used for the tubes, and is found to be practically unaffected by the gas, a thin coating of lead chloride forming on the inside, which completely protects it. The gas is drawn into the cells, not forced in, so that there is a slight vacuum (2 or 3 inches of water) inside, which effectually prevents any possibility of leakage of chlorine, which might occur if there were pressure inside. The liquid used— ZnCl_2 —(the supply of which is kept up by the action of the cells) is deliquescent, so that there is no tendency of the crushed carbon to get dry.

The description and cuts will show that apparently the utmost simplicity has been attained, and that there is nothing in the battery at all likely to get out of order.

Its E.M.F. is 2.1 volts, and is absolutely constant so long as chlorine is supplied. The whole of the chemical changes being the combustion of zinc or iron by chlorine, and that purely electrolytically, there is an entire absence of local action. This has also been proved by delicate tests, and is clearly shown by the condition of the zinc plates shown us, which came out of the cells all on the same day, all used up to the thinness of a wafer, and every one to the same extent.

To the probable user of a primary battery, information on the amount of attendance required and the possibility of inconvenience is of the greatest interest.

Assuming the battery and apparatus to be installed in a cellar, outhouse, yard, or other convenient position, all that a servant has to do is, once a month, to fill the generator with a charge of manganese, and every few days to run sulphuric acid from one tap and brine from another into the funnel, after opening the lower tap to allow the spent liquid to run off into the drain, at the same time the burner underneath may be lighted; or, if preferred, the heat may be arranged so that the process is continuous. The necessity for fresh or more rapid generation of gas is indicated by the color bulbs

FIG. 7.

in the tubes between the holders, which show how many columns full of gas there are in hand.

The only other attention necessary is to fill up the cells with plain water once a week.

By using heavy zinc plates, the renewal of these is only necessary once in six months or more, and, as before stated, they are all consumed alike, so that the whole are ready to be replaced on the same day.

If a battery is going to be unemployed for a considerable time, all that is necessary is to turn off the taps, T, and raise the safety tube of the first bubbling bottle. The cells then draw in air instead of gas, and soon stop, leaving any gas in the holders for future use, while the liquid only percolates through the pots till it is level outside and in. To start the battery again, it is only necessary to open the taps, T, push the safety tube down again, and fill up with water, as plenty of zinc chloride solution has been retained in the inner cells.

With regard to the cost of the electrical energy produced by the battery, it is not to be considered that this will be so low as when obtained from an engine and dynamo; but in many cases these are perfectly inadmissible, and it is here that a reliable primary battery becomes invaluable. As to the actual working cost, for 1,000 watt-hours' work done we shall require,

according to the inventor's calculations, $\frac{1,000}{2.1}$ ampere-hours; or, since 1 lb. zinc is equivalent to 374 A.H.,

$\frac{1,000}{2.1 \times 374} = 1.27$ lb. at $2\frac{1}{2}$ d. per lb. = 3.2 pence, and 1.27

lb. of zinc to form ZnCl_2 consumes $1.27 \times \frac{35 \times 2}{65} = 1.36$

lb. Cl. We have no exact data of the cost of chlorine, but we believe it is generally reckoned, where used on a manufacturing scale, as costing £5 per ton. Of course, we cannot expect to get it at that rate on a small scale; but even assuming it costs six times as much, or $3\frac{1}{4}$ d. per lb., we have the total cost per 1,000 W.H. as under 8d. Allowing for the battery working at a very high rate, and for loss in the accumulators, let us assume that as little as one-half of the total work is done on the lamps; then, taking lamps of the efficiency of 3 watts per candle, we have an outside cost per 1,000 C.P. hours of 8d. $\times 2 \times 3$, or 4s., or $\frac{1}{2}$ d. per hour per 10 C.P. lamp. Now, when burnt in an ordinary burner, 5

feet of gas do not give more than 10 C.P., so that, even taking the extreme figures for cost that we have done, we have electric light at a cost equivalent to gas at 8s. per 1,000 cubic feet.

We have no hesitation in saying that if the battery gives as little trouble as asserted, there should be a very large field for its immediate introduction; and from the cells we saw and the report of Prof. Oliver Lodge, which, we learn, is particularly favorable, we have great hopes of its commercial success, believing it to be the first thoroughly practical primary battery for electric lighting.—*Electrical Review*.

THE ECLIPSE OF ALGOL, WITH THE LATEST DETERMINATIONS OF ITS DISTANCE AND DIMENSIONS.

By ROYAL HILL.

By far the greater number of the stars visible to the naked eye appear to shine with unvarying brilliancy. But when we compare our own observations of theirre-

lative brightness with those of the astronomers of past ages, we find many stars in which very great changes have occurred in the amount of light emitted. Some are much brighter; others which were once among the brightest in their constellations are now quite inconspicuous. Even in our own day perceptible changes have occurred in the relative brilliancy of well-known stars. For instance, in the British Association Catalogue of 1850, of the two brightest stars of the constellation of the Twins, Castor is noted as being of the $1\frac{1}{2}$ magnitude and Pollux of the 2d. At the present time the latter is evidently the brighter of the two.

Whether these variations are, in the majority of cases, of such a character that the stars will in time resume their former appearance, is not known, and it will be necessary to combine the observations of many ages of astronomers before this can be determined. There are, however, about one hundred and fifty stars whose variations of light are so decided in amount that they are known as variable stars, and the periods of maximum and minimum brilliancy of a large proportion of these have been ascertained with more or less exactness, dependent upon the length of their periods, which vary from a few days to several months or even years.

Variable stars are at present divided into five classes, according to the character of their changes. The most interesting of these is that in which the stars undergo for a few hours a remarkable diminution of light with great regularity of period—so regular, in fact, that astronomers who have investigated the subject have satisfied themselves and the majority of the profession, that the variation of light in stars of this class is caused by the revolution around a luminous sun of a dark planet of large size, the plane of whose orbit passes so near the earth as to bring the planet between us and the star at every revolution, and so cuts off a portion of its light.

Of stars of this class, only six are known, and of these, β Persei, otherwise known as Algol, is at once the most conspicuous and in many respects the most interesting of all the variable stars. Its variations have been the subject of investigation by many eminent astronomers, among whom are Herschel, Lalande, Argelander, Schmidt, Schonfeld, and, in our own country, Mr. Pickering. The researches of this gentleman, at present the Director of the Harvard College Observatory, are of the most interesting character.

β Persei is a star of the second magnitude, in the constellation Perseus. Its rapid variations of brilliancy were well known to the Arabs, from whom it received its name, Al Gol, signifying the Demon. Its rediscovery in modern times as a variable star is due to Montanari, in 1669, though Goodricke, an English astronomer of York, was the first to exactly ascertain its period. Its right ascension is 3 hours 0 min. 45 sec.; declination, north, $40^\circ 30' 55''$. In the Edinburgh Catalogue, Algol is described as having a companion of the 11th magnitude, of a purple color, distant $55''$, but whether this companion revolves around Algol as a primary is not yet determined.

On account of its high northern declination, Algol is below the horizon in the northern part of the United States only about five hours and a half, and it can be seen at some time or other during the night in every month except May and June. It begins to be visible as an evening star in August, when it may be seen rising in the northeast about eight o'clock, and, rising about four minutes earlier every day, it becomes very conspicuous in September. Toward the last of December it is visible in the evening near the zenith, and in the spring it appears in the northwest.

Its situation in the heavens, when it is about four hours high, is shown in the illustration, which gives a view of the constellation Perseus as it appears in the northeast in the evenings of October.

The other bright star in Perseus, about 10° north of Algol, is Mirfak. Algol is very easily found, being situated about half way upon a line drawn from the Pleiades to the northern end of the wide W of Cassiopeia. About half way between Mirfak and Cassiopeia is the celebrated cluster in the sword handle of Perseus. It is a beautiful object as seen through even the smallest telescope.

As usually seen, Algol appears as a clear white star of the second magnitude (more exactly 2.2), hardly so bright as Mirfak. It remains of this degree of brilliancy for about two days and twelve hours when it begins to fade, and in four hours and a quarter it has lost so much of its light as to appear as only of the 4th magnitude. It remains in this condition for about fifteen minutes, and then begins to brighten, and in four hours more resumes its ordinary appearance. To the unassisted eye of the ordinary observer, there is no very perceptible diminution of the light except during the three hours on each side of the minimum. During the time that the light is the least, it can be compared with the fourth magnitude star ρ , a little to the south of it (marked in the illustration); it will be then seen to be a very little brighter than ρ .

Various conjectures have been made as to the cause of this phenomenon, but the exact equality of the intervals between the minima has disposed of all theories except those based upon the rotation of the star itself, or the revolution around it of some dark body which intercepts part of its light.

For a long time the first of these suppositions was the only one entertained, one side of the star being considered as not being so bright as the other, and by

its periodical presentation to the earth to cause the observed diminution of the light. But when astronomers began to measure the amount of light received from the star, and found that it came without any perceptible diminution for two days and a half, it was seen that this theory was inadequate to account for the appearances. It is evident that, if one side of the star is not so bright as the other, there would be a gradual decrease of light during one half the period of its rotation, and an equally gradual increase during the other half, the decrease and increase occupying the whole period, which is contrary to what is observed. No theory is admissible which does not leave the light of the star undimmed for nearly seven-eighths of the whole period. To obviate this difficulty, Algol was

capable of producing any marked diminution of the light coming from the star. To these objections the reply is made that the absence of such a secondary in such close proximity to the sun in the solar system is no proof that such may not exist in some of the stellar systems that surround us on every side. It is not at all necessary that such a planet should have the same origin as the star, that is, have originated from the same nebulous mass from which Algol has contracted. It may be, and probably is, a dead sun that has been brought within the attractive influence of Algol, under such conditions as to be forced to travel in a closed and very small orbit around it. On the other hand, it is shown that the observed phenomena are completely explained by the existence of such a dark satellite,

more rapid just before and after the annular phase than at the beginning and end of the eclipse. If, therefore, we can ascertain the exact proportion of the whole light of the star which is cut off at regular intervals during the eclipse, we have the proportion of its surface which is covered from view at the time, and the relative diameters of the star and planet can be computed. Some of the most eminent astronomers of the present day have applied themselves to this task, notably Argelander, Schonfeld, and Mr. Pickering. The result of their researches is shown in the following table, which exhibits the amount of light received from the star at intervals of half an hour each way from the middle of the eclipse:

From Minimum.	Light.	From Minimum.	Light.
At 4.6 hours.	1000	At 2 hours.	685
" 4 "	968	" 1½ "	566
" 3½ "	920	" 1 hour.	480
" 3 "	861	" ½ "	433
" 2½ "	762	Minimum.	416

From these data it was required to compute the diameter of a planet which, during its transit in the time observed, should cover the surface of the star in correspondence with the above diminution of its light. In general terms, the result of the investigations is that a planet having a diameter 0.764 that of the star, and occupying nine hours and twelve minutes in its transit, will intercept just that amount of light which is missing at the observed intervals, if the plane of its orbit is so placed in respect to the earth as to produce an eclipse nearly, but not quite, annular.

As soon as the relative sizes of the two bodies had been ascertained, it became possible to compute the relative size of the orbit in which the planet revolves. Knowing the whole period and the time occupied in transit, and combining these with the ratio of the diameters, it was found that the diameter of the orbit of the planet is 4½ times that of the star, or 6.1 times that of the planet.

Fig 3 gives a view of the relative sizes of the star,

Fig 3

the planet, and its orbit, the planet being shown at the middle of the eclipse and also at one elongation, the orbit being presented as seen from the earth.

Fig. 4 represents the orbit in its own plane. It will be observed in this view that the star has an orbit around the common center of gravity at C of the two bodies of about one-third the diameter of the orbit of the planet. This is according to the ratio of the masses of the two bodies, which, supposing them to be of the same density, is as 1.0 to 0.446.

So far the relative dimensions of Algol and its dark secondary. The absolute dimensions cannot be determined with the like accuracy. The following considera-

Fig 4

supposed to have a large spot near one of its poles, and to be so poised as regards the earth that the spot is visible during only a small part of its period of rotation. But as the light of the star at minimum is less than half its normal brilliancy, it has been found impossible to locate so large a spot as is necessary to produce this diminution so that it should not present itself for sixty hours out of sixty-nine. There are also dynamical objections to this theory which cannot be disposed of. According to this supposition, Algol makes one revolution on its axis in about sixty-nine hours, which is scarcely one-ninth of the rotation period of the sun. Such a speed is incompatible with its existence as a spherical body, unless it is very much smaller than the sun. As it is certain, from considerations yet to be presented, that Algol is very much larger than the sun, the theory becomes inadmissible and, in fine, the difficulties connected with it are so insuperable that astronomers have ceased to consider it as a

Fig 1

possible explanation of the periodical diminution of the light of the star.

There remains, then, the theory of a body, usually spoken of as a dark planet, revolving around Algol, and passing at every revolution between it and the earth, and so cutting off a portion of its light. During the rest of the period, the planet would be to the side of or behind the star, whose light, therefore, would come to us undiminished.

The objections made to this theory are, that there is no instance in the solar system of any planet so near the same size as its primary as the supposed planet must be to intercept so large a portion of the star's light, nor any so near as to be forced to revolve in so short a period as that observed. Neither is it conceivable, say the opponents of this theory, how such a body can be dark; being so near the same size as its primary, it should itself be luminous, and, even if not quite so intrinsically bright, because, being of smaller size, it has cooled off more, yet it would be in-

while no other theory hitherto advanced will explain them. The most careful observations of astronomers armed with the most refined instruments of modern optical science, and these combined with the strictest mathematical analysis, only tend to confirm this theory, and have at length resulted in giving us as precise conceptions of the conditions of Algol's system as we have of any in which both bodies are luminous and therefore visible.

Upon this theory Algol suffers a partial eclipse of about nine hours duration once in each revolution of a planet having a period of two days and about twenty-one hours. Careful photometric observations have resulted in establishing the ratio of the light of the star when at a minimum to that at maximum as 416 to 1,000. There are several ways in which a dark body of sufficient size might be interposed so as to reduce the light in this proportion. If we suppose the eclipse is caused by the interposition of a body as large or larger than the star, so placed as to cut off 0.584 of its surface from our view, then, if we had no further data, we might suppose the planet to be of any size if it only traveled fast enough to begin and end its transit within the observed time of its continuance. This may be considered as one extreme of the possibilities, and it will be seen by examination of Fig. 1, which represents the

Fig 2

eclipse of the star by a dark body of twice its diameter, that in such a case the light would decrease from the beginning of the transit to the middle, and then immediately begin to increase. It is also evident that this decrease and increase at the middle would be more or less rapid according to the relative degree of curvature of the circumference of the planet as compared with that of the star—the larger the body, the more rapid would be the change at the beginning and end of the eclipse, and the slower it would be at the middle.

If we suppose the eclipse to be caused by the transit across the center of the star of a planet just large enough to cover 0.584 of its surface, we have the other extreme represented by Fig. 2.

Here, it is evident, we have an annular eclipse, and that during the time the planet is traveling across the face of the star, that is from the time that the annular phase begins (as represented in the figure) till it ends, the light would remain at a minimum. It will also be seen that the decrease and increase would be

tions, however, are extremely interesting, and afford an approximation to the desired information.

From the distance at which we are from the sun, he presents to us a disk of 32' 4" in diameter, or 1924". In order to present to us the appearance of a star of the same magnitude as Algol, he would have to be removed from us about 320,000 times as far as he is now, and his disk would then be six one-thousandths of a second (0.006) in diameter, becoming, in fact, as every fixed star is, a mere point of light. The sun's annual parallax at this distance would be six-tenths of a second (0.6). This is a larger parallax than any fixed star has, except perhaps *α Centauri*.

But the parallax of Algol has not been determined, being so small as to escape the fine nets which astronomers spread for such exceedingly minute quantities as stellar parallax. The parallax of Algol is certainly not more, if so much, as one-tenth of a second (0.1); for if it

were as large as this, it could not have escaped observation and approximate measurement. If the sun were removed from us to such a distance that its parallax were 0".1, it would then be only a sixth magnitude star, and scarcely visible to the naked eye.

This shows that Algol must be very much larger than the sun, probably not less than six times larger in diameter, it being a second magnitude star at a distance from which the sun would appear to be only of the sixth. Even if this difference of magnitude is partly due to a superior brightness of its surface, we have a reserve of smaller parallax for Algol than 0".1 to fall back upon. It will, however, simplify these considerations to suppose Algol as being of the same intrinsic brilliancy as the sun, and to have an annual parallax of one-tenth of

of the arrow leaves the shadow behind it, which darts out from the star at the rate of 186,000 miles per second, and by the time the planet has returned to its position, the shadow of the previous eclipse is 46,078,000,000 miles on its way. For about nine hours a partial eclipse ensues, the shadow being deeper in the middle than at the beginning and end, during which time the beginning of the eclipse has advanced 6,010,000,000 miles. This last, which is the width of the shadow, is somewhat over the diameter of the orbit of Neptune, which, for the sake of comparison, is drawn to the same scale in the upper corner. The light space some 40,000 millions of miles in width is that occupied by light in traveling the sixty hours during which the star appears of its full brilliancy. By rotating the page in the direc-

falling into it of some extraneous body not sufficiently large to produce any marked increase of the light.

Another theory has been brought forward to account for the variation of Algol. It is that a vast cloud of meteors, and not a massive planet, revolves round the star in the observed period. It is easy to conceive that such a cloud exists and should cut off just so much of the star's light. But it is not easy to conceive how such a cloud should be of such an exact circular form as to fulfill the conditions of the eclipse as the planet does, and, still more, how it should preserve this form, being neither condensed by the mutual attraction of its members to the center of the mass and so shorten the duration of the eclipse, nor be scattered by the perturbations of other masses in the system, and so lengthen it. Such changes have occurred, and are yet occurring, in the meteoric systems of the solar system, such as those which follow cometary paths. The changes in the dimensions of Saturn's ring are strictly analogous to those which we might look for in a cloud of meteors circling round a star. If it shall be found that the light received from the star during the eclipse varies as time rolls on, and the duration of the eclipse lengthens or shortens, then the meteoric theory will be taken as the explanation of the phenomena. But as no such variation has been observed, we are compelled to accept the theory of a stable body such as the planet.

A very neat demonstration of the conditions of the eclipse can be made by drawing on good cardboard two circles tangent to each other of 10 inches and 7 64 inches respectively, as representing the beginning of the eclipse, and drawing the larger circle again in the position shown in Fig. 3 for the middle of the eclipse. The distance between the centers of the two large circles can thus be divided into nine parts, representing the half hour intervals of the table on page 8915. By arcs drawn from the points thus obtained, the smaller circle can be traversed as shown in this illustration. Fig. 6.

The two circles should then be cut out, and the smaller one divided up on the lines. The larger circle should then be weighed in grains, and from this weight should then be subtracted the weights of the successive portions of the smaller circle. If these remainders, which strictly represent the area of the star uncovered at each interval, are put in decimal proportion to the whole weight of the larger circle, they will be found to correspond pretty closely with the light of the star in the table. A more exact demonstration can be made by correcting the distances 1, 2, 3, 4, representing the half-hourly progress of the planet, for the curve of the orbit.

When we remember that the amount of light at each half hour interval of the eclipse was accurately ascertained by years of observation before any attempt was made to compute the size of the planet, it is difficult to believe that we have not here the true solution of one of the most interesting problems ever presented to astronomers.

The variations of Algol are, of course, most conveniently observed in the evening. The minima of light occur at intervals of about three days, each one being nearly three hours earlier than the preceding. In this way they run the course of the twenty-four hours in about three weeks. When a minimum occurs at a convenient hour of observation in the evening, seven periods of the eclipse will bring another minimum twenty days after, but one hour and forty two minutes later. If this is inconveniently late, another period will bring one twenty-three days after, but one hour and twenty-nine minutes earlier.

The length of the interval is such that fifteen periods make forty-three days and thirteen minutes. Consequently, minima are repeated at the same hour of the day at intervals of six weeks and one day.

The most interesting phase to observe is the decrease of the light from the normal brilliancy to the minimum as the phenomenon is a little more striking, and partly because the decrease, owing to a slight ellipticity of the orbit, is rather more rapid than the increase.

The following is a list of the dates in the latter part of 1886 and the first two months of 1887, on the evenings of which the minimum of Algol's light may be observed. The dates are given in Eastern standard time. For central time they will be one hour earlier, and for mountain time two hours earlier.

September 28	10.41 P. M.
October 1	7.30 "
" 19	12.23 A. M.
" 21	9.12 P. M.
" 24	6.04 "
November 10	10.54 "
" 13	7.43 "
December 1	1.36 A. M.
" 3	9.25 P. M.
" 6	6.14 "
" 23	11.07 "
" 26	7.56 "
January 13	12.49 A. M.
" 15	9.38 P. M.
" 18	6.27 "
February 4	11.20 "
" 7	8.09 "
" 27	9.52 "

The season of the year when evening observation of Algol may be commenced is about the 1st of September, when the star rises about 7 o'clock. The following are the dates nearest September 1 for the next three years, when the minimum may be observed in the evening :

Sept. 10, 1887	9.16 P. M.
" 11, 1888	9.33 "
August 24, 1889	8.08 "

THE NEXT LOUISVILLE EXPOSITION.

FOR three years past, commencing with 1883, the exhibitions held at Louisville, Ky., have been brilliantly successful, alike in the attendance and in the variety and excellence of their display of works of art, industry, and agriculture. This year the exhibition opened August 28 and closes October 23, and its managers propose to make the show contribute materially to the attractions which Louisville always presents to visitors at that season.

—Fig. 5—

a second (0".1). Its apparent disk being six one-thousandths of a second (0".006) in diameter, its actual diameter would be 5,544,000 miles, that of the planet being 4,235,000 miles and of the orbit 25,835,000.

We thus become able to apply a scale of miles, instead of one of arc, to Figs 3 and 4, one view being here reproduced, with the sun and its nearest planet, Mercury, drawn to the same scale for the sake of comparison. M' being the planet at perihelion and M" at aphelion. See Fig. 5.

Algol is thus shown to be a sun very nearly six and a half times the diameter of our own, with a planet nearly five times the diameter of the sun revolving around the common center of gravity of the system, in an orbit about one-third of the size of Mercury's, at the rate of 327 miles per second, which is over ten times that of Mercury, the fastest traveling planet in the solar system, the motion of the star itself in its smaller orbit being one-third that of the planet.

Vast, and indeed appalling, as these dimensions and speeds may appear to us, because we are accustomed to limit our conceptions to those of the solar system, yet we have no right on that account to reject the conclusions arrived at. It is very certain that the annual parallax of Algol is less than 0".1; and to be of the observed magnitude, the star must be thus immensely larger than the sun, if of the same intrinsic brightness.

It is interesting to note, and gives an idea of the immense distance of the fixed stars, that if Fig. 3 were placed 325 miles from the eye, it would be of the same angular dimensions that are presented by Algol and its dark secondary, that being the radius of a circle in which 0".006 would be equal to the diameter of the little circle representing Algol in the figure. Of course, the actual distance of the star exceeds 325 miles in the same ratio that its actual size exceeds that of its little representative, that is, as 5,544,000 miles is to 0.6 of an inch. This distance will be the same as the radius of a circle in which 0".006 shall be equal to the diameter of the star. Either way gives a distance of 190,576,000,000 miles, which also corresponds to that due to an annual parallax of 0".1, the distance of the earth from the sun being considered as 92,394,000 miles, computed from

tion of the arrow, which is the same as that of the planets round the sun, the spiral path will seem to advance outward. The motion would be exactly imitated, and, in fact, be produced, on the same principle, by causing the point of a stick to mark a circular path in the center of a smooth sheet of water, when the wave would be found to travel in a spiral direction to the shores.

How far that shore may be against which the waves of Algol's light break, and the spiral path of its eclipse is extinguished, we may never know. It reaches us in about thirty years, by which time Algol has diminished from a tremendous sun to a star of the second magnitude. After traveling one hundred and twenty years, Algol sinks to the eye of the distant observer to the 6th magnitude, and if that eye is like ours, it cannot be seen at minimum. The light of a star of the 15th magnitude is estimated to have been on its journey nearly 2,000 years, and smaller and still more distant stars than these are now seen with the largest telescopes. But how far the light of such a star as Algol must travel ere it would be unable to produce vibrations visible to any eye, or else meet the ramparts of space, cannot be known.

It may be said that any dark body revolving round a luminous sun produces such a spiral path in its shadow. But it is only in such instances as that of Algol, in which a sun has a planet very near to it, and therefore revolving at a very rapid rate, and of sufficient size to intercept a large proportion of the light emitted, that the distinction of full light and the eclipse, and also the angle of the spiral, would be sufficient to make such an illustration interesting. Jupiter, for instance, being about one-tenth the diameter of the sun, only intercepts to the eye of the distant observer one-hundredth of its light, and this only for a few hours in a period of about twelve years.

So far the period of Algol has been spoken of as about sixty-nine hours. A nearer approximation is about eleven minutes less than this. In 1784 Goodricke ascertained its period to be 2 days 20 hours 48 minutes 58.6 seconds. Since then it has been gradually decreasing, and is now 2 days 20 hours 48 minutes 52.5 seconds. To account for this decrease, it is con-

Fig. 6

Professor Newcomb's solar parallax of 8".848. This distance of Algol is a little more than that given by Peters as the average distance of second magnitude stars, and is what we should look for, as Algol is less than the second magnitude. Like all estimates of the distances of the fixed stars, it is but an approximation.

To cross this enormous distance, light, traveling at the rate of 186,000 miles per second, requires nearly thirty-two and a half years, and over it are spread over four thousand pulsations of the light of the star. It is somewhat novel to conceive of this partial shadow of Algol's satellite as traveling out from the star in a perpetual spiral generated by the revolution of the planet combined with the velocity of light proceeding in straight lines. The accompanying illustration gives a view of this spiral as it must actually exist, and as it would be seen by an eye capable of seeing the transmission of light when situated at a sufficient distance above the plane of the orbit of the planet.

The small circle in the center may be supposed to be the planet's orbit, though vastly too large for the scale of the drawing. The planet traveling in the direction

jectured that the planet moves in a resisting medium the effect of which would certainly be to cause the planet to draw nearer to the star. It is not at all unlikely that the immediate neighborhood of all suns is occupied by vast clouds of meteors, which would resist slightly the passage of a large body among them. But such can hardly exist near Algol, as the disturbing effect of such a large body as the planet must be enormous, and would eventually precipitate every small body upon the surface of either the star or the planet. It may be that this constant increase of the mass of the two bodies may be the cause of the decrease of the period. If there is any resisting medium, it is more likely to be the tremendously extended atmosphere of the central body, in which case the planet itself must eventually be brought to the surface of the star.

A singular circumstance in connection with this decrease of period is that nearly one-half of the decrease since 1784 occurred during the ten years between 1840 and 1850. This may have been occasioned by a sudden increase of the mass of one of the two bodies by the