To get familiar simply with higher dimensional space and time as a 2d quantity in physics

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Abstract. *It is a never-ending desire for human to understand the world around him as more as he could. Because of this essential curiosity, he could describe the universe and its building-blocks, the elementary particles, by using mathematical and scientific methods. During recent decades, he has made many progresses in physics, such as higher dimensional space in string theory and calculation of second dimension for time that is originated from F-theory, one of the theories which is able to answer lots of unknowns. In this paper, we have tried to introduce a simple educational model which is used to teach the complicated scientific issues for undergraduate students of physics. The aim of this paper is that the students obtain an enjoyable but simple and comprehensive view of the physical world.*

Keywords. F-theory, Higher dimension, Physics education, Second dimension time, String theory.

1. Introduction

Higher dimensions in popular culture: As a result of the efforts of Helmholtz and others like him, the public began speculating wildly about beings from the fourth dimension, who would be able to walk through walls, reach through solid barriers, appear or disappear on a whim, and materialize in whatever location they pleased. To understand this idea, imagine a flat sheet of paper with some two-dimensional beings living on it. A three-dimensional human's powers to change shape (his cross-section in two dimensions), see through "impenetrable" walls (lines or circles), and lift the beings off their paper would seem magical to the two-dimensional beings, who cannot conceptualize the idea of "up." The same applies to humans: we cannot conceptualize the fourth spatial dimension, so its inhabitants would seem omnipotent to us. The public did not readily understand the complex physics questions raised by the fourth dimension, but they did recognize the powers of a four-dimensional being. They immediately correlated such beings with the only familiar entities reputed to walk through walls, appear and disappear at will, etc. - ghosts. Similarly, mystics and magicians long claiming supernatural powers latched on to this new, seemingly reputable claim: to be able to access the fourth dimension!

The 1877 London trial of Henry Slade provides an excellent example of this phenomenon. Slade, an American psychic, was visiting London and holding seances when he was arrested for fraud. However, many prominent London physicists suddenly came to his defense, maintaining that his supposed psychic powers derived from ability to access the fourth dimension. Johann Zollner, in particular, defended Slade's abilities and suggested several experiments impossible to complete successfully in three dimensions, but elementary in four: intertwine two separate, unbroken rings; reverse the twisting pattern of a sea shell; tie a knot in a circle of rope without cutting it; tie a right-handed knot in a left-handed position without breaking a wax seal atop it; and remove something from a sealed bottle without unsealing it. Though Slade was eventually convicted of fraud, Zollner and his compatriots did demonstrate that four-dimensional creatures can execute feats obviously impossible in three dimensions Religious groups also wholeheartedly embraced the idea of higher dimensions after they saw the powers held by a

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hypothetical four-dimensional being. They had long been at a loss to answer such seemingly logical questions as, where do angels live? where are heaven and hell? if atmosphere and finally space are above us, where does God reside? With the advent of the fourth dimension, they had an out. A. T. Schofield, a Christian spiritualist, stated that God, heaven, and other religious locales resided in the fourth dimension. Theologian Arthur Willink took the idea one step further, claiming that only an infinity of dimensions was glorious enough for God. Literature was also infused with the idea of the fourth dimension. Oscar Wilde contributed a clever spoof on the gullible Society for Psychical Research, which had believed Slade, in his 1891 play *The Canterville Ghost.* H.G. Wells, renowned for his science-fiction stories, added another literary contribution - his 1894 novel *The Time Machine*, which disseminated the idea that the fourth dimension could be viewed as time; it was not necessarily space. He also published a number of short stories adding other ideas and speculations on the fourth dimension. Perhaps the most lasting of all the contributions of the fourth dimension to popular culture came in the form of a bestselling novel. Written by clergyman Edwin Abbott, the book, called *Flatland: A Romance of Many Dimensions by a Square*, combined the popular interest in dimensions with a biting social commentary. It was the first mathematically correct description of such matters to reach a wide audience.

2. Higher Dimensions after Riemann

After Riemann's work, research into higher dimensions blossomed, but theorists of the time lacked essential equations necessary for the completion of a geometric theory of gravity, electricity, and magnetism. Despite this, study and especially popularization of Riemann's idea continued even after his death. William Clifford, a British mathematician translating Riemann's work in 1873, furthered Riemann's insight by theorizing that electricity and magnetism as well as gravity are also the result of bending of higher dimensions. Thus, his rudimentary speculation preceded Einstein and Kaluza by 50 years. Hermann von Helmholtz, a renowned German physicist, spent a great deal of time speaking to the public about the import of Riemann's work.

3. The Fourth Dimension and Relativity

The Albert Einstein, arguably the greatest physicist of all time, created two of the most famous theories of physics: special and general relativity. They showed that time can be viewed as a dimension and combined our three spatial dimensions with one temporal dimension to form the idea of space-time, the fundamental fabric of our universe.

Using time as the fourth dimension, four-dimensional beings would see humans as an infinite series of static forms that represent all motions of life moving through time as seen all at once; (a section of such a world-sheet is seen in the image at right.) Relativity, a description of gravity, was one of the first theories to simplify the laws of nature in higher dimensions and was based on Riemannian geometry.

Maxwell's famous theory of electromagnetism consists of a total of eight equations when space and time are treated separately; these simplify to one equation when written relativistically. Relativity has one consequence important to the current topic: it implies that space itself is curved. Einstein's theory of general relativity and the equations of quantum theory are very accurate at describing all the nuances of matter and other forces, from magnets to strong and weak nuclear forces, but his theory of gravity doesn't fit with quantum theory. In 1915, Einstein changed completely our notion of gravity by leaping to the extra dimension of time.

Also in 1919, the German mathematician Theodor Kaluza used the Riemann metric tensor, expanded to fit five dimensions in a 5×5 array [1], to unite Einstein's and Maxwell's theories - that is, the theories of gravity and electromagnetism. Kaluza's theories [2] were later refined by Oskar Klein. This was a great step forward in the search for a geometrical description of the universe, but fundamental problems in the theory arose, and it was abandoned in favour of point-particle quantum mechanics. Only in the 1980s did physicists return to this idea to create superstring theory.

One intriguing feature of string theory is that it predicts the number of dimensions which the universe should possess. Nothing in Maxwell's theory of electromagnetism or Einstein's theory of relativity makes this kind of prediction; these theories require physicists to insert the number of dimensions "by hand". Instead, string theory allows one to compute the number of space-time dimensions from first principles. Technically [3], this happens because Lorentz invariance can only be satisfied in a certain number of dimensions. This is roughly like saying that if we measure the distance between two points, then rotate our observer by some angle and measure again, the observed distance only stays the same if the universe has a particular number of dimensions.

4. Extra dimension space

Extra space dimensions are not easy to imagine in everyday life, nobody ever notices more than three. Any move you make can be described as the sum of movements in three directions-up-down, back and forth, or sideways. Similary, any location can be described by three numbers(on Earth, Latitude, Longitude and altitude), corresponding to space's three dimensions. They claim that a subatomic particle might detect the presence of extra dimensions, and that certain properties of matter's basic particles, such as electric charge, may have something to do with how those particles interact with tiny invisible dimensions of space.

They believe that the Big Bang that started the baby universe growing 14 billion years ago blew up only three of space's dimensions, leaving the rest tiny.

Physicists around the world are still trying to come up with a universal theory that could unify every other already existing law and equation, but have so far come up empty. It seems some piece is missing in the picture puzzle of physical reality.

5. Need to second dimension for time

A theoretical physicist is stating that a second dimension of time could help physicists better explain the laws of nature. Now, the dimension of time has an important role in describing matter, gravity and other forces of nature, but something doesn't fit. So they have been pondering the role of time in basic physics for a long time and thinks one of the missing pieces is a hidden dimension of time. They believe that our universe can have two times, which could make many of the mysteries of today's laws of physics disappear, As strange as it may seem. Also they think that other dimensions could exist, curled up in little balls, so tiny to notice that if you moved through one of those dimensions, you'd get back to where you started so fast you'd never realize that you had moved.

It's a concept extremely difficult to grasp with our limited perception, almost like asking a two-dimensional character drawn on a flat piece of paper to describe that width, when that's world has none. "extra dimensions of space could really be there, it's just so small that we don't see it,"

For now, these opinions are controversial, but if they are right and could prove it, it will change the way we think of some of the most basic processes in physics, like velocity, mass and the resulting momentum of a particle.

The pioneer physicists effort to discern how a second dimension of time is not enough. You also need an additional dimension of space. In fact, extra dimensions of space have become a popular way of making gravity and quantum theory more compatible. Something as simple as show particles move, for example could be viewed in a new way. In classical physics (before the days of quantum theory), a moving particle was completely described by its momentum (its mass times its velocity)and its position. But quantum physics says you can never know those two properties precisely at the same time. The physicists alter the laws describing motion even more, postulating that position and momentum are not distinguishable at a given instant of time. Technically, they can be related by a mathematical symmetry, meaning that swapping position for momentum leaves the underlying physics unchanged (just as a mirror swiching left and right dose not change the appearance of a symmetrical face).

In ordinary physics, position and momentum differ because the equation for momentum involves velocity. Since velocity is distance divided by time, it requires the notion of a time dimension. If swapping the equations for position and momentum really dose not change anything, then position needs a time dimension too. "If make position and momentum indistinguishable from one another, then something is changing about the notion of time," the pioneer physicists said. "If demand asymmetry like that, must have an extra time dimension." "So this task has been especially difficult because mathematicians have not worked out the topology and properties of these higher dimensional universes. Time is no longer a simple line from the past to the future, in a four dimensional world consisting of three dimensions of space and one of time. In the quest for that all embracing theory, scientists have been adding extra dimensions of space to their equations for decades. As early as the 1920s, mathematicians found that moving up to four dimensions of space, instead of the three we experience, helped in their quest to reconcile theories of electromagnetism and gravity.

6. Changing of time picture

Changing our picture of time from a line to a plane (one to two dimensions) means that the path between the past and future could loop back on itself, by using a new kind of symmetry - a mathematical property to work out the relationship between the quantities of position and momentum. It is this symmetry that might help reconcile the two mighty pillars of 20th-century physics, quantum mechanics and relativity.

Although we cannot experience the extra time dimension directly, we can effectively notice it through the different perspectives of the different "shadows". In this sense, he points to already existing evidence of physical phenomena at both macroscopic and microscopic scales. Furthermore, he believes that more evidence for his theory could emerge next year, when particles are smashed together in an accelerator.

6.1. The work poses a question: is this proposal a mathematical fix, rather than a real physical entity?

Simply adding an extra dimension of time dose not solve everything, however. To produce equations that describe the world accurately, an additional dimension of space is needed as well giving a total of four space dimensions. Then, the math with four space and two time dimensions reproduces the standard equations describing the basic particles and forces. In a similar way, the observable universe of ordinary space and time may reflect the physics of bigger space with an extra dimension of time.

In ordinary life nobody notices the second time dimension, just as nobody sees the third dimension of an object's two dimensional shadow on a wall. Today, theoreticians are studying a theory of everything called M-theory [4] that adds yet another dimension, taking the total to 11: 10 of space and one of time. Efforts to formulate a clear and complete version of M theory have so far failed. "Nobody has yet told us what the fundamental form of M theory is," the pioneer physicists said. "We just have clues — we don't know what it is."

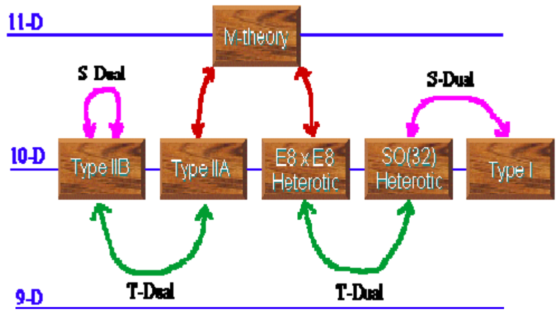

Figure 1. There's just one theory

F-theory is a branch of string theory developed by Cumran Vafa. The new vacua described as F-theory were discovered by Vafa, and it also allowed string theorists to construct new realistic vacua — in the form of F-theory compactified on elliptically fibered Calabi-Yau four-folds. The letter "F" stands for "Father". F-theory is formally a 12-dimensional theory, but the only way to obtain an acceptable background is to compactify this theory on a two-tours. By doing so, one obtains type IIB superstring theory in 10 dimensions. The SL(2,Z) S-duality symmetry of the resulting type IIB string theory is manifest because it arises as the group of large diffeomorphisms of the two-dimensional torus. More generally, one can compactify F-theory on an elliptically fibered manifold (elliptic fibration), i.e. a fiber bundle whose fiber is a two-dimensional torus (also called an elliptic curve). For example, a subclass of the K3 manifolds is elliptically fibered, and F-theory on a K3 manifold is dual to hetrotic string theory on a two-torus. (Eight dimensions are large.) The well-known large number of semirealistic solutions to string theory referred to as string theory landscape, with 10^{500} elements or so, is dominated by F-theory compactifications on Calabi-Yau four-folds..

7. Extra time dimensions in F-theory

F-theory, as it has metric signature (11,1), as needed for the Euclidean interpretation of the compactification spaces (e.g. the four-folds), is not a "two-time "theory of physics. However, the signature of the two additional dimensions is somewhat ambiguous due to their infinitesimal character. For example, the Supersymmetry of F-theory on a flat background corresponds to type IIB (i.e. (2,0)) supersymmetry with 32 real supercharges which may be interpreted as the dimensional reduction of the chiral real 12-dimensional supersymmetry if its spacetime signature is (10,2). In (11,1) dimensions, the minimum number of components would be 64

7.1. Is there a Final Theory in physics?

Will we one day have a complete theory that will explain everything from subatomic particles, atoms and supernovae to the big bang? In the 1980s, attention switched to superstring theory as the leading candidate for a final theory. This revolution began when physicists realised that the subatomic particles found in nature, such as electrons and quarks, may not be particles at all, but tiny vibrating strings. Superstring theory was a stunning breakthrough. It became one of the fastest growing and most exciting areas of theoretical physics, generating a feverish outpouring of thousands of papers. Then, in the early 1990s, progress seemed to grind to a halt. People became discouraged when they failed to find the answers to two key questions: where do strings come from, and is our universe among the many solutions of superstring theory? In superstring theory, the subatomic particles we see in nature are nothing more than different resonances of the vibrating superstrings, in the same way that different musical notes emanate from the different modes of vibration of a violin string. (These strings are very small-of the order of 1035 metres.)

The trigger for this excitement was the discovery of "M-theory", which may answer those two vital questions about superstrings. " In one dazzling stroke, M-theory has come close to solving superstring theory's two long-standing questions, M-theory, moreover, may even force string theory to change its name because, although many features of M-theory are still unknown, as we said, it does not seem to be a theory purely of strings. Other strange beasts seem to emerge, including various types of membranes. But, of course, all this takes place in 10 dimensions. Physicists retrieve our more familiar 4-dimensional universe by assuming that, during the big bang, 6 of the 10 dimensions curled up (or "compactified") into a tiny ball, while the remaining four expanded explosively, giving us the Universe we see. What has consumed physicists for the past ten years is the task of cataloguing the different ways in which these six dimensions can compactify and These efforts have revealed millions of compactifications, each of which yields a different pattern of quarks, electrons and so on.

8. Acknowledgements

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9. References

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