A TREATISE

ON

LIGHT, VISION & COLOURS;

COMPRISING

A THEORY ON ENTIRE NEW PRINCIPLES,

DEDUCED, BY GREAT CARE AND STUDY, FROM COMMON NATURE, EXPLANATORY OF MUCH PHENOMENA NOT BEFORE EXPLAINED OR UNDERSTOOD.

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PREFACE.

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PREFACE.

It is with extreme diffidence that I venture to lay before the public a book of philosophy on Light, Vision, and Colours.

Under all circumstances, a generous and enlighted public will speedily discern the merits or defects of a work submitted for their consideration, and an author may always expect a candid opinion will be given thereon; but, when I consider that the subject before me has occupied the consideration of the greatest talented philosophers the world ever produced, and that the opinions of those eminent persons have been sanctioned and recorded, and again and again confirmed by all the learned and intelligent communities in every country and kingdom throughout the world, without one dissenting voice; and that the opinions I have here expressed are in diametrical opposition to those I have before mentioned, it is only reasonable to anticipate an amount of opposition from those whose interests and prejudices are affected by improvements and strongly protected by wealth and talent. Under such circumstances, I find a greater demand upon my courage than I ever before experienced; but when, on the contrary, I look at the importance of the subject that has engaged my attention, and feel a conviction of the purity of the motives which have induced me to develope the truth, with, also, a firm conviction that certain phenomena in light and vision could not be accounted for under either of the present existing theories; and that science in that department must remain stationary until a complete revolution in the theory of light and vision could be effected, I come to the resolution that nothing should deter me from endeavouring to add my mite to the improvement of science, by endeavouring to correct the numerous misunderstandings that abound in the minds of millions that are in extreme anxiety upon a subject that has never been satisfactorily explored or explained. When I take into consideration that where there is such an amount of learning and wealth, there must also be an amount of independence, and that in most instances it requires less labour to establish truth than it does to maintain errors; and also, that I believe there is in existence a class of persons, both wealthy and learned, whose whole aim is directed to philosophic pursuits, and whose ambition is to arrive at correct notions, and whose honour and integrity are only equalled by their disgust at mean actions. I therefore feel a consolation that the merits of this work are under better protection than were the works of Galileo and Copernicus in their days.

THE THEORY OF LIGHT explains the origin and cause of light,—its method of shining and finding its passage through the different media, in such a way as fully to develop the cause of reflection and refraction; it also discovers that light has peculiar qualifications strictly essential to vision, and it fully explains a mass of phenomena in light not before understood.

THE THEORY OF VISION supersedes the necessity of objects sending their images to the eyes to be seen, and fully explains the capacities of the eye and its capabilities of taking perceptions of objects without the use of images; and it also demonstrates the absurdity of a thoroughfare for perceptions through the convex lens to the brain, and points out a better means of taking perceptions and a better rout for them to the brain.

THE THEORY OF COLOURS shows how, and by what means, the colours that are hid in the atmosphere are discovered and made visible by the use of the prism, and its magnifying powers in connection with shadows and grades of light; and satisfactorily demonstrates that each of the prismatic colours has a shadow peculiar to itself, by which only it can be seen; and it renders the theory of the rainbow and other clouds, with their colours, familiar to a common capacity.

The claims of discovery by the Author are the following:

1st. That the eyes of animals produce genuine light, and that eye-light partakes of all the properties or qualifications appertaining to the other light of the universe, such as reflection and refraction.

2nd. That light does not bring the images of objects to our eyes to be seen, but that the eye with vision extended, takes perception of objects in their respective localities.

3rd. That he has solved the question amongst optical writers, why we do not see double, in as much as we have two eyes.

4th. That he has solved the question amongst optical writers, why we see things in their natural state.

5th. That genuine light is the mere shine of bright substances.

6th. That light has no regular progressive motion, as is imputed to it by modern philosophy.

7th. That the path of light in reflection, refraction, and direct light, is directed by its power of shining, and its power of shining proceeds from its own shape.

8th. That light has three qualifications that befit it for its office, and that without either of those qualifications, it would be incompetent.

9th. That things called reflectors of light, are also producers of light.

10th. That day and night are not formed by the heat of the sun, but by the gravitation of the sun operating upon the heat and light contained in the different atmospheres of the planets, in the solar system, all of which possess a sufficiency of heat for their respective purposes.

11th. That the retina of the eye does not receive images or impressions of objects, but that the cornea is wisely contrived by nature, for the express purpose of a seat of vision, and for taking perception of objects.

12th. That perceptions of distant objects are obtained by a union of vision, which I term universal eye-sight.

13th. That if genuine light is capable of passing through the different lenses of a telescope, it is not capable of taking an image with it through them, and that if an image could be taken through them, it would be so mutilated by the process, that it would not be known or identified.

14th. That Roemer, the Danish astronomer, failed to discover the true cause of the lateness of the appearance of Jupiter's satellite, after it emerged from behind the planet.

15th. That Dr. Bradley failed to discover the true cause of the aberation of the stars.

16th. That he gave a correct explanation of what has been called the phenomena or illusion of the lenticular stereoscope, lately brought to a high state of perfection by Sir David Brewster.

17th. That he explained the true cause why we can see a coin lying at the bottom of a bowl, by means of pouring water into the bowl, although we could not see that same coin without the use of the said water.

18th. That he satisfactorily demonstrates and explains, by the use of a convex lens, that the sun, the moon, and the principal stars, do not send their image with any light of theirs to the eye.

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A TREATISE

ON

LIGHT, VISION AND COLOURS.

SECTION I.

Strange Appearances. Incompetency of Light to convey Images of Objects to the Eye. Occular Demonstrations upon Vision. Mystery. The Cause why we do not see Double, and why we see things in their Natural State.

It has always appeared strange to me that images of objects should be brought by light and placed upon the retina of the eye—particularly so—when we consider that the eye has a better view of objects when stationed in a dark place and viewing any object in the light, than it would have if stationed in a light place and viewing objects in the dark.

Suppose a man standing at the bottom of a well, he would see a thing more distinctly at the top of the well than he would see the same thing if he was stationed at the top, and the thing he was looking at were placed at the bottom.

It appeared equally strange to me that the image of a star or planet should be brought, and partly conducted, through a telescope by light, and placed between the eye-lens and the field-lens there to be viewed. But, above all other considerations, the strangest appearance was that light should bring to my eyes the image of any shadow whatever. If I look at the moon, I behold the different shadows projected by the hills and mountains upon the moon's disc; so long as those shadows are screened from the sun's rays we see them, but, no sooner do they become exposed to the sun than they are obliterated by the sun's brilliancy and rendered invisible by the very same body that we are to consider the faithful bearer of all images to the eyes.

It also appears very strange to me, that modern philosophy should attribute to light a regular progessive motion, sufficiently correct and undeviating as to be used as a standard for several purposes of the greatest nicety, and to lay it down as a rule that its motion is not instantaneous, as the ancients considered it, but that it progresses regularly about 192,000 miles per second.

Appearances so at variance with my understanding, and apparently so with nature, created in me a desire to develope the truth, and unravel the apparent mystery concerning them, and, to accomplish the desired object, I considered it most prudent to consult common nature and begin at the bottom, making sure that, if I could but follow nature through all her intricacies and windings, I should not be led astray.

Thus, taking nature for my guide, I resolved to throw off all prejudices and former impressions that might influence my consideration, and thereby enable myself to look common nature fully in the face. I resolved to commence thinking in earnest, and after thinking, considering and comparing, I at length arrived at certain conclusions, and, by degrees, I discovered certain criteria which, though humble in their appearance, afforded me substantial assistance, because founded upon nature.

If we examine the capabilities of light we find it incompetent to the task of transporting or conducting the images of objects to our eyes, for both light and image must, of necessity, pass thousands of miles transversely through all the light that is moving out of the path, or orbit, of a planet or satellite that it might be despatched from or proceeding to.

I cannot see how an image or a shadow, or the image of a shadow, or any other faint substance, could be conveyed to such distances through so much light without being obliterated, nor through so many atmospheric fluids without interference; and though light itself might find its way through transverse currents of light, its own thinness of substance, and its imponderability, would greatly assist its passage or admission, yet, it would undoubtedly have no chance of carrying images with it.

Where, I would ask, is the consistency of considering that light brings the images of objects to our eyes, as millions of us gain perception of objects at one and the same time from all parts of the universe. How could light answer so many demands from numberless eyes and how receive our requisitions for dispatch of business? Light would require a previous communication from the eye, to enable it to answer so punctually all the uncertain and irregular demands with such amazing dispatch, millions of millions of images to be dispatched momentarily!

besides all this, light would require life; no inanimate substance could perform an office, whose duties require so much discretion and punctuality.

The more I think of such things, the more unreasonable does it appear that light should travel undeviatingly 2,880,000 miles, in fifteen seconds, leaving the image of Jupiter's satellite; such an unerring performance to be required, of such an unsteady fluid, is too unreasonable to be entertained.

Suppose I am looking across a field: I see a tree; if I shut my left eye I see the tree with my right eye, if I shut my right eye I see the tree with my left eye; but, when I open both my eyes, I only see one tree; now, as the right eye viewed the tree it must be evident that vision unites the right eye with the tree, and that vision must have been on the right side of the nose, so, as the left eye viewed the tree, it must be evident that vision united the left eye with the tree, and that vision must have been on the left side of the nose.

If it was, as is generally believed, that light brought the images of objects to our eyes, it would undoubtedly have brought me an image for each of my eyes, and I should have received as many impressions with my two eyes, conjointly, as I received with my two eyes individually; and, in case of viewing a plurality of trees, I should have received two perceptions for each tree; but, be there many or be there few, I only receive one perception for each tree or just the same number of perceptions with both my eyes as another man receives who has but one eye.

It seemed so mysterious to me that a person who had but one eye should gain as many perceptions of a certain number of trees as I could gain with both my eyes; the phenomenon seemed to overpower me, and I found my curiosity aroused, and having recourse to a book of Philosophy upon the subject, the author's account only added mystery to mystery, it was there said, "As the image which is formed by a convex lens, is inverted as respects objects, so must the image which forms at the bottom of the eye. It has therefore been a question amongst optical writers why we see objects in the natural position, and also, why we do not see double, inasmuch as we have two eyes. Various explanations of these facts have been offered chiefly founded upon optical principles, none however appear to have given general satisfaction."

I therefore made it a particular portion of my enquiry, and, by a series of experiments and a deal of consideration, I plainly discovered that light did not bring images of objects to the eye, but that the eye, with vision extended, takes perception of objects in their respective locality, and this is the sole cause why we only get one perception for each object with both eyes, or in other words why we do not see double, inasmuch as we have two eyes.

It must be evident, that if the two eyes send forth a stream of vision each, and those two streams after passing the nose, unite and form but one stream, the amount of both united will only be one stream and can take but one perception in the locality of the objects, but far different would it be if an object had to send its image to the eye, in that case it must either send two whole images in the the same manner that it sent them individually, or, two halves of an image, which process it never performs. It is therefore very clear why we do not see double. And the same may be said about images being formed at the bottom of the eye, and why we see things in their natural position.

The cause of this is similar to the former. There is no image formed at the bottom of the eye, and the eye by extending its vision to the object, sees things in their natural position, and also in their right place.

When I look with only one eye at an object singly, that one eye occupies nearly all the space between it and the object, and when I look with both my eyes, they together only occupy the same space as the one did; therefore, it is clear to be understood that if perceptions are taken by a mass of vision, leaving the eye never to return, only one perception can be had of one object at one time, any more with two eyes than one; but, if light brought the images of objects to the eyes when both were in readiness to receive them, it certainly would use both eyes alike and give each an image.

I will not trouble the reader with all the expedients I have had recourse to before bringing myself to the aforementioned conclusions, suffice it to say, that I have fully satisfied myself, and I will endeavour to satisfy the reader with more facility and less labour.

To avoid misunderstandings, it is necessary here to mention that it is not contended that the light of the universe does not reflect or refract, but it is strongly denied that light brings the images of objects to our eyes by any progressive motion. It is also denied that light has any regular progressive motion; and it is also asserted that there is no need for such a regular progressive motion; and it is also asserted that the eye is a producer of light, and by it, united with the light of the universe, takes perceptions of objects in their respective localities, and that the light of the eye possesses the qualities of reflection and refraction as all other light does, and to the general light of the universe may be attributed the illumination of all objects, and rendering them visible with the exceptions of shadows, which light renders invisibie.

SECTION II.

Demonstration on Reflected Light by a Looking-glass and Candle. Observations on the same may be demonstrated by the Sun, Moon or Stars. A man in front of a Looking-glass. Experiment upon Vision by the use of Poles. Observations thereon.

It has always been considered that when a person looks at a mirror he sees the image of some object that light has brought to the glass and reflects back to the eye, but after various considerations I find that light neither brings the image of objects to the glass, nor reflects them back to the eye, it merely illuminates the object, and the light of the eye, performs that office of reflection at the glass, and falling back upon the object where it takes its perception.

Suppose I take a looking-glass and lay it flat upon a table, and place a candle on the opposite side of the table, at some distance from the glass, and somewhat elevated above it, and then place myself on the other side of the table in such a position that I can clearly see by reflection the flame of the candle by looking at the surface of the glass, and then I procure some person to assist me. First I shut my left eye and direct my assistant to make a mark upon the glass where the flame of the candle is seen by my right eye; next, I hold my head steady and shut my right eye, and direct my assistant to make a mark upon the glass where the flame of the candle is seen with my left eye. Next, with a steady head and both my eyes open, I tell my assistant to make a mark where the flame of the candle is seen with both my eyes, having done thus, I perceive the three marks upon the glass will correspond with my two eyes and the centre between them.

From this demonstration I readily perceive that as there never was but one flame seen at one time, and that flame was seen each time in a different situation, at the discretion of one or both of my eyes, where and when they please to have it, and as the eyelids opened and shut, so the flame seen on the glass removed from place to place, whilst all the time the candle remained stationary, and all the motions of the flame corresponded to the motions of the eyelids; in such case surely it must be that the light of the eye proceeds to the glass and is reflected from thence to the candle where perception is had.

Similar experiments may be made on the sun, in the day time, by the use of a looking-glass, and on the moon or the stars, by a pool of water in the night. They will all corroborate the fact that light does not, by either direct approach or by reflection, perform any office of bringing images of objects to the eye, but that eye-light is entitled to the credit of taking perceptions of objects in their respective locality.

Try another experiment. Let a man place himself in front of a looking-glass and observe what he sees whilst his eyes are directed to what are called their images. The vision of the eye, in this case, passing to the glass, must directly meet the vision that is returning from the glass, and, if any image or substance, whatever, was returning from the glass to the eye, it would cause interference with the vision passing from the eye to the glass, and no perceptible substance could be there without being perceived; but there is no such interference, all is calm and clear perception, and the, so-called, images appear to be as far in the rear as the man is in front of the glass, although the glass itself is, perhaps, no more than the eighth or tenth part of an inch thick.

The only conclusions we can possibly draw from this, are, that the apparent distance in the rear was the real distance in front of the glass, and that every particle of matter between the man's eyes and the glass, whether atmospheric air or fluid contained therein, formed part and parcel of his vision, that was completely doubled about at the glass and continued back to the eyes, and that the so-called images are the eyes in reality.

If I take a thin rod or pole and set it up about two feet distant before my eyes and place another pole at a considerable distance, say a furlong, in front of the first, and then arrange myself behind the first pole, so that the centre between both my eyes is in line with both poles, then, with my left eye shut, the vision from my right eye will pass the right side of the first poll and spread on both sides of the distant pole to a great extent, and then, with my right eye shut, the vision from my left eye will pass the left side of the first poll and spread on both sides of the distant poll to a great extent. Thus the vision from both my eyes will cross over and intermix with each other and pass through each other, and unite with each other, yet they do not incommode each other, nor in the smallest degree interfere with each other, there is no obstruction, nor is the vision of either eye interfered with by any image intended to be conveyed by any means to either the one or the other of my eyes, but the vision used by one eye is also used by both my eyes.

SECTION III.

The cause of Light. It is produced by many substances. Genuine and Compound Light· Its Substances not the quickest traveller, if it carries Images with it. Error and misunderstanding about Light.

Light is the brilliancy or mere shine of bright substances, whether transparent, opaque or in a fluid state, as a diamond or other bright gems, polished steel or iron, or other smooth substances, or water and other liquids, or the different atmospheres of the sun and planets with their components, such as fluids and vapours that float in them, so also the eyes of animals, and, in short, everything that shines and will produce light in an otherwise dark place, may be considered as a producer of light.

As light is produced by so many substances, and has its abode amidst so many vapours and fluids, it is very natural for us to err whilst considering it to partake of so many different colours; there can be no wonder that we have what is called white light, red light, blue light, and many other coloured lights; but, although light and colours may perchance be produced by one and the same parent, and at one and the same time, they are not one and the same thing, for light is imponderable and invisible, whilst colours are both ponderable and visible, and the properties of light and colours are as much opposed to each other as their weight and visibility are different, for light illuminates and shines, whilst colours cloud and darken the appearance of any object. It should therefore be borne in mind that light and colours are entirely distinct substances when unadulterated, and as the former is so liable to be adulterated by the latter, it is strictly necessary, for perspicuity, that a division be made into genuine light and compound light. Genuine light is only the shine of those substances that produce it free from all adulteration. Compound light is genuine light intermixed with the atmosphere and all its components, such as colours, vapours and fluids, &c.

As all light is immediately adulterated as it unites with the atmosphere, so the only portion that we can make use of, in its genuine state, is the light of our eyes, which can never be seen because it is genuine and, consequently, invisible, and because of its equality with our vision, and that it forms no contrast. When we speak of light we labour under a degree of difficulty, as it is both imponderable and invisible, but, after a due consideration these two properties are the chief amongst the qualifications that befit light for the performance of its office, and although we cannot see, feel, hear, smell, or taste light, still we have criteria within our reach, and some of those criteria are afforded us by those very properties that we cannot weigh or see, for we know that some things are practicable for light that no other agent could perform, and we know of other things that can be done by other agents that light cannot do. We use it. It guides the sportsman to elevate his gun at a bird, or a gunner to direct the charge of a cannon at a battery wall, or a surveyor, or a geographer to take altitudes and distances, or an astronomer to guage the Heavens; in fact we know that it passes through transparent substances but it cannot pass through opaque bodies.

Some persons have doubted whether light has substances, if light has motion it cannot have substance, for nothing moves but what has substance. A nonentity cannot have motion.

If perceptions of objects are had by means of motion in light—whether it be by the light of the eye or the light of the universe, the fact is the same—such vision, in such case, must be matter in motion.

If perceptions of objects are had by a chain of vision uniting the eye with the object, and not in motion, then, in such case, vision is matter stationary, for a nonentity cannot unite any two objects.

Amongst the popular errors may be found the following:—

It is said that light is the quickest travelling agent we know of; yet the same persons who hold such a belief also hold a belief that light brings the images of objects to our eye. I think it would only be fair to allow, that light and its passenger image, travelling together, are at equal speed.

It is said that light has a great effect upon vegetables, in giving them colours; such ideas arise from not considering light and colours distinct substances. We know that if some kinds of vegetables are debarred from compound light, containing all its adulterating colours, they will loose or exchange their colours; such as celery, endive, lettuce, and cabbages, if either covered with mould or tied up close will grow white, and the green will forsake them. I think we ought to impute this exchange of colours to the exclusion of those colours that associate with light, and not to light itself. Genuine light has no colours either to withhold or bestow.

We also err when we suppose that the gay colours of the rose and other flowers receive their colours from light; as light always has its associates convenient, they, by their capabilities of colour-giving, should be entitled to the credit of adorning the flowers of the field, and light should have credit for illuminating them and showing them in their colours. It is said that "the action of light upon vegetables is proved, not merely by their colours, but, by the actual composition of their substances; plants which grow in the dark are not only blanched, but they do not produce carbon and many other of the products which are found in the plants exposed to light." I do not see how we can impute the absence of carbon to the absence of genuine light; there seems to be as great a difference between the nature of light and carbon as there is in their substances, and I think it would puzzle a geologist of the first water to calculate how many cubic feet of light it would require to produce one cubic foot of carbon; I am therefore inclined to think, we may give credit to those substances which are composed of carbon for affording carbon to the plants. "It is said that many of the tropical plants, that flower abundantly in their native places, will not flower in the artificial hot-houses, though they have stems and leaves in abundance: that we can give them tropical heat but we cannot give them tropical sun-beams, and so the circumstances more favorable to them are not complete." It is admitted we can give them heat in those places, but how to give them tropical heat in those places I do not understand any more than how we could give them tropical sun-beams. The sun-beams at the tropics are adulterated and so are the sun-beams of our climate; at the tropics the sun-beams are in the open air, and the beams and light, with their associates, all have a chance of surrounding the plants without hindrance; in our hot-houses they find obstructions, and, although light may be allowed to enter freely through glass windows, yet its associate, the colours, may be kept outside.

It is said that "light has an influence on the animal world; that the dull and sombre hues of animals which inhabit cold climates may be strikingly contrasted with the rich and gaudy colours of those that bask in the full sunshine of the tropics." I think, as in the foregoing, that the associates of light and not light itself, have the means of producing the contrast; and, in this latter case, heat has more to do with giving animals a fine colour than any other of the associates of light.

It is said that "there is a difference in the action of the different coloured light upon the organ of vision, independently of the mere sensation of colour; that there is an absolute pain in the continued looking at red, which we do not feel in the looking at any other of the refracted colours." In this case the red colour must be the pain giver, and light has nothing to do with it. It is said that "a pale and blue light, as produced from sulphur and spirits of wine, is accompanied with less heat than when light is white." It is evident that the cause of the difference of heat between the pale blue light and white light, is caused by one or both of those colours, and light is not concerned in it.

Some writers have committed themselves by their inconsistencies, as follows:—

"We see light at a much greater distance than we feel heat;" and in another part of the same book, it is said, "light is not a body, neither is heat; for we cannot attribute weight to either of them, and as little can we know anything about their existence in space, except by their effect upon something else which really is a body, and and exists in the same place at the same time." If light and heat are not bodies, what is meant by their effect upon something else that really is a body; a nonentity cannot effect anything upon something else that exists in the same place at the same time or any other time.

SECTION IV.

The Fleetness of Electricity and Light.

These two fluids, in their subtilty, surpass all description that can be given of them, as they both possess the power of passing through such substances that nearly confound our understanding.

If the fleetness of one of these substances can be satisfactorily explained, the fleetness of both will be understood, as there can be no doubt but that a similar cause to that which produced it in one will produce it in the other.

If we speak of light, which undoubtedly is a mere shine we are bound to admit it to be something; and we may venture to say, that it is nearly a resemblance of nothing; and to be anything at all I cannot perceive how it could be nearer to nothing than it really is. Well, this mere shine, that can rest in or pass through a diamond, a piece of glass, or a piece of steel, without inconvenience to those substances or to itself, and can at leisure leave those substances and take its abode in the atmosphere or the universe, without disturbing either, such a substance that can either remain at rest in, or pass through, other substances, without interference, must be as nearly independent of the power of friction and the pressure of the atmosphere, as it is related to nothing. This fluid, possessing so much freedom from friction and pressure of the atmosphere, is thereby qualified to traverse all systems; and being imperceptible by any of our senses, may, and does, fill al! space with its presenee; yet from its invisibility some persons are credulous enough to consider that "in the immensity of space between the stars and planets nothing doesexist—no not so much as light itself." This one of the effects of giving an opinion without weighing it, and such opinions, pernicious as they are, are not easily supplanted by reason.

Most intelligent persons believe that gravitation is universal; if it was not so how could it govern the universal system; it consequently must exist everywhere, and gravitation as well as light must be something.

All ignorant persons believe that the sun supplies us with light and heat for our use; if such be the case by what route are they sent. If there is no light in the universe, besides this we know, there is a difference between that portion of space that is darkened by the shadow of a planet and that which is not, surely that must be light; neither cou!d a shadow be projected without light. I think we need not to hesitate in our belief that these fluids that govern the universe, and light the universe, should be universal.

If Electricity is universal, it is reasonable to suppose that its powers of attraction will operate upon the lightest fluids first; and it must be considered natural for attraction, having an universal influence, not to rest alone in the universe, whilst such an easy, light-moving substance as light is so convenient to receive the powers of gravitation. It is more natural to consider those two fleet-moving fluids, to be the chief residents in the space between the stars.

However, to go back to our subject of fleetness, we must observe, that an universal system must have a connection with the pressure of the atmosphere, as well as the fluids contained within it. It is well understood that the atmosphere, by its weight, has a pressure upon all earthy substances, and all those substances that are heavier than the atmosphere, are pressed towards the earth by the weight of the atmosphere, and all those substances that are lighter than the atmosphere are, by its weight, pressed upwards from the earth. Now, if light did not possess the power of evading the pressure of the atmosphere in some degree, or by some means, it undoubtedly would be poised up to the top of the atmosphere, or farther from the earth than any fluid that possesses more substance than itself; but the fineness of its substance, giving it a chance to remain below, and taking shelter within the particles of other fluids nearer to the earth, helps it to avoid the pressure of the atmosphere, and the universal attraction, which is everywhere by its nature, may always retain light as a companion. I therefore think, we may fairly consider that we believe the cause of their fleetness is owing to their subtilty, that renders them free from the pressure of the atmosphere and the annoyance by friction. These two fluids, possessing so much freedom from the annoyance of friction and the pressure of the atmosphere, and also possessing the power of passing through other fluids, are almost free agents, and they must be at times more in readiness to move when an impulse is given than the grosser fluids are; and there can be no doubt, but, that as electricity moves more quickly through good conductors than it does through bad, so light has its good conductors and its bad; the good, is a good clear atmosphere, free from fog, mist and vapours; and the bad is an atmosphere loaded with them, and also when over-loaded with light fluids.

SECTION V.

Light does not rebound like a Ball.—Reflection and Refraction explained.—Rough Surfaces do not Reflect Light.—Light has three qualifications, all essential to Vision.

It is said that light against a reflecting surface rebounds in the same manner that a ball does when thrown against a wall, and the line by which the light passes to the reflecting surface is called the line of incidence, and the line by which the light returns from the reflecting surface is called the line of reflection.

No account has ever been given about the light of the eye, in fact it has never been considered as possessing the same qualities and properties as other light does; but if we consider that the light of the eye possesses all the qualities and properties that other light does, (which is certainly the case), when we are looking at a candle by the help of a looking-glass, the line of incidence for the light of the candle is the line of reflection for the light of the eye, and the line of incidence for the light of the eye is the line of reflection for the light of the candle, consequently both the lines are lines of reflection of light.

Had the writers upon light possessed the necessary knowledge, that the eye possessed all those qualities and properties, and as the light of the eye and the light of the candle, in passing to and from a looking-glass, must pass directly through each other in consequence of the fineness and softness of their properties, so light is the least capable of all substances to possess a sufficient quantity of elasticity to create a rebound when falling upon a reflecting surface.

Before a person can well understand the true cause and nature of light, it is strictly necessary that he should well understand the natural cause of reflection and refraction, for when the cause of these two particulars are known and well understood, a key to all other considerations is obtained, for on this branch of knowledge hang all the laws of light and vision. A thorough understanding of these two particulars unveils all the appearance of phenomena, and a misunderstanding of them leaves all in labyrinth and mystery.

All smooth surfaces are reflectors, and all reflectors are producers of light, more or less, according to their degree of shining or emitting light; and that portion, be it ever so small, whenever the light of the eye or the light of a candle falls upon it, immediately shines through the light so falling on it; and according to the shape or figure that the falling light makes upon the reflector, so the reflector, with its small portion of light, shines through the approaching light; and, according as the approaching light has made its shape upon the reflecting surface, so the reflector's light passes through it and makes its reflected ray according to the shape of light it has to pass through.

When a ray of light is made to fall upon a reflecting surface, direct or perpendicularly, it does not change its shape, and the reflector sends its small portion of light directly through all the advancing light, and only one line of light is made; the advancing light and the returning light makes but one line, and the reflection is directly back again.

When a ray of light is made to fall upon a reflector obliquely, that portion of the ray that falls on the reflector is changed in shape, and the refractor's light shining through this light in its changed shape, takes its direction, according to the said shape, and a line of reflection is produced according to the line of incidence. It follows, that the more obliquely the light is allowed to fall upon a surface, the more is its shape changed upon that surface, and the reflector again shining through that changed shape, sends forth its reflected ray accordingly, which will be equal to the incidental ray; so, in all cases, the direction of the incidental ray forms the shape of light upon the surface, and by the shape of light upon the surface the reflector forms the reflected ray, and in all cases the angles of incidence and reflection are according to the shape of the light lying upon the surface at the angles.

As the angle of the incidental ray is increased or decreased, so the light at the angle is changed in shape, and so, also, is the reflected ray increased or decreased; the reflecting surface performs its duty by shining through any bright substance that falls on it, and the powers of shining are according to shape.

As it is with reflection of light, so it is with refraction as in passing through the different media, light changes its shape at every surface it has to pass through, and each time that it changes its shape it changes its direction accordingly; and, if it be well noticed, it is very clear that the elements of reflection are similar to the elements of refraction. And as it is with reflection and refraction as far as regards the light of the universe, so it is with reflection and refraction as far as regards the light of the eye;

in all respects the actions and properties of both are the same.

Light has but few properties, and the same that are useful in reflection are also useful in refraction. It performs most of its duties by shining in straight lines, and in point of fact all of them are straight from place to place, for though in reflection and refraction it has sometimes the appearance of shining crooked, such is not its nature, for every independent particle of light will shine straight, and the crooked paths it appears to describe may be attributed to additions, enlargements, or diminutions in size, and change of shape, of any luminous substance, whilst every independent particle in a crooked journey passes straight from stage to stage.

Light has three qualifications: one is, to shine; another is, it is invisible; and the other is, its subtilty. All these three qualifications are so strictly necessary, that a deficiency in either, would be a deficiency in our system of vision.

By shining we are enlightened, by invisibility of light one portion of the particles of vision so readily pass through other portions of it; or in other words, one man's vision passes so readily through another man's vision, that thousands may be looking at one and the same object at one and the same time, and the different persons vision may so cross each other that nothing but an invisible agent could perform the office of vision; and also its subtilty must be a great qualification, for its fineness renders it capable of passing through transparent crystals without receiving much check.

It may be interesting to know the cause why dark rough surfaces do not reflect light. Every rough surface, by its raised particles, must project so many small shadows, every one of which are a barrier to the advance of light; the surface itself, not being smooth, cannot produce a shine, and consequently no reflection. Were the surface smooth instead of rough, the light shining upon it would obliterate all those small shadows, when the said surface might perform the office of a reflector.

SECTION VI.

Reflectors and producers of Light.—Experiment on a Gun Barrel.—Experiment on a Lamp in an Orchard.

It is well understood that things called reflectors serve to increase light, whatever may be the origin of it, but it is not so well understood that those reflectors are producers of light, as well as reflectors, and that they are capable of producing light in an otherwise dark place.

Take an instrument of polished steel into an otherwise dark room, and if there be any small spots of rust upon it they immediately become visible; but if the steel instrument is not polished, no particles of rust can be seen. Rust and other dark spots may be seen within and at the bottom of a gun barrel, if the inside of the barrel is clean and bright, but if it is not bright, then no spots can be seen. Thus, bright substances produce light, and they are capable of illuminating the dark ether around them; and if a small substance produces a small portion of light, we may readily suppose that the atmospheres of the sun and all the planets, as they are loaded with bright fluids, are amply provided with light producing fluids for all purposes.

Suppose I take a bright lamp, and go into an orchard or enclosed field on a dark night; I hold the lamp in my hand, suspended, and by turning round as on a pivot, the lamp shines on the atmosphere, or on the wall or hedge bounding the space; a white spec is seen upon the atmosphere, or limits of the place, and as the lamp turns round, the spectre at a distance seems to fly round, first illuminating one thing and then another, and each object so illuminated exhibits its own colour, and in the course of one revolution, I behold the whole of the fluids in the place illuminated. The lamp has been making use of its borrowed light to illuminate the magazine it was borrowed from.

SECTION VII.

Heat—a sufficiency for all purposes.

It is not my wish to go into particulars about heat, I only wish it to be understood that we have plenty of heat attached to the earth and atmosphere surrounding it, without receiving supplies from the sun, and the unreasonableness of being supplied by that body.

The housewife can tell how to procure a sufficient quantity of heat from the atmosphere, by virtue of flint and steel, for all ordinary purposes; the chemist can tell how to procure a sufficiency of heat from the atmosphere to dissolve the hardest of metals, by virtue of a burning glass, and the philosopher can tell how to extract fire from the clouds, by the help of a paper kite, and the hot fluid obtained by all these processes is only momentarily borrowed from an inexhaustible magazine, for, take what quantity you will, you leave no scarcity.

I think no one will dispute that the army in the Crimea had their magazine of fire fully as convenient for their use as were the guns and balls, and yet after the great consumption there was no scarcity nor any perceivable reduction in that article; and with such an abundance in store and at command, and in readiness for all our demands, it would be inconsistent with a reasonable understanding to suppose that we stand in need of, or receive, supplies from a globe that so much resembles our own, but situated at a distance of 95,000,000 of miles.

Everything in the universe, as far as our vision can reach, seems conveniently constructed and abundantly supplied; and as for fire, our superabundance in that article, induces us as often to seek shelter from heat, as we are induced to seek protection from cold.

SECTION VIII.

The Solar System.—The Sun and Moon cause Tides, and in the same manner they form Day and Night.—The Sun and Planets illuminate Space between them.

The sun is the centre of the solar system; around him revolve certain planets and satellites in their orbits, at certain distances; some of these distances are very great, but great as they are, all the planets adhere to certain laws of gravitation.

It was believed anciently, that the sun revolved around the earth, but Copernicus, in the fifteenth century, discovered, and Galileo, in the seventeenth century, illustrated the discovery, by the help of his newly invented telescope, that the earth and moon moved round the sun; instead of the sun moving round the earth; and Sir Isaac Newton, in the seventeenth century, discovered that gravity, and no other force but gravity, acts upon the moon and makes her revolve around the earth; and it has since been proved, by conclusive reasoning, that similar force compels the planets to circulate round the sun. The greatest astronomers have since been employing themselves in following out the plan of universal gravitation to all the subordinate as well as the grand movements of the spheres.

As part of the system of universal gravitation, Sir Isaac Newton proved that the waters of the ocean were influenced by the united attraction of the sun and moon in such a manner as to produce flood tides and neap tides, both of which so correspond to the sun and moon, in their position to each other and to the earth, as to render a calculation of the ebbing and flowing of the seas familiar to all persons who have made themselves acquainted with his writings thereon.

Almost all these discoveries were strongly objected to by ignorant and interested persons at the times of their discovery, but later discoveries have corroborated and established those principles, satisfactorily to all intelligent persons, still more may be explained illustrative of the universal law of gravitation than what was known by its discoverer.

Sir Isaac Newton was content to understand that universal gravitation governed the movements of the planets in their orbits, and influenced the waters in the ocean; of these movements and influences, there can be no doubt but Sir Isaac Newton was correct in his opinion, but as to the movements of the Planets my opinion was, that a demonstrable fact was wanting to prove how, and by what means, the planets were carried round in their orbits by the system of gravitation. I shall try to supply this apparent deficiency; but with respect of the gravitation upon the waters of the ocean it seems so satisfactory that nothing need be said upon that subject.

Sir Isaac Newton never contemplated that universal gravitation had anything to do with the different atmospheres of the sun and all the planets, whereby he caused all of them to form day and night for themselves by the use of their own materials of heat and light, contained within those atmospheres, respectively, much less did he contemplate, that the sun received the assistance from the planets to form day and night for himself by his materials of heat and light contained in his atmosphere.

He did not object to the sun being considered a globe of fire, as the ancients considered it; neither have any of the Philosophers that have followed in his train attempted to do so, but time and common sense have almost eradicated the absurd notion about the sun being a globe of fire, without the assistance of highly cultivated Philosophy.

I shall hereafter endeavour to explain and supply the deficiency I have spoken of as wanting to show how the planets are moved round in their orbits by the gravitation of the sun, and how the planets reciprocate and move the sun, in return, on his axis, and how the sun and planets, by a system of reciprocity, cause each other to form day and night for themselves with their respective materials. It is not consistent with the amount of wisdom bestowed upon the creation of the solar system, that a globe of fire should be placed in its centre, and that globe composing more than one half of the system, for the purpose of warming and lighting all the planets of that system, particularly so, as they are situated at such a variety of distances, without any regard to their size. Were the sun a globe of fire of his dimensions, and the planets were depending on him for light and heat, we might reasonably expect that the small planet Mercury, in his nearness to the sun, would either be melted to a fluid or calcined to a cinder; while the large planets, Herschel and Neptune, at their immense distance, would be froze into a solid ball of ice. As our nature leads us to admire the beauties of the creation, so it also leads us to censure any absurdities that may be discovered that are calculated to deform it.

If we cease to consider the sun as a globe of fire, our curiosity is excited to know what he is composed of, for certain he is a globe of some sort, and until we can, by any means prove to the contrary, we ought to consider him a globe of materials, like any other globe of the solar system, and partaking of similar nature, properties and qualities.

If carefully examined, the sun resembles the other planets of the system in their motions, and according to the universal law of gravitation, his connection with the other parts of the solar system prove him to possess some of our nature, and, as he contains more than one half of all the system, it must be an idea appertaining to the extremes of absurdity, to suppose the sun to be in anything, or in any wise, different from the remainder of the system, composing the minor half; that his motions are like the planets,—as he moves, they move,—as he turns round, they turn round; he has spots on his surface, as all the planets have, and he shines, as all the other planets shine, and he proves himself to govern the planets, by the same system that the planets govern him, and they together govern by a system of reciprocity, under the general or universal law of gravitation.

As the sun and the planets govern by a system of reciprocity, under the universal law of gravitation, so they prove themselves to possess natural principles, alike to each other; and it appears to me, that the sun in his brilliancy, does not exceed the brilliancy of the earth, more than his bulk exceeds the bulk of the earth, and if it were possible that an eye could be placed without the limits of the earth's atmosphere and all her fluids, it would not be more dazzled than by looking at any other planet. What makes the sun brighter than any other planet is, that he, by his great powers of attraction, always has the greatest portion of the fluids of our atmosphere on the side next himself, and we have to look through them when we look at the sun.

The explanation I promised to give, to show how, by gravitation, the planets are continued moving in their orbits, is as follows:—

It is well known that a smooth ball, placed upon a smooth horizontal surface or plane, requires but little force to drive it along, and the smoother the ball and plane the less force is required to keep it in motion; but as an horizontal plane gradually leaves the surface of the earth, in the same manner that any straight pole would leave the surface of a round tub or barrel if laid across the round part of it, so a ball rolling across an horizontal plane must, necessarily, as it leaves the round shape of the earth, become more and more impeded in its passage by gravitation, because it is going further and further from the centre of the earth; whereas, if a ball were so placed as to roll in a curve line round the earth, it would not be so impeded in its passage by gravitation, as it would always keep at the same distance from the earth. Now, suppose it were possible that we could put a flat glass belt, in the shape of a hoop, round the body of the earth, and this belt was made perfectly smooth and exactly round, then if a glass ball was made perfectly smooth and exactly round, and placed upon the belt, we might in such a case, consider that the powers of gravitation would be equal on each side of the ball, and by its lying upon a circle so smooth and so equi-distant from the centre of the earth, and the smoothness of the surface, would almost annihilate the friction between them. In such a state and position the most trifling force would be required to put the ball in motion, and still less, if any at all, would be required to keep it going. This would be coming as near as possible to a perpetual motion, and would as near as possible resemble a planet in its orbit, only the planet would have no belt to rest upon, and consequently would be entirely free from friction. Thus, then, a very small amount of force is sufficient to keep a planet in motion, and we have to point out, according to our opinion, where that small amount of force is to come from.

The sun being considered a globe of materials like the earth or any other planet, must possess an immense atmosphere, loaded with fluids, as all the planets are loaded, producing heat, light and electricity, but this large atmosphere may be spread over his surface. There can be no more fear of animals being scorched beneath it than there is of the animals of the planets. They can be as well sheltered under a large atmosphere as a small one.

Whilst we acknowledge a system of gravitation between the sun and all the planets, it is only reasonable to admit a system of gravitation between the sun and the different atmospheres of the planets, or between the sun's atmosphere and the planets' atmospheres it is the same. The quick-moving fluids will be first attracted and soonest affected by it, and it is understood that the powers of attraction are at one time positive and at another time negative or repulstive, as the bodies it is acting upon are more or less loaded with electricity. So, on the morning side of the earth, at sunrise, the fluids in the atmosphere will be less loaded, and consequently in more readiness to be attracted positively, whereby the earth will be pulled round in her diurnal motion; and, on the evening side of the earth, at sunset the fluids are loaded with electricity, and therefore negatively attracted or repulsed; so by the morning attraction the fluids in the atmosphere are pulled towards the sun, and by the evenihg attraction the fluids in the atmosphere are repulsed and forced from the sun, thus the earth is round in her orbit and the light-giving fluids are attracted and kept constantly on the side next the sun, hence we have day and night with our own materials of light and heat by the help of the powers of gravitation or attraction of the sun.

And whilst we are gaining 365 days and nights by being rolled round the sun in one year, by the same power of attraction the light-giving fluids in the sun's atmosphere are all this time influenced and pulled round his body by the gravitation of the earth, whereby a great amount of light and heat must be moving round the sun as the earth moves round. This process of influence is sufficient to move the brilliancies in the sun's atmosphere to a great extent, and therefore a great body of light and heat are kept on that side of the sun next the earth, the accumulation of which, might produce a summer season on the sun's disk once a year, and always leaving behind it a great space for winter or for other planets, each to form a season likewise, and thus the planets situated as they are in the ecliptic, some more oblique to the sun than others, would each of them form one summer round and upon the sun's body, consequently, a variety of seasons would be performed by the different planets according to their position to the sun and to the lengths of their several periods of revolution; and as those seasons would not depend upon any of the planets for supplies of light and heat, but only upon their assistance in the exchange of gravitation, so each planet might cause a season, according to the size and the period of its annual revolution, extending from the sun's equator towards each of his poles, according to the position of each planet to the sun, whilst each planet would enjoy a day and a night for each diurnal period upon its axis.

It does appear that a system of reciprocity between the sun and the planets is natural, whilst we take a natural survey of it, and that it is as essential as it is natural to the convenience of life upon the sun's disc, and that he should possess a variety of seasons, so that the fluids contained in its atmosphere should be divided, as a means of preserving a moderation of heat, instead of having the whole drawn together into one district, whereby the animal and vegetable creation might be scorched in one section and froze in another.

If we remove the absurd notion, that the sun furnishes the planets with light and heat, and consider that our intercourse with the sun is by a reciprocity of gravitation only, what then becomes of the system of radiation of light from the sun? It is true we observe the shadows projected by straight lines, but none of those lines can extend any farther towards the sun than the opaque body that projects them. It seems contrary to our system of nature, that so fine and subtle a body as light is, should, by any means, be transmitted from the surface of the atmosphere to the surface of the earth. It is contrary to the rules of gravitation that a light substance should find its way to the bottom or nearest station to the earth. Besides, if light was sent from any body in straight lines to project shadows, what is there to prohibit it from spreading behind the body of a planet, and damaging or obliterating the shadow; such a fluid as light would require something to keep it in a straight line, and I know of only one power that can be considered competent to the task, and that power is gravitation, which seems peculiarly adapted to control light substances; and as we consider the sun as the main source of gravitation, and as we constantly see all the lines by the sides of shadows in direct line towards the sun, and all the genuine light of the solar system continually retained in front of the sun, and also in front of each planet; and, apparently in obedience to both, the sun and planet that are always appearing between them, and always accompanying the latter in its orbit. When we consider all these circumstances, we can have no hesitation in concluding, that instead of emitting rays of light and sending them for our use, he exerts a power directly contrary, and drags all the light to the front of each planet by his powers of gravitation, and leaves the rear of the planets and all other opaque substances in the dark.

SECTION IX.

The Eye.—The opinion of Optical Writers.—The Author's opinion different.—Description of the Eye.—Observations.—The Cornea.—The Vitreous Humor and Convex Lens are powerful Reflectors.

It is said by optical writers, "that the retina receives the impressions of light and they are conveyed along the optic nerve to the brain." It is also said, "that as respects the optical action of the eye it is nothing more than that of a convex lens, to which its structure actually corresponds; and as in the focus of such a convex lens objects form images, so by the conjoint action of the cornea and the crystalline images of things to which the eye is directed, form, at the proper focal distance behind that, is upon the retina."

My opinion is very different upon those considerations. I do not consider that light forms any image upon the retina; neither do I consider that perceptions taken by vision are carried from the cornea through the crystalline lens to the retina; but, that perceptions once received, in the transparent nerves of the cornea, by vision, are instantly made known throughout the nervous system, as perceptions received in the same cornea, by feeling, are made known throughout the same nervous system.

A convex lens, of itself, has but two qualifications: one is to shine, and the other is to allow the light of the eye and the other light of the universe to shine through it in different directions; but with respect to objects forming images in its focus, I must observe, that all images that are formed in the focus of a lens are the offspring of some opaque substances that intervene themselves between a light and the lens, and thereby project shadows; but from distant objects we cannot expect to find shadows long enough to reach either the lens or its focus, and, consequently, we have to look for other causes than images made of shadows for perceptions; but first it may be necessary to take a glance at the construction of the eye.

There is, around the back of the eye, a very tough coat, called the sclerotic, that gives insertion to certain muscles that roll the eye-ball and give direction to any object. The interior of the sclerotic is lined with a coat almost entirely made up of blood vessels and little arteries, which, by their internetting, cross one another in almost every possible direction. This lining is called the choroid coat. The surface of the choroid coat, inside, is thickly covered with a slimy figment of black colour, and this again is overlaid by a serous shed called Jacob's membrane; inside of all this is what is called the retina. These coats form the rear of the eye, and in the interior there is a quantity of vitreous or glassy humor, and in front of this glassy humour is suspended what is called a double convex lens; in front of this lens is the iris, and a certain opening in it is the pupil; and in front of the iris is a chamber filled with a watery fluid, and this watery fluid fills up the space between the iris and the cornea before mentioned. Into the rear of the sclerotic and choroid coats, from the brain, comes the optic nerve for each eye, and spreads itself out upon the interior surface of the retina. Here, it is worthy of particular notice, that the optic nerve, coming from the brain, spreading all over the retina, and extending until it unites with the beautiful transparent shell called the cornea, which forms the front of the eye-ball.

There can be no doubt but the cornea itself—being of a nervous substance—forms part and parcel of the optic nerve, wisely contrived for the express purpose of forming a seat for the life of the animal, the light of the eye, and the other light of the universe, to unite for the convenience of taking perceptions of distant objects.

We know that in the cornea the most acute sensation of feeling is manifested by the simple touch of a feather, and the perceptions so taken by feeling must undoubtedly be transmitted to the brain by means of the optic nerve, of which the cornea forms all the front section, and is entirely transparent. As the cornea possesses the power of taking perceptions by feeling, and passing them instantaneously throughout the nervous system, as well as to the brain itself, as all other members of the system do so, therefore, it must be reasonable to consider, that the cornea, in taking perceptions by seeing, will immediately transmit those perceptions that are taken in the same place by the same route; and it would be very unreasonable to suppose that when a perception is once within any portion of the nervous system—as within the transparent cornea, where there is a massive substance composed of nerves all leading to the brain—that it will again leave that mass of nerves to pass through a watery fluid where there are no nerves at all, then to enter the iris and pass through it and the nerves within it, then again to pass through the convex lens, and on leaving the lens to pass through the vitreous or glassy humor; and after all it would have to get into the optic nerve at the back of the eye on the retina, without the benefit of a transparent portal for its entrance, as it does not appear that the optic nerve is any where provided with the necessary accommodation to receive perceptions by sight with a transparent entrance, only at the cornea, which forms the front section of the optic nerve, and is united with it by transparent fibres.

The reader can judge for himself which passage is the most practical and the most reasonable of the two now mentioned for perceptions. The vitreous or glassy humor, in the interior of the eye, seems wisely constructed for the purpose of supplying the lower lens with genuine light, and the lens itself seems as wisely adapted for the very necessary and useful purpose of a powerful reflector, it being constantly supplied with living light; and the glassy humor and the lens, in junction, send their living light through the iris into the transparent seat of vision, where life and the light of the eye are seated, in junction with the other light of the universe.

As it can be satisfactorily demonstrated by various means that the light of the eye is capable of obliterating a faint shadow, and as nothing but light is capable of accomplishing such an act, so it may be considered that the eye is constantly emitting light when uncovered by the eye-lid, and it would be extremely unreasonable, and in fact unnatural, to consider that the eye which obliterates shadows could, at one and the same time, emit light from the eye and receive a shadow or image into the eye. The idea is contradictory of itself.

SECTION X.

The Vision contains all the Media between the Eye and the Object.—An Image is something.—How Perceptions are had.—Vision is influenced by Gravitation. —The Cornea is the seat of living Light.—The Crystalline Lens.—Vitreous Humour.—Agneous Humour.—The Media in the Night a good Conductor.—The Media in Day-time a bad Conductor.—Reason.

The vision of the eye contains the eye-light, which is the natural production of the eye, together with all the media between the eye and the object, whether it be glass, water, atmosphere or fluids within it.

The line of vision for the eye is the size and shape of the object at the thick end which is next to the object, and of the size and shape of the eye at the thin end which is next to the eye. The small end of the line of vision may be used individually, by its respective observers, but the large end next to the object must be used in company with all eyes that are viewing the same side of an object at the same time, and therefore the range of vision is general and generally used, and the very same particles or fluids that form vision for one eye—particularly when looking at large and distant objects—may be used for vision, or lines of vision, for hundreds and thousands of eyes that are employed looking at one and the same object at one and the same time, therefore the whole universe is one common joint-stock of vision for the eyes of all persons desiring to make use of it, and may be considered the greatest joint-stock the world possesses, and the most commonly used; and therefore it is no wonder that our curiosity is excited to discover how, and by what means, vision can inform us that there are certain immense bodies circulating in space, in regular orbits, and performing certain revolutions in certain periods of time. All this information is gained by vision, or by the help of vision, and without vision none of it could be had; yet, vision, amidst all its generosity has not satisfactorily revealed to us how, or by what means, itself has been working, whilst such an amount of information has been gained.

I think, if our vision had been exerted as much to discover and disclose its own natural way of working, as it has been exerted to discover the motions and properties of other substances; and assisted as much in the one case as in the other by the ingenious contrivances that have been bestowed upon matters and properties not more deserving assistance, a greater progress would have been made in the right way; but as it is, but little is known, and mankind have been content to consider that the light of the universe brings images of objects to our eyes at the rate of 192,000 miles per second of time, such of my readers as have considered the inconsistencies mentioned in the former part of this book, and can, at the same time, find courage to discard all former prejudices, will feel no difficulty in coming to a right understanding concerning the natural workings of vision. The getting into a right understanding is simple when once got out of a wrong one, but the greatest difficulty is to get rid of prejudice; and the absurd notion that light brings us an image of every thing we see, must be got rid of.

An image must be something, be it ever so small, and if it be small enough to be carried by light, it would be obliterated by light, and if it be large, light could not bear the burden of it; besides, any number of images, whether large or small, would choke up the small avenue leading through the eye to the brain. The idea is ridiculous; and still more ridiculous is the notion, that the perception of a fixed star can be conveyed to the eye in the short space of the twinkling of an eye. The nearest fixed star considered to be about sixty-two billions four hundred and eighty-one thousand five hundred millions of miles, and to suppose that a perception of a star at that distance can be brought over that space in that time, by light or by any other means of mere motion, is mere madness.

The vision of the eye comprises all the transparent media before the eye, and must be subject to, and influenced by, the universal law of gravitation. Every large body of light must influence a small body; and as the greatest amount of fluid is, by gravitation, kept on the front of every planet, and light is generally kept in the general stream of gravitation, which is towards the sun, so the light, outside of a planet's shadow, influences and attracts all the light from the rear of a planet, and thereby leaving it in darkness.

As the eye is purposely constructed for taking perceptions, so it is furnished by nature with means adequate to the purpose. The cornea, being a seat of living light, being always loaded, and situated in front of the eye, and receiving life throughout the different fibres from the optic nerve, leaving the agneous humor immediately behind it, and the crystalline lens immediately behind the agneous humor, and the vitreous humor immediately behind the crystalline lens.

The crystalline lens performs the office of a lamp, and is supplied with light matured and conducted to it by the vitreous fluid. The aqueous humor in front of the lens, or lamp, may be useful in straining and regulating the issue of the light from the lens to the cornea, and the whole of the apparatus so situated in rear of the cornea, mature and send their productions of light directly through the load of life and light seated in the cornea, from whence it emerges, and divergingly spreads upon all objects, passing through all transparent fluids in the atmosphere; but finding a limit at every opaque substance, it is thereby united with the light of the universe, and all the light of the universe is vision, for all eyes generally and each eye individually. All the transparent media may be considered eye-sight, and all the opaque substances, that limit the range of vision, may be considered perceptions.

I have observed that the light of the eye and all other light is under the influence of gravitation. Taking all things into consideration they all conspire to prove such to be the fact; and the media that light has to pass through must be considered as a conductor of light, and, like galvanic electricity, light has its good conductors and bad conductors.

The media, on a fine night, when the atmosphere is free from vapours and less loaded with bright fluids or brilliancies may be considered a good conductor. The light of the eye is attracted by the light outside the shadow of the earth very rapidly, as far as the extent of the atmosphere, which, probably, is as far as a conductor is required, for the light must then and there be all alike and independent of atmospheric influence; for, in the space beyond the atmosphere, all must be one vast amount of vision, that extends to and encloses all objects.

The media in the day-time is always a bad conductor for eye-light, for if the atmosphere is free from vapours it is always loaded with fluids that allow the eye-light to range only to certain distances. It must be obvious to every thinking person that the eye, being a mass of living transparencies, comprising nerves and fibres and fluids, and being used by all animals to take perception of distant objects, must have been originally intended—as its formation and structure describe it to be—for the purpose of uniting the life of the animal with the light of the universe; and by a careful inspection it is rendered clear to the understanding that such is the purpose for which it was intended, for we find, not only is the eye united with all the visible objects in the universe by a transparent medium, but by means of a transparent shell; the eye of the internal discerning power of the living being, is united with, and forms part and parcel of a chain of vision that has the life and light of the eye of the said being for one end, and the farthest visible fixed star for the other end; and that it is also further wisely provided with a moveable cover, to be used at the discretion of the animal, for the purpose of preventing too great an escape of eye-light, that is apt to cause sleep or drowsiness, and at the same time to protect the eye-ball, whilst sleep and rest replenish the exhausted eye-light. Thus, man, by the lift of the eye-lid, is not only united with all objects in front of him, but by the turn of the head and the roll of the eye, he can, by one single revolution, alternately behold all the distant stars, situated millions of miles from the eye, and millions of miles from each other.

SECTION XI.

The Lenses in the interior of a Telescope.—Passage of Light through them.—The reader is requested to form his own opinion thereon.—The Agent that passes through a Lens can have but one Substance.—Observations on a Telescope.

The lenses that form the interior of a telescope may fairly be considered to form part and parcel of the vision of the eye that is looking through them. The side of the convex lens next the eye extends the vision. Some particles of vision pass directly through the whole of the lenses at the centre, which is called their axis.

Some particles of vision diverge and pass through at some distance from the centre, and some diverge and pass still wider, until the whole of the hemisphere of the lense next the eye is formed into vision, extended and magnified.

We will now consider the state and situation of the vision which we find in possession of the whole of the hemisphere next to the eye of the first lens, and observe, that as the vision for the eye at the first focus advanced by diverging and taking possession of the first hemisphere of the lens, so it will, by leaving possession of the first hemispere, converge and advance to the focus of the second lens, and the principal line of vision will continue its passage through the centre, and all other particles of vision will be prepared to cross each other in all directions, and whatever might have been seen before the vision arrived at or departed from this position, must have been seen erect, as none of the vision had before changed sides. We may now consider that the vision is in the act of crossing over in all manner of directions at the focus between the first and second lens; each particle of vision, as it leaves the extremity of the first lens, will now enter on the contrary side, near the axis of the second lens, and each particle of vision that leaves its situation near the axis of the first lens, will enter the second lens near to the extremity on the contrary side of the axis; and so with all the other particles of vision, all cross over, and each changes sides with the reverse of its corresponding particle, and the vision is thereby in possession of the first hemisphere of the second lens, and in all respects inverted; and whatever has been seen by the eye, immediately after arriving at this position, may be seen inverted, and these processes may be carried on by increasing the number of lenses, at the discretion of the maker of the telescope. Thus, the first lens stretches the vision and magnifies it at its centre, the vision at the focus, between the first and second lens, crosses over and inverts itself, and it again, between the second and third lens, crosses over and becomes erect, and so on alternately, it sees its object, first erect, then inverted, and so forth, between each lens. It is the same with the light of the eye and the other light of the universe. After leaving the telescope, as in all other vision, the light of the eye illuminates as near the telescope as its radiance can reach; but the light of the eye has to find its way through the different lenses, and from thence onward through the dark shades of the night unto the object.

Now let the curious reader carefully examine the interior of a telescope, and explore the path that the light of the eye, or the other light of the universe, has to pass through. When we look through a telescope we feel confident that either the one or the other must so pass through, or we could not see distant objects through it; and we have now to consider which is the most fit agent for such an office.

Here we have one of our eyes close to one end of a telescope, with genuine eye light, the natural produce of the eye, unadulterated, to send through the telescope, and opposite the other end, millions of miles distant, we have an object, either opaque or transparent, considered to be sending to the telescope an image of itself, by the help of the light of the universe as a carrier.

It does appear natural, that genuine light from the eye, just issuing from its parent producer, unclothed with colours, and unloaded with images, and having no shape to be demolished or protected, may possess the power of passing through a kindred light producer (such as a glass or crystal lens) in its naked shining shape; but for the light of the universe receiving a perception from a distant object, and to attempt to enter the telescope at the other end, with perhaps a plurality of images, I cannot think that any of our transparent substances would so readily afford it admission, without first divesting it of its load and encumbrance.

An image is something, be it ever so small, and if the smallest of small substances be brought and put through the lenses of a telescope, that small something would first have to undergo the operation of stretching and extending upon the first lens, until it formed the shape and size of the first hemisphere of that lens; then again it would have to undergo the operation of changing sides and crossing over, whereby every particle of that small something would have to pass through itself at the focus of the first lens in very small compass; then again, it would have to be stretched upon the second lens, and again it would have to pass through itself, and cross over between the second and third lens, as before; and again, at each lens, it would have to do likewise, until it had proceeded through all the lenses within the telescope, by which process the mutilated particles of this small something would be so mixed together that it would be as difficult to distinguish a cluster of stars, a grove of trees, a fleet of shipping, or a flock of sheep, as it would be for a miller to distinguish the size and shape of each grain of wheat or other grain that he had reduced to flour by the process of grinding.

It is said by optical writers, that for an object to be seen it must be of certain magnitude and remain on the retina a certain length of time, and for distinct vision must not be nearer than a certain distance, as eight or ten inches; and it is also said that the luminous impressions made on the retina last for a certain space of time, varying from one-third to one-sixth of a second. Now if an object be of any magnitude at all, and has to remain on the retina a certain space of time, at least one-sixth of a second; and I can see at one view a squadron of horse soldiers, a brigade of foot soldiers, and a drove of oxen, and many other things, I think my eye would be too crowded to view any of those objects distinctly. And again, if it is necessary for distinct vision, that the object should not be nearer than eight or ten inches, what makes opticians consider that images of objects are always brought through a telescope so far as to the focus of the first lens, to be viewed and magnified? Sure, there are many telescopes that are not eight inches long altogether, yet they will give distinct vision, and in some of them the focus of the eye lens is not half that distance from the eye.

Another difficulty,—Supposing that one of Jupiter's satellites to send us an image of itself, either at the time it is about to immerge behind the planet, or immediately after it has emerged from behind the planet, in either case a perception so sent would have to pass through the immense atmosphere of Jupiter. It is possible that light might find its way through the said atmosphere—having neither weight nor visible substance, whereby it might be liable to be influenced by the laws of attraction or gravitation—but as for an image of a satellite to find its way through an atmosphere of such extent, either heat or cold, or attraction or gravitation, would certainly influence it to a great extent; and its own substance too would be a great barrier to its velocity, and would certainly prevent it from traveling at the rate of 192,000 per second. Therefore, by whatever means we gain perception, certain it must be, that whatever be the agent that passes through the lenses it can have but one substance, and it is strictly requisite that that substance should be the most subtile of all substances; its thinness and fineness is the only qualification that can possibly befit it for the office of passing through transparent lenses and through itself; to no other substance than a shine can we ascribe such a qualification, and from no other substance can we ascribe such a qualification, and from no other substance than the eye (which is expressly constructed by nature for the purpose) can we expect such a shine.

There is something wonderful in a telescope and wonderful discoveries have been made by it, and wonderful genius has been employed to enlarge and extend those discoveries, but the most wonderful of all to me is, that amidst all the learning and improved talent so employed, none have noticed this simple fact, whilst light has so often engaged the attention of so many eminent philosophers. It would appear as though this part of the subject of philosophy had been slighted, and yet I have too great an opinion of the many who have allowed it to escape their notice to suppose that they would allow their curiosity to be limited in any one instance; but so it has been, and that whilst the person was inventing what is called the spider legs and placing them in the focus of the eye lens he never thought that the vision in looking by them would have to roam and extend to the object to take a perception, but considered that every distant object sent its image to keep company with the spider legs of every telescope made use of to view it; but so it has been, and from that and other events and circumstances, it appears to me that every invention must be preceded by some striking event, though perhaps very trifling in appearance, to actuate the mind before curiosity can be aroused; and that genius cannot work without a criterion, and although criterions are constantly staring us in the face, some trifling event is requisite to make us recognize them. It must therefore follow, that philosophy is a compound of the consequents of events and circumstances.

SECTION XII.

The Aberration of the Stars.—Roemer and Dr. Bradley at fault.

It is generally considered that the aberration of the stars is a corroboration of the present theory of regular progressive motion in light. Roemer, the Danish astronomer, found a consequent in the lateness of Jupiter's satellite in emerging from behind the planet, where it had been eclipsed, and when he thought he had discovered a regular and steady progressive motion in light, he was so far satisfied with it as to consider it a sufficient cause for the lateness of the appearance of the satellite. Some years after, Dr. Bradley found a consequent in the aberration of the stars, and giving things a hasty consideration, he came to the conclusion that the progressive motion was the cause.

The difference of the velocities of light discovered by these two persons was three thousand miles per second of time. Roemer's discovery gives 192,000 miles per second, and Dr. Bradley's discovery gives 195,000 miles per second. Had they each of them took more time to have considered the subject, it is probable they might have corrected their understanding, and finally have arrived at different conclusions, which might have been nearer correct, and consequently more satisfactory. It is evident that they both considered that light brought images of objects to the eyes to be seen. This belief was handed down to them from the ancients, and without hesitation they adopted it and built upon it without sufficiently criticizing and comparing it with nature; hence the error of building upon a rotten foundation.

It is also evident that they did not know that the eye-sight was genuine light, and that the light of the eye and the light of the universe possessed the power of obliterating shadows and shades of all descriptions; neither did they consider the nature of the duties they were imposing upon light, compelling it to carry dark fluids that the brilliancy of light always ruins when coming in contact. Neither did either of them consider the multiplicity of velocities of light that must surround both Jupiter and the earth, by being continually forced out of the paths of those planets, and that the motion of light in the conveyance of those images would be transverse to the path of light with its passenger, when passing from Jupiter to the earth, or from the earth to Jupiter.

If Dr. Bradley had rejected the prevailing idea about light carrying images of objects, he might probably have discovered a means of bringing himself correctly to the conclusion that the aberration was 20¼ seconds for all the stars. Surely it is inconsistent to suppose that light could bring images from all the stars, whose difference of distance from us is so great, in the same space of time.

Everybody knows that it requires a longer time to perform a long journey than it does to perform a short one; but everybody does not know, but a great many persons do know, that there are as many degrees and minutes in a small circle as there are in a large circle, and that the farthest distant fixed star describes the same number of circles round the earth, either daily or annually, as the nearest fixed star does; and each of these circles, great or small, contain 360° and no more; and as the aberration for all the stars is $20\frac{1}{4}$ seconds for each, and no more, I think the cause of the aberration of the stars is occasioned by a little time lost, whilst the eye is looking outwards for a perception, instead of being occasioned by light having to travel 2,880,000 miles, to overtake the earth in her orbit, in the short space of fifteen seconds of time. I therefore feel fully confident that when the true cause of the aberration of the stars shall be determined, it will have no connection with any regular progressive motion in light.

SECTION XIII.

The lenticular Stereoscope.—A description of the lenticular stereoscope as brought to a high state of perfection, by Sir David Brewster, and published in London.

I have copied an account of this instrument, together with an explanation of it, given by the publisher, whose notions of vision and perceptions of objects, taken by the eye, are strictly in unison with the popular notions of the present day; and as my notions upon similar subjects are strictly at variance with both the author and the public, I have considered it essential, to a right understanding, that the whole should be exhibited in such a manner, that the curious may first read the instrument itself in its own natural language, then read the author's account of it, and then read my account of it, after which, they can think, deliberate, and decide, between me and the author, as to which account coincides most with the natural account given by the instrument itself.

"It is fourteen years since Mr. Wheatstone first gave publicity to his views, on what he termed some previously unobserved phenomena of binocular vision, that is sight with two eyes. An instrument he had invented, was at the same time described, by means of which, two separate diagrams representing different perspective views of the same object could be made, when viewed in a particular way, so to unite as to form only one figure having the appearance of a perfect solid. Hence the name of the instrument which is compounded of two Greek words, signifying to see a solid."

"Like many other ingenious and in reality valuable inventions, the stereoscope, when first made known, attracted but little attention; this was probably owing to its being then considered more curious than useful, or it might have been in consequence of the principle of the instrument being very imperfectly understood, and the difficulties attending its construction; we think it still more likely that the discoveries and rapid advances in the art of photography, occuring about the same time, drew off attention from Mr. Wheatstone's invention; and no wonder if it did so, the discoveries of Neipce, Talbot, Daguerre, being justly considered as among some of the most wonderful applications of optical and chemical knowledge which the world had ever witnessed.

"The stereoscope was laid aside, but not entirely forgotten even by its inventor: its principle appears to have been but superficially investigated, whilst it was probably never suspected that the discovery was not new; attention was no sooner directed to the phenomena which had been so happily illustrated, than it was found that the subject had been treated of and with a remarkable degree of accuracy, by writers on optics, more than two hundred years ago."

"To Mr. Wheatstone, is due, the merit of having first devised the means of practically illustrating the principle of binocular vision; to Sir David Brewster, we are indebted for a truly philosophical explanation of its theoretical principles, which he has shown, are as much dependant on the physical construction of the eye, and as much a part of its duty, when in a normal and healthful condition, as any of the ordinary processes by which external objects are seen and judged of in the daily business of life."

"In its earliest forms, the stereoscope consisted of a box containing two plain mirrors, about four inches square, fixed at right angles to each other, (figure 1.) The binocular pictures were so placed, that each of them should be opposite its corresponding mirror, the reflected images being brought exactly to the centre of the box, between the eyes of the observer. There the two figures united, and presented an apparently soild substance, so unlike the mere surface pictures, that it seemed incredible the laws of optics could be alone concerned in converting one into the other."

"Combining theory with practice, Sir David Brewster very soon simplified and improved upon Mr. Wheatstone's apparatus; the most popular form of the instrument is the invention of Sir David, this is called the lenticular stereoscope, that is formed or constructed by means of a lens, (figure 2.); we will refer to it more particularly by and by, observing as we pass along, that it was first made at Dundee, then taken up in earnest by an eminent philosophical instrument maker in Paris, whence it found its way back to this country, at the exhibition in 1851, and since then, it has been made in London in almost every variety of material, and sold at prices from a few shillings to as many pounds."

"It is not an easy matter to describe the stereoscope; assisted by diagrams, the difficulties are not entirely removed. Even the complete instrument with its appropriate pictures is, in the hands of many persons, little else than a puzzle, and if they express approval or surprise, it seems by way of compliment or custom, more than from a just appreciation of the effects produced."

"Let us try to explain what might not improperly be termed the optical illusion of the sterescope, that is the method by which two dissimilar pictures drawn on flat surfaces, and placed several inches appart, may be made when viewed with both eyes perfectly to coalesce, and to present the appearance of only one figure, not however, any longer a flat surface but raised or depressed in its proper proportions, so as not to be distinguishable from a solid."

"If we take a piece of card-board, about nine inches square, and fold it like a book, then set it on one end, with the folded edge towards the observer, the sides being very slightly separated, we shall, by looking at what might be considered the thin end of a wedge; place it at a convenient distance from and on a level with the eyes, and so adjust it that each eye shall be able to see the sides of the cardboard in equal proportions. Continue to look steadily at the object for a few seconds, and then shut each eye alternately, when it will be noticed that a smaller portion of the left side of the wedge comes into view with the left eye shut, and *vice versa* than when both eyes are open."

"Try another experiment—to a fixed point, about two feet from the inside of a window of a room, attach a thread with a weight at the bottom to make it answer the purpose of a plumb-line, look steadily at the thread with both eyes and get it exactly in line with one of the upright bars of the sash; without moving the head, direct the eyes towards the sash bar, and two threads will be seen, one in its former position and another at the right side of it; repeat the experiment, and when the thread is again in line with the sash-bar, shut the left eye, and the thread will appear to change its position several inches to the right side of the bar; again, adjust it with the right eye only, then shut that eye and look at it only with the left, the thread will retain its position; do the same thing with the left eye, and then shut the right, and the thread will change its position as before.* The distance to which the thread appears to move, depends on the distance at which the observer stands from the window."

"Look at an object out of doors, as the angle or window frame of a building, and try the experiments just described, and the plumb-line will appear fifty or a hundred feet to either side of the central line, according to circumstances."

"These examples may be considered very simple and unmeaning, but they serve to illustrate the principles of binocular vision quite as satisfactorily as if we had recourse to expensive instruments or apparatus; our two eyes, under ordinary circumstances, perform their duties so readily, so perfectly, and to ourselves so unconsciously, that we scarcely ever think of them as being in reality a pair of the most beautiful optical instruments; nor does it occur to us, that each external and visible eye transmits to the internal and invisible eye a separate picture or image of the objects within its range; two distinct pictures are however admitted into the darkened chamber behind the eyes, although

* It is probable that the habit of shutting the left eye when plumbing objects, might be the cause of this apparent difference in the power of the eyes. The writer is not sure that it exists in all persons alike.

one picture only is seen. The inner eye is supplied with machinery for making suitable adjustments, so that two dis-similar parts or images of the same objects are instantly combined and converted into one. Nothing is more certain in following out the experiment with the cardboard and the plumb-line, than that in looking at an object with both eyes, there are parts on the left hand of the observer, which it is physically impossible should be seen with the right eye, and *vice versa*. The nearer the object is to the observer, the more readily is this law determined; hence, therefore, it is plain, that the images or pictures received upon the retina, are not exactly alike, and yet they are so instantly and perfectly united, that we never detect the difference, and never should know that more than one picture had entered the eyes."

"So it is with the ears; the softest whisper or the loudest report, whether entering both ears with equal force, or one ear with greater force than the other, is so perfectly equalized with the inner ear, that we are conscious of only one vibratory impression, although the external ears are two-fold in their mechanism. If we try to apply these principles to the stereoscope, there will be no longer any difficulty in understanding it."

"Obtain two pictures or diagrams of any particular object—in such forms as would present at a certain distance, when viewed by each eye separately, or, in other words, let the picture vary in perspective to a given angle—such pictures, if taken for Mr. Wheatstone's reflecting stereoscope, when placed in the instrument and viewed with both eyes, will so unite, that a few lines traced upon paper seems to stand out in full relief; two separate pictures of a solid being apparently changed into the object intended to be represented. Nor is this all, the real pictures cannot be seen in the places they actually occupy, whilst the combined image is seen at a part of the instrument where there is no picture of any kind."

"In the lenticular (Sir David Brewster's,) stereoscope, the process is greatly simplified, the pictures being prepared, as in the former case, expressly for the instrument, are viewed by both eyes, but they are combined by lenses made for the purpose, (in reality semi-lenses,) each of which turns the line of vision in an angular direction inward, where only one picture is seen, (see figure 2,) resembling a solid."

"Whatever be the process employed to explain the phenomena of binocular vision, it must be understood to consist of certain arrangements by which the eyes are compelled to do something of the same sort of work outside the head, which they are in the constant habit of doing inside."

"The dis-similar image of an object entering each eye, is by the natural process of vision turned aside in an angular direction towards the centre, and there combines and forms a perfect image within the head; by the means we have described, a similar result, is by artificial means produced outside the head; a little practice in the management of the eyes will enable a person to combine stereoscopic pictures without the aid of the instrument, but in that case, three pictures are visible, that in the centre being the true stereoscopic representation of the fainter images on each side."

"Viewed only as an instrument for occasional recreation or amusement, the stereoscope occupies an important place;

applied to higher objects of study, and especially as an auxiliary to the various branches of photography, it is as useful as it is beautiful, adding to our pleasures, at the same time, that it helps to increase our knowledge."

The foregoing is the opinion of the author of a very useful book, in some other respects; but, in my opinion, as far as light and vision are concerned, he has left much room for improvement, whilst giving a description of the instrument, and making observations thereon.

The stereoscope is a very pleasing and amusing instrument, calculated to arouse our curiosity, increase our knowledge, and correct our understanding, with respect to the true theory of light and vision, which can well be found out by first discovering the working of the eyes upon the machine or by the working of the machine upon the eyes.

I shall proceed to make some remarks upon the author's observations, and then leave the reader at liberty to consider and judge for himself.

He says, that each external or visible eye transmits to the internal or invisible eye, a separate picture or image of the object within its range.

To allow this, we must certainly admit, that every entire animal has at least three eyes, that is, two external and one internal.

He says, that two pictures are admitted into the darkened chamber behind the eyes, although only one picture is seen.

He has not told us what has become of the other picture.

He says, that the inner eye is supplied with machinery for making suitable adjustments, so that two dis-similar parts or images of the same object are instantly combined and converted into one.

He has not given us a description of this machinery for converting two objects into one, and as it surpasseth my understanding, I must let it pass, and leave the reader to frame an opinion for himself.

He says, hence therefore, it is plain, that the images or pictures received upon the retina are not exactly alike, and yet they are so instantly and perfectly united, that we never detect any difference, and never should know that more than one picture had entered the eyes.

He has not told us how he came possessed by a knowledge, that they are so instantly and perfectly united, that we never detect any difference, nor how he came to know that even one picture had entered the eye.

If we receive all this as a satisfactory explanation of the stereoscope with the eyes, or the workings of the eyes with the stereoscope, we must consider that the phenomena is not explained, for we have a greater task to unravel the internal machinery than we had to understand the external illusion; certainly, we have, by an intricate and circuitous journey after truth, arrived at some place still farther distant from it, for intricate as is the working of the stereoscope, it becomes totally eclipsed by the internal machinery that unites two dis-similar objects so instantly and so perfectly.

He says, nor is this all, the real pictures cannot be seen in the places they actually occupy, whilst the combined image is seen at a part of the instrument, where there is no picture of any kind.

If the author would try to correct himself, and discard the notions about images and pictures, he would soon perceive that the two objects taken respectively by each eye, are both actually seen at the places they respectively occupy, and are only apparently seen where there is no picture of any kind.

First, consider that perceptions are taken externally, and blot out of memory all about images and pictures and internal machinery, then direct both your eyes to where the mirror meets in a wedge-like shape, your vision there falls upon the edge of a wedge and is divided in two halves, the right half slides along the right side of the wedge-shaped mirror and proceeds by reflection of the eye to the right lens; the left half slides along the left side of the wedge-shaped mirror and proceeds by reflection of the eye to the left lens; the two halves of vision infringing upon their respective lenses double back upon their respective objects, where they are purposely placed to be seen, and where in reality they are to be seen, and where in reality they ought to be seen, and like all other objects, are seen in their respective stations, and the combined images will not be seen at a part of the instrument where there is no picture of any kind, but only apparently seen there, that is, at a place where the vision from both eyes separate and make their first bend or reflection. There it is, that things that are seen by reflection always appear to be seen; but in point of fact, the vision doubles back upon the object and takes its perception, and I consider this to be the law of taking perceptions, be there ever so many bends or reflections in the vision or light of the eye; at the first bend nearest to the eye, the object always appears to be seen, but in reality it is always seen at its respective station, be it ever so distant.

SECTION XIV.

More observations on Reflection and Refraction.

In all cases of reflection and refraction, both the light of the eye and the other light of the Universe perform their several offices, by similar means of shining in straight lines as far as the different media, through which they pass, will afford them a passage, or until the said media admits a greater or less portion of their light, in such manner as to increase or decrease the amount of light passing through them, and by such means, to produce a change of shape on light, which change of shape, as I have before said, produces a change of direction; and that in vision, every crook or bend in it, may be considered a reflection or refraction of the eye-light, and though there may be a plurality of bends in the vision, the eye-light proceeds from bend to bend, until it falls upon the objects, and whether the object be opaque or transparent, or fluid, it matters not; at the first bend, the object is always apparently seen, because there is no return of the eye-light in vision, and the same holds good in all cases, whether with the kaleidescope, the stereoscope, or any other instrument; it is the reflection of the eye that follows the object, by any number of bends in vision, from bend to bend, or from reflection to reflection; when this position of the working of the eye is understood, a correct notion may be formed about light, sufficient to dispel all apparent phenomena and illusions.

A great misunderstanding exists in the consideration respecting the different refractions produced in light.

The solution of placing a coin in an otherwise empty bowl, and placing the bowl in such a position to the eye, that the coin cannot be seen at the bottom of the bowl, the edge of the vessel intervening; in this state, if the eye is kept steady in its station, whilst water is poured into the bowl, the coin instantly comes into view.

Now, the consideration in this case is, how is this coin brought into view? does the light of the universe raise the coin to the top, or does the vision of the eye, as it unites with the water, swell in extent in the same manner that it does when it enters any other kind of prism, whatever, whether composed of water or crystal.

In all cases, when we look at a lens or crystaline prism, we water prism, the vision instantly swells or increases in accordance with the nature or shape of the media it so enters.

Now, this water in the bowl, that the light of the eye or the vision of the eye has entered and united with, is a medium and composing part of the vision of the eye that has now swelled down to the coin, where it takes its perception without obstructing or disturbing the coin that is lying close down to the bottom of the bowl.

I have tried this solution in every possible way I could think of, with straight viewing and oblique viewing, with strong lights and with partial lights, with opposition lights and with conjunction lights, and from all I can discover, the light of the universe has no more to do with it than to illuminate, whilst the light of the eye is swelled at the entrance of the water, as it does swell when it enters any prism whatever.

One observation, however, may be made, that is, whilst the coin is lying in the middle of the bottom of the bowl, it is apparently seen at the middle of the surface of the the water, at top, and if we can only allow the light of the universe to fall upon the water, at one side or point, and at the same time allow the eye to pass round at a distance, so as to complete a revolution, the coin is apparently seen from all points of the edge of the bowl, whether looking towards or from the light let in upon it, which would certainly not be the case if light had anything to do with forwarding images to the eye.

There is no phenomena in solution of this description, a right understanding is all that is required, and to get at a right understanding, we must travel by the right road to it.

I may be observed, that the other light of the universe is subject to enlargement, as well as the light of the eye, but it must be ridiculous to suppose that light raises the image of the coin from the bottom of the bowl to the top of the water.

Twenty persons may be arranged around the bowl, and each, without difficulty, gains a perception ; but how would twenty images be, sent there by light, or how could twenty eyes be supplied with an image, a piece out of one solitary coin ; it would seem that the farther we travel from the natural path the more we are bewildered, and that it consequently, follows, that the more we correct our notions by comparing them with nature, the more clearly will we be enabled to see through what is now considered mystery, illusion, and phenomenon.

SECTION XV.

An extract from Publication.—Comment thereon.—The Masterpiece.

The following is an extract from a publication, purporting to be a production by Thomas Dick, LL. D., called "Celestial Scenery, or the wonders of the Planetary System displayed," and is published at Philadelphia, in the year 1853:—

At page 227 of the said book is the following, and upon it I have made a comment:—

"From what we have stated above, in relation to the phases and motions of the moon, it is evident that the moon is a dark body like the earth, and derives all its light from the sun; for its enlightened side is always turned towards that luminary. It likewise derives a faint light from the reflection of the sun's rays from the earth in the same way that we derive a mild light from the moon. And as the earth has an uneven surface composed of mountains and vales, so the moon is found to be diversified with similar inequalities. It is owing to these inequalities, or the roughness of the moon's surface, that the light of the sun is reflected from it in every direction; for if the surface of the moon were perfectly smooth, like a polished globe or speculum, her orb would be invisible to us, except perhaps at certain times when the image of the sun reflected from it would appear like a lucid point. This may be illustrated by the following experiment:—Place a silver globe, perfectly polished, about two inches in diameter, in the sun; the rays which fall upon it being reflected variously, according to their several incidences upon the convex surface, will come to our eye only from one point of the globe, which will therefore appear a small bright spot, but the rest of the surface will appear dark. Let this globe then be boiled in liquor used for whitening silver, and placed in the sun, it will appear in its full dimensions, all over luminous; for the effect of that liquor is to take off the smoothness of the polish and make the surface rough, and then every point of it will reflect the rays of light in every direction."

Mr. Dick speaks of the image of the sun, being reflected from the moon, would appear like a lucid point. It should be understood that there is no image of the sun, whatever, reflected from the moon to the earth, nor from the earth to the moon. I have not a silver globe two inches in diameter to experiment upon, but I have that which will answer my purpose full as well: I have a pair of convex spectacles, which are all sufficient for the purpose that I am about to explain. I will now endeavor to demonstrate what I have, in different parts of this book, endeavoured to explain, that is, that eye-sight is eye-light, and eye-light reflects and refracts as all other light does, and eye-sight, by reflection, takes perceptions of objects in their respective localities, and the other light of the universe, commonly called sunlight, only illuminates objects and renders them visible.

Let a person take any convex glass—an eye-glass, the top of an opera glass, or a glass from a pair of spectacles, either will do very well; let him hold the convex glass to the sun as he would hold any other mirror to enable him to see the sun by reflection, whilst shutting one eye, let him look upon the surface of the glass with the other eye and he will perceive two bright lucid spots upon the glass.

These two spots, may, by a movement of the glass, be made to move round each other at any distance to the extent of the glass; they may be made to approach each other, to eclipse each other on the centre of the glass, and again to extend from each other to the extremities of the glass. When these two spots appear to eclipse each other, it is then only that they have any connection with each other, and it is then only that there can be a misunderstanding about which is and which is not the incidental or the reflected ray between the light of the eye and the light of the universe. It is only when those two spots are in that one position upon a convex lens that the line of reflection for one might be taken for the line of incidence for the other. Were a person making use of a plane mirror the case would be very different, as every incidental ray from the eye might be taken for a reflected ray from the light of the universe, and every incidental ray from the light of the universe might be taken for a reflected ray from the light of the eye. We are therefore indebted to the convex lens for preventing us from falling into errors that we would be liable to fall into whilst making use of a plane mirror.

If we examine these two spots, one of them appears as though it floated upon the surface of the glass, and, from its position and circumstances, it must be formed by the light of the universe, in a direction from and between the sun and the spot itself. The other spot does not appear upon the surface of the glass, but has the appearance of being a long distance through the glass; and from its position and circumstances it must be formed by the light of the eye in a direction from and between where the spot itself has the appearance of being seen on the glass and the sun. By a careful inspection these two spots cannot be mistaken for each other, for move the glass how you will, and put them in what position you will, each of them support distinct appearances, and even when they are, by a movement of the glass, brought in such a position as to partially eclipse each other, that is, when the spot that floats upon the surface of the glass seems to cover one half of the spot which appears to be at a great distance through the glass—which is at a time when each of them form an equal angle with the sun and the eye—then, in that case, as in all others, there is a visible distinction; the one is always floating upon the surface of the glass, whilst the other is apparently seen at a great distance through the glass, and the former always appears much nearer the eye than the latter, whilst the latter always appears more clear and distinct than the former. The position and appearances of these two spots denotes them to be produced by two incidental rays of light; the one that has the appearance of floating upon the surface of the glass is produced by the light of the universe, that shines some little space beyond the upper limb of the glass, and thereby falling obliquely upon it, and subsequently reflecting into the atmosphere. The other, that has the appearance of being seen a long way through the glass, is produced by the light of the eye that shines some little space beyond the upper limb of the glass, contrariwise to the former, and thereby falling obliquely upon the glass, and subsequently, reflecting back, it takes perception of the body of the sun. Here we have the light of the universe or sun-light shining upon one spot of the lens and reflecting into the atmosphere, whilst we have the light of the eye shining upon another spot of the lens where the light of the universe does not meet it.

These spots demonstrate, sufficiently and satisfactorily, what I could not by other means satisfactorily explain.

In sections 1 and 2, I endeavored to explain the same subject by observations upon a plane mirror, and my ideas were then, as they are now, that the light of the eye took perception of objects, and the light of the universe illuminated and rendered them visible; but with a plane mirror the task was a difficult one, for the incidental ray of the eye-light was always meeting the reflected ray of the light of the universe, and the incidental ray of the light of the universe was always meeting the reflected ray of the light of the eye, and the one was always taken for the other; and I could not possibly procure a criterion that was sufficient to illustrate my own ideas until, perchance, I was looking at a book, which acknowledged Mr. Thomas Dick to be its author, and on reading about the moon I discovered the words,—"When the image of the sun, reflected from it, would appear like a bright lucid point." An idea instantly struck me, that a convex lens would be the identical implement for the consummation of my wishes; and immediately I made application, first to my spectacles, then to the lens of my opera glass, and both of them gave me immediate satisfaction, for as the light of the eye and the light of the universe have each a line of incidence, independent of each other, so their lines of reflection must be independent of each other too; and as there is no difficulty in determining the claim of each to its respective incidental spot upon the glass, so I must consider the object fully accomplished.

Should the observer find any difficulty in distinguishing the difference between the spot produced by the light of the eye and the spot produced by the light of the universe, he can conveniently satisfy himself by making use of a candle, instead of the light of the universe, to demonstrate upon the lens, and the spot that is produced by the light of the eye will exhibit to his view, not only the flame of the candle, but also the candle itself; thus he will have occular demonstration that the light of the eye takes perceptions of objects in their respective locality.

It is evident that these two spots are produced by different lights, for each of them are inverted towards each other.

When examined by a lens and a candle, the one that appears to float on the glass has all the appearance of a shadow projected by the genuine light of a candle, showing through the common light or flame of the same candle, and leaving an imperfect shadow of the candle upon the glass; whilst the one that has the appearance of being seen at a great distance through the glass has all the appearance of the candle in as full perfection as though the eye were looking directly at the candle; and the fact that they both are always inverted towards each other denotes that the lights that produced them must come upon the glass from different directions, for, whichever way the one points, the other always points to the contrary; that is, if the point of one is towards the north, the point of the other is always towards the south, and if the point of one is towards the east, the point of the other is always towards the west, and such is the case in every position that they may be made to occupy.

As for the lucid point upon the silver globe, Mr. Dick has deceived himself. It can easily be ascertained that the spot he speaks of is a production of the light of the universe, yet it is not the spot where the sun is seen, and consequently the picture of the sun is not by it reflected to the earth from the moon.

Surely Mr. Dick must have been in error when he considered that the surface of a perfectly polished silver globe does not reflect so much light from one part as from another, because he merely sees a lucid spot in one place. The cause why the bright polished globe could not be seen in sun-light was because there was too much light, and consequently no colour; for too much light destroys colours, and renders objects invisible, hence the necessity of boiling the silver globe to give it a colour to render it visible.

The bright spot or point that Mr. Dick spoke of was a colour, and consequently not so bright as the invisible portion of the silver globe that was exposed to sun-light. This was an error occasioned by not knowing that light and colours are distinct substances, and that genuine light is always invisible because it is colourless. The polished silver globe, before it was boiled, was brighter, and a greater reflector of light than it was afterwards, but it could not be seen because it was void of colour.

SECTION XVI.

Colours in the Atmosphere.—The Prism and Sir Isaac Newton.—Opinion thereon. —The Atmosphere contains a variety of Fluids.—The Fluids are earthy productions from opaque and transparent substances.—Colours are seven in number, exclusive of white.—Eye-light and the light of the Universe destroy all Colours.—Names of Colours erroneously arranged.—Colours can only be seen in certain degrees of Light respectively.—The Prism as a magnifying power.—Observations upon a Window.—The light of the Eye obliterates fine Shadows.—Blue ether can be looked through to a great distance, and White may be discerned by certain means.—Shadows projected by Window Bars.

By the use of the Prism seven different colours are revealed to our view, viz.: red, orange, yellow, green, blue, indigo and violet.

Those seven colours have been termed the solar spectrum, because they have been considered a production of solar light.

Sir Isaac Newton and many other eminent philosophers have considered that the whole of those seven colours are a production from white light, by virtue of the Prism, and that white light contains the whole seven.

That the Prism possesses the power of separating white light into those seven colours, and when they employed a second Prism, with power equal to the first, they supposed that they had found a means of returning all those colours into white light again.

If Sir Isaac Newton considered that the white light he spoke of to be, and to contain, all the atmosphere, and all fluids therein contained, his ideas, so far, were close upon the subject, but the idea that the prism possessed the power of separating all those colours to be seen, and that a second prism, with power equal to the first, restored them again to their original state of white light, cannot at all be correct.

It is true that we see colours by the help of the prism, that we cannot see by the naked eye, but that is no reason that those colours are separated and again united by the power of the prism. Colours will not separate by being looked at. Their existence in the atmosphere is constant unity, and if we can see them by one means, and cannot see them by another, it is not because the colours separate and again unite, but because of other circumstances that affect the vision.

In the time of Sir Isaac Newton it was not known that the eye viewed all things in their respective localities, but he, like all other persons of his day, and also of the present day, considered that colours, like all other objects, sent images of themselves to our eyes to be seen. The power and qualifications of the eye were not understood at that time, and eye sight was not known to be genuine light, possessing all the powers of diverging and converging, of reflecting and refracting, and, in all instances, finding its path through the atmosphere and all other media, as all other genuine light does; and, without such information first obtained, he was ill prepared for the exploration of light with all its intricacies and qualities.

The atmosphere contains a variety of fluids, and there can be no doubt but all those fluids are exhalations from the earth, consequently they must be earthy substances.

It is understood that all nature is changeable, and that no substance is entirely at rest, not even the hardest and largest stones that lie deep in the earth; all are given to change in their properties, but perhaps those substances that are most exposed are most rapid in the process of changing.

It is generally understood that all the planetary system is governed in their motion by an universal system of gravitation, and, as far as I can discern, all nature is conducted and matured by a system of reciprocity.

The fluids contained in the atmosphere are of two kinds, viz.: opaque and transparent, and the substances composing the body of the earth may also be considered opaque and transparent.

As the earth supplies the atmosphere with exhalations consisting of colours and fluids, so the atmosphere supplies the earth with colours and properties to the animal, vegetable, and mineral creation.

We have many instances how vegetables, when deprived of air, loose their colour, and when again a free circulation of air is allowed them they regain their colour, and, it is also understood, that those plants that in their growth are excluded from the air, do not give carbon like those that receive the fresh air, and we know that no animal can live long or enjoy good health without the enjoyment of fresh air, and also, we observe how petrefaction is carried on by the three elements—earth, air and water—all these things may be considered as proving that the whole system of nature is conducted and matured by a system of reciprocity, between the animal, vegetable, and mineral creation, on one part, and the atmosphere and all its components, on the other part.

My belief is, and I have strong reasons for my belief, that the opaque substances of the earth supply the atmosphere with colours, by exhalation, and that all those colours must be amazingly fine or subtile; and further, that all the earthy transparent and bright substances, by their shining, supply the atmosphere with light.

If the exhalations of the opaque substances are amazingly fine, as they are so thinly scattered in the atmosphere, what must be the fineness of the mere shine of those bright substances that undoubtedly produce light in its genuine state.

As all the colours in the atmosphere are a production from opaque ponderable substances, they must have a tendency to create darkness in the atmosphere, and as light is the mere shine of bright shining substances, it is imponderable, and in quality or substance, it surpasses in fineness anything we can think of; nevertheless, when all the productions, both opaque and transparent, are intermixed in the atmosphere, they compose, what I denominate, common light, and this common light, together with the atmosphere itself, bears a white colour.

The colours seen in the atmosphere, are seven, including green, which is a compound formed of yellow and blue; these are the colours generally seen by the help of the prism.

As the white or common light which comprises the whole of the colours I have mentioned, and can only be seen by the naked eye in some particular position, and does not make its appearance by the use of the prism, so I shall omit mention of it for the present, whilst discussing the use of the prism.

Eye-light, or otherwise eye-sight, which is the production or mere shine of the eye, and, an account of its fineness, it is possessed of the power of passing some distance through the dark ether, composing common light; this distance may be about as far as our vision will range on a clear day, that is until it reaches what appears to be the canopy of blue sky; but if assisted by a strong light, at a distance, as the light between the eye and the sun, then these two lights know no bounds, but by their shining obliterate all colours and substances between them, that is, they by their fineness shine so easily and freely through the whole, that neither colours nor fluids can be perceived, this is the case upon all occasions, when the eye-light meets any strong light, in the absence of any intervening opaque substance.

All persons that have previously written upon the colours, have given them in the following order, viz.: red, orange, yellow, green, blue, indigo and violet; had they possessed the knowledge, that all these colours are produced by two shadows, which is evidently the case, viz., a light shadow, that produces the yellow, orange, and red, and a dark shadow, that produces the blue, indigo, and violet, they certainly would have begun with one extreme of the colours and ended with the other; instead of which, they have begun with the extreme of what is produced by the light shadow, and ended with the extreme of what is produced by the dark shadow, thus they have the extreme dark grade of each shadow at the ends respectively, and the light grade of each shadow at the centre respectively; thus, instead of having red, orange, yellow, green, blue, indigo, and violet, by leaving out the green as a compound, they should have had yellow, orange, red, blue, indigo, and violet, for as the yellow is produced in the strongest light, those two colours should have formed the extremities, and the remainder the intermediate grades, for it is evident and strictly essential to be understood, that no two of those six colours can be seen in one grade of a shadow, that is, the yellow cannot be seen in the same grade of shadow as the orange, the orange cannot be seen in the same grade as the red, the red cannot be seen in the same grade as the blue, the blue cannot be seen in the same grade as the indigo, the indigo cannot be seen in the same grade as the violet, neither can the violet be seen with the same light as white.

As none of these colours can be seen, only in a certain degree of light, in the shape of a shadow respectively, on account of the brilliancy of the eye, and the strong light of the universe, so neither of them can be seen without having its particles magnified by the use of the prism, and by having the eye that is viewing them lowered in its brilliancy, by the use of the same instrument.

The prism generally in use is made of glass, a description of it is unnecessary.

It has a high magnifying power transverse to its shape, viz.:—when it is held horizontally, all the objects perpendicularly to it are greatly magnified in size, whilst those objects that are parallel to the prism are not at all magnified. I can, at pleasure, increase or decrease the apparent size of all objects, by increasing or decreasing the size of that side the prism next the object, this is done simply by turning the prism up or down, whilst looking at any object; for instance, if I am looking out of a room, through a window, and holding the prism horizontally, if I turn the prism upward, the side of the prism next the window is enlarged, and consequently my vision also, and the panes of glass are greatly increased in length, but not in breadth; if I turn the prism down, the side of the prism next the window, the panes of glass are greatly decreased in length, but not in breadth. If I change the position of the prism from horizontal to perpendicular, with the thin edge of the prism to myself, and the back to my right, I can then, by turning the face of the prism to my right, increase the panes of glass in breadth, but not in length, and by turning the face of the prism back to the left, I decrease the panes of glass in breadth, but not in length.

It should be understood, every colour that is seen by the use of a prism, is first brought into readiness to be seen by the projection of a shadow, and each particle of a colour, fine and transparent as it is, is, of course, enlarged by the shadow so attached to it, and as it is the shadow of a fluid, it will at the same time partake of the colour of the particle that projects it; still, in this stage, it cannot be seen as a colour by the naked eye, the light of the eye obliterates the colour, and the shadow alone can be seen; as a shadow, the light of the eye can perceive as much of the shadow as it does not obliterate, but it cannot perceive a substance so fine as a colour, but obliterates it; nevertheless, in this state, it is in readiness to be viewed by the prism, whose capabilities will not only lower the brilliancy of the eye, but, at the same time, magnify each and all the particles of both the colours and their shadows.

Perhaps, there is no better place for a person to commence observations upon, than inside of a room, and looking out through a window on a fine clear day.

It should be borne in mind, that the light of the eye obliterates fine shadows, and that the light of the universe obliterates almost all shadows before it; but when the light of the eye directly meets the light of the universe, or that portion of it, generally called sun-light, they, between them, obliterate all appearance of colours or shadows, and nothing can be seen in such a position, but the amount of brilliancy of the universe that surpasses the amount of brilliancy of the eye, not even the blue ether that can be seen otherwise as blue sky, nor the white atmosphere that has so often and so erroneously been termed white light.

The blue ether can be well seen in a clear day, by the naked eye, by a long range of vision looking through the atmosphere, until a sufficiency of blue is before the eye to render it visible, and the white atmosphere may also be seen by the naked eye, by looking through a window with one eye closed and the other partially closed, or by looking at the moon on a fine light night, with eyes so partially closed, when a long stream of white atmosphere is seen both upwards and downwards from the moon.

It should be noticed, that the light coming in at a window, projects several shadows into the room, and these shadows generally reach farther into the room than most persons are aware of, for the light of the eye destroys or obliterates all the extremities of them, and also reduces the appearance of the more substantial part of those shadows; but, if a person wishes to gratify his curiosity in this respect, let him hang up a fine curtain so as to cover the upper part of the window, and to produce a dimness in the part so covered, and then with his eyes so partially closed, as I have mentioned, he will then perceive all the dark shadows, that are perpendicular to the eyes, to be still more darkened, and, by opening the eye, that is viewing them to the full extent, its brilliancy partially obliterates them, and by partially closing the eye again, the shadows appear more darkened as before, so by alternately viewing those perpendicular to the eye, first with a bright eye, then with a dim eye, we have occular demonstrations, that the light of the eye is capable of obliterating a fine shadow altogether, and also of reducing the dense darkness of a dark shadow.

It should be noticed, at the same time, that those shadows that are parallel with the partially closed eye, are not at all affected by the process, because the position of the eye was such, that the light of the eye was passing through the thinner part of them and kept them constantly reduced by obliteration.

It is well understood how a dark shadow is projected by an opaque substance, and that no intermediate shadow can be seen within it, and that its own colour of blue cannot be discerned within, unless by the help of some light on one of its surfaces, or on the contrary side to the eye, for as the colour is enlightened, so the dark is obliterated, and another colour becomes visible; this shadow, when shown upon by light, produces violet, indigo, and blue.

It is not so well understood, that a shadow is projected on the sides of an opaque substance, and by what means, but such is a fact, and were it not for a shadow of this description, none of the three light colours could be seen; in the darkest part of this shadow the red colour can be seen, and next the orange, and then yellow, and green, which is generally seen between yellow and blue.

The colour blue is seen in the lightest grade of the dark shadow, and the colour that is seen in the darkest grade of the light shadow, is red.

As the violet colour is the nearest to where no other colour can be seen, because of darkness, and the yellow is the nearest to where no other colour can be seen, because of light, the order of the colours ought to be, yellow, orange, red, blue, indigo, and violet.

SECTION XVII.

Production of two Shadows.—The Umbra and the Penumbra.—How perceived.—Observations on the Shadows and Prism.—The Rainbow.—The Solar Spectrum.

The following is a description of how the light shadow is produced :—

All light, when not intercepted by some opaque substance, has a tendency, as part of its nature, for the different particles to assist each other in all directions, by a system of reciprocity of shining upon or through each other; but if an opaque substance intervenes, not only is a dark shadow projected in its rear, but all the light is immediately, on both sides of the opaque substance, debarred of the additional light that it would otherwise receive by reciprocity, if the opaque substance were not there; consequently, a faint shadow is produced on both sides of all opaque substances.

The dark shadow, in the rear of an opaque substance, may be termed the umbra; and the light shadow, on the sides of an opaque substance, may be termed the penumbra.

Both these shadows are visible to the naked eye. There is no difficulty in discerning the dark shadow in the rear; and, by taking a little pains, the light shadows on the sides are equally discernable, in the following manner :—

Let any person hold up any smooth substance, where there is not too much nor too little light, and he will perceive, by the side of the said substance, a very small faint shadow; this may very well be seen by looking by the side of a sash-bar of a window, or by holding up your finger; or the back of your hand, in either case a small shadow is perceivable on each of those surfaces; but a better view of the light shadow may be had by the use of something smooth, as the edge of a knife, or the edges of the two blades of a pair of scissors; the latter, if they are held up in a moderate light with the blades a little extended, a shadow will be seen on the edge of each blade, and at the junction of the two blades, the two shadows, by their junction with each other, will form a compound shadow.

Here we discover, that a dark shadow is projected on the inner side of each sash-bar of a window, and a light shadow is also projected on two sides of each bar, thus every pane of glass is surrounded by four dark shadows and four light shadows; the four dark shadows are in the interior of the room altogether, and the four light shadows are on the sides of the bars, partly outside and partly inside, but rather more outside than inside.

All those shadows are much larger than can be seen by the naked eye, particularly the dark shadows, that are projected a long way into the interior of the room, but they have their extremities obliterated by the light of the eye, and the light shadows that are most exposed are still more obliterated by the united light of the eye and the light of the universe.

From what has been said, we plainly perceive, that the atmosphere, whether illuminated or shaded, contains all the colours equally distributed and intermixed. Where the atmosphere is illuminated—that is, shone through by the light of the eye and the other light of the universe—

no shadows can be seen. This is the case with a pane of glass: where the shadows from the sash-bars do not reach, there no colours can be seen, there all the colours and atmosphere are obliterated, and they together form common light.

There are four light penumbra shadows, and four dark umbra shadows; the light of the eye cuts off, or obliterates, a portion of all these shadows, by its brilliancy, but the prism, by its dimness, restores it again.

As it appears that the light of the eye and the light of the universe, by their fineness or brilliancy, are capable of obliterating, and do obliterate all shadows and all distinctions of colours between them, so, it is highly essential to the discernment of shadows or colours, contained in the atmosphere, that the light of the universe should be lowered in its brilliancy by virtue of some shadow, and that the light of the eye should be lowered in its brilliancy by looking through a crystallized prism, by which means we have the light of the eye brought down near enough to a level (but not exactly so), but to a fit state of taking cognizance of the colours contained in the shady places of the atmosphere, that is, to such a state that neither of those lights should possess the power of passing through those colours without a touch.

It is now necessary to take a view of the position of the shadows, and observe how they have been formed, particularly the light penumbra shadow, as it is formed by the light in front of the sash-bar; its breadth will be greatest towards the inside of the window, and, consequently, every particle of colour will point its shadow in the same direction, that is, inwards and downwards.

At the same time, it is necessary to take a view at the position of the prism, and observe how it directs the eyesight upwards to this shadow; here, we may perceive that the magnifying power of the prism does not fall immediately upon the apex or point of each particle of colour in the shadow, but somewhat on one side, so that it strikes the particle and passes through it diagonally, thereby magnifying both particle and its shadow, both in density and size, at the same time; it thereby finds the three degrees of shadow in the colours of red, orange and yellow.

With respect to the dark umbra shadow, not much need be said; the light from the prism rising upward, merely slides over the surface, and, together with the light of the universe, dips as deep into the shadow as is necessary to form the three dark colours, violet, indigo and blue; and, with respect to the green, it is a mixture or compound of yellow and blue.

Enough has been said to give an idea how colours, that reside in the atmosphere, are brought into visibility by the use of the prism. I have demonstrated, by looking through a window—and it is necessary to understand that if so much is well considered and understood, very little more can be added—that the same theory which applies to appearances produced by a prism upon a window, applies to the numberless appearances that amuse the observer when looking over the horizon by the help of the prism; every cloud, plant, house, building, or animal, produces its shadows, and the prism and the eye observe them in the same manner as they made observation upon the window.

The rainbow that has amused the multitudes by its splendid appearance, and aroused the curiosity of thousands to explore and explain what is called its phenomena, has never been explained or understood, the cause of which has been the same that has prevented the advance of knowledge in the other departments of light, which is, the idea that objects sent images of themselves to all eyes that viewed them.

The rainbow is formed by what I term a natural prism, being and composing a section of the atmosphere that is sufficiently darkened to lower the brilliancy of the eye, in the same manner that the prism does. The sun is shining on the back of an observer, whilst he is looking at the bows, the great light of the sun, with the addition of the eye-light of the observer, meet at an angle and obliterate all shadows, hence the space between the bows. The light from this space is gradually darkened, upwards and downwards, and thereby the necessary shadows are formed, and the light of the eye, by the direction of the magnifying power of the prism, finds its right place for seeing the colours, in the curvilinear shape.

The fact that the bows are formed by the magnifying power of the prism, in union with the circular arch of the eye, may be easily understood by a knowledge, that if a number of persons are standing in a row, with their backs to the sun, whilst the rain forms the necessary cloud for making a bow in their front; then each of those persons will have a bow, respectively; and if that number of persons stand at equal distances from each other, so will the arch or upper section of their bows be at equal distances from each other. It therefore follows, that all parts of the cloud, with right height and right density, possesses all the necessary materials for rainbow making; and the light of the universe and the light of the eye have nothing more to perform than to meet each other, and, under the directions of the magnifying power of the prism, unite and form junctions upon the several grades of shades, above and below the illuminated space.

The solar spectrum about which so many curious notions have been formed, (all of which, instead of explaining, are calculated to confound the understanding) is as simple as the English alphabet, if considered rightly. It is produced by letting a portion of strong light through an aperture into a dark room, and by placing a prism in the aperture for the sun to shine through. A screen of white paper may be held up at some little distance from the prism in the dark room to receive the light; the light, of course, is strongest in the middle, and from thence it decreases towards the top and bottom, and accordingly the colours are seen from thence, varying in their tint towards the top and bottom, each colour in its respective grade of light; that towards the bottom being yellow, orange, and red; that towards the top being blue, indigo, and violet, and that remaining in the centre being green, is a compound of yellow and blue.

If rightly considered, the theory for the rainbow and the spectrum, is the same in every respect but one, that is, the shape of the bows, for, when looking through the artificial prism at the rainbow, the eye-light or eye-sight forms the bows, as it does by looking at a rail or any other pole of timber lying horizontally and parallel with the eye; but whilst looking at the spectrum, the eye-light does not pass through the prism at all, so, consequently, no bows are formed, but if the prism is taken from the aperture and placed before the eyes, and looking towards the aperture, we there see all the colours reversed and the bows formed as upon other occasions, because the light of the eye is now doing what the light of the universe had done before.

Having shown that all those seven colours have their residence in the atmosphere, and also shown how they are magnified into visibility by the use of the prism, assisted by shadows, that each colour requires a shade peculiar to itself to enable it to be seen, and that where the light of the eye and the other light of the universe, either meet or unite, they obliterate all the shadows that are essential to the exhibition of the different colours respectively, and that when all the shadows that exhibit the different colours are obliterated, all distinction of colours is also obliterated, and they together become common light; enough has been done to enable any observer of those colours to form a correct opinion for himself on the ground of what has been said of the pane of glass with its four light colours, and four dark colours, it and they may be considered as a specimen of all that can be seen, when looking through the prism at the clouds or over a landscape, to see more, would only be to see the same over again in a different position.

The white atmosphere, as I have before stated, may be seen by certain contrivances by the naked eye, better without than with a prism.

As it appears that the different colours are affected by their proximity to each other, under various circumstances whereby they produce a mixture of appearances, it may be a gratification to an observer to witness the real cause of the same. I would observe, that any person may gratify his curiosity by procuring a pasteboard, and proceed in some regular way to cut interstices through it, some big and some little, some near together, and some far asunder, by so doing, and by the use of the prism, he may observe how any two shadows coming in contact with each other form a third shadow or colour between them, or by their tints and touchings, they variegate each other.
