 5h. 40m., totality coming on at 6h. 59m., and lasting till 8h., and the eclipse ending 9h. 19m.; consequently, a great part of the phænomenon would take place before the moon was risen. This would not at all agree with Plutarch's account. He is very accurate, and says the moon was "very high" when it began to be darkened, and the army was going to rest. There is no doubt the eclipse on the night of June 10-11, 167 B.C., is the right one. This would come on about 11h. 58m. night, and pass off about 3h. 22m. next morning, totality lasting 40m.

Eclipse of Julius Cæsar, 51 B.C.—Tycho Brahe has given B.C. 49 as the date of the eclipse that happened on Julius Cæsar's crossing the Rubicon. Dio Cassius, lib. 41, says of it, *ὅτε ἥλιως σύμπας ἐξέλιπε*. On March 7, however, of the above year, there was a large solar eclipse in these regions, not total, but annular.

Eclipse of Herod, 1 B.C.—While describing Herod's last illness, Josephus, after speaking of his burning alive Matthias and his companions, who had raised sedition, says, "and that very night there was an

eclipse of the moon." He enters into no particulars, and this is the only eclipse of either of the luminaries mentioned by him. It is of the highest importance for determining the death of Herod and Antipater, and for the birth and chronology of our blessed Lord. Tycho Brahe, Kepler, &c., have considered it happened on March 13, B.C. 4. Calvisius, Hind, &c., have considered the eclipse of B.C. 1, January 9, to be referred to. We shall be in a better position for forming an opinion by comparing these two eclipses. That on the night of January 9, B.C. 1, was a fine total phænomenon. The moon's latitude being practically *nil*, she passed right through the centre of the earth's shadow, an almost unique instance[b]. I find, by calculation, it would commence 11h. 17m. night, totality coming on at 12h. 16m., and lasting till 1h. 53m.; and the obscuration would have passed off by 2h. 53m. morn. I make the eclipse of 4 B.C. to begin about 1h. 17m. a.m., and the greatest magnitude at 2h. 34m. a.m., with scarcely half of the moon's upper limb obscured. It seems highly improbable that Josephus, who speaks only of one eclipse, should refer to a small one happening far on into the morning, while that of 1 B.C. must have attracted some attention. In the years 2 B.C. and 3 B.C. there was no eclipse of the moon visible at Jerusalem.

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[b] Leovitius has drawn the moon passing through the umbra of the earth centrally in the eclipse of June 5, 1555, but his imperfect tables would need verification.

CHAPTER III.

OTHER LESS IMPORTANT ECLIPSES IN THE YEARS B.C.

Going back into fabulous ages, Plutarch relates, that, according to one Tarutius, an astrologer, Romulus was conceived in the 1st year of the 2nd Olympiad, when there was a great eclipse of the sun. Now the first Olympiad was in 776 B.C., and, curiously enough, I find that on Nov. 28, 771 B.C., there was an annular eclipse, very large across Italy, greatest magnitude at Rome about $\frac{1}{4}$ to 11h. A.M. The same historian, speaking of the end of Romulus, says, "The air on that occasion was suddenly convulsed and altered in a wonderful manner, for the light of the sun failed." Cicero mentions this darkness in a fragment of his 6th book, *De Repub.* In the year 715 B.C., supposed to be about the date of the death of Romulus, I find the sun eclipsed at Rome on May 26 about ten digits on the north limb, between six and seven in the afternoon.

The following are referred to by Tycho Brahe, who has collected them from Xenophon (Hellenics), Livy, &c. I have ascertained, by approximate calculation, that eclipses did take place on the dates mentioned.

B.C. 463, April 30. Eclipse of sun, alluded to by Eusebius.

B.C. 406, April 14. Total eclipse of moon. Temple of Minerva burnt at Athens.

B.C. 404, Sept. 3. Eclipse of sun. In time of Dionysius, tyrant of Syracuse.

Eclipse of Ennius, B.C. 400, June 21. In Monthly Not. Royal Ast. Soc., Jan. 1857, Professor Hansen's results are given about the eclipse of Ennius, mentioned by Cicero, *De Republica.* It is said, "Nonis Junii soli luna obstitit et nox." "On the nones of June, the moon and night were in opposition to the sun." This singular expression would indicate an eclipse near sunset, either of great magnitude, or total. By the tables in the *Encyclopædia,* the eclipse was a trifle short of totality at Rome; greatest obscuration 7h. 6m. (In the time of Ennius, on account of the lunar years and intercalary month, the nones were between June 5 and July 4.) Hansen makes the total obscuration to end at Rome at 7h. 33m., the sun setting 3 min. afterwards. Baron de Zach made the eclipse only partial there, and the middle below the horizon.

B.C. 394, Aug. 14. Eclipse of sun. The Persians beaten by Conon in a sea engagement. Tycho Brahe gives 393 B.C. as the date, and so does Smyth in his history of Greece. Ferguson gives 394 B.C., both astronomers no doubt referring to the same year.

B.C. 219, Mar. 20. Eclipse of moon, seen in Mysia. (Polybius.)

B.C. 203, May 5. Eclipse of sun, in consulship of Cn. Servilius Cæpio, and C. Servilius Geminus, seen in Latium.

B.C. 190, Mar. 14. Eclipse of sun, in consulship of L. Conr. Scipio, and C. Lælius. It would be near sunrise.

B.C. 188, July 17. Eclipse of sun, seen at Rome.

B.C. 104, July 19. Eclipse of sun, spoken of by Julius Obsequens in his book, *De Prodigiis.* Happened

at the time the Cimbri crossed over into Spain, and laid it waste.

About the time of the death of Julius Cæsar, there is recorded to have been an extraordinary dimness of the sun. M. Arago has gone so far as to explain it by an annular eclipse in the year 44 B.C. But calculation shews there was no such phænomenon. Arago must have confused it with the annular eclipse that happened seven years earlier, when Cæsar crossed the Rubicon. Pliny makes use of the word *defectus*, but he cannot be understood to mean an eclipse, as he speaks of its lasting a whole year. Tibullus also says, "the misty year saw the darkened sun drive pale horses." Plutarch mentions the paleness of the sun for a year after Cæsar's death, but adds that for want of the sun's heat the fruits did not come to maturity. The whole phænomenon was doubtless owing to some peculiar meteorological condition of the atmosphere.

CHAPTER IV.

ECLIPSES IN EACH CENTURY OF THE CHRISTIAN ERA, TO THE PRESENT DATE.

The eclipses will now be arranged according to centuries. My chief authority, in the following catalogue, has been the *Historia Celestis* of Tycho Brahe. In every instance, I have ascertained by calculation that an eclipse took place at the date mentioned.

First Century.

A.D. 5. Small eclipse of the sun, on March 28, at Rome, alluded to by Dion Cassius, lib. 55.

A.D. 14. Total eclipse of the moon on the morning of Sept. 27. About the time that Drusus settled the mutiny of the Pannonian legions.

A.D. 17. "Totus sol, Romæ, et compluribus Italiæ locis visus fuit obscurari."—Ty. Br., *Historia Celestis.* Misled by his imperfect tables, Tycho has considerably exaggerated the size of this eclipse. The obscuration at Rome seems to have been about two-thirds of the southern part of the sun's disc. Little difference in the semi-diameters.

The Crucifixion, and the eclipse of Phlegon. Phlegon, a heathen writer, tells of a most extraordinary eclipse of the sun in the 202nd Olympiad. Calculation shews that it took place on Nov. 24 of the year 29, and that it was total for a little more than a minute only, at a point north of Palestine. As this was within a few years of our Lord's Crucifixion, some sceptics, with their usual shallowness of argument, have tried to explain away the supernatural darkness by a total eclipse of the sun. But our Lord suffered at the time of the Jews' Passover, which was always kept at the full moon, when there could be no eclipse of the sun. Again, the darkness in total eclipses of the sun cannot be prolonged beyond seven minutes, nor over a wider space than 180 miles; whereas, the inspired writers tell us the darkness at the Crucifixion lasted three hours, and overspread the whole land of Judea.

"The dispute among chronologists," says Ferguson, "about the year of Christ's death, is limited to four or five years at most. But as He was crucified on the day of a paschal full moon, and on a Friday, all we have to do, in order to ascertain the year of His death, is

to compute in which of those years there was a Passover full moon on a Friday. The only Passover full moon that fell on a Friday about this time, was on April 3, in the 4746th year of the Julian period, which was the 490th year after Ezra received his commission from Artaxerxes Longimanus, and the year in which the Messiah was to be 'cut off,' according to ancient prophecy. This 490th year was the 33rd of our Lord's age, reckoning from the common era of His birth."

A.D. 45, Aug. 1. Speaking of the Emperor Claudius, Dion Cassius, lib. 60, says, "As there was going to be an eclipse on his birthday, through fear of a disturbance, as there had been other prodigies, 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 that produce such an event." The Romans of old were by no means noted for their astronomical skill, troubling themselves about little but military exploits. It is satisfactory, therefore, to be able to record an exception to the general rule. The above is the date Tycho Brahe gives from Petavius, but I find the eclipse on that morning was very small at Rome. On Jan. 23, A.D. 44, however, there would be a larger one, about the going down of the sun.

A.D. 47, Jan. 1. Total eclipse of moon, seen at Rome. It is added, that in the same night an island rose up in the Ægean sea.

A.D. 59, April 30. Large solar eclipse at Rome, mentioned by Tacitus and Pliny. It was reckoned among the prodigies, on account of the murder of Agrippinus, by Nero. The sun would appear of a crescent shape, being nine-tenths eclipsed about 1h. 40m.

A.D. 69, Oct. 18. Eclipse of moon, referred to by Dion Cassius, lib. 65.

A.D. 72, Feb. 22. A horizontal eclipse of the moon. Described further on.

Two phænomena at the end of the first century seem perplexing. Philostratus (*vitâ Apollon. Thian.*) says, that before the death of Domitian there appeared at Ephesus a corona like the iris round the sun, which obscured his light. Chambers ("Handbook of Astronomy") has called this the earliest mention of the corona, which is seen round the sun during total eclipses. Ricciolus has called it an annular eclipse, and the account reads like one; but there was no large eclipse of the sun in any year about this time. It is difficult to see what is alluded to, perhaps some peculiar solar halo, or mock sun, or other meteorological formation.

A.D. 83, Dec. 26. Plutarch speaks of an eclipse of the sun, about noon, that caused considerable gloom, the date of which is very hard to determine. After examining a great number of years about this time, I think it possible he may have had in mind the merely partial eclipse of the above date. The magnitude at Rome seems to have been about ten digits soon after noon. Though the total phase would run a long way to the southward, we may suppose, at this civilized period, accounts might be brought of it as easily to Rome, as of the total eclipse of 1842 from the south of France to London. Kepler fancied the eclipse of A.D. 113, June 1, might be meant. Tycho Brahe supposed it occurred in A.D. 97, but there does not seem to have been an eclipse visible at Rome that year, except a total one of the moon in October.

Second Century.

The last of the eclipses of Ptolemy were observed in this century, those in the years 125, 133, 134, 136.

Under the date of A.D. 192, it has been brought forward that Herodian says, "before the death of the Emperor Commodus stars were seen in the daytime." There was only a small solar eclipse at Rome on Feb. 29, A.D. 192; nor have I discovered a large one about that time.

Third Century.

A.D. 237, April 12. According to Julius Capitolinus, "so great was this eclipse of the sun, that people thought it was night, and nothing could be done without lights." Ricciolus has remarked that it happened about the time of the sixth persecution of the Christians, and when the young Gordian was proclaimed emperor. Struyk has put it down as total at Bologna, and he seems pretty correct. I obtain a great eclipse at Rome about 5h. 21m. afternoon, the total phase passing somewhat north of that city.

A.D. 291, May 15. In 7th year of Diocletian. Small solar eclipse, seen at Carthage. Mentioned by Idatius.

Fourth Century.

A.D. 306, July 27. Large solar eclipse in the year the Emperor Constantius died.

A.D. 316, July 6. An eclipse of the sun, seen at Constantinople, near sunrise.

A.D. 324, Aug. 6. According to Calvisius, thirteen cities in Campania were shattered by an earthquake in this year, and there was so great an eclipse of the sun, that the stars were seen at midday. The magnitude seems to have been scarcely three-fourths of the sun's

disc in Campania. The greatest obscurity, soon after 3h. p.m., night, in an Italian sky, bring out one or two of the planets.

A.D. 346, June 6. Eclipse of the sun, in the early morning. (Theophanes.)

A.D. 347, Oct. 19. Eclipse of sun, "anno 11 Constantii ut adnotat S. Hieronymus in Chronico Eusebii." (Ty. Br., *Hist. Cel.*)

A.D. 348, Oct. 9. Eclipse of sun, seen at Byzantium. (Theophanes.)

A.D. 364, June 16. Eclipse of sun, observed by Theon at Alexandria, began 3h. 18m., ended 5h. 15m.; also Nov. 25, eclipse of moon, spoken of by Theon in Comm. Ptolem.

A.D. 393, Nov. 20. Solar eclipse, seen at Rome and Constantinople.

Fifth Century.

A.D. 402, Nov. 11. Solar eclipse, mentioned by Idatius *in Fastis.*

A.D. 410, June 18. About the time that Alaric, king of the Visigoths, appeared before Rome, the gloom was such that stars appeared in the daytime. The size of this eclipse does not appear to have been very considerable; say about two-thirds of the sun, a few minutes after two o'clock. The central and annular phase must have exhibited itself far south of Rome. The same remarks will therefore apply to the darkness, as in the eclipse of A.D. 324.

A.D. 418, July 19. This eclipse is remarkable, from the fact that a comet, previously unseen, was detected during the sun's obscuration. It is the second case

of this sort on record, the first being mentioned by Seneca. In this instance, Philostorgius (xii. 8) says, that "on July 19, towards the eighth hour of the day, the sun was so eclipsed, that the stars were even visible. But, at the same time the sun was thus hid, a light in the form of a cone was seen in the sky." He also relates that the comet was seen for four months afterwards, and that it passed over the last star in the Bear's tail. I obtain about 12h. 39m. noon, as the time of the greatest phase at Constantinople, the place of observation, and a thin crescent uncovered at the northern part of the sun's face; according to which, the eclipse would be total a little southward of this point.

A.D. 451, Sept. 24. Moon eclipsed at its rising. (Idatius *in Fastis.*)

A.D. 452, Sept. 15. Trithenius speaks of an eclipse of the moon observed in the time of Merovæus (from whom the first race of French kings are called Merovingians). This will be the one referred to.

A.D. 453, Feb. 24. I take this to be the eclipse at the time Attila and the Huns made incursions and ravages. Projecting for Rome, about three-fourths of the sun's disc would be eclipsed at sunset. According to S. Gregory (Turonensis), "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."

A.D. 458, May 28. Eclipse of sun observed this day. (Idatius.)

A.D. 462, March 2. Lunar eclipse seen at Rome this night.

A.D. 485, May 29. An eclipse of the sun, referred by Tycho to Jan. 13, 484, is said to have turned day into night, causing "profound darkness, and the stars being seen." There is no doubt that of May 29, 485, is the correct phænomenon (that of 484 not being visible in Europe). It took place in the evening, and at Rome would be partial, the central and total eclipse passing far north of that city, but the place of observation is not given.

A.D. 486, May 18. Eclipse of the sun, seen at Constantinople (*ex vitâ Procli*).

Sixth Century.

A.D. 538, Feb. 15. It may be interesting to know which is the first eclipse on record, as seen in our own land. As might be expected, we have no mention of any till the sixth century. The "Saxon Chronicle" thus alludes to it: "This day was the sun eclipsed fourteen days before the calends of March, from early morning till nine." I make the greatest obscuration at London to have amounted to $8\frac{1}{2}$ digits about 7h. 43m. a.m. Tycho Brahe, from Calvisius, says it happened "in the fifth year of Henry, king of the West Saxons, at the first hour of the day, till nearly the third, or immediately after sunrise." 540 is given in the translations of the "Saxon Chronicle" as the date of an eclipse, which is said to have happened "on the 12th of the calends of July, and in which the stars shewed themselves full nigh half-an-hour after nine." The middle of the eclipse comes out at about 7h. 37m. a.m., at London, magnitude two-thirds of the sun's diameter. The moon's semi-diameter was almost as large as it

could be; the sun's semi-diameter nearly as small as possible. How are we to explain the notice of the stars shewing themselves, when totality would take place far south of this land? It may be, the narrative was borrowed from those who saw or heard of the phænomenon in more southerly countries. In two or three eclipses already mentioned we have inferred that an obscuration of two-thirds of the sun would be sufficient to bring out planets in the pure skies of southern climates. But in England it would hardly be likely to do so, even with a clear atmosphere. Those who witnessed the eclipses of 1860, 1867, and 1870 will be able to bear this out. Upon examining a few years preceding and following A.D. 540, I found that on Sept. 1, 536, there was an eclipse attaining its maximum at London about 12h. 37m. noon, the obscuration nine-tenths of the sun's diameter. Though we may not be entirely justified in substituting 536 for 540, yet English chronicles at this early date, sixty years before the arrival of S. Augustine, would be very vague, and probably put together long afterwards, from confused accounts. As it occurred in the middle of the day, the gloom would be more striking, and the stars more likely to be noticed. The Chronicle says the stars appeared "full nigh half-an-hour after nine." This may mean the ninth hour of the day, as it does elsewhere in the same work. But that is not much to be regarded, considering the Chronicle says the great eclipse of 1140 was "about the noon-tide of the day," and calculation shews it was near 3h. p.m.

A.D. 581, April 4. Eclipse of moon, mentioned by S. Gregory of Tours; also the next.

A.D. 582. Two total eclipses of the moon, March 25 and Sept. 18.

A.D. 590. "The sun in the month of October was so eclipsed, that it had scarcely the crescent of a five-night-old moon to give light." (S. Gregory of Tours.) The day I find to be Oct. 4, when there was a partial eclipse across France, not very large.

A.D. 592, March 19. Eclipse of sun, in the time of the Emperor Mauritius, "verno tempore, ut habent annales Constantinopolitani, Theophanes," &c.

A.D. 594, July 23. The exaggerated accounts of chronicles state that this eclipse lasted from morning to noon-day. But I find there was a solar eclipse in the early morning.

A.D. 596, Jan. 4. Eclipse of sun, seen in France. (Calvisius.)

SEVENTH CENTURY.

A.D. 603, Feb. 12. Eclipse of sun, large at Paris.

A.D. 644, Nov. 4. Eclipse of sun, mentioned by Cedrenus.

A.D. 650, Feb. 6. The year after Pope Martin held a synod to condemn the Monothelite heresy, an eclipse of the sun took place, which, according to the Danish astronomer Tycho, was seen in England. I find more than three-fourths of the sun's disc under obscuration at London at half-past 3 this afternoon.

A.D. 664, May 1. "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." (Saxon Chronicle.) Kepler thought this eclipse was total in England, and,

calculating for London, I find the sun so far eclipsed soon after 5h. in the evening, that there was only a thin crescent uncovered on the southern limb, according to which the totality would pass across this country some distance to the north of London.

A.D. 661, July 2. A solar eclipse, "three years after the southern Saxons in England embraced Christianity," according to Calvisius. It took place in the early morning, the sun rising eclipsed. About 4h. 23m. in the morning, nine-tenths of the upper limb would be obscured.

A.D. 671, Dec. 7. This is the date Mr. Hind has found for the eclipse of the sun at Medina, when the Caliph Moawiyah was going to remove the pulpit of Mahomet.

A.D. 680, June 17. An eclipse of the moon, mentioned by Anastasius; according to Struyk, it was seen at Paris about midnight.

A.D. 683, April 16 (midnight). The account states that the moon appeared covered with blood, and did not emerge from its obscurity till cock-crowing.

A.D. 693, Oct. 5. An eclipse of the sun, very large at Constantinople, where the stars were seen.

Eighth Century.

A.D. 716, April 12. "A wonder was brought about in the moon in the time of Pope Gregory," says Anastasius, "and she appeared like blood until the middle of the night."

A.D. 718, June 3. A solar eclipse, seen in Spain, spoken of by Isidorus; and very large at Constantinople, according to Struyk.

A.D. 733, Aug. 14. "In this year Ethelbald captured Somerton, and the sun was eclipsed, and all the sun's disk was like a black shield; and Acca was driven from his bishopric." (Saxon Chronicle.) The eclipse must be that of August 14, when I find a very large one occurred, which, by the tables I used, was annular in England, the greatest phase at London about ¼ past 8h. It is mentioned by several old writers, Tycho Brahe, Calvisius, Struyk, &c. In Humboldt's *Cosmos*, vol. iii. part 2, seventeen instances are given, in a note, of sudden diminutions of the light of day. Humboldt treats them as if they were meteorological phænomena, and, doubtless, some may be disposed of in that way; as, for instance, that in 45 B.C., about the death of Cæsar, but not all; and in his notice under A.D. 733 the above eclipse is probably alluded to. "A year after the Arabs had been driven back beyond the Pyrenees, as the result of the battle of Tours, the sun was darkened on the 19th of August, in a terrifying manner." (Schnur Chron.)

A.D. 734. Jan. 24. The next eclipse referred to in the "Saxon Chronicle" is connected with the death of a noted ecclesiastic. "In this year," the Chronicle relates, "the moon was as if it had been sprinkled with blood, and Archbishop Tatwine and Beda [c] died."

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[c] Amid the animosities of the present day, we cannot refrain from quoting the following with regard to S. Bede. As to "his desire that prayers should be said for him, and masses offered after he was dead, it is plain that he did not ask for them in expectation that they would help his soul out of purgatory, for he died in joyful confidence that his labours had been accepted, and that he should soon be with Christ. He believed that in the Holy Communion it was fit that a re-

I find a total eclipse of the moon, early on the above morning, commencing about 1h. 2m. and ceasing 4h. 38m. The total phase, when the moon would appear coppery, "as if sprinkled with blood," would last from 2h. 4m. to 3h. 37m. The eclipse would consequently be a few months before the death of Venerable Bede, for he is said to have lived on till the eve of Ascension-day, May 26, that year; then, seeing his end approaching, to have taken farewell of those in the monastery, and to have sunk down from his seat to the floor, uttering as his last words, "Glory be to the Father, and to the Son, and to the Holy Ghost."

A.D. 752, July 30. An eclipse of the moon, seen in England.

A.D. 753. An eclipse of the sun, seen on Jan. 9. At the following full moon, on the night of Jan. 23, "the moon was covered with a horrid black shield."—(Tycho Brahe, and Calvisius.) As I find an eclipse of the moon in the middle of this night, may we infer from the description that this was one of those rare cases when the moon becomes dark during the eclipse, instead of assuming the copper tint?

A.D. 755, Nov. 23, 7h. An eclipse of the moon, seen in England, which is said to have been "total close to

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membrance should be made of the faithful departed, and that God should be entreated to keep them, as it is His will, in mercy and peace, until the resurrection of the last day. It were well if such a prayer had never been perverted to dangerous superstitions, and if it had been thus retained, as it was in the first Communion Service put forth for the use of the English Church after the Reformation, the first Prayer-book in King Edward VI.'s reign."—*Churton's Early English Church.*

the eye of the Bull," (that is, the bright red star Aldebaran). It is added, that the moon was the same distance on one side of the star when it began to be obscured, as it was on the other side when it recovered its light.

A.D. 760, Aug. 15. An eclipse of the sun was seen at Constantinople on this day. (Theophanes.)

A.D. 764, June 4. An eclipse of the sun, about midday, seen in France and England.

A.D. 787, Sept. 16. A large eclipse of the sun, seen at Constantinople in the time of Constantine VI., emperor of the East.

A.D. 796, March 28. "In this year the moon was eclipsed between cock-crowing and dawn, on the 5th of the calends of April; and Erdwulf succeeded to the kingdom of the Northumbrians on the 2nd of the ides of May." (Saxon Chronicle.) This would signify between 3h. and 6h. in the morning, the method of dividing the night into equal portions of three hours each, being long continued by historians. The eclipse began about 4h. a.m., was total for nearly an hour, and ended about half-past 7h., so the moon would set totally eclipsed.

Ninth Century.

A.D. 800, Jan. 15. "This year the moon was eclipsed at 8h. in the evening, on the 17th day before the calends of February; and soon after died King Bertram, and Ealdorman Worr." (Saxon Chronicle.) I find a large lunar eclipse on this night, beginning at seven o'clock, middle 8h. 34m., when nine-tenths

of the moon's upper limb would be obscured, end 10h. 8m.

A.D. 802, May 21. "This year was the moon eclipsed at dawn on the 13th of the calends of January," (December 20). Some mistake about the date in the translations of the "Saxon Chronicle." The December full moon will not answer in 800, 801, nor 802. I believe the eclipse referred to occurred on May 21, 802. It seems to have come on about 2h. 20m., that morning, and to have been almost total about 3h. 55m., near the time of sunrise.

A.D. 806, Sept. 1. "This year was the moon eclipsed on the 1st of September; Erdwulf, king of the Northumbrians, was banished from his dominions, and Eanbert, Bishop of Hexham, departed this life." (Saxon Chronicle.) I find a total eclipse of the moon this evening lasted from about 8h. 25m. till after midnight. Totality, according to the tables employed, was from 9h. 37m. to 10h. 59m.

A.D. 807, Feb. 11. An eclipse of the sun, amounting to about three-fourths of his disc, was seen in England and France about 10¼h. a.m.

Two total eclipses of the moon were seen at Paris, Feb. 26, Aug. 22.

A.D. 809, July 16. "In this year the sun was eclipsed in the beginning of the fifth hour of the day, on the 17th of the calends of August, on the second day of the week, the 29th of the moon." (Saxon Chronicle.) I find an eclipse on July 16, not, however, very remarkable; greatest phase at London about 9h. 22m. a.m., when the magnitude was seven-tenths of the sun's upper limb. North of London the eclipse would be

larger. By the fifth hour of the day, we must, no doubt, understand the fifth hour from sunrise. So the account in the Chronicle is very exact.

A.D. 810. Three eclipses in France this year: a total one of the moon on the evening of June 20; another of the moon early in the morning of Dec. 14; and one of the sun, November 30, which must have been very large at Paris.

A.D. 812, May 14. Solar eclipse at Constantinople, in the afternoon. (Ricciolus.)

A.D. 813, May 4. Eclipse of the sun, seen in Cappadocia early in the morning, in the last year of the Emperor Michael Curopolites, and the first of Leo Armen.

A.D. 817, Feb. 15. An eclipse of the moon was observed early this evening at Paris, and it is added that the same night a comet was noticed.

A.D. 818, July 7. Eclipse of sun, seen at Paris early in the morning. (Aimoinus.)

A.D. 820, Nov. 23. Total eclipse of moon, seen in France early this evening.

A.D. 824, March 18. Total eclipse of moon, seen in France before the death of the pope, Paschal I.

A.D. 828. Two total eclipses of the moon mark this year; one seen in France, July 1, very early in the morning, the other in England and France on Christmas morning. The "Saxon Chronicle" has this notice of the last: "In this year the moon was eclipsed on midwinter's mass night; and the same year, King Egbert subdued the kingdom of the Mercians, and all that was south of the Humber." It commenced about a quarter-of-an-hour past midnight, and, after

passing through a total phase for 40 min., terminated about 4h. a.m. It must have taken place about the time historians say Egbert triumphed over all opponents, and united the several Anglo-Saxon kingdoms into one powerful monarchy. It is just alluded to in Tycho Brahe's *Historia Celestis:* "Eclipsis lunæ altera die Nativitatis Christi circa mediam noctem."

A.D. 831. Three eclipses observed in France this year; a total one of the moon on the evening of April 30, of which only the end would be visible; one of the sun on May 16; and another total one of the moon on October 24.

A.D. 840, May 5. In the troubled and unquiet days of this century, we have the two most noted eclipses of the sun on record in Europe, those of A.D. 840 and 885. The darkness in each case has been found, by recent investigations, to have lasted longer than was once supposed possible in these latitudes. In the eclipse of A.D. 840, total darkness continued upwards of five minutes across what is now called Bavaria. It took place in the middle of the day, and with the sun high in the sky. It was noticed, as far back as this, how everything gradually changed colour during the obscurity. We are told, "there seemed no difference from the reality of night, that the stars shone out without any sensible diminution of light." It is recorded that Louis[d], the Emperor

[d] "Louis acquired the surname of 'the Pious.' He spent the whole time of Lent in singing psalms, prayer, attendance on divine service, distributing alms, and other works of piety; so that he scarcely mounted his horse, and took exercise, more than two or three days the whole time."—*Palmer.*

of the West, died a little while after it, and he seems never to have recovered the fright he received from the eclipse.

A.D. 842, March 30. Eclipse of the moon, seen in France this morning. (Ricciolus.)

A.D. 878, October 29. Total solar eclipse at London, in the time of King Alfred. After a lunar eclipse seen in France on Oct. 15, we come to one of the sun on the 29th, which is pointed to in the translations of the "Saxon Chronicle" by the following meagre notice, under the date of 879: "The sun was eclipsed one hour of the day." No month is given. On examining the new moons, I found no visible solar eclipses that year, but in 878 a great one. The tables I used gave totality at London about 1h. 14m., and Mr. Hind, by a more recent calculation, found that total darkness came on at 1h. 16m. 20s., and lasted nearly two minutes. A note in Thorpe's translation of the Chronicle, says "the eclipse happened on March 14, 880;" but as that one turns out to be near sunset, and nowhere total, it will not be the one here signified. I have examined the years from 878 to 1715, but without finding one other eclipse of the sun total at London in this long interval. Tycho Brahe's *Historia Celestis* gives the following account of this eclipse of 878: "Ait autem auctor vitæ Ludovici solem post horam nonam ita obscuratum esse, ut stellæ in cœlo apparerent, et omnes sibi noctem imminere putarent."

A.D. 881, Aug. 28. An eclipse of the sun seen in France, according to Calvisius.

A.D. 885, June 16. A great total eclipse of the sun, mentioned in the *Chronicon Scotorum*, but not

alluded to in the "Saxon Chronicle." It was seen in Ireland, but its full grandeur would be developed across Scotland, where, from the moon being near perigee, and the sun near apogee, its duration was nearly five minutes.

Tenth Century.

A.D. 901, Jan. 23. Eclipse of sun, observed by Albategnius at Antioch, "obscurata est semissis et paulo plus de sole;" also one of the moon, Aug. 3.

A.D. 904. "This year the moon was eclipsed." "Saxon Chronicle." I find two total eclipses of the moon. One on May 31; beginning, by the tables I used, 9h. 22m.; totality commencing, 10h. 23m.; end of totality, 12h. 4m.; end of the eclipse, 1h. 5m. next morning. The other eclipse was on Nov. 25; beginning, 7h. 22m.; total darkness began, 8h. 31m.; terminated, 9h. 42m.; end of eclipse, 10h. 51m. Tycho Brahe speaks of one of them in the following quaint way in his *Historia Celestis:* "A great eclipse of the moon happened this year, says Cedrenus, and if anyone, terrified at it, should ask what it meant, the answer is, that by this eclipse death is foretold to a kinsman of the emperor."

A.D. 912, Jan. 7. Lunar eclipse seen in England, in the time of King Edward.

A.D. 926, March 31. A total eclipse of the moon, seen at Paris; the moon getting clear of the shadow just as it was beginning to dawn. (Frodoard.)

A.D. 934, April 16. A solar eclipse, supposed to be a sign of the death of the emperor. (Calvisius.) But this did not take place for two years.

A.D. 939, July 19. A large eclipse of the sun was observed in Spain a little before the victory of Rameses II. over the Saracens.

A.D. 961, May 17. "A sign placed in the sun," says Hermannus Contractus, "by which words he indicates an eclipse of the sun in this year, in the which Otto proceeded into Italy." (Tycho Brahe, and Calvisius.)

A.D. 968, Dec. 22. I make this eclipse to have been almost total at London about 8h. 33m. a.m., or soon after sunrise. It was observed on the continent, according to Cedrenus.

A.D. 977, Dec. 13. Eclipse of sun, observed at Cairo; beginning, 8h. 25m.; end, 10h. 45m.; dig., 8; sun's altitude at beginning, 15° 43′; at end, $33\frac{1}{2}°$.

A.D. 978, June 8. The sun was observed eclipsed at the same place; beginning, 2h. 31m.; end, 4h. 50m. These eclipses have been used in determining the moon's secular acceleration. Dr. Vince remarks that "the astronomical tables have been found to represent the moon's place in these two eclipses of 977 and 978 before its true position, and in more ancient eclipses behind its true place. It follows, then, that its mean motion in ancient times was slower, and in latter times quicker, than the tables give; therefore, it must have been accelerated. There must also have been a time when the tables would give the true place; and, although the ancient observations of the times of the eclipses were not very accurate, yet they were sufficiently so, to prove, beyond all doubt, that the moon's motion is greater at this time than it was when the ancient eclipses were observed."

ELEVENTH CENTURY.

A.D. 1009, Oct. 6. The moon was "changed into blood," this year, according to Belgian Chronicles. I find there was a total eclipse this night.

A.D. 1010, March 18. Eclipse of the sun, mentioned by Sigebert.

A.D. 1020, Sept. 5. Eclipse of moon, seen at Cologne this night.

A.D. 1023, Jan. 24. This must have been a very large solar eclipse at London. The greatest phase fell about noonday. Struyk says the magnitude there was 11 digits, but I find an obscuration somewhat larger than this. Still, London appears to lie south of the line of totality.

A.D. 1033, June 29. An eclipse of the sun, spoken of by all the writers of this time. Projecting for London, I find the magnitude about eight-tenths on the sun's lower limb at 10h. 50m. in the morning, leaving therefore a crescent of a fifth part of his disc still bright. Glaber, an eye-witness, writes, 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 very sun became of a sapphire colour; in its upper part having the likeness of a fourth part of the moon."

A.D. 1037, April 18. A solar eclipse, very large in France, where it is recorded that the sun looked like the crescent of a new moon two nights old.

A.D. 1031, Aug. 31. An eclipse of the sun, large in France, said to have been observed after the death of Conrad II. Tycho gives 1039 as the date, but as Conrad died in 1030, is not the above the right eclipse?

A.D. 1044, Nov. 8. A large partial eclipse of the moon was observed the morning of this day. In the following words, Glaber, a writer of this century, describes the phænomenon: "In what manner it happened, whether a prodigy brought to pass by the Deity, or by the intervention of some heavenly body, remains known to the author of knowledge. For the moon herself became like dark blood, only getting clear of it a little before the dawn." A fragment of an old French Chronicle says it happened between the Hyades and the Pleiades.

A.D. 1056, April 2. A total lunar eclipse, about midnight, in which we are informed "the whole of the moon became darkened like a glowing coal, after the first cock-crowing, and then recovered its light." Nuremberg is one of the places where it is recorded to have been seen.

A.D. 1078, Jan. 30. The only eclipse this century, of which we are favoured with an account in the "Saxon Chronicle." It goes thus: "In this year, the moon was eclipsed three nights before Candlemas, and Ægelwig, the 'world-wise' abbot of Evesham, died on S. Juliana's mass-day (Feb. 16), and in this year was the dry summer, and wildfire came in many shires, and burnt many towns." I find a total eclipse of the moon on the evening of Jan. 30. At London, the moon would first touch the umbra of the earth about 6h. 11m., totality commencing 7h. 16m., and continuing till 8h. 58m., and the eclipse would be over 10h. 3m.

A.D. 1093, Sept. 3. Eclipse of sun, observed at Augsburg.

A.D. 1096. Two total eclipses of the moon observed

this year in Europe; one on the morning of Feb. 11, the other early in the evening of Aug. 6. In both cases the moon dipped very deeply into the earth's shadow. Tycho Brahe says these two eclipses are recorded by many writers.

A.D. 1098, Christmas-day. An eclipse of the sun, seen at Augsburg.

A.D. 1099, Nov. 30. The year in which Pope Urban II. died, we are told by Calvisius and Tycho Brahe there was an eclipse of the moon, and that it took place on June 5, when the moon was rising. Now, I find scarcely anything of that eclipse would be seen in Europe, the moon being below the horizon. There was, however, a total one on Nov. 30, the moon rising eclipsed, but a great part of the phænomenon would be visible here. The latter seems, therefore, to be the eclipse alluded to.

Twelfth Century.

A.D. 1110, May 5. A curious total eclipse of the moon observed in England. Described further on.

A.D. 1113, March 19. Eclipse of the sun, in the morning, seen at Jerusalem by William of Tyre.

A.D. 1114, Aug. 18 (morn). A total eclipse of the moon seen in England. The "Saxon Chronicle," which does not mention it, speaks of other phænomena during the year. "In the latter end of May was seen an uncommon star with a long train, shining many nights. In this year was so great an ebb of the tide everywhere in one day, as no man remembered before; and men went riding and walking over the Thames eastward of London Bridge."

A.D. 1117, June 16, Dec. 10. The first was a total eclipse of the moon, seen in France; the latter is thus spoken of in the "Saxon Chronicle." "In the night of the 3rd day before the ides of December was the moon during a long time of the night as if covered with blood." I find the eclipse began about 10h. 35m., became total 11h. 36m., continued so till 1h. 17m., and ended 2h. 17m. (morning).

A.D. 1121, April 4. "The moon was eclipsed on the night of the nones of April, being a fortnight old." Calculating for London, I find the eclipse began 7h. 23m., and lasted till about 11h. 19m.

A.D. 1124, Aug. 11. An eclipse of the sun observed in England between 11h. and 12h. in the day.

A.D. 1133, Aug. 2. One of the most noted eclipses in mediæval times. The "Saxon Chronicle" describes it in this fashion, the translations giving the date of 1135: "In this year went the King Henry over sea at Lammas, and the next day, as he lay asleep on ship, the day darkened over all lands; and the sun was all, as it were, a three-night old moon, and the stars about him at midday. Men said a great event would come, and the same year was the king dead, the day after S. Andrew's mass-day in Normandy." There is a mistake about the date the translations have given. Henry I. died in 1135; but at the new moon, in August of that year, I find there was no eclipse. On August 2, the day after Lammas, 1133, an eclipse took place which thoroughly answers the conditions. At London that morning nearly nine-tenths of the sun's disc were obscured. In Scotland the eclipse was total. William of Malmesbury, speaking of the death

of King Henry I., writes: "The elements manifested their sorrow at this great man's last departure; for the sun, on that day, at the 6th hour, shrouded his glorious face, as the poet's say, in hideous darkness, agitating the hearts of men by an eclipse; and, on the sixth day in 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." According to Calvisius it was seen in Flanders, and the stars appeared.

A.D. 1135, Dec. 22. At the death of Henry I., it is recorded by Matthew Paris, "lunam nunquam comparuisse," by which words a total eclipse of the moon is clearly indicated. It happened after the death of Henry, on the day on which Stephen was crowned. I find only the first part of this eclipse would be visible in our land, the moon setting before the middle.

A.D. 1140, March 20. A total eclipse of the sun in England. The "Saxon Chronicle" relates: "In the Lent, the sun and the day darkened, about the noon-tide of the day, when men were eating, and they lighted candles to eat by. That was the 13th day before the calends of April. Men were very much struck with wonder." William of Malmesbury records: "During this year, in Lent, on the 13th of the calends of April, there was an eclipse throughout England, as I have heard. With us and with all our neighbours, at the ninth hour of the fourth day of the week, the obscuration was so remarkable, that people said chaos was come again, since it was Lent. 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." According to the tables I used, the greatest obscuration of this eclipse took place at London at 2h. 36m., when a narrow crescent was uncovered at the south of the sun, shewing the line of totality must have gone north of London, a result not agreeing with Dr. Halley's. Halley said it was the total eclipse in London preceding that of 1715. This statement is now known to be an error. Tycho Brahe in his *Historia Celestis*, says the magnitude at London was 11° 38′, and he, with inferior tables to Halley, proves correct. Mr. Hind has shewn that the central line of totality crossed over Aberystwith, Stafford, and Lincoln, and that Northampton and Norwich were on the southern boundary.

A.D. 1147, Oct. 26. Solar eclipse, seen in France. It is said to have occurred after the departure of Conrad into Palestine.

A.D. 1150, Mar. 15. Eclipse of moon, total. (Calvisius.)

A.D. 1153, Jan. 26. A solar eclipse is obscurely recorded by historians on this day, when they state "something singular happened to the sun, the day after the Conversion of St. Paul." I find an eclipse of the sun, which at Augsburg appears to have been pretty large.

A.D. 1161, Aug. 7. Total eclipse of moon, seen at its rising. (Calvisius.)

A.D. 1172, Jan. 12. An eclipse of the moon this winter is said by historians to have lasted about four hours. It was total, and occurred on the above night. Cologne was one of the places where it was seen.

A.D. 1178, Mar. 5. An eclipse of the moon is re-

corded by the Monk of Cologne, who states that "half of it was darkened for the space of one hour, and the other half remained bright."

A.D. 1178, Sept. 13. A large partial solar eclipse observed at Cologne. Calculating for that place, I find about eight-tenths of the sun's disc obscured a little before noon.

A.D. 1179, Aug. 19. A total eclipse of the moon seen at Cologne early in the morning. The account states that it lasted from the middle of the night till sunrise.

A.D. 1180, Jan. 28. Large eclipse of the sun seen in France. (Calvisius.)

A.D. 1181, July 13. Partial eclipse of the sun (not large,) observed, in France, near the time of the death of Louis VII.

A.D. 1185, May 1. A solar eclipse of some note. It was observed, amongst other places, at Rheims, in France. In Scotland, Tycho Brahe says it was total, and he seems correct. At London, I find between eight and nine-tenths of the sun's upper limb covered soon after two o'clock.

A.D. 1186, April 5. An eclipse of the moon on the eve of Palm Sunday is mentioned by a monk of Cologne. The monk thought it was partial, because the moon rose when the shadow was going off her face. I find, however, it was total, and the moon would rise during the phænomenon at Cologne.

A.D. 1186, April 21. The Arabians speak of an eclipse of the sun on this day, in the year of the Hegira 582; but it was not large, and probably recorded as being in the same year as the celebrated conjunction of all the planets.

A.D. 1187, Sept. 4. This solar eclipse occurred in the time of the Crusades, in the year in which Saladin defeated the crusaders at Tiberias, re-took Jerusalem, and made prisoner its sovereign, Guy of Lusignan. The eclipse was large at Jerusalem, and the stars are said to have been seen.

A.D. 1189, Feb. 2. Partial eclipse of moon seen in England, and on the continent.

A.D. 1191, June 23. A great solar eclipse is mentioned by English writers as having been seen on the vigil of St. John the Baptist, in this year. It happened in the middle of the day. The moon's semi-diameter was very small, so that it could only be annular.

A.D. 1192, Nov. 21. Partial lunar eclipse (morning). A French observation.

A.D. 1193, Nov. 10. Total lunar eclipse, during which the moon rose. Another French observation.

Thirteenth Century.

A.D. 1204, April 15. A total eclipse of the moon, about midnight. It is recorded to have happened after Alexius III., the Emperor of the East, was dethroned. It was also observed in England.

A.D. 1207, Feb. 28. Eclipse of sun, spoken of by several historians.

A.D. 1208, Feb. 2. Eclipse of moon, seen early this evening. The total phase would be of long continuance.

A.D. 1215, Mar. 17. A total eclipse of the moon, seen at Cologne, "from cock-crowing to sunrise."

A.D. 1230, May 14. Great solar eclipse about sun-

rise. It is said the night appeared to be prolonged by it. (Calvisius.)

A.D. 1232, Oct. 15. Small eclipse of sun, mentioned by a monk of Cologne.

A.D. 1239, June 13. Eclipse of sun, 11h. a.m. (Calvisius.)

A.D. 1241, Oct. 6. Solar eclipse, spoken of in the *Historia Celestis* of Tycho Brahe. He states that "a few stars appeared about noonday, and the sun was hidden from sight in a clear sky." I find it would be seen in this country, as a large partial eclipse, between the hours of eleven and twelve. Humboldt, in *Cosmos*, vol. iii. pt. 2, has the following in a note: "1241. Five months after the Mongol battle of Leignitz, obscuratus est sol (in quibusdam locis ?) et factæ sunt tenebræ, ita ut stellæ viderentur in cœlo, circa festum S. Michaelis hora nona.—*Chronicle of the Neuburg Convent near Vienna.*"

A.D. 1248, June 7. An eclipse of the moon is recorded to have been seen in England, soon after sunset, this day. I find it was total, and the moon would rise eclipsed.

A.D. 1255, July 20. Another total eclipse of the moon, seen in England, after sunset.

A.D. 1263, Aug. 5. An eclipse of the sun observed at Augsburg, where it would be of considerable magnitude. (Calvisius.)

A.D. 1267, May 25. A large solar eclipse, mentioned by Nicephorus Gregoras. It was seen at Constantinople. I find the semi-diameters of the sun and moon almost exactly alike.

A.D. 1272, Aug. 10. Partial eclipse of the moon,

seen this evening at Vienna. I find the moon would rise after the commencement.

A.D. 1274, Jan. 23. A lunar eclipse took place this night, which is recorded to have been seen at Vienna. Tycho Brahe says that Gerard Mercator (the author of the projection of the world inserted in some Atlases,) found an account of it in an old book.

A.D. 1279, April 12. Eclipse of the sun, seen at Frankfort, a little before sunset. This one is also mentioned by Mercator.

A.D. 1290, Sept. 5. Large solar eclipse across central Europe. (Spangenbergius.)

FOURTEENTH CENTURY.

A.D. 1307, April 3. Small eclipse of sun, seen in northern Italy.

A.D. 1310, Jan. 31. A solar eclipse mentioned by Spangenbergius. It is said to have been seen at Wittemberg.

A.D. 1312, July 5. Eclipse of sun, (not large,) about midday. (Calvisius.)

A.D. 1321, June 26. An eclipse of sun early in the morning, mentioned in Bohemian history. The semi-diameters of the sun and moon turn out pretty nearly alike, and both very small.

A.D. 1327, Sept. 1. Total eclipse of moon, just before sunrise, seen at Constantinople.

A.D. 1328, Feb. 25. An eclipse of the moon, recorded to have been seen at Constantinople in the beginning of spring this year.

A.D. 1330, July 16. Eclipse of the sun, recorded in Bohemian Chronicles. It was observed also at Con-

stantinople; and, I find, it would be a large eclipse across Great Britain, but the semi-diameters would be very similar.

A.D. 1331, Nov. 30, Dec. 15. The first was an eclipse of the sun, about sunrise; the latter, one of the moon; both observed at Prague.

A.D. 1338, Feb. 5. An eclipse of the moon, recorded by Nicephorus Gregoras. We are informed that when the moon "rose, it was almost all darkened, and therefore all the more notable and striking." The place of observation is not given, but, no doubt, it would be Constantinople. I find an eclipse this afternoon, in the latter part of which the moon would be above the horizon there.

A.D. 1339, July 7. Eclipse of the sun, about midday. (Calvisius.)

Supposed eclipse at the battle of Cressy. History tells us of an eclipse of the sun at the battle of Cressy, August 26, A.D. 1346. Lingard, in his History of England, Edw. III., uses these words: "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, the precursors of a storm, flew screaming over the two armies, and the rain fell in torrents, accompanied by incessant thunder and lightning. About five in the afternoon the weather cleared up, the sun in full splendour darted his rays in the eyes of the enemy." I find there was no eclipse at all. There were two eclipses of the sun this year, Feb. 21 and Aug. 17, but neither was visible in Europe. From the account in Lingard's history, the atmosphere appears to have been in a dis-

turbed condition; so the supposed solar eclipse was evidently nothing more than a dark cloud, or some meteorological phænomenon.

A.D. 1349, June 30. This eclipse is referred to by Calvisius. Churton, in his "History of the Early English Church," has the following: "The worthy Abp. Bradwardine, who flourished in the reign of the Norman Edwards, and died A.D. 1349, tells a story of a witch, who was attempting to impose on the simple people of the time. It was a fine summer's night, and the moon was suddenly eclipsed. 'Make me good amends,' said she, 'for old wrongs, or I will bid the sun also to withdraw his light from you.' Bradwardine, who had studied the Arabian astronomers, was more than a match for this simple trick, without calling in the aid of the Saxon law. 'Tell me,' he said, 'at what time you will do this, and we will believe you; or, if you will not tell me, I will tell you, when the sun or the moon will next be darkened, in what part of their orb the darkness will begin, how far it will spread, and how long it will continue.' It is needless to add that the witch was quite dumb-founded. This was 200 years before the Reformation. How miserable to think that 100 years after it, in the sixteen years of Cromwell and the Long Parliament, more than 300 unhappy persons were tried for witchcraft, and the greater part were executed. There had been only fifteen executions for a century before, and probably not so many suffered by Saxon ordeals." Bradwardine was only archbishop for one year, A.D. 1349, and we are told the eclipse was on a fine summer's night. It was, therefore, that of June 30, 1349. Cal-

culating for London, I find the moon first touched the earth's shadow about 9h. 26m., became totally immersed 10h. 24m., totality ending 12h. 4m., and the eclipse 13h. 2m.

A.D. 1354, Sept. 17. An eclipse of the sun was observed this morning. Said to be about the time Charles IV. proceeded into Italy. (Calvisius.)

A.D. 1361, May 5. Large solar eclipse, seen at Constantinople.

A.D. 1386. An eclipse of the sun Jan. 1, was total in the south of France.

Fifteenth Century.

A.D. 1406, June 1. Total eclipse of moon, seen at Constantinople.

A.D. 1406, June 16. A great solar eclipse, early in the morning. I find the greatest phase at London about 6 o'clock, when the sun was eclipsed to the extent of nine-tenths on the lower limb. Hence, totality passed a trifle south of England. Accounts state the darkness was such that "one person could hardly recognise another."

A.D. 1415, June 7. Solar eclipse, which is related to have happened after the feast of Corpus Christi. Total in the south of France. In Bohemia, we are told that "birds terrified with the sudden darkness fell down dead."

A.D. 1424, June 26. Another total eclipse of the sun in Europe this afternoon. At Wittemberg it appears to have been observed nearly total.

A.D. 1433, June 17. A noted solar eclipse. It was total across Scotland, including Edinburgh, also in

Northumberland. The total phase was exhibited about three in the afternoon, and for generations afterwards it went by the name of the "black hour." The moon's semi-diameter was very large, the sun's very small. Calvisius tells us that in Turkey, "near evening, the light of the sun was so overpowered that darkness covered the land."

A.D. 1438, Sept. 19. The eclipse of the sun that was seen at the death of Edward, king of Portugal.

A.D. 1448, August 29. Eclipse of sun, seen at Tubingen.

A.D. 1457, Sept. 3. Total eclipse of the moon, observed near Vienna by George Purbach and his pupil, John Muller, who generally went by the name of Regiomontanus. A volume by Regiomontanus is in the library of the Royal Astronomical Society at London. It contains positions of the planets for each day from 1474 to 1506, a calendar for every month, the festivals of the Church, coloured figures of the eclipses, with the number of digits obscured. Scarcely any copies of this rare, early printed work, that are perfect, remain.

A.D. 1460, July 3. Partial eclipse of moon; Dec. 28, total eclipse of moon. Both observations of Regiomontanus.

A.D. 1460, July 18. The sun would rise eclipsed, the morning of this day, to Great Britain. In Austria and the Turkish dominions it was a great eclipse. The accounts tell us that "when day began, the sun lost his light to such an extent that everything was wrapt in darkness."

A.D. 1461, June 22, Dec. 17. Two total eclipses of the moon, both observed by Regiomontanus. Only

the latter portion of that on Dec. 17 would be visible in Europe.

A.D. 1464, April 22. Total eclipse of moon, seen at Padua in the morning.

A.D. 1471, June 2. Partial eclipse of the moon. It is mentioned by Tycho in his *Historia Celestis*, and he adds, "the end was not observed owing to the intervention of clouds."

A.D. 1485, March 16. A very large solar eclipse the afternoon of this day. We are informed that there was intense gloom, and nothing was done without artificial light. Fowls and other animals betook themselves to their nightly resting-places. Crusius says candles had to be lighted between the hours of four and five. Nuremberg is mentioned as one of the places where the eclipse was seen. The total phase would pass south of this country.

A.D. 1493, April 2. This is the lunar eclipse taken by Ricciolus to be the one that was of such use to Christopher Columbus. There seems, however, a little doubt which of Columbus' voyages is referred to. The eclipse on the evening of March 1, 1504, has also been given as the correct date. When the celebrated voyager was in great distress for want of provisions, which the natives refused to supply, he told them the moon would be darkened on a certain day to shew the anger of heaven at their conduct to him. This was at first treated with unconcern. But when the eclipse was seen gradually creeping over the moon, the barbarians were so terrified that they strove who should be the first in bringing him all sorts of provisions, and threw them down at his feet, imploring his forgiveness.

SIXTEENTH CENTURY.

As the design of this little work was mainly to give the eclipses in ancient and mediæval times, we shall now only notice a few of the most remarkable.

A.D. 1530, March 29. Kepler tells us this solar eclipse was seen by his uncle, and that "when the day had only become light, it was extinguished, and turned into night." In England I find the sun would not be up.

A.D. 1540, April 7. The sun would not be risen in England, but this would be an important eclipse, and slightly total in countries lying more easterly. Cyprianus Leovitius, in the preface to his work on eclipses, to which we have already alluded, thus speaks of it: "Anno nativitatis 1540, quum Wratislaniæ essem, fuit eclipsis solis penè integra in Ariete, quæ in ipso ortu prorsus horribilis apparuit, quum statim æstus gravissimus, cum siccitate magnâ, et annonæ caritatis subsequebant."

A.D. 1544, Jan. 24. An eclipse of the sun, in which the semi-diameters of the two luminaries would be similar. Tycho Brahe tells us it was "observata Lovanii à Gemma Frisio per foramen fenestræ dig. 10." Kepler says that the day began to become dark, as if in evening twilight, and the birds, which from break of day had been singing, became mute. Leovitius alludes to it in these words: "Similiter anno 1544, die 24 Januarii, cum gravium virorum consuetudine Lipsiæ uterer, fuit eclipsis solis integra in Aquario, ita ut ipso die tenebræ quasi suborirentur; erat autem alioquin tempestas nebulosa, quæ tenebras illas augebat." In

the days of Leovitius, of course, no astronomical work could be found without a strong smattering of astrology; and he informs us that this eclipse was the precursor of wars in Germany, famine, pestilence, &c.; that in 1551 of "dangerous changes in religion, the death of Pope Paul, and other events, as many know."

A.D. 1560, Aug. 21. A noted eclipse of the sun, total in Spain and Portugal, observed at Coimbra by Clavius, who says, "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." P. Emmanuel Vega gives a still more highflown description. He says it "lasted for three hours, amid the screams of women, who cried out that the last day of the world had arrived, never were the stars so bright, and men could scarcely see each other in their houses, and there was need of lights." Tycho Brahe, not admitting any total eclipses of the sun, did not believe this account, and wrote to Clavius to that effect in the year 1600, as Kepler informs us. I make the middle of this eclipse to have occurred at Coimbra a few minutes after eleven. Leovitius has drawn it for Augsburg as an eclipse of $7\frac{1}{2}$ digits on the lower limb, too small a magnitude for that place; but he makes the moon's semi-diameter $17' 22''$, a much larger magnitude than it can ever attain, just an opposite result to what Tycho would have given.

A.D. 1567, April 9. Annular eclipse of the sun, observed by Christopher Clavius at Rome. He says, that

"the whole sun was not eclipsed, but there was left a certain bright circle all round." Tycho relates that he saw it, when he was a young man, on the shores of the Baltic. Cornelius Gemma, at Louvain, observed that it "began at 10h. 12m., was at its height (vigorem) 11h. 40m., and ended a little after 12½h., digits nearly 9. The light was very pale, and it looked like evening, but no stars came out." Kepler thought the bright circle was a dense portion of the æther inflamed by contact with the sun, or else the margin of the sun enlarged in some optical manner by the refraction of his rays around the moon. Calculating for Rome, I make the eclipse annular there at 12h. 20m. (noon), but the augmentation of the moon's semi-diameter would almost produce totality.

A.D. 1598, Feb. 25, "The Black Saturday." For generations afterwards the day went by this name. The sun was totally eclipsed in the morning in Scotland, Edinburgh being within the zone of complete obscurity.

Seventeenth Century.

A.D. 1610, July 6. An eclipse of the moon the morning of this day deserves notice, simply because it must be the first that was ever viewed through a telescope. The observer is not stated, but there is the following remark about it in the Supplement to the *Historia Celestis:* "The beginning of the eclipse of the moon, as observed through the Roman telescope, appeared like a dark thread in contact with the shadow." The eclipse of the sun, May 30, 1612, is also recorded to have been seen "through a tube," and it is added,

"the spots on the sun then appeared darker than the moon."

A.D. 1620. Two peculiar total eclipses of the moon. Described further on.

A.D. 1630, June 10. A large solar eclipse. Gassendi, at Paris, observed the beginning at 6h. 16m., middle, 7h. 12m. p.m., dig. ecl. 11° 32′. Dr. Bainbridge, at Oxford, found the commencement 5h. 58m., termination 7h. 48m.

A.D. 1652, April 8. The last eclipse of the sun that was total in Scotland. Our Scotch neighbours will not get another, in any county, till the twenty-second century. The eclipse of 1652 went by the name of "Black Monday," for a long while afterwards. At London the middle was found to be at 10h. 29m., digits 11°. Hevelius, at Dantzic, observed the middle 12h. 10m. 35s., digits eclipsed $9\frac{3}{8}$, and the proportion of the semi-diameter of the sun to that of the moon as 1,000 to 1,033.

A.D. 1668, Nov. 4. An eclipse of about two-thirds of the sun's disc in this country. Flamsteed gives us several figures of its different stages in his *Historia Celestis*. He states that he found the tables in the *Astronomia Carolina* very much out. The defective state of the lunar tables led, a few years later, to the foundation of the Greenwich Observatory.

The Caroline Tables were by Thomas Street, an Englishman, and were in use for a long time. They first appeared in 1661. Another edition was published by Dr. Halley in 1710. Street constructed the Logistic logarithms. A copy of the 1661 edition is in my possession.

EIGHTEENTH CENTURY.

A.D. 1703, Dec. 23. A singularly bright total eclipse of the moon. Described further on.

A.D. 1706, May 12. A total eclipse of the sun, of which only a partial phase was visible to England. Captain Stannyan, at Bern, in Switzerland, after noticing a star and a planet shining brightly, says the sun's "getting out of the eclipse was preceded by a blood-red streak of light from its left limb, which continued not longer than 6 or 7 seconds. 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 moonlight." Here is one of the earliest, and probably the first account we have of the red flames.

A.D. 1715, May 3. Eclipse of the sun, total right across England, from Cornwall and Devon to the Wash. London was included in the totality, which took place soon after nine o'clock on a fine spring morning. This, with the sun high in the sky, rendered it a sight that Londoners may never expect to witness again. Flamsteed gives the following account of it in his *Historia Celestis*:—

"20h.	5m.	54s.	Beginning, apparent time.
21	9	0	Totalis obscuritas.
,,	12	12	Lux prima.
22	19	51	Finis.

"Valde sereno per totam eclipsis durationem aere."

Dr. Halley says, that "when the last part of the sun remained on its east side, it grew very faint, and was

easily supportable to the naked eye above a minute before total darkness;" that "a few seconds before the sun was totally hid, there discovered itself round the moon a luminous ring," (he means the corona;) "this was of a pale whiteness, or rather, pearl colour, a little tinged with the colours of the iris, and concentric with the moon." During the eclipse, flashes of light seemed to dart out from behind the moon. Two or three seconds before the emersion, where the sun was just coming out, a long and very narrow streak, of a dusky but strong red light, seemed to colour the dark edge of the moon." Halley states that Jupiter, Mercury, and Venus were seen during the totality by people in London, also Capella and Aldebaran; that north of London, in the centre of the line of totality, twenty stars were seen. Surely there must be some interesting accounts of this eclipse remaining, if old families could only be induced to search their papers.

A.D. 1724, May 22. The last eclipse of the sun, total in England. A map of the path of totality, by Dr. Halley, in the rooms of the Royal Astronomical Society, places London just outside the total phase. When a great solar eclipse happens at any particular place, it is frequently followed by three at the space of half a Chaldæan period (nine years) between them. For example, the large eclipse of 1406 was followed by others in 1415, 1424, 1433. At the beginning of the eighteenth century great eclipses fell in this country in 1706, 1715, 1724, 1733. In our own times we have had a nine-year period, comprising four eclipses of some magnitude, those of 1833, 1842, 1851, 1860.

Returning to the eclipse of 1724, it was observed by Dr. Stukeley, who selected as his place of observation an eminence called Haraden Hill, having Salisbury Plain on the front. The Doctor said he seemed to "feel the darkness drop down like a great mantle," that during totality "it was beyond all that he had ever seen, or could picture to his imagination, the most solemn." He could only with difficulty discern the faces of his companions, which had a ghastly, startling appearance. Sky and earth were covered as with a funeral pall. In the sun's place at length appeared a small lucid spot, and from it ran a rim of faint brightness. In about 3½ minutes from this appearance, the hill-tops changed from black to blue, the horizon gave out the grey streaks previous to morning dawn, and the birds sprang joyously into the air, and the great sight of 1724 was gone, not to be displayed in this country again till many generations had passed *ad majores.*

A.D. 1737, March 1. An eclipse of the sun, annular, at Edinburgh. This is one of the very few instances in which something was seen of the red flames on the edge of the sun, when he was not totally eclipsed.

A.D. 1748, July 14. An eclipse of the sun, nine to ten digits in magnitude, at London; annular in Scotland. Short, one of the observers, noticed the mottled appearance of the sun's photosphere. An indication was again perceived of the "red flames" in the shape of a kind of brown light.

A.D. 1793, Sept. 5. After the annular eclipse of 1764 already alluded to, there was no other large eclipse of the sun in this country, in the latter part of the last

century, except this one. The magnitude was eight-tenths at London, and annular in the north of Scotland. Considerations respecting the shape of one of the moon's horns in this eclipse led Sir W. Herschel to form an opinion against a lunar atmosphere.

The eighteenth century was a rich time for central eclipses in Great Britain, two being total, and one annular in England, 1715, 1724, 1764; and three annular ones in Scotland, 1737, 1748, 1793.

Nineteenth Century.

A.D. 1820, Sept. 7. A large partial eclipse of the sun on the afternoon of this day was well observed in England, the sky being generally quite clear. The Lords, engaged in summing up the charges against Queen Caroline at the time, left off, to attend to their astronomical call. The magnitude of the eclipse in the eastern counties was nine-tenths of the sun's face: and stars are said to have been detected. This latter point is of importance with regard to our records of ancient eclipses, as indicating what degree of obscuration, even in a northern latitude, is sufficient to bring out the planets during the obscuration caused by an eclipse.

A.D. 1836, May 15. An eclipse of the sun on a Sunday afternoon, well observed throughout Great Britain. Annular in the northernmost counties of England, and in the south of Scotland. Famous for what is known as "Baily's beads," noticed by Mr. Baily, at Jedburgh, in Roxburghshire. About the formation, and rupture of the ring, he observed the rough mountains on the moon's edge projected on the sun's bright

face like a row of bead-like dots. Some indication of the red flames was perceived where the eclipse was annular. Henderson, who observed at Edinburgh, states that previous to the formation of the annulus an arc of faint reddish light was seen. Bessel, at the Konigsberg observatory, a little out of the annularity, saw a "luminous point near the extremity of the upper cusp. As the cusps were then approaching each other, I hoped the annulus was about to form, but this did not happen." Admiral Smyth, observing it at Bedford, as a partial eclipse of nine-tenths, states that "as the sun obfuscated, the air grew cooler;" that vegetation assumed a yellow tinge, the light became mellower; that Venus became visible to the naked eye, and Mercury through the finder.

A.D. 1842, July 8. Total eclipse of the sun in the south of France. The present interest felt in total solar eclipses seems to have been kindled by this one. After a long interval, ever since 1724, in which no total eclipse of the sun could be viewed within a reasonable distance from this country, that of 1842 happened, and was total over some of the populous districts in Europe. Arago informs us that the poorest villagers of the Alps and Pyrenees repaired in crowds to culminating points, where the phænomenon could be best seen. At Perpignan, only persons who were confined to their chambers by ill-health remained at home. "The magnificence of the phænomenon had triumphed over the petulance of youth, over the levity affected by some of the spectators, and the usual indifference of soldiers; a profound calm reigned throughout the air during the two minutes of totality, birds

ceased to sing, &c. The main point of interest consisted in some strange red flames that were seen shooting forth from the black disk in the sky. To solve the nature of these red flames, astronomers looked forward to the eclipse of 1851."

A.D. 1851, July 28. Total eclipse of the sun in Norway and Sweden. Great numbers of observers proceeded from all parts for the observation of this important phænomenon. It was clearly seen that the red flames which had been noticed in 1842, belonged to the sun, and not to the moon. As the moon's black globe passed over the sun, the flames on one side diminished in size, while those on the other increased. The gloom is said to have had a very unearthly appearance, not resembling that of night. The sea appeared lurid red. The aspect of nature was grand beyond description.

A.D. 1860, July 18. Eclipse of the sun, total in Spain, whither a large party proceeded from England in the "Himalaya." Other nations prepared well-equipped expeditions, including even the Pacha of Egypt. Although the summer of 1860 was notedly wet, some good photographs were obtained of the totality, and the fact of the red flames belonging to the sun, and not to the moon, was confirmed beyond a doubt.

A.D. 1868, Aug. 18. An eclipse of the sun, of which the totality was of extreme duration. Unfavourable weather prevailed at Bombay, but in some places valuable observations were obtained of the red prominences by the spectroscope, proving them to be gaseous.

A.D. 1870, Dec. 22. Total eclipse of the sun in the south of Spain and north of Africa. Though bad wea-

ther in a great measure interfered with observations, it was ascertained that the red prominences are composed of flames of hydrogen. A line of green light was found in the spectrum of the corona, the same that appears in the spectra of the aurora and zodiacal light.

CHAPTER V.

THE PRESENT PROSPECTS OF THE AMATEUR.

We may now pause to consider what are the prospects the astronomical observer has at the present day. For the concluding thirty-six years of the last century there was no large solar eclipse in our own country but one: there is a greater scarcity of such phænomena during the years that have to run out in the present century. Let us just suppose the lover of astronomy to have set up an observatory in England thirty years ago, and to have been spared to continue his observations to the present day. First of all, he would have had a great solar eclipse in 1847, annular in the south of England, and the largest eclipse since 1764. This was followed in 1851 by an eclipse of at least eight-tenths of the sun here, and total by taking a trip across the water to Norway. Again, in 1858, there came a notable phænomenon, annular, but almost total. On the central line, as, for instance, about Swindon, in Wiltshire, it was considered that if the sun's face could be divided into 1,000 parts, 999 of these would be

eclipsed. Two years more pass, and we come to July, 1860, with another eclipse of at least eight-tenths of the sun's diameter on the lower limb here, and total in Spain. In 1867 there came another eclipse, magnitude at London exactly three-fourths of the sun. In a few years more we had the eclipse of 1870, amounting to eight-tenths in England, and total at Gibraltar, quite easy of access. In other words, six fine eclipses of the sun have presented themselves to our view within the last thirty years. To be sure, this must be modified, when we look at the result, and not at the prediction. The eclipse of 1847 was obscured by clouds where annular, and only well seen, we believe, in some places in the north of England; those of 1851 and 1860 seen through passing clouds; that of 1858 hardly seen anywhere. Let us now suppose an observer to commence his observations at the present date, and to continue them thirty years. He will not have a single solar eclipse of the size of any of the six that happened in the last thirty years. Should his observatory be in the south of England, he will have just one eclipse, attaining a magnitude of two-thirds of the sun's disc, that of 1900. To an observer in the northern counties of Scotland there will be no eclipse to the extent of nine-tenths of the sun till 1921; to an observer in the northern counties of England, none till 1927, and that one happens shortly after five in the morning. It is necessary, therefore, to undertake a sea voyage to view the phænomenon an astronomer must long to observe, a total eclipse of the sun. The observation of solar eclipses on a large scale in our own country will have to be left to another generation. With regard to the

partial eclipses of the sun we shall have to put up with, the following are the most note-worthy points:—(1.) The time of commencement and cessation, and the measurement of the magnitude with a micrometer. (2.) The projection of the lunar mountains on the sun's bright face, giving a rough and jagged appearance to the rim of the moon, as seen in the telescope. (3.) The projection of a small portion of the moon's black globe against the sky, outside the sun. I have never observed a solar eclipse in a clear sky without noticing this. Perhaps the portion of the moon is rendered visible by being projected against the luminous corona that surrounds the sun. (4.) Some observers notice very carefully the passage of the moon over certain solar spots. This can only be interesting so far as it shews the different shades of blackness between the moon's globe and the spots. (5.) It is said that during a partial solar eclipse a curious phænomenon is sometimes produced. The light of the sun shining through the leaves of a tree casts a number of little lengthened-out crescents of the sun on the ground, figures of the eclipse. In large eclipses, a peculiar livid, unearthly gloom begins to come over the landscape, deepening more rapidly as totality approaches. Of course this is seen, in a small degree, in partial eclipses. I found in 1867 and 1870 this gloom began to be very perceptible when the eighth digit was reached; in other words, when two-thirds of the sun were cut off by the advancing body of the moon. This would, probably, be more noticeable in summer than in winter; and, of course, in an oriental, clear climate the gloom would be much greater than in our

latitude. If many clouds prevail in the sky, this gloom is scarcely to be detected, as I found to be the case in 1860.

CHAPTER VI.

CURIOSITIES IN LUNAR ECLIPSES, BRIGHT AND BLACK TOTAL ECLIPSES, HORIZONTAL ECLIPSES, THE RETURN OF CYCLES.

When the amateur has observed one solar eclipse he will find somewhat of a sameness in another, except it be a total or an annular one. This is not the case with an eclipse of the moon. The latter possesses an interest of its own, arising from the variation of colour our satellite exhibits, at different times, when considerably immersed in the earth's shadow. The following is the programme of an ordinary total eclipse of the moon. First of all, a smokiness appears on our satellite. This is the penumbra, or shadow of a shadow. It gradually merges into the true umbra, and a black segment of a circle creeps on over the lunar mountains and plains. Let it be remembered, an eclipse of the moon is a real darkening of the moon's surface; in other words, a real eclipse. One of the sun, is the mere shutting off the solar disc from a certain portion of the earth's surface. While only a small portion of the moon is obscured, the shadow is of a black, or rather dark grey colour; but when the eclipse reaches four digits, or one-third of the moon's diameter, I have always noticed the beginning of a coppery tint. When a magnitude of half the moon's disc is attained, this coppery tint begins to be discernible with the naked eye. The

whole surface then becomes lighter, the grey colour diminishes, and, when totality is attained, the whole of the lunar mountains, valleys, plains, &c., appear involved in a dull red gloom. The most striking time is always when the first streak of light bursts forth at the edge of the moon. The singular ruddy tint, with a streak of silvery light at this time, has been not inaptly likened to a magnificent peach hung in the sky. The declining phases resemble the increasing phases, only in an inverse order, the ruddiness giving place to a greyish colour, and that, in its turn, to a darker grey or black, when the shadow is nearly passing off. The ruddy hue, which the moon assumes during the total phase, puzzled mankind for centuries. The Greeks thought the darkened moon should be of different colours, according to the hours at which the eclipse happened. Kepler gave the explanation of the red colour on the moon in a total eclipse. He shewed that it is caused by the refraction of the sun's rays; to put it in plainer words, *the sun's rays are bent over the earth and thrown into the earth's shadow.* These rays have a reddish look, because of the thickness of the atmosphere through which they have to penetrate. This density will stop all the other rays, and transmit only the red. Red rays are always the last to disappear, and for this reason the sun appears red through a fog. But the strata of our atmosphere are variable, as regards saturation. Sometimes they will hold much vapour; at other times they will be transparent. For this reason, in some very rare cases, the moon will disappear altogether during a total eclipse, as if blotted out of the sky; at other times it has been known to

shine with singular distinctness, when totally immersed in our shadow. Thus are produced what we may term *black total eclipses* and *bright total eclipses.* If the region through which the sun's rays pass is saturated in some parts and not in others, a portion of the moon will be very obscure during totality, and another part may be illuminated. Such is said to have been the case in the eclipses of August 16, 1598, and Oct. 13, 1837. I witnessed this, to a certain extent, in the total eclipse of July 12, 1870; at 9h. 55m. that night I found half the moon's surface quite invisible, both with the naked eye and telescope. Three of the so-called *seas* at the eastern limb were alone discernible at that time.

Thus, in a total eclipse of the moon, we have not merely the beauties of tint to notice, but we may have some idea of the state of transparency of the several strata of our atmosphere. During the next forty years the following total eclipses of the moon will be visible in Great Britain, thus affording an opportunity for such observations:—1877, Feb. 27 and Aug. 23; 1884, Oct. 4; 1888, Jan. 28; 1895, March 11; 1898, Dec. 27; 1902, Oct. 17; 1909, June 3; 1910, Nov. 16. Besides these there will be a few eclipses in which the moon will be rising or setting, and so part of the total phase may be seen if the sky is very clear. Two or three other eclipses that are almost total might be also included. It will be seen, that we do not get a total eclipse of the moon at a sufficient altitude for fair observation above once in five years on the average. Previous to that of July 12, 1870, the author had seen none since Oct. 13, 1856, which was a hair's breadth

short of totality; on other occasions, 1862, 1863, and 1866, clouds entirely interposed.

Black Total Eclipses.—The earliest mention I have been able to find of this, occurs in the "Saxon Chronicle." The description given there of an eclipse in the time of Henry I., May 5, 1110, records that "neither light, nor orb, nor anything of the moon was seen." The inference appears to be, that it was a case of the disappearance of the moon during the total phase. The "Saxon Chronicle" says, "On the fifth night in the month of May the moon appeared in the evening, brightly shining, and afterwards, by little and little, its light waned, so that as soon as it was night it was so completely quenched, that neither light, nor orb, nor anything of it was seen; and so it continued very near until day, and then appeared full and brightly shining. It was this same day a fortnight old. All the night the air was very clear, and the stars over all the heaven brightly shining, and the tree fruits on that night were sorely nipt." By the tables I used the moon entered the earth's shadow about 9h., and emerged from it, after being totally eclipsed, about 12h. 30m. Other cases, in which the moon has become invisible during a total eclipse, are said to have occurred in 1601, 1620, 1642, 1761, 1816.

On calculating that on the afternoon of Dec. 9, 1601, I find the obscuration was not total, but nine-tenths on the lower limb. In the "Paralipomena" to Tycho Brahe's *Historia Celestis* the observation of this eclipse is recorded, but nothing is said about the disappearance of the moon. Perhaps Dec. 9, 1601, has been given in mistake for Dec. 9, 1620. It is re-

corded in the same work that there were two eclipses in 1620, in both of which the moon shewed with peculiar obscurity during the total phase, one on June 20, when we are told "the moon was seen with great difficulty. It shone, moreover, like the thinnest nebula, far fainter than the milky way, without any coppery-tinge (rubedine). About the middle of the second hour, nothing at all could be seen of the moon with the naked eye, and through the telescope so doubtfully was anything seen, that no one could tell whether the moon was not something else." It is added that "the sky was quite clear." Of the eclipse of Dec. 9, this year, (1620), it is recorded, "the moon altogether disappeared, so that nothing could be seen of it, though the stars shone brightly all around; and she continued lost and invisible for a quarter-of-an-hour, more or less." The observation appears to have been made at Ingolstadt, where, by the tables I used, the obscuration began about 4h. 18m. (afternoon); totality lasting from 5h. 18m. to 6h. 54m., and the end at 7h. 54m. This is one of the best-authenticated instances of the moon becoming utterly invisible during the total phase. The eclipse of 1642, April 4, is recorded by Flamsteed in his *Historia Celestis* to have been observed by Crabtree, who speaks of clouds, but not about the disappearance of the moon. That of May 18, 1761, was observed at Stockholm by Wargentin, who tells us the moon became utterly invisible both with the naked eye and the telescope. The last instance, on June 10, 1816, (a noted wet summer,) was observed at London, when the moon could not be detected with telescopes.

Bright total eclipses.—As a contrast to the preceding, we may mention the total eclipse of Dec. 23, 1703, in which the moon, when totally immersed in the earth's shadow, was visible at Avignon by a ruddy light of such brilliancy that one might have imagined her body to be transparent, and to be enlightened from behind. At London I find this eclipse would begin about 4h. 31m. (morning), the total phase commencing 5h. 36m. and ending 7h. 22m., and the eclipse ending below the horizon 8h. 27m. On the evening of March 19, 1848, so bright a red colour did the moon wear during total immersion that some persons could hardly be persuaded it was eclipsed. Mr. Forster, at Bruges, says, the marks on the moon's face "could be almost as well made out as in an ordinary dull, moonlight night." The British consul at Ghent, not knowing there was any eclipse, wrote to him to know the reason of the peculiar red colour of the moon the previous evening.

Horizontal Eclipses.—In some rare cases it happens that the sun and moon are both seen above the horizon at the same time when the moon is eclipsed. It would seem, at first sight, that the sun, moon, and earth were no longer in a straight line, as they must be when there is an eclipse. The appearance is owing to refraction. The sun, already below the horizon, is raised up by refraction, and is visible to us. Refraction hastens the apparent rising of one body, and retards the apparent setting of the other. A remarkable instance of this was observed at Montmartre, by the members of the Academy of Sciences, on May 26, 1668. Projecting for Paris, the beginning seems to

have been about 2h. 17m. a.m., and at 3h. 45m., shortly before sunrise, eight-tenths of the moon would be obscured. On June 16, 1666, the moon was seen in Tuscany to rise eclipsed, the sun being still above the western horizon. On July 19, 1750, there was another case of this. In more ancient times there are a few instances on record. The following happened in 1590, and is recorded by Tycho in these words: — "7 July in the morning, about $3\frac{3}{4}$h., the moon began to be eclipsed; in this eclipse it is notable that both luminaries were at the same time above the horizon, a like case to what Pliny cites, lib. ii. ch. 3. For the centre of the sun emerged when the moon was 2° elevated above the western horizon, and when her centre was setting, the centre of the sun was elevated nearly 2°." I find an eclipse of the moon the morning of this day, corresponding to the time here mentioned. The magnitude would be very small. The case of which Pliny speaks occurred on Feb. 20, A.D. 72, in the time of Vespasian. Pliny tells us, "By some means, when, at sunrise, the umbra ought to have its place beneath the earth, it has now once happened that the moon was eclipsed at its setting, both heavenly bodies being conspicuous above the earth." I find, by calculation, the eclipse would be total, but very little indeed would be seen of it in Europe, the commencement being about the time the moon was getting down to the horizon.

A clear proof of the rotundity of our globe may be obtained by merely watching an eclipse of the moon. The obscurity we see creeping over the moon is the actual shadow of our earth, and it is a complete seg-

ment of a circle. From the beginning to the end of an eclipse it preserves a circular form. This remark was made by the earliest observers. Two writers, Manilius and Cleomedes, who lived about the time of the Christian era, have brought this forward as a proof of the roundness of our earth. Thus there is another method of ascertaining this point besides noticing the disappearance of a hull of a ship before the masts, or by a voyage round the world.

The return of Cycles of Eclipses.—The period of eighteen years and eleven days, in which eclipses return in the same order, is said to have been found out by the Chaldæans, and to have been called by them the Saros. It gives a fair idea of lunar eclipses, though the magnitude will alter a little at each return. It also indicates that there will be a solar eclipse visible from some place on the earth on a particular day. It may interest the reader to go through the courses of one or two eclipses. The next one we shall have in Great Britain, Oct. 10, 1874, is thus traced by Ferguson from its commencement. This eclipse, after traversing the voids of space since the Creation, at last began to enter the *Terra Australis Incognita* about eighty-eight years after the Conquest, which was the last of King Stephen's reign; every Chaldæan period it has crept more northerly, but was still invisible in Britain before the year 1622, when on the 30th of April, it began to touch the south part of England about 2h. in the afternoon, its central appearance rising in the American south seas, and traversing Peru and the Amazons' country, through the Atlantic Ocean into Africa, and setting in the Ethiopian continent,

not far from the beginning of the Red Sea. Its next visible period was after three Chaldæan revolutions, in 1676 on June 1st., rising central in the Atlantic Ocean, passing us about 9h. in the morning, with four digits eclipsed on the under limb, and setting in the gulf of Cochin-China in the East Indies. It being now near the solstice, this eclipse was visible the very next return, in 1694, in the evening; and in two periods more, which was in 1730, on July 4, amounted to rather more than six digits just after sunrise, and was observed at Wittemburg in Germany, and Pekin in China, soon after which it went off. Eighteen years more afforded us the eclipse which fell on July 14, 1748. The next visible return was on July 25, 1766, in the evening, about four digits being eclipsed; again, after two periods more, on August 16, 1802, early in the morning, about five digits; the centre coming from the north frozen continent, by the Capes of Norway, through Tartary, China, and Japan, to the Ladrone Islands, where it went off. Again, in 1820, on Sept. 7, it was large at London, nine-tenths being obscured; but happening so near the equinox, the centre left every part of Britain to the west, and entered Germany at Embden, passing by Venice, Naples, Grand Cairo, and set in the gulf of Bassora, near that city. It is no more visible here till 1874, Oct. 10, the centre being now about to leave the earth, whence the central and annular phase is exhibited only to a very small portion of country north-east of Russia. Ferguson says, "that about the year 2090 the whole penumbra would be worn off, whence no more returns of this eclipse could happen till after a revolution of 10,000

years." In this he is wrong; I find the same eclipse will continue to return for a much longer period, before it entirely leaves the earth. It would be visible in this country again as a partial eclipse in Nov., 1928; Dec., 1982; Jan., 2037; Feb., 2091, &c. In like manner an eclipse of the moon, after coming on as a very small obscuration, will get larger at every eighteen-year return, till at length it becomes total. It will continue so for several periods, and then gradually diminish until it goes off. A lunar eclipse, which had commenced a few hundred years ago, was still total on July 18, 1692, when it was observed by Flamsteed. Every eighteen years it became smaller and smaller. At its return in 1800, its magnitude was two-tenths, in 1836 less than one-tenth. On the morning of Nov. 15, 1872, this eclipse returned for the last time, and would have been seen to obscure only one-fiftieth part of the moon's diameter, if clouds had not intervened.

To take another example. An eclipse of the moon first became visible in June, 1835, as an obscuration of one-thirteenth of her diameter. It returned in 1853 and 1871, increasing each time. It comes round again in 1889, as an eclipse of nearly half the moon. In 1907 it will exhibit a magnitude of six-tenths, and so forth.

CHAPTER VII.

CURIOUS PHÆNOMENON IN THE SLIGHTLY TOTAL SOLAR ECLIPSE, JUNE 29, 1927.

On the morning of June 29, 1927, there will be the next solar eclipse in England in which anything in the shape of totality can be seen. To those who will be stationed in a line drawn from the Isle of Anglesey across Northumberland, the sun will appear totally obscured for just a few seconds. Here, therefore, and in Norway and Sweden, a curious phænomenon may be noticed, viz. the appearance of the red flames, not as prominences, but as a ring of red light surrounding the sun. The probable appearance of such a phænomenon in a slightly total eclipse of the sun was pointed out by Professor Grant, in a paper contributed to the December meeting of the Royal Astronomical Society in 1871. The eclipse of June 29, 1927, seems to afford such an opportunity as the Professor wished to find out. Although this eclipse, then, is but an apology for a total one, it may acquire an interest of its own for our posterity. Professor Grant says, "Since the apparent diameter of the moon sometimes exceeds, sometimes equals, and sometimes falls short of the apparent diameter of the sun, it is obviously possible, that the existence of such an envelope may be occasionally revealed by the phænomenon of a circle of red light surrounding the moon's disc, during slightly total eclipses of the sun. No instance, however, of such an occurrence has been recorded in the annals of telescopic

observations of solar eclipses." "Seeing that when a great number of solar eclipses, observed indifferently with respect to the limiting lines of the moon's shadow or penumbra, are taken into consideration, the slight overlapping of the moon takes place at all parts of the solar disc, and that wherever this overlapping really does occur, there is visible at the moon's disc an arc or band of red light, the existence of such a margin of light becomes thus inductively traceable round the entire contour of the solar disc."

CHAPTER VIII.

FUTURE ECLIPSES.

The following list of eclipses in future years was undertaken at first for my own information and curiosity. Delambre has left behind him a list of the transits of Venus for a period of two thousand years. Curiosity may, therefore, be gratified by some examination of the eclipses for a fourth of this period. Bishop Pearson remarks, "Again, for the calculation of eclipses, as it may be made for many thousands of years, and be exactly true, and yet the world may end to-morrow, because the calculation is made with this condition, if the bodies of the earth, sun and moon, continue in their substance and proper motion so long; so it may be made for millions of years past, and be true, if the world have been so old, which the calculation does not prove, but suppose[e]." The question of future eclipses

[e] Pearson on Creed, Art. Maker of Heaven and Earth. The Bishop is here shewing the non-eternity of the world, from the fact that

was gone into in some measure in the last century. In the *Mémoires* of the French Academy (1768), there is a paper by M. du Vaucel on the Solar Eclipses visible at Paris after 1767, but it goes no further than 1900. This catalogue was computed from the tables of Mayer to gratify the French king, who was anxious to know whether a total or annular eclipse was going to happen soon. Hallasckha's list of eclipses does not go beyond the limits of the present century. For the following eclipses, which will be visible in England during the next forty years, I have used the same tables as for the ancient ones.

1874. Eclipse of sun, Oct. 10, 10h. (morn.), magnitude between three and four-tenths on the upper limb. Total eclipse of the moon on Oct. 25, of which a partial phase will be visible to us. The transit of Venus, on the morning of Dec. 9, cannot be seen nearer than eastern Russia.

1875. Eclipse of sun, soon after noon, Sept. 29; but only one-tenth on the extreme south of the sun's face. In the north of England the magnitude will be almost nil. There will be an occulation of Spica Virginis on the morning of Nov. 23. Immersion behind the moon's bright limb 7h. 25m., emersion 8h. 37m.

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heathen historians and poets can find no theme before the Trojan and Theban wars, and the adventure of the Argonauts. He said that "although the Egyptian priests gave a catalogue of eclipses of the sun and moon for myriads of years, it does not follow that they were taken from observation, but merely from proleptical supposition." Mr. William Chapman, of Foxton, Leicester, computed all the solar eclipses between 1766 and 2000. I have found it, in the main, correct, but there are a few omissions and errors in his list; the eclipse of 1900 is omitted, &c.

The moon at the time will be a crescent, and though daylight has just arrived, a small telescope, screened from the sun, will exhibit it as an interesting sight.

1876. Two eclipses of the moon, each of about one-quarter of her diameter; the first on March 10, in which the moon sets eclipsed; the other on Sept. 3, 9½h. (evening). The Pleiades will be occulted by the moon this year on Oct. 6, Nov. 30, Dec. 28. No very great optical power will be needed to view this pleasing phænomenon. On Feb. 28, 1860, I witnessed the occultation of three stars of the group, through an old ship glass, with a power of 16.

1877. This year we shall have two visible total eclipses of the moon; that on Feb. 27 begins about moon-rise (why should we not use this word as well as sun-rise), and ceases about nine o'clock. The other, on Aug. 23, lasts from nine till one.

1878. An eclipse of six-tenths of the moon's lower limb at midnight, Aug. 12. At the preceding new moon, July 28, there will be an eclipse of the sun, total in the western parts of America, as for instance at Denver, in Colorado; also in the Island of Cuba. Denver, where the sun's altitude will be pretty high, offers the next best temptation to the amateur who wishes to observe a total eclipse of the sun. The town is easily reached by the Great Pacific Railway. A description of it is given in "Good Words" for January and March, 1873.

1879, Dec. 28. Small insignificant eclipse of the moon. The middle, under two-tenths of her diameter, is soon after she rises.

1880. On Dec. 16 the moon rises towards the end of

the total phase of an eclipse. On Dec. 31 the sun is between three and four-tenths eclipsed, on the upper limb, about ¼ to 3h. in the afternoon.

1881, Dec. 5.. An eclipse of the moon commences below the horizon. At the middle, when the moon will have risen above an hour, only a crescent of less than a tenth of her diameter will remain uncovered at the lowest point.

1882. On the morning of May 17, there is a small eclipse on the sun's south limb, but a fourth of his diameter being obscured; middle, about 6h. 50m. In Upper Egypt, Persia, and across the Red Sea, about the little island of Shadwan, this will be total. The probable clearness of an eastern climate will offer inducement for observers; but the duration of totality is short.

1882, Dec. 6. Transit of Venus, partly visible in England.

1883, Oct. 16. A small partial eclipse of the moon this morning, which will only be seen for about half-an-hour in this country, the moon then descending below the horizon.

1884, Oct. 4. Total eclipse of the moon 10h. Occultations of Aldebaran may be expected about this time.

1886, Aug. 29. An eclipse of the sun, not visible here, but total at Grenada soon after 7h. a.m. for three minutes, the sun's altitude 20°. The greatest duration of the total phase, six minutes, an extraordinary length, falls on the Atlantic; so that it cannot be observed to full advantage. Some meteorological observations taken on the east side of Grenada in August, 1873,

shew the sky nineteen days cloudy, and twelve clear about an hour after sunrise; not much better than England.

1887, Aug. 3. Four-tenths of the moon obscured, 8¾h. p.m. At the following new moon, Aug. 19, there is an eclipse of the sun, which at one time was thought likely to prove total in England, but upon more accurate examination, the whole phænomenon is found to end here just after the sun has risen. The total phase is presented to view in Eastern Europe and Asia, commencing in Germany. At Wilna, the easiest point reached from this country, i.e. by steamer to Riga, totality comes on less than an hour after sunrise, with the sun at an altitude of 10°. The more easterly observers can get, the better chance they will have. We may apply to this the somewhat poetical description given in Moore's Almanack of the eclipse of 1842, happening under similar circumstances, that the "lovely orb of day, having risen upon the summer scene, will appear to sink back into the arms of night, while the stars of heaven resume their twinkling."

1888. Total eclipse of the moon, Jan. 28, 11¾h. night.

1889, Jan. 17. Eclipse of the moon, magnitude seven-tenths, 5½h. morn.

1889, July 12. An eclipse of the moon begins below the horizon; at the greatest phase, 9h., when the moon will be risen high enough to be pretty well seen, nearly half her surface will be obscured.

1890, June 17. Partial eclipse of the sun, magnitude four-tenths, about 9h. 10m.

1891, May 22. The termination of a lunar eclipse happens above our horizon.

1891, June 6. One-fourth of the sun's upper limb obscured about 5h. 42m. afternoon.

1892, May 11. Eclipse of moon, nine-tenths of her diameter under obscuration at eleven o'clock.

1892, Nov. 4. A lunar eclipse, only the end of which will be seen, for scarcely an hour in this country. Moon rises after totality is over.

1894, Sept. 15. Eclipse of moon, 4¼h. morn., magnitude two-tenths.

1895, March 11. Total eclipse of moon, 3½h. morn. On the morning of March 26, the sun is eclipsed in high northern latitudes, and the obscuration may reach us, in a small degree, about half-past ten.

1895, Sept. 4. The moon sets just after the totality of an eclipse commences.

1896, Feb. 28. Eclipse of moon, magnitude eight-tenths, 7¾h. afternoon. On the morning of Aug. 19, there will be a total eclipse of the sun in Lapland, and high northern latitudes. At Tana, in Finmark, totality begins, according to Hind, at 5h. 50m. 53s. morn., and lasts 1¾m. Sun's altitude, 15°.

1898. Three lunar eclipses visible this year. Jan. 7, 12⅔h. night, magnitude little over one-tenth. July 3, begins below horizon, magnitude nine-tenths, 9¼h. evening. Dec. 27, total 11¾h. night.

1899, June 8. One-fourth of the sun obscured, 5¼h. morn.

1899, Dec. 17. An almost total eclipse of the moon, 1¼h. morn.

1900, May 28. Seven-tenths of the sun will be eclipsed in England about four o'clock in the afternoon. Total across Spain. On the morning of June 13, the moon appears just in contact with the earth's shadow, about sunrise. Hence there will be a duskiness or faint penumbra on the lower limb. Full moon by the tables I used, 15h. 38m. Sun rises, 15h. 44m.

Twentieth Century.

1902, April 22. Eclipse of moon, middle about sunset; moon rises towards the termination of the total phase.

1902, Oct. 17. This morning the moon sets totally eclipsed, but the greater part of the phænomenon will be seen from this country.

1903, April 11. Eclipse of moon, more than nine-tenths obscured, 12¼h. night.

1905, Feb. 19. Eclipse of moon, magnitude one-third of her diameter, 7h. night.

1905, Aug. 15. About three-tenths of the moon obscured, 3½h. morning. The moon will be getting near the horizon at the termination of the eclipse.

1905, Aug. 30. Eclipse of the sun, the magnitude will be eight-tenths in the south of England, in the northern parts of the kingdom less than this. Total over Madrid, and about the centre of Spain.

1906, Feb. 9 (morn.) A total eclipse of the moon, but the moon sets soon after totality has been attained.

1907, July 25. The moon begins to be eclipsed an hour before sunrise. The greatest obscuration would

amount to six-tenths of the moon's disc, but will not be seen from this country.

1908, June 28. Little more than one-tenth of the sun eclipsed, 5h. 35m. p.m.

1909, June 4. Total eclipse of the moon, 1½h. morning.

1909, Nov. 27. The first half of a lunar eclipse will be seen for about half-an-hour, and then the moon sets.

1910, Nov. 16. Total eclipse of moon, 12¼h. night.

1911. Halley's comet is due about this time.

1912, April 1. Partial eclipse of the moon, magnitude only two-tenths, 10¼h. night.

1912, April 17. The next solar eclipse in England, of considerable size. At London I make the greatest obscuration to come on at 12h. 22m. (noon), nine-tenths of the sun's lower limb being obscured. In the western and northern parts of the kingdom, the magnitude will be slightly less than at London. It is a return of the eclipse of 1858. In 1912 the central and annular phase, which, however, will be almost total, passes along the north of Portugal and Spain, then a little west of Paris, and afterwards across Belgium; so it will not visit us in England, but merely leave a large partial eclipse for our gaze[f].

1914, March 12. Nine-tenths of the upper part of the moon eclipsed, 4¼h. morning.

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[f] In this case, on the central line, instead of an unnatural gloom, the spectators will be entertained with a thin ring of light encompassing the moon's dark body on every side, beautiful to behold; but this appearance will be of very brief duration.

1914, August 21. Eclipse of the sun, of which a partial view will be afforded to Great Britain. At London two-thirds of the sun's disc will be eclipsed at noon. In the western parts of the country, and in Ireland, the size will be a little less than this. The totality of this eclipse occurring about noon-day will be a most striking phænomenon. It can be viewed as near as Norway and Sweden. Drontheim and Stockholm will probably be within the belt of the total phase.

The next remarkable eclipse after this occurs on April 8, 1921, and is evidently annular about the Shetland Isles, or Orkneys, and, consequently, the next central eclipse we shall have in Great Britain. After that of 1927, the next eclipse that is of some magnitude is on June 30, 1954. At London, between eight and nine-tenths of the sun's upper limb are obscured about half-past twelve. The total phase passes just north of the Shetland Islands; so it may be viewed by a short trip out to sea. The eclipse of 1999 has been found by Mr. Hind to be total in the south-west of England, continuing so for two minutes at Plymouth, Torquay, Weymouth, &c.

The size of each eclipse is expressed by the old method of digits, or twelfth parts of the sun's surface; M. signifies morning, A. afternoon. Column (1.) gives date, (2.) approximate time of greatest obscuration, (3.) digits, or twelfth parts of the sun's diameter eclipsed.

(1.)	(2.)	(3.)	(1.)	(2.)	(3.)
1905, Aug. 30,	1.4 A.	10	1912, April 17,	0.25 A.	11
1908, June 28,	5.40 A.	2	1914, Aug. 21,	11.57 M.	8

(1.)	(2.)	(3.)
1916, Feb. 3,	sets eclipsed	
1919, Nov. 22,	,,	
1920, ,, 10,	,,	
1921, April 8,	8.53 M.	10
1922, March 28,	2.8 A.	2
1925, Jan. 24,	3.50 A.	7
1927, June 29,	5.12 M.	11
1928, Nov. 12,	8.28 M.	2
1929, ,, 1,	11.37 M.	1
1936, June 19,	4.15 M.	6
1939, April 19,	6.19 A.	4
1942, Sept. 10,	4.20 A.	4
1945, July 9,	1.57 A.	7
1949, April 28,	7.29 M.	4
1952, Feb. 24,	8.55 M.	1
1954, June 30,	0.28 A.	10
1959, Oct. 2,	0.21 M.	4
1961, Feb. 15,	7.28 M.	11
1966, May 20,	9.28 M.	6
1968, Sept. 22,	10.15 M.	4
1971, Feb. 25,	9.31 M.	7
1972, July 10,	8.3 A.	6
1973, Dec. 24,	sets before the middle	
1975, May 11,	6.29 M.	6
1976, April 29,	10.17 M.	4
1982, Dec. 15,	8.16 M.	5
1984, ,, 30,	6.13 A.	5
1994, May 10,	6.45 A.	6
1996, Oct. 12,	2.27 A.	7
1999, Aug. 11,	10.8 M.	11

In all cases projections were made for London.

Eclipses of the Twenty-first Century.

Those of 2026 and 2081 appear to be total in France, that of 2093 is annular in England. In 2090 there is an eclipse about twenty-five minutes before sunset, total along the south coast, as e.g. Cornwall, Devon, and Dorset[g].

(1.)	(2.)	(3.)
2003, May 31,	rises eclipsed	
2005, Oct. 3,	9¼ h. M.	7
2006, March 29,	10¼ M.	3
2008, Aug. 1,	9 M.	2
2011, Jan. 4,	sunrise	8
2015, March 20,	9½ M.	10
2017, Aug. 21,	7 A.	2
2021, June 10,	10½ M.	3
2025, March 29,	11½ M.	4
2026, Aug. 12,	6 A.	11
2027, ,, 2,	9 M.	5
2028, Jan. 25,	4¼ A.	7
2030, June 1,	5¼ M.	7
2036, Aug. 21,	6 A.	8

[g] Mr. Maguire, of Norwich, has informed me that he considers Brighton just within the north limit of totality.

(1.)		(2.)	(3.)	(1.)		(2.)	(3.)
2037, Jan.	16,	8¼ M.	7	2076, Nov.	26,	11 M.	5
2038, July	2,	2 A.	1	2079, May	1,	11 M.	5
2039, June	21,	6½ A.	9	2080, Sept.	13,	4¾ A.	9
2048, ,,	11,	1¼ A.	9	2081, ,,	3,	7½ M.	11
2050, Nov.	14,	2 A.	9	2082, Feb.	27,	4 A.	6
2053, Sept.	12,	8¼ M.	7	2088, April	21,	10½ M.	6
2059, Nov.	5,	8 M.	9	2090, Sept.	23,	5½ A.	11
2060, April	30,	10¼ M.	2	2091, Feb.	18,	10 M.	6
2066, June	22,	8¼ M.	9	2092, ,,	6,	4¼ A.	7
2069, April	21,	10 M.	4	2093, July	23,	0¼ A.	11
2075, July	13,	4¾ M.	10				

ECLIPSES OF THE TWENTY-SECOND CENTURY.

For this century I find the four following very large eclipses :—

2135, Oct. 7.	Greatest phase hour			7¾ M.
2142, May 24.	,,	,,	,,	8¾ M.
2151, June 14.	,,	,,	,,	6½ A.
2200, April 14.	,,	,,	,,	5¼ A.

Those of 2135 and 2200 seem total in this country north of London, but in the last instance the duration could only be for a few seconds.

The eclipse of 2151, June 14, appeared at first total at London, but on projecting a second time, I obtained a thin crescent on the sun's disc. Hind computes the central line to go through Garstang in Lancashire, and that totality would last between two and three minutes at Sheffield. Maguire has made the central line to pass Ayr, Penrith, and Cromer. To speak about this is the same as if an astronomer in the latter years of Queen Elizabeth's time had written a prediction about an eclipse at the present day.

Twenty-third Century [h].

Omitting cases in which the sun's semi-diameter exceeds the moon's, there seems no eclipse of any importance, none in which the line of totality approaches our shores. There is a nine-year period, producing eclipses of some size in May of the following years, 2227, 2236, 2245, 2254.

Twenty-fourth Century.

In the first half of this century, I did not find the "celestial sight" of which I was in search. But on July 21, 2381, there is a fine eclipse of the sun, which seems total in the more northern counties of England. The moon is near perigee, the sun near apogee. The middle is soon after ten in the morning.

Having arrived at this distant period, five hundred years hence, we may now pause. One thing is noticeable, that if this long search be accurate, it has not revealed one solar eclipse total at London.

Should the present economy of things be spared so long, we cannot conceive what will be the state of astronomical science at that distant date, except, perhaps, by comparing its present state with that of some hundreds of years past. Of this we may be certain, that as the phænomena we have described have excited men's marked attention from the earliest days, so they will continue to do till the end of time.

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[h] We must wait till this century before Easter Sunday falls again on March 22, its earliest possible date, A.D. 2285. It did so the last time in 1818. It falls on April 25, its latest date, in 1734, 1886, 1943, 2038. It fell on April 24 in 1859, but will not do so again till 2011.

PART II.

A CYCLE OF CELESTIAL OBJECTS FOR A SMALL TELESCOPE.

PSALM xix. 1.

The heavens declare the glory of God, and the firmament sheweth His handy-work.

THE science of Astronomy appears to have been cultivated by the immediate descendants of Adam: for Josephus informs us that the sons of Seth employed themselves in it, and that they wrote their observations on two pillars, one of brick, the other of stone, to preserve them against the destruction which Adam had foretold should come on the earth. He also relates that Abraham "read lectures in astronomy and arithmetic to the Egyptians, which they understood nothing of, till Abraham brought them from Chaldæa into Egypt, and from there they passed to the Greeks." Berosus also observes that "Abraham was a great and just man, and famous for his celestial observations," the making of which these sages thought so necessary to the human welfare, that they assign it as the principal cause of the Almighty's prolonging the life of man. For the same author, giving an account of the longevity of the antediluvians, says, that "Providence found it necessary for the study and ad-

vancement of virtue, and for the improvement of Geometry and Astronomy, which required at least six hundred years for making and perfecting observations." An observer, without any instrument, may do much that will gratify himself, and be of advantage to mankind. He may note down the positions of the stars, follow the wanderings of the planets, observe eclipses, record the tracks of meteors. As to utility, let us remember the calendar was altered and set right, from observations made before the invention of the telescope.

We are not about to teach astronomy here, but rather, to use the words of the Hon. Mrs. Ward, to deal with observation, "shewing how the stars appear in their season, coming back year after year in their appointed time, while the stately planets move in their solemn paths among the stars, as they have done before our time, and will do when we have passed away." The observation of the starry heavens was carried on in the earliest time in the plains of Chaldæa, and still the observer should endeavour to get an unobstructed position, at any rate, towards the east, south, and west. After all, much will depend on climate. For an object to be astronomically visible and really visible are two different things. Astronomers assure us of the first, but only a clear and tranquil sky can give us the second. For those who have very large telescopes, and who are not disposed to take them to oriental climates, it would be useful to have records of the number of clear nights in different parts of the kingdom. By clear nights, let us understand nights cloudless, or nearly so, till 11 p.m., or else clear for a full

hour or two. Formerly my observations were taken in South Lancashire, but since the early part of 1870 in Devonshire. In 1859 the number of nights clear, partly or throughout, was sixty; in 1860, forty-three; in 1861 and 1862, forty-six each; in 1863, forty-seven; in 1864, eighty-three; in 1865, eighty-two; in 1866, seventy-seven; in 1867, fifty-five; in 1868, sixty-two; in 1869, fifty-eight; in 1870, a hundred and twelve; in 1871, ninety-eight; in 1872, ninety; in 1873, eighty-two.

The Sun.

The solar orb, as the great centre of our system, must first claim our notice. When viewed with the telescope, we shall perceive a number of dark spots on the surface. Our countryman Harriot seems to have detected them with a telescope as early as 1610. About the same time they occupied the attention of Fabricius. The latter does not seem to have used any dark glass to mellow the sun's rays, but observed when the sun was near the horizon, and his brilliancy impaired. The nucleus or dark kernel of a sun-spot is surrounded by an umbra or lighter part. When approaching the sun's limb, first the umbra and then the nucleus contract, and appear fore-shortened. Spots of nearly 1′ in diameter are visible to the naked eye, through a piece of smoked glass or through a fog. These spots take different curved paths across the sun at different times in the year. At the beginning of June and December, however, they are seen to move in straight lines. They are most plentiful every eleven years, as in 1859 and

1870. The sun is, of course, viewed by means of a dark screen glass put on the eye-piece. It is also advisable, except near sunrise and sunset, to use a diagonal prism, which will give us only a portion of his disc, otherwise there is a danger of the glass being cracked by the heat, and instances of this have occurred even with a $2\frac{1}{4}$ in. telescope. Besides the dark spots, certain bright streaks are, at times, to be seen on the sun; they are not very easy of observation, but I have on a few occasions found them within reach of $2\frac{1}{4}$ in., the best observation of this sort being on Dec. 21, 1869.

In high latitudes, the phænomenon of a "parhelion," or mock sun, is often seen, a luminous halo surrounding the sun, with three or four images of the sun on it. One or two mock suns, imperfectly formed, may occasionally be seen in England; the last time I noticed the phænomenon was on Jan. 19, 1872. It is rare to see the mock suns perfectly formed in our country. The "Saxon Chronicle" records that in 1104, on the Tuesday after Pentecost, "four circles were seen at midday about the sun, of a white hue, each described under the other, as if they were measured."

Mercury.

Sometimes, in spring, a little object like a first-magnitude star may be seen following the sun, while the twilight yet remains. If the amateur notices this, he will not see it for more than a few successive nights. Mercury never departs more than 29° from the sun. At the end of the year, he is too near the horizon to be descried after sunset; and in summer, the twilight

is too strong. The best time is about an hour after sunset in March, and about an hour before sunrise in September; I have never seen Mercury in the mornings, but have several times been able to detect him with the naked eye after sunset; three times in 1858, (April); three times in March, 1860; three times in February, 1862; once in April, 1865; once in February, 1868; once in April, 1871; twice in 1872; and twice in March, 1873. Dr. Dick, in his "Celestial Scenery," speaks of seeing Mercury with the naked eye three or four times. In Humboldt's *Cosmos*, there occurs the following passage about the planet:—"If we remember how much from the earliest times the Egyptians were occupied with the planet Mercury (Set, Horus), and the Indians with their Budha; how, under the clear sky of Western Arabia, the star worship of the tribe of the Asedites was directed exclusively to Mercury, and that Ptolemy in the ninth book of the 'Almagest,' was even able to avail himself of fourteen observations of the planet, extending back to 261 years before our era, and belonging in part to the Chaldæans; we shall be surprised that Copernicus, who lived to attain his seventieth year, should have had to complain on his death-bed, that much as he had tried, he had never seen Mercury. Nevertheless, the Greeks designated the planet, and justly so, the 'strongly sparkling,' στίλβων, on account of its occasional intense light." The amateur may look out for Mercury a little after sunset, near the western horizon, on the following dates, and a few days before and after:—1874, Feb. 26; 1875, Feb. 8; 1876, Jan. 24; 1877, Jan. 10 (perhaps), April 29; 1878, April 10; 1879, March 26;

1880, March 7; 1881, Feb. 20; 1882, Feb. 2; 1883, May 6; 1884, April 18; 1885, March 31; 1886, March 15. The apparitions of the planet are repeated much the same, every thirteen years; for instance, he will come round in a similar manner in 1887 to 1874, or thirteen years previously, in 1861.

At certain times, Mercury transits the disc of the sun, appearing like a circular black spot. The first time this was seen was by Gassendi, at Paris, in 1631. In 1651, a young Englishman, Jeremiah Shackerley, made a voyage to Surat, to observe a transit of Mercury, which his calculations told him would not be visible in England. It is satisfactory to know that he was successful in his wishes. Ten years afterwards there was another transit of Mercury. Thomas Street, in his *Astronomia Carolina*, thus describes it in his quaint way. We give his own words: "Anno 1661, April 23, being the day of the coronation of our Most Gracious Soveraign, King Charles the Second, that ingenious Gent. Christianus Hugenius of Zulichem, Mr. Reeves, with other mathematical friends, and myself, being together at Long Acre, by the help of a good telescope, with red glasses for saving our eyes, saw Mercury from a little past one until two of the clock, appearing in the sun, as a round black spot, below and to the right hand, so that in the heavens he was above and to the left from the sun's centre, and entered on the sun much about one of the clock." The diameter of Mercury to the diameter of the sun seemed scarce so much as 1 to 100. At the transit in 1799, a luminous ring was observed surrounding Mercury, in its passage across the sun, indicating

probably an atmosphere of considerable density. On the morning of Nov. 12, 1861, I caught sight of Mercury, when transiting the sun, with an old ship-glass, carrying a power of about 16. He appeared as a most minute black spot. This shews the impossibility of some ancient legends, of Mercury and Venus being seen on the sun's disc for a long time with the naked eye.

The next transit is on May 6, 1878, when we shall see Mercury entered on the sun's disc about three o'clock in the afternoon. The following transit in 1881 is not to be seen in England. There is another on May 10, 1891, when Mercury passes off the sun soon after sunrise, so we may observe something of it, if the sky is very clear. Again, on Nov. 10, 1894, the ingress of Mercury on the sun takes place just before sunset.

Suspicious-looking spots have been seen on the sun at various times, one especially by Dr. Lescarbault at Orgères, in France, March 26, 1859. This was so far taken up by some astronomers that they called it the planet Vulcan. At any rate, it is worth while for observers to scrutinize the sun carefully, about the end of March and the end of September, to verify this point.

On April 25, 1838, there was an occultation of Mercury by the moon under most singularly favourable circumstances. It happened during the few days when the planet is visible to us after sunset. The immersion was at 8h. 29m., the emersion at 9h. 2m., the moon setting at 9h. 24m.

If we want to turn our telescopes on Mercury, it

must be done in the daytime. When visible to the naked eye, he is too much in the mists of the horizon for a distinct view with anything but a very low power. Little or nothing has been made out definitely with regard to markings on the planet. At one time, it was considered some decisive results had been obtained, and Schroeter spoke of lofty mountains on the surface, but one does not hear of modern observations confirming this.

The sun would appear to Mercury seven times larger than he does to us, and to Neptune he would have dwindled to a star in the firmament. Hence we might infer extreme heat in the one case, and extreme cold in the other. The thickness of atmosphere might, however, answer to ward off great heat in Mercury, and in Neptune the same cause might prevent extreme cold. At any rate, the Creator can suit the constitution of inhabitants to their dwelling. The Neptunians, if such there be, may have the same opinion of the heat of some planets nearer the sun that we have of the climate of Mercury.

Venus.

Ἔσπερος ὅς κάλλιστος ἐν οὐρανῷ ἵσταται ἀστήρ.—Homer.

This planet is frequently so brilliant as to be gazed at with wonder by the most casual observer. It has excited the admiration of every clime and age of the world, whether shining in the west after the sun has gone down, or heralding the approach of day in the morning skies. It is spoken of by Homer and Hesiod, the most ancient of the poets.

The phases of Venus are one of the easiest objects for a small telescope, nor is there much difficulty in seeing it in the daytime with such means. On May 11, 1871, I picked up Venus and Jupiter with a 2¼ in. telescope, about noon, when they were very near together, the brilliant silvery colour of the former contrasting strongly with the faintness of Jupiter when seen in daylight. Venus was occulted by the moon so as to be visible in England twice in 1841, once in 1867, but each time in daylight. Again, on Oct. 14 of the present year, 1874, Venus will disappear behind the moon's dark limb at 3h. 27m., and re-appear at the bright limb at 4h. 42m. The moon at the time is four days old; and Venus will appear through the telescope as a crescent a little wider than the moon. As the sun sets at 5h. 8m., the phænomenon will be in daylight, but there is little doubt it will be visible to the naked eye, and even through an opera-glass or small telescope it will be a most pleasing spectacle. Tycho Brahe, who lived before the invention of the telescope, tells us he saw an occultation of Venus on May 23, 1587, the planet going behind the moon, when the sun was 15° high, and re-appearing when the sun's altitude was 29°.

A small instrument will sometimes shew a slight blunting of the cusps of Venus' crescent. Flamsteed mentions such a case on Dec. 4, 1671, and I have occasionally suspected it with 2¼ in. It is an interesting point for observers to notice how long Venus remains invisible when in conjunction with the sun. On Oct. 2, 1843, Dr. Dick perceived the planet within two hours of its superior conjunction.

The apparitions of Venus are repeated very much in the same way every eight years; so that any of the following years may be multiplied by 8, 16, 24, &c., to give the planet's re-appearance in any future year; but telescopic observations should be made in daylight, there being too much glare about the planet when the sun is absent.

1874. The planet will not be a very striking object this year. It will be visible in the evenings after March, but will not remain long above the horizon after sunset. At this appearance, which corresponds to 1858 and 1866, I have noticed Venus with the naked eye after sunset till the third week in November.

1875. Not very well suited for observation. Best seen in the mornings of January and February, when it will appear a fine crescent through the telescope. The last fortnight in the year it exhibits the resemblance to a little full moon, and will be visible just after sunset.

1876. Venus particularly splendid in the evening skies till July. She should be observed with the telescope in May and June, in the daytime. A fine morning star from August to the end of the year.

1877. As seen by the naked eye, Venus will be a fine object in the mornings of January, and in the evenings of November and December. In the spring and summer months she follows the sun too closely, and will need an equatorial telescope to be easy of observation.

1878. A striking object in the west during the evenings of January and the first half of February. Through the telescope, Venus will appear a beautiful

crescent, like the moon a few days after the change. A morning star about August and September.

1879. Visible in the evenings of the spring and summer months, and from September to the end of the year in the mornings, when through a telescope she will appear a beatiful crescent.

1880. The planet will be especially conspicuous during the mornings of January, and the evenings of December. In the spring and summer months, it does not depart far from the sun, but an equatorial telescope in the daytime will readily follow it, and even one on a plain stand, with a little trouble.

1881. Very brilliant in the evenings till May; afterwards visible in the mornings till the end of the year. A fine crescent in April.

The markings on Venus are faint, and somewhat puzzling. Some observers declare they can detect them without difficulty, and papers have recently been presented to the Royal Astronomical Society, stating that they have been observed with a 6 in. speculum, 4 in. achromatic, and even $2\frac{1}{8}$ in.; while Dawes could never see them with 8 in., although he was able to detect the little companions of Rigel and Polaris with far less optical aid than any other observer. It has been said that those who are the least successful in catching the minute companions of double stars, are generally the most likely to see these faint markings. Similarly, telescopes which bring out minute points of light well, are often not the best for dark streaks on the planets, and *vice versâ*. I have frequently examined Venus with every power on a 4 in. telescope, but as yet have not been able to see any of these

markings for certain. Probably, the observer need not employ a high power for the purpose, and the search should be made in the day-time.

Another puzzler is the satellite of Venus, which some observers speak of seeing. The common explanation is, that a defect in the instrument caused the illusion. It is difficult, however, to see how this would explain away four observations in 1761, when Montaigne saw a small crescent describe about 200° of a circle round Venus between the nights of May 3 and 11. If such a body exists, it must be seen as a dark spot on the sun near Venus at some of its transits. On this point, the following remarks of Dr. Dick are worthy of the attention of observers:—"It is evident, that if Venus have a satellite, it must be difficult to be seen, and can only be perceived in certain favourable positions. It cannot be seen when nearly the whole of its enlightened hemisphere is turned to the earth, on account of its great distance at such a time, and its proximity to the sun; nor could we expect to see it when the planet is near its inferior conjunction, as it would then present to the earth only a very slender crescent, besides being in the immediate neighbourhood of the sun. The best position in which such a body might be detected, is near the time of the planet's greatest elongation, and when it would appear about half enlightened. If the plane of its orbit be nearly coincident with the plane of the planet's orbit, it will be frequently hid by the interposition of the body of Venus, and likewise when passing along her surface in the opposite point of its orbit; and if one side of this body be unfitted for reflecting

much light, it will account in part for its being seldom seen." We cannot, therefore, entirely disbelieve in this supposed satellite of Venus, till the transits of 1874 and 1882 are gone by. We must now proceed to the transits of Venus across the disc of the sun.

These transits, when observed at opposite points on the earth's surface, afford the means of obtaining the sun's parallax, and hence the distance of the sun, on which so much depends. The sight of a transit of Venus was afforded in 1639 to the Rev. Jeremiah Horrox, of Hoole, a young Lancashire clergyman, and to him first since the creation. Horrox had discovered that the transit would happen on November 24. He communicated with his friend William Crabtree, of Manchester, requesting him to observe especially the diameter of Venus, which, according to Kepler, would be 7m. of a degree; according to Landsberg, (whose tables were much vaunted at that time,) 11m.; but according to his own expectation but 1m. Horrox observed at intervals on the 24th, being called away at other times, he tells us, "by business of the highest importance, which I could not, with propriety, neglect for these pastimes" (meaning, to perform the Church's offices, it being Sunday). But at 3h. 15m., when he was again at liberty, the clouds were dispersed, and then, says Horrox, "I beheld a most agreeable sight, the object of my sanguine wishes, a spot of unusual size, and perfectly circular shape, which had already fully entered on the sun's disc on the left, so that the limbs of the sun and Venus precisely coincided." Horrox was able, in the remaining half-hour before the sun set, to make observations as to diameter, in-

clination, approach of centres, &c. His friend Crabtree, at Manchester, had but one sight of Venus, at 3.35, when the sun broke out from the clouds, but he was too excited for observation, "scarcely trusting his own senses through excess of joy," and before he recovered himself, clouds came over the sun again. Horrox, who appears to have been a prodigy for his skill in mathematics and astronomy, died suddenly about a month after the transit[a]. In 1716, Dr. Halley pointed out the value of the ensuing transit of June 6, 1761, mentioning places for observation, and stating that the entry of Venus on the sun would not be visible in England, but that it might be seen in the north frigid zone, the north coast of Norway, &c.; that when Venus was nearest the sun's centre, the sun would be vertical to the bay of Bengal. Halley urged that observations should be made at several places, lest clouds should spoil "a sight which, I know not whether any man living, in this or the next age, will ever see again; and on which depends the certain solution of a problem the most noble, and at any other time not to be attained to. I commend it, therefore, again and again to those curious scrutinizers of the stars, who, when I am gone, will have an opportunity of observing these things, that they would remember this my admonition." Early in the morning, when every one was prepared for the transit, the sky was so cloudy as to render it doubtful whether anything could be seen;

[a] James Gregory, the inventor of the Gregorian telescope, seems to have shewn, in 1663, the great advantage to be derived from the transits of Venus.

but at $7^h.38.21$ the clouds had sufficiently broken at Greenwich to allow Venus to be seen on the sun. The centre of Venus then preceded the sun's centre by 6′.18.″9 right ascension, and was south of the sun's centre 18′.42″.1 declination. The internal contact of Venus with the sun's limb, was at 8h. 19m. Various observations were obtained here, also at Stockholm, Torneo in Lapland, Madras, Calcutta, &c.

On June 3, 1769, there happened the last transit of Venus. As seen from the northern parts of the earth, Venus was depressed by a parallax of latitude on the sun's disc, so the visible duration of the transit was lengthened; in southern regions, she was elevated by a parallax of latitude on the sun, which shortened the visible duration of the transit with respect to its duration as supposed to be seen from the earth's centre. The best observations were obtained by the Danish astronomers in Lapland, and by Captain Cooke, who was sent to Otaheite to observe the transit. The value deduced for the sun's parallax from these transits, was 8″.6. Recent investigations have, however, led to the conclusion that the parallax is 8″.9, and hence the sun's distance from the earth three or four millions of miles less than was supposed.

A considerable portion of the last pair of transits, 1761, 1769, was visible to Great Britain, but we are not so fortunate in the next pair; that of 1874 being wholly invisible here, and that of 1882 commencing a little before sunset. At the last transit, in 1769, Dr. Wilson requested the inhabitants of Glasgow to put out their fires in the afternoon, that there might be no smoke in the air to hinder the observations. It

is gratifying to know that his request was heartily complied with.

Transit of Dec. 9, 1874. As Venus, after an interval of 105 years, is about to pass over the sun once more, astronomers are again on the *qui vive*. Both the entry and departure of the planet from the sun must be observed at stations where the sun is ascending, and secondly, where he is sinking. We have selected eight stations, besides Lord Lindsay's private expedition to the Mauritius, the Americans eight, the Germans four, the French five, the Russians nineteen in East Russia and Siberia.

The transit of Dec. 6, 1882, will be partly visible in Great Britain, Venus being fully entered on the sun at 2h. 5m. afternoon, (see frontispiece). So we hope this will be seen by many who read these lines, but no eye that casts sight on it may ever hope to behold a similar spectacle again, for the succeeding transit is not till June 8, 2004, when it will be visible throughout in this country; commencement at Greenwich, 5h. 9m. 56s. morn., egress 11h. 22m. 15s. morn. At the following transit, June 6, 2012, the sun will rise at Greenwich an hour before the planet begins to leave his disc. The next pair of transits take place on Dec. 10, 2117, and Dec. 8, 2125, the ingress of the latter being visible here. The succeeding pair fall on June 11, 2247 (visible throughout in Great Britain), and June 8, 2255, partly visible here. A transit could not take place under the most favourable circumstances possible till the last on Delambre's list, June 14, of the good year 2984, when the centres of Venus and the sun coincide within 0′.45″ !

The Earth.

As the next planet in order from the sun, our own globe will claim space for a few remarks. And here we may notice an instance of the Creator's peculiar favour to the whole of our world, for as the sun's rays are withdrawn from the various parts of it, they get the benefit of the moon's reflected light, and by this, the darkness of the poles is relieved; while by half of the moon we are never seen, as she only turns round her axis during the month she moves round us, always presenting the same side to us. On that part of the moon that does see us, we should reflect thirteen times more light than the moon does on us, and appear thirteen times as large.

Some two centuries ago, a Frenchman discovered on a voyage, that when he was near the equator the beats of his clock were not so frequent as in his native land. In order to make it agree with his time, obtained by observing the stars, the pendulum had to be made shorter. Similar experiments were made in other places, and at length it was found that this alteration diminished, the further one receded from the equator. Degrees having been measured in different parts of the earth, it was seen that the figure of our globe is that called an oblate spheroid, in other words, somewhat flattened at the poles, and jutting out a little at the equator.

The ancients, judging from mute gaze at the sky, imagined the earth was in the centre, and the sun and stars went round it. The absurdity of such an idea may be seen by comparing the enormous size of

a globe like the sun, with a mere spec, such as our world. There were, however, some men of deep thought and observation. Pythagoras, 600 years B.C., declared that the sun was in the centre, and that the earth and planets went round it. This system, restored by Copernicus, will account for all the phænomena of the heavens, which could not be explained if the earth did not move round on its axis. If we study our earth carefully, we shall see that everywhere it bears marks of having undergone a fearful catastrophe. Fossil substances, which originally belonged to the sea, have been found on the heights of mountains; the bones of animals have been discovered in countries the most remote from those they inhabit. Again, if we look at our maps, we shall see the parts of one continent that jut out, agree with the indented portions of another. The prominent coast of Africa would fit in the opposite opening between North and South America, and so in numerous other instances. A general rending asunder of the world would seem to have taken place, when "the foundations of the great deep were broken up," and "the waters prevailed exceedingly upon the earth, and all the high hills that were under the whole heaven were covered." Such an excess of ocean, covering so many millions of acres of ground, such scorching heat in one climate, and withering cold in another, do not indicate a world made for man in his primeval state, but rather after his fall. At the Creation, therefore, it is possible that the axis of the earth did not point exactly the same as at present, and that a more equable temperature prevailed.

Under the head of "the Earth" we may mention

the most remarkable of those commotions called earthquakes in our country. One, in 1185, destroyed the church of Lincoln; another, in 1274, threw down the church of Glastonbury; others occurred as follows:—1328, very severe over all England; 1382, several churches thrown down in the southern counties; 1426, in the midland counties, accompanied by thunder and lightning; 1428, very severe all over England; 1571, Herefordshire, Marcley Hill removed, which contained twenty-six acres; 1693, in England, France, and Germany, 60,000 persons perished in Sicily, Spanish Town in Jamaica destroyed; 1703, felt in England and Rome, Aquila in Naples destroyed, and 7000 persons; 1734, in Ireland, destroyed one hundred houses and five churches; 1755, felt in London and many other parts of England, the same that destroyed Lisbon; 1777, Manchester; 1790, Perthshire, many violent concussions, and great variations in the barometer; 1850, North Wales; 1852, slight shocks in Manchester; 1863, many parts of England had slight shocks.

Extremes of Temperature.—The hottest day on record in this country is July 14, 1808, when the thermometer stood at 98° in the shade. At other times, 1750, July 11, therm. 96°; July 13, 1808, therm. 93°; July 24, 1844, therm. 93°; July 18, 1859, therm. 93°. 1826, 1868, 1870 were summers of continued warmth and dryness. For the coldest winters, we might mention 1709, 1740; but the coldest month on record was January, 1795. Again, on Christmas Day, 1796, and on Christmas Day, 1860, the thermometer stood below zero. The coldest spring in the present century was

1837. The years of most rain during the present century were 1816, 1828, 1829, 1852, 1853, 1860. It often happens that a great fall of rain for a day or two may take place in the midst of long drought. 1834 and 1857 being summers of parching skies and heat, brought an amount of water exceeding that of a real wet summer. In such rainy summers as 1709, 1816, 1823, 1860 there were almost continual light falls. In the year 768 the Black Sea and the Straits of Dardanelles were frozen over, the snow in some places drifted fifty feet high. In 822, the Danube, Elbe, &c., were so hard frozen as to bear heavy waggons. In 1134, the Po was frozen from Cremona to the sea; the wine-sacks burst, and the trees split from the action of the frost with immense noise. In 1316, the crops wholly failed in Germany; wheat, which some years before sold in England at six shillings the quarter, rose to £2. In 1368, the wine distributed to the soldiers was cut with hatchets. In 1683, most of the hollies were killed. Coaches drove along the Thames (as in 1814), the ice of which was eleven inches thick. The Thames is said to have been frozen over for fourteen weeks in 1063; and below bridge to Gravesend, from Nov. 24 to Feb. 10, in 1434.

Marshal Bugeaud, when captain in the Spanish campaign, under Napoleon I., met with a manuscript bearing the following rules, and in after years he found they held good from observation. Eleven times out of twelve the weather remains the same during the whole moon as on the fifth day, if it continues unchanged over the sixth; and nine times out of twelve like the fourth day, if the sixth resembles the fourth.

In counting the fourth and sixth days we should be particular in beginning from the exact time of the new moon.

Most persons are acquainted with the old lines:—

> "Saturday's moon and Sunday full
> Never was fair and never wool (will)."

In February, 1849, it was proposed, in a scientific periodical, to test this, the next Saturday's new moon being on March 24. So it happened, that out of a tolerable course of dry weather there came more wind and rain on that Saturday, followed by a week of clouds, slight rain, and snow. Dr. Forster, of Bruges, had declared to the Astronomical Society that in journals kept by himself, his father and grandfather, from 1767 to 1849, every Saturday's moon had, in nineteen cases out of twenty, been followed by twenty wet and windy days. Qy. Where is the explanation to be found?

The Moon.

When the brightness of the moon overpowers the fainter stars the observer will have plenty to do in examining her surface. To see anything in the shape of intelligent life on the moon is not to be expected. The largest telescope ever constructed, Lord Rosse's, has a speculum six feet in diameter. Supposing this charged with a magnifying power of 6,000 times, (100 to the inch, an extreme power,) an object in the moon would be seen as if forty miles off, a great deal too far to discern animal life. A telescope to carry a far higher power might be constructed, but the state of

our atmosphere would render these high magnifiers utterly useless.

It is a curious point to notice how soon we can see the crescent of the moon after new. In the spring a casual observer may catch sight of it when very clear, twenty-four hours afterwards; but I have hardly ever detected it younger than this. A case is related of the moon's thin crescent being seen early one morning before sunrise, and after sunset the next day. But, in the torrid zone, Vespucius is said to have seen the moon to the east and west of the sun the same day.

It would seem that a lunar atmosphere, except of great tenuity, does not exist. In some rare cases, a star has been seen to linger on the edge of the moon during an occultation, instead of popping out instantaneously. This has been brought forward as an argument for a lunar atmosphere. It has been said to have taken place often with the bright red star Aldebaran. Smyth says this is "owing to the greater proportionate refrangibility of the white lunar light than that of the red light of the star, elevating her apparent disc at the time and point of contact." We may here remark that the amateur will not find occultations of bright stars occur too often. Since that of Regulus, in 1858, I have seen no other but one of Aldebaran imperfectly in 1867. There were several first magnitude occultations in 1866 and 1869, but I always met with a cloudy sky.

When the moon is about three or four days old, and we see her hanging in the western sky, a faint, ashy, grey light is visible all over the unenlightened part of her surface; in other words, the whole circle of her

surface is clearly seen. This is the earth-light received on the moon, the sun's-light that shines on our earth reflected on to the moon. Humboldt tells us that Lambert, on Feb. 14, 1774, noticed that this light on the moon was of an olive-green colour. The moon, which then stood vertically over the Atlantic, received the earth-light sent to it, in a cloudless sky, from the forest-covered regions of South America.

To enter into a description of lunar objects would be impossible within the limits of this little work. The best book for this purpose is Webb's "Cycle of Celestial Objects." By studying the map given there, the amateur will very soon become acquainted with the principal mountains and plains. When the moon is about a day old, I have noticed the mountains called Ansgarius, Kastner, Hecatæus; at four or five days old, the plains called the Mare Crisium and the Mare Fecunditatis come into view pretty well. Shortly afterwards they are succeeded by some still larger ones, the Sea of Tranquillity and the Sea of Serenity. These surfaces, though less rugged than other parts of the moon, are by no means universally plain. In fact, one of the craters on the Mare Tranquillitatis, called Linnè, has been the subject of much debate, from some fancied alteration. Just as the moon has turned the first quarter, a host of fine objects come into sight, Walter, Regiomontanus, Purbach, Arrachel, Alphonsus, Ptolemæus. About this time, the rough-looking ramparts of Copernicus, still more rugged with every increase of telescopic power, will occupy attention. North of Copernicus is the little Pico, casting an enormous long shadow, in the form of a pyramid. Still

further north is Plato, with its dark interior, which has gained much interest from the observation of certain streaks and spots. As a contrast to this, the observer will notice two small objects a good way east of Plato, when the moon is about two days off her full, Aristarchus and Herodotus; the former of them appears of a brilliant snowy whiteness. The grandest lunar object is certainly Tycho. From this emanate a number of peculiar bright streaks, running over the moon's surface, and very conspicuous at the full. Clavius, south of Tycho, will also be found a magnificent specimen. It contains many craters in the interior. Maginus, which lies nearly between the two, is a vast ring, and, strange to say, becomes invisible at the full. Some jagged mountains will also be noticed on the very rim of the moon, the Leibnitz and Dorfel mountains. They make the moon's limb appear rough and uneven when projected on the sun in an eclipse. I have found a power as high as 200 on $2\frac{1}{4}$ in. very serviceable for the moon. Many features may be brought out even with a small instrument; while, to wander over the wild and apparently desolate surface of our satellite with 185, 300, 420 on 4 inches is absorbingly interesting.

Mars.

Every two years we may notice a fine red star rising in the east, as the sun goes down. This is Mars, which is so remarkable for the ruddiness of its light, and the dark marks which a powerful telescope shews on its surface. As its orbit is outside that of our earth, we never see it like a half-moon, or a crescent,

if we turn our instrument to it. Sometimes, however, it appears a little gibbous, like the moon a few days short of the full. The ruddy tint of Mars was once ascribed to thickness of atmosphere, but now generally to the colour of the soil, such as red sandstone. When the planet is near its opposition to the sun, something may be seen of the dark marks on its surface, with only a small instrument, if really good. After examining the planet in May, 1873, with a 4 in. telescope, I brought out a $2\frac{1}{4}$ in., and was astonished at the distinctness with which it exhibited the dark markings, especially on fine evenings. Everything that could be seen with 4 in. could be distinctly traced with $2\frac{1}{4}$ in., only smaller, and a little fainter. Flamsteed, who had very inferior optical aid, gives us a drawing of Mars, taken Oct. 11, 1672, in his *Historia Celestis*. It shews a resemblance to a sun-spot with a penumbra. He adds, "Planetæ semper circa medium obscuritas aliqua apparuit[b]." At the next opposition, in 1875, the planet will be very low in the south, and its diameter small. But in the autumn of 1877 there will be an opposition in the constellation Aquarius, under the most favourable circumstances. The planet will arrest the attention of the most casual star-gazer. Such a case happened in 1719, when Mars, equalling Jupiter in splendour, but of a blood-red colour, created a perfect alarm among the peasantry in France.

Several attempts have been made to discover the solar parallax by the oppositions of Mars, but they do not seem to yield results quite as accurate as the tran-

[b] In my note-book, Sept. 30, 1862, I find I have made a remark in almost the same words, using power 70 on $2\frac{1}{4}$ inches.

sits of Venus, affected, though the latter are, by irradiation. The first case of this appears to have been by Flamsteed in 1672. He found the planet would pass among the three stars marked ψ in the water of Aquarius. He tells us, "My father's affairs caused me to take a journey into Lancashire, the very day I had designed to begin my observations; but God's Providence so ordered it, that they gave me an opportunity to visit Townley, where I was kindly entertained by Mr. Townley, with whose instruments I saw Mars near the middlemost of the three adjacent fixed stars. My stay in Lancashire was short. At my return from there, I took his distance from three of them at different times of the night; whence I determined his parallax, then 25″, equal to his visible diameter, which therefore must be its constant measure, and consequently the sun's horizontal parallax, not more than 10″. The French, soon after, declared, from their observations, that they had found the same."

Some white spots at the poles of the planet have been considered to indicate snow, for they vanish after being long exposed to the sun, and are largest when emerging from the polar winter in Mars.

The dark markings are considered seas, for water will reflect a less quantity of the sun's light than land. The proportion of ocean to land on Mars seems just the reverse to that on our globe. In the features of Mars, the only planet that comes near enough for us to scrutinize its surface, we find a striking similarity to our own earth.

The Minor Planets.—The great blank between the orbits of Mars and Jupiter had long been considered

unaccountable. At length, in the year 1800, it was resolved that a search should be made for some unknown world, and the first day of the present century, Jan. 1, 1801, was signalized by the discovery at Palermo of a little erratic star in the constellation Taurus. After three others had been detected, these little bodies were supposed to be hunted up, but again, in 1845, another was found, and since then, every year brings us some more. Not to lose sight of these little points of light, adds immensely to the labours of our celebrated observatories. The amateur must not expect to pick up any of them, unless he have a chart of stars of very small magnitudes, and then he may compare this with the heavens, and search for "wanderers." Vesta, the brightest of the group, was occulted by the moon on the night of Dec. 30, 1871. I was enabled to catch sight of its re-appearance on the moon's dark limb with a power of 70 on $2\frac{1}{4}$ inches.

Jupiter.

Next to Venus, Jupiter is the planet that shines with the greatest brilliance, and most attracts the attention of the commonest observer. When we look at Jupiter through a good telescope, we perceive several parallel bands stretching across his globe. These were first noticed about twenty years after Galileo had observed the satellites. A very small instrument is sufficient to bring out one or two of them, and the whole four are very easy of observation. Their discovery by Galileo in 1610 is related in his *Nuntius Sidereus*. He tells us he first heard of a perspective, made by a Bel-

gian, that brought objects much nearer the eye. At length, "after sparing no expense and labour," he constructed an instrument that performed admirably on terrestrial objects, and shewed the moon also to be "rough and full of cavities like the face of the earth." On Jan. 7, Jupiter being in view, he saw three bright little stars near him; and although he thought they belonged to the fixed class, he very much admired them, because they seemed in a straight line, and parallel to the ecliptic. On Jan. 11, he came to the conclusion that there were "three stars wandering round Jupiter, like Venus and Mercury round the Sun." On the 13th he found they were four in number. He was enabled to observe them till March 2. The eclipses, transits, occultations of these little moons by the body of Jupiter always prove highly interesting to the astronomer. They cannot all be eclipsed together, but by one or two being behind Jupiter, there may be an entire disappearance of them for a time. Jupiter has thus been seen divested of his satellites four times, once in 1681, and three times in the present century, the last occasion being on August 21, 1867.

The amateur may set his watch correctly by observing the eclipses of Jupiter's first satellite, and to within a trifle by the second satellite. This may be done with a small telescope. The disappearance or re-appearance of the first and second takes place very rapidly. Both immersion into Jupiter's shadow, and emersion from it may often be seen with the third and fourth, and this is sometimes the case with the second. The eclipses of the third satellite are two or

three minutes wrong at times, and those of the fourth sometimes as much as twenty minutes at variance from the predicted time. Those of the first afford means of determining the longitude of places on the earth.

Many years after these satellites had been discovered, it was noticed that the eclipses of them were sixteen minutes later, when the earth was at its greatest distance from Jupiter, than when it was at its nearest point. The conclusion indicated was, that light is not propagated instantaneously, but takes a certain time to travel from one object to another.

Besides the belts, certain other spots have occasionally been seen on the planet. By the revolution of one of these, the rotation of Jupiter was found to be under ten hours. With such a short day as this, the heavens would appear to a spectator on the planet to be changing every minute. We may imagine how the nocturnal scene from Jupiter must be diversified by these four moons, one rising, another high in the south, another going down in the west; at other times all the four shining in one glorious assemblage.

The last occultation of Jupiter by the moon visible here took place on May 24, 1860, in daylight. Still I managed to catch sight of the planet with an old ship-glass, power 16.

Thomas Street, in his *Astronomia Carolina*, gives us the following: "Anno 1170, Sept. 13, midnight, two of the planets were so conjoined, that it appeared as if they had been one and the same star, but they were presently separated. (*Gervasii Chronicon.*) These two planets were Jupiter and Mars, being then so near together that they appeared as one star."

On Jan. 9, 1591, Kepler witnessed an occultation of Jupiter by Mars, and the red colour of the latter clearly indicated that Jupiter was the further of the two.

Our earth would be too small, and too near the sun, to be seen from Jupiter; and Jupiter himself is situated but one fourth of the way across our solar system. It is a humiliating thought for man's pride, that before we could pass one quarter of the distance across our own solar system, our world would have altogether vanished from sight like an atom in the universe, and would be as though it never existed.

Saturn.

Very different is the appearance of this planet to the naked eye, and the telescope. With the one, it is but a dull-looking star of scarcely the first magnitude; through the other, our eye is attracted by the appearance of a singular ring surrounding a globe. Galileo, whose telescope was not powerful enough to bring it out as a ring, could not tell what to make of its malformation, and so he concluded the planet was "triple-shaped." Half a century afterwards, Hevelius was enabled to state that it was surrounded by a ring "nowhere adhering to it." A few years more passed over, and this ring was found to consist of two. Modern observations, with gigantic instruments, exhibit several other subdivisions of the ring. With a $2\frac{1}{4}$ in. telescope, and power 100, a very fair view of Saturn's ring may be obtained, and also of one of his satellites, Titan, which is equal to a star of the eighth magnitude. Occasionally, I have caught sight of another

satellite with these means. With 4 in. I have no difficulty in detecting four satellites, when the planet is near opposition, and no doubt all the old five would lie within its reach at times. The fainter satellites require first-class instruments. To obtain a good view of the division of the ring even with 4 in., the planet must be pretty favourably placed, and not at a low altitude. Every fifteen years the ring disappears from sight to all but the largest telescopes, the thin edge being then turned to the earth. For a few days before and after this takes place, the ring has the appearance of a fine pencil of light on each side of the planet. Such was the case the last time in 1862. The belts on Saturn are very faint and difficult of observation compared with those on Jupiter. I witnessed occultations of Saturn by the moon on the evenings of May 8, 1859, and Sept. 30, 1870. On each occasion, the dull hue of the planet contrasted strikingly with the brilliant yellow of the moon. Old Thomas Street tells us that Bullialdus found an ancient Greek manuscript, relating an occultation of Saturn by the moon "observed in the year of Christ 503, Feb. 21, at night; in which, near about the fourth hour, the moon hid the star of Saturn; but after Saturn was fully freed from the interposition of the moon, the observator, together with his loving brother, found the temporal hours by an astrolabe $5\frac{2}{4}$, so they conjectured a central conjunction of the moon and Saturn about the 5th hour, for he appeared to emerge in the middle of the enlightened part of her circumference."

Uranus and Neptune.—If unprovided with an equatorial stand, the amateur will have some difficulty in

picking up the two remotest members of our solar system, and when he is able to make them out by their motion among the stars, they will scarcely repay the search. Uranus was occulted by the moon in 1871, the time of the occultation shewing the tables to be about five minutes wrong. Neptune is about equal in light to Saturn's brightest satellite.

The Aurora.

This is a phænomenon which will attract the attention of the observer, especially in the winter months. It is seen in perfection near the poles, and is not visible from regions round the equator of the earth. It is usually of a whitish colour, occasionally tinted with green, but more commonly with red. Sometimes it takes the form of an arch of light, but this is not often the case in latitudes so far south as Great Britain. It has been considered a result of a combination of the two powers of magnetism and electricity. Dr. Wykandar and Lieutenant Parent, having studied the Aurora with the aid of the spectroscope, think it related to the fall of fine particles of iron and carbon, the presence of hydrogen, and probably of snow. The whole phænomenon appears at some periods more frequently than at others. Stow, the chronicler, gives us a quaint description of a display in the year 1575, wherein "the heavens did burn marvellous ragingly." For a great many years the Aurora had not been seen in England till March 6, 1716, when there burst into view a brilliant exhibition visible from the west of Ireland to Russia. On Feb. 17, 1773, Captain Cook, who was

then in southern latitudes, witnessed a fine Aurora Australis. Although in most respects similar to our northern lights, it differed from them in being always of a whitish hue. Of late, it has been found that fine displays of the Aurora take place about every eleven years, at which period there is also an excessive number of solar spots, and a disturbance in Jupiter's belts. On May 13, 1869, I observed an Aurora, which caused the sky for some time to assume the resemblance to an enormous umbrella. Thick columns of light started up from the horizon on all sides, and met at a point overhead. Though there was no moon or twilight, the time could be easily read on a small watch held at the distance of a foot from the eye. On the night of Oct. 24, 1870, we had a complete arctic display. A superb rosy arc extended from north to north-east, the heavens there resembling a red curtain illuminated from behind, or being like flames erupted from a volcano. Early in the evening of Feb. 4, 1872, a magnificent Aurora was seen all over Europe, and at Alexandria, &c. Streamers of a brilliant carmine colour sprung up side by side with greenish streamers, generally converging to a point overhead. The coruscations were intensely vivid. In old times, accounts spoke of a crackling sound accompanying the Aurora, but it has been well observed that as Auroræ became better understood, they also became less noisy.

The Zodiacal light.—Sometimes in February and March, after sunset, an ill-defined light of a conical shape may be seen in the west. This is termed the Zodiacal light. The first clear notice of it seems to have been published by Childrey, chaplain to Lord

Somerset, in 1661. Tycho Brahe had mistaken the phænomenon for the evening twilight. On Feb. 21, 1870, I witnessed this phænomenon from Lytham, on the Lancashire coast. It stretched faintly beyond the head of Aries. The extent near the base was from about *a* Pegasi into Cetus. The time was about 7½h., and twilight had gone. The cause of the zodiacal light has been conjectured to be a ring of nebulous matter revolving between the orbits of Mercury and Venus.

Meteors.

These brief notes on astronomy would be incomplete, were we to omit a few remarks on the subject of Meteors. Appearing suddenly in the nocturnal skies, they sometimes startle the beholder by their size and trains. The origin would appear to be some mass of nebulous matter. This idea is strengthened by the fact that Meteors in abundance enter our atmosphere at stated periods; the most plentiful displays being on Aug. 10 and Nov. 13. Those who witnessed the glorious sight in 1866 will be able to bear this out. At Greenwich, on this occasion, 7,000 were counted between eleven o'clock and five. Of these, 4,000 were between one and two. The November meteors are subject to a periodicity of 33 or 34 years. They had been seen in great brilliancy on Nov. 12, 1833, in America. Between the hours of four and six that morning, it was estimated that more than 1,000 per minute might have been counted, and they continued till the sun's brightness overpowered them. MM. Bonpland and Humboldt saw the previous return, in No-

vember, 1799, at Cumana, in South America. From the beginning of the spectacle, there was not a place in the firmament, equal in extent to three diameters of the moon, which was not filled at every instant with falling stars. The inhabitants of Cumana stated that the earthquakes of 1766 were preceded by similar phænomena. As the November falls are now declining in importance, we must look to the August ones, and they are steady and certain. The August stream was often termed the "tears of St. Lawrence." Humboldt says that, from several years of observation, there were on August 9th twenty-nine meteors per hour; on the 10th, thirty-one; on the 11th, nineteen; on the 12th, seven. Clouds and moonlight have interfered with my own observations of the August meteors every year, except one, 1871, when the nights of the 9th, 10th, 11th, 12th, were perfectly clear, and the moon absent. On the night of the 9th, I noticed ten meteors per hour; on the 10th, thirty-seven; 11th, twenty; 12th, nine. As only a third or a fourth part of the sky could come under my gaze at a time, these numbers would have to be multiplied to ascertain the actual number passing across the sky at the time. Another minor period, but deserving attention, occurs about April 20th. Streams of meteors are said to have been seen, in former times, about this date. In 1870, I noticed several bright meteors on April 18 and 20. The radiant point of the August meteors is in the constellation Perseus; that of the November meteors, in Leo.

Apropos of meteors, there was a communication in the "Spectator" some time back, by the Rev. E. L. Garbett, suggesting that the cities of Sodom and Go-

morrah were destroyed by a group of the meteors following Tempel's telescopic comet of 1866.

1. The period deduced for the node-passage of the comet's two observed visits, 1366 and 1866, would give a visit in the autumn between B.C. 1898 and 1897, in one of which years the catastrophe is dated, consequently in the right biennium out of $16\frac{1}{2}$.

2. The earth's passage of the node was then about July 31, and the event was in a hot season (when Abraham needed shade at noon, and the visitors proposed abiding in the street all night). Suppose this applicable in Palestine to half the year, we have the right half-year out of two.

3. A fall, as vertical as rain ("then the Lord rained"), was possible, from this source, in no hour but that of sunrise. Hence we have the right hour out of twenty-four.

4. Dividing each hemisphere (say) into eight zones of latitude, this degree of verticality was possible in none of these, but the third north. Hence we have the right latitude region out of sixteen.

5. Sodium, the chief element in the abnormal deposits, now there (and in the salt with which Lot's wife is recorded to have been covered), was also the chief, observed by Secchi, in these meteors; and it is not the chief in one-thousandth of the matters on earth. But, supposing a twentieth of all matter to display it as prominently as the meteors did, we have the right chief element out of twenty.

6. Magnesium, the second in those salt deposits, was the only other ingredient conspicuous to Secchi in the meteors by means of the spectroscope, and

would not be thus conspicuous in one known solid out of ten.

Suppose any event, not due to this comet, to be recorded. The chances against the account presenting these six agreements with its elements, and no disagreement, are found by deducting 1 from $16\frac{1}{2} \times 2 \times 24 \times 16 \times 20 \times 10$, that is, three millions to one that the history of Sodom is true, and this the physical cause.

List of 152 *Double Stars and Nebulæ.*

The ancients divided the starry sphere into constellations, or groups of stars, just as they lay near one another, so as to occupy the spaces which the figures of different sorts of animals would take up if they were delineated there. The twelve constellations of the zodiac stretch round the heavens. They take in the orbits of the moon and the principal planets. Along the middle of this belt is the ecliptic, or circle, which the earth describes every year, if we could see it from the sun, and which the sun appears to describe as we see it from the earth. The distribution of the stars into constellations dates from the first ages of the world. The fact that very few constellations really resemble the animal or thing whose name they bear is easily accounted for. Our primitive fathers made the groups of stars indicate what they wished to perpetuate. They did not pick out a group of stars, and think first what figure it might faintly resemble. The principal constellations were known, as we have them now, among all nations, and in all ages. They are recognised in most ancient monuments. Aquarius has been supposed to refer to the overflowing of the Nile;

Virgo, to the harvest in primeval times. But if one constellation coincides with a certain season, there is seldom a plausible explanation to be given of another. A Divine symbolical origin has been suggested. In all nations the tradition has prevailed of one, born of a woman, engaged in conflict with a serpent, and at last triumphing over him. This tradition seems reflected in the emblems of the ancient constellations. It has been remarked, that the primitive year must have begun in Virgo, the stars of which would shine in the evening sky, when the sun was in Aries. "The splendid star, still called by us Spica, the ear of corn in the woman's hand, marked the leading idea, the Promised Seed. In this sign, long before the Christian era, there was figured, in the Egyptian zodiac, a woman with an ear of corn in her hand, and below, another female figure holding an infant. In the next sign, Libra, we have His work, which was to buy, to redeem, figured in the balance, weighing the price against the purchase. Then, in Scorpio, follows an indication of what that price was to be; the conflict in which the seed of the woman receives the wound in his heel, while his other foot is on the head of the enemy, here figured by the Scorpion, a venomous reptile, which can sting, even while his head is bruised."—(*Rolleston.*) In each other sign of the zodiac, some point in man's redemption is said to be indicated, till we come to Leo, representing invincible strength, and so the final separation between the good and evil. The feet of Leo have always been placed on the constellation Hydra, the serpent, thus representing the final crushing of the serpent, man's great enemy. It has also been sug-

gested, that the well-known constellation of the Great Bear may, in primitive ages, have been an emblem of death. It is probable there might be such an emblem, and the Bear would be a very fit animal to represent it. Its Arabic name was Banáat n'ash, "daughters of the bier." It would pursue its slow constant course, like a funeral procession, round the Pole-star, κ Draconis, 4000 years ago. Draco, situated near the Bear, has been supposed to indicate the serpent, who suggested the sin of which death was the penalty. Near this, Bootes, with its bright star Arcturus, the Bear-keeper, twice mentioned by Hesiod, has been called an emblem of Him who controls Death and Satan. One of the Arabic names of this constellation is Háris-as-Semá, "keeper of heaven."

According to an ancient Jewish belief, the twelve constellations of the zodiac were expressed by the first twelve letters of the alphabet. There is a likeness between the position of the chief stars in these constellations and the first twelve Hebrew letters, beginning in Taurus.

The cipher emblems, by which the twelve zodiacal constellations have always been expressed up to the present day, also bear some resemblance to the stars in each sign. The form of any of these emblems cannot be found in any other constellation but its own. "If the antediluvians found appropriate ciphers, in the twelve signs of the zodiac, to represent the signs themselves, it is but going one step further to say that they found, in the natural configuration of the constellations, their one primæval alphabet. That astronomy and the primæval alphabet originated much

about the same time, was an ancient belief, as it is by some of the Jewish rabbins in our day."—(*Broome.*) Very interesting, even if not convincing, reasons for the above statements will be found by Mr. G. J. Walker, (quoting from the late F. Rolleston,) Rev. J. H. Broome, &c., in the "Astronomical Register" for Nov., 1867; Sept., Dec., 1870; Sept., 1871. The reader would find the perusal of the above articles would well repay his time.

We now proceed to note what objects may be seen with a small instrument. Much more may be done than one might suppose with such an instrument, as, says Mrs. Ward, "we may see at every sixth window, on a fine summer's day at a watering-place, its object-glass, capable of better things, idly directed to fishing-boat or distant steamer, or, still more idly, to some unconscious group on the pier." A small telescope, if the object-glass is really good, will often bear a high magnifying power, and with a little practice the amateur will soon find the use of it. On my $2\frac{1}{4}$ in. achromatic, by Cooke, a power of 200 can be employed with advantage [c]. On my 4 in., by Wray, a power of 420 is useful for a lunar crater, or Saturn's ring, and occasionally for a close double star. The amateur will find a very low power the best for comets, a somewhat higher one for nebulæ, about 40 to the inch of aperture for the planets, and about 60 to the inch for double-stars. The standard work on double-stars and nebulæ,

[c] Opticians, however, seem to have a dislike to making these deep eye-pieces for small telescopes. The makers refused to supply me one for my $2\frac{1}{4}$ in. Nearly twelve years after obtaining the instrument, I managed to procure one from another optician.

Smyth's "Cycle of Celestial Objects," was compiled from observations taken with a 6 in. glass. Webb, in his "Celestial Objects," states the limits of his $3\frac{7}{10}$ in. to be stars of the eleventh magnitude. With my 4 in., stars of the twelfth are readily discernible, when sufficiently removed from the glare of a bright star. The limit of a $2\frac{1}{4}$ in. is stars of magnitude $8\frac{1}{2}$, and occasionally magnitude 9.

From the right ascension, and north or south declination, the position of any of the following may be easily seen, by referring to a star atlas. The dots indicate the double-stars. Of course they will only be in this relative position when the object is on or near the meridian. The following list contains the double stars and nebulæ which I have frequently examined with $2\frac{1}{4}$ in., using powers of 70, 100, 150, 200.

ANDROMEDA.

(1.) ∴ γ Andromedæ, mag. of the components $3\frac{1}{2}$, $5\frac{1}{2}$, dis. 11″. Right ascension 1^h 56′. Decl. north $41\frac{3}{4}°$. One of the loveliest objects in the sky, and yet it only began to attract attention ninety-six years ago. The larger star will be found orange-coloured, the smaller, green. The smaller is also double; a good test for a 6 in. achromatic, or an 8 in. reflector.

(2.) ∴ 59 Andromedæ, mag. 6, $7\frac{1}{2}$, dis. 16″. R. A. 2^h 3′. decl. $38\frac{1}{2}°$ N.

(3.) ∴ 175 P. O. Andr., mag. 8, 8, dis. 46″. 0^h 39′, N. $30\frac{1}{4}°$. By referring to δ, this object will be easily found.

(4.) Nebula 31 M. R.A. 0^h 36′. Dec. N. $40\frac{1}{2}°$. A splendid neb. A little patch of hazy light may be detected by the naked eye, and as such it is mentioned

as far back as A.D. 905. Marius, who looked at it through a telescope on Dec. 15, 1612, calls it like the light of a candle seen through horn. Sir W. Herschel imagined it was the nearest of nebulæ; that certain parts might be only 2,000 times further off than Sirius, but a train going constantly at the rate of sixty miles an hour could not reach it under seventy or eighty-thousand million years!

ANTINOUS.

(5.) ·. 26 P. XX. Antinoi, mag. $6\frac{1}{2}$, 7, dis. $3\frac{1}{2}''$. 20^h 6′, N. $0\frac{1}{2}°$.

(6.) Nebula 11 M. 18^h 44′. s. $6\frac{1}{2}°$. The peculiar triangular shape of this neb., which has been compared to a flight of wild ducks, may be noticed with a small instrument.

(7.) Nebula 26 M. 18^h 38′, s. $9\frac{1}{2}°$. Much fainter than 11 M. The star η in Antinous varies from mag. $3\frac{1}{2}$ to less than the fifth magnitude. Its period is 7 days 4 hours.

AQUARIUS.

(8.) .· ζ Aquarii, mag. 4, $4\frac{1}{2}$. 22^h 2′, s. $0\frac{3}{4}°$, dis. 2″ 7, in 1842, according to Smyth; now $3\frac{1}{3}''$. Well worth watching.

(9.) .· ψ' Aquarii, mag. $5\frac{1}{2}$, 9. 23^h 9′, s. $9\frac{3}{4}°$, dis. $49\frac{1}{2}''$. The uppermost of three similar stars, which are thought to have a common motion.

(10.) Nebula 2 M. 21^h 27′, s. $1\frac{1}{2}°$. A fine round neb., compared by Sir J. Herschel to "a heap of fine sand." It seems to have been first noticed by Maraldi, in 1746, when looking after the celebrated comet, which is said to have had its tail divided into six parts.

Aquila.

(11.) .· 5 Aquilæ, mag. 7, 8. $18^h\ 40'$, s. 1°, dis. 13″.

(12.) : 57 Aquilæ, mag. $6\frac{1}{2}$, 7. $19^h\ 48'$, s. $8\frac{1}{2}$°, dis. 35″.

(13.) ·. 15 Aquilæ, mag. 6, $7\frac{1}{2}$. $18^h\ 58'$, s. $4\frac{1}{4}$°, dis. 35″.

(14.) : 43 P. XX. Aquilæ, both $8\frac{1}{2}$ mag. $20^h\ 8'$, N. $6\frac{1}{4}$°, dis. 44″.

The three stars, "*α β γ* Aquilæ, have been mistaken, by rather green hands, for Orion's Belt. M. Dupuis fancifully thought the name was given when the sun was near the summer solstice, and that the bird of highest flight was chosen to express the greatest elevation of the sun."—(*Smyth.*) In the year 389, a new star burst forth near *α* Aquilæ, and vanished in three weeks.

Argo Navis.

(15.) .· 2 Argûs, mag. 7, $7\frac{1}{2}$. $7^h\ 40'$, s. $14\frac{1}{2}$°, dis. $16\frac{3}{4}$″.

A constellation of great antiquity. Its principal star, Canopus, is not visible in England. Smyth says, "Etymologists are 'crowding on,' when they derive the word canopy from Canopus, as hath been lately imprinted; such sages would see our 'son of a gun' in *Παῖς γυνῆς.*"

Aries.

(16.) ·. *γ* Arietis, mag. $4\frac{1}{2}$, 5. $1^h\ 46'$, N. $18\frac{3}{4}$°, dis. 8″. 8.

A very pretty object for a small telescope. Hook observed the comet of 1664 pass by this star, which, he says, "consisted of two small stars, very near together, a like instance to which I have not elsewhere met with in all the heavens."

(17.) ·. λ Arietis, mag. $5\frac{1}{2}$, 8. 1^h 51′, N. 23°, dis. 37″.
(18.) ·· 30 Arietis, mag. 6, 7. 2^h 29′, N. 24°, dis. 38″.

Auriga.

(19.) ·. 14 Aurigæ, mag. 5, $7\frac{1}{2}$. 5^h 7′, N. $32\frac{1}{2}$°, dis. $13\frac{1}{2}$″.

There is another very minute companion.

26 Aurigæ ought also to come within the range of $2\frac{1}{4}$ in. The companion is of the 8th mag., but its violet colour rendered it only visible to me by glimpses. Light from Capella, the brightest star in Auriga, is considered to be seventy years in reaching us.

Bootes.

(20.) ·. κ Bootis, mag. $5\frac{1}{2}$, 8. 14^h 9′, N. $52\frac{1}{2}$°, dis. $12\frac{1}{2}$″.

(21.) ·. ι Bootis, mag. $4\frac{1}{2}$, 8. 14^h 12′, N. 52°, dis. 38″. The principal star is also very closely double.

(22.) .· π Bootis, mag. $3\frac{1}{2}$, 6. 14^h 35′, N. 17°, dis. 6″.

(23.) .· ξ Bootis, mag. $3\frac{1}{2}$, $6\frac{1}{2}$. 14^h 45′, N. $19\frac{3}{4}$°, dis. now about 5″, forty years ago 7″. The actual period of the revolution of one star round the other is given by Hind at 169 years.

(24.) : ε Bootis, mag. 3, 7. 14^h 39′, N. $27\frac{3}{4}$°, dis. $2\frac{3}{4}$″. In Arabian, izár, "a girdle." From the brightness of the principal star, and colour of the companion, it is not a very easy object even with 4 in. I have, however, divided it very plainly in the summer of 1872, with power 150 on $2\frac{1}{4}$ in.

(25.) ·. 39 Bootis, mag. $5\frac{1}{2}$, $6\frac{1}{2}$. 14^h 45′, N. $49\frac{1}{4}$°, dis. $3\frac{3}{4}$″.

(26.) ·. 44 Bootis, mag. 5, 6. 15^h, N. $48\frac{1}{4}°$, dis. 2″. 9 in 1830, now 5″. An interesting binary.

Arcturus, the brightest star in Bootes, will long be memorable, on account of Donati's comet passing over it on Oct. 5, 1858. Many will remember the glorious sight it presented.

Date of Hesiod, &c.—Arcturus is first mentioned by Hesiod, from which it seems there is a difference of 40 days in the achronical rising of the star since the days of the poet, and by allowing $50\frac{1}{4}$″ annually as the movement of the equinoxes, we obtain about 2800 years since the days of Hesiod, who must therefore have flourished about the time of Solomon. The change between the summer and autumn Etesian winds, being preceded by a few days' squally weather, was ascribed to the power of Arcturus. Horace says, "a contented man is not troubled about the tempests or stars," "Nec sævus Arcturi cadentis impetus, aut orientis Hædi."

(27.) Nebula, 101 M., 13^h 58′. N. 55°, very faint.

Camelopardus.

(28.) : 232 P. xii. Cam., mag. 6, $6\frac{1}{2}$. 12^h 48′, 84° N., dis. 22″.

Cancer.

(29.) .· ι Cancri, mag. $5\frac{1}{2}$, 8. 8^h 39′, N. $29\frac{1}{4}°$, dis. 30″. One star is orange, the other blue. I have found the colours very distinct, even with $2\frac{1}{4}$ in.

(30.) Cluster, 44 M. 8^h 32′, N. $20\frac{1}{2}°$. Visible to the naked eye, as a little patch of hazy light. The Arabians call it Al-m'alaf, "a stall, or den." Aratus tells us, its dimness was regarded as a sign of coming rain.

As the crab walks obliquely, it figures the sun's going back, when he has reached his highest north point in summer.

Canes Venatici.

(31.) ·. 12 Can. Ven. (Cor Caroli), mag. $2\frac{1}{2}$, $6\frac{1}{2}$. 12^h 50′, N. 39°, dis. 20″.

A very pretty object for a small telescope. I am able to separate it with a little pocket instrument, $\frac{4}{5}$ in. aperture. There is a story that Scarbro', the court-physician, gazed at this star the evening before Charles II. returned, whence its name, Cor Caroli.

(32.) Neb. 51 M. 13^h 24′, N. 48°. The wonderful spiral neb. in Lord Rosse's telescope. This and the three following are fine objects, even in a small instrument.

(33.) Neb. 94 M. 12^h 45′, N. $41\frac{3}{4}$°.

(34.) Neb. 63 M. 13^h 10′, N. $42\frac{3}{4}$°.

(35.) Neb. 3 M. 13^h 36′, N. 29°.

Canis Major.

(36.) ·. ν' Can. Maj., mag. $6\frac{1}{2}$, 8. 6^h 31′, S. $18\frac{1}{2}$°, dis. 17″.

Most, if not all our readers, have gazed with admiration at Sirius, the lucida of this constellation, and, indeed, of the whole heavens. It is mentioned as a star by Hesiod, and Homer compares the flashing of Achilles' armour to the blaze of the dog-star. The Arabians call it Alshira, from Ash-shírá-l-yemeníyah, "the bright shining star of Yemen," or Arabia Felix. Much has been said about the change of colour in Sirius, as Seneca and Ptolemy call it a fine red star;

and now, any of us who look through our windows in the winter months see it as a brilliant white star. At what time the change took place we know not. It is difficult to reconcile a red hue with Homer's comparison of the dog-star; and Smyth says the ancients used the names of colour with great latitude, so that the "rubra canicula" of Horace may allude to heat.

A pretty triangle of stars appears a little way above the southern horizon in winter. The uppermost of these, δ Canis Majoris, is called Wezn, from Al Wezn, "a weight," since it seems to rise with difficulty above the horizon, as if chained to the ground. To the right of this triangle, and far lower down, close to the horizon, lies the constellation of Columba Noachi, "Noah's Dove." This also consists of a pretty triangle of stars. The uppermost, *a*, I have seen several times; but the lower stars of the triangle I have never perceived clearly but once, so low an altitude do they reach in England.

Canis Minor.

Procyon, *a* Can. Min., is called Procyon from *προκύων*, "the precursor dog," because it appeared in the morning dawn before Sirius.—(*Smyth.*) In Proctor's Star Atlas the constellation is called Felis, "the cat," displaying unconsciousness of this fact.

Capricornus.

(37.) ·. o^2 Cap. mag. 6, 7. 20^h 22′, s. 19°, dis. 22″.

(38.) Neb. 30 M. 21^h 33′, s. $23\frac{3}{4}°$. A neb. well worth looking at. "What an immensity of space is here indicated. Can such an arrangement be intended, as

a bungling spouter of the hour (Dr. Whewell, of Cambridge?) insists, for the mere appendage to the spec of a world on which we dwell, to soften the darkness of its petty midnight."—(*Smyth.*) Resolved into stars by Herschel. *a* Capricorni is a double-star to the naked eye, if a good one. "Macrobius says, that as the sun approached this sign he quitted his lower course, and so the figure of a goat was chosen to represent it, because that animal climbs the sides of mountains. Cancer and Capricorn form the boundaries of the sun's course in the zodiac, the portæ solis. The Platonists held that souls descended from heaven into mortal bodies through one, and when released from the body re-ascended through that of Capricorn, which was called the gate of the gods, as the former was called that of men."—(*Smyth.*)

Cassiopea.

η Cassiopeæ has a $7\frac{1}{2}$ mag. companion, which, though 9″ from the principal star, is most difficult to catch, with $2\frac{1}{4}$ in. from its purple hue.

Above the well-known w, of which this constellation consists, Tycho's new star burst out in 1572, and, after becoming visible in the daytime, dwindled away. From similar appearances in 945 and 1264, Sir J. Herschel fancied a return about 1872. It will be well, therefore, to direct our gaze to this part of the sky every clear night for a few years to come.

(39.) 30 H VI. Cassiopeæ will be found a splendid cluster of minute points of light.

CEPHEUS.

(40.) ·. β Cephei, $21^h\ 27'$. N. 70°, dis. 14″. The mag. of the principal star is given by Smyth at 3, by Darby at $4\frac{1}{2}$; that of the smaller has been rated at 7 and 8, "called Alphirk, from Arabian Kawákib-al-firk, 'stars of the flock,' which α and β were supposed to represent. Flocks constituted the natural imagery among the nomad tribes."—(*Smyth.*)

(41.) ·. δ Cephei, mag. $4\frac{1}{2}$, 7. $22^h\ 24'$, N. $57\frac{3}{4}°$, dis. 41″. The chief star varies in brightness.

(42.) .· ξ Cephei, mag. 5, 7. $22^h\ 0$, N. 64°, dis. 6″.

(43.) .· 11 P. XXII. Cephei, mag. 6, $6\frac{1}{2}$. $22^h\ 4'$, N. $58\frac{3}{4}°$, dis. 21″. The companion star is very closely double.

γ Cephei, according to Smyth, would be the Pole-star in 2400 years. Its movements, he says, may then puzzle the unborn, for it has a decided motion through space.

CETUS.

(44.) .· 37 Ceti, mag. 6, $7\frac{1}{2}$. $1^h\ 8'$, s. $8\frac{3}{4}°$, dis. 51″.

(45.) ·. 66 Ceti, mag. 7, $8\frac{1}{2}$. $2^h\ 6'$, s. 3°, dis. $15\frac{1}{2}$″.

(46.) ·· γ Ceti, mag. 3, 7. $2^h\ 37'$, N. $2\frac{3}{4}°$, dis. 2″ 6. The larger star yellow, the smaller blue. I found the definition round and good, with a power of 200 on $2\frac{1}{4}$ in. Powers of 100 and 150 shewed it but imperfectly.

(47.) Neb. 77 M. $2^h\ 36'$, s. $0\frac{1}{2}$″.

There is a star in Cetus, called *o*, or, more commonly, Mira, "the wonderful," which shines for a fortnight like a second magnitude star; then, diminishing, it beeomes invisible for five months, and increases again for three months. The period is generally 322 days, but there are irregularities.

Coma Berenices.

(48.) ∴ 24 C. Beren., mag. $5\frac{1}{2}$, 7. $12^h\ 29'$, N. 19°, dis. 21″. The larger star orange, the other emerald.

(49.) Neb. 84 H I. $12^h\ 30'$, N. $26\frac{3}{4}°$. Why is it omitted by Smyth?

(50.) Neb. 64 M. $12^h\ 50'$, N. $22\frac{1}{2}°$.

(51.) Neb. 53 M. $13^h\ 7'$, N. 19°.

(52.) Neb. 92 H I. $12^h\ 28'$, N. $28\frac{1}{2}°$.

(53.) Neb. 85 M. $12^h\ 18'$, N. 19°.

(54.) Neb. 83 H I. $12^h\ 25'$, N. 27°.

The mythological origin of the constellation C. Beren. (Berenice's hair) is, that it was to console a lady for the loss of a lock of her hair, which had been dedicated to Venus, on account of a victory of her husband, Ptolemy Euergetes.

Corona Borealis.

(55.) ∴ ζ Cor. Bor., mag. 5, 6. $15^h\ 34'$, N. 37°, dis. 6″.

(56.) ∵ σ Cor. Bor., mag. 6, $6\frac{1}{2}$. $16^h\ 10'$, N. $34\frac{1}{4}°$. Forty years ago, we should have gazed in vain at this star with a $2\frac{1}{4}$ in. Its distance then was scarcely over 1″. Now it is over 3″, and I find it easy with a power of 100. It is a binary star, but the period is uncertain.

Corvus.

(57.) ∵ δ Corvi, mag. 3, $8\frac{1}{2}$. $12^h\ 23'$, s. $15\frac{3}{4}°$, dis. 24″. I have often found the little companion very hard to catch, from its dark hue, and the brightness of the principal star.

Crater.

One star, 17, of this constellation, mag. $5\frac{1}{2}$, 7, dis. 9″, ought to be seen with a moderate instrument, but it is very low on the horizon.

Cygnus.

(58.) ∴ β Cygni, mag. 3, 7. 19^h 25′, N. $27\frac{3}{4}°$, dis. 34″. The larger star, yellow; the companion, blue. The colours stand out in beautiful contrast even with $2\frac{1}{4}$ in.

(59.) .· 61 Cygni, mag. $5\frac{1}{2}$, 6. 21^h 1′, N. 38°. Thirty years ago the distance between the two stars was 16″, now $19\frac{1}{4}$″. One of the nearest stars in the sky to us.

(60.) .· 16 Cygni, mag. $6\frac{1}{2}$, 7. 19^h 38′, N. $50\frac{1}{4}°$, dis. 37″.

(61.) .· μ Cygni, mag. 5, 6. 21^h 38′, N. $28\frac{1}{4}°$, dis. $5\frac{1}{2}$″.

(62.) ∴ 278 P XIX. Cygni, mag. 6, 8. 19^h 41′, N. $34\frac{3}{4}°$, dis. 39″.

(63.) .· 276 P XIX. Cygni, mag. 8, $8\frac{1}{2}$. 19^h 41′, N. $35\frac{3}{4}°$, dis. 15″.

(64.) ·· χ Cygni, mag. 5, 9. 19^h 41′, N. $33\frac{1}{2}°$, dis. 26″.

Delphinus.

(65.) ·· γ Delphini, 20^h 41′, N. $15\frac{3}{4}°$, dis. $11\frac{3}{4}$″. A very pretty object in a small telescope. All our works on double-stars give the magnitude at 4, 7. On Dec. 13, 1862, I found them almost equal, and so they still remain.

(66.) ·· 178 P XX. Delphini, mag. $7\frac{1}{2}$, 8. 20^h 25′, N. $10\frac{3}{4}°$, dis. 14″.

DRACO.

(67.) ·. ψ Draconis, mag. 5½, 6. 17ʰ 44′, N. 72¼°, dis. 31″.

(68.) ·. 40 Draconis, mag. 5½, 6. 18ʰ 10′, N. 80°, dis. 20″.

(69.) : μ Draconis, 17ʰ 3′, N. 54¾°. The distance, forty years ago, was 3½″, now 2½″. Smyth and Webb give mag. 4, but Dawes more properly says 6 mag. This I find to be the case, the star being but just visible to the naked eye.

a Draconis was once brighter than it is now. "It is called Thuban, from the Arabian, al thubán, 'the Dragon,' upwards of 4,600 years ago the Pole-star of the Chaldæans. In that remote age, it must have remained stationary, though it is now 25° from the Pole."—(*Smyth.*)

EQUULEUS.

(70.) .· 355 P xx. Equulei, mag. both 8½. 20ʰ 46′, N. 6¾°, dis. 40″.

ERIDANUS.

(71.) .· 55 Eridani, mag. both 7½. 4ʰ 37′, s. 9°, dis. 10″. Some have thought Eridanus was originally intended to indicate the Nile.

GEMINI.

(72.) ·. *a* Gemin. (Castor), mag. 3, 3½. 7ʰ 26′, N. 32¼°, dis. now 5¾″, forty years ago it was 4¾″. The amateur will find it to be the finest double-star in our northern hemisphere. The period in which one component revolves round the other is not quite certain. Bradley

gives us their position in 1719. "Among the orientals, Gemini was represented as a pair of kids, denoting that part of spring when these animals appear, but the Greeks changed them to two children."—(*Smyth.*) The Arabians drew them as a couple of peacocks. Their religion prevented them drawing the human figure.

(73.) ·. 15 Gemin., mag. 6, 8. 6^h 20′, N. 21°, dis. 33″.

(74.) ·. 20 Gemin., mag. 8, $8\frac{1}{2}$, 6^h 25′, N. 18°, dis. 20″.

Hercules.

(75.) .· *a* Herculis, mag. $3\frac{1}{2}$, $5\frac{1}{2}$. 17^h 9′, N. $14\frac{1}{2}$°, dis. $4\frac{1}{2}$″. Owing to the flare, I find this fine object troublesome, except on very quiet nights, with a small telescope. Hercules is represented on the maps and globes, as a man kneeling. Some have fancied this indicates the bruising of the serpent's head.

(76.) ·. *κ* Herculis, mag. $5\frac{1}{2}$, 7. 16^h 2′, N. $17\frac{1}{2}$°, dis. 31″.

(77.) : 100 Herculis, mag. both 7. 18^h 2′, N. 26°, dis. 14″.

(78.) : δ Herculis, mag. $4\frac{1}{2}$, 8. 17^h 10′, N. 25°, dis. 19″ now. Formerly it was wider, about 26″, forty years ago. The companion being a dull grape colour, I only get it by glimpses with $2\frac{1}{4}$ in.

(79.) .· *ρ* Herculis, mag. 4, $5\frac{1}{2}$. 17^h 19′, N. $37\frac{1}{4}$°, dis. $3\frac{3}{4}$″.

(80.) ·· 95 Herculis, mag. $5\frac{1}{2}$, 6. 17^h 56′, N. $21\frac{1}{2}$°, dis. 6″.

(81.) Neb. 13 M., 16^h 37′, N. $36\frac{3}{4}$°. This is a superb object; just visible to the naked eye as a spot, on a dark night. It was noticed by Dr. Halley in the early part of the last century, and he admits there may be more.

(82.) Neb. 92 M., 17^h 13′, N. $42\frac{1}{4}°$. Even brighter in the centre than 13 M., but not quite so large.

Hydra.

ϵ Hydræ, mag. 4, $8\frac{1}{2}$, dis. 4″ now, and widening; also 108 P VIII. Hydræ, mag. 6, 7, dis. 10″; and neb. 68 M., in this constellation, should be caught by a small telescope.

Lacerta.

(83.) ·· 8^2 Lacertæ, mag. both $6\frac{1}{2}$. 22^h 30′, N. 39°, dis. 23″.

Leo.

(84.) ·· γ Leonis, mag. 2, 4. 10^h 13′, N. $20\frac{1}{2}°$, dis. 3″ now, formerly less. The colours are orange and yellow. A binary star, period perhaps 1,000 years.

(85.) Neb. 95 M., 10^h 37′, N. $12\frac{1}{4}°$. Just discernible with $2\frac{1}{4}$ in.

(86.) Neb. 65 and 66 M., 11^h 13′, N. $13\frac{3}{4}°$. Two nebulæ of an elongated form.

(87.) Neb. 13 H I., 10^h 59′, N. $0\frac{3}{4}°$.

The longitude of Regulus, the lucida of Leo, has been made a step for ascertaining the recession of the equinoctial points through successive ages.

Lepus.

(88.) Neb. 79 M., 5^h 19′, S. $24\frac{3}{4}°$.

Libra.

(89.) Neb. 5 M., 15^h 12′, N. $2\frac{1}{2}°$. A splendid heap of stars.

a Libræ will be seen by an opera-glass to have

a companion, called Kiffa Australis, from the Arabian, al kiffah-al-jenúbiyah, "the southern scale." β Libræ is of a peculiar green colour. A Chaldæan observation of the approach of Mars to this star, is recorded in the 476th year of Narbonassar, or 271 B.C. Called Kiffa Borealis, from al-kiffah-al-shemaliyah, "the northern scale."

Lynx.

It is very difficult to find an object here, there being no bright star to point to. Those who would examine the Lynx ought, said old Hevelius, to be lynx-eyed.

(90.) ∴ 12 Lyncis, mag. 6, 7½. 6^h 35′, N. 59½°, dis. 8½″.

(91.) ∴ 19 Lyncis, mag. 7, 8. 7^h. 12′, N. 55½°, dis. 14½″.

Lyra.

(92.) ∴ ϵ Lyræ, mag. 5, 6½; 5, 5½. 18^h 40′, N. 39½°. Dis. of the first pair, 3″; of the other, 2½″. To a very sharp eye, or to an opera-glass, there is a pair of stars, and on examining these with the telescope, both come out double. One pair will be found closer than the other, but both form a very pretty object for a moderate instrument. 150 on 2¼ in. has exhibited both very plainly to me. ϵ and its wide companion are considered to be connected. Smyth tells us, "it may be roundly stated that B will revolve around A in 2,000 years, C take a circuit round D in half that time; perhaps both systems may go round the central ones in something less than a million years. But what is this to the *annus magnus* of the whole creation."

(93.) ∴ β Lyræ, mag. 3, 8. $18^h\ 45'$, N. $33\frac{1}{4}°$, dis. 46″. The larger star varies a magnitude in brightness.

(94.) ∴ ζ Lyræ, mag. 5, $5\frac{1}{2}$. $18^h\ 40'$, N. $37\frac{1}{2}°$, dis. 44″.

(95.) ·· η Lyræ, mag. 5, 9. $19^h\ 9'$, N. 39°, dis. 28″. Though the companion is 9th mag., it is just discernible with $2\frac{1}{4}$ in.

(96.) Neb. 56 M., $19^h\ 11'$, N. 30°. Faint with $2\frac{1}{4}$ in.

(97.) Neb. 57 M., $18^h\ 49'$, N. 33°. The celebrated ring neb. Of course this figure will not be seen with a small instrument.

Monoceros.

(98.) ·. 8 Monoc., mag. $5\frac{1}{2}$, 8. $6^h\ 17'$, N. $4\frac{3}{4}°$, dis. 13″.

(99.) .: 11 Monoc., mag. $6\frac{1}{2}$, 7, 8. $6^h.\ 23'$, S. 7°, dis. 7″ and $9\frac{1}{2}$″ from the principal star. With a powerful instrument, Sir W. Herschel calls this one of the most beautiful sights in the sky.

Ophinchus.

(100.) ·. 53 Oph., mag. 6, 8. $17^h\ 28'$, N. $9\frac{3}{4}°$, dis. 41″.

(101.) : 39 Oph., mag. $5\frac{1}{2}$, $7\frac{1}{2}$. $17^h\ 10'$, S. $24\frac{1}{4}°$, dis. 12″.

(102.) ·· 61 Oph., mag. both $7\frac{1}{2}$. $17^h\ 38'$, N. $2\frac{3}{4}°$, dis. 21″.

(103.) ∴ 67 Oph., mag. 4, 8. $17^h\ 54'$, N. 3°, dis. 55″.

(104.) ·· 70 Oph., mag. $4\frac{1}{2}$, 7. $17^h\ 59'$, N. $2\frac{1}{2}°$, dis. $4\frac{1}{4}$″ now, formerly wider. It is a binary star, the revolution about 90 years. Other periods have been imagined. In 1779 Herschel found the two component stars on the parallel. This star is considered difficult of observation, from the rings of light about it.

(105.) Neb. 12 M., $16^h\ 40'$, S. $1\frac{3}{4}°$.

(106.) Neb. 10 M., 16^h 50′, s. 4°.

(107.) Neb. 19 M., 16^h 55′, s. 26°.

(108.) Neb. 14 M., 17^h 31′, s. $3\frac{1}{2}$°.

All the above nebulæ will be found pretty bright, and well worth inspecting.

Orion.

(109.) ∴ θ Orionis, Neb. and multiple star, 5^h. 29′, s. $5\frac{1}{2}$°. Ptolemy and Tycho marked θ a 3rd mag. star. A small telescope, with a power of 100, reveals four stars resting on, and surrounded by, a misty glow of light. The mag. of the stars are 6, 7, $7\frac{1}{2}$, 8. Powerful instruments shew more than four stars here: some observers make 9 or 10. Two years ago the fifth star was said to have been detected by telescopes of only 3 in. aperture, so it may be variable. This splendid nebula seems to have been first noticed by Huygens in 1656.

(110.) ·: σ Orionis, mag. 4, 8, 7. 5^h 32′, s. $2\frac{3}{4}$°, dis. 12″ and 42″. Triple to a small telescope; but Struve, with the Dorpat refractor, reckoned eighteen stars in the group; and Schroeter, with a 25 feet reflector, could see twelve.

(111.) ·. δ Orionis, mag. 2, 7. 5^h. 25′, s. $0\frac{1}{2}$°, dis. 53″. The uppermost of the three conspicuous stars called Orion's belt. Called Mintaka, from Mintakah-al-jauza, "the giant's belt." The belt has been called Jacob's Staff, the Three Kings, the Ell and Yard, &c.

(112.) ·. 23 Orionis, mag. 5, 7. 5^h 16′, N. $3\frac{1}{2}$°, dis. 32″.

(113.) ·. λ Orionis, mag. 4, 6. 5^h 28′, N. $9\frac{3}{4}$°, dis. $4\frac{1}{2}$″.

(114.) Neb. 78 M., 5^h 40′, N. 0°.

Two bright stars, α and γ, form the shoulders of Orion. α is called Betelgeuze, from Ibt-al-jauza, "the giant's shoulder." "Hood says, The reason this fellow, Orion, was placed in the heavens, was to teach men not to be too confident in their own strength. The University of Leipsic proposed to call the belt and sword of Orion by the name of Napoleon. Was that learned body in possession of a copy of Tom Hood's Treatise?" —(*Smyth.*)

γ Orionis, a fine red star, is called Bellatrix. Its gender, feminine, puzzled Hoode, who knew not why it should be feminine, "except that women born under this constellation shall have mighty tongues."

PEGASUS.

(115.) .· 3 Pegasi, mag. 6, 8. 21^h 31′, N. 6°, dis. 39″.

(116.) .· 216 P XXIII. Pegasi, both $8\frac{1}{2}$. 23^h. 46′, N. $11\frac{1}{4}$°, dis. $18\frac{1}{2}$″.

(117.) Neb. 15 M., 21^h 24′, N. $11\frac{1}{2}$°. A conspicuous object.

ζ Pegasi is called Homam, from Sád-al-homám, "the hero's happy star" of the Arabians. Included in the "fortunate stars;" a group so called, because they appear to the Bedouin Arabs at the dawn of day as spring comes on.

PERSEUS.

(118.) .· η Persei, mag. 5, $8\frac{1}{2}$. 2^h 41′, N. $55\frac{1}{4}$°, dis. 28″. There are nine stars in a group about here, and some are said to form a miniature representation of Jupiter and his satellites.

(119.) ·· 220 P II. Persei, mag. 6, 8. 2^h 52′, N. $51\frac{3}{4}$°, dis. $12\frac{1}{2}$″.

(120.) ·. near 12 Persei, mag. $7\frac{1}{2}$, 8. 2^h. 34′, N. $39\frac{3}{4}°$, dis. 23″.

(121.) Great cluster, 33 H VI. 2^h 10′, N. $56\frac{1}{2}°$. Visible to the naked eye. With a low power, the telescope is filled with myriads of stars.

Pisces.

(122.) .· ψ Piscium, mag. both $5\frac{1}{2}$. 0^h 59′, N. $20\frac{3}{4}°$, dis. 30″.

(123.) .· *a* Piscium, mag. 5, 6. 1^h 55′, N. $2\frac{1}{4}°$, dis. $3\frac{1}{4}$″; called Okda from 'okda-al-khaitaïn, a "knot of the two threads."

(124.) ·. 100 Piscium, mag. 7, 8. 1^h 28′, N. $11\frac{3}{4}°$, dis. 16″.

(125.) ·. ζ Piscium, mag. 6, 8. 1^h 7′, N. $6\frac{3}{4}°$, dis, 23″.

(126.) ·· 77 Piscium, mag. $7\frac{1}{2}$, 8. 0^h 59′, N. $4\frac{1}{4}°$, dis. 32″.

Sagitta.

(127.) Neb. 71 M., 19^h 48′, N. $18\frac{1}{2}°$.

Sagittarius.

(128.) ·. 54 Sag., mag. $5\frac{1}{2}$, 8. 19^h 33′, S. $16\frac{1}{2}°$, dis. 28″.

(129.) Neb. 22 M., 18^h 28′, S. 24°. A fine round mass of stars. It attracted attention as far back as 1665.

(130.) Neb. 28 M., 18^h 17′, S. 25°.

(131.) Neb. 17 M., 18^h 13′, S. $16\frac{3}{4}°$. More properly, in Scutum Sobieski.

(132.) Neb. 20 M., 17^h 52′, S. 23°.

Scorpio.

A beautiful constellation, which glitters low in the south in the brief interval of the summer nights.

(133.) ·. β Scorpii, mag. 2, 5½. 15^h 58′, s. 19½°, dis. 13″.

(134.) .· ν Scorpii, mag. 4, 7. 16^h 4′, s. 19°, dis. 40″. With a very good telescope, the smaller star is double also. As Herschel and Smyth do not speak of this, it must have come out since their time.

(135.) Neb. 4 M., 16^h 16′, s. 26¼°.

a Scorpii, a brilliant red star, is called Antares, *Ἀντάρης*, i.e. rivalling Mars in splendour. Scorpio is seen, says Sherborne, to crawl towards our meridian at midnight about the end of May.

Serpens.

(136.) .· θ Serpentis, mag. 4½, 5. 18^h 50′, N. 4°, dis. 22″. A very small instrument makes this a pretty pair. I have seen it well with a deep eye-piece fitted to a small pocket-telescope.

(137.) ·. δ Serpentis, mag. 3, 5. 15^h 29′, N. 11°, dis. 3¼″. Binary.

Sextans.

(138.) Neb. 4 H. I., 10^h 8′, N. 4°.

Taurus.

(139.) ·. ϕ Tauri, mag. 6, 8½. 4^h 12′, N. 27°, dis. 56″.

(140.) ·. χ Tauri, mag. 6, 8. 4^h 15′, N. 25¼°, dis. 19″.

(141.) .· 62 Tauri, mag. 7, 8½. 4^h 16′, N. 24°, dis. 29″.

(142.) .· 257 P IV. Tauri, mag. 7, 8. $4^h\ 52'$, N. $14\frac{1}{4}°$, dis. 39″.

(143.) Neb. 1 M., $5^h\ 27'$ N. 22°. Called the crab neb. Resolved into stars by Lord Rosse. It was discovered by Messier in 1758, while observing a comet.

4,000 years ago Taurus led the celestial signs, and was their leader for 2,000 years. The chief star, Aldebarán, the hindmost, because he drives the Pleiades before him, is a bright red one. It is situated in a group of stars, called the Hyades, precisely in the form of the letter V. The group was called Υ-psilon, the Pythagorean symbol of human life, from its shape. Next in the group to Aldebaran, comes θ Tauri, which the naked eye shews to consist of two; and enormously apart as they are, they are suspected of physical connection.

β Tauri is figured on the tip of the horn of Taurus, and so at the greatest distance from the hoof. This has been thought to give rise to the phrase of not knowing B from a bull's foot.

The Pleiades is a cluster of stars in Taurus of even greater interest than the Hyades. Much attention has been directed to them in latter years, from the discovery of a supposed variable nebula in them. Alcyone, the brightest of the Pleiades, (round which the whole visible creation has been supposed to be moving) is called by the Arabians Jauza, "the walnut." Homer speaks of six stars in the Pleiades. Hipparchus mentions seven. A small telescope readily shews a hundred. The Pleiades are mentioned by Job, between three and four thousand years ago. They have been represented in ancient times as full-grown women, and as

a bunch of grapes. Hesiod, nearly 1000 B.C., has a passage on the Pleiades, which is thus rendered by Cooke:—

> "There is a time when forty days they lie,
> And forty nights concealed from human eye;
> But in the course of the revolving year,
> When the swain sharps the scythe again appear."

Triangulum.

(144) ·. λ Trianguli, mag. $5\frac{1}{2}$, 7. 2^h 5′, N. $29\frac{3}{4}°$, dis. $3\frac{1}{2}''$.

(145.) Neb. 33 M., 1^h 27′, N. 30°. A very large object, but faint.

Ursa Major.

(146.) .· ζ Ursæ Maj., mag. 3, 5. 13^h 19′, N. $35\frac{3}{4}°$, dis. $14\frac{1}{3}''$. One of the finest objects in the sky. The colours are white and emerald. Noticed in the year 1700 by Godfrey Kirch, and his wife Mary Margaret. A little distance from ζ the naked eye perceives a small star, called Alcor. This is, of course, very widely separated in the telescope. Alcor is called by the Persians Saidak, "the test," a test of vision in their latitude, where the Great Bear lies low on the horizon. The Arabians have a proverb, "Thou canst see Alcor, but thou canst not see the full moon."

(147.) Neb. 81 M. and 82 M., 9^h 45′, N. $69\frac{3}{4}°$. Very near together.

(148.) Neb. 97 M., 11^h 7′, N. $55\frac{3}{4}°$. Pale, but large. From its curious appearance in Lord Rosse's telescope, it has gained the name of the owl nebula.

Ursa Minor.

(149.) ·· π Ursæ Min., mag. 6, 7. $15^h\ 37'$, N. $81°$, dis. $30''$.

α Ursæ Minoris, generally called the Pole-star, is a rare test for a telescope between 2 and 3 inches in aperture, the companion being of barely the 9th mag. I have been able to glimpse it with $2\frac{1}{4}$ in. The Pole-star has been called Kotb, "a spindle," as the constellation is swung round the Pole. Its use in navigation seems to have been known to the Phenicians.

Virgo.

(150.) : γ Virginis, mag. 4, 4. $12^h\ 35'$, s. $0\frac{3}{4}°$. If we had gazed at this object in the year 1836, we should have found it round, but since then its companion has so far come out, as to be distant $4\frac{1}{2}''$. The revolution of one star round the other is performed in something under 200 years. Cassini, in 1720, witnessing an occultation of it, by the moon, saw one star disappear $30''$ before the other.

Hipparchus compared the place of Spica Virginis with what Timocharis and Aristyllus had laid down 170 years previously, and from this, he ascertained that the equinoctical points had gone backward.

ϵ Virginis is called Vindemiatrix in the Alphonsine tables, an adaptation of the longer word Provindemiator, a translation of $\pi\rho o\tau\rho\upsilon\gamma\eta\tau\grave{\eta}\rho$, given to the star because it rises in the morning just before the vintage. "It is called Mukdim-al-kitaf, 'the forerunner of the vintage,' among the Arabians."—(*Smyth.*)

If the amateur will pass his telescope over the

northern parts of Virgo, and over Coma Berenices, many nebulæ will enter the field of view, but generally very faint.

Five of these nebulæ I have found more conspicuous than the rest.

VULPECULA.

(151.) .· 320 P XIX. Vulp., mag. both 7. 19^h 48′, N. 20°, dis. 43″.

(152.) Neb. 27 M., 19^h 54′, N. $22\frac{1}{4}°$. A very fine object, known from its figure by the name of the "dumb-bell" neb.

Note on Aries.—Aries is marked by a neat triangle of three stars. The sun's place at the time of the Crucifixion was undoubtedly in the head of Aries. It may have been divinely ordered that during the miraculous darkness, these three stars should be seen close to the sun. They were said by the ancient Greeks to contain the name of the Deity, and to be a most Divine emblem. It may not, then, be going too far, to see in the stars α β γ Arietis an emblem of the blessed Trinity. The mathematical student may be interested by a pamphlet in the library of the Royal Astronomical Society, entitled "Creed of S. Athanasius proved by a Mathematical Parallel." The writer says in his preface: "It is appalling to see so many depart from the Church, or remain dissatisfied, because the powers of their minds are not comprehensive enough to understand how that most beautiful combination of heavenly power and grace can exist, as set forth in the Creed. As we generally rest more satisfied on any point above the comprehension of our

weak understandings, when we can bring into juxtaposition a parallel proof to support it, and as this will shew clearly to the mathematician that such a combination as that expressed in the Creed can take place with mathematical accuracy and magnitude, who that understands this can for a moment doubt the essence of the Omnipotent Deity, or the attributes of the blessed Trinity ?"

Many celestial sights, in this way, may be caught sight of by means of a small instrument, and, with every increase of telescopic power, more and more stars come into view, of whose existence we were absolutely ignorant till the invention of the telescope. From the Creation to the time of Galileo mankind were only acquainted with a thousand or two of the heavenly bodies, not the most infinitesimal portion of the whole universe. For what purpose, then, were all these enormous globes created ? Certainly not to cast any light on our earth. Another moon, hundreds of times smaller than our own, would have done that better. Not to ornament our nocturnal skies, since all but a very few are too faint to be seen by our unaided eyes. Look at our own solar system. See what means there are for giving light, the further we recede from the sun. We have but one moon; Jupiter has four, Saturn eight, and so on. See the provision we behold for other races of animated beings. If vast worlds were dreary wastes, without intelligent life, would this be consistent with the wisdom and beneficence of the Creator ? Matter is evidently framed for living creatures ; otherwise there is no purpose in it. Whether we are the only race of intelligent beings that have sinned, or

whether our Lord's sojourn in this world will benefit other worlds, we cannot conjecture; for "now we know in part, but hereafter we shall know, even as also we are known."

"O all ye works of the Lord, bless ye the Lord: praise Him, and magnify Him for ever."—*Benedicite.*

NOTE.—In the case of the foregoing double stars, the dots simply indicate their relative positions; the actual magnitude of the two components, and the distance by which they are separated in space, being stated immediately afterwards.

Printed by James Parker and Co., Crown-yard, Oxford.

DIAGRAMS OF ECLIPSES,

1890—1950.

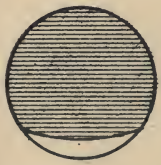
1890, 17 June.

1891, 23 May, *rising.*

1891, 6 June.

1891, 15 Nov.

1892, 11 May.

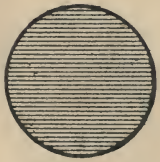


1892, 4 Nov. *rising.*

1894, 15 Sep.

1895, 11 March.

1895, 4 Sep.

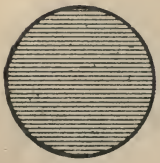


1896, 28 Feb.

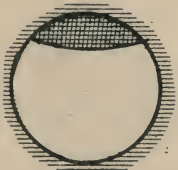
1898, 7 Jan.

1898, 3 July.

1898, 27 Dec.

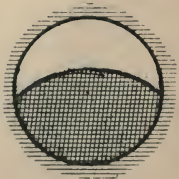


1899, 8 June.



1899, 17 Dec. *almost total.*

1900, 28 May.



1902, 22 April.

1902, 17 Oct.

1903, 11 April.

1905, 19 Feb.

1905, 15 Aug.

1905, 30 Aug.

1906, 9 Feb.

1907, 25 July, *setting.*

1908, 28 June.

1909, 8 June.

1909, 27 Nov. *setting.*

1910, 16 Nov.

1912, 1 April.

1912, 17 April.

1914, 12 March.

1914, 21 Aug.

1916, 3 Feb. *setting.*

1916, 15 July, *setting.*

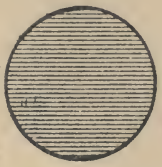
1917, 8 Jan.

1917, 4 July.

1919, 7 Nov.

1919, 22 Nov.
setting.

1920, 3 May.



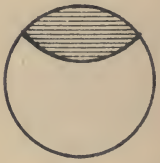
1920, 10 Nov.
setting.

1921, 8 April.

1921, 16 Oct.

1922, 28 March.

1923, 3 March.



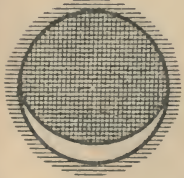
1924, 20 Feb.
rising.

1924, 14 Aug.

1925, 24 Jan.

1925, 8 Feb.

1927, 29 June.



1927, 8 Dec.

1928, 12 Nov.

1928, 27 Nov.
rising.

1929, 1 Nov.

1931, 2 April.

1931, 26 Sep.

1932, 14 Sep.

1934, 30 Jan.

1935, 19 Jan.

1935, 16 July, *setting.*

1936, 8 Jan.

1936, 19 June.

1938, 7 Nov.

1939, 19 April.

1939, 28 Oct. *almost total.*

1942, 2 March.

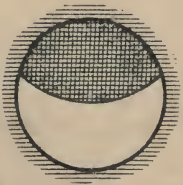
1942, 26 Aug.

1942, 10 Sep.

1943, 20 Feb.

1943, 15 Aug.

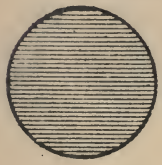
1945, 9 July.



1945, 19 Dec.

1946, 14 June, *rising.*

1946, 8 Dec.



1949, 13 April.

1949, 28 April.

1949, 7 Oct.

SUPPLEMENT.

THE following Supplement to "Eclipses Past and Future, with General Hints for Observing," &c., is designed for purposes of reference. It is reduced from a MS. volume presented by the Author to the Royal Astronomical Society, containing projections and diagrams of eclipses from the year A.D. 538 to the year 2500.

Eclipses of sun and moon and transits of Mercury are given between the years 1890 and 2000. Solar eclipses visible in England, between A.D. 2000 and A.D. 2200. Large solar eclipses, from A.D. 2200 to A.D. 2500. Calculations made for London.

NOTE.—The times of eclipses are expressed throughout in tenth parts, or decimals, of hours. Thus 1890, 17 June. Sun, beg. 8h. 3 morn would signify $8\frac{3}{10}$ hours morn.

u.l. signifies upper limb: l.l. = lower limb: h. = hours.

S. J. JOHNSON.

April, 1889.

1890, 17 June. Sun, beg. 8h. 3 morn.; under 4-tenths 9h. 4; end, 10h. 5, l.l.

Annular, North Africa, Turkey in Asia, Thibet.

A return of the celebrated eclipse of 1836 after three Chaldean periods.

1891, 10 May. Mercury leaves sun's disc half an hour after sunrise.

1891, 23 May. Moon, beg. 4h. 7 aft.; total, 5h. 8 to 7h. 2. Moon rises, 7h. 9; end, 8h. 3.

„ 6 June. Sun, beg. 5h. aft.; 2-tenths at 5h. 8; end, 6h. 4, u.l.

Narrowly annular in polar regions north of Siberia.

„ 15 Nov. Moon, beg. 10h. 6; total, 11h. 6 to 1h.; end, 2h. morn.

1892, 11 May. Moon, beg. 9h. 3 night; 9-tenths at 11h.; end, 12h. 7.

„ 4 Nov. Moon, beg. 2h. 2 aft.; total, 3h. 4 to 4h. 1; end, 5h. 3. Sun sets, 4h. 4.

1894, 15 Sep. Moon, beg. 3h. 5 morn.; 2-tenths at 4h. 3; end, 5h. 1.

„ 10 Nov. Mercury enters sun's disc about 20 minutes before sunset.

1895, 11 March. Moon, beg. 1h. 8 morn.; total, 2h. 8 to 4h. 4; end, 5h. 4.

„ 26 March. Slight eclipse on sun's north limb about half-past 10h.

„ 4 Sep. Moon, beg. 3h. 9 morn.; total, 5h. 1 to 6h. 7; end, 7h. 9. Sun rises, 5h. 3.

1896, 28 Feb. Moon, beg. 6h. 3 evening; 8-tenths at 7h. 8; end, 9h. 3.

„ 9 August. Sun's limb eclipsed in Scotland, at sunrise. Total in Finmark and Siberia.

1898, 7 Jan. Moon, beg. 11h. 7 night; over 1-tenth at 12h. 5; end, 1h. 3 morn.

„ 3 July. Moon, beg. 7h. 7 evening; 9-tenths at 9h. 2; end, 10h. 7. Sun sets, 8h. 3.

„ 27 Dec. Moon, beg. 9h. 7 night; total, 10h. 9 to 12h. 4; end, 1h. 6 morn.

1899, 8 June. Sun, 2-tenths about 5h. 3 morn., u.l.

1899, 17 Dec. Moon, beg. 11h. 8 night (16th); almost total, 1h. 5 morn.; end, 3h. 2.

1900, 28 May. Sun, 7-tenths at 4h. aft., l.l.
Total across Portugal and Spain from Ovar to Alicante.

„ 13 June. Strong penumbra on moon's lower limb just before sunrise.

An eclipse commencing, which becomes total in the year 2044.

1902, 22 April. Moon, beg. 4h. 9 aft.; total, 6h. 1 to 7h. 5; end, 8h. 7. Sun sets, 7h. 1.

„ 17 Oct. Moon, beg. 4h. 3 morn.; total, 5h. 3 to 6h. 8; end, 7h. 8. Sun rises, 6h. 5.

1903, 11 April. Moon, beg. 10h. 6 night; 9-tenths at 12h. 2; end, 1h. 8 morn.

1905, 19 Feb. Moon, beg. 5h. 8 evening; over 3-tenths at 6h. 9; end, 4h.

„ 15 Aug. Moon, beg. 2h. 6 morn.; 3-tenths at 3h. 6; end, 4h. 6.

„ 30 Aug. Sun, 8-tenths at 1h., l.l.
Total in Spain from Corunna to Valencia.

1906, 9 Feb. Moon, beg. 6h. morn.; total, 7h. to 8h. 7; end, 9h. 7. Sun rises, 7h. 5.

1907, 25 July. Moon, beg. 3h. 2 morn.; 6-tenths at 4h. 5; end, 5h. 8. Sun rises, 4h. 3.

„ 12 Nov. Transit of Mercury between 10h. 2 morn. and 1h. 8 aft., approximately.

1908, 28 June. Sun, 1-tenth 5h. 6 aft., l.l.
Annular, Mexico.

„ 7 Dec. Penumbral eclipse of moon, 9h. 7 night.

1909, 3 June. Moon, beg. 11h. 8 night; total, 1h. 1 morn. to 2h. 1; end, 3h. 4.

1909, 27 Nov. Moon, beg. 7h. 1 morn.; total, 8h. 1 to 9h. 5; end, 10h. 5. Sun rises, 7h. 7.

1910, 16 Nov. Moon, beg. 10h. 7 night; total, 12h. to 12h. 8; end, 2h. morn.

1912, 1 April. Moon, beg. 9h. 4 night; 2-tenths at 10h. 2; end, 11h.

„ 17 April. Sun, 12h. 4 noon, 9-tenths, l.l. Central, near Paris and Brussels.

1914, 12 March. Moon, beg. 2h. 8 morn.; nearly 9-tenths at 4h. 3; end, 5h. 8.

„ 21 Aug. Sun, 12h. noon, 7-tenths, u.l. Total, Sweden, Norway, to Persia.

„ 6 Nov. Transit of Mercury, 9h. 8 morn, to 2h. aft., approximately.

1916, 19 Jan. Moon touches earth's shadow just before setting.

„ 3 Feb. Sun goes down with half its disc eclipsed. Total, Caribbean Sea, across Atlantic, setting before reaching Britain.

„ 15 July. Moon, beg. 3h. 2 morn.; 8-tenths at 4h. 7; end, 6h. 1. Sun rises, 4h.

1917, 8 Jan. Moon, beg. 5h. 8 morn.; total, 7h. to 8h. 5; end, 9h. 7. Sun rises, 8h. 1.

„ 4 July. Moon, beg. 7h. 9; total, 8h. 9 to 10h. 5; end, 11h. 5. Sun sets, 8h. 3.

„ 28 Dec. Moon begins to be eclipsed just before setting. Total without continuance below our horizon. Seven eclipses happen this year as in 1805.

1919, 7 Nov. Moon beg. 11h. night; 2-tenths at 11h. 7; end, 12h. 4.

1919, 22 Nov. Sun, 2-tenths at sunset.
Annular, West Indies to Africa.

1920, 3 May. Moon, beg. 11h. 9 (2nd); total, 1h. 2 to 2h. 4; end, 3h. 7 morn.

„ 10 Nov. Sun, 3-tenths at sunset, u.l.

1921, 8 April. Sun, 8h. 9 morn., 8-tenths.
Annular about Shetland Isles.

„ 16 Oct. Moon, beg. 9h. 3 night; 9-tenths at 11h.; end, 12h. 7.

1922, 28 March. Sun, 2h. 2, 2-tenths.
Annular, Guiana, North Africa.

1923, 3 March. Moon, beg. 2h. 4 morn.; 3-tenths at 3h. 5; end, 4h. 6.

1924, 20 Feb. Moon, beg. 2h. 4 aft.; total, 3h. 4 to 5h. 1; end, 6h. 1. Sun sets, 5h. 3.

„ 7 May. Mercury passes off sun's disc about an hour after he rises.

„ 14 Aug. Moon, beg. 6h. 5 aft.; total, 7h. 5 to 9h. 1; end, 10h. 1. Sun sets, 7h. 4.

1925, 24 Jan. Sun, 3h. 8 aft.; 8-tenths, u.l.
Total, United States, across Atlantic, setting near Faroe Isles.

„ 8 Feb. Moon, beg. 8h. 2; 7-tenths at 9h. 7; end, 11h. 3.

1927, 29 June. Sun, 5h. 2 morn., 9-tenths.
Total for a few seconds across North Northumberland to Norway.

„ 12 Nov. Mercury leaves sun's disc about an hour after sunrise.

„ 8 Dec. Moon, beg. 3h. 8; total, 4h. 8 to 6h. 1; end, 7h. 2 aft.

1928, 12 Nov. Sun, 8h. 4 morn., 2-tenths, u.l.

1928, 27 Nov. Moon, beg. 7h. 4 morn.; total, 8h. 6 to 9h. 5; end, 10h. 6. Sun rises, 7h. 7.

1929, 1 Nov. Sun, 11h. 5 morn., 2-tenths, l.l. Annular, Sierra Leone.

1930, 7 Oct. Moon grazes earth's shadow on her north limb, 7h. 1 aft.

1931, 2 April. Moon, beg. 6h. 4 aft.; total, 7h. 4 to 8h. 9; end, 9h. 9.

„ 26 Sep. Moon, beg. 5h. 8 aft.; total, 7h. to 8h. 5; end, 9h. 7.

1932, 14 Sep. Moon, beg. 7h. 3 aft.; nearly total, 9h.; end, 10h. 7.

1934, 30 Jan. Moon, beg. 4h. aft.; 1-tenth at 4h. 6; end, 5h. 3. Sun sets, 4h. 7.

1935, 19 Jan. Moon, beg. 1h. 8 aft.; total, 3h. to 4h. 5; end, 5h. 7. Sun sets, 4h. 4.

„ 16 July. Moon, beg. 3h. 2 morn.; total, 4h. 2 to 5h. 8; end, 6h. 8. Sun rises, 4h. 1.

Seven eclipses this year, five of the sun and two of the moon.

1936, 8 Jan. Moon, beg. 4h. 5; total, 6h. 1 to 6h. 2; end, 7h. 8 aft.

The moon only just dips entirely into the earth's shadow. A like instance of the moon being totally eclipsed for only a few minutes occurred on 31 Jan., 1580. Moestlin observed it as total, but adds, "sed brevissimo tempore totam in umbrâ latuisse."

1936, 19 June. Sun, 4h. 2 morn., 6-tenths, l.l. Total, Black Sea, across Asia, towards Kamschatka.

1937, 10 May. Mercury on the sun from 8h. morn. to 9h. 2, approximately.

1938, 7 Nov. Moon, beg. 8h. 7; total, 9h. 8 to 11h. 1; end, 12h. 2.

1939, 19 April. Sun, 6h. 2 aft., 2-tenths, u.l.

„ 28 Oct. Moon, beg. 5h. morn.; almost total, 6h. 6; end, 8h. 3. Sun rises, 6h. 8.

1942, 2 March. Moon, beg. 10h. 6 aft.; total, 11h. 7 to 1h. 3 morn.; end, 2h. 3.

„ 26 Aug. Moon, beg. 1h. 9 morn.; total, 2h. 9 to 4h. 5; end, 5h. 5. Sun rises, 5h. 1.

„ 10 Sep. Sun, 4h. 3 aft., 3-tenths, u.l.

1943, 20 Feb. Moon, beg. 4h. 2; 7-tenths at 5h. 7; end, 7h. 3 morn.

„ 15 Aug. Moon, beg. 6h. aft.; 8-tenths at 7h. 5; end, 9h. Sun sets, 7h. 3.

1945, 9 July. Sun, 1h. 9 aft., 6-tenths, u.l.
Total, Canada, Greenland, Lapland, Northern Russia.

„ 19 Dec. Moon, beg. 12h. 5; total, 1h. 6 to 2h. 8; end, 3h. 9 morn.

1946, 14 June. Moon, beg. 4h. 9 aft.; total, 6h. to 7h. 5; end, 8h. 7. Sun sets, 8h. 2.

„ 8 Dec. Moon, beg. 4h. 2 aft.; total, 5h. 4 to 6h. 3; end, 7h. 5.

1949, 13 April. Moon, beg. 2h. 5 morn.; total, 3h. 5 to 4h. 8; end, 5h. 8. Sun rises, 5h. 2.

„ 28 April. Sun, 7h. 5 morn.; 3-tenths, u.l.

„ 7 Oct. Moon, beg. 1h. morn.; total, 2h. 3 to 3h. 6; end, 4h. 9.

1950, 2 April. Moon, beg. 7h. 2 aft.; total, 8h. 6 to 9h.; end, 10h. 4.

„ 26 Sep. Moon, beg. 2h. 4 morn.; total, 3h. 8 to 4h. 6; end, 6h.

1952, 10 Feb. Moon, 12h. 6 night, under 1-tenth.

„ 25 Feb. Sun, 8h. 8 morn., 1-tenth, l.l.
Total, Guinea, Red Sea to Central Asia.

„ 5 Aug. Moon, beg. 6h. 5 aft.; 5-tenths at 7h. 7; end, 8h. 9. Sun sets, 7h. 7.

1953, 29 Jan. Moon, beg. 9h. 9 aft.; total, 11h. to 12h. 5; end, 1h. 6 morn.

„ 13 Nov. Mercury's ingress about an hour before sunset.

1954, 19 Jan. Moon, beg. 12h. 8; total, 2h. 4 to 2h. 7; end, 4h. 2 morn.

„ 30 June. Sun, 12h. 4 noon, 8-tenths, u.l.
Total, North America, passing just north of Shetlands, Central Russia.

„ 15 July. Moon, beg. 11h. 2 aft.; 4-tenths at 12h. 4; end, 1h. 6 morn.

1955, 29 Nov. Moon, beg. 4h. 4; 1-tenth at 4h. 9; end, 5h. 4 aft.

1956, 18 Nov. Moon, beg. 5h. 1; total, 6h. 1 to 7h. 5; end, 8h. 5 morn. Sun rises, 7h. 4.

1957, 13 May. Moon, beg. 8h. 8 aft.; total, 9h. 8 to 11h. 2; end, 12h. 3.

1959, 24 March. Moon, beg. 7h. 2 aft.; 3-tenths at 8h. 2; end, 9h. 2.

„ 2 Oct. Sun, 12h. 2 noon, 3-tenths, l.l.
Total, Atlantic, across Northern Africa to Abyssinia.

1960, 6 Nov. Ingress of Mercury about two hours before sunset.

1961, 15 Feb. Sun, 7h. 5 morn., 9-tenths, l.l.
Total, France, Northern Italy, Crimea, upwards to Siberia.

1961, 26 Aug. Moon, beg. 1h. 7 morn.; almost total 3h. 2; end 4h. 7.

1963, 6 July. Moon, beg. 8h. 5 aft.; 7-tenths at 10h.; end, 11h. 5.

1964, 24 June. Moon, beg. 11h. 1 aft.; total, 12h. 3 to 1h. 9 morn.; end, 3h. 1.

„ 19 Dec. Moon, beg. 1h. morn.; total, 2h. 3 to 3h. 1; end, 4h. 3.

1965, 14 June. Moon, beg. 1h. 1 morn.; 2-tenths at 1h. 9; end, 2h. 7.

1966, 20 June. Sun, 9h. 4 morn., 4-tenths, l.l. Central, West Africa, Greece, Central Asia.

1968, 13 April. Moon, beg. 3h. 3 morn.; total, 4h. 5. Sun rises, 5h. 2.

„ 22 Sep. Sun, 10h. 3 morn., 3-tenths, u.l. Total, North Pole, Nova Zembla, Central Asia.

1970, 9 May. Transit of Mercury. Planet enters shortly before sunrise, and continues in transit till noon.

„ 17 Aug. Moon, beg. 2h. 2 morn.; 4-tenths at 3h. 3; end, 4h. 4.

1971, 10 Feb. Moon, beg. 5h. 8; total, 6h. 9 morn. Sun rises, 7h. 4.

„ 25 Feb. Sun, 9h. 5 morn., 6-tenths, u.l.

„ 6 Aug. Moon. Total phase ends 8h. 6 aft.; end of eclipse, 9h. 6. Sun sets, 7h. 5.

1972, 10 July. Sun. Greatest obscuration at sunset, over 5-tenths. Total, Kamschatka, Mackenzie River, Greenland.

1973, 9 Nov. Ingress of Mercury about half an hour after sunrise. Egress about 1h. aft. No more transits of Mercury visible in England until

2003, when observers will be looking forward to the Venus-transit in July, 2004. "Alas! who shall live when God doeth this!"

1973, 10 Dec. Moon eclipsed on lower limb, under 1-tenth, 1h. 7 morn.

„ 24 Dec. Sun, 2-tenths eclipsed at sunset. Annular, Colombia to N. W. Africa.

1974, 4 June. Moon, beg. 8h. 6 aft.; 8-tenths at 10h. 2; end, 11h. 8.

1975, 11 May. Sun, 6h. 5 morn., 6-tenths, u.l.

„ 18 Nov. Moon, beg. 8h. 8 aft.; total, 10h. 2 to 10h. 8; end, 12h. 2.

1976, 29 April. Sun, 10h. 2 morn., 4-tenths, l.l. Annular, Atlantic, Morocco, Turkey in Asia.

„ 13 May. Moon, under 1-tenth on south limb, 8h. aft.

1977, 4 April. Moon, beg. 3h. 5 morn.; 2-tenths at 4h. 2; end, 5h. 5.

1978, 16 Sep. Moon, beg. 5h. 3 aft.; total, 6h. 3 to 7h. 7; end, 8h. 7. Sun sets, 6h. 2.

1979, 13 March. Moon, beg. 7h. 5 aft.; 8-tenths at 9h. 2; end, 10h. 9.

1981, 17 July. Moon, beg. 3h. 5 morn.; sets 3-tenths obscured. Sun rises, 4h. 1.

1982, 9 January. Moon, beg. 6h. 2 aft.; total, 7h. 2 to 8h. 5; end, 9h. 5.

„ 15 Dec. Sun, 8h. 2 morn., 3-tenths, l.l.

1984, 30 May. Sun, 6h. 3 aft., 5-tenths, l.l. Annular, Southern States of America, across Atlantic to Morocco.

1985, 4 May. Moon rises totally eclipsed, also sun sets, 7h. 4 totality over, 8h. 6; end, 9h. 7.

1985, 28 Oct. Moon. Sun sets, 4h. 6; total phase, 5h. 3 to 6h.; ends, 7h. 5 aft.

Thus the two eclipses visible this year commence below the horizon, but in each case more or less of the total phase can be seen. It is possible for three total lunar eclipses to fall in one year. Such was the case in 1544, when three total eclipses of the moon took place, all more or less visible here. Also refer to 1917.

1986, 17 Oct. Moon, beg. 5h. 4 aft.; total, 6h. 6 to 7h. 8; end, 9h.

1989, 17 Aug. Moon, beg. 1h. 4 morn.; total, 2h. 4 to 4h. Sun rises, 4h. 8.

1990, 9 Feb. Moon, beg. 5h. 6 aft.; total, 6h. 9 to 7h. 6; end, 8h. 9.

1992, 9 Dec. Moon, beg. 10h. aft.; total, 11h. 1 to 12h. 4; end, 1h. 5 morn.

1993, 29 Nov. Moon, beg. 4h. 7 morn.; total, 6h. 2 to 6h. 8. Sun rises, 7h. 7.

1994, 10 May. Sun, 6h. 8 aft., 5-tenths, l.l.

Annular across centre of United States.

„ 25 May. Moon, beg. 2h. 7 morn.; 3-tenths at 3h. 5. Sun rises, 4h.

1996, 3 April. Moon, beg. 10h. 4 aft.; total, 11h. 5 to 1h. morn.; end, 2h. 1.

„ 27 Sep. Moon, beg. 1h. 1 morn.; total, 2h. 2 to 3h. 5; end, 4h. 6.

„ 12 Oct. Sun, 2h. 6 aft., 6-tenths, u.l.

1997, 24 March. Moon, beg. 2h. 9 morn.; 9-tenths at 4h. 6; end, 6h. 4. Sun rises, 5h. 9.

„ 16 Sep. Moon, beg. 5h. 2 aft.; total, 6h. 3 to 7h. 4; end, 8h. 5. Sun sets, 6h. 2.

1999, 11 Aug. Sun, 10h. 1 morn.; over 9-tenths, l.l. Total, Atlantic, S.W. corner of England, Persia.

2000, 21 Jan. Moon, beg. 3h. 1 morn.; total, 4h. 1 to 5h. 3; end, 6h. 3.

2003, 3 May. Sunrise, 8-tenths, u.l.

2004, 8 June. The transit of Venus will be visible throughout in Great Britain, a circumstance which has not happened since that of 1283. Ingress about 5h. morn. Egress about half-past 11h. (morn.).

2005, 3 Oct. 9h. 2 morn., 6-tenths, l.l.

2006, 29 March. 10h. 2, 3-tenths, l.l.

2008, 1 Aug. 9h. morn., 1-tenth, u.l.

2011, 4 Jan. Sunrise, 6-tenths, u.l.

2012, 6 June. Transit of Venus. On this occasion the sun rises at Greenwich only about an hour before Venus begins to leave his disc.

2015, 20 March. 9h. 5 morn., 9-tenths, u.l.

2017, 21 Aug. 7h. aft., 2-tenths, l.l.

2021, 10 June. 10h. 5 morn., 2-tenths, u.l.

2025, 29 March. 11h. 5 morn., 3-tenths, u.l.

2026, 12 Aug. 6h. aft., 9-tenths, l.l. Total in France.

2027, 2 Aug. 9h. morn., 4-tenths, l.l.

2028, 25 Jan. 4h. 2 aft., 6-tenths, l.l.

2030, 1 June. 5h. 2 morn., 6-tenths, l.l.

2036, 21 Aug. 6h. aft., 6-tenths, u.l.

2037, 16 Jan. 8h. 2 morn., 6-tenths, u.l.

2038, 2 July. 2h. aft., 1-tenth, l.l.

2039, 21 June. 6h. 5 aft., 8-tenths, u.l.

2048, 11 June. 1h. 5 aft., 7-tenths, u.l.

2050, 14 Nov. 2h. aft., 8-tenths, u.l.

2053, 12 Sep. 8h. 2 morn., 6-tenths, l.l.
2059, 5 Nov. 8h. morn., 7-tenths, l.l.
2060, 30 April. 10h. 2 morn., 1-tenth, l.l.
2066, 22 June. Sunset, 8-tenths, l.l.
2069, 21 April. 10h. morn., 3-tenths, u.l.
2075, 13 July. 4h. 7 morn., 9-tenths, l.l.
2076, 26 Nov. 11h. morn., 4-tenths, u.l.
2079, 1 May. 11h. morn., 4-tenths, u.l.
2080, 13 Sep. 4h. 7 aft., 8-tenths, u.l.
2081, 3 Sep. 7h. 5 morn., 9-tenths, l.l.
Total in France.
2082, 27 Feb. 4h. aft., 5-tenths. l.l.
2088, 21 April. 10h. 5 morn., 5-tenths, l.l.
2090, 23 Sep. 5h. 6 aft.
Total in Paris; also on S.W. coast of England about twenty minutes before sunset.
2091, 18 Feb. 10h. morn., 5-tenths, u.l.
2092, 6 Feb. 4h. 2 aft., 6-tenths, l.l.
2093, 23 July. 12h. 2 noon, 9-tenths, u.l.
Annular in England.
2102, 15 July. 6h. 5 morn., 3-tenths, u.l.
2104, 17 Dec. 2h. 7 aft., 8-tenths, u.l.
2106, 3 May. 6h. 7 aft., 6-tenths, l.l.
2107, 16 Oct. 8h. morn., 3-tenths, l.l.
2113, 8 Dec. 7h. 7 morn., 6-tenths, l.l.
2117, 11 Dec. On this morning Venus will cross the northern part of the sun's disc, but below our horizon, the egress being about 5 o'clock.
2119, 11 March. 10h. 5 morn., 7-tenths, u.l.
2120, 25 July. 3h. 5 aft., 3-tenths, u.l.
2125, 8 Dec. Venus crosses the southern part of the sun this afternoon, entering the disc about 1 o'clock.

2126, 16 Oct. 8h. 2 morn., 6-tenths, u.l.
2128, 1 March. 7h. morn., 1-tenth, l.l.
2130, 30 Dec. 1h. aft., 6-tenths, u.l.
2133, 3 June. 9h. 5 morn., 8-tenths, u.l.
2134, 17 Oct. Sunset, 6-tenths, u.l.
2135, 7 Oct. 7h. 7 morn.

Total across England, north of London.

2136, 1 April. 3h. 2, aft., 6-tenths, l.l.
2142, 24 May. 8h. 7 morn., 9-tenths, l.l.
2146, 12 March. 5h. 2 aft., 8-tenths, l.l.
2147, 26 Aug. 6h. 2 morn., 6-tenths, l.l.
2151, 14 June. 6h. 5 aft.

Nearly, if not quite, total at London.

2159, 19 Jan. 3h. 7 aft., 4-tenths, u.l.
2160, 4 June. 6h. 2 aft., 8-tenths, l.l.
2166, 25 Aug. 4h. 7 aft., 7-tenths, u.l.
2173, 12 April. 9h. 7 morn., 8-tenths, u.l.
2175, 16 Aug. 12h. 5 noon, 7-tenths, l.l.
2182, 3 April. 7h. 2 morn., 2-tenths, l.l.
2185, 31 Jan. 3h. 7 aft., 1-tenth, u.l.
2187, 6 July. 6h. 7 morn., 7-tenths, l.l.
2189, 8 Nov. 8h. 7 morn., 9-tenths, l.l.
2191, 23 April. Sunset, 4-tenths, u.l.
2192, 6 Sep. 5h. 2 aft., 4-tenths, u.l.
2196, 26 June. 6h. morn., 5-tenths, u.l.
2200, 14 April. 5h. 2 aft., 9-tenths, u.l.

Central in this country.

Large eclipses in three following centuries.

2205, 15 July. 3h. 7 aft., 6-tenths, l.l.
2220, 26 Sep. 1h. 5 aft., 9-tenths, l.l.
2227, 15 May. 7h. 7 morn., 8-tenths, l.l.
2229, 18 Sep. 8h. 7 morn., 7-tenths, u.l.

2234, 20 Dec. 1h. 2 aft., 6-tenths, l.l.
2236, 5 May. 6h. 2 morn., 7-tenths, l.l.
2245, 25 May. 5h. 2 aft., 8-tenths, u.l.
2247, 11 June. A transit of Venus visible throughout in Great Britain. Ingress, 9h. 7 morn. Egress, 2h. 7 aft.
2254, 16 May. 3h. 5 aft., 6-tenths, u.l.
2255, 9 June. Venus on the sun again. Mid-transit about 5h. morn. Egress about half-past 8h.
2274, 29 Oct. Noon, 6-tenths, l.l.
2290, 7 June. 4h. 5 morn., 9-tenths, u.l.
Total in north of Great Britain.
2294, 26 March. 5h. 5 aft., 8-tenths, u.l.
2299, 27 June. 1h. 7 aft., 9-tenths, l.l.
2305, 19 Aug. 9h. morn., 7-tenths, u.l.
2321, 26 April. 11h. 5 morn., 7-tenths, u.l.
2350, 30 Sep. 10h. 2 morn., 9-tenths, u.l.
2360. A transit of Venus, 12 December, about midnight.
2368, 10 Dec. The succeeding passage. Ingress at noon. Middle of transit about half-past 2h. aft.
2377, 1 Oct. 2h. 7 aft., 8-tenths, l.l.
2381, 20 July. 10h. 2 morn.
Total across England, a little north of London.
2388, 7 March. 8h. 7 morn., 7-tenths, l.l.
2390, 9 Aug. 7h. aft., 8-tenths, l.l.
2426, 1 Sep. 8h. 2 morn., 8-tenths, u.l.
2431, 4 Nov. 11h. 7 morn., 8-tenths, l.l.
2433, 10 April. 11h. 2 morn., 9-tenths, l.l.
2442, 10 April. 9h. 7 morn., 9-tenths, u.l.
2446, 26 Jan. 12h. 5 noon, 9-tenths, l.l.
2480, 3 Oct. 9h. 7 morn., 8-tenths, l.l.

2485, 6 Dec. 10h. 7 morn., 8-tenths, u.l.

2490, 12 June. A short transit of Venus across sun's south limb from a quarter past two to a quarter past four (afternoon).

2491, 9 March. Large eclipse about sunset.

2498, 10 June. Ingress of Venus about half-past four this morning. Egress about noon.

ERRATA.

Page 117, line 23, *for* Mare Tranquillitatis, *read* Mare Serenitatis.
,, 170, ,, 2, ,, July, 2004, ,, June, 2004.

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