It might not be out of place to mention here that I am engaged in writing a treatise (to be styled Jyothisha Chinthamany) containing rules, formulæ and tables based on the English methods of calculation for the guidance of our Sidhantis. As the cost of publication will overtax my very slender means, a number of influential native gentlemen met at Pacheappah's Hall some months ago to consider what means should be adopted to obtain the necessary funds as well as to establish an Observatory to serve as a school for the instruction of Hindu students desirous to qualify in practical Astronomy. On that occasion an address (the substance of which is appended to this pamphlet in a slightly modified form) was read by me, a Society was formed, of which the Hon'ble V. Ramiengar, C. S. I., was elected President, R. Raghunatha Rao, Esq., Secretary, and Sir T. Mathava Rao, K. C. S. I., T. Moothoosawmy Iyer, Esq., B. L., P. Chentsal Rao, Esq., M. Venkatsawmy Naidu, Esq., M. Ramaswamy Naidu, Esq., Y. Venketramiah, Esq., D. Sashiengar, Esq., and other well known gentlemen became members. I earnestly commend this movement to all native noblemen and wealthy gentlemen in this Presidency as well as throughout India, who are interested in the improvement of their fellowcountrymen, and beg them to join heartily in a design which aims at promoting a most fascinating branch of knowledge, the cultivation of which, although under besetting difficulties and imperfections, is now and always has been highly prized by Hindus throughout the country.

To this pamphlet is also appended a memorandum of the times of the two next ensuing solar eclipses (one in October of this year, the other in the following April) for a few principal places in India, which will shew that calculations on modern methods are far more reliable than results worked out by Sidhantis from ancient tables.

I must not conclude without an expression of my genuine gratitude to J. E. Cooke, Esq., the Deputy Accountant General of Madras, a gentleman who takes a keen interest in Astronomy and who has secured me valuable encouragement and support from quarters I could not have reached without his help.

C. R.

THE TRANSIT OF VENUS.

1. *Pandit.*—Sidhanti avaul, Namaskaram.

2. *Sidhanti.*—Namaskarum. Pray sit down. What is your business?

3. *Pan.*—I have come from one of the Southern districts. I am known there as Varuna Pandit, or as Varuna Josier. I have long had a desire to have a talk with you about your Punchangum. If you permit me, I shall trouble you to explain a few things and to give some account of the astronomical phenomenon which you call the Transit of Venus across the Sun's disc, and which you say, in your Punchangum, will happen in December next, as I have not found the subject treated in any Hindu book on Astronomy.

4. *Sid.*—I am generally very happy to talk to such as are anxious to extend their knowledge of Astronomy. I believe you have read the principal Hindu treatises on the subject, and know the true causes of the eclipses of the Sun and Moon.

5. *Pan.*—I have read Surya-Sidhantum, Aryabhatceum and Sidhanta Siromani. I know how to compute Thithi, Natshatrum, eclipses, conjunctions, and other necessary materials for a Punchangum. I was much enlightened by the perusal of your pamphlet on the Total Eclipse of the Sun of 1871. A Solar eclipse is caused by the inter-

vention of the Moon between the Sun and the Earth, and a Lunar eclipse by the coming of the Earth between the Sun and the Moon. So it is mentioned in our Shastras. It is only the ignorant who, from the allegorical expressions in the Puranas, say that the Serpents Rahu and Kethu swallow the heavenly bodies, and after a time release them.

6. *Sid.*—I have said a little about the Transit of Venus in my pamphlet which I have referred to; and, in the chapter on Conjunctions of Planets in Surya-Sidhantum and Sidhanta Siromani, the general nature of such phenomena is explained.

7. *Pan.*—I have seen what you have stated in your pamphlet. In Surya-Sidhantum and Sidhanta Siromani, in the chapters you refer to, it is stated that Bhétha Yogum and Bhetha Yuthum of planets, that is one planet crossing the disc of another, occur. But no mention is made of the Transit of Venus across the Sun's disc.

8. *Sid.*—The Transit of Venus is one of such phenomena.

9. *Pan.*—Why is it not specially treated of in our books?

10. *Sid.*—Simply because our astronomers, not having accurately determined the true orbits of the planets, their periods, &c., could not compute the time of such occurrences. Moreover this phenomenon is a very rare one.

11. *Pan.*—Will you please explain how it is caused?

12. *Sid.*—Yes, I will. The numberless stars that we see in the firmament, are all supposed to be centres of different systems. They are of immense sizes, and are at very great distances from each other. Our Sun is only one of such heavenly bodies. The Sun and stars are called

Maha Grahms or mighty planets, as they shine by their own light. To come to our own system, the primary planets revolve round the Sun. Mercury is the nearest to the Sun, Venus comes next, then our Earth, then Mars, Jupiter and Saturn in order. Round some of these again revolve secondary planets, called satellites. The primary and secondary planets are non-luminous bodies; therefore only those hemispheres that are turned towards the Sun are illuminated by his light.

Vide Figs. 1 and 2.

13. *Pan.*—Do the planets revolve from left to right or from right to left around the Sun?

14. *Sid.*—It is really a difficult question to answer; but I will try to give you some idea of the direction in which they revolve. By carefully observing the stars, you will find that they appear to describe a complete revolution in a day. One of them, however, appears to be stationary. That star is Polaris. Supposing you stand with your face towards it, you see the north, your right is the east, your left is the west, and your back is turned towards the south. Having determined the cardinal points, let us watch a planet's motion among the stars. It will generally move in an easterly direction, that is, from right to left if you face the south, and will travel quite round the heavens until it returns to nearly the same position. The time thus occupied will shew one revolution of the planet round the Sun; but I must tell you that it does not appear to move uniformly, for though it usually moves towards the east at certain times, it will slacken its pace, become stationary, and for some little time will even appear to go westward or from left to right; but this is only caused by the earth's motion in her

orbit being at such time faster than that of the planet. In any one year the motion eastward will be greatly in excess, and if the planet were viewed from the fixed Sun instead of from the moving Earth, its apparent motion would be always to the left hand amongst the stars and nearly uniform. Of course the motion would be contrary, *i. e.*, left to right for a person facing the north. The path in which a planet moves is called its orbit, and the time it takes to describe one complete revolution, is called its periodic time. The distance of Venus from the Sun is nearly 68 millions of miles, while that of the Earth is 95 millions. The periodic time of Venus is 224 days 16 hours 49 minutes and 8 seconds; that of the Earth, called also its sidereal year, 365 days 6 hours 9 minutes and 10 seconds.

15. When Venus is in the line between the Sun and the Earth, she is said to be in inferior conjunction with the Sun, and when she is in the same line but on the other side of the Sun, she is said to be in superior conjunction. At inferior conjunction she is only 27 millions of miles distant from the Earth. Being then nearest to us, she will appear bigger than at any other time; but her bright half is turned away from us, so that, if we could see the planet at all, it would be her unilluminated side. It is true that at superior conjunction the bright half of Venus is turned towards us; but she is then 163 millions of miles from the Earth, and appears very small on account of this vast distance, and also we cannot see her owing to her apparent proximity to the Sun and his much stronger light.

16. If the orbit of Venus were in the same plane with that of the Earth, then, at every inferior conjunction, we should see a transit of the planet over the Sun's disc. But the orbit of Venus is inclined to that of the Earth at an

angle of 3° 23′. The two points where the orbital planes cross each other are called Nodes. At most inferior conjunctions Venus is a little removed to the north or south of the node, and therefore passes above or below the Sun, and so there is no transit; but if Venus happens to be, at the time of inferior conjunction, at or near either of the nodes, she will then be seen to cross the Sun's disc from east to west as a dark spot. This phenomenon is called a "Transit of Venus." The time of such occurrence and the places, on the earth's surface, where it will be visible, can be determined by calculation.

17. *Pan.*—Can you call this an eclipse of the Sun?

18. *Sid.*—Yes. You can call it an Annular eclipse, if you like. The Transit of Venus very much resembles an Annular eclipse of the Sun caused by the Moon. A conical shadow is cast by Venus and is turned towards us at the time of inferior conjunction. Imagine a person standing in the shadow, he will not see the Sun at all, and the Sun will, therefore, be totally eclipsed to him. But if the person is a little on either side of the shadow, he will see a partial eclipse of the Sun; and if he is beyond the end of the conical shadow, then he will see an Annular eclipse of the Sun, and the portion obscured will decrease as he recedes from Venus till when he reaches the Earth the planet's disc will have diminished so much in apparent size as to be seen only as a dark round spot.

Vide Fig. 3.

19. *Pan.*—Now I know something about the transit of Venus. You say it is a phenomenon occurring rarely. When did it last happen, and when will it occur next, after the one in December?

20. *Sid.*—The intervals that must elapse between successive Transits of Venus are in the following series—121½ years, 8 years, 105½ years, 8 years, 121½ years, 8 years, 105½ years, 8 years and so on. The last, which occurred on June 3rd, 1769, was visible here; the next one, which will happen on the 9th of December this year, will be visible to us, but not to those in Europe. There will be one in 1882 which will not be visible in India, and the next will occur 121 years after that, *viz.*, in A. D. 2004.

21. *Pan.*—So this is the only opportunity we have of witnessing this phenomenon. It will not be seen by three more generations. What are the respective magnitudes of the Sun and Venus, and what portion of the Sun's disc will be darkened by Venus during her transit?

22. *Sid.*—The diameters of the Earth and Venus are 7,924 and 7,700 miles, repectively; therefore they are nearly of the same size. The diameter of the Sun which is immensely larger than any planet revolving round him is about 882,000 miles or nearly 111 times that of the Earth; and his volume is 1,400,000 times as great as that of the Earth. The apparent diameters of the Sun and Venus are not proportionate to their true diameters, as their distances from the Earth are different. The farther an object is, the smaller it looks. Roughly speaking, the apparent diameter of the Sun, as measured by a Micrometer, (an instrument used to measure small distances between celestial objects) is 32 minutes, while that of Venus at inferior conjunction will be one minute in space. The breadth of the black spot at the time of transit will, therefore, be about $\frac{1}{32}$ of the Sun's diameter.

23. *Pan.*—Will it be visible to the naked eye?

24. *Sid.*—Yes. You must only take care to look at the Sun through a dark glass; otherwise your eyes will be dazzled.

25. *Pan.*—What are those curious phenomena, which, you say in your Punchangum, can be seen at the time of the transit with the aid of a telescope.

26. *Sid.*—You will see the whole thing beautifully through a telescope with a dark glass attached to the eyepiece. When the centre of Venus is in contact with the Sun's limb both at ingress and egress, the planet will be seen as an indentation or break in the Sun's limb as shown at *a.* and *c.* in Fig. *4.* Venus will present different forms, see Fig. 5, when she is in internal contact with the sun at both ingress and egress; these varying forms will last only for a few seconds, after which Venus will resume her own shape as a round spot. The shapes of Venus at ingress and egress observed and recorded by Astronomers on previous occasions differ from each other very considerably, and this difference was not satisfactorily accounted for till very lately. Some time back Sir G. B. Airy, the Astronomer Royal of England, constructed an ingenious apparatus to represent the Transit of Venus with a view to training observers as to what to expect upon the all-important occasion, and the use of this apparatus shewed that the variations in the shape of Venus were mere optical illusions.

Fig. 4 and 5.

27. *Pan.*—I wish to see a telescope. Can you take me to the observatory?

28. *Sid.*—I do not think I can. But I will show you the instruments in my possession. I keep some at home expressly for the purpose of explaining to our countrymen

their nature and use. One of them is a five foot equatorial telescope through which I will show you the Moon, some of the planets and stars to-night, and you can see the Sun to-morrow.

29. *Pan.*—Last night I learnt the use of a telescope; and the heavenly bodies, namely, planets, stars, clusters and nebulæ, when seen through it, presented a very glorious appearance. A telescope practically brings a distant object near to us. Just as a mountain which looks smooth in the distance presents a rugged appearance when the spectator approaches it, so too, the tender crescent of the Moon which looked very even and regular to the naked eye presented a very uneven surface when seen through the telescope. The horns of the crescent which appeared sharp to the naked eye looked split, and in some places detached bright spots resembling stars were seen. Near the concave rim of the crescent I saw something resembling the eye in a peacock's tail, bubbles of water and carded cotton. The planets, which when seen with the naked eye, resembled stars, appeared with well-defined limbs through the telescope. Mercury and Venus were of a crescent-shape, and I was delighted to see Jupiter with his belts and four satellites, and Saturn with his beautiful rings. Will you please show me the Sun with the telescope?

30. *Sid.*—Well. I have now pointed the telescope to the Sun, and you can look at him, but take care to look through the dark glass; otherwise you will injure your sight.

31. *Pan.*—Ah! I see a large spot on the surface of the Sun. Is there any Transit of Venus now?

32. *Sid.*—There is none now. You will see some more, if you observe carefully. These are spots on the

Sun's surface, which vary from time to time both in number and in size. They are of very irregular shape, with penumbræ around them. The black spot which will be seen on the Sun at the time of the Transit of Venus will appear much bigger and will be perfectly round with well-defined pitchdark edges.

33. *Pan.*—By the bye, I can see that big spot with the naked eye. I shall measure its diameter with the micrometer as you have taught me to do. I find it is $28\frac{3}{4}$* seconds in space. If, as you say, the diameter of Venus is 60 seconds, it must be twice as large as this, and one can easily see the ensuing transit without the aid of a telescope, but the day must be fine. You say, in your pamphlet on the Solar Eclipse of 1871, that Europeans were making grand preparations to observe the approaching Transit of Venus. Is it simply for the sake of curiosity that they put themselves to so much trouble and expense?

34. *Sid.*—Europeans generally put their money to very good use. You must not suppose that the practical people, who have constructed so many thousands of miles of Railway, and who have almost annihilated distance by means of the Electric Telegraph, will spend millions of rupees merely to satisfy their curiosity. They expect much practical good to result from the observations of the approaching transits as they furnish the best means we have of accurately determining the parallax of the Sun, and hence the distances and dimensions of the Sun and the planets.

35. *Pan.*—You said that the distance of the earth from the Sun was 95 millions of miles, and the distances of the other planets are also determined. Is not this sufficient?

* This is the actual measurement taken by the Author, of a spot on the Sun which was visible to the naked eye on the morning of 29th June 1872.

36. *Sid.*—Only the approximate distances are known. The last transit of Venus occurred 105 years ago. The instruments that were then used were inferior in both size and quality to those we now possess; therefore the observation made with such instruments could not be very accurate. With the delicate instruments now in use we can find out with very great accuracy the distances and magnitudes of the planets and satellites; then the calculated positions of planets corrected for the perturbations which they produce upon each other will agree with actual observation. It is for this reason that they are about to spend such an enormous sum of money.

37. *Pan.*—The time given in your Punchangum, of Solar and Lunar Eclipses and other Astronomical phenomena, is accurate. It follows, then, that the calculated distances of the planets from the Sun are right. Where then is the necessity of expending so much to take observations of the coming Transit of Venus?

38. *Sid.*—If you had observed any of those phenomena with a telescope, then you would have found that the time given by me was not quite accurate, but that there was generally a difference of some seconds. The observations of the next Transit of Venus will lessen even this small error.

39. *Pan.*—Ah, Sidhanti! Some ignorant men among us despise the European and call him a heenah, but after what I have heard from you I cannot help having the greatest respect for his industry, intelligence, and laudable attempts to extend human knowledge. Bhaskarachariar says in Sidhanta Siromani that the distance of planets from the earth can be found by means of a pole. And

as an illustration, he tells us how to determine the distance of a distant terrestrial object from us. How will the Transit of Venus enable us to determine the distance of the Sun and all the planets from the earth?

40. *Sid.*—We find out first the true parallax of the Sun and its distance from us from which we can find the true distances of all the other planets. I shall first tell you what parallax means. Supposing you stand at A and look at an object C on the surface of the earth, then you see it projected to D, a point in the horizon, say a star. The horizon is a circle of an indefinite radius having your eye for its centre. Supposing you change your position from A to B you will see C referred to E another point in the horizon. This change in the apparent position of C from D to E resulting from your going from A to B is called the parallax of C; it is measured by the arc DE. Suppose BA is produced to meet the celestial vault in S. Then the angular distance of D (the apparent position of C when you are at A) from S may be expressed by the arc SD or by the angle SAD; and the angular distance of E (the apparent position of C when you are at B) from S may be represented by the arc SE or the angle SBE. This change in the apparent position of C, on account of your moving from A to B, may be represented by the arc ED, the difference of arcs SE and SD, or by the angle ACB, the difference of the angles SAD and SBE. The parallax of C in such a case is generally represented by ACB, the angle which AB subtends at C. Take another object K in a line with ACD, but farther from A than C. When you are at B, you will see it projected to a in the horizon. The parallax of K is Da. You find that Da is less than DE, the parallax of C

Vide Fig. 6.

Thus the more distant the object, the less the parallax. Again, suppose you move along AB to a point P, then you will see C referred to a point *m* in the horizon. The parallax of C on account of your change of position from A to P is the arc *Dm*, and this is greater than DE. Thus the more you are moved from A, the greater is the parallax of C. What we mean by the parallax of a heavenly body seen from a point on the surface of the earth, is the change in the positions of that body as seen from that point and the centre of the earth, and is represented by the angle which the radius of the earth subtends at that body. It is zero when the heavenly body is in the zenith. It is greatest when it is on the horizon, and is then called the Horizontal Parallax. Now I shall tell you how to determine the Parallax of the Sun by observations of the Transit of Venus.

41. *Sid.*—In Fig. 8, BADE is the circumference of the earth's equator, C is the earth's centre, V is Venus, KL represents a portion of her orbit, S the eastern limb of the Sun, and ONM a circle of the celestial vault. Suppose that the centre of Venus is in contact with the Sun's eastern limb to a person at A, when both objects are transiting his meridian; he will refer them to the point M in the celestial vault. Suppose another person to be stationed at D, 90° to the west of A. When the observer at A sees Venus in contact with the Sun's limb, the sun will have just completely risen to the person at D, N will be the apparent position of the sun's eastern limb, and, if it were possible for him to see Venus, he would refer her to the point O in the celestial vault. This deviation in the positions of the Sun and Venus is due to parallax. To the person at D the horizontal parallax of

Fig. 8.

Venus can be measured by the arc OM, and that of the Sun by the arc NM. Therefore the difference of parallax is represented by the arc ON. If there was no parallax, then the moment of contact of Venus with the Sun's eastern limb, as observed at D and A, would be the same in absolute time (The local time of D would be six hours previous to that of A; the difference in longitude being 90°). But on account of parallax, Venus, which is nearer, appears depressed more than the Sun's eastern limb. The person at D does not, on account of parallax, see Venus in contact with the Sun at the time that the one at A does. The time that elapses before he sees the contact of Venus with the Sun, would be that which Venus takes to describe an arc ON in the heavens. This interval is ascertained by comparing the moment when Venus is observed to be in contact with the Sun's limb at A with that at which the same phenomenon is seen to occur at D. We know the relative motion of Venus, *i. e.*, the rate at which she appears to overtake the Sun at the time of the transit, and thus we can calculate the magnitude of the arc ON that is traversed by Venus, and the number of minutes and seconds in it. This is the difference of the horizontal parallax of Venus and the Sun.

42. *Sid.*—It is a law of nature discovered by the illustrious German astronomer Kepler, that the squares of the periodic times of planets are to one another as the cubes of their mean distances from the Sun. The periodic times of all the planets have been well ascertained by observations. Thus we know the ratios of the distance of the Earth from the Sun to the distances of all the other planets from him. Then, if the Earth's mean distance from the Sun be divided into 1,000 equal parts, the mean dis-

tance of Mercury from the Sun must be equal to 387 of these parts, that of Venus to 723, of Mars 1,524, of Jupiter 5,203, and of Saturn 9,539. When, therefore, the true distance in miles of any planet from the Sun is known, we can by these proportions find the mean distances in miles of all the rest. The distances of all celestial objects from us vary inversely as the sines of their horizontal parallax, and the sines vary similarly as the angles themselves the parallax of all the planets being less than one minute, therefore the parallax of any planet is to that of the Sun, as the distance of the Sun is to that of the planet from us. Now, at the time of transit the parallax of Venus will be to that of the Sun, as the Sun's distance is to the distance of Venus from us; namely, as 1,000 to 277, according to our supposition. Therefore the parallax of Venus minus that of the Sun, *i. e.*, the relative parallax of the two bodies is to the Sun's; as 1,000 — 277 or 723 to 277; that is, $\frac{\text{Relative Horizontal Parallax}}{\text{Sun's Horizontal Parallax}} = \frac{723}{277}$.

Therefore, if we divide the Relative Horizontal Parallax by $\frac{723}{277} = 2{\cdot}61$, we get the Sun's Horizontal Parallax. Now the difference between the horizontal parallax of Venus and that of the Sun is found, from observation of the Transit of Venus, in the manner above mentioned. The number 2·61 is not the correct divisor for the day of observation, but we can readily find it by the help of any Ephemeris, such as the Nautical Almanac. Thus we get the Sun's Horizontal Parallax. Now the sine of the Horizontal Parallax of the Sun $= \frac{\text{Earth's radius in miles}}{\text{Sun's distance from the Earth}}$

Therefore the Sun's distance

$$= \frac{\text{Earth's radius in miles}}{\text{Sine of Sun's Horizontal Parallax}},$$

and thus the distance in miles of the Sun from the Earth is found. The law stated above gives us at once the distances of the other planets from the Sun, and their horizontal parallax. Now it is not difficult to find their true diameters in miles and their volumes. We can measure with a Micrometer the angle which a planet's diameter subtends at our eye. This angle is to the true diameter of the planet, as its horizontal parallax is to the Earth's radius; *i. e.*, the true diameter of the planet

$$= \left\{\begin{matrix}\text{The Earth's} \\ \text{radius in miles.}\end{matrix}\right\} \times \frac{\text{Planet's apparent Diameter}}{\text{Planet's Horizontal Parallax}}$$

The cubical content of a planet or its volume is found by multiplying the square of its diameter by its circumference and dividing by six; or the volume $= \frac{4}{3}\pi r^3$, r being the radius and π being 3·14159. Thus the earth's distance from the Sun being known, the magnitudes of all the other planets, and their distances from the Sun are determined.

43. *Pan.*—Can we choose places on the earth's surface answering to A and D in the figure?

44. *Sid.*—No, I took an imaginary case. I supposed that Venus was in contact with the Sun's limb when she was in the meridian of A; and that a man was stationed exactly 90° to the west of A. In practice we can only choose places that answer nearly to the conditions I have assumed, and the necessary amount of calculation we have to go through in finding the Parallax of the Sun by means of the Transit of Venus is very complicated. The least correction on account of change of right ascension, declina-

tion, &c., ought not to be neglected, as an error of one-tenth of a second in the Parallax of the Sun would lead to an error of about a million of miles in his distance. But I cannot now enter into details, nor would you like to be worried with them. There are several other methods of determining the Sun's Parallax from the observation of Transit of Venus. I will briefly describe one of them. Supposing two observers are stationed as distant as possible from each other in opposite latitudes; each can determine the least distance of Venus on the Sun's disc from his centre, either by noting the time of the duration of transit, or by actual measurement with a Micrometer of her distance from the limb of the Sun. The difference in the distances, as found by the two observers, being due to relative parallax, the Sun's horizontal parallax can be determined by calculation.

45. *Sid.*—The Transit of Venus being the best means we have of accurately determining the distances of the planets from the Sun, preparations on a grand scale are being made by the several Governments of Europe for the observations of the approaching Transit of Venus. The observers are to be supplied with the best instruments of recent construction, to reduce the uncertainty arising from instrumental defects to the smallest possible amount.

46. *Pan.*—I had till now a belief that it was madness to suppose that the magnitudes of such distant objects as the planets and, what is still more remarkable, their distance from the Sun could be found. Will you please give me some idea of the nature of the preparations Europeans are making to take observations of the approaching Transit of Venus?

47. *Sid.*—Though the next Transit of Venus will be only partially visible in Europe, still the different Governments have selected several stations in other continents at which observations are desirable. England has chosen 9, America 8, France 5, Germany 6, Russia 27, Italy 2, Portugal 2, Lord Lindsay has equipped two stations for observation and has gone with an expedition to Mauritius at his own expense, and numerous scientific Europeans will take observations at different stations at their own cost. The total number of places already decided upon is about 80. They are at great distances from each other. Thus, for instance, we have Alexandria, in Latitude 31° North, and Longitude 50° West of Madras; the Island of Rodrigues, near Mauritius, in Latitude 20° South, and Longitude 17° West of Madras; and Honolulu, a town in the Sandwich Islands, in Latitude 21° North, and Longitude 122° East of Madras. At Madras, although the transit is visible throughout, the geographical position of the place renders ordinary observations only of secondary value, though, of course, all will be done that is possible by the Government Astronomer, N. R. Pogson, Esq., F. R. A. S., and his Assistants, especially as regards the application of photography to securing instantaneous records of the position of Venus upon the Sun's disc frequently throughout the transit. The most important spot in India has been shewn to be Peshawur, and accordingly both this station and Roorkee will be occupied by Colonel Tennant, F. R. S., assisted by officers of the Trigonometrical Survey of India. An astronomer with two or more assistants and an establishment will be located at each station some months before the date of the transit. The nature of the work that each has to do, has, of course, been previously arranged. A small observatory must be

erected at each station and the necessary instruments fixed and every thing kept ready for the precious day of observation. The total cost of these expeditions is estimated at about 30 lakhs of Rupees.

48. *Sid.*—Each party will take with it the necessary apparatus, instruments, clocks and chronometers to determine the latitude and longitude of the places, local time, and to observe and photograph the different phenomena that may be visible at the time of transit. The chief appliances are Meridianal instruments, Altazimuth Circles, Heliographic Instruments, Equatorial telescopes with Micrometers, Photographic apparatus, Spectroscopes, Astronomical Clocks and Chronometers, Barometers, Thermometers, and other minor Instruments. With the help of these they will take accurate observations, both at ingress and egress, of the external and internal contacts (more especially the latter) of Venus with the Sun. The cusp measurements of the Sun's limb will be taken by the Micrometer. The apparent diameters of Venus will be measured. Several photographs of the image of the Sun at different stages of the transit will be secured. In short, nothing will be neglected that is worth observing, but every phenomenon that can present itself, whether foreseen or otherwise during the time of transit, will be most scrupulously recorded.

49. *Pan.*—It is no wonder that the people of Europe are so much in advance, seeing how persevering they are, and how many public-spirited men there are among them. What Hindu gentleman of the present day evinces the same interest in science that the European does? Are there men among us who will devote their whole life and fortune to advance human knowledge? Unfortunately the

answer is, that there are few such men. I am wandering away from my present purpose. Will you kindly tell me when and at what point of the limb Venus will appear to enter the Sun's disc for each of the large towns in India?

50. *Sid.*—In the approaching Transit of Venus which is to take place on the morning of 9th December next, the extreme difference in the time of observation of the same phenomenon at any two places on the Earth's surface will not exceed 20 minutes; the greatest difference in the time of observation in India will be about 4 minutes, absolute time being taken. The points at which Venus will appear to enter the Sun's disc and emerge from it, will be nearly the same for all places in India. The point of ingress will be about 50° to the East of the northernmost point of the Sun's limb, or 120° to the left of his vertex; and that of egress will be 22° to the west of his northernmost point, or 16° to the right of his vertex. At the middle of the transit the centre of Venus will be about $2\frac{1}{2}$ minutes in space from the northern limb of the Sun, or at a distance of $\frac{1}{77}$ of his diameter. At different localities in India the time of ingress will be within an hour and a half after sunrise, and that of egress will be within an hour before or after the Sun's meridian passage. The duration of transit will be from 4*h*. 40*m*. to 4*h*. 47*m*. and the interval of time between external and internal contact of Venus with the Sun both at ingress and egress will be 28 minutes. The accompanying Table gives the local time of the ingress and egress of the centre of Venus, the time of sunrise, and the time and the length of the shadow of a twelve inch rod at the middle of the transit, for the principal towns in India.

Vide Fig. 4.

TABLE showing the LOCAL MEAN TIME, &c., of the Transit of Venus occurring on the 9th December 1874, for the following places in India :—

No.	Places.	North Latitude.		Difference of Long. to convert Local into Madras Time.		Local Mean Time of Sunrise.		Ingress of Venus Centre.		Middle of Transit.		Egress of Venus Centre.		Shadow length of a 12 Inch Rod at Middle of Transit.
		°	′		m	h.	m.	h.	m.	h.	m.	h.	m.	Inches.
1	Agra	27	10	+	9	6	42	7	15	9	25	11	33	22·0
2	Ajmeer	26	27	+	23	6	41	7	4	9	12	11	20	23·5
3	Allahabad	25	26	—	7	6	38	7	32	9	41	11	48	19·1
4	Ambala	30	21	+	14	6	49	7	10	9	20	11	28	25·6
5	Bangalore	12	58	+	11	6	14	7	15	9	23	11	29	15·0
6	Bellary	15	9	+	13	6	18	7	13	9	21	11	27	16·0
7	Benares	25	18	—	11	6	38	7	36	9	45	11	53	18·6
8	Bhopaal	23	13	+	11	6	34	7	15	9	23	11	30	19·9
9	Bombay	18	54	+	30	6	25	6	56	9	4	11	11	19·8
10	Cabul	34	27	+	44	6	59	6	40	8	56	10	59	36·6
11	Calcutta	22	33	—	32	6	33	7	56	10	5	12	15	15·6
12	Calicut	11	15	+	18	6	11	7	9	9	16	11	22	15·0
13	Cashmere	34	5	+	22	6	58	7	1	9	12	11	21	30·6
14	Cochin	9	58	+	16	6	9	7	11	9	18	11	23	14·2
15	Coimbatore	11	1	+	13	6	11	7	14	9	21	11	26	14·5
16	Colombo	6	57	+	2	6	4	7	25	9	32	11	37	12·3
17	Cuddapah	14	29	+	0	6	17	7	20	9	28	11	34	15·0
18	Darjeeling	27	3	—	32	6	43	7	55	10	5	12	14	18·1
19	Delhi	28	35	+	12	6	46	7	12	9	22	11	30	23·6
20	Galle	6	3		0	6	2	7	27	9	34	11	39	11·9
21	Ganjam	19	22	—	20	6	26	7	45	9	53	12	1	15·1
22	Gaya	24	49	—	19	6	37	7	44	9	53	12	0	17·5
23	Gowhatti	26	6	—	46	6	40	8	10	10	18	12	27	16·4
24	Guntore	16	18	—	1	6	20	7	27	9	35	11	42	15·2
25	Hyderabad	17	27	+	7	6	22	7	19	9	27	11	34	16·3
26	Indore	22	12	+	18	6	32	7	8	9	16	11	23	20·0
27	Kurnool	15	50	+	9	6	19	7	17	9	25	11	31	15·7
28	Kurrachi	24	45	+	53	6	37	6	53	8	41	10	48	27·7
29	Lahore	31	31	+	29	6	52	7	0	9	10	11	19	28·1
30	Lucknow	26	51	—	3	6	42	7	28	9	37	11	45	20·5
31	Madras	13	4		0	6	15	7	25	9	33	11	40	14·1
32	Madura	9	55	+	9	6	9	7	18	9	25	11	30	13·8
33	Mangalore	12	52	+	22	6	14	7	5	9	12	11	18	16·2
34	Multan	30	10	+	35	6	48	6	42	8	59	11	7	28·8
35	Mysore	12	18	+	14	6	13	7	13	9	20	11	26	14·7
36	Nagpore	21	10	+	5	6	30	7	21	9	29	11	36	18·0
37	Nellore	14	28	+	1	6	17	7	25	9	33	11	39	14·6
38	Peshawar	34	0	+	35	6	58	6	49	8	59	11	8	33·6
39	Pondicherry	11	56	+	2	6	13	7	21	9	32	11	38	14·1
40	Rajahmundry	17	11	—	6	6	22	7	32	9	40	11	47	15·1
41	Sagar	23	50	+	6	6	34	7	20	9	28	11	35	19·5
42	Salem	11	39	+	8	6	12	7	19	9	26	11	32	14·3
43	Simla	31	6	+	12	6	52	7	12	9	22	11	31	28·0
44	Surat	21	10	+	30	6	30	6	56	9	4	11	11	18·9
45	Tanjore	10	47	+	4	6	11	7	23	9	30	11	35	13·5
46	Tinnur	26	6	—	21	6	40	7	45	9	54	12	2	15·4
47	Tinnevelly	8	44	+	19	6	7	7	17	9	24	11	29	13·6
48	Tripaty	13	36	+	3	6	16	7	23	9	31	11	37	14·5
49	Trivandrum	8	30	+	18	6	7	7	14	9	21	11	26	13·6
50	Vizianagaram	18	0	—	18	6	28	7	38	9	47	11	52	16·2

In the above table the time of ingress and egress of the centre of Venus is given. If you wish to find the time of external or internal contact of Venus with the Sun, you have to add or substract 14 minutes, as the case may be.

52. *Pan.*—My sincere thanks are due to you for the explanation of this phenomenon. I have to search the Shastras to find out if any ceremonies are prescribed to be performed on the occasion; and what is more important to me, I have to provide myself with a telescope to observe this most interesting sight. I shall see you once more before I leave this for my native town. Good bye for the present.

EXPLANATION OF DIAGRAMS.

Fig. 1.—Shews the orbits of four of the primary planets round the Sun ; S. being the Sun, *a* the orbit of Mercury, *b* that of Venus, *c* of the Earth, and *d* of Mars. (Vide para. 12.)

Fig. 2.—Represents the phases of Venus in the course of her motion around the Sun ; that is, her apparent size and illuminated portion, as seen from the Earth E at different points in her orbit. (Vide para. 12.)

Fig. 3.—Represents Eclipses of the Sun caused by Venus. Within the conical shadow the Sun will be more than covered, as shewn at *a*. Just at the end of the shadow, 600,000 miles beyond Venus, the eclipse will be exactly total, but only momentary, as at *b*. Shortly beyond that distance only an annular eclipse will be seen as at *c*, and on receding from the Sun less and less of her disc will be observed as at *d*, *e*, *f* and *g*. Seen from the Earth, Venus will appear only as a dark spot on the Sun's disc as shewn in *h* of the figure. (Vide para. 18.)

Fig. 4.—Shews the path and position of Venus, when crossing the Sun's disc during its transit, on the 9th December 1874. N. W. S. and E. mark the cardinal points

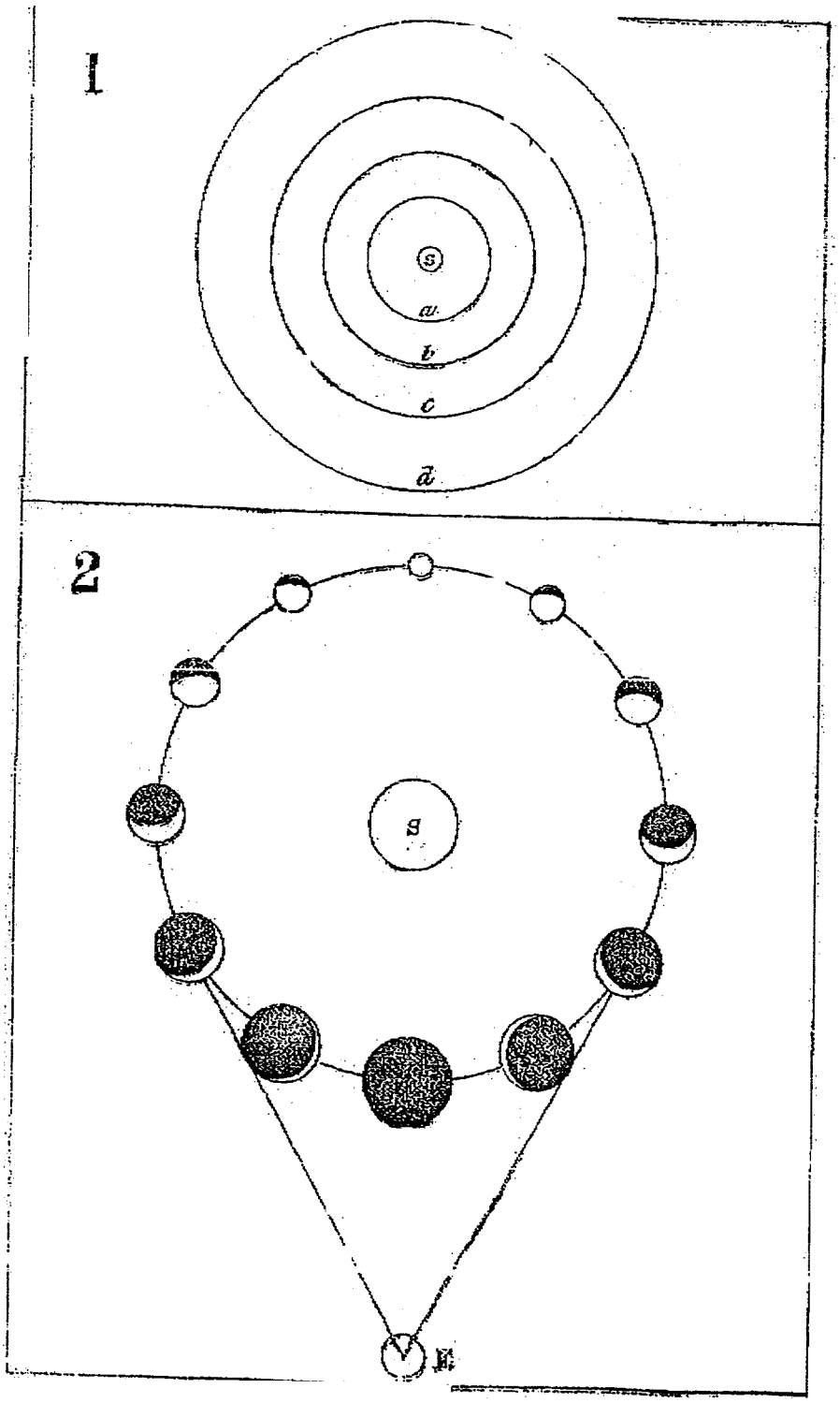
of the Sun's disc; the arrow-headed line K L. traces the path of Venus across the Sun's disc; *a* and *c* are positions of ingress and egress respectively; and *b* the point when Venus will be nearest the Sun's centre, *i. e.* at the middle of the transit. (Vide paras. 26 and 50.)

Fig. 5.—The different forms that Venus will present both at ingress and egress as seen through a telescope. (Vide para. 26.)

Fig. 6.—Diagram illustrating the explanation of Parallax. (Vide para. 40.)

Fig. 7.— Also illustrates the explanation of parallax of terrestrial objects; 1, 2, 3, 4, 5 are balls which are at equal distances strung together in a horizontal line. When a person at A sees through the line he will refer all the balls to the point C, but if he sees them from the point B, he will refer them to, *a*, *b*, *d*, *e*, and *f* respectively. This change in the apparent positions of the balls, is caused by the displacement of the spectator from A to B, and constitutes what is known technically as parallax.

Fig. 8.—For explanation see para. 41.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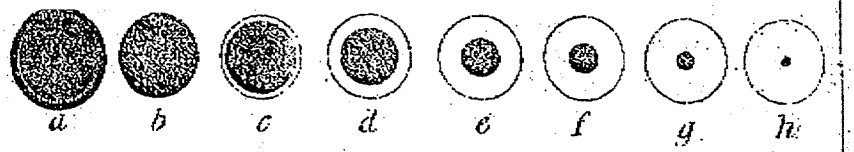

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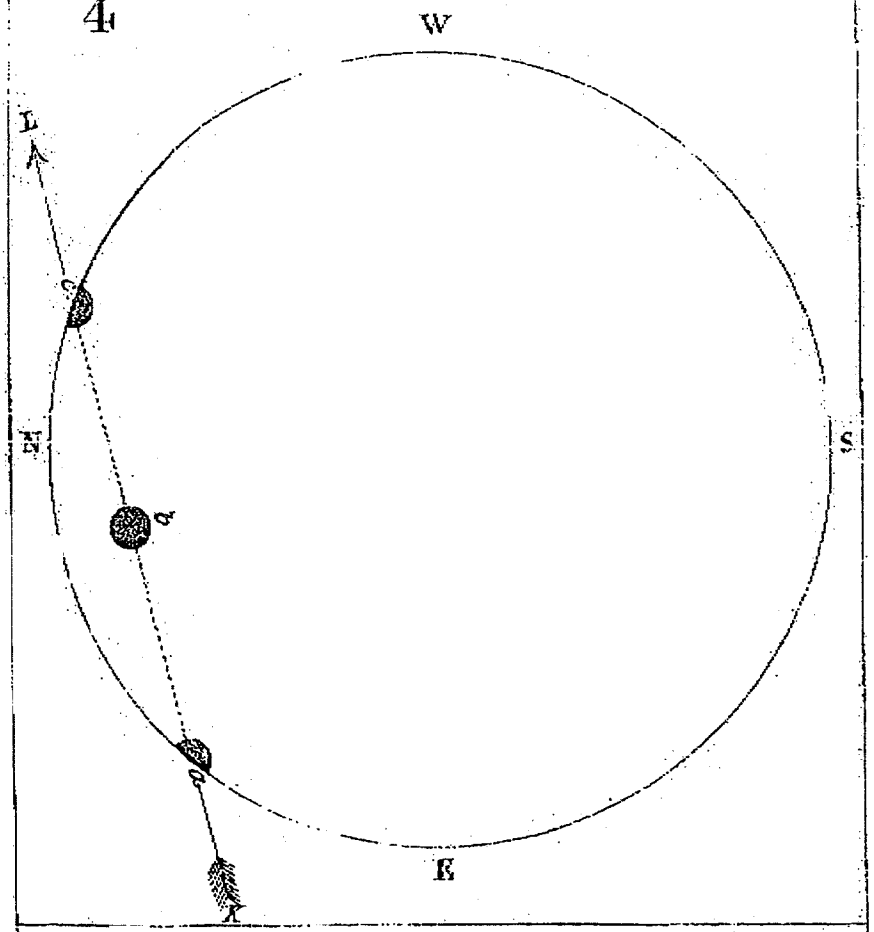

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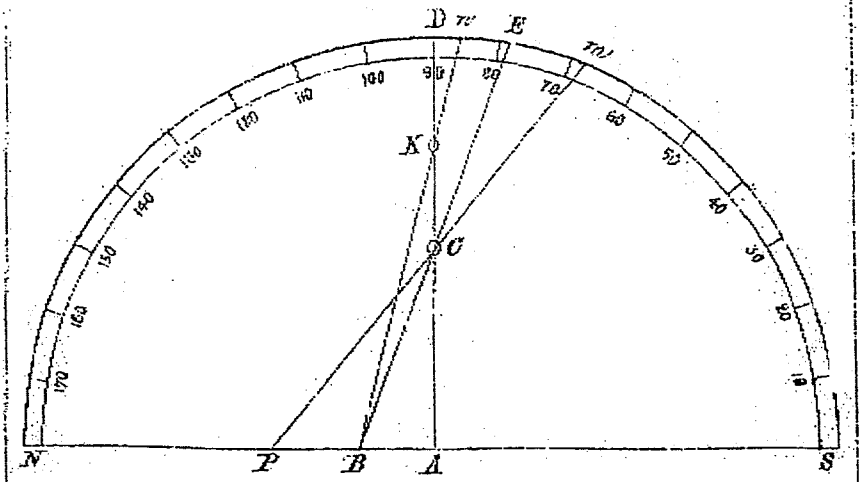

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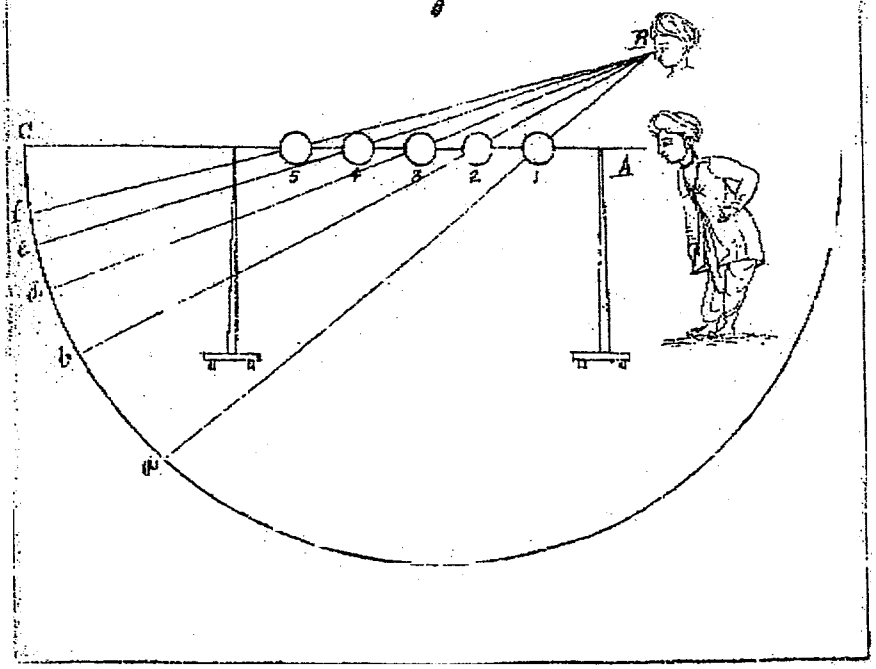

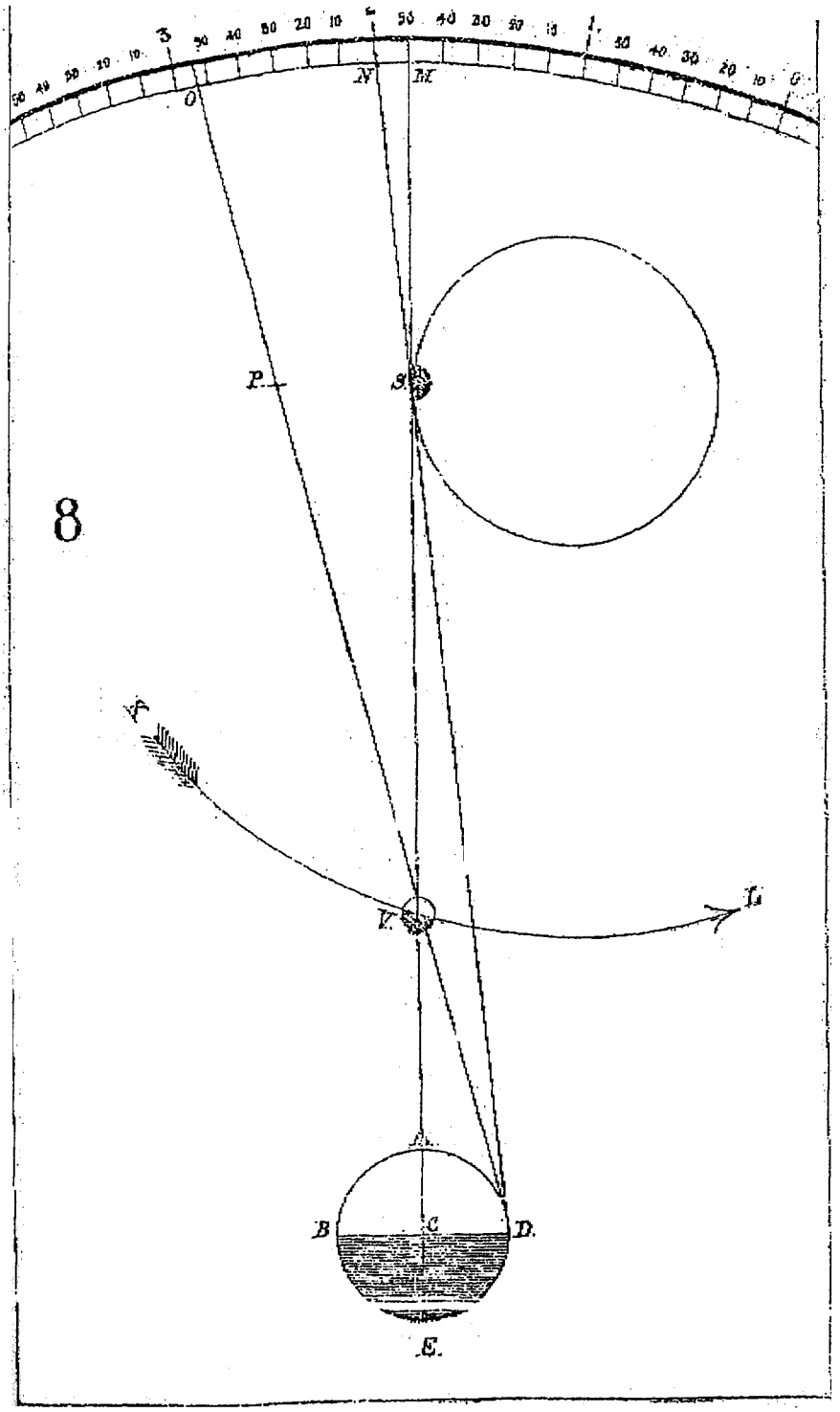
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APPENDIX.

Table showing the LOCAL MEAN TIMES, *&c., of the two Solar Eclipses occurring on the 10th October 1874, and on the 6th April 1875, for the few following chief Places in India.*

No.	Places.	Solar Eclipse of 10th October 1874.			Solar Eclipse of 6th April 1875.			
		Beginning of Eclipse.	Shadow length of a 12 Inch Rod at Beginning.	Setting of the Eclipsed Sun.	Beginning of Eclipse.	Shadow length of a 12 Inch Rod at Beginning.	End of Eclipse.	Shadow length of a 12 Inch Rod at ending.	Magnitude of Eclipse, Sun's diameter = 1.
		h. m.	Inches	h. m.	h. m.	Inches	h. m.	Inches	Decimal
1	Agra	4 18	41	5 33	11 34	4·8	1 20	6·3	0·24
2	Bangalore	4 52	57	5 41	10 47	4·3	1 37	4·2	0·55
3	Bellary	4 43	50	5 40	10 49	4·4	1 14	4·3	0·49
4	Benares	4 46	63	5 34	11 46	4·2	1 56	7·8	0·40
5	Bhopaul	4 25	42	5 36	11 18	4·3	1 18	5·5	0·33
6	Bombay	4 13	34	5 38	10 45	5·0	0 45	3·5	0·31
7	Calcutta	5 10	150	5 36	12 4	3·5	2 31	9·8	0·57
8	Calicut	4 48	51	5 42	10 33	5·0	1 3	3·4	0·54
9	Cashmere	3 47	33	5 29	12 2	6·3	0 32	6·5	0·02
10	Columbo	5 19	111	5 44	10 41	4·5	1 25	4·6	0·74
11	Guntur	4 56	66	5 39	11 8	3·6	1 38	5·7	0·54
12	Hyderabad	4 44	55	5 39	11 4	3·9	1 26	5·1	0·47
13	Indore	4 19	38	5 36	11 9	4·5	1 7	4·9	0·30
14	Lucknow	4 33	52	5 34	11 45	4·6	1 41	7·2	0·31
15	Madras	5 3	73	5 41	11 0	3·6	1 35	5·2	0·60
16	Nagpore	4 38	50	5 37	11 19	3·9	1 31	5·8	0·41
17	Rajahmundry ...	4 59	75	5 39	11 18	3·8	1 47	8·4	0·55
18	Tanjore	5 4	74	5 42	10 47	4·1	1 25	4·6	0·64
19	Trevandrum ...	5 1	66	5 43	10 31	5·1	1 9	3·5	0·61
20	Vizyanagarum ...	5 5	87	5 38	11 29	3·1	1 58	7·1	0·57

The first contact will take place in India generally at about 105 degrees to the Right from the Vertex of the Sun's limb. The magnitude of the eclipse will vary from 0·38 to 0·78 (the sun's diameter being 1,) for places between Colombo and Cashmere.

The first contact will occur between Colombo and Agra from 100 to 170 degrees to the Right from the sun's Vertex: and the last contact 50° from the Vertex to the Left. This eclipse will be total, and its central line will pass through the Nicobar Island, Siam and Anam.

OCCULTATIONS AND CONJUNCTIONS.

At noon, on Thursday the 12th November 1874, Venus will be seen to disappear behind the Moon's northern limb by spectators in the southernmost part of India, and to approach near by those in the Northern part. Although this phenomenon occurs at midday, still, it will be visible to the naked eye, as it happens only a few days after Venus has attained her greatest brilliancy, and as she will be about 35° to the East of the Sun, the crescent Moon will also be seen just to the south of Venus. At Mangalore, Mysore, Salem, Trichinopoly, Tanjore, and Negapatam, Venus will be seen either passing behind or gliding along the Moon's north limb; and to places south of the abovementioned Towns, she will be actually occulted; while to those in the North, she will appear very close to the Moon's limb. The times of disappearance and reappearance are given below for the following places:—

		h.	m.		h.	m.
Trevandrum...	Disappearance	11	32	Reappearance	0	23
Cochin ...	do.	11	33	do.	0	17
Madura ...	do.	11	49	do.	0	11

On Wednesday the 16th December 1874 a close conjunction of Mars with Jupiter will occur. At 5 A.M. this day Mars will be situated 5' North and 3' East of Jupiter.

Address delivered by C. Ragoonatha Chary, F. R. A. S., at Pucheappah's Hall, Madras, on 13th April 1874, to a large meeting of Native Gentlemen.

GENTLEMEN,

It has been often and truly remarked of us that we are a people who eat, drink, and sleep religiously. Every part of the texture of our daily life is interwoven with religious obligations, and the ordinary details of our social and domestic economy are all governed by positive rules springing out of our religious system. However much this arrangement may be denounced as the outcome of mere superstition, it has certainly been fruitful of benefit, and the subject to which I desire to point your attention to-night, viz., Hindu Astronomy, owes much to this superstition.

We need not be altogether ashamed of a superstition, if indeed it can be fairly called such, which has preserved to us a rich heritage of science and art. It is to the superstition of our fathers, directly or indirectly, that we owe our Architecture, our Music and our Poetry, arts which still attract attention throughout the thinking world. To the same source do we trace the marvellous discoveries in science made by the early Aryans. Of such a superstition, Gentlemen—a superstition which has both generated and embalmed knowledge more precious than gold—Hindu patriots may well be proud.

The scrupulous care with which our forefathers were wont to determine the time for proceeding with any matter, domestic or public, of the slightest moment, necessitated, from the earliest times, close attention to astronomical study. As an inductive science, every step in its real progress had to be wrought out by patient and laborious observation, and when we come to think of the rude contrivances which alone were available in early ages, the mechanical destitution which prevailed in the land, we cannot help being struck with the conviction that those were indeed master minds which pushed the boundaries of the science.

Many ancient works on Astronomy, such as those of Brahma, Vasishtah Ganga, Parasara and Powlesa, are constantly mentioned in treatises which are extant, but the works themselves are either totally lost to us, or are scarcely ever to be met with. The oldest of our existing treatises, Surya

Sidhanta, appears to have been written 5,000 years ago. Arya Bhatteeum and Sidhanta Siromani are said to have been composed in $\frac{\text{Kali } 3600}{\text{A. D. } 499}$ and $\frac{\text{Kali } 4251}{\text{A. D. } 1151}$ respectively, and Grahn Laghavam about 400 years ago. The last named authors discovered the position, motion, and distances of planets, and, considering the wretched instruments which alone they could employ, it is no disparagement of their talent to say that their computations were after all only approximately true. Indeed our authors were fully sensible of defects, for they distinctly admit that their methods would become inexact if not closely revised from time to time and tested and confirmed by frequent observation; and their commentators have therefore, on detecting differences between the predicted and observed times of eclipses and other phenomena, supplied such corrections as observation, by almost unaided vision, could furnish. But even at the present day the calculations of our Sidhantis are inaccurate. This is for the most part the result of the political changes which have swept over the country, and hitherto deprived modern native computors of the opportunity of obtaining from either the State or from wealthy citizens, support sufficient to enable them to prosecute their labors with efficiency and success.

The object I have to propose to you to-night is to make a serious attempt to surmount this difficulty which has caused Hindu Astronomy to stagnate, by some organisation which will provide the required encouragement, and I am prepared to suggest a definite plan for giving effect to the attempt.

The nature of my appointment of Assistant Astronomer at the Madras Government Observatory has enabled me to acquire a fair practical knowledge of the science of which I am speaking, as well as some considerable familiarity with the uses of the powerful and delicate instruments with which alone it is possible to keep abreast of the knowledge of the age. I have also from the first been actuated with an ardent desire to study our own systems, to examine Hindu methods critically, and generally to determine the points at which it would be useful to engraft on our own stock the reasoning and investigations in which we have been surpassed by more favored nations.

The practical result of this earnest enquiry entered into by me, has been an attempt to embody the corrections, equations and formulæ which have been established by recent European research into a good standard

book, together with whatever it is proper to retain from our own works and thus to construct a manual accessible to Hindu Astronomers, and sufficient for all the purposes to which Astronomy is applied in our social and religious practices.

For five years I have devoted to this task such leisure as I could snatch from my regular duties, and at one time I hoped the work would have been completed at a very early date, but the labor yet to be undertaken is heavy, my spare moments are fewer than I could wish, and the call on my purse has already been so severe that I see plainly the resources required are much more ample than my very slender means can provide. Not that I have been without promises of support, for that enlightened statesman of Hyderabad, Sir Salar Jung Bahadur, G. C. S. I., has subscribed for 60 copies of the work, (50 for the kingdom of Hyderabad and 10 for himself) and the Peishkar Rajah Narabandra Bahadur for 9, and these 69 copies at rupees 25 per copy, the proposed selling price, would recoup me to the extent of over 1,700 rupees; but this eventual return will not ease the intermediate strain, and you will see from the particulars I am about to furnish that the task is really one of very considerable magnitude.

Our Sanscrit treatises in Algebra, Trigonometry, etc., agree fairly enough in principle with European works, although less complete and explanatory; and they contain many equations and formulæ which are necessary for Astronomical calculation, but most of our modern Sidhantis are ignorant, not only of the English methods but also of the principles of our own, and with them the reckoning of eclipses, of the entrance of the Sun into the Zodiacal signs and other phenomena, become a sort of Astronomical juggle. Not a few of these men profess to calculate according to Vakyas, which are Sanscrit verses stringing bare formulæ without a particle of explanation or even reference to scientific principles, and it is not too much to say that most of the Vakya Sidhantis simply churn out results without possessing an atom of mathematical knowledge. This circumstance renders it necessary that the work should be published in Sanscrit, containing not only these verses, but their meaning and explanations in full detail for the benefit of those who know Sanscrit, and in Tamil for the use of such as are ignorant of Sanscrit. The Sanscrit text again should appear separately in the Devanagari and Telugu characters, so as to be within reach of the large numbers of professing computers who reside in those parts of India where the one character or the other prevails.

The name I intend giving to the proposed work is "Jyotisha Chintamani." It will consist of three parts, in two volumes, of Royal Octavo size, containing about 500 and 300 pages respectively. Part I. will be named Mathyathyanm, and will treat of the division and measurement of time, the shape and magnitude of the earth and the other planets and their mean motions, revolutions and distances, the causes of eclipses, the precession of the equinoxes, &c. explained by diagrams. Part II. will be styled Sputadhyayanm, and it will give the rules and formulæ with the corrections to be applied in calculating the time and apparent motion of planets from the mean; as also of Thithis, Natchathras and Yogas, or in other words the true geocentric places of the sun and the moon; and it will also explain the method of calculating eclipses and conjunctions, and afford explanations of other astronomical calculations with illustrations and figures. Part III. will be named Karana Paddhati and contain tables with rules for using them in calculating the phenomena treated of in Parts I. and II., and illustrative examples for using the method.

Being unversed in Sanscrit, I shall need the services of one qualified assistant to translate into that language, and of another for general help. Already I have had to engage the services of one competent Sanscrit scholar, who is also a good Sidhanti, and his labors are increasing so much that his remuneration must keep pace with the growth.

The following then will be an estimate of cost

	Rs.
Paper for 500 copies	500
Printing charges for 100 forms at an average rate of 10 Rs.	1,000
Lithograph and wood cut charges	200
Binding, &c. charges	300
Total for each language, Rs...	2,000
or for the three...	6,000

add to this establishment charges, for 20 months at the rate of Rupees 50 a month, or rupees 1,000. The total Rs. 7,000, so far as I can now see, will represent the expense yet to be incurred to complete the undertaking.

For my own part, it is a matter of the deepest regret that I should be unable to carry out my design, so long the cherished object of my life, without invoking help from others. But you are all aware that my income has always been very slight, barely sufficient to provide for

simple wants, an allowance of Rs. 100 per mensem after 33 years service leaves scanty margin for saving, and what little I had managed to put aside has been dispersed in meeting the charges which have had to be incurred in proceeding with the work so far. My health too is becoming weaker daily, and I cannot shut my eyes to the fact that my retirement from active work is not very distant. I have, however, resolved to take 18 months' furlough shortly, and to devote the whole of my energies to bring my work to a thorough and satisfactory conclusion. It remains with you to help or to hinder.

Gentlemen—You have now my plan, you can judge of my capacity to execute it.

Of the value of the undertaking, no vindication can be needed. Not only is Astronomy a splendid science leading to exalted conceptions of the wisdom and might of the Great Father of the world, but its practical benefits are direct, immediate, palpable. The two words Navigation and Geodesy sum up many of these, but why need we Hindus go so far? What should we do without our Almanacs? To strangers it may at first sight seem that the English calendars can be utilised—but the reckonings needed for our numerous religious observances and social rites are not such as English calendars could ever supply, nor could our ordinary Sidhantis for many a decade be educated to use these calendars. This, however, is not the sole use which my undertaking would serve. There is another yet, which ought to be dear to the heart of every right-thinking fellow-countryman. To rescue from undeserved neglect the works of such illustrious sons of India, as Arya Bhatta Charriar, Bhaskera Charriar and others who have as good a claim to be remembered as many of the best philosophers in the Western world, would be no slight honor.

It is a work which would be truly a national treasure and a privilege to our generation to construct. If to-day in Europe it were advisable to raise a memorial to Gallileo, Newton or Kepler, contributions from every side would flow in fast and freely, rich and poor would vie in their zeal, soon would the gathering be sufficient for a worthy celebration to mark the occasion. And what do I ask of you? A small sum of 7,000 rupees, a trifle for a community such as ours, an invisible drop out of the resources of the people of India who will hold the result. Why, more is frequently given by a private person in Europe for a single instrument, a new Telescope for an Observatory—the inventor of an useful mechanical contrivance

or the holder of a copy-right sometimes gets 4 times that sum in a lump, witness the reward of 3,000£ lately bestowed on Professor Mayor's widow for the manuscript and lunar tables framed by her deceased husband, we ourselves hear of 20,000 rupees being spent in India on a marriage feast. It would be a slight on our patriotism to imagine that there can be the least difficulty in raising the insignificant sum we want for a purpose in which all India will be sharers. The one consolation I feel in not being able to dispense with your help is, that it is good a good work should be set on foot by the pious charity of many.

You have heard me out so far, let me throw out one suggestion before I finish. Why should we not have an Observatory of our own, where our countrymen should find easy access, learn the use of Astronomical Instruments, and be taught to make careful observations? A very humble beginning will suffice. I have two transit circles or meridional instruments, two good clocks, a sextant and an artificial horizon. These I freely offer, and if in addition we obtain a moderate sized Equatorial Telescope with driving clock and Micrometer, our equipment will be respectable enough for a commencement. The fine Government Observatory in which I have served for 33 years had its origin in the gift to the East India Company of a 20 inch transit instrument by a retiring servant.

In the various countries of Europe, the prosecution of useful and interesting studies is helped by numerous societies which rank amongst the noblest institutions of the land. Honorary distinctions are conferred on deserving persons by such bodies, and bear a high value. I myself having the great honor of being the fellow of one such Society—the Royal Astronomical—can vouch for the inestimable benefit which organisations of the kind confer in stimulating zeal, preserving results and ensuring steady progress. A properly modelled Society in Madras for the encouragement of the study of Astronomy by natives would communicate a wonderful impulse, while the association of a number of educated men who have earned distinction in our Indian Universities or have raised themselves to good public position by energy and talent, would at once give a high stamp to the movement. Native princes and noblemen would, I feel assured, gladly co-operate, and a foundation be laid on which a stately structure might soon rise.

As an Astronomer, I have been familiar all my life with the triumphs which have crowned sustained effort in working out the science of the heavens, and can well realise the good that would be done to the country

if a Society were here established, with a small Observatory as a training School for our Sidhantees, and a place of instruction for all interested in the wonders of the skies. In Europe, excluding Russia, there now exist 54 public and 16 private Observatories spread over an area of less than 2 million square miles. In India with a surface of 1½ million miles we have but one--and that one wholly supported by the State. What, however, I propose, is not to erect a place of observation which will take rank with the institutions on the scale of those here enumerated, that indeed would be aiming at a height which for the present at least must altogether be beyond our reach. I recommend no more than that a modest but thorough place of instruction and study should be founded where theoretical knowledge can be united to accurate practical work, and where the mathematician equally with the humble Sidhanti may find pleasure and profit. Such places exist in hundreds in Europe, but nowhere is the need for them greater than in India. Not much money, a little zeal, a little stedfastness of purpose, wed these to a regard for Science, and soon would the metropolis of Southern India be graced with an Institution which would be an honor to the country.

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