

## V.

REFUTATION OF THE ARGUMENTS ADDUCED TO PROVE THE  
EXISTENCE OF A FOUR-DIMENSIONED SPACE INCLUSIVE  
OF THE VISIBLE WORLD.

The considerations of the preceding section will have convinced the cultured non-mathematician of the service which the theory of multi-dimensioned spaces has done, and bids fair to do, for geometrical research. In addition thereto is the consideration that every extension of one branch of mathematical science is a constant source of beneficial and helpful influence to the other branches. The knowledge, however, that mathematicians can employ the notion of four-dimensioned space with good results in their researches, would never have been sufficient to procure it its present popularity; for every man of intelligence has now heard of it, and, in jest or in earnest, often speaks of it. The knowledge of a four-dimensioned space did not reach the ears of cultured non-mathematicians until the consequences which the spiritualists fancied it was permissible to draw from this mathematical notion were publicly known. But it is a tremendous step from the four-dimensioned space of the

mathematicians to the space from which the spirit-friends of the spiritualistic mediums entertain us with rappings, knockings, and bad English. Before taking this step we will first discuss the question of the real existence of a four-dimensioned space, not deciding the question whether this space, if it really does exist, is inhabited by reasonable beings who consciously act upon the world in which we exist.

Among the reasons which are put forward to prove the existence of a four-dimensioned space containing the world, the least reprehensible are those which are based on the existence of symmetry. We spoke above of two triangles in the same plane which have all

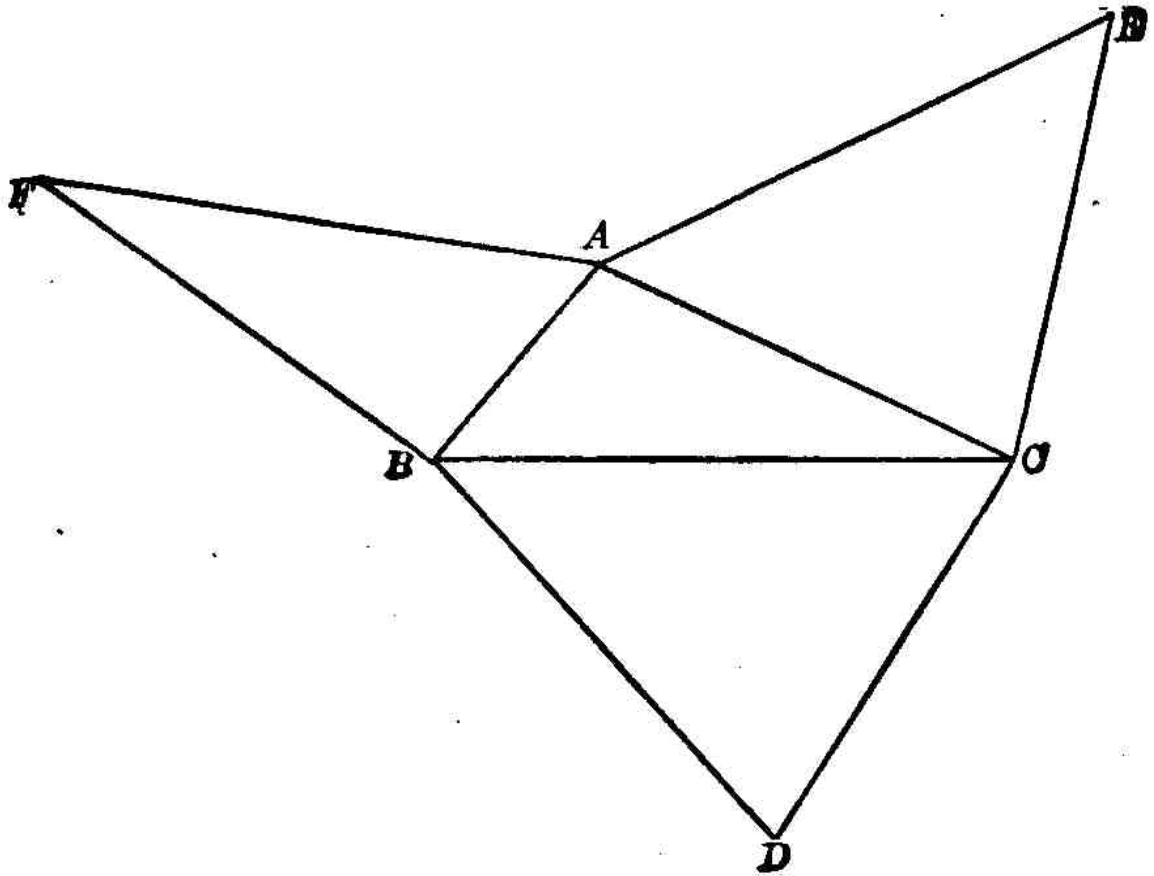


Fig. 38.

their sides and angles congruent, but which cannot be made to coincide by simple displacement within the plane; but we saw that this coincidence could be effected by holding fast one side of one triangle and moving it out of its plane until it had been so far turned round that it fell back into its plane. Now something similar to this exists in space. Cut two figures, exactly like that of Fig. 38, out of a piece of paper, and turn the triangle  $ABF$  about the side  $AB$ ,  $ACE$  about the side  $AC$ ,  $BCD$  about the side  $BC$ , and in one figure above and in the other below; then in both cases the points  $D$ ,  $E$ ,  $F$  will meet at a point, because  $AE$  is equal to  $AF$ ,  $BE$  is equal to  $BD$ ,  $CD$  is equal to  $CE$ . In this manner we obtain two pyramids which in all lengths and all angles are congruent, yet which cannot,

no matter how we try, be made to coincide, that is, be so fitted the one into the other that they shall both stand as one pyramid. But the *reflected* image of the one could be brought into coincidence with the other. Two spatial structures whose sides and angles are thus equal to each other, and of which each may be viewed as the reflected image of the other, are called *symmetrical*. For instance, the right and the left hand are symmetrical; or, a right and a left glove. Now just as in two dimensions it is impossible by simple displacement to bring into congruence triangles which like those above mentioned can only be made to coincide by circumversion, so also in three dimensions it is impossible to bring into congruence two symmetrical pyramids. Careful mathematical reflection, however, declares that this could be effected, if it were possible, while holding one of the surfaces, to move the pyramid out of the space of experience, and to turn it round through a four dimensional space until it reached a point at which it would return again into our experiential space. This process would simply be the four-dimensional analogue of the three-dimensional

circumversion in the above-mentioned case of the two triangles. Further, the interior surfaces in this process would be converted into exterior surfaces, and *vice versa*, exactly as in the circumversion of a triangle the anterior and posterior sides are interchanged. If the structure which is to be converted into its symmetrical counterpart is made of a flexible material, the interchange mentioned of the interior and exterior surfaces may be effected by simply turning the structure inside out; for example, a right glove may thus be converted into a left glove.

Now from this truth, that every structure can be converted, by means of a four-dimensional space inclusive of the world, into a structure symmetrical with it, it has been sought to establish the probability of the real existence of a four-dimensioned space. Yet it will be evident, from the discussion of the preceding section, that the only inference which we can here make is, that the idea of a four-dimensioned space is competent, from a mathematical point of view, to throw some light upon the phenomena of symmetry. To conclude from these facts that a space of this kind really exists, would be as daring as to conclude from the fact that the uniform

angular velocity of the apparent motions of the fixed stars is explicable from the assumption of an axial motion of the firmament, that the fixed stars are really rigidly placed in a celestial sphere rotating about its axis. It must not be forgotten that our comprehension of the phenomena of the real world consists of two elements: first, of that which the things really are; and, second, of that by which we rationally apprehend the things. This latter element is partly dependent on the sum of the experiences which we have before acquired, and partly on the, necessity, due to the imperfection of reason, of our classifying the multitudinous isolated phenomena of the world into categories which we ourselves have formed, and which, therefore, are not wholly derived from the phenomena themselves, but to a great extent are dependent on us.

Besides geometrical reasons, Zöllner has also adduced cosmological reasons to prove the existence of a four-dimensional space. To these reasons belong especially the questions, whether the number of the fixed stars is infinitely great, whether the world is finite or infinite in extension, whether the world had a beginning or will have an end, whether the world is not hastening towards a condition of equilibrium or dead level by the universal distribution of its matter and energy; the problems, also, of gravitation and action at a distance; and finally, the questions concerning the relations between the phenomena in the world of sense-perception to the unknown things-in-themselves. All these questions which can be decided in no definite sense, led Zöllner and his followers to the assumption that a four-dimensioned space inclusive of the space of experience must really exist. But more careful reflection will show that this assumption does not dispose of the difficulties but simply displaces them into another realm. Furthermore, even if four-dimensioned space did unravel and make clear all the cosmological problems which have bothered the human mind, still, its existence would not be proved thereby; it would yet remain a mere hypothesis, designed to render more intelligible to a being who can only make experiences in a three-dimensional space, the phenomena therein which are full of mystery to it. A four-dimensioned space would in such case possess for the metaphysician a value similar to that which the ether

possesses for the physicist. Still more convincing than these cosmological reasons to the majority of men is the psychophysiological reason drawn from the phenomena of vision which Zöllner adduces. Into this main argument we will enter in more detail.

When we "see" an object, as we all know, the light which proceeds or is reflected therefrom produces an image on the retina of our eye; this image is conducted to our consciousness by means of the optic nerve, and our reason draws therefrom an inference respecting the object. When, now, we look at a square whose sides are a decimetre in length, and whose centre is situated at the distance of a metre from the pupil of our eye, an image is produced on the retina. But exactly the same image will be produced there if we look at a square whose sides are parallel to the sides of the first square but two decimetres in length, and whose centre is situated at a distance of two metres from the pupil of the eye. Proceeding thus further, we readily discover that an eye can perceive in any length or line only the ratio of its magnitude to the distance at which it is situated from it, and that generally a three-dimensional world must appear to

the eye two-dimensional, because all points which lie behind each other in the direction outwards from the eye produce on the retina only one image. This is due to the fact that the retinal images are themselves two-dimensional; for which reason, Zöllner says, the world must appear for a child as two-dimensional, if it be supposed to live in a primitive condition of unconscious mental activity. To such a child two objects which are moving the one behind the other, must appear as suffering displacement on a surface, which we conceive behind the objects, and on which the latter are projected. In all these apparent displacements, coincidences and changes of form also are effected. All these things must appear puzzling to a human being in the first stages of its development, and the mind thus finds itself, as Zöllner further argues, in the first years of childhood forced to adopt a hypothesis concerning the constitution of space and to assume that the world is three-dimensional, although the eye can really perceive it as only two-dimensional. Zöllner then further says, that in the explanation of the effects of the external world, man constantly finds this hypothesis of his child-

ish years confirmed, and that in this way it has become in his mind so profound a conviction that it is no longer possible for him to think it away. Consonant with this argumentation, also, is Zöllner's remark, that the same phenomenon has presented itself in astronomical methods of knowledge. To explain the movements of the planets, which appear to describe regular paths on the surface of a celestial sphere, we were compelled in the solution of the riddles which these motions presented, to assume in the structure of the heavens a dimension of "depth," and the complicated motions in the two-dimensioned firmament were converted into very simple motions in three-dimensioned space. Zöllner also contends that our conception of the entire visible world as possessed of three dimensions is a product of our reason, which the mind was driven to form by the contradictions which would be presented to it on the assumption of only two dimensions by the perspective distortions, coincidences, and changes of magnitude of objects. When a child moves its hand before its eyes, turns it, brings it nearer, or pushes it farther away, this child successively receives the most various impressions on the surface of its retina of one and the same object of whose identity and constancy its feelings offer it a perfect assurance. If the child regarded the changeable projection of the hand on the surface of the retina as the real object, and not the hand which lies beyond it, the child would constantly be met with contradictions in its experience, and to avoid this it makes the hypothesis that the space of experience is three-dimensional. Zöllner's contention is, therefore, that man originally had only a two-dimensional intuition of space, but was forced by experience to represent to himself the objects which on the retinal surface appeared two-dimensional, as three-dimensional, and thus to transform his two-dimensional space intuition into a three-dimensional one. Now, in exactly the same way, according to Zöllner's notion, will man, by the advancement and increasing exactness of his knowledge of the phenomena of the outer world, also be compelled to conceive of the material world as a "shadow cast by a more real four-dimensional world," so that these conceptions will be just as trivial for the people of the twentieth century as since Copernicus's time the explanation of the mo-

tions of the heavenly bodies by means of a three-dimensional motion has been.

Zöllner's arguments from the phenomena of vision may be refuted as follows: In the first place it is incorrect to say that we see the things of the external world by means of two-dimensional retinal images. The light which penetrates the eye causes an irritation of the optic nerves, and any such effect which, though it be not powerful, is, nevertheless, a mechanical one, can only take place on things which are material. But material things are always three-dimensional. The effect of light on the sensitive plates of photography can with just as little justice be regarded as two-dimensional. Our senses can have perception of nothing but three-dimensional things, and this perception is effected by forces which in their turn act on three-dimensional things, namely our sensory nerves. It is wrong to call an image two-dimensional, for it is only by abstraction that we can conceive of a thickness so growing constantly smaller and smaller as to admit of our regarding a three-dimensional picture as two-dimensional, by giving it in mind a vanishingly small thickness. It is also wrong to say, as Zöllner says, that when we see the shadow of a hand which is cast upon a wall we see something two-dimensional. What we really perceive is that no light falls upon our eye from the region included by the shadow, while from the entire surrounding region light does fall on our eye. But this light is reflected from the

material particles which form the surface of the wall, that is, from three-dimensional particles of matter. We must always remember that our eye communicates to us only three-dimensional knowledge, and that for the comprehension of anything which has two, one, or no dimensions, a *purely intellectual act of abstraction must be added to the act of perception*. When we imagine we have made a lead-pencil mark on paper, we have, exactly viewed, simply heaped alongside of each other little particles of graphite in such a manner that there are by far fewer graphite particles in the lateral and upward directions than there are in the longitudinal direction, and thus our reason arrives by abstraction at the notion of a straight line. When we look at an object, say a cube of wood, we recognise the object as three-dimensional, and it is only by abstraction that

we can conceive of its two-dimensional surfaces, of its twelve one-dimensional edges, and of its eight no-dimensional corners. For we reach the perception of its surface, for example, solely by reason of the fact that the material particles which form the cube prevent the transmission of light, and reflect it, whereby a part of the light reflected from every material particle strikes our eye. Now, by thinking exclusively of those material particles which are reflected, in contrariety to the empty space without and the hidden and therefore non-reflected particles within, we form the notion of a surface.

It is evident from this, that all that we perceive is three-dimensional, that we cannot reach anything two-dimensional without an intellectual abstraction, and that, therefore, we cannot conceive of anything two-dimensional exerting effects upon material things. But this fact is a refutation of the retinal argument of Zöllner. If vision consisted wholly and exclusively in the creation of a two-dimensional image, the things which take place in the world could never come into our consciousness. The child, therefore, does not originally apprehend the world, as Zöllner says, as two-dimensional; on the contrary, it apprehends it either not at all, or it apprehends it as three-dimensional. Of course the child must first "learn how" to see. It is found from the observation of children during the first months of their lives, and of the congenitally blind who have suddenly acquired the power of vision by some successful operation, that seeing does not consist alone in the irritations which arise in the optic nerves, but also in the correct interpretation of these irritations by reason. This correct interpretation, however, can be accomplished only by the accumulation of a considerable stock of experience. Especially must the recognition of the distance of the object seen be gradually learned. In this, two things are especially helpful; first, the fact that we have two eyes and, consequently, that we must feel two irritations of the optic nerves which are not wholly alike; and, secondly, the fact that we are enabled by our power of motion and our sense of touch to convince ourselves of the distance and form of the bodies seen. The question now arises, what sort of an intuition of space would a creature have that had only one eye, that could neither move itself nor its eye, and also

possessed no peripheral nerves. According to Zöllner's view, this creature could, owing to its two-dimensional retinal images, have only a two-dimensional intuition of space. The author's opinion, however, is, that such a creature could not see at all, as it has no possibility of collecting experiences which are adapted in any way to interpreting the effects of things on its retina. The light which proceeded from the objects roundabout and fell on the retina could produce no other effect on the being than that of a wholly unintelligible irritation, or perhaps even pain.

The reflections presented sufficiently show that neither the phenomena of symmetry nor the retinal images of the objects of vision necessarily force upon us the assumption of a four-dimensioned space. If the material world should ever present problems which could not in the progress of knowledge be solved in a natural way, the assumption that a four-dimensional space containing the world exists would also be incompetent to resolve the difficulties presented; it would simply convert these difficulties into others, and not dispose of the problems but simply displace them to another world. Yet the question might be asked, is the existence of a four-dimensional space really *impossible*? To answer this question we must first clearly know what we mean by "exist." If existence means that the intellectual *idea* of a thing can be formed and that this idea shall not lead to contradictions with other well-established ideas and with experience, we have only to say that four-dimensioned space does exist, as the arguments adduced in sections III and IV have rendered plain. If, namely, the space of four dimensions did not exist as a clear idea in the minds of

mathematicians, mathematicians could certainly not have been led by this idea to results which are recognised by the senses as true, and which really take place in our own representable space. But if existence means "material actuality," we must say that we neither now nor in the future can know anything about it. For we know material actuality only as three-dimensional, our senses can only make three-dimensional experiences, and the inferences of our reason, although they can well abstract from material things, can never ascend to the point of explaining a four-dimensional materiality. Just as little,

therefore, as we can locally fix the idea of a two-dimensional material world, as little can we ever verify the notion of a four-dimensional material existence.

## VI.

EXAMINATION OF THE HYPOTHESIS CONCERNING THE EXISTENCE  
OF FOUR-DIMENSIONAL SPIRITS.

In connection with the belief that the visible world is contained in a four-dimensioned space, Zöllner and his adherents further hold that this higher space is inhabited by intelligent beings who can act consciously and at will on the human beings who live in experiential space. To invest this opinion with greater strength, Zöllner appealed to the fact that the greatest thinkers of antiquity and of modern times were either wholly of this opinion or at least held views from which his contentions might be immediately derived. Plato's dialogue between Socrates and Glaukon in the seventh book of the Republic, is evidence, says Zöllner, that this greatest philosopher of antiquity possessed some presentiment of this extension of the notion of space. Yet any one who has connectedly studied and understood Plato's system of philosophy must concede that the so-called "ideas" of the Platonic system denote something wholly different from what Zöllner sees in them or pretends to see. Zöllner says that these Platonic ideas are spatial objects of more than three dimensions and represent "real existence" in the same sense that the material world, as contrasted with the images on the retina, represents it. Zöllner similarly deals with the Kantian "thing-in-itself," which is also regarded as an object of higher dimensions.

To show Kant in the light of a predecessor, Zöllner quotes the following passage from the former's "Träume eines Geistersehers, erläutert durch Träume der Metaphysik" (1766, *Collected Works*, Vol. VII. page 32 et seq.): "I confess that I am very much inclined to assert the existence of immaterial beings in the world, and to rank my own soul as one of such a class. It appears, there is a spiritual essence existent which is intimately bound up with matter but which does not act on those forces of the elements by which the latter are connected, but upon some internal principle

of its own condition. It will, in the time to come - I know not when or where - be proved, that the human soul, even in this life, exists in a state of uninterrupted connection with all the immaterial natures of the spiritual world; that it alternately acts on them and receives impressions from them, of which, as a human soul, it is not, in the normal state of things, conscious. It would be a great thing, if some such systematic constitution of the spiritual world, as we conceive it, could be deduced, not exclusively from our general notion of spiritual nature, which is altogether too hypothetical, but from some real and universally admitted observations, - or, for that matter, if it could even be shown to be probable."

What Kant really asserts here is, first, the partly independent and partly dependent existence of the soul, and of spiritual beings generally, on matter, and, second, that spiritual beings have some common connection with and mutually influence one another. This contention, which is that of very many thinkers, does not, however, entail the consequence that the "transcendental subject of Kant" must be four-dimensional, as Zöllner asserts it does. Kant never

even hinted at the theory that the psychical features of the world owe their connection with the material features to the fact that they are four-dimensional and, therefore, include the three-dimensional. Is it a necessary conclusion that if a thing exists and is not three-dimensional, as is the case with the soul, it is therefore four-dimensional? Can it not in fact be so constituted that it is wholly meaningless to speak of dimensions at all in connection with it?

Yet still more strangely than the words of Plato and Kant do certain utterances of the mathematicians Gauss and Riemann speak in favor of Zöllner's hypothesis. S. v. Waltershausen relates of Gauss in his *Gruss zum Gedächtniss*, (Leipsic, 1856), that Gauss had often remarked that the three dimensions of space were only a specific peculiarity of the human mind. We can think ourselves, he said, into beings who are conscious of only two dimensions; similarly, perhaps, beings who are above and outside our world may look down upon us; and there were, he continued, in a jesting tone,

a number of problems which he had here indefinitely laid aside, but hoped to treat in a superior state by superior geometrical methods. Leaving aside this jest, which quite naturally suggested *itself*, the remarks of Gauss are quite correct. We possess the power to abstract and can think, therefore, what kind of geometry a being that is only acquainted with a two-dimensional world would have; for instance, we can imagine that such a being could not conceive of the possibility of making two triangles coincide which were congruent in the sense above explained, and so on. So, also, we can understand that a being who has control of four dimensions can only conceive of a geometry of four-dimensional space, yet may have the capacity of thinking itself into spaces of other dimensions. But it does not follow from this that a four-dimensional space exists, let alone that it is inhabited by reasonable beings.

Riemann, on the other hand, speaks directly of a world of spirits. In his *Neue mathematische Principien der Naturphilosophie* he puts forth the hypothesis that the space of the world is filled with a material that is constantly pouring into the ponderable atoms, there to disappear from the phenomenal world. In every ponderable atom, he says, at every moment of time, there enters and appears a determinate amount of matter, proportional to the force of gravitation. The ponderable bodies, according to this theory, are the place at which the spiritual world enters and acts on the material world. Riemann's world of spirits, the sole office of which is to explain the phenomenon of gravitation as a force governing matter, is, however, essentially different from the spiritual world of Zöllner, the function of which is to explain supposed supersensuous phenomena which stand in the most glaring contradiction with the established known laws of the material world.

Besides this appeal to the testimony of eminent men like Plato, Kant, Gauss, and Riemann, the scientific prophet of modern spiritualism also bases his theory on the belief, which has obtained at all times and appeared in various forms among all peoples, that there exist in the world forces which at times are competent to evoke phenomena that are exempt from the ordinary laws of nature. We have but to think of the phenomena of table-turning which once ex-

cited the Chinese as much as it has aroused, during the last few decades, the European and American worlds; or of the divining-rod, by whose help our forefathers sought for water, in fact, as we do now in parts of Europe and America.

Cranz, in his essay on the subject, divides spiritualistic phenomena into physical and intellectual. Of the first class he enumerates the following: the moving of chairs and tables; the animation of walking-sticks, slippers, and broomsticks; the miraculous throwing of objects; spirit-rappings (Luther heard a sound in the Wartburg, "as if three score casks were hurled down the stairs"); the ecstatic suspension of persons above the floor; the diminution of the forces of gravity; the ordeals of witches; the fetching of wished-for objects; the declination of the magnetic needle by persons at a distance; the untying of knots in a closed string; insensibility to injury and exemption therefrom when tortured, as in handling red-hot coals, carrying hot irons, etc.; the music of invisible spirits; the materialisations of

spirits or of individual parts of spirits (the footprints in the experiments of Slade, photographed by Zöllner); the double appearance of the same person; the penetration of matter (of closed doors, windows, and so forth). As numerous also is the selection presented by Cranz of intellectual phenomena, namely, spirit-writing (Have's instrument for the facilitation of intercourse with spirits), the clairvoyance and divination of somnambulists, of visionary, ecstatic, and hypnotised persons, prompted or controlled by narcotic medicines, by sleeping in temples, by music and dancing, by ascetic modes of life and residence in barren localities, by the exudations of the soil and of water, by the contemplation of jewels, mirrors, and crystal-pure water, and by anointing the finger-nails with consecrated oil. Also the following additional intellectual phenomena are cited: increased eloquence or suddenly acquired power of speaking in foreign languages; spirit-effects at a distance; inability to move, transferences of the will, and so forth.

All these phenomena, presented with the aspect of truth, and associated more or less with trickery, self-deception, and humbug, are adduced by the spiritualists to substantiate the belief in a world of spirits which intentionally and consciously take part in the events

of the material world, and to prove that these phenomena may be sufficiently and consistently explained by the effects of the activity of such a world. It is impossible for us to discuss and put to the test here the explanations of all these supersensuous phenomena. Anything and everything can be explained by spirits who act at will upon the world. There are only a few of these phenomena, namely, clairvoyance and Slade's experiments, whose explanations are so intimately connected with our main theme, the so-called fourth dimension, that they cannot be passed over.

First, with respect to clairvoyance, the American visionary Davis describes the experiences which he claims to have made in this condition, induced by "magnetic sleep," as follows :\* "The sphere of my vision now began to expand. At first, I could only clearly discern the walls of the house. At the start they seemed to me dark and gloomy; but they soon became brighter and finally transparent. I could now see the objects, the utensils, and the persons in the adjoining house as easily as those in the room in which I sat. But my perceptions, extended further still; before my wandering glance, which seemed to control a great semi-circle, the broad surface of the earth, for hundreds of miles about me, grew as transparent as water, and I saw the brains, the entrails, and the entire anatomy of the beasts that wandered about in the forests of the Eastern Hemisphere, hundreds and thousands of miles from the room in which I sat." The belief in the possibility of such states of clairvoyance is by no means new. Alexander Dumas made use of it, for example, in his *Mémoires d'un médecin*, in which Count Balsamo, afterwards called Cagliostro, is said to possess the power to throw suitable persons into this wonderful condition and thus to find out what other persons at distant places are doing. Zöllner explains clairvoyance by means of the fourth dimension thus:

A man who is accustomed to viewing things on a plain is supposed to ascend to a considerable height in a balloon. He will there enjoy a much more extended prospect than if he had remained on the plain below, and will also be able to signal to greater dis-

\* Quoted by Cranz.

tances. The plain, that is, the two-dimensioned space, is accordingly viewed by him from points outside of the plain as "open" in all directions. Exactly so, in Zöllner's theory, must three-dimensioned spaces appear, when viewed from points in four-dimensioned space, namely, as "open"; and the more so in proportion as the point in question is situated at a greater distance from the place of our body, or in proportion as the soul ascends to a greater height in this fourth dimension. Zöllner thus explains clairvoyance as a condition in which the soul has displaced itself out of its three-dimensioned space and reached a point which with respect to this space is four-dimensionally situated and whence it is able to contemplate the three-dimensional world without the interference of intervening obstacles.



The following remark is to be made to this explanation. The reason why we have a better and more extended view from a balloon than from places on the earth is simply this, that between the suspended balloon and the objects seen at a distance nothing intervenes but the air, and air allows the transmission of light, whereas, at the places below on the earth there are all kinds of material things about the observer which prevent the transmission of light and either render difficult or absolutely impossible the sight of things which lie far away. In the same way, also, from a point in four-dimensioned space, a three-dimensional object will be visible only provided there are no obstacles intervening. If, therefore, this awareness of a distant object is a real, actual vision by means of a luminous ray which strikes the eye, there is contained in the explanation of Zöllner the tacit assumption that the medium with which the four-dimensional world is filled is also pervious to light exactly as the atmosphere is.

The theory that there are four-dimensional spirits who produce the phenomena cited by the spiritualists received special support from the experiments which the prestidigitateur Slade, who claimed he was a spiritualistic medium, performed before Zöllner. Of these experiments we will speak of the two most important, the experiment with the glass sphere and the experiment with the knots. To explain the connection of the glass sphere experiment with the fourth

dimension, we must first conceive of two-dimensional reasoning beings, or, let us say, two-dimensional worms, living and moving in a plane. For a creature of this kind it will be self-evident that there are no other paths between two points of its plane than such as lie within the plane. It must, accordingly, be beyond the range of conception of this worm, how any two-dimensional object which lies within a circle in its space can be brought to any other position in its space outside the circle without the object passing through the barriers formed by the circle's circumference. But if this worm could procure the services of a three-dimensional being, the transportation of the object from a position within the circle to any position outside it could be effected by the three-dimensional being simply taking the object *out of* the plane and placing it at the desired point. This object, therefore, would, in an inexplicable manner, suddenly disappear before the eyes of the worms who were assembled as spectators, and after the lapse of an interval of time would again appear outside the circle without having passed at any point through the circle's circumference. If now we add another dimension, we shall derive from this trick, which is wholly removed from the sense-perception of the flattened worms, the following experiment, which is wholly beyond the perception of us human beings. Inside a glass sphere, which is closed all around, a grain of corn is placed; the problem is to transport the corn to some place outside the sphere without passing through the glass surface. Now we should be able to perform this trick if some four-dimensional being would render us the same aid that we before rendered the two-dimensional worm. For the four-dimensional being could take the grain of corn into his four-dimensional space and then replace it in our space in the desired spot outside of the glass sphere. Slade performed this trick before Zöllner. Its mere performance sufficed to convince this latter investigator that Slade had here made use of a four-dimensional agent, who, in respect of power of motion, controlled his four-dimensional space as we do our three-dimensional space. It never occurred to Zöllner that this experiment was the cleverly executed trick of a prestidigitateur, or, as it would at once occur to us, that the whole thing was a sensory illusion. The fact

that we cannot explain a trick easily and naturally does not irrevocably prove that it is accomplished by other means than those which the world of matter presents.

Still better known than this last performance is Slade's experiments with knots. To explain this in connection with the fourth dimension, we must resort again to the plane and the flat worm inhabiting it. To two parallel lines in a plane let the two ends of a third line, which has a double point, that is, intersects itself once, be attached. Our flat worm would not be able to untie the loop formed by the doubled third line, which we will call a string, because it cannot execute motions in three dimensions. If, therefore, a two-dimensional prestidigitateur should appear and accomplish the trick of untying this loop without removing the two ends of the string from the parallel lines, he will have accomplished for our flat worm a supersensuous experiment. A human being engaged in the service of the prestidigitateur could

execute for him the experiment by simply lifting the string a little out of the plane, pulling it taut, and placing it back again. This suggests the following analogous experiment for three-dimensional beings. The two ends of a string in which a common knot has been made are sealed to the opposite walls of a room. The problem is to untie this knot without breaking the seals at the two ends of the string. Everybody knows that this problem is not soluble, but it may be calculated mathematically that the knot in the string can be untied as easily by motions in a fourth dimension of space as in the experiment above described the knot in the two-dimensional string was untied by a three-dimensional motion. Now as Slade untied the knot before Zöllner's eyes without apparently making any use of the ends fastened in the walls, Zöllner was still more firmly confirmed in the view that Slade had power over spirits who performed the experiments for him.

Still more far-reaching is the theory of Carl du Prel concerning the relations of the material and the four-dimensional world. (Compare his numerous essays in the spiritualistic magazine *Sphinx*.) Just as the shadows of three-dimensional objects cast on a wall are controlled in their movements by the things whose projections they are, in the same way it is claimed does there exist back of every-

thing of this sense-perceptible world a real transcendental and four-dimensional "thing-in-itself" whose projection in the space of experience is what we falsely regard as the independent thing. Thus every man besides existing in his terrestrial self also exists in a spiritual or astral self which constantly accompanies him in his walks through life and whose existence is especially proclaimed in states of profound sleep, of somnambulism, and in the conditions of mediums. In this way Du Prel explains the wonderful feats of somnambulists, and the aerial journeys of sorcerers and witches. Whereas, ordinarily the separation of the material body from the astral body is only effected at the moment of death; in the case of somnambulists this separation may take place at any time, or, as Du Prel says, "the threshold of feeling may be permanently displaced."

In view of the natural relations of such theories to the dogmas of Christianity it is explainable that theologians also have raised their voices for or against spiritualism. While the *Protestant Church Times* beheld in the "repulsive thaumaturgic performances which these coryphaei of modern science offer, a lack of comprehension of real philosophy," the magazine *The Proof of Faith* expresses its delight at the discovery of spiritualism in the following manner: "Every Christian will surely rejoice at the deep and perhaps mortal wound which these new discoveries have in all probability administered to modern materialism."

We shall pass by the childish opinion that the Bible also speaks of four dimensions, as both in Job (xi. 8-9) and in the Epistle to the Ephesians (iii. 18) only breadth, length, depth, and height, that is, four directions of extension, are mentioned. Yet we will still add, as Cranz has done, the reflections which Zöllner, as the most prominent representative of modern spiritualism, has put forward respecting its relations to the doctrines of Christianity (*Wissensch. Abhandl.*, Vol.III). By the foundation of transcendental physics on the basis of spiritualistic phenomena, the "new light" has arisen which is spoken of in the New Testament. The rending of the veil of the Temple on the crucifixion of Christ, the resurrection, the ascension, the transfiguration, the speaking with many tongues on the giving out of the Holy Ghost, all these are in Zöllner's view

spiritualistic phenomena. Similarly, he sees a reference to the four-dimensional world of spirits in all those sayings of Christ in which the latter speaks to his Apostles of the impossibility of their having any image or notion of the place to which when he disappeared he would go and whence he would return. (Gospel of St. John, xii. 33, 36; xiv. 2, 3, 28; xvi. 5, 13.)

Ulrici, however, goes farthest in the mingling of spiritualistic and Christian beliefs; for he sees in the doctrine of spiritualism a means of strengthening belief in a supreme moral world-order and in the immortality of the soul. In answer to Ulrici's tract "Spiritualism So-called, a Question of Science" (1889) Wundt wrote an annihilating reply bearing the title "Spiritualism, a Question of Science So-called." Wundt criticises the future condition of our soul

according to spiritualistic hypotheses in the following sarcastic yet pertinent words, which Cranz also quotes: "(i) Physically, the souls of the dead come into the thralldom of certain living beings who are called mediums. These mediums are, for the present at least, a not widely diffused class, and they appear to be almost exclusively Americans. At the command of these mediums, departed souls perform mechanical feats which possess throughout the character of absolute aimlessness. They rap, they lift tables and chairs, they move beds, they play on the harmonica, and do other similar things. (2) Intellectually, the souls of the dead enter a condition which, if we are to judge from the productions which they deposit on the slates of the mediums, must be termed a very lamentable one. These slate-writings belong throughout in the category of imbecility; they are totally bereft of any contents. (3) The most favored, apparently, is the moral condition of the soul. According to the testimony which we have, its character cannot be said to be anything else than that of harmlessness. From brutal performances, such, for instance, as the destruction of bed-canopies, the spirits most politely refrain." Wundt then laments the demoralising effect which spiritualism exercises on people who have hitherto devoted their powers to some serious pursuit or even to the service of science. In fact it is a presumptuous and flagrant procedure to forsake the path of exact research, which

slow as it is, yet always leads to a sure extension of knowledge, in the hope that some aimless, foolhardy venture into the realm of uncertainty will carry us farther than the path of slow toil, and that we can ever thus easily lift the veil which hides from man the problems of the world that are yet unsolved.

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Now that we have presented the opinions of others respecting the existence of a four-dimensional world of spirits, the author would like to develop one or two ideas of his own on the subject. In the preceding section it was stated that everything that we perceive by our senses is three-dimensional and that everything that possesses four or more dimensions can only be regarded as abstractions or fictions which our reason forms in its constant efforts after an extension and generalisation of knowledge. To speak of two-dimensional matter is as self-contradictory as the notion of four-dimensional matter. But a two or a four-dimensional world might exist in some other manner than a material manner, and for all we know in one which to us does not admit of representation. But in such a case, if it were without the power of affecting the material world, we should never be able to acquire any knowledge concerning its existence, and it would be totally indifferent to the people of the three-dimensional world, whether such a world existed or not. Just as an artist during his lifetime produces a number of different works of art, so also the Creator might have created a number of different-dimensional worlds which in no wise interfere with one another. In such a case, any one world would not be able to know anything of any other, and we must consequently regard the question whether a four-dimensional world exists which is incapable of affecting ours, as insoluble. We have only to examine, therefore, the question whether the phenomenal world perhaps is a single individual in a great layer of worlds of which every successive one has one more dimension than the preceding and which are so connected with one another that each successive world contains and includes the preceding world, and, therefore, can produce effects in it. For our reason, which draws its inferences from the phenomena of this world, tells us, that if outside the three-dimensional world there exists a

second four-dimensional world, containing ours, there is no reason why worlds of more or less dimensions should not, with the same right, also exist. But if now, as Zöllner and his adherents maintain, four-dimensional spirits exist which can act by the mere efforts of their own wills on our world, there is surely no reason why we three-dimensional beings should not also be able to produce effects on some two-dimensional animated world. Whether we have, generally, any such influence we do not know, but we certainly do know that we do not act purposely and consciously on a two-dimensional world. If, therefore, Zöllner were right, the plan of creation would possess the wonderful feature that four-dimensional beings are capable of arbitrarily affecting the three-dimensional world, but that three-dimensional beings have no right in their turn consciously to affect a two-dimensional world.

The supporters of Zöllner's hypothesis will perhaps reply to the objection just made, that the plan of creation might, after all, possibly possess this wonderful peculiarity, that we human beings perhaps, in some higher condition of culture, will be able to act consciously on two-dimensional worlds, and that at any rate it is simply an inference by analogy to conclude from the non-existence of a relation between three and two dimensions that the same relation is also wanting in the case of four and three dimensions. As a matter of fact, the objection above made is not intended to refute Zöllner's hypothesis, but only to stamp it as very improbable. But despite this improbability Zöllner would still be right if the phenomena of the material world actually made his hypothesis necessary. That, however, is by no means the case. Although most of the phenomena to which the spiritualists appeal are probably founded on sense-illusions, humbug, and self-deception, it cannot be denied that there possibly do exist phenomena which cannot be brought into harmony with the natural laws now known. There always have been mysterious phenomena, and there always will be. Yet, as we have often seen that the progress of science has again and again revealed as natural what former generations held to be supernatural, it is certainly wholly wrong to bring in for the explanation of phenomena which now seem mysterious an hypothesis like that of Zöllner, by which

everything in the world can be explained. If we adopt a point of view which regards it as natural for spirits arbitrarily to interfere in the workings of the world, all scientific investigation will cease, for we could never more trust or rely upon any chemical or physical experiment, or any botanical or zoological culture. If the spirits are the authors of the phenomena that are mysterious to us, why should they also not have control of the phenomena which are not mysterious? The existence of mysterious phenomena justifies in no manner or form the assumption that spirits exist which produce them. Would it not be much simpler, if we *must* have supernatural influences, to adopt the naive religious point of view, according to which everything that happens is traceable to the direct, actual, and personal interference of a single being which we call God? Things which formerly stood beyond the sphere of our knowledge and were regarded as marvellous events, as a storm, for example, now stand in the most intimate connection with known natural laws. Things that formerly were mysterious are so no longer. If one hundred and fifty years ago some scientists were in the possession of our present knowledge of inductional electricity and had connected Paris and Berlin with a wire by whose aid one could clearly interpret in Berlin what another person had at that very moment said in Paris, people would have regarded this phenomenon as supernatural and assumed that the originator of this long-distance speaking was in league with spirits.

We recognise, thus, that the things which are termed supernatural depend to a great extent on the stage of culture which humanity has reached. Things which now appear to us mysterious, may, in a very few decades, be recognised as quite natural. This knowledge, however, is not to be obtained by the lazy assumption of bands of spirits as the authors of mysterious phenomena, but by performing what in physics and chemistry is called experiment. But the first and essential condition of all scientific experimenting is that the experimenter shall be absolutely master of the conditions under which the experiment is or is not to succeed. Now, this criterion of scientific experimenting is totally lacking in all spiritualistic experiments. We can never assign in their case the conditions un-

der which they will or will not succeed. When all the preparations in a spiritualistic *séance* have been properly made, but nothing takes place, the beautiful excuse is always forthcoming that the "spirits were not willing," that there were "too many incredulous persons present," and so forth. Fortunately, in physical experiments these pretexts are not necessary. By the path of experiment, and not by that of transcendental speculation, physics has thus made incredible progress and has piled new knowledge strata on strata upon the old. Accordingly, the prospect is left that the mysteries which the conditions and properties of the human soul still present can be solved more and more by the methods of scientific experiment. To this end, however, it is especially necessary that the physio-psychological experiments in question should only be performed by men who possess the critical eye of inquiry, who are free from the dangers of self-illusion, and who are competent to keep apart from their experiments all superstition and deception. The history of natural science clearly teaches that it is only by this road that man can arrive at certain and well-established knowledge. If, therefore, there really is behind such phenomena as mind-reading, telepathy, and similar psychical phenomena,

something besides humbug and self-illusion, what we have to do is to study privately and carefully by serious experiments the success or non-success of such phenomena, and not allow ourselves to be influenced by the public and dramatic performances of psychical artists, like Cumberland and his ilk.

The high eminence on which the knowledge and civilisation of humanity now stands was not reached by the thoughtless employment of fanciful ideas, nor by recourse to four-dimensional worlds, but by hard, serious labor, and slow, unceasing research. Let all men of science, therefore, band themselves together and oppose a solid front to methods that explain everything that is now mysterious to us by the interference of independent spirits. For these methods, owing to the fact that they can explain everything, explain nothing, and thus oppose dangerous obstacles to the progress of real research, to which we owe the beautiful temple of modern knowledge.

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[Schubert - Part 1](#)

[Schubert - Part 2](#)

[Top of Page](#)

[YGGDRASIL Homepage](#)

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