"Stretched out upon the Waters."

A PAMPHLET

BEARING UPON

THE FORM OF THE EARTH.

BY

E. H. RICHES, LL.D., F.R.A.S.

MEMBER OF THE "LONDON MATHEMATICAL SOCIETY," LATE CANTAB.
ETC.

Veritas Triumphans

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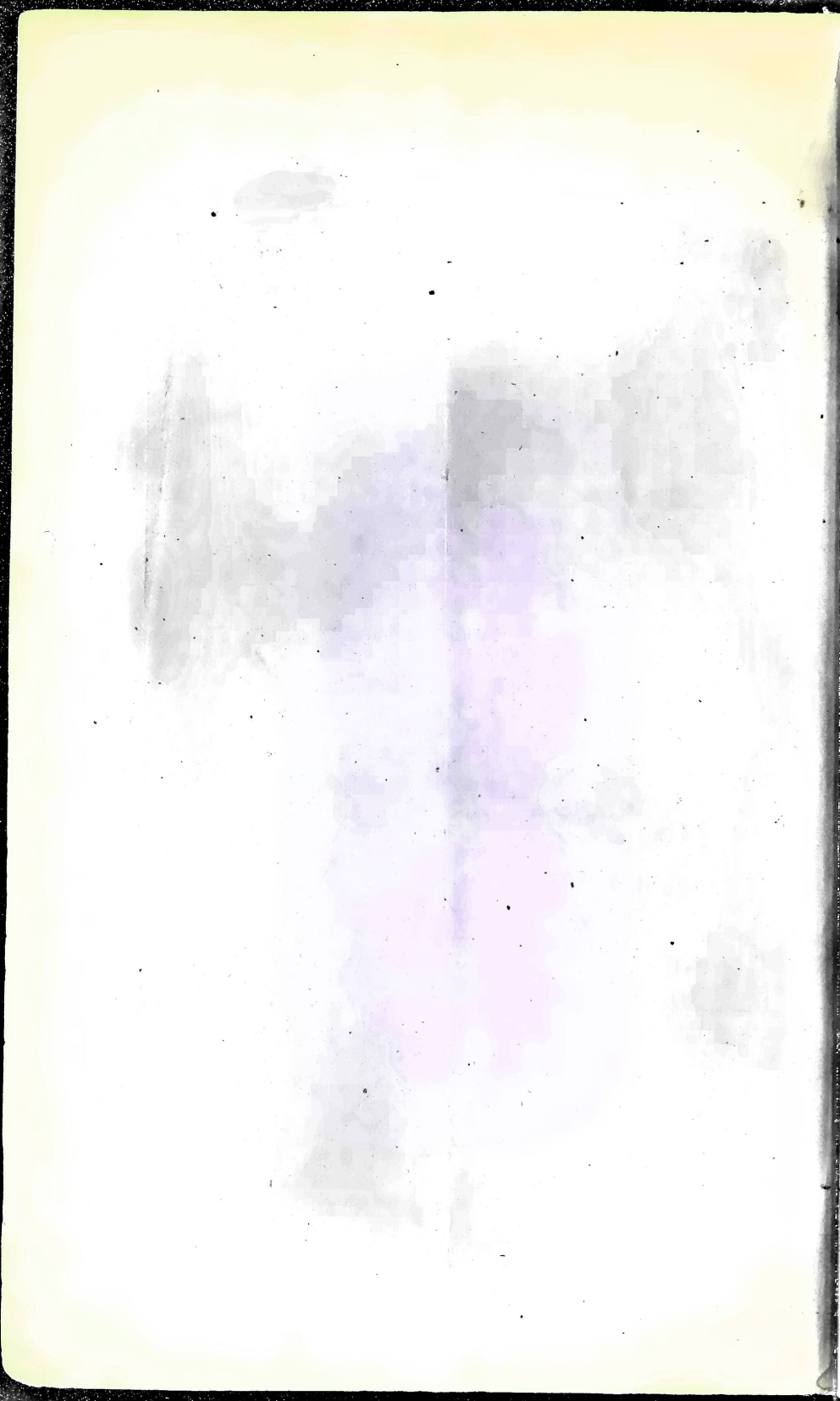MEMBER OF THE "LONDON MATHEMATICAL SOCIETY," LATE CANTAB.
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INTRODUCTION.

It is not to be supposed that, in the following brief consider-
ations of certain facts (which cannot fail to be patent even to
those unacquainted with the Newtonian philosophy with refer-
ence to the form of the earth), I am endeavouring to *show* that
the earth's surface is a plane ; nor is it my intention to attack
any portion of the science of astronomy as it at present exists ;
but my main object is, to endeavour to interest the thoughtful
reader chiefly in the matter of the *form* of the earth, which is
generally supposed to be that of a *globe*. To *prove* that the
form of the earth is *not* globular, and to show that it is a
plane, is therefore not my intention. Still there will be perhaps
some who, after reading this pamphlet, may have their belief in
the popular notion of the earth's form somewhat shaken ; and
some also, whose knowledge and calibre can permit them, may
be led hastily to the conclusion that the earth is a plane.

After investigating certain experiments, which tend much to
support the theory of those who believe that the earth is a plane
and fixed, I shall (supposing the earth to be a plane and fixed)
enter, in as intelligible a manner as possible to the non-mathe-
matician, into some simple methods which might be adopted to
arrive at the distance from us of the sun and stars, also to cal-
culate the motion (?) of the sun, and enter into the causes of
sunrise and sunset; accounting also for day and night, and
the seasons as they occur.

To avoid any argumentative deductions, and to state dis-
tinctly and briefly what is intended to be of interest to the
thoughtful reader, is my intention.

" Stretched Out upon the Waters."

THERE exists a popular belief that the form of the earth is that of a globe or sphere. This being the case, we rightly conclude that the surface of the earth must of necessity be *convex*. By *earth* we understand water and land; consequently, the surface of the water is not a plane, and convexity must exist with it as with the other portion of the surface of the earth, namely, the land.

One of the most common illustrations brought forward to prove the convexity of the earth's surface is that of observing a ship at sea, hastening towards the horizon. It is known that, at a certain distance from the observer, the hull of the ship will vanish from his sight; and as the distance increases between the ship and the observer, the masts, too, will gradually disappear, and ultimately vanish. This *gradual* disappearance of, first, the hull, and then the masts of the ship, would seem to strengthen the belief that the surface of the water must be convex.

Before investigating an illustration of this character, as to the distance which must intervene between the ship and the observer before it disappears under certain circumstances, also the *apparent mode* of its disappearance, it would be well to inquire briefly into the measurement of the convexity of any distance of arc of the earth's surface. In the " Encyclopædia Britannica," article " Levelling," we find the following : " If a line which crosses the plumb-line at right angles be continued for any considerable length, it will rise above the earth's surface; and this rising will be as the square of the distance to which the said right line is produced; that is to say, it is raised eight inches very nearly above the earth's surface at one mile's distance; four times as much, or thirty-two inches, at the distance of two miles; nine times as much, or seventy-two inches, at the distance of

three miles. This is owing to the globular figure of the earth, and this rising is the difference between the true and apparent levels; the curve of the earth being the true level, and the tangent to it the apparent level. So soon does the difference between the true and apparent levels become perceptible, that it is necessary to make an allowance for it if the distance betwixt the two stations exceeds two chains.
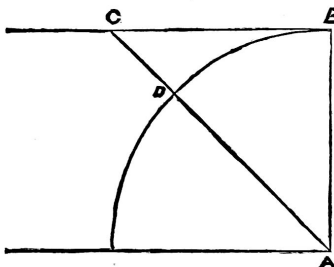
" Let BD be a small portion of the earth's circumference, whose centre of curvature is A, and consequently all the parts of this arc will be on a level. But a tangent BC meeting the vertical line AD in the point C will be the apparent level at the point B; and therefore DC is the difference between the apparent and the true level at the point B.

" The distance CD must be deducted from the observed height to have the true difference of level; or, the differences between the distances of two points from the surface of the earth, or from the centre of curvature A. But we shall afterwards see how the correction may be avoided altogether in certain cases. To find an expression for CD we have Euclid, third book, thirty-sixth proposition, which proves that $BC^2 = CD (2D \times CAD)$; but since in all cases of levelling CD is exceedingly small compared with 2AD, we may safely neglect CD^2, and then $BC^2 = 2AD \times CD$, or $CD = \dfrac{BC^2}{2AD}$. Hence the depression of the true level is equal to the square of the distance divided by twice the radius of the curvature of the earth.

" For example, taking a distance of four miles, the square of 4=16, and putting down twice the radius of the earth's curvature as in round figures, about 8,000 miles, we make the depression on four miles $= \dfrac{16}{8000}$ of a mile $= \dfrac{16 \times 1760}{8000}$ yards $= \dfrac{176}{50}$ yards $= \dfrac{528}{50}$ feet, or rather better than $10\frac{1}{2}$ feet. Or, if we take the mean radius of the earth as the mean radius of its curvature, and consequently 2AD = 7912 miles, then 5280 feet

being one mile, we shall have CD the depression in inches=
$\frac{5280 \times 12 \times BC^2}{7912}$=8008 BC^2 inches.

" The preceding remarks suppose the visual ray CB to be a straight line; whereas, on the unequal densities of the air at different distances from the earth, the rays of light are incurvated by refraction. The effect of this is to lessen the difference between the true and the apparent levels, but in such an extremely variable and uncertain manner, that if any constant or fixed allowance is made for it in formulæ or tables, it will often lead to a greater error than what it was intended to obviate. For though the refraction may at a mean compensate for about a seventh of the curvature of the earth, it sometimes exceeds a fifth, and at other times does not amount to a fifteenth. We have, therefore, made no allowance for refraction in the foregone formulæ."

It is thus seen, that the degree of convexity per mile will be eight inches multiplied by the square of the distance. This must apply to the surface of the water equally with that of the land; but it must be remembered that with water at sea there is a constantly changing attitude; so it is possible that an objection might fairly be made to this method of measurement of a distance of arc of the surface of the water. It *might* happen that if this mode of measurement were applied to a certain extent of standing water on the land, it might somewhat fail, inasmuch as the surface of the water might actually be a *plane* owing to the nature of the land on which it was. However, in the fen country of England there is a kind of canal known as the " Old Bedford," in length some twenty miles, on which an experiment was made in the following manner :—A distance of six miles was selected, and from a point A a boat, with a flag standing three feet above the water, was directed to sail to the end of the distance (six miles), which we will call B. An observer with a telescope fixed at eight inches from the surface of the water, sighted this boat, and pronounced *the whole of it to be clearly visible throughout the entire distance.*

From this fact a conclusion was at once arrived at that the arc of convexity of the surface of the water was *nil;* or, in other words, the surface of the water was a *plane.*

Now, according to what was said as to the degree of convexity of any arc being equal to eight inches multiplied by the square of the distance,—in this case, at the distance of three miles from the observer the boat would be floating on a surface of water exactly six feet higher than the line of sight from A to B, which was said to exist; and, consequently, as the boat approached the distance of six miles, when once past the distance of three miles, it would seem only reasonable to suppose that it would gradually have ceased to be wholly in view; or, in fact, to have been in view at all at the end of the distance.

This experiment may be found mentioned in a book entitled "Zetetic Astronomy," published by Messrs. Simpkin, Marshall, & Co., London, where it is illustrated by appropriate diagrams. To the same work I am indebted for some information concerning an observation made from the Isle of Man across the Irish Sea. The distance between Douglas Bay (Isle of Man) and the Great Orm's Head in North Wales is fully sixty miles. At an altitude of not more than one hundred feet in Douglas Bay, the Great Orm's Head can be seen distinctly in clear weather. Now, taking into consideration the convexity of the earth's surface (the distance of arc between these two places being sixty miles), according to the calculation which has already been explained, the centre of this arc would be 1944 feet higher than the coast line at each end: thus it seems natural to suppose that if the Great Orm's Head is to be seen from Douglas Bay, it would be necessary to be at an altitude of 1,944 feet at the latter place. How, it might be asked, is this fact—namely, the possibility of seeing a something at one end of an arc of sixty miles from the other—to be accounted for, if the mode of measurement of the earth's convexity be correct? for, with an altitude of only one hundred feet at the end of the arc (sixty miles) from which the observation is made, a something is seen at the other end of it. Many like observations to this have been made in different places, and similar results have been obtained, which would appear to support the theory of those who maintain that the surface of the earth is a plane.

We will now pass on to the consideration of the well-known illustration in support of the rotundity of the earth; namely, observing a ship sailing directly towards the horizon. As has

been stated, at a certain distance from the observer the hull of the ship will gradually disappear from his view ; and when that is quite out of sight, it will be observed that the masts will also disappear in a similar way. Now, it will readily be perceived that this *mode* of disappearance would happen in the event of the surface on which the ship is sailing being an arc— in fact, in no other way could the ship disappear; but by a short consideration of the case, we may be led to question, whether or not this same mode of disappearance of the ship might occur if the surface on which the ship is sailing be a *plane*.

The following fact has been noted, viz. : That a ship lost to view under the circumstances just mentioned, has been seen, after its disappearance, by the observer using a powerful telescope. The whole of the ship has thus been brought back to sight. Might one argue from this that the ship was lost to sight *because* it was so far advanced along the convex arc that the surface of the water came between the ship and the sight of the observer ? Those who maintain that this experiment is a proof of the rotundity of the earth would tell us so. If it is, what is to be said to the ship's being brought to view again by means of the telescope ?

Optics tells us that any object travelling from us (as the ship in the above instance) would disappear in a similar way, in the case of the surface between us and the object being a *plane*. If an observer standing at the end of a long street, observe the rows of gas lamps on either side, and their apparent diminution of size as the distance increases, he will see that those *nearly* lost to view in the extreme distance will present to him nothing but their tops, the lower portions being quite lost to view. If a train be watched closely as it travels from an observer, the wheels and lower part of the carriages will disappear before the top of the train will do so. Briefly, then, the following fact may be stated, viz. : that the *lower part* of any object travelling away towards the observer's horizon, will disappear *first*, and the *top part* will be *last* in view. This holds good on water as on land ; and as so, must of necessity hold in the case of a ship at sea hastening towards the horizon, which does disappear in the exact manner described.

A question thus suggests itself, viz.: Is the mode of disappear-

ance of the ship at the horizon any proof of the rotundity of the earth?

Mr. Glaisher, whose name is so well known in connection with balloon ascents for purposes of scientific discovery, has affirmed that even at the greatest distance from the earth which he has gone, he has always found that " the horizon appeared on a level with the car; " and in the London Journal of July, 1857, the following interesting reference to balloon ascents may be found : " The chief peculiarity of the view from a balloon, at a considerable elevation, was the altitude of the horizon, which remained practically on a level with the elevation of two miles, causing the surface of the earth to appear *concave* instead of *convex*, and to recede during the rapid ascent, whilst the horizon and the balloon seemed to be stationary."

This curious fact of the *concave* appearance of the surface of the earth, as seen from a balloon at an altitude of two miles, is worthy of note, and appears to be difficult of solution when considered by one acquainted with optics.   How is it that a sphere or globe of large dimensions when viewed in space at a distance of two miles or less, loses its natural form and assumes that of a convex surface to the eye of the observer ?   It seems natural to suppose that the earth being of the form of a globe, its surface as viewed from a balloon would appear just the opposite (viz. : *convex*) from what has been affirmed unanimously by all aëronauts.   Philosophy tells us that the surface of the earth (land and water) is the opposite to a *plane*, viz. : that it is convex; still it can be seen that it is possible to bring forwards arguments in favour of the earth's surface being a plane, and also that those arguments generally supposed to support the theory of the earth's rotundity are really no arguments in its favour, but decidedly against it.   It is not my intention to consider any more of the experiments that have been made than I have, but will simply leave my brief and somewhat rough explanatory statements of the same to the consideration of the reader.

In the face of modern philosophy, it would be a bold thing for one to say that the theory of Newton's disciples is a mistake, and to affirm that there *is* enough proof to show that the surface of the earth is a *plane*, and that there is no proof whatever of its being a globe.   If one were bold enough to advance such a

theory, men would smile, and the chances are that the man who did advance the same, would be ridiculed, as he might possibly deserve. Only those who have studied astronomy, can tell into what a vast sea of hazy doubt one is often plunged ; and results so bewildering are arrived at, that one is almost led to doubt any known theory whatever.

On page 392, volume ii. of Extracts from the works of Rev. John Wesley, may be found the following :—" The more I consider them, the more I doubt of all systems of astronomy. I doubt whether we can with certainty know either the distance or magnitude of any star in the firmament ; else why do astronomers so immensely differ, even with regard to the distance of the sun from the earth ? some affirming it to be only three, and others ninety millions of miles."

This extract is of some interest, in that Wesley was well up in the astronomy of his day ; and methinks he but re-echoes the sentiments of many even of the present day.

The word " speculation " might fairly be applied to many portions of the Newtonian philosophy.

To use plain language it may be said that, after all, the earth may *not* be a globe. Philosophers may be wrong. Astronomers may be only right in their general theory up to a point. The *earth* which is " stretched out upon the waters," " founded on the seas, and established on the floods," and " standing in the water and out of the water," may, after all, *be a plane !* Let us suppose it to be a plane, as the experiments which we have considered certainly tend to show. Let us suppose it to be literally " stretched out upon the waters," and in so doing, by the consideration of certain facts with reference to the position of different countries, both hot and cold, as discovered by us, we may be led to see, and that very clearly, that the supposition of the non-convexity of the earth's surface is by no means antagonistic to those parts of our established geography which decide the position of certain countries with respect to each other. The land then which is known to us, we will regard as a quantity of matter " stretched out upon the waters," the surface of both being a plane, or in other words, the whole collection of land and water known to us on the supposed convex surface of the world to be reduced to a plane. This being done, what will be-

come of the north and south poles? The north pole might still be regarded to be in the same *position* as it is now, but what becomes of the south pole? In this vast plane we naturally are at a loss to decide upon its limit! How far away from our known land do the waters surrounding it stretch in all directions? This is beyond our power to decide, or even guess at, if this vast plane which we have been supposing does really exist. Who can tell of the boundless extent of the " world without end;" or who dare say that there is any limit to the waters, which, maybe, extend into infinite space? In the consideration of this vast plane, the surrounding waters of the earth must be, what is called by philosophers, the south pole, which has been regarded to be in a similar position to the north pole, at the other extreme of the supposed globe. The space within the arctic circle has been explored to a certain extent by navigators, but the space within the antarctic circle at the south pole, has never been. The most experienced navigators have always failed to make any progress of importance at the south pole, and all reckoning and calculation have been baffled. The barriers of ice at the south have prevented navigators from penetrating far, and even as far as they have gone, they have been much puzzled by a total disarrangement of their calculations. In the account of one of his voyages Sir James Clark Ross observes:—" We found ourselves every day from twelve to sixteen miles by observation in advance of our reckoning," and again, " by our observations we found ourselves fifty-eight miles to the eastward of our reckoning in two days."

Up to the present time, no navigator that has been heard of has succeeded in sailing round the world within or upon the antarctic circle; and if the antarctic circle was similarly placed in the south to the corresponding arctic circle in the north, where were the difficulty in sailing round it? At the north, navigators have found none of the disarrangement of their calculations, that has always perplexed them at the south. For this there must be a reason; and if what we have defined to be the antarctic circle be really a very large circle, or glacial boundary, at a certain distance from the region of our known land in the vast plane, the truth of the reports of navigators who have attempted to sail round the world at the south, may easily be imagined.

And it may be remarked here, that with respect to the fact noticed by aëronauts, that the surface of the earth, from a balloon, appears to be concave, and that the horizon appears to be always on a level with the car of the balloon, is quite agreeable to the notion that the water in the south (viz. : the horizon to the observer in a balloon) is higher than that in the north. It is well known that the atmospheric pressure in the south is much less than it is in the north, and consequently the water in the southern region must be higher than elsewhere. A quotation bearing upon this point may be made from Captain Ross's voyages :—" Our barometrical experiments appear to prove that a gradual diminution of atmospheric pressure occurs as we proceed southwards from the tropic of Capricorn." Further on he says : —" It has hitherto been considered that the mean pressure of the atmosphere at the level of the sea was nearly the same in all parts of the world, as no material difference occurs between the equator and the highest northern latitudes." And again he observes :—" The causes of the atmospheric pressure being so very much less in the southern than in the northern hemispheres remains to be determined."

It may be found upon consideration that the argument in favour of the rotundity of the earth, with respect to navigators sailing in the direction due east or due west, returning in the opposite direction, will also apply, and equally well too, in the case of the supposition that the earth's surface is a plane. This can be easily understood, and does not require any explanation or illustration. Since, therefore, this argument does apply in the case of the earth being a plane, does it follow that the argument, applying in the case of its being a globe, *proves* that it is a globe ?

It has been noted by navigators, that there is a certain gain and loss of time in the matter of sailing east and west. This fact has been cited as a proof of the rotundity of the earth. It may be observed, however, that this gain and loss of time will also appear in the case of the earth's surface being a plane. It is wrong and unfair, therefore, to affirm that this effect can *only* be produced in the case of the earth being a globe. There is a well known story told by many in support of the theory of the convexity of the earth's surface, that two brothers, who were twins, when they arrived at a certain age started in opposite

directions with a view of circumnavigating the earth.   They did
so, and upon their again meeting it was found that one was older
than the other by one day !   If this story be a fact, it is still no
less a fact that the same thing might happen in the case of the
earth being a plane.   Hence it is hardly right to cite this story
as a proof of the earth's rotundity.

One great argument in support of the rotundity of the earth,
with respect to the north star is often quoted.   It may be in-
teresting briefly to notice this, and endeavour to see if the
argument be a strong one or not.   The north polar star (Polaris)
is supposed to hang, so to speak, immediately over the north
pole.   Navigators have observed that this star appears gradually
to approach the horizon as they proceed towards the equator,
receding from the north, and because this star vanishes upon
their arriving at the equator, it is argued that the earth's surface
must be convex.

It is a known fact in optics that, as the space between the observer
and the thing observed increases, the thing observed becomes
smaller, and *its height diminishes*.   This may always be noticed
at any time, by observing a tall tree, or church spire, &c., the
distance between the object and the observer to vary.   If any
tall object be sighted on a plane, it will be observed that, as the
observer recedes from it, its height will gradually diminish ; and
at a sufficiently great distance, the angle of sight, now very
small, will ultimately vanish altogether.   By the same rule,
therefore, the apparent height of Polaris will diminish, and at a
certain distance, it will be lost to sight by this simple truism in
optics.   It may be seen, therefore, that, though Polaris vanishes
in the case of the surface over which the observer is receding,
being convex, still it would also vanish in the case of that same
surface being a plane.   But we now arrive at a very interesting
point with reference to the observation of the North Star.   If
the north star be placed where we have supposed it to be, and
the surface of the earth be of the exact convex form that we
have supposed it to be, then it would be an impossible thing for
this star to be seen from any place south of the equator ; for the
line of sight from any point south of the equator, must of neces-
sity go off at a tangent to the sphere, and, in that case, must
fail to reach the north star.   This seems evident, and must be

acknowledged to be so. It is curious, therefore, to note the several accounts that have come to us at different times, of this north star having been seen from the south side of the equator. How it is possible, seems difficult to say, if the sphericity of the earth exists, as the Copernican and Newtonian philosophy tells us that it does. This star has, however, been seen as far south as the tropic of Capricorn. I am given to understand that, in the " Naval and Military Intelligence " of the *Times,* of 13th May, 1862, it is stated that Captain Wilkins distinctly saw the southern cross and the polar star at midnight, in 23·53 lat., and 35·46 long. It would seem, therefore, that this fact with reference to the polar star being visible below the equator, at such a distance, might form a strong argument against the rotundity of the earth.

Some time since, it was a common practice amongst surveyors and men employed in laying out canals and railways, to allow eight inches for every mile for the consideration of the convexity of the surface of the earth. It was supposed that, if this were not done, the water in the canal would not remain stationary. It has, however, since been discovered, that things are more satisfactory when this allowance of eight inches to the mile is not permitted to enter into the calculations at all; in fact, in those cases where an allowance is made, every thing turns out most unsatisfactory. The allowing then for convexity, or what was called by engineers " forward levelling," has given way to the method of " back-and-fore " sight, or " double sight," where no allowance whatever is made for convexity. Those who argue in favour of the earth's surface being a plane, point proudly to the fact that all the most practical scientific men of the day totally disregard the sphericity of the earth's surface, and regard it, for all practical purposes, as if it were a plane.

What has been thus far said with reference to the form of the earth, is intended to be of interest to the reader; and it is not to be supposed that the theory of the earth being a *fixed plane* has been supported in opposition to the generally received idea of the sphericity of the earth, and of its orbital and axial motion. Some of the leading arguments in favour of the Newtonian theory have been briefly touched upon, and in such a manner that it might be said the soundness of the same is brought in question;

still, if the way in which I have treated the same be in accordance with the *truth*, it will not be necessary for any one to be offended.   The reader who is not versed in astronomy, and unacquainted with the method adopted for the calculation of various astronomical phenomena, will readily point to the splendid exactness with which astronomers foretell a coming eclipse, and hold that up to those who would advance the theory of the earth's surface being a plane.   It might, at first, seem fair and just for him to do so; but when it is known that these astronomical calculations, exact as they are, are not dependent upon any theory whatever, and would hold even in the event of all known theories being disregarded, he will be led to see that the theory of the earth's surface being a plane, does not seriously affect astronomy in the main.   Those acquainted with astronomy, know full well that the necessary data for managing calculations are tabulated, and used without necessary reference to any known theory.   And again, at the will of the calculator, *any* theory might be adopted, and equally true results will follow. From years of practical observation, certain tables of the moon's relative positions have been made, and may, if it please the astronomer, be used in connection with any theory whatever. It is a known fact that Ptolemy, who lived in the second century of the Christian era, did not fail, notwithstanding the considered defects of his system—to calculate with exactness all the eclipses that happened during the period of the coming 600 years.

In his Lectures on Natural Philosophy, Professor Partington observes :—" The most ancient observations of which we are in possession, that are sufficiently accurate to be employed in astronomical calculations, are those made at Babylon, about 719 years before the Christian era, of three eclipses of the moon. Ptolemy, who has transmitted them to us, employed them for determining the period of the moon's mean motion ; and, therefore, had probably none more ancient on which he could depend. The Chaldeans, however, must have made a long series of observations before they could discover their ' saros,' or lunar period of 6,585 days, or about 18 years ; at which time, as they had learnt, the place of the moon, her *node* and *apogee*, return nearly to the same situation with respect to the earth and the sun, and, of course, a series of nearly similar eclipses occur."

In Somerville's " Physical Sciences," it is said:—" No parti-cular theory is required to calculate eclipses ; and the calculations may be made with equal accuracy *independent of every theory.*"

And, again, Sir Richard Phillips, in his " Million of Facts," says :—" The precision of astronomy arises, not from theories, but from prolonged observations, and the regularity of the motions, or the ascertained uniformity of their irregularities. Ephemerides of the planets' places, of eclipses, &c., have been published for above 300 years, and were nearly as precise as at present."

According, therefore, to my intention, as stated at the com-mencement of this pamphlet, we will suppose the earth to be a plane, and free from any orbital or axial motion. The earth then being *fixed*, we must suppose the sun to move, and we shall be led to see that, with these suppositions,—namely, the surface of the earth being a plane, and fixed, and the sun to move, in such a manner as will be described, the change of seasons, sun-rise and sunset, the positions of some countries necessitating a higher temperature than that of others, can all be accounted for, and perfect harmony *may* exist between our *suppositions* and those facts with which we are acquainted.

It may be stated here, that experiments tending to show that the earth is fixed and free from all motion, have been brought under my notice, which were of a somewhat interesting char-acter ; but I refrain from bringing them before the reader, for the reason that too much space would be occupied by consider-ing the same.

The motion of the earth with its accompanying atmosphere, is not perceptible to us ; but the sun *appears* to us to move. We are now about to suppose this apparent motion of the sun to exist in reality, and in doing so, to regard the locus of its motion as a circle, at a certain distance from the *plane* of the earth's surface, concentric with the north pole. It is at once acknow-ledged that, if the apparent (?) motion of the sun be noticed from any northern latitude, and for any period before and after the time of its passing the meridian (or southing), it will appear that, in its motion, it describes the arc of a circle. Now, any object moving in an arc, cannot possibly return to the centre of that arc without having completed a circle. It would seem, then, that the

sun does this daily, and that visibly. To support this, we might call to mind the observations of the arctic navigator, Captain Parry, who, with several others with him, upon ascending high land at the north pole, saw the sun *describing a circle upon the northern horizon*, and that more than once. Regarding the earth's surface as a vast plane, this phenomenon can be readily conceivable, and also that the circular path of the sun's daily motion be over some countries of this plane. In performing its journey, the sun may travel at just such a rate as to afford light to those countries within its reach, for the period of time called by us day, regarding the *extent* of land and water thus receiving light to be such as to admit of this idea. It is well known that those parts of the earth's surface in the vicinity of the north pole, have no light from the sun for some months in the year. This is by no means a difficulty to be accounted for in the theory which we are supposing, for the diameter of the sun's path is constantly changing,—diminishing, as it does, from December 21st to June 15th, and enlarging from June to December. There is no doubt of this fact, for it is proved by the northern and southern declination ; or, in other words, that the sun's path is nearest the north pole in summer, and in the winter it is farthest away from it. In the following table by Mr. Glaisher, the difference of altitude caused by the difference in position, as noted at different times of the year, may be seen.

SUN'S ALTITUDE AT THE TIME OF SOUTHING, OR BEING ON THE MERIDIAN :—

Date.		Sun's Altitude.	Time of Southing. M. S.	
June	15,	62°	0 4	before noon.
„	30,	61⅔°	3 18	after noon.
July	15,	59⅔°	5 38	„
„	31,	56½°	6 4	„
Aug.	15,	52½°	0 11	„
„	31,	47°	0 5	„
Sept.	15,	38⅔°	4 58	before noon.
„	30,	35½°	10 6	„
Oct.	31,	24°	16 14	„
Nov.	30,	17°	10 58	„
Dec.	21,	12°	0 27	„
„	31,	15°	3 29	after noon.

Date.		Sun's Altitude.	Time of Southing.		
			M.	S.	
January	1,	15½°	3	36	after noon.
,,	15,	17°	9	33	,,
,,	31,	21°	13	41	,,
Feb.	15,	25°	14	28	,,
,,	29,	30½°	12	43	,,
March	15, {On the Equator at 6 a.m.}	{ 36°	9	2	,,
		{ 38½°	0	0	,,
,,	21,	42½°	4	10	before noon.
April	15,	48°	0	8	,,
,,	30,	53°	2	58	,,
May	15,	57°	3	54	,,
,,	31,	60°	2	37	,,

Briefly then, it may be observed, that the six months' darkness at the north pole is at once accounted for by noting the change in the length of the diameter of the circular line of motion of the sun's course. The sun travelling over the plane surface of the earth at once, too, decides the question of *why* some countries should be warmer than others. Those immediately under the influence of the sun's rays must naturally be warmer than those more remote.

We have supposed, then, the sun to travel in a circular course parallel to the earth's surface, and perform the whole circle of its journey once in twenty-four hours. Thus, then, in twenty-four hours, every part of the earth experiences day, night, sunrise, and sunset. At whatever place on the earth's surface an observer may be, it will appear to him that the sun seems to *rise* in the east (with respect to his position), and *set* in the west. According, though, to one supposed theory, however, the sun is *always* at the same distance from the earth's surface, and the *apparent arc* which it makes from our sunrise and sunset is only natural, even if the earth *be* a plane. Optics tells us so. Let us compare the sun to a balloon sailing away from us. As the distance between us and the balloon increases, although its altitude may not increase, it will appear to us gradually to approach the horizon. So it is with our view of the sun : when at sunrise it first appears to our view, it would *seem* to be rising from the horizon. By the same rule in optics, at the close of our day, when the sun is travelling away in the distance, *sunset* will

come to us, as the sun appears again to dip beyond the horizon;
so, as sunset is coming on with us, sunrise is coming on to others.
This is plain and consistent and worthy of consideration. Again
let it be repeated that all that has been briefly stated with res-
pect to sunrise and sunset, is strictly in accordance with acknow-
ledged laws in optics, supposing the earth's surface to be a plane.
It is at once seen, therefore, that the *seasons,* as they occur, fol-
low naturally and at once from the sun's relative position to the
north pole.

It has, doubtless, often been observed that the size of the sun
at the times of sunrise and sunset appears to be much larger than
at other times. This, however, is merely an *apparent* change
in the size of the sun, as will be shown. It is well known that
any object viewed through a dense atmosphere appears much
larger in size than when viewed otherwise. This applies, per-
haps, particularly true in the case of a light; for instance, a gas-
light viewed in a fog, when the atmosphere is dense and filled
with aqueous particles, appears to be nearly double its usual size.
The atmosphere nearer the earth is more dense than that which
is more remote; and in consequence of our viewing the sun at
sunrise and sunset through the atmosphere directly between us
and our horizon (viz.: a far more dense atmosphere than that
immediately above us), it appears to us to be of a different size.
Sir Richard Phillips proves by actual measurement that this dif-
ference in the size of the sun as it appears to us is only an optical
impression; for he says: " If the angle of the sun or moon be
taken either with a tube or micrometer when they appear so large
to the eye in the horizon, the measure is identical when they
are in the meridian, and appear to the eye and mind but half the
size. The apparent distance of the horizon is three or four
times greater than the zenith. Hence the mental mistake of
horizontal size, for the angular dimensions are equal; the first
5° is, apparently to the eye, equal to 10°, or 15° at 50° or 60° of
elevation; and the first 15° fill a space to the eye equal to a
third of the quadrant. This is evidently owing to the ' habit of
sight;' for, with an accurate instrument the measure of 5° near
the horizon is equal to 5° in the zenith."

In regarding the surface of the earth to be a plane, the method
of calculating the exact distance of the sun from us is very simple,

in consequence of this arc (?) of the distance between the two
points from which the observation is made being *nil*. In ob-
serving the angles of altitude of the sun at the same moment
from two places, some fifty miles apart, by means of plane trigo-
nometry, the perpendicular distance of the sun from the earth's
plane is at once calculated, and found to be less than 4,000
miles. The officers engaged in the ordnance survey some time
since gave the following observation to us. Altitude of sun at
London 55° 13'; altitude taken at the same time on the grounds
of a school at Ackworth, in Yorkshire, 53° 2'; the distance be-
tween the two places in a direct line, as measured by triangula-
tion, is 151 statute miles. From these elements the distance
of the sun may be readily computed. It will be found to be less
than 4,000 miles. This is a startling statement, and may possibly
be of interest to the reader.

The method for calculating the sun's distance from the earth,
which has been briefly touched upon, would of course apply
equally in computing the distance of the stars, &c., from us.
The distances of these heavenly bodies being reduced so greatly
will certainly affect the magnitude of the same. Upon this
point, though, it will not be our object to dwell.

Enough has been said to engage the attention of the thought-
ful reader upon the subject of the form of the earth; and it may
be interesting to add an extract upon "perspective on the sea,"
taken from a small book entitled "Zetetic Astronomy," pub-
lished by Messrs. Simpkin, Marshall, & Co., London; which
extract, though not stated in the exact words of the account
given there, is still in the main the same. The law of perspective,
as often taught, is fallacious and contrary to every thing seen
in nature. If any object be held up in the air, and gradually
carried away from an observer who maintains his position, it is
true that all its parts will converge to one and the same point;
but if the same object be placed upon the ground and similarly
moved away from a fixed observer, the same predicate is false.
In the first case the *centre* of the object is the *datum* to which
every point of the exterior converges; but in the second case the
ground becomes the *datum* in and towards which every part
of the object converges in succession, beginning with the lowest,
or that nearest to it.

Instances :—A man with light trowsers and black boots, walking along a level path, will appear at a certain distance as though the boots had been removed, and the trowsers brought in contact with the ground.

A young girl, with short garments terminating ten or twelve inches above the feet, will, in walking forward, appear to sink towards the earth, the space between which and the bottom of the clothes will appear gradually to diminish ; and in the distance of half a mile her legs, which were at first seen for ten or twelve inches, will be invisible—the bottom of the garment will seem to touch the ground.

A small dog running along will appear gradually to shorten by the legs ; which, in less than half a mile, will be invisible, and the body appear to glide upon the earth.

Horses and cattle moving away from a given point will seem to have lost their hoofs, and to be walking upon the outer bones of the limbs.

Again, it may be noticed that carriages receding in a similar way to the above, will seem to lose that portion of the rim of the wheels which touches the earth ; the axles will appear to get lower ; and, at the distance of a few miles, the body will appear to drag along in contact with the ground. This fact is very remarkable in the case of a railway-carriage, when moving away, from the straight and level portion of line several miles in length. These instances, which are but a few of what might be quoted, will be sufficient to prove, beyond the power of doubt or the necessity for controversy, that, upon a plane or horizontal surface, the *lowest part* of bodies receding, from a given point of observation, will disappear *before the higher*. Now, this is exactly the case when a ship at sea is observed : when outward bound, the *lowest* part—the hull—disappearing before the higher parts —the sails and masthead. Abstractly, when the lowest part of a receding object thus disappears by entering the " vanishing point," it could be seen again to any and every extent by a telescope, if the power of the same were sufficient. This is, to a great extent, practicable upon smooth horizontal surfaces, as, for instance, upon frozen lakes, and also upon long straight lines of railway. But the power of restoring such objects is greatly modified and diminished where the surface is undulating

or otherwise movable, as in the large and level plains of
America and the vast prairies; and particularly so upon the
ocean, where the surface is always more or less in an undulating
condition. In Holland and other level countries, persons have
been seen in winter skating upon the ice, at distances varying
from ten to twenty miles. On some of the straight and " level "
lines of railway which cross the prairies in America, the trains
have been seen for more than twenty miles : but upon the sea
the conditions are altered, and the hull of a receding vessel
can only be visible to the naked eye for a few miles, and this will
depend very greatly—the altitude of the observer being the
same—upon the state of the water. When the surface is
calm, the hull may be seen much farther than when it is rough
and stormy; but, under ordinary circumstances, when, to the
naked eye, the hull has just become invisible, or is doubtfully
visible, it may be seen again distinctly by means of a powerful
telescope. Although abstractly or mathematically there should
be no limit to this power of restoring, by means of a telescope,
a lost object upon a smooth horizontal surface, upon the sea
this limit is soon observed; the water being variable in its
degree of agitation, the limit of sight over its surface is equally
variable, as shown by the following experiments : In the month
of May, 1864, on several occasions when the water was unusually
calm, from the landing stairs of the Victoria Pier, Portsmouth,
and from an elevation of 2ft. 8in. above the water, the greater
part of the hull of the Star Light Ship was, through a telescope,
distinctly visible ; but on other experiments being made, when
the water was less calm, no portion of it could be seen from the
same elevation, notwithstanding that the most powerful telescope
was used. At other times, half the hull, and sometimes only
the upper part of the bulwarks, was visible. If the hull had
been invisible from the rotundity of the earth, the following cal-
culation will show that it should at all times have been 24ft.
below the horizon : " The distance of the light-ship from the
pier is eight statute miles. The elevation of the observer being
thirty-two inches above the water, would require two miles to
be deducted as the distance of the supposed convex horizon ; for
the square of two, multiplied by eight inches (the fall in the first
mile of the earth's curvature), equals thirty-two inches. This,

deducted from the eight miles, will leave six miles as the distance from the horizon to the light-ship. Hence, $6^2 \times 8in.=288in.$ or 24ft. The top of the bulwarks, it was said, rose about ten feet above the water line; hence, deducting ten from twenty-four feet, under all circumstances, even had the water been perfectly smooth and stationary, the top of the hull should have been fourteen feet below the summit of the arc of water, or beneath the line of sight! This one fact is entirely fatal to the doctrine of the earth's rotundity."

The above experiment I have given to the reader in the exact words in which it was stated. There is great room for interest in following the reasoning of the same.

It is known also, that the two High Whitby Lights are 240ft. above high water, and are visible for some twenty-three nautical miles at sea. The proper calculation would appear to be 102ft. below the horizon!

Many like instances might be cited, which would present equally great difficulties in explaining upon the theory of the sphericity of the earth's surface.

Reader! my few lines are written, and it is to be hoped that they will afford some amount of interest to those wishful to distinguish between the two theories as to the form of the earth. That I shall not be accused of assisting to propagate the theory of the non-sphericity of the earth, I humbly trust; and that one who sees and is unable to explain away several portions of this pamphlet, militating, to a certain extent, against the Copernican and Newtonian philosophy, would be unwishful to see those points clearly met, and in such a manner as would add to the honour of modern astronomy and science generally, I would not suppose. Let those who say that astronomy, such as it is, is antagonistic to Scripture, be shown that they are wrong in what they say; or if they are *not* wrong, let them know, and prove that they are right.

" He stretcheth out the north over the empty place, and hangeth the earth upon nothing " (or, *layeth it upon the waters*, according to a Chaldee version). Job xxvi. 7.