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The Impact of Four Forces in Our Daily Life and the Approach of Uniting Them

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Abstract: *This review is the impact of four forces in our daily life (gravity, electromagnetic, weak and strong force) and the approach of uniting them. It was shown that all the forces of nature are identical when the Universe was young. They are not different rather than the vibrating of the tiny string which split and give four forces and the kaluza Klein approach of uniting (Einstein and Maxwell Field) i.e. gravity and electromagnetic waves at fifth dimension.*

Keywords: *Four forces, Daily life, Approach of uniting them (Gravity, Electromagnetic Weak and Strong force)*

I. Introduction

Over the last two thousand years one of the crowning achievements of physics has been the isolation and identification of the four forces that rule the universe. All of them can be described in the language of fields introduced by Faraday.

A force is anything that can move an object. Magnetism, for example, is a force because it can make a compass needle spin. Electricity is a force because it can make our hair stand on end. Over the last two thousand years, we gradually have realized that there are four fundamental forces: gravity, electromagnetism (light), and two types of nuclear forces, the weak and the strong force. (Other forces identified by the ancients, such as fire and wind, can be explained in terms of the four forces.) The idea of forces, therefore, is an old and familiar one, dating back at least to Isaac Newton. What is new is the idea that these forces are nothing but different manifestations of a single force. Everyday experience demonstrates the fact that an object can manifest itself in a variety of forms. Take a glass of liquid coffee and heat it until it boils and turns into steam. Coffee, normally a liquid, can turn into steam, a gas, with properties quite unlike any liquid, but it is still coffee. Now freeze the glass of coffee into ice. By withdrawing heat, we can transform this liquid coffee into a solid. But it is still coffee the same substance merely turned into a new form under certain circumstances, scientists have realized over the past hundred years that electricity and magnetism are manifestations of the same force. Only within the last twenty-five years, however, have scientists understood that even the weak force can be treated as a manifestation of the same force.

The Nobel Prize in 1979 was awarded to three physicists (Steven Weinberg, Sheldon Glashow, and Abdus Salam) who showed how to unite the weak and the electromagnetic forces into one force, called the electro-weak force. Similarly, physicists now believe that another theory (called the GUT or grand unified theory) may unite the electro-weak force with the strong interactions. But the final force gravity has long eluded physicists. In fact, gravity is so unlike the other forces that, for the past sixty years, scientists have grappled with the problem of uniting them in to a coherent picture. One of the great scientific puzzles of our universe, however, has been why these four forces seemed so different. (Michio kaku, beyond Einstein: superstrings and the quest for the final theory 1997 Page 16)

In the years immediately following Einstein's November 1915 announcement of the general theory of relativity (GTR), numerous attempts were made by Einstein and others to unify gravitation and electromagnetism, the only forces of Nature then known. In 1919, the German mathematician Theodor Kaluza developed a theory that maintained all the formalism of Riemannian geometry but extended the geometry's reach by proposing the possibility that Nature in fact utilized a five-dimensional space-time, with electromagnetism appearing as a natural consequence of the unseen fifth dimension (the same idea was actually proposed by the Finnish physicist Gunnar Nordström in 1914, but was ignored Einstein had shown that the world had four dimensions, not three, so an added space dimension was not viewed as entirely absurd. In addition, the apparent invisibility of the extra space dimension was explainable by assuming that it was too small to observe directly (Kaluza assumed that all physical phenomena was independent of the fifth coordinate, thus effectively "shielding" the fifth dimension from view). But in order to work the theory had to assume several arbitrary parameters and conditions that the theory could not explain.

Consequently, in 1926 the Swedish mathematician Oskar Klein reexamined Kaluza's theory and made several important improvements that also seemed to have application to the then-emerging quantum theory. Since that time, theories involving extra hidden (or compactified) dimensions have become known as Kaluza-Klein theories.

II. Four Forces

1) **Gravity,**

The silent force that keeps our feet on the ground, prevents the Earth and the stars from disintegrating, and holds the solar system and galaxy together. Gravity is an attractive force that binds together the solar system, keeps the earth and the planets in their orbits, and prevents the stars from exploding. In our universe, gravity is the dominant force that extends trillions upon trillions of miles, out to the farthest stars; this force, which causes an apple to fall to the ground and keeps our feet on the floor, is the same force that guides the galaxies in their motions throughout the universe. Without gravity, we would be flung off the Earth into space at the rate of 1,000 miles per hour by the spinning planet. Gravity is attractive, not repulsive; is extremely weak, relatively speaking; and works over enormous, astronomical distances. For example, it takes the entire planet Earth to attract a feather to the floor, but we can counteract Earth's gravity by lifting the feather with a finger. The action of our finger can counteract the gravity of an entire planet that weighs over six trillion trillion kilograms.

2) **The weak force**,

This force is responsible for nuclear beta decay and other similar decay processes involving fundamental particles. The range of this force is smaller than 1 fm and is 10^{-7} weaker than the strong force. Nevertheless, it is important in understanding the behavior of fundamental particles. However we know from experience that certain nuclei (such as uranium, with ninety-two protons) are so massive that they automatically break apart, releasing smaller fragments and debris, which we call radioactivity. In these elements the nucleus is unstable and disintegrates. Therefore, yet another, weaker force must be at work, one that governs radioactivity and is responsible for the disintegration of very heavy nuclei. This is the weak force. The weak force is so fleeting and ephemeral that we do not experience it directly in our lives. However, we feel its indirect effects When a Geiger counter is placed next to a piece of uranium, the clicks that we hear measure the radioactivity of the nuclei, which is caused by the weak force. The energy released by the weak force can also be used to create heat. For example, the intense heat found in the interior of the earth is partially caused by the decay of radioactive elements deep in the earth's core. This tremendous heat, in turn, can erupt in volcanic fury if it reaches the earth's surface. Similarly, the heat released by the core of a nuclear power plant, which can generate enough electricity to light up a city, also is caused by the weak force (as well as the strong force).

3) **Electromagnetism** (EM),

The force that lights up our cities. Lasers, radio, TV, modern electronics, computers, the Internet, electricity, magnetism-all are consequences of the electromagnetic force. In fact all the electrical wonders we see around us is the by-product of the electromagnetic force It is perhaps the most useful force ever harnessed by humans. Unlike gravity, it can be both attractive and repulsive. The electromagnetic force holds together the atom. It makes the electrons (with negative charge) orbit around the positively charged nucleus of the atom. Because the electromagnetic force determines the structure of the orbits of the electrons, it also governs the laws of chemistry. On the earth, the electromagnetic force is often strong enough to overpower gravity. By rubbing a comb, for example, it is possible to pick up scraps of paper from a table. The electromagnetic force counteracts the downward force of gravity and dominates the other forces down to 0.0000000000001 inch (roughly the size of a nucleus).

(Perhaps the most familiar form of the electromagnetic force is light. When the atom is disturbed, the motion of the electrons around the nucleus becomes irregular, and the electrons emit light and other forms of radiation. This is the purest form of electromagnetic radiation, in the form of x rays, radar, microwave, or light. Radio and television are simply different forms of the electromagnetic force.)

4) **The Strong force**,

For example, is responsible for binding together the protons and neutrons in the nucleus. In any nucleus, all the protons are positively charged. Left to themselves, their repulsive electric force would tear apart the nucleus. The strong force, therefore, overcomes the repulsive force between the protons. Roughly speaking, only a few elements can maintain the delicate balance between the strong force (which tends to hold the nucleus together) and the repulsive electric force (which tends to rip apart the nucleus), which helps to explain why there are only about one hundred known elements in nature. Should a nucleus contain more than about a hundred protons, even the strong nuclear force would have difficulty containing the repulsive electric force between them. When the strong nuclear force is unleashed, the effect can be catastrophic. For example, when the uranium nucleus in an atomic bomb is split deliberately, the enormous energies locked within the nucleus are released explosively in the form of a nuclear detonation. Pound for pound, a nuclear bomb releases over a million times the energy contained in dynamite. Indeed, the strong force can yield significantly more energy than a chemical explosive, which is governed by the electromagnetic force.

The strong force also explains the reason why stars shine. A star is basically a huge nuclear furnace in which the strong force within the nucleus is unleashed. If the sun's energy, for example, were created by burning coal instead of nuclear fuel, only a minuscule fraction of the sun's light would be produced. The turn into a cinder. Without sunlight, the earth would turn cold and life on it would eventually die. Without the strong force, therefore, the stars would not shine, there would be no sun, and life on earth would be impossible.

If the strong force were the only force at work inside the nucleus, then most nuclei would be stable.

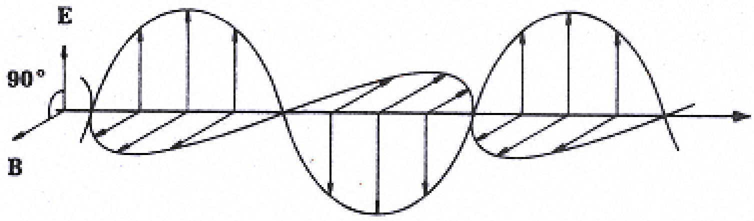
III. UNIFICATION OF FOUR FORCES

1) **Electromagnetic force**

For centuries it was thought that magnetism, the force that guides the compass needles of navigators while at sea, and electricity, the force that creates everything from lightning bolts to the shock upon touching a doorknob after walking across a carpet, were distinct forces. However, by the mid-1800s, this rigid separation was falling apart as scientists realized that vibrating electric fields could create magnetic ones, and vice versa. This effect can be demonstrated easily. For example, simply by shoving a bar magnet into a coil of wire we can generate a small electric current within the wire. Thus, a changing magnetic field has created an electric field. Similarly, we can reverse this demonstration by running an electric current through this coil of wire, thereby producing a magnetic field around the coil. Thus, a changing electric field has now created a magnetic field.The same principle that changing electric fields can produce magnetic fields and vice versa is the reason why we have electricity in our homes. In a hydroelectric plant, water falling over a dam rotates a huge wheel connected to a turbine. The turbine contains large wire coils that spin rapidly in a magnetic field. Electricity is created by the spinning motion of these coils as they move in the magnetic field. This electricity, in turn, is sent over hundreds of miles of wires into our homes. Thus, a changing magnetic field (created by the dam) is transformed into an electric field (which brings electricity into our homes through our wall sockets).

In 1860, however, this effect was understood poorly. An obscure thirty-year-old Scottish physicist at Cambridge University, James Clerk Maxwell, challenged the prevailing thinking of the day and claimed that electricity and magnetism were not distinct forces but two sides of the same coin. In fact, he made the most astonishing discovery of the century when he found that this observation could unlock the secret to the most mysterious phenomenon of all: light itself. Electric and magnetic fields, Maxwell knew, could be visualized as force fields that permeate all space. They can be represented by an infinite array of arrows emanating smoothly from an electric charge. For example, the force fields created by a bar magnet reach into space like a spider web and can ensnare nearby metallic objects. Maxwell went further than this, however, and argued that it might be possible for electric and magnetic fields to vibrate together in precise synchronization, so that they generated a wave that could travel by itself in space without assistance. One can visualize the following scenario: What would happen if a vibrating magnetic field created an electric field, which in turn vibrated and created yet another magnetic field, which in turn vibrated and created still another electric field, et cetera? Wouldn't such an infinite chain of vibrating electric and magnetic fields travel by itself, much like a wave?

To most physicists, however, the idea seemed preposterous because there was no ether to conduct these waves. These fields were disembodied and moved by themselves, without a conducting medium.



(Michio kaku, Beyond Einstein: 1997, Page 32).

According to Maxwell's theory, light consists of electric fields (E) and magnetic fields (B) that oscillate in unison. Here the electric fields vibrate vertically while the magnetic fields vibrate horizontally. Maxwell was undaunted, however. By calculating with his equations, he found that he was able to derive a specific number for the speed of this wave. Much to his astonishment, he found it to be the speed of light. The conclusion was inescapable: light was revealed as nothing but a chain of electric fields turning into magnetic fields. Quite by accident, Maxwell found that his equations unraveled the nature of light as an electromagnetic wave. Therefore, he was the first to discover a genuine unified field theory. This was a fantastic discovery, ranking in importance alongside Newton's discovery of the universal law of gravitation.

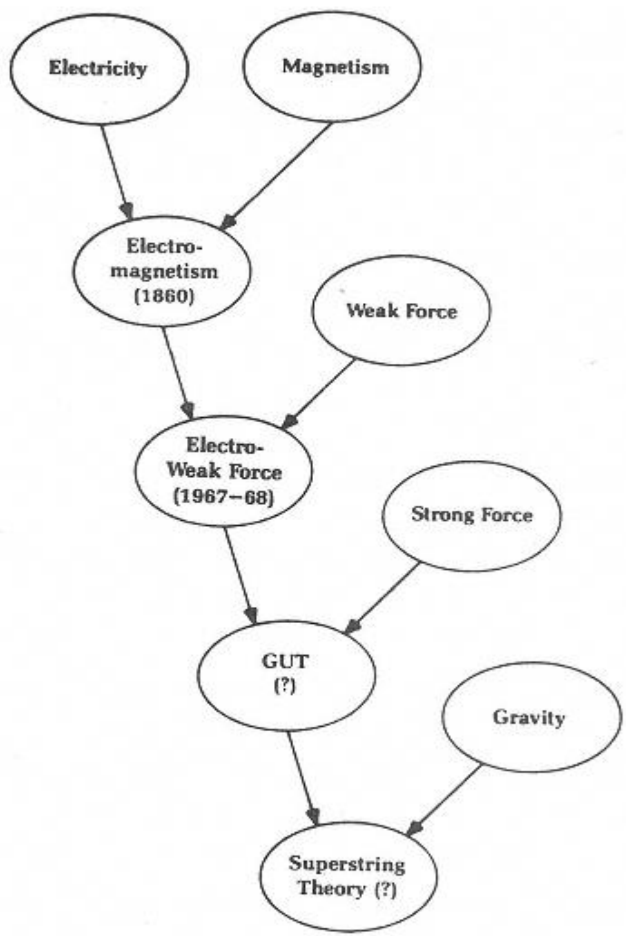
2) **Electroweak Unification**

The discovery of the W and Z particles, the intermediate vector bosons, in 1983 brought experimental verification of particles whose prediction had already contributed to the Nobel prize awarded to Weinberg, Salam, and Glashow in 1979. The photon, the particle involved in the electromagnetic interaction, along with the W and Z provide the necessary pieces to unify the weak and electromagnetic interactions. With masses around 80 and 90 Gev, respectively, the W and Z were the most massive particles seen at the time of discovery while the photon is mass less. The difference in masses is attributed to spontaneous symmetry breaking as the hot universe cooled. The theory suggests that at very high temperatures where the equilibrium kT energies are in excess of 100 GeV, these particles are essentially identical and the weak and electromagnetic interactions were manifestations of a single force. The question of how the W and Z got so much mass in the spontaneous symmetry breaking is still a perplexing one. The symmetry-breaking mechanism is called a Higgs field, and requires a new boson, the Higgs boson to mediate it. The next step is the inclusion of the strong interaction in what is called grand unification.

3) **Grand Unification**

Grand unification refers to unifying the strong interaction with the unified electroweak interaction. The basic problem of "restoring the broken symmetry" between the strong and electroweak forces is that the strong force works only on colored particles and the leptons don't have color. You have to be able to convert quarks to leptons and vice versa. But this violates the conservation of baryon number, which is a strong experimental nuclear physics principle. Baryon number minus lepton number (B-L) would still be conserved as a quark is changed to an anti-lepton. The required mass of the exchange boson is 10^{15} eV, which is more like the mass of a visible dust particle than that of a nuclear entity. This particle is called the X-boson. One prediction of the grand unified theories is that the proton is unstable at some level. In the 1970's, Sheldon Glashow and Howard George proposed the grand unification of the strong, weak, and electromagnetic forces at energies above 10^{14} GeV. If the ordinary concept of thermal energy applied at such times, it would require a temperature of 10^{27} K for the average particle energy to be 10^{14} GeV.

This chart below represents the historical sequence of the evolution of the unified field theory, beginning in 1860 with Maxwell's discovery that electricity and magnetism can be united as the electromagnetic force to superstring theory.



(Michio kaku, Beyond Einstein: 1997-1995 Page 203).

4) **Superstring Theory**

The superstring theory, however, assumes that the ultimate building blocks of nature consist of tiny vibrating strings. If correct, this means that the protons and neutrons in all matter, everything from our bodies to the farthest star, are ultimately made up of strings. Nobody has seen these strings because they are much too small to be observed. (They are about 100 billion billion times smaller than a proton.) According to the superstring theory, our world only appears to be made of point particles, because our measuring devices are too crude to see these tiny strings. At first it seems strange that such a simple concept replacing point particles with strings can explain the rich diversity of particles and forces (which are created by the exchange of particles) in nature. The superstring theory, however, is so elegant and comprehensive that it is able to explain simply why there can be billions upon billions of different types of particles and substances in the universe, each with astonishingly diverse characteristics.

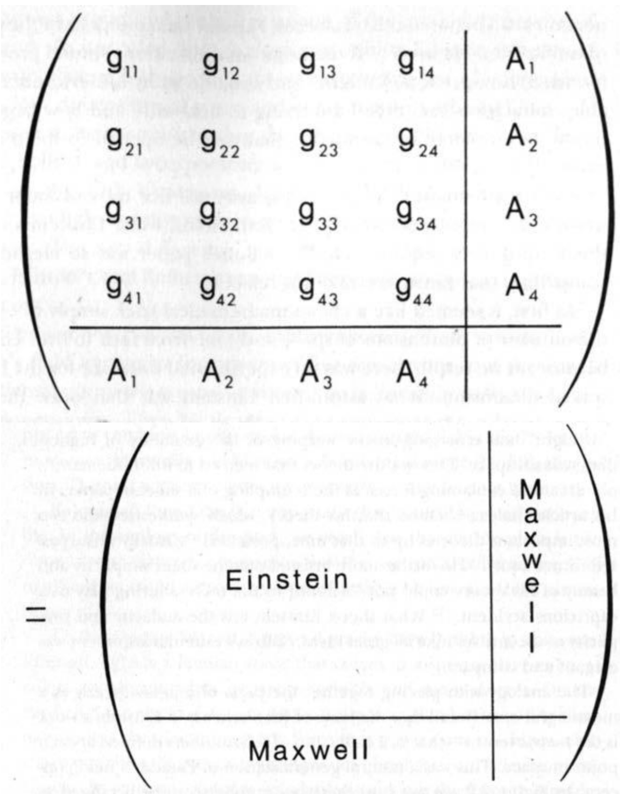
The superstring theory can produce a coherent and all-inclusive picture of nature similar to the way a violin string can be used to unite all the musical tones and rules of harmony. Historically, the laws of music were formulated only after thousands of years of trial-and-error investigation of different musical sounds. Today, these diverse rules can be derived easily from a single picture that is, a string that can resonate with different frequencies, each one creating a separate tone of the musical scale. The tones created by the vibrating string, such as C or B flat, are not in themselves any more fundamental than any other tone. What is fundamental, however, is the fact that a single concept, vibrating strings, can explain the laws of harmony.

Knowing the physics of a violin string, therefore, gives us a comprehensive theory of musical tones and allows us to predict new harmonies and chords. Similarly, in the superstring theory, the fundamental forces and various particles found in nature are nothing more than different modes of vibrating strings. The gravitational interaction, for example, is caused by the lowest vibratory mode of a circular string (a loop). Higher excitations of the string create different forms of matter. From the point of view of the superstring theory, no force or particle is more fundamental than any other. All particles are just different vibratory resonances of vibrating strings. Thus, a single framework the superstring theory can in principle explain why the universe is populated with such a rich diversity of particles and atoms. The answer to the ancient question what is matter? Is simply that matter consists of particles that are different modes of vibration of the string.

IV. **Kaluza Klein Approach**

The primary assumption of the original Kaluza-Klein theory (other than a fifth dimension actually exists) is the independence of all vector and tensor quantities with respect to the fifth coordinate. This assumption is due to Kaluza, who needed to make a more straightforward connection of his theory to the gauge transformation property of electromagnetism? This has come to be known as the “cylinder condition,” since it implies that 4-dimensional space time underlies a cylindrical fifth dimension whose special extent is small enough to render it invisible to the underlying subspace. It was Klein who first postulated the idea that the fifth dimension is a cylindrical space having a radius roughly equal to the Planck length (10^{35} meter), a concept that conveniently explains why the fifth dimension has never been directly observed. This same concept has been carried over to string theory, where it partially explains why that theory has been so difficult to verify experimentally. Indeed, a space having the dimensions of the Planck length would require energies equivalent to that of the Big Bang to resolve.

Kaluza combine, in one stroke, the two greatest field theories known to science, Maxwell's and Einstein's, by mixing them in the fifth dimension. To understand Kaluza's trick, let us now begin with Riemann's theory in five dimensions. Then the metric tensor can be arranged in a 5 X 5checkerboard. Now, by definition, we will rename the components of



(Michio kaku Beyond Einstein 1995- 1997)

Kaluza's brilliant idea was to unite down the Riemann metric in five dimensions. The fifth column and row are identified as the electromagnetic field of Maxwell, while the remaining 4X4 block is the old four-dimensional metric of Einstein.

V. **Conclusion**

The importance of four forces in our daily life could not be over emphasize, without all these forces the atoms of our bodies will dissolve, life would be unimaginable our sun the stars planets earth and all other astronomical bodies will burst or disintegrate, and the atomic fires lighting the stars and galaxy would be snuffed out, we will flung off the earth in to space in fact life will be too difficult without all these forces there is no.

In one stroke, Kaluza unified the theory of gravity with light simply by adding another dimension. The higher dimension, which was not observable by experiment, was different from the other dimensions. It had, in fact, collapsed down to a circle so small that even atoms could not fit inside it. Thus the fifth dimension was not a mathematical trick introduced to manipulate electromagnetism and gravity, but a physical dimension that provided the glue to unite these two fundamental forces into one force, but was just too small to measure. Anyone walking in the direction of the fifth dimension would eventually find himself back where he started. This is because the fifth dimension is topologically identical to a circle, and the universe is topologically identical to a cylinder.

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