SOME ASTRONOMICAL CURIOSITIES.

CELESTIAL PARADOXES.

BY J. E. GORE, M.R.I.A.

THERE are many curious facts and observations connected with astronomy which are not usually mentioned in popular books on the subject. The following are some of these:

From experiments made in November, 1906, at Moscow, Prof. Ceraski found that the light of the sun's limb is only 31 to 38 times brighter than the illumination of the earth's atmosphere close to the limb. This is a very unexpected result; and considering the comparative faintness of the sun's corona during a total eclipse of the sun, it is not surprising that all attempts to photograph it without an eclipse have failed.

The so-called blackness of sun-spots is merely relative. They are really very bright. The most brilliant light which can be produced artificially looks like a black spot when projected on the sun's disk.

M. Leo Brenner thinks that he has seen the dark side of the planet Mercury in the same way that the dark side of Venus has been seen by many observers. In the case of Mercury the "dark side" appeared darker than the background of the sky. Perhaps this be due to its being projected on the zodiacal light, or outer envelope of the sun.²

When Venus is at its greatest brilliancy and appears as a morning star about Christmas time (which occurred in 1887 and again in 1889), it has been mistaken by the public for a return of the "Star of Bethlehem." But whatever "the star of the magi" was it certainly was not Venus. It seems indeed absurd to suppose that the wise men of the East should have mistaken a familiar object like Venus for a strange apparition. There seems to be nothing whatever in the Bible to lead us to expect that the Star of Bethlehem will reappear. Mr. J. H. Stockwell has suggested³ that the "Star of Bethlehem" may perhaps be explained by a conjunction of the planets Venus and Jupiter which occurred on May 8th, B. C. 6, about two years before the death of Herod. From this it would follow that the crucifixion took place on April 3rd, A. D. 33. But it seems very doubtful that the phenomenon recorded in the Bible refers to any conjunction of planets.

The crescent shape of Venus is said to have been seen with the naked eye by Theodore Parker in America when he was only twelve years old. Other observers have stated the same thing; but the possibility of such an observation has been much disputed in recent years.

The well-known French astronomer, Trouvelot—a most excellent observer—saw white spots on Venus similar to those on Mars. These were well seen and quite brilliant in July and August, 1876, and in February and November, 1877. The observations seem to show that these spots do not (unlike Mars) increase and decrease with the planet's seasons. These white spots had been previously noticed by former observers, including Bianchini, Derham, Gruithuisen, and La Hire; but these early observers do not seem to have considered them as snow caps, like those of Mars. Trouvelot was led by his own observations to conclude that the period of rotation of Venus is short, and the best result he obtained was 23 h. 49 m. 28 s. This does not differ much from the results previously found by De Vien, Fritsch, and Schröter.⁴ A white spot near the planet's south pole was seen on several occasions by H. C. Russell in May and June, 1876.⁵ Photographs of Venus taken on March 18th and April 29th, 1908, by M. Quénisset at the observatory of Juvisy, France, show a white polar spot. The spot was also seen at the same observatory by M. A. Benoit on May 20th, 1903.

The controversy on the period of rotation of Venus, or the length of its day, is a very curious one, and has not yet been decided. Many good observers assert confidently that it is short (about 24 hours), while others affirm with equal confidence that it is long (about 225 days, the period of the planet's revolution round the sun). Among the observers who favor the short period are D. Cassini (1667), J. Cassini (1730), Schröter (1788-93), Mädler (1836), De Vico (1840?), Trouvelot (1871-9), Flammarion, Leo Brenner, Stanley Williams, and J. M'Harg; and among those who support the long period are Bianchini (1727), Schiaparelli, Cerulli, Tacchini, Mascari, and Lowell. Some recent spectroscopic observations seem to favor the short period.

The "secondary light" of Venus, or the visibility of the dark side (when the planet is in the crescent phase) seems to have been first mentioned by Derham in his "Astro Theology," published in 1715. He speaks of the visibility of the dark part of the planet's disk "by the aid of a light of a somewhat dull and ruddy color." The date of Derham's observation is not given; but it seems to have been previous to the year 1714. The light seems to have been also seen by a friend of Derham. We next find observations by Christfried Kirch, assistant astronomer to the Berlin Academy of Sciences, on June 7th, 1721, and March 8th, 1726. These observations are found in his original papers, and were printed in the *Astronomische Nachrichten*, No. 1586. On the first date the telescopic image of the planet was "rather tremulous," but in 1726 he noticed that the dark part seemed to belong to a smaller circle than the illuminated portion of the disk. The same effect was also noted by Webb. A similar appearance is seen in the case of the crescent moon, and this has given rise to the old saying: "The old moon in the new moon's arms."

We next come in order of date to an observation made by Andrias Mayer, professor of mathematics at Greifswald in Prussia. The observation was made on October 20th, 1759, and the dark part of Venus was seen distinctly by Mayer. As the planet's altitude at the time was not more than 14 deg. above the horizon, and its apparent distance from the sun only 10 deg., the phenomenon, as Prof. Safarik has pointed out, must have had a most unusual intensity.

Sir William Herschel makes no mention of having ever seen the "secondary light" of Venus, although he noticed the extension of the horns beyond a semi-circle.

In the spring and summer of the year 1793 Von Hahn, of Ramplin, in Mecklenburg, using excellent telescopes, made by Dolland and Herschel, saw the dark part of Venus on several occasions, and describes the light as gray verging upon brown.

Schröter, of Lilienthal, the famous observer of the moon, saw the horns of the crescent of Venus extended many degrees beyond the semi-circle on several occasions in 1784 and 1795, and the border of the dark part faintly lit up by a dusky gray light. On February 14th, 1806, at 7 P. M. he saw the whole of the dark part visible with an ash-colored light, and he was satisfied that there was no illusion. On January 24th of the same year (1806) Harding at Göttingen, using a reflector of 9 inches aperture and power 84, saw the dark side shining with a pale ash-colored light, and very visible against the dark background of the sky. The appearance was seen with various magnifying powers, and he thought there could be no illusion. In fact, the phenomenon was as evident as in the case of the moon. Harding again saw it on February 28th of the same year, the illumination being of a reddish gray color, like that of the moon in a total eclipse.

The light was also seen by Pastorff in 1822, and by Gruithuisen in 1825. Since 1824 observations were made by Berry, Browning, Guthrie, Langdon, Noble, Prince, Webb, and others. Webb saw it with powers of 90 and 212 on a 9.38-inch mirror and found it equally visible when the bright crescent was hidden by a field bar.⁶ Capt. Noble's observation was rather unique. He found that the dark side was always distinctly and positively darker than the background upon which it is projected. The light was also seen by Lyman in America in 1867, and by Safarik at Prague. In 1871 the whole disk of Venus was seen by Prof. Winnecke.⁷ On the other hand, Winnecke stated that he had only seen it twice in twenty-four years. The great observers Dawes and Mädler never saw it at all.⁸

Various attempts have been made to explain the visibility, at times, of the dark side of Venus. The following may be mentioned: (1) Reflected earth-light analogous to the dark side of the crescent moon. This theory was advocated by Harding, Schröter, and others. But, although the earth is undoubtedly a bright object in the sky of Venus the explanation is evidently quite inadequate. (2) Phosphorescence of the planet's atmosphere. (3) Visibility by contrast, a hypothesis advanced by the great French astronomer Arago. (4) Illumination of the planet's surface by an aurora. This also seems rather inadequate, but would account for the light being sometimes visible and

sometimes not. (5) Luminosity of the oceans—if there be any—on Venus. But this also seems inadequate. (6) A planetary surface glowing with intense heat. But this seems improbable; and (7) the *künstliches Feuer* (artificial fire) of Gruithuisen, a very fanciful hypothesis. Flammarion thinks that it may perhaps be explained by its projection on a somewhat lighter background, such as the zodiacal light, on an extended solar envelope.⁹

It will be seen that none of these hypotheses is entirely satisfactory, and the phenomenon, if real, remains a sort of astronomical enigma. The fact that the light is visible on some occasions and not on others would render some of the explanations improbable or even inadmissible. But the condition of the earth's atmosphere at times might account for its invisibility on many occasions.

M. Hansky finds that the visibility of the light is greater during periods of maximum solar activity, that is at the maxima of sun-spots. This he explains by the theory of Arrhenius in which electrified ions emitted by the sun cause the phenomena of terrestrial magnetic storms and auroras. In the same way the dense atmosphere of Venus is rendered more phosphorescent and therefore more easily visible by the increased solar activity.¹⁰ This seems a very plausible hypothesis.

There is a curious illusion with reference to the moon's apparent diameter referred to by Proctor.¹¹ If, when the moon is absent in the winter months, we ask a person whether the moon's diameter is greater or less than the distance between the stars δ and ϵ , and ϵ and ζ Orionis (the three well-known stars in the belt of Orion), the answer will probably be that the moon's apparent diameter is about equal to each of these distances. But in reality the apparent distance between δ and ϵ Orionis (or between ϵ and ζ , which is about the same) is more than double the moon's apparent diameter. This seems at first sight a startling statement; but its truth is, of course, beyond all doubt, and is not open to argument. Proctor points out that if a person estimates the moon as a foot in diameter, as its apparent diameter is about half a degree, this would imply that the observer estimates the circumference of the star sphere as about 720 feet (360 deg. $\times$ 2), and hence the radius (or the moon's distance from the earth) about 115 feet. But in reality all such estimates have no scientific (that is, accurate) meaning. Some of the ancients, such as Aristotle, Cicero, and Heraclitus seem to have estimated the moon's apparent diameter at a foot.¹² This shows that even great minds may make serious mistakes.

Chacornac found that the illumination of Saturn's disk is the reverse of that of Jupiter, the edges of Saturn being brighter than the center, while in the case of Jupiter, as that of the sun, the edges are fainter than the center. According to Mr. Denning, Saturn bears satisfactorily greater magnifying power than either Mars or Jupiter.

It was computed by M. Faye that the volume of the famous Donati's comet (1858) was about 500 times that of the sun! On the other hand, he calculated that its mass (or quantity of matter it contained) was only a fraction of the earth's mass. This shows how almost inconceivably tenuous the material forming the comet must have been—much more rarefied indeed than the most perfect vacuum which can be produced in an air pump! This tenuity is shown by the fact that stars were seen through the tail "as if the tail did not exist." A mist of a few hundred yards in thickness is sufficient to hide the stars from our view, while a thickness of thousands of miles of cometary matter does not suffice even to dim their brilliancy.

On November 29th, 1905, Sir David Gill observed a fireball with an apparent diameter equal to that of the moon, which remained visible for five minutes and then disappeared in a hazy sky. Observed from another place, Mr. Fuller found that the meteor was visible two hours later! Sir David Gill stated that he does not know of any similar phenomenon.¹³

During the night of July 21st-22nd, 1896, Mr. William Brooks, the well-known astronomer, and director of the Smith Observatory at Geneva (New York), saw a round dark body pass slowly across the moon's bright disk, the moon being nearly full at the time. The apparent diameter of the object was about

¹⁰ Nature, October 17th, 1895.

¹¹ Nature, July 27th, 1905.

¹² Nature, March 3rd, 1870.

¹³ Nature, March 31st, 1870, p. 557.

¹⁴ Bulletin, Ast. So. de France, May, 1906.

¹ Nature, April 11th, 1907.

² Nature, November 29th and December 10th, 1894.

³ Nature, December 22nd, 1892.

⁴ Nature, September 15th, 1892.

⁵ The Observatory, 1880, p. 574.

⁶ Celestial Objects, Vol. I, p. 65 (Fifth Edition).

⁷ Ast. Nach., No. 1,863.

⁸ Nature, June 1st, 1876.

⁹ Nature, June 8th, 1876.

one minute of arc, and the duration of the transit 3 or 4 seconds, the direction of motion being from east to west. On August 22nd of the same year, Mr. Guthman (an American observer) saw a meteor crossing the sun's disk, the transit lasting about 8 seconds.¹⁵

A meteor which appeared in Italy on July 7th, 1892, was shown by Prof. von Niessl to have an ascending path toward the latter end of its course! The length of its path was computed to be 683 miles. When first seen its height above the earth was about 42 miles, and when it disappeared its height had increased to about 98 miles, showing that its motion was directed upward!¹⁶

In the case of the fall of meteoric stones, which occasionally occurs, it has sometimes been noticed that the sound caused by the explosion of the meteorite, on its passage through the air, is heard before the meteorite is seen to fall. This has been explained by the fact that owing to the resistance of the air to a body moving at first with a high velocity its speed is so reduced that it strikes the earth with a velocity less than that of sound. Hence the sound reaches the observer before the body strikes the ground.¹⁷

In Central Arizona there is a hill called Coon Butte, or Coon Mountain. This so-called "mountain" rises to a height of only 130 to 160 feet above the surrounding plain, and has on its top a crater of 530 to 560 feet deep, the bottom of the crater, which is dry, being thus 400 feet below the level of the surrounding country. This so-called "crater" is almost circular, and nearly three-quarters of a mile in diameter. It has been suggested that this "crater" was formed by the fall of an enormous iron meteorite, or small asteroid. The crater has been carefully examined by a geologist and a physicist. From the evidence and facts found, the geologist (Mr. Barringer) states that they do not leave in his mind a scintilla of doubt that this mountain and its crater were produced by the impact of a large meteorite or small asteroid. The physicist (Mr. Tilghmann) says that he is justified, under due reserve as to subsequently developed facts, in announcing that the formation at this locality is due to the impact of a meteor of enormous and unprecedented size. There are numerous masses of meteoric iron in the vicinity of the "crater." The so-called Canyon Diablo meteorite was found in a canyon of that name, about 2½ miles from the Coon Mountain. The investigators estimate that the great meteoric fall took place not more than 5,000 years ago, perhaps much less. Cedar trees about 700 years old are now growing on the rim of the mountain. From the results of artillery experiments, Mr. Gilbert finds that a spherical projectile striking solid limestone with a velocity of 1,800 feet a second will penetrate to a depth of something less than two diameters, and from this Mr. L. Fletcher concludes that a meteor of large size would not be prevented by the earth's atmosphere from having a penetrative effect sufficient for the production of such a crater.

The Canyon Diablo meteorite above referred to was found to contain diamonds—some black, others transparent. So some have said that the diamond is a gift from heaven, conveyed to earth in meteoric showers. But diamond-bearing meteorites would seem to be rather a freak of nature. It does not follow that all diamonds had their origin in meteoric stones. The mineral periodot is frequently found in meteoric stones, but it is also a constituent of terrestrial rocks.

With reference to the rising and setting of the stars, due to the earth's rotation on its axis, the late Sir George Airy, astronomer royal of England, once said to a schoolmaster, "I should like to know how far your pupils go into the first practical points, for which reading is scarcely necessary. Do they know that the stars rise and set? Very few people in England know it. I once had a correspondence with a literary man of the highest rank on a point of Greek astronomy, and found that he did not know it."¹⁸

On the 4th of March, 1796, the famous French astronomer, Lalande, observed on the meridian a star of small sixth magnitude, the exact position of which he determined. On the 15th of the same month he again observed the star, and the places found on these two nights refer to the numbers 16,292-3 of the reduced catalogue. In the observation of March 4th, he attached the curious remark, "Etoile singuliere." (The observation of March 15th is without note.) This remark of Lalande has puzzled observers, who failed to find any peculiarity about the star. Indeed, the remark is a strange one for the observer of so many thousands of stars to attach, unless there was really something singular in the star's aspect at the time. On the evening of April 18th, 1887, the star was examined by the present writer, and the following is the record in his observing book: "Lalande's 'étoile singulière' (16,292-3) about half a magnitude less than η Cancri. With the binocular I see two streams of small stars branching out from it north proceeding

[northwest] like the tails of a comet." This may, perhaps, have something to do with Lalande's curious remark.

Burnham once saw a faint companion to Sirius of the sixteenth magnitude and measured its position. But he afterward found that it was not a real object but a reflection from Sirius (in the eyepiece). Such false images are called ghosts.

With reference to the well-known double (or rather quadruple) star ϵ Lyrae, near Vega, and supposed faint star near it, Burnham says: "From time to time various small stars in the vicinity have been mapped, and much time wasted in looking for and speculating about objects which only exist in the imagination of the observer." He thinks that many of these faint stars supposed to have been seen by various observers are merely ghosts produced by reflection.

It is a curious fact that the performance of a really good refracting telescope actually exceeds what theory would indicate, at least so far as double stars are concerned. For example, the famous double-star observer, Dawes, found that the distance between the components of a double star which can just be divided is found by dividing 4.56 sec. by the aperture in inches. Now theory gives 5.52 sec. divided by the aperture. The actual telescope—if a really good one—thus exceeds its theoretical requirements. The difference between theory and practice in this case seems to be due to the fact that in the "spurious" disk shown by a good telescope, the illumination at the edges of the star disk is very feeble, so that its full size is not seen except in case of a very bright star.

The star known as W Ursæ Majoris (the variability of which was discovered by Muller and Kempf in 1902), and which lies between the stars θ and ν of that constellation, has the marvelously short period of four hours (from maximum to maximum). Messrs. Jordan and Parkhurst find from photographic plates that the star varies from 7.24 to 8.17 magnitude. The light at maximum is therefore more than double the light at minimum. A sun which loses more than half its light and recovers it again in the short period of four hours is certainly a curious and wonderful object.

Dr. See, observing with the telescope of the Lowell Observatory, found that when the sky is clear, the moon absent, and the seeing perfect, the sky appeared in patches to be of a brownish color, and suggests that this color owes its existence to immense cosmical clouds, which are shining by excessively feeble light. Dr. See found that these brown patches seem to cluster in certain regions of the Milky Way.

Some curious and interesting phenomena are recorded in the old Chinese annals which go back to a great antiquity. In B. C. 687 a night is mentioned without clouds and without stars. This may perhaps refer to a total eclipse of the sun; but if so the eclipse is not mentioned in the Chinese list of eclipses. In the year 141 B. C. it is stated that the sun and moon appeared of a deep red color during five days, a phenomenon which caused great terror among the people. In 74 B. C. it is related that a star as large as the moon appeared, and was followed in its motion by several stars of ordinary size. This probably refers to an unusually large bolide or fire-ball. In 38 B. C. a fall of meteoric stones is recorded of the size of a walnut. In 88 A. D. another fall of stones is mentioned. In A. D. 321 sun-spots were visible to the naked eye.

There is a story of an eminent astronomer who had been on several eclipse expeditions, and yet was heard to remark that he had never seen an eclipse. "But your observations of several eclipses are on record," it was objected. "Certainly I have on several occasions made observations, but I have always been too busy to look at the eclipse." He was probably in a dark tent taking photographs, or using a spectroscope during the totality.—Knowledge and Scientific News.

SIMPLE SOLUTION OF EXPONENTIAL FORMULÆ.

A CORRESPONDENT sends us the following simple method, by which he solves the exponential formulæ frequently encountered in hydraulic and similar work. When, for instance, the formula includes a decimal fraction which was either to be raised to a decimal fractional power or to have a fractional root extracted, the operation by the methods usually given in books on logarithms is confusing to some, and the following method avoids addition or subtraction of ten to or from the characteristic, and is easily remembered.

For example, to obtain the value of an expression that is a decimal, and has a decimal exponent, make the decimal into a true fraction. Raise the numerator to the desired power, and the denominator to the same power. Subtract logarithm of denominator from logarithm of numerator, and the remainder is the logarithm of the required value.

The logarithm of a logarithm is used, which is added to the logarithm of the exponent. And the number corresponding to this logarithm is itself the logarithm of either numerator or denominator, as the case may be.

In a decimal root example, the reciprocal of the decimal exponent is found, and it always becomes greater than unity, so that the logarithm of this exponent will have a plus characteristic, and is therefore easily found.

$$0.455^{0.237} = \frac{455^{0.237}}{1000^{0.237}}$$

$$\begin{aligned} \log 455 &= 2.658011 \\ \log \text{ of } (\log 2.658011) &= 0.424557 \\ \log 0.237 &= 1.374748 \end{aligned}$$

Number corresponding to 1.799305 is 0.629948 = log of numerator.

$$\begin{aligned} \log \text{ of } 1000 &= 3.000,000 \\ \log \text{ of } (\log) 3 &= 0.477121 \\ \log \text{ of } 0.237 &= 1.374748 \end{aligned}$$

$$1.851869$$

Number cor. to 0.711000 = log of denominator.

$$\begin{aligned} \log \text{ of numerator} &= 0.629948 \\ \log \text{ of denominator} &= 0.711000 \end{aligned}$$

$$1.918948$$

Number corresponding to = 0.82975 = 0.455^{0.237}. Answer.

Then the reverse operation, to obtain the decimal root of a decimal fraction

$$0.82975 \sqrt[0.237]{0.82975} = \sqrt[0.237]{\frac{82,975}{100,000}} = \frac{82,975^{0.237}}{100,000^{0.237}}$$

The exponent when reduced becomes a whole number,

$$\begin{aligned} \log 1 &= 0.000000 \\ \log 0.237 &= 1.374748 \end{aligned}$$

$$0.625252$$

4.2194 = number corresponding, = new exponent.

$$\frac{82,975^{0.625252}}{100,000^{0.625252}} = \frac{82,975^{4.2194}}{100,000^{4.2194}}$$

First to find logarithm of numerator of this fraction.

$$\begin{aligned} \log 82975 &= 4.918947 \\ \log \text{ (of log) } 4.918947 &= 0.691873 \\ \log \text{ of exponent } 4.2194 &= 0.625251 \end{aligned}$$

$$1.317124$$

Number corresponding = 20.755072 = log of numerator.

To find logarithm of denominator:

$$\begin{aligned} \log \text{ of } 100,000 &= 5.000000 \\ \log \text{ of } (\log 5.000,000) &= 0.698970 \\ \log \text{ of exponent } 4.2194 &= 0.625251 \end{aligned}$$

$$1.324221$$

Number corresponding = 21.096990 = log of denominator.

$$\begin{aligned} \log \text{ of numerator} &= 20.755072 \\ \log \text{ of denominator} &= 21.096990 \end{aligned}$$

$$1.658082$$

Number corresponding = 0.455.

GERMAN DIATOMACEOUS EARTH.

INFUSORIAL or diatomaceous earth finds many practical applications, notably in the manufacture of dynamite, polishing soaps, soluble glass, gutta percha articles, and many other things. Germany has long been the principal producer of this earth and affords the best qualities. The principal deposits are in Hanover, where the kieselguhr occurs in beds among other alluvial deposits or in proximity with lignite seams. It generally forms a granular mass of gray, brownish, or pale green color; it has a dry feeling, absorbs water with avidity, is friable, and at ordinary temperatures resists chemical decomposition. It occurs in great quantities near Hützel, in the Lünberger Heide, and at Unterhness, in the same part of Hanover. It is also found at Vogelsberg, in Hesse, at Jastrobe, in Hungary, at Franzenbad, in Bohemia, and in Tuscany.

The valuable characteristics of the earth are its light weight, its absorptive power, and its non-conductivity of heat, which makes it one of the best insulating materials. It is mined in much the same way as brick clay, in open pits. It is then spread on planks or on the bare ground, in the sunshine, to dry. Artificial methods of drying do not seem to prevail. The earth should never be allowed to come in contact with flame, as it will calcine rapidly. There is no special necessity for drying kieselguhr beyond that point accomplished by the sun, and, although numerous artificial means have been tried, they have not come into general use. Dry-air ovens may be advantageous in wet seasons, but are not economical except with the very finest grades of earth, such as are used for dynamite.

As the earth comes from the ground, it contains 70 to 90 per cent of water; after drying in the sun, it still retains 15 to 25 per cent of moisture. During shipment, it must be carefully protected from moisture.—Engineering and Mining Journal.

¹⁵ Nature, September 10th, 1896.

¹⁶ Nature, June 9th, 1893.

¹⁷ Journal, B.A.A., May 22nd, 1903.

¹⁸ The Observatory, July, 1895, p. 290.