Rudy Rucker's introduction to *Speculations on the Fourth Dimension: Selected Writings of Charles H. Hinton,* (Dover Publications, New York 1980). Many of the book's Hinton selections can be found online at http://www.ibiblio.org/eldritch/chh/hinton.html.

INTRODUCTION

The father James Hinton was an ear surgeon who was best known for *The Mystery of Pain,* a little book which sets forth the Panglossian thesis that "all that which we feel as painful is really *giving*—something that our fellows are better for, even though we cannot trace it." It gives some idea of the turn of the son Charles Hinton's mind to learn that he wrote a piece, "The Persian King," in which he attempted to use higher dimensions and infinite series to obtain a mathematically accurate model of this idea.

Charles Howard Hinton was a professional mathematician—he took the master's degree at Oxford, taught at Princeton, and published pure mathematics related to work of Morley, Hamilton, and Cayley—but for him formal mathematics was never an end in itself.

Hinton's touchstone was, rather, direct and intuitive knowledge of four-dimensional space. The bulk of his writings are aimed at developing in the reader the power to think about 4-D space; and the rest of his work focuses on using a knowledge of higher space to solve various problems in physics and in metaphysics.

Hinton was born in London in 1853, the first son in his family. He was schooled at Rugby, and matriculated at Oxford in 1871. From a letter written to him by his father in 1869, we learn that already while at Rugby, Hinton evidenced an interest in "studying geometry as an exercise of direct perception."

After two years at Oxford, he was granted a three-year term as Exhibitioner of Balliol College in the University. This meant that the college paid him a stipend or "exhibition" to pursue his studies there. On the strength of this honor, Hinton obtained a post as Assistant Master at the Cheltenham Ladies' College in 1875. He continued his studies at Oxford, some 50 miles distant from Cheltenham, receiving his B.A. in 1877. In 1880, he left Cheltenham to teach at the Uppingham School, where he remained until he received his M.A. from Oxford in 1886. It is during the decade 1877–1887 that Hinton found his life work.

Of this period he writes in *A New Era of Thought* that, "I found myself in respect to knowledge like a man who is in the midst of plenty and yet who cannot find anything to eat. All around me were the evidences of knowledge—the arts, the sciences, interesting talk, useful inventions—and yet I myself was profited nothing at all; for somehow, amidst all this activity, I was left alone, I could get nothing which I could know." Desperate for some absolute knowledge, Hinton hit upon the plan of memorizing a cubic yard of one-inch cubes. That is, he took a 36 × 36 × 36 block of cubes, assigned a two-word Latin name (e.g. *Collis Nebula*) to each of the 46,656 units, and learned to use this network as a sort of "solid paper." Thus when he wished to visualize some solid structure, he would do so by adjusting its size so that it fit into his cubic yard. Then he could describe the structure by listing the names of the occupied cells. Hinton maintains that he thereby obtained a sort of direct and sensuous appreciation of space.

Given that Hinton's father had been known for his exceptional memory, and that there is a system which reduces the brute facts to be memorized to 216, this learning of a block of one-inch cubes is not inconceivable. But now Hinton went on to memorize the positions of the little cubes for each of the 24 possible orientations (six choices for the bottom face times four choices for the front face) which the block might have relative to the observer.

His reasons for doing this are described in his essay "Casting Out the Self." If cube A is touching cube B, this is an absolute fact. But to say that cube A is above or behind cube B is simply to say something about the relation of the self to the arrangement of cubes. It was in order to eliminate such "self-elements" that Hinton learned the block of cubes in each of its 24 possible orientations.

This casting out of self-elements led to an interesting question: Is the difference between an arrangement of cubes and the mirror image of this arrangement absolute or relative? Hinton brooded over Kant's remarks (in section 13 of the *Prolegomena*) on the question of whether the apparently irreconcilable difference between a right hand and a left hand is not somehow the result of a limited space intuition; and he may have heard of A. F. Möbius's 1827 discovery that any 3-D object can be turned into its mirror-image by a rotation through 4-D space.

In any case, Hinton now became interested in the fourth dimension. He used his "solid paper" to construct for himself the various cubical cross-sections of the hypercube or tesseract (a word which Hinton may have coined himself), assigning a different color to each of the 81 parts

(1 tesseract + 8 cubes + 24 squares + 32 line segments + 16 points) of the tesseract to keep things straight. By working with these cross-sections he was able to visualize the reality of the fact that if a tesseract is pushed through our space, turned over, and pushed back through, then the last cubical cross-section seen will be the mirror image of the last seen the first time through.

As his understanding of the fourth dimension grew, Hinton set to writing about it. His first published essay, "What Is the Fourth Dimension?," appeared in 1880 in the *Dublin University Magazine,* was reprinted in the *Cheltenham Ladies' College Magazine* of September 1883, and finally was published as a pamphlet, with the subtitle *Ghosts Explained,* by Swann Sonnenschein & Co. in 1884. In the period 1884–1886, Swann Sonnenschein published in London nine different such pamphlets by Hinton which were then collected in the two-volume set, *Scientific Romances.*

Swann Sonnenschein was to be the original publisher for all of Hinton's books. Around 1910, Allen & Unwin obtained the rights to the books, which they kept in print for a number of years. In the introduction to *The Fourth Dimension* Hinton acknowledges his debt to "the publisher of this volume, Mr. Sonnenschein, to whose unique appreciation of the line of thought of this, as of my former essays, their publication is owing."

All but three of the *Scientific Romances* are partially reprinted below. I have omitted the lengthy "The Persian King," subtitled "The Mystery of Pleasure and Pain," which is about a king who keeps a valley running by absorbing a small amount of pain from everyone, so that there is enough differential between pleasure and pain for activity to exist. I have left out "On the Education of the Imagination," which is basically an exhortation to memorize large blocks of cubes; and I have left out the long novella *Stella.*

This last piece is a first-person description of the narrator's love affair with a girl who has been made invisible by her guardian. That is, he has provided her with an elixir which she drinks to make her index of refraction equal to that of air. This work can be viewed as a very early piece of science fiction (perhaps providing the inspiration for H. G. Wells's *The Invisible Man*), but it also has a certain didactic purpose. Hinton shared with his father a very strong conviction that the key to right living is openness and altruism. As Stella says, "Being is being for others." The reason Stella chooses to remain invisible is so that she will not fall into a self-serving concern with her own ap-

pearance. Hinton clearly was groping for some higher-dimensional justification of his ethical beliefs in *Stella,* but the time was not yet ripe.

The most interesting idea in *Stella,* that of two-dimensional time, is treated in a more vivid fashion in the stunning tale "An Unfinished Communication." Two-dimensional time works something like this: First start with the idea of your entire life as being a fixed object in 4-D spacetime, then imagine that while some second time lapses, your entire life gradually evolves into a different one. Hinton returns to this theme in *A New Era of Thought,* where, rather than suggesting a second time dimension, he employs the notion of the eternal return and speaks of life as a sort of phonograph record which is played over and over, undergoing slight alterations each time.

Returning to the *Scientific Romances* collection, we have "A Plane World," a cousin of Abbott's 1884 *Flatland,* which Hinton refers to in a brief introduction to his essay: "And I should have wished to be able to refer the reader altogether to that ingenious work, 'Flatland'. But on turning over its pages again, I find that the author has used his rare talent for a purpose foreign to the intent of our work. For evidently the physical conditions of life on the plane have not been his main object. He has used them as a setting wherein to place his satire and his lessons. But we wish, in the first place, to know the physical facts."

A really remarkable feature of the 2-D world described in "A Plane World" is that it exists on the surface of a sphere, instead of a plane; and is thus more similar to Dionys Burger's Sphereland than to Edwin A. Abbott's Flatland. The logical step to take after describing this 2-D world on a sphere would be to suggest that our 3-D space is the hypersurface of a hypersphere. Bernhard Riemann hinted at this idea as early as 1854, but it was Einstein who first seriously advocated it.

"A Picture of Our Universe" was written as a companion piece to "A Plane World," and here Hinton makes a sustained effort to find some physical application for the notion of 4-D space. Hinton's working hypothesis, which he presented as early as the end of "What Is the Fourth Dimension?," is that the matter of our world actually has a slight hyperthickness in the direction of a fourth spatial dimension.

In the first part of the essay under discussion, Hinton attempts to explain static electricity as a twisting of matter in 4-D space. He comes remarkably close here to anticipating the modern notion of antimatter—as Martin Gardner has pointed out in Chapter 24 of *The*

Ambidextrous Universe, which also contains a reference to the Kaluza-Klein five-dimensional theory of relativity which in some sense formalizes the idea Hinton presented here. In a much later essay, "The Recognition of the Fourth Dimension," Hinton was to present a very different 4-D modeling of static electricity.

In the second part of "A Picture of Our Universe," Hinton describes his conception of the aether as a 4-D hypersolid upon which the (hyperthin) 4-D objects of our space move about. This represents a distinct deviation from modern physical theory. As Hinton says in *A New Era of Thought,* "We will suppose, then, that we are not *in,* but *on* the aether, only not on it in any known direction, but that the new direction is that which comes in. The aether is a smooth body, along which we slide, being distant from it at every point about the thickness of an atom." [My italics.] Now, the question of whether or not our matter is ultimately four-dimensional is, to say the least, open. But there are now no scientists who would assent to the conception of a fixed spatial aether *next to* our universe.

If there is an aether, it is to be conceived of as something which we are *in*—primarily because only needless complications result if anything else is assumed. Indeed, it might not be too much to say that Hinton's belief that we are not in, but on the aether proved to be the major stumbling block in his attempts to attain a higher-dimensional physics. It should be pointed out on Hinton's behalf that he had good reason for believing that we cannot be *in* the luminiferous aether. The conclusion from the observed properties of light and the physics of the time seemed to be that the aether is solid—and we cannot very well be moving around inside a solid.

This whole puzzle was dissolved by the Special Theory of Relativity in 1905 with the abolishing of *space* aether in favor of *spacetime* aether. It is hard, initially, to appreciate the difference. But a curious suggestion which Hinton makes at the end of "A Picture of Our Universe" (and which he returns to in *An Episode of Flatland*) serves to clarify the issue. Hinton suggests that, "A being able to lay hold of the aether by any means would, unless he were instantly lost from amongst us by his staying still while the earth dashes on—he would be able to pass in any space direction in our world. He would not need to climb by stairs, nor to pass along resting on the ground." In other words, if one only had some 4-D pitons, then one could climb up the face of the aether to float a hundred feet above the ground. But a marker driven into the aether would supply an absolute standard of

rest—which is ruled impossible by Special Relativity. However, as Einstein pointed out in his essay "Ether and the Theory of Relativity," the very notion of the spacetime metric tensor's existence in empty spacetime serves to validate the notion of a *spacetime* aether.

The only selection from *Scientific Romances* I will not discuss at length is the piece "Many Dimensions." This is one of the most inspiring of Hinton's writings. With his usual elegance of style he moves from the question of "Why not *five* dimensions?" to drawing ethical lessons from the existence of 4-D space.

Soon after Hinton recieved his master's degree from Oxford in 1886, he left his post at Uppingham School to teach for several years in the Japanese government middle schools. He left the book *A New Era of Thought* in manuscript form with his friends Alicia Boole and H. John Falk. They used his manuscript, essentially unrevised, for Part 1 of *A New Era of Thought*; and for Part 2 they themselves wrote up a detailed description of the exercises with colored cubes which Hinton had employed to get a mental image of the tesseract.

Part 1 consists of a somewhat rambling and disconnected series of chapters about the possibility of thinking four-dimensionally, and about the religious and philosophical insights thus obtainable. This part bears evidence of not having been reworked by the author; for instance, Hinton somehow neglects to make a crucial point (that a cube can be turned into its mirror image by rotation through the fourth dimension) which he spends several chapters leading up to. Nevertheless, this book was written at the high point of Hinton's confidence in the fourth dimension as a sort of philosopher's stone for human inquiry, and his enthusiasm is infectious.

Chapters 7 and 9 of *A New Era of Thought* (the sections entitled "Self Elements in Our Consciousness" and "Another View of the Aether" in the present volume) are of particular interest. Some treatments of the fourth dimension, for example that of E. H. Neville in his *The Fourth Dimension,* proceed purely analytically, treating 4-D space as nothing but a collection of ordered quadruples of real numbers with certain "distance" and "angle" relations defined among these quadruples. Other treatments, for example that of H. P. Manning in his *Geometry of Four Dimensions,* proceed synthetically in the manner of Euclid, stating axioms about 4-D entities from which theorems are then derived. Hinton is one of the very few who has held to the intuitive and descriptive approach in discussing 4-D space. In the section of *A New Era of Thought* entitled "Self Elements in Our Consciousness," he provides a very ingenious rebuttal to the so-com-

monly-heard philistinism that it is hopeless to imagine what the extra spatial dimension looks like because no one has ever seen it.

In Chapter 9 Hinton describes in some detail his phonograph-record view of the aether. The idea is that the aether has grooves which control the behavior of the matter sliding over it. The assumption seems to be that every so often the Earth will slide back to its starting point on the aether, and then history will repeat itself. In order to make room for free will and the sort of 2-D time he describes in "An Unfinished Communication," Hinton assumes that each time the eternal return is accomplished and we slide over the grooves of our life again, we are able to alter slightly the directions of the grooves. He goes on to draw the moral that since we all have aethereal bodies which are grooves on the one aether, then the mystic teaching All is One is to be upheld.

Hinton's father James once had his marriage proposal rejected because he was suspected of having abandoned Christianity for the abstract ideal of altruism. (The third time he asked the girl, a Miss Haddon, she accepted.) Hinton proves himself a loyal son in this book, written some ten years after the father's death from inflammation of the brain in 1875. There is a great deal in Part 1 about the idea that the sooner we start thinking of those around us as the same as ourselves, the sooner we will be able to enter into the higher mysteries.

The second part of *A New Era of Thought* consists of a description of how to visualize a tesseract by looking at various 3-D cross sections of it. One is to construct a set of 12 cubes, coloring the faces, edges and corners all manner of different colors. (Eighty-one different colors are used, and some rather unfamiliar ones are resorted to. The modern reader may be amused to note that the line going into the fourth dimension relative to the first cube is to be colored "stone.") Eight of these cubes make up the boundaries of the hypercube, and the four others are cross sections taken between pairs of opposite cubes. The way in which all the cubes fit together is really explained rather well, if one has the will to endure not only 81 colors, but the 81 Latin names which Hinton assigns to the parts of the tesseract.

In addition to the set of 12 large cubes, there was also to be a set of 81 small monochrome cubes, each representing a part of the tesseract. By moving these little cubes about one could better comprehend the fact that rotation through the fourth dimension corresponds to mirror image reflection in 3-D space.

Judging from the quotes which Sonnenschein & Co. reprint on the endpapers of Hinton's books, both the *Scientific Romances* and *A*

New Era of Thought were quite favorably received in England. Of the Scientific Romance "What Is the Fourth Dimension?," the *Pall Mall Gazette* wrote, "It is a short treatise of admirable clearness. Mr. Hinton brings us panting, but delighted, to at least a momentary faith in the Fourth Dimension, and upon the eye there opens a vista of interesting problems. It exhibits a boldness of speculation and a power of conceiving and expressing even the inconceivable, which rouses one's faculties like a tonic." The *Literary World* discussed *A New Era of Thought* in equally athletic terms, "A theoretical and practical treatise on the Fourth Dimension. The book is a powerful mental gymnastic; the style is as clear as it can be. The author is in grim earnest, and promises a complete system of four-dimensional thought—Mechanical, Scientific, and Aesthetic."

But meanwhile Hinton was in Japan, perhaps at a position where he was allowed to drill students in the use of his cubes. Such far-ranging travels were nothing unusual for Hinton's family. His grandfather, a Baptist minister, had been across the Atlantic and was best known for his book *The History and Topography of the United States of America*. His father spent some time working on a ship transporting Blacks from Sierra Leone to Jamaica, lived for a while in New Orleans, and owned property in the Azores, where he died.

Exactly how long Hinton stayed in Japan is unclear, but in the Fall of 1893 he started a stint as Instructor in the Mathematics Department of Princeton University. There were only three other teachers in the department at that time, but Hinton seems to have been at the bottom of the pecking order. He taught only Freshman and Sophomore level courses—Elementary Solid Geometry and Mensuration, Trigonometry, and Conic Sections, in particular—and he was fired after four years. In a piece called "The Oxford Spirit" which he wrote for the *Independent* in 1902, Hinton expressed some bitterness at his treatment by the American educational system. "In America a new phenomenon has arisen—the business man in control of the halls of learning. The college president runs his university as if it were a great factory. He makes a number of provisional appointments—instructors. The instructors know that during term time they must work to the full extent of their energy in instruction, and occupy their vacations in prosecuting their subject if they are to retain their positions."

It cannot really be said that Hinton followed this formula while teaching at Princeton. He was friendly with his students and became very interested in baseball—so much so that he invented a sort of base-

ball gun. As he wrote in his article "A Mechanical Pitcher," in *Harper's Weekly*, March 20, 1897, "The project of constructing a mechanical pitcher was suggested to me by considerations all who are interested in baseball will appreciate. I had remarked the frequent occurence of 'sore arm', as also that it was only in the matches themselves that many a batter had experience of really first class pitching." So, after a period of experimentation, he developed a gun which, when charged with gunpowder, would shoot a baseball at the requisite 40 to 70 miles per hour. The speed was adjusted by varying the size of the adjustable breech; and, most importantly, any desired curve or drop ball could be shot by adjusting two rubber-coated steel fingers attached to the muzzle of the gun. The Princeton nine worked out with this mechanical pitcher for several years, although it was eventually abandoned because of the fear it inspired in the batters.

There is a curious story connected with Hinton's discovery of the baseball gun which is reported in his obituary, which Gelett Burgess contributed to the *New York Sun* on May 5, 1907. "Although on account of his enthusiasm for metageometry he was never a great success as an instructor in his college positions, he made many friends, and in Princeton endeared himself to the students by one of the most successful practical jokes ever perpetrated there. This was just after his perfection of the baseball gun. He invited the faculty and students to a lecture, at which he demonstrated the machine and described its scientific theory. While he was upon the platform the lecture was interrupted by the arrival of a special delivery postman who walked down the aisle and called to the professor. As he had been the victim of many practical jokes and 'horsed' by the students according to the Princeton custom, the audience prepared for some absurd diversion. After protesting against the interruption, but not being able to send away the messenger, Prof. Hinton begged permission to look at a letter important enough to demand consideration at such a time. He read aloud, and had turned two pages, reading an account of a baseball game in the year 1950, before the students discovered that the joke was upon them." Presumably this fictional baseball game included the use of Hinton's baseball gun. In the article on his gun mentioned above he indicates that he expected the use of it to become commonplace. There is something magically apt in this story of Hinton, the student of spacetime, seeming to receive a message from the future.

The students' nickname for Hinton at Princeton was "Bull," but it seems that this nickname was intended to have the connotation of

physical strength rather than verbal extravagance. In the same obituary we read that "After a Pennsylvania-Princeton football game, Prof. Hinton became the myth hero of the students by throwing bodily over a fence a husky Pennsylvania man who had attempted to snatch a yellow chrysanthemum from the professor's coat."

After leaving Princeton, Hinton took a position as Assistant Professor at the University of Minnesota. He continued using his baseball gun there, and he also gave a number of extracurricular talks and lectures. One, held at his home on 516 Thirteenth Ave., was entitled "Double Personality—Who Am I?" In 1900 he resigned from the University to take a position at the Naval Observatory in Washington, D.C. The famous astronomer Simon Newcomb had recently retired from his post there, but still took an active part in the affairs of the Observatory. In view of the fact that Newcomb wrote a paper on 4-D rotations in the first volume of the *American Journal of Mathematics,* it seems likely that he helped Hinton obtain his position at the Naval Observatory.

In November 1901, Hinton read a paper called "The Recognition of the Fourth Dimension" before the Philosophical Society of Washington. This paper contains two interesting ideas about electricity. First, Hinton shows how the sort of "double rotation" which is possible in 4-D space might be used to give a geometric model of electrical charge. Second, he formulates the idea that an electric current can be geometrically represented as a vortex sheet whose edge meets the aether along the wire of the circuit. He was very proud of this paper. He wrote a popular article about it called "The Fourth Dimension" for *Harper's Monthly Magazine* of July 1904; he formally developed some of its mathematical suggestions in a paper in the *Proceedings of the Royal Irish Academy* of November 1903; and he included it as the last chapter of his book *The Fourth Dimension.*

The Fourth Dimension was published in 1904. The chapters are largely independent of each other, and one has the impression that they were written at various times over the 16 years since publication of *A New Era of Thought.* The tone of this book is much more subdued than that of the earlier works. Hinton remarks that his earlier systems of naming regions of space "turned out, after giving them a fair trial, to be intolerable." He is no longer absolutely sure that he can teach everyone to see the reality of the fourth dimension, and says, "I do not like to speak positively, for I might occasion a loss of time on the part of others, if, as may very well be, I am mistaken."

Nevertheless, Hinton continues to try to teach the reader to see 4-D space. *The Fourth Dimension* contains a greatly streamlined version of the tesseract section models which Hinton introduced in *A New Era of Thought*. There were actually three parts to the complete set of tesseract models. There was a set of 27 "slabs," actually cardboard squares; a set of 81 one-inch monochrome cubes, each a different color; and a set of 12 multicolored "catalogue cubes," which were depicted in a color plate bound into *The Fourth Dimension*. When the book came out, one could buy a set consisting of the 27 slabs and the 81 little cubes for 16 shillings, or a set consisting of the 12 catalogue cubes for 21 shillings. (The book itself cost 4 shillings and sixpence.) It would be interesting to know how many of these sets were actually sold. Appended to the essay "Hypercubes" in Martin Gardner's book *Mathematical Carnival,* there is a curious letter from a former user of Hinton's cubes who calls them "completely mind-destroying."

In Chapters 1, 4, and 5 (included in the present anthology), there are some interesting remarks on the history of 4-D thinking from Parmenides to Bolyai. Chapter 5 has an amazing anticipation of the Special Theory of Relativity—Hinton here works with a non-standard definition of distance which is identical with the definition of the invariant spacetime interval.

In Chapter 8 we hear once again from the Alicia Boole who helped edit *A New Era of Thought*. This was the daughter of George Boole, the renowned logician, and in this chapter Hinton describes a very pretty chain of reasoning which she developed, leading from a sort of 4-D truth-table to an unexpected gap in logical practice. Hinton's father was a friend of the Boole family, and *The Life and Letters of James Hinton* contains numerous references to them. Hinton courted and married Boole's daughter Mary.

He explained his system to one of Mary's younger sisters, Alicia, and she eventually wrote a number of papers on four-dimensional figures. The middle part of her life was devoted to the raising of her family with a Mr. Stott; but when Alicia Boole grew older she came into contact with H. S. M. Coxeter and took up her work on four-dimensional space again. Coxeter's book *Regular Polytopes* (a Dover reprint) describes her and her work on pp. 258–259. Alicia Boole's geometrical understanding and mathematical precision were in some ways greater than Hinton's.

Mary Boole bore Hinton four sons: Eric, George, Sebastian and William. Like her youngest sister Ethel, who wrote novels under the

name E. L. Voynich, Mary Boole Hinton was literary. She was known in Washington as a lecturer on poetry. I have been unable to learn the date of their marriage, but I would hazard the guess that it took place while Hinton was teaching at Cheltenham.

After spending several years at the Naval Observatory, Hinton took the civil service test for a position in the Patent Office, having studied only one night. He qualified as an examiner of chemical patents, and he remained at this post until his sudden death at the age of 54 on April 30, 1907.

Dramatically enough, Hinton suffered cerebral hemorrhage and dropped dead on the spot while leaving the annual banquet of the Washington, D.C., Society of Philanthropic Inquiry. He was a prominent member of the Society and had wound up the evening by complying with the toastmaster's request for a toast to "female philosophers." His death is described in an article called "Scientist Drops Dead" in the *Washington Post* of Wednesday, May 1, 1907.

At the time of his death, Hinton's last book, *An Episode of Flatland: or How a Plane Folk Discovered the Third Dimension*, was in press; and we can fittingly regard this mature and mellow work as his last testament. Any preconceptions of Hinton as some sort of narrow-minded crank are dispelled by the gentle self-irony of this novel, which features two characters (Hugh Farmer, and the school director in Chapter 16), who seem to be modeled on Hinton himself.

An Episode of Flatland returns to Hinton's notion that the aether is a solid body which is next to us in the direction of the fourth dimension, and that our bodies actually have a slight 4-D hyperthickness. In his novel, the soul is taken to be a very small 4-D entity which directs the 3-D motions of the body—just as the captain of a ship is a small 3-D entity which directs the 2-D motions of the ship. The use to which Hinton puts these ideas in his last book is wholly at odds with Special Relativity, but the trick is so clever that one does not really care.

Hinton seems never to have been involved with the active spiritualist movement of his time, despite the fact that the spirit world is customarily said to be in the fourth dimension. He did have a strong belief in the reality of the fourth dimension, and anticipated the day when this could be scientifically proved. "It will be an exhilarating moment when an investigator comes upon phenomena which show that external nature cannot be explained except by the assumption of a four-dimension space," he wrote in *A New Era of Thought*.

Has this moment arrived? Is there anything in physics, chemistry, biology or psychology to suggest that the fourth dimension is anything more than a useful ideal conception? It is certainly true that the space-time of modern physics is a sort of 4-D space, but spacetime differs essentially from a pure Euclidean 4-D space in several ways, most essentially in the fact that the invariant metric is *interval* rather than *distance*. (As mentioned above, in Chapter 5 of *The Fourth Dimension* Hinton actually seems to have anticipated this development!)

Is there any evidence for Hinton's belief that the *space* of the world is 4-D? It is certainly true that the most natural way of presenting Einstein's theory of gravitation entails viewing our space as a curved hypersurface in some higher-dimensional space. But General Relativity does not seem to demand any hyperthickness to the space of our world, and it is thus possible to think of that higher-dimensional space as simply a compact way of describing a tensor-valued field which exists in our space and time.

The quantum-mechanical treatment of elementary particles involves viewing the particle as an entity in an infinite-dimensional Hilbert space; but, again, this higher-dimensional space is generally regarded as a mathematical tool with no "real" physical correlate. This could just be because there has been no serious effort to think about Hilbert space in the sort of literal and intuitive fashion which Hinton advocates.

There are also a number of new geometrical treatments of elementary particle phenomena which do seem to demand the real existence of higher spatial dimensions—I am thinking here of Wheeler's geometrodynamics program, particularly his "wormhole" theory of electric charge. So there is some hope of confirmation for Hinton's beliefs in the field of particle physics; although at this point in history it is hard to even guess what the final theory of elementary particles will be.

Another area of physics where there is some possibility of attaining a higher-dimensional space is in Hugh Everett's Many Universe and John A. Wheeler's Superspace interpretations of quantum mechanics. These theories contemplate the idea of a continuum of parallel worlds—an idea which Hinton anticipated with his 2-D time—but they have by no means attained widespread acceptance.

In the end it seems that the best place to look for higher-dimensional space is, as Hinton so often said, in the mind. We still have no

idea of how to axiomatize the logical space in which our mind moves about, but there is every reason to believe that this space is higher-dimensional. It has been my personal experience that Hinton's claim that the mind can move in 4-D space is true, although I cannot say that I find the experience of turning the world into its own mirror image a pleasant one.

We are only at the threshold of a non-reductive theory of consciousness; and any final higher-space expression of higher consciousness is something which is no closer now than it was in Hinton's time. Indeed, it would be folly to expect that everything can be explained along any given lines—the world exists both before and after our attempts to understand it. Hinton eloquently continues this line of thought in "Many Dimensions": "If we want to pass on and on till magnitude and dimensions disappear, is it not done for us already? That reality, where magnitudes and dimensions are not, is simple and about us. For passing thus on and on we lose ourselves, but find the clue again in the apprehension of the simplest acts of human goodness, in the most rudimentary recognition of another human soul wherein is neither magnitude nor dimension, and yet all is real."

R.v.B.R.

Geneseo, N.Y.
July 15, 1977

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