

A Classical Electromagnetic Theory of Elementary Particles*

Part 1, Introduction

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Abstract. At the beginning of the Twentieth Century, the electron, proton, and neutron were discovered and identified experimentally. From cosmic ray experiments and accelerator experiments, this initially satisfying list of elementary particles has been expanded to include six spin- $\frac{1}{2}$ leptons, nine spin- $\frac{1}{2}$ baryons, four spin- $\frac{3}{2}$ baryons, twenty spin-0 pseudo-scalar mesons, and seven spin-1 vector mesons, plus the antiparticles of each.

The first theoretical approach to order all of these particles in a systematic way in terms of certain internal symmetry properties was the Standard Model of Elementary Particles. It was based upon six hypothetical unobserved spin- $\frac{1}{2}$ particles called 'quarks.' All of the heavy elementary particles called hadrons are formed from these quarks. In this model the strong interaction is mediated[#] by the exchange of gluons, the electromagnetic interaction is mediated by the exchange of photons, and the weak interaction is mediated by the exchange of W^\pm and Z^0 particles.

In the Standard Model, use of the Higgs mechanism for symmetry breaking allowed the electromagnetic and weak force to be combined into the electroweak force. In a similar way the Higgs mechanism allows the strong interaction to be unified with the electroweak. An attempt to unify all of the forces in nature, including the gravitational force, has led to a string theory of 26 dimensions that can be represented by a ten-dimensional rotating string theory assuming supersymmetry. One of these dimensions is *time*.

Both the Standard Model and the Superstring Model of Elementary Particles are closely integrated with cosmology and the Big Bang Theory of the origin of the universe. This approach represents the earth and the universe as very old compared to Biblical revelation. Furthermore, there is no role for God in creating or daily sustaining the universe. The universe supposedly came about as a chance quantum fluctuation that produced the "big bang." According to this approach, the design of the universe is inherent in the properties of the elementary particles that resulted from the "big bang." All matter and life itself are built from these elementary particles. Their inherent properties are supposed to determine the design of all matter and the nature of living things.

[#] Editor's Note: *interaction is mediated*. Many physicists use this quaint expression to assert that *force is exerted*—because they are uncomfortable with the Newtonian concept of force. One prominent physicist stated that force " $F = ma$ is formally empty, microscopically obscure, and maybe even morally suspect..." [Frank Wilczek, "Whence the Force of $F = ma$? I: Culture Shock," *Physics Today*, p. 11 (October 2004)].

A new classical electrodynamic approach is presented in this paper to explain the existence of all the observed elementary particles and their internal symmetries. This classical approach is based on the plasma physics experiments of Winston Bostick with plasmons that indicate how continuous charge-fibers exist without radiating energy and can be combined to build larger complex stable structures.

In particular, this paper introduces a model consisting of classical electromagnetic charge-fibers in continuous loops that explains the existence of all the observed elementary particles above. It explains the *physical origin* of the six quarks and six leptons that is unexplained in the Standard Model. Furthermore, it explains the physical origin of the ten dimensions of the Supersymmetric String Theory and how six of these dimensions curl up to be non-observable.

This initial draft of a new purely classical electromagnetic model of elementary particles appears capable of accomplishing the scientists' goal of a unified theory of elementary particles and forces in a simply elegant manner. It is significant to the Judeo-Christian community, because it is purely electromagnetic in origin in agreement with the scriptures. Also the model shows remarkable symmetry in the design of elementary particles uniquely identifying them with the creator God. The model is based on the Biblical and classical notion of *cause and effect* instead of the *random-chance* of Quantum Theory. It has significant cosmological implications for the structure of the solar system, galaxies, and the universe itself [0].

History of Atomism. The concept of a particle is a natural idealization of the everyday observation of matter in the form of rocks and small dirt-particles. These are stable objects that move as a whole and obey simple laws of motion. However, neither of these is structureless. If sufficiently large forces are applied to them, they can readily be broken apart into smaller pieces.

The notion that there must be some set of smallest constituent parts, which are the building blocks of all matter, is very old. Democritus (born about 460 B.C. in Abdura, Thrace, Greece) is commonly credited with introducing this idea. His

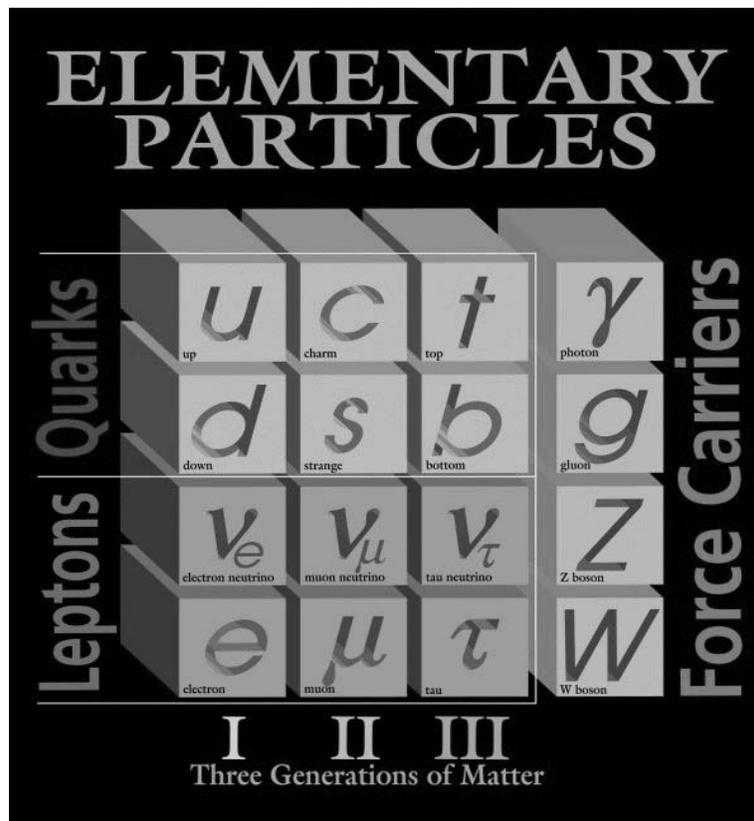


Figure 1.
Building Blocks of Standard Model
of Elementary Particles [2]

concept of the building block consisting of *small particles with hooks on them* is quite different from our notions today. Nevertheless, he did introduce the word, which in English translates as ‘atom,’ to describe the building blocks—whatever they might be.

Over time, the word ‘atom’ has acquired a meaning that only partly matches Democritus’s idea. Atoms are defined to be the smallest part of a chemical element that still retains the properties of the element. This type of atom is no longer considered indivisible. Nowadays, atoms are known to consist of a small nucleus made of shells or layers of neutrons and protons surrounded by shells of bound electrons.

In the 1930’s, protons, neutrons, and electrons were thought to be the smallest objects into which matter could be divided. They were called ‘elementary particles.’ The word elementary meant in those days “having no smaller constituent parts” or ‘indivisible.’ They were the new ‘atoms’ in the original sense.

Later experiments allowed scientists to infer yet another layer of structure within the protons and neutrons consisting of quarks. Over 100 other ‘elementary particles’ have been discovered between 1930 and the present time [1]. Physicists believe that these elementary particles, called ‘hadrons,’ are all made up of quarks and/or antiquarks.

Once quarks were discovered (invented might be a more accurate word), all hadrons were considered to be composite particles. After that hadrons, such as the neutron and proton, could no longer be called ‘elementary’ particles. On the other hand leptons, such as the electron, muon, tau, and neutrinos still appeared to be structureless.

The Standard Model. The Standard Model of Elementary Particles was developed to provide a theoretical framework (largely mathematical instead of physical) for describing the fundamental particles of matter and all the forces by which they interact (except for gravity). According to this model there are two kinds of fermions, or matter-particles, called ‘quarks’ and ‘leptons’ which are grouped into three ‘generations’ of increasing mass. Leptons include the electron, muon, tau, and the neutrinos (see Figure 1).

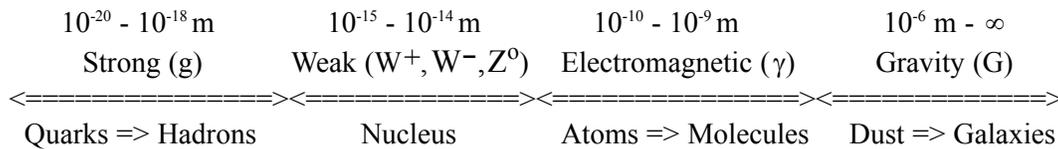
Scientists have identified four types of forces acting upon elementary particles, *i.e.* the strong and weak nuclear forces, the electromagnetic force, and the gravitational force.

1. The strong interaction force is responsible for quarks ‘sticking’ together to form protons, neutrons, and other hadrons.
2. The weak interaction force describes the forces between electrons (or positrons) and nucleons. It describes the decay of heavy particles (hadrons) into smaller particles such as nucleons, electrons, positrons, *etc.*
3. The electromagnetic force binds electrons in shells to atomic nuclei to form atoms. Also it binds atoms together to form molecules.

- The gravitational force acts between large collections of atoms. Even though gravity is the weakest of the four forces, it is the dominant force in our everyday life and throughout the universe.

The chart below summarizes the information on the dominant range of each of the forces:

Chart 1. Principal Range of Fundamental Forces



According to the Standard Model, each fundamental force has a carrier particle that transfers energy, momentum, charge, and other properties from one particle to another particle with the aid of one of the fundamental forces. These carrier particles, which are also elementary particles, are given below:

- Gluon (g) spin-1 particle associated with the strong interactions between quarks
- W^+, W^-, Z^0 spin-1 particles associated with the weak interaction
- Photon (γ) spin-1 particle associated with the electromagnetic interaction
- Graviton (G) spin-2 particle associated with the gravitational interaction— not yet observed

Ordinary matter is composed of the lightest generation of fermions. Up-quarks and down-quarks combine to form the protons and neutrons in the shells of atomic nuclei. Electrons form shells about the atomic nucleus and bind atoms together into molecules.

Over the years, the Standard Model has been successfully used to predict the existence of some new particles and their properties before the particles were experimentally found. The final particle that must be discovered, in order to confirm the complete set of Standard Model predictions, is the Higgs particle.

The Higgs particle is a *boson* or *force-carrier*. It is thought to give mass to the elementary particles through its interaction with them. One of the key measurements used to predict the mass of the Higgs particle is the direction of the decay of Z-particles into bottom-quarks and antibottom-quarks. The result of this measurement disagrees significantly with the Standard Model's predicted value. If this decay scheme is not correct, then the CERN Large Electron Positron Collider (LEP) lower limit for the mass of the Higgs particle at 114.1 GEV is too high. In any case, the Standard Model has a dilemma suggesting that there may be still more to be discovered about elementary particles.

There are many questions that the Standard Model leaves unanswered as seen below:

1. Are leptons and quarks truly fundamental?
2. Are there more particles and forces to be discovered?
3. Why are there three kinds of leptons and three kinds of quarks associated with each charge?
4. What is the role of muons, taus, and the quarks?
5. What do real elementary particles look like physically?
6. What is the origin of gravity?
7. How is the force of gravity related to the other forces?
8. Why are there just three generations of quarks and leptons?
9. Why are there just four fundamental forces?
10. Could there be more fundamental forces on even smaller scales?

The Supersymmetric String Model. The central paradox of the contemporary physics of elementary particles is the apparent incompatibility of its two main theoretical foundations. Einstein's General Theory of Relativity is the foundation which relates the force of gravity to the structure of space and time on a macroscopic level. Quantum Mechanics, the second foundation, describes the atomic and subatomic world. Quantum theories have been formulated for three of the four identified forces of nature, *i.e.* the Strong, Weak, and electromagnetic interactions.

A unification of Relativity and Quantum Theories seems to call for a radically new formulation of the laws of physics at the smallest distance scales. In such a formulation the idea that space and time are continuous sets of points may have to be abandoned. Without a quantum theory of gravity and the conceptual revisions such a theory implies, it appears that a comprehensive description of all the forces of nature may not be realizable.

In String Theory, elementary particles can be thought of as strings. String theories differ fundamentally from quantum-mechanical field theories such as the Quantum Theory of Electromagnetism whose quanta or constituent particles are point-like. Since a string has extension, it can vibrate much like an ordinary violin string. The normal modes of vibration are determined by the tension of the string.

In Quantum Mechanics, waves and particles are *dual aspects of the same phenomenon*. From that point-of-view, each vibrational mode of a string corresponds to a particle. The

vibrational frequency of the mode determines the energy of the particle and also its mass. The various ‘elementary particles’ are understood as different modes of a single string.

Superstring Theory combines String Theory with a mathematical structure called Supersymmetry. Superstring Theory makes it possible to consider all the four fundamental forces as various aspects of a single underlying principle. The unification of the forces is accomplished in a way that is almost uniquely determined by the logical requirement that the theory be internally consistent.

According to Superstring Theories, the standard laws of physics are approximate versions of a much richer theory that takes into account structures at an inconceivably small distance scale. The strings postulated by the theory are about 10^{-35} meters long, *i.e.* 10^{-20} times the size of the proton.

In Superstring Theory, gravity is defined in a world expanded to nine spatial dimensions plus time. Evidently, six of the nine spatial dimensions must be hidden from view, leaving only the four customary dimensions of space-time to be observed. The six extra dimensions must be curled up to form a structure so small that it cannot be directly seen. For example, a hose has the three-dimensional surface that appears to be one-dimensional when it is observed at scales too coarse to resolve its thickness or volume. In Superstring Theory, it is assumed that the size of the six curled up dimensions is approximately the same as the length of the string or smaller.

In Superstring Theory, there is a string-field that depends on the configurations of the string. A string-like particle is thought of as a ‘wavelike’ disturbance in ten-dimensional string space. The harmonics of the string vibrations are supposed to correspond to the observed hadrons. Generally speaking, the strings serve to bind together the quarks that make up the proton, the neutron, and other hadrons.

The original string model could only account for bosons, *i.e.* particles with an integral spin such as the pi-meson. A variation of the theory, called the Spinning String Theory, was able to describe both bosons and fermions. The original string theory for bosons required 26 dimensions. The Spinning String Theory only required ten dimensions.

According to Noether’s [13] theorem, for every continuous symmetry in physics there is a conserved quantity or charge. The continuous symmetry of rotations in space gives rise to the conservation of angular momentum. Many symmetries in particle string physics are not related to ordinary space. These can be thought of as symmetries related to some so-called internal space involving the six hidden dimensions.

As a string moves, it sweeps out a two-dimensional surface in spacetime called a worldsheet. The only meaningful vibrations of the string are undulations of the worldsheet perpendicular to its surface. Thus, if the string is moving in d dimensions, two dimensions of vibration have no physical reality (time and longitudinal vibrations). All real vibrations are transverse vibrations in $d-2$ dimensions.

The vibrational frequencies of a superstring are determined by its tension, which is measured in units of energy per unit length. The frequencies of the normal vibrational modes of the string are separated by huge gaps. Particles corresponding to the lowest vibrational state are massless. The massless states of Superstring Theory include not only the spin-2 graviton, the spin-1 gauge particles of the other forces, and the spin-0 and spin- $\frac{1}{2}$ particles, but also the spin- $\frac{3}{2}$ gravitino gauge particle associated with supergravity.

For internal consistency superstring theory must lead to the observed *chirality*, or handedness, of the weak force. The weak force is chiral in the sense that it gives rise to effects whose mirror-reflected counterparts do not exist in nature. It is only when space has an odd number of dimensions that the concept of chirality can be defined at all. For example, with nine spatial dimensions superstring theory can be chiral.

Like the Standard Model, the theory of superstrings leaves a lot of unanswered questions as follows:

1. Why is observed space-time approximately flat and four-dimensional?
2. What sort of mechanism causes the six internal dimensions to curl up?
3. Could fundamental particles be composed of multiple strings instead of just one?
4. Are there more fundamental forces at scales smaller than string dimensions?
5. Why are strings not three dimensional like physical strings?

The Classical Electromagnetic Model. Toward the end of the nineteenth century most scientists were of the opinion that all the universe was electromagnetic in origin [14]. There was great optimism at that time that even gravity would turn out to be electromagnetic in origin, since it had the same $1/R^2$ dependence as the electric force.

With the rapid succession of new scientific discoveries of the twentieth century, scientists were unable to keep pace with an electromagnetic explanation. As a result many new theories were added to science, *e.g.* Quantum Theory, Relativity Theory, Atomic Theory, Nuclear Theory, and Elementary Particle Theory.

The author's work is part of a larger work that seeks to build on the electrodynamic base of the nineteenth century and replace the rashly introduced theories named above. Already completely classical electrodynamic explanations for the structure of the atom [3,4,5], and the nucleus [6]—as well as the emission spectra of the atom, black body radiation, and the photoelectric effect [7]—have been published. Also, a rigorous derivation of the origin of special 'relativistic effects' due to the electrodynamic feedback effect from finite-size elastic charged particles has been published [8]. In each of these cases the classical electrodynamic explanation based on finite-size charged elementary particles has

proved to be logically superior, describe more experimental data, and to lead to a simpler theory than the one it is replacing.

In this same vein, a new completely classical electrodynamic theory of elementary particles is introduced. It will be shown that this approach is logically superior to the Standard Model and the Supersymmetric String Model of elementary particles and better describes more elementary particles and their decay schemes.

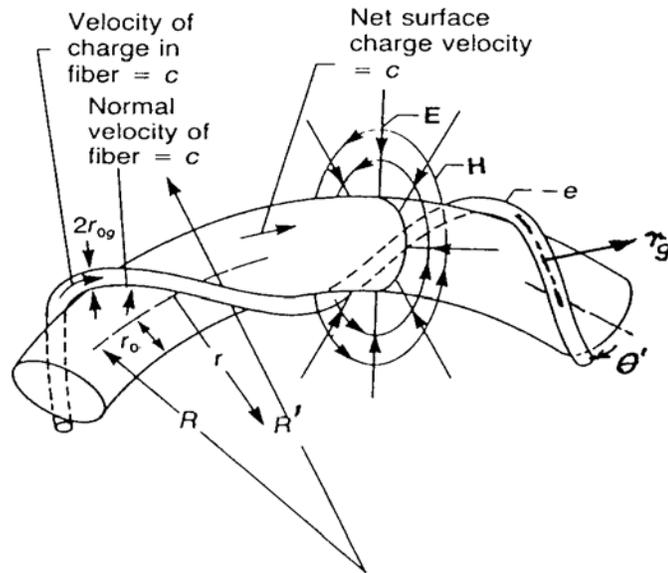


Figure 2.
Bostick's Toroidal Charge Fiber Ring

Three Key Experiments. The key to developing an electrodynamic model of elementary particles is based upon a long history of papers [4]. For the purposes of this paper only the work of Arthur Compton, one of his last graduate students (Winston Bostick), and my own experiments with a plasma lightning ball will be referenced.

In 1917, Compton [9,10,11] published a series of experimental papers on the size and shape of the electron as determined by analysis of hard X-ray and gamma ray scattering. He showed that the results are consistent with scattering from thin flexible rings of charge, *i.e.* ring electrons. Compton also derived Owen's experimental law for fluorescent absorption of X-rays based on the electron ring model.

In 1956, Bostick began developing plasma-focus devices and plasma-jet devices in the plasma fusion effort to develop controlled nuclear fusion. With these devices, he was able to demonstrate the existence of *plasmoids*. These spherical droplet-like charge structures were formed from charge-fibers. They were stable with a balance of internal forces. From scattering experiments with plasmoids, Bostick discovered that the slender charge-fibers possessed a significant tensile

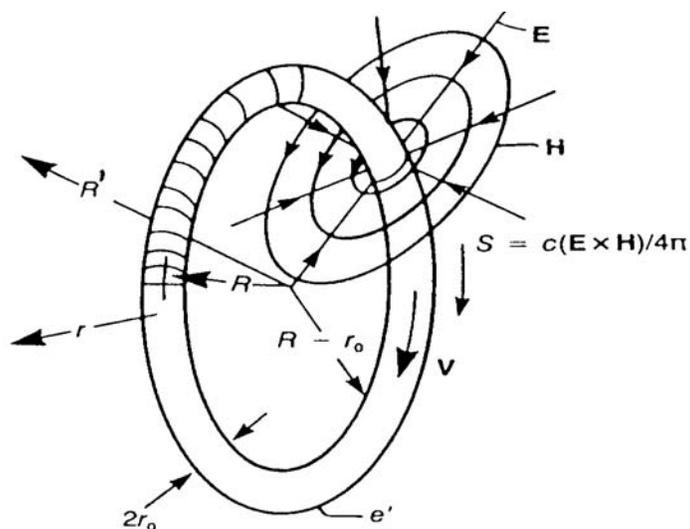


Figure 3.
Bostick's Toroidal Ring

strength.

In 1966, Bostick [12] proposed that the electron is a string-like submicroscopic force-free plasmoid. He further proposed that the string of charge that makes up the electron naturally assumes the configuration of a helical spring that is connected end-to-end to form a deformable ring or torus (see Figures 2 and 3).

In the late 1990's, gift shops in the United States began carrying a curiosity device (perhaps based on Bostick's plasma jets) called a "Plasma-Force Ball" or a "Plasma Lightning Ball." What this curiosity device *does* is produce long charge-fibers that extend from a source at the center of a glass globe to the inner surface of the globe. By placing one's finger on the globe where one of these charge-fibers ends on the inner surface of the globe, one can cause the fiber to split into multiple secondary fibers. Occasionally the primary fiber will split into multiple secondary fibers before it reaches the inner surface of the glass globe. These thinner secondary fibers split into multiple tertiary fibers upon contact with the inner surface of the glass sphere when your finger is in contact at the proper spot. It appears that the structure of the original charge-fiber is similar to a rope that consists of multiple intertwined smaller strings.

Thus, experimentally it appears quite natural for charge-fibers to be complex such that there may be a primary charge-fiber that consists of multiple secondary charge-fibers which in turn consist of multiple tertiary charge-fibers. The number of levels to which the primary charge-fiber may be physically subdivided beyond this is unknown, but three levels are sufficient to build a new classical electrodynamic string theory of elementary particles—as will be explained in the subsequent parts of this article that was originally published in [18].

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