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STRING THEORY (The Hidden Reality):" DOES IT REVEAL SECRETS OF UNIVERSE"

RESMI DAS[1], JISHA.M. CHAKO[2]

[1] *Lecturer in Physics, Dept. of Science and Computing, Air Force Technical College, Muscat, Oman*
[2]*Lecturer in IT, Dept. of Science and Computing, Air Force technical college, Muscat, Oman*

Abstract - *String theory, a unified field theory able to describe all four known forces in nature under a single mathematical framework. String theory also called "Theory of everything" aims to find out various theoretical conundrums like how gravity works for electrons, Photons etc. and it has been applied to a variety of problems in Condensed matter physics, Nuclear physics, Black holes and so on. Bosonic String theory was its early version. Later developed into Super String theory which includes both bosons and Fermions by posing a connection called Super Symmetry between them. According to this theory one-dimensional "String like entities" are used to define the subatomic particles in Particle physics. These strings that twist and turn in complicated ways can vibrate in different modes and it gives the particles its energy and mass. In late 1997, theorist relates String Theory to quantum field theory after discovered an important relationship called CFT correspondence. String Theory is a vast and varied subject able to explain most of the deep questions in Fundamental Physics.*

This article is an attempt to explicate how string theory is known as "Theory of Everything" and how this theory was developed to unite general theory of Relativity and Quantum Mechanics in a consistent manner.

***Key Words*: Quantum gravity, S-Duality, Graviton, Black hole, Super Symmetry, Branes, M- Theory, Hadrons.**

1. INTRODUCTION

The 20th century was the century of the birth of two of the greatest theories ever. Albert Einstein explained the force of gravity and the structure of the space-time in his Theory of Relativity at the macro level that is for large objects whereas Quantum field theory gave a completely new explanation for the other three fundamental forces at the micro-level. Rather more Einstein Theory of Relativity has been formulated within the framework of classical physics whereas Quantum mechanics describes the other three fundamental forces in its framework. These two theories are sufficient to explain most of the problems in Theoretical Physics except Quantum Gravity. Several difficulties arise when one attempts to apply the laws of Quantum theory to the force of gravity. This is where the String theory comes into picture which enables us to explain gravity at the quantum level. String Theory replaces all matter and forces particles with tiny vibrating strings whose structure and vibrating energies determine which particle it is. The Pros of the string theory was never-ending. But String theory needs supersymmetry to get the work done but all this time none of the super partners has been found this makes the string theory harder to accomplish.

2. STRING THEORY- AN OVERVIEW

2.1 The Evolution of String Theory

According to the standard model of particle physics, everything that we see around us made up of particles called Atom. This atom consists of a nucleus made up of protons and neutrons surrounded by a cloud of electrons. Protons and neutrons are further made up of elementary particles called Quarks that make up our universe. These elementary particles are classified as matter particles called "Fermions" and force particles called "Bosons". But string theory says that this story does not end like this. Rather these particles are further made up of some tiny vibrating strands of energy which we term as **STRINGS** from which all the matter and all the forces in the universe emanates.

The original string theory was developed in 1960 in an attempt to explain strong nuclear force. These strings were considered to be the carriers of nuclear force. These little loops of strings vibrate with different frequencies represents different energies and different masses. But this early version of string theory was not that successful due to its prediction about the existence of Tachyons and also the greater recognition of "Quantum Chromo Dynamics" at that time in explaining the strong nuclear force.

Moreover, it also demands extra dimensions of the universe to work. Thus, it became a failed theory to solve strong force. Later in 1970 string theory again came to the scene with an explanation for the energy inconsistencies of Hadrons and other fundamental particles in physics. Quantum mechanics and the general theory of relativity were two of the most successful theories in physics at that time. But both were working on different frames of reference. So, one of the aims of the string Theory was Unification of these two theories under a single framework. That was almost successful. Another achievement of String theory is it can give a clear explanation for the Quantum gravity which was a very hectic issue faced by all theoretical physicists at that time. This way it gradually turns out to be a fundamental theory of everything to explain the whole universe with its tiny

vibrating strings. For this theory to be in full swing it requires some interesting concepts like Super Symmetry.

Fig -1: Strings

2.2 Super Symmetry

Super symmetry is a proposed symmetry in nature between the matter particles Fermions and force particles Bosons. It says that Fermions and Bosons are connected in a mathematical complicated way. As a consequence, every Fermion has a Boson super Partner and every Boson has a Fermion Super Partner. More clearly, the super partner particles for fermions are called "Sparticle" has the same mass and charge as its partner but different spin. This concept tries to find out solutions for many problems in our standard model of particle physics; like "Why is Gravity so weak?" "How the fundamental forces in nature is unified at high energies?" and so on.

When string theory combines with Super Symmetry, Super String theory emerges, and this give rise to 5 Super String theories. Also, Super String theory describes all the fermions and Bosons as being the results of vibrating Super Strings of energy.

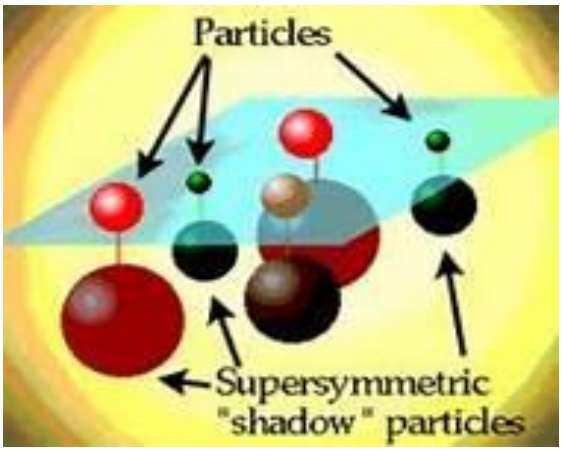

Fig -2: Super symmetry

However, these Super String theories were found to be perturbative with no single one seeming to be a Theory of everything and looks like String theory failed to reveal the nature of our universe. Also, Super Symmetry only appears at very high energies and that is not possible at normal conditions and that is why at this time none of these super partners has been found which make the String theory harder to believe.

2.3 M-Theory

In 1990's the physicists had explored the 5 consistent versions of Superstring theory after applying super symmetry to this theory. Each version looks radically different and they all claim to be the original one. Some of them allowed closed strings while others had only open. Also, these theories exhibit various combinations of strings to show how the universe works. So, to rectify these problems an American theoretical Physicist Edward Witten proposed a single unified theory called "M- Theory". In this theory all five string theories are related to each other and each was a manifestation of a single underlying theory. They also noticed several forms of duality between the theories called "S-Duality" and "T-Duality" and these are certain forms of mathematical transformations. So, M-Theory is like the mother theory and these 5 theories were different ways of mathematically expressing the same underlying theory.

Duality explains String theory and Quantum gravity with a clear picture which provides a non-perturbative formula. It is very helpful in studying strongly coupled Quantum Field Theory. For an example, some strongly interacting particles in Quantum field Theory appears weak in gravitational theory and thus more mathematically tractable. Many problems in Nuclear and Condensed matter Physics has been translated to tractable problems in String theory by using this fact.

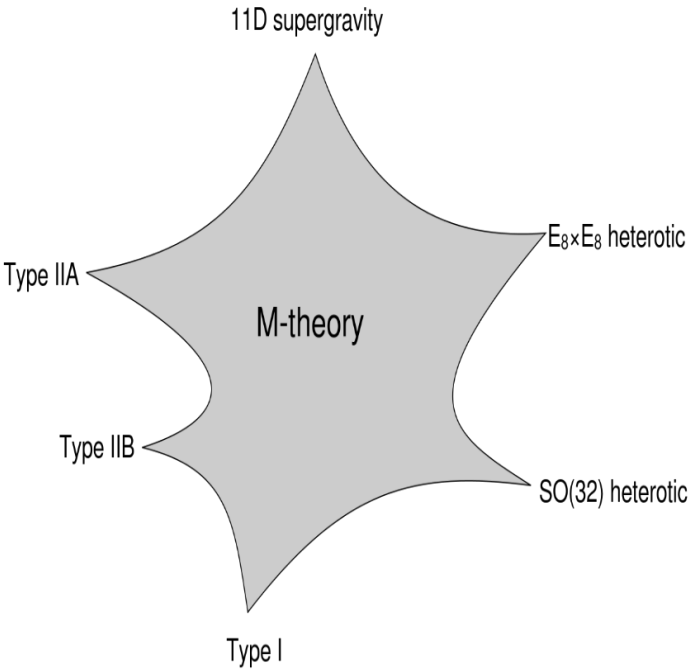

Fig -3: M-Theory

In addition to the 4 dimensions (3 space dimensions and one-time dimension) of our observed universe, M-theory includes 6 additional dimensions by thinking of the universe having 10 dimensions. But these 6 dimensions compactified into a sub microscopic scale in the range of Planck's length. So, it has been never observed. By this assumption, the transformations between the different 10-dimensional string theory variants were allowed. Super string theory is 10-dimensional whereas M-theory is 11-dimensional. These 11-dimensions are compactified into a circular curled up shape called Calabi-yau Manifold.

This idea of compactification helps to find a solution for the presence of extra dimensions in the string theory. Also different types of particles in our universe arises due to the geometry of folding. For an example, we can predict three families of particles if the Calabi-yau shape has three holes in it. If it has 5 holes, we predict about 5 families of particles. But physicists are only concerned about 3 families of particles which they known to be exist in the universe. For 6 dimensions there are thosands of combinations of calabi-yau manifolds are possible, but it is hard to find out which is the right one.

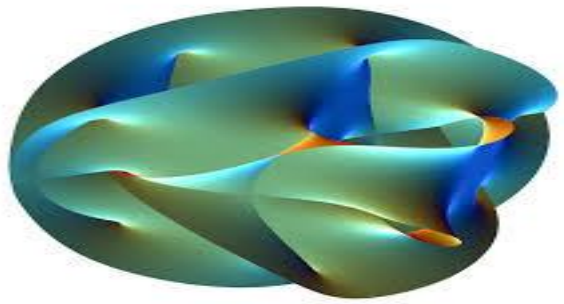

Fig -4: Calabi-Yau Manifold

M-theory also describes an 11th dimensional Super Gravity at low energy and contains no strings but 2 dimensional and 5 dimensional extended objects typically referred to as "Branes" (pict:5). This Brane world scenario is an approach by Physicist to reduce the number of dimensions of observable universe in to a 4-dimensional sub space and we cannot experience other dimensions. In such models Boson arises from open strings that are attached to the branes while gravity arises from closed strings that can sweep off the branes which makes gravity the weakest force in nature. These ideas inaugurated "Second String Revolution".

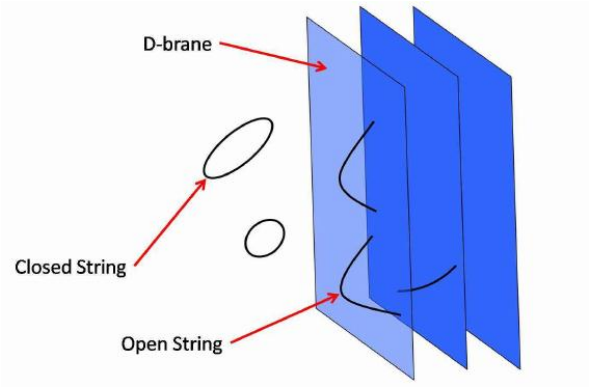

Fig -5: D-branes

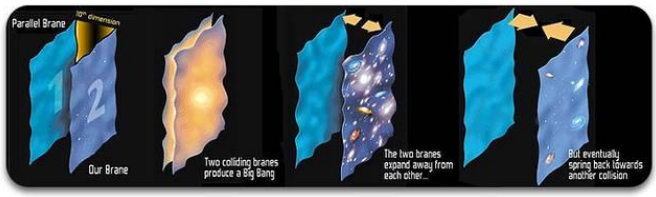

Fig -6: Branes

M-theory too does not make any real predictions. No evidence strongly argues that Witten's M-theory conjecture is false, either.

2.4 ADS/CFT correspondence

In late 1997, the Anti-de Sitter / Conformal Field theory was first proposed by Juan Maldacena describes the geometry of space-time in terms of Anti-de sitter space. ADS is a mathematical model in which the distance between the points in this space differs from the distances in Euclidean Geometry.

ADS Space resembles a hyperbolic disk with tessellations of triangles and squares of the same size as shown in Figure: 7

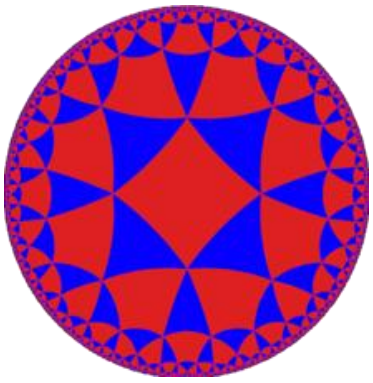

Fig -:7 A tessellation of the hyperbolic plane by triangles and squares.

If this viewed as a 3-dimensional stack of the hyperbolic disk, each disk represents the state of the universe at a given time. Time is taken along the vertical axis. It looks like a solid cylinder which defines space-time.

CFT sometimes referred to as Gauge-Gravity Correspondence as it shows a relationship between Quantum Gravity and Quantum Field Theory. When gravitational theories seem hard to solve, we can use QFT and vice versa. This way CFT helps to find out solutions for many problems in Quantum Field Theory through simple calculations in gravity theory.

This relationship has no mathematical evidence. However various calculations that involve different techniques and methods provide strong evidence for this correspondence. Nowadays ADS/CFT correspondence has become one of the largest areas of research in String theory.

3. Drawbacks of String Theory

String theory has not yet produced any testable experimental predictions. This makes the Physicists believe that String theory is unscientific and merely an intellectual exercise.

One of the main criticisms of string theory from early on is that it is a background dependent approach. In string theory, one must typically specify a fixed reference geometry for space-time, and all other possible geometries are described as perturbations of this fixed one.

Unlike in quantum field theory, string theory does not have a full nonperturbative definition, so many of the theoretical questions that physicists would like to answer remain out of reach.

If String theory is the ultimate theory, it should have to shed light on a mysterious quantity “Dark Matter” a hypothetical form of energy responsible for the accelerating expansion of the universe. But so far nobody came up with a satisfying String explanation.

4. CONCLUSION

String theory is still a vibrant area of research that is undergoing rapid developments. Several proposed experiments might have the possibility of displaying string effects. But these experiments require extremely very high energy that is not obtainable under normal conditions although some are within the bounds of possibility in the near future, such as possible observations from black holes. Only time will tell if String theory will be able to take a dominant place in science, beyond inspiring the minds and hearts of many Physicists.

Nevertheless, even without signs of flashy progress, the resulting insight has left a deep imprint on both physics and math.

''If string theory is right, the microscopic fabric of our universe is a richly intertwined multidimensional labyrinth within which the strings of the universe endlessly twist and vibrate, rhythmically beating out the laws of the cosmos.'' Brian greene.

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