Chapter 35

PARTICLE PHYSICS, QED, SUPERSTRINGS & SPECIAL RELATIVITY

A. Quantum Field Theories and QED

During the mid 1920's, French physicist Louis de Broglie and Austrian physicist Erwin Schrödinger, each working separately, developed the mathematical concepts of 'wave mechanics' to describe the motions and properties of quantum particles, such as electrons. During the same period English physicist Paul Dirac (1902 – 1984) and German physicist Werner Hersenberg developed a different mathematical theory for quanta, called 'matrix mechanics.' In 1927, the two theories were determined to be mathematically equivalent, and thereafter together were called 'quantum mechanics.' Danish physicist Niels Bohr and German physicist lent wisdom and interpretation to this process. (Rohrlich, pp. 134 – 136)

Quantum mechanics can be characterized as "the quantum version of Newtonian mechanics."

> "it describes quantum particles with respect to inertial reference frames that are related by *Galilean* transformations. The laws of quantum mechanics are invariant only under *those* transformations." (Rohrlich, p. 189)

One major difference is that all attempts to observe electrons without disturbing them have failed; we can either determine their position or their velocity (momentum), but never at the same time. This intrinsic limitation is known as Hersenberg's 'uncertainty principle.' (*Id*., pp. 147 – 151) Another major difference is that: "Quantum mechanics is…not applicable to very fast moving quantum particles." (*Id*.)

In 1928, Dirac invented an equation that described an electron in terms of a field rather than in terms of an uncertain probability. *A priori*, this electron field in conjunction with an electromagnetic quantum field, permitted electrons to exert electromagnetic forces upon one another. Two decades later this concept would be called "quantum electrodynamics' (QED). (*Id*., p. 192)

> "Another consequence of this equation was that for every solution there is a second solution which describes the same electron (same mass, spin, etc.) but with its electric charge of opposite sign. At that time only electrons with negative electric charge were known. (Rohrlich, p. 192)

Four years later, in 1931, a new quantum particle was discovered. Because it was indistinguishable from an electron (except that it had a positive charge) this new particle was dubbed a 'positron,' and considered to be an 'antiparticle' or antimatter. Dirac, by reason of his above equation, was considered to have predicted its existence.[1] (*Id*.)

Soon other quantum theorists also attempted to unify "electromagnetism with quantum theory." (Smolin, p. 55)

> "As the basic phenomena of electromagnetism are fields, the unification that would eventually result is called a *quantum field theory*. And because Einstein's special theory of relativity is the right setting for electromagnetism, these theories can also be seen as unifications of quantum theory with special relativity." (*Id*.)

> "It is a relativistic theory in the sense that two inertial reference frames that move with constant velocity relative to one another will observe the same laws of motion and are related by a Poincaré transformation. Quantum fields, however, differ from fields of classical physical sciences [and] each quantum field is associated with a particular type of quantum particle."[2] (Rohrlich, pp. 190 – 191)

One problem with this implied unification was that Special Relativity asserts that "there are a continuous infinity of variables."

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[1] Since this time, many other particles-antiparticle pairs have been discovered and each pair is claimed to be able to annihilate each other in a collision.
[2] This sounds a lot like ether, where each phenomenon had its own different ether.

> "In quantum theory, each variable is subject to an uncertainty principle. One implication is that the more precisely you try to measure a variable, the more it fluctuates uncontrollably. An infinite number of variables fluctuating uncontrollably can easily get out of hand." (Smolin, p. 55)

After World War II, the goal was a fully consistent theory of QED. By 1948, American physicists Richard Feynman and Julian Schwinger had independently satisfied this goal.[3] (*Id*.) Then, because of Dirac's prior success in predicting the existence of the positron it was suggested that the Quantum Field theory should be applied to explain the weak and strong forces that hold the particles of the atom together. Thus, the application to the weak forces resulted in the 'electroweak theory,' and the application to the strong forces resulted in the theory of 'quantum chromodynamics.' Together they were called the 'grand unified theory.' However, experimental data failed to demonstrate the validity of either theory. (Rohrlich, p. 192)

All of the quantum field theories (including QED and chormodynamics) "are defined only in terms of an approximate procedure." (Smolin, p. 182) And, although their results are consistent:

> "there is good reason to believe that the standard does not exist as a rigorously defined mathematical theory. This is not disturbing, as long as we believe that the standard model is only a step toward a deeper theory. String theory was at first thought to be that deeper theory. On the present evidence, we must admit that it is not." (*Id*., pp. 182 – 183)

The string theory is also only defined in terms of an approximate procedure, and it fails to predict anything new. (*Id*.)

Many believers in Special Relativity claim or imply that" 1) Special Relativity 'drastically changes our very concept of 'matter'" (Giulini, p. 94); 2) that Dirac's prediction of a "mutation between different forms of matter" (particles and anti-particles)

[3] "QED was first solved by the Japanese physicist Sin-Itiro Tomonaga during World War II, but the news did not reach the rest of the world until 1948 or so." (Smolin, p. 55)

and the various quantum field theories are all relativistic concepts and consequences of Special Relativity (*Id*., pp. 94 – 98); 3) that Quantum Field theory “unifies quantum mechanics with special relativity theory” (Rohrlich, p. 189); and/or 4) that all of the above are experimental confirmations of Special Relativity. Einstein, Weyl, Eddington and Schroedinger all worked in a somewhat different direction to arrive at a unified field theory for electromagnetism and gravitation, and to explain “all of the results usually described by quantum mechanics.” (Born, pp. 370, 371) They failed.

Regardless of the theoretical merits or failures of any of the above theories, it is quite obvious from reading this book that Einstein’s empirically invalid Special Theory of Relativity should have little or no part in any of them. Likewise, it is also clear that any of the successes attributed to such theories are not experimental confirmations of Einstein’s Special Theory.[4]

B. Superstring Theory

For the last 30 years of his life, Einstein attempted to combine electromagnetism and relativity into a single unified theory. He failed. “During the 1960’s and 1970’s particle physicists made great strides in understanding the quantum structure of matter and the non-gravitational forces that govern its behavior.” [5] (Greene, p. 352) These efforts resulted in the ‘Standard Model’ of particle physics, which is based on quantum mechanics, 12 matter particles (including electrons, muons, neutrinos, taus, and 6 types

[4] The fact that quantum physicists may use Special Relativity as an approximation in order to design their particle accelerators does not effect these conclusions. (see Giulini)

[5] “But today, despite our best efforts, what we know for certain about these laws is no more than what we knew back in the 1970s.” (Smolin, p. viii)

of quarks),[6] and 3 force particles: photons (electromagnetism), gluons (the strong force that holds atomic nuclei together) and the weak force particles W (which are responsible for nuclear decay). (*Id*.; Smolin, p. x) The Standard Model predicted 'how' the particles would interact and influence each other, but not 'why,' and it failed to unify gravity with quantum mechanics. (Greene, pp. 352 – 353)

In 1968, an Italian scientist named Gabriele Venezano realized that a 200-year-old formula created by Euler "matched data on the strong nuclear force with precision." (*Id*., p. 339) By 1970, three other scientists independently interpreted these findings and came up with the same physical picture. Instead of the classical picture of small points for atomic particles, such particles were characterized as tiny one-dimensional vibrating strings of energy, which stretched when they gained energy and contracted when they lost it. Thus, the string theory was born.[7] (Smolin, pp. 103 – 104)

The three original scientists also mandated that the string theory be consistent with both Special Relativity and quantum mechanics. In order for this to theoretically happen, space must have twenty-five dimensions (instead of the normal three). (*Id*., pp. 104 – 105) "In fact, neither theory nor experiment offers any evidence at all that extra dimensions exist." (*Id*., p. xvi) There also had to be a 'tachyon' particle that moves faster than the speed of light, and there were other seemingly impossible requirements. (*Id*., pp. 104 – 105)

Later, in 1970, Pierre Raymond found a way to remove the tachyon requirement, gave the theory a new 'supersymmetry,' and reduced the requirement of space-time dimensions to ten: nine dimensions for space and one for time. (Smolin, p. 105) There

[6] "particle physicists have more than once felt the need to invent an unseen particle, such as the neutrino, in order to make sense of certain theoretical or mathematical results." (Smolin, p. 26)
[7] It should be pointed out at this juncture that "no one has ever seen a string." (Greene, p. 352)

was only one fundamental type of string; the unique properties of each different particle resulted from the specific vibration pattern of a particular string.[8] (Greene, p. 346) More dimensions meant more possible vibration patterns.[9] It turned out that nine space dimensions provided the perfect number of vibration patterns.[10] (*Id*., pp. 370 – 371) Later a force particle (the 'graviton') was added to this new superstring theory, in an attempt to unify General Relativity with quantum mechanics.[11] (Smolin, p. 106, 122)

Over the intervening years, the superstring theory (or the 'Theory of Everything,' as it is often called) has experienced many revisions, controversies and at least two revolutions, but almost no empirical observations. It has also faced many detractors. For example, Richard Feynman stated: "I don't like that they're not calculating anything…I don't like that for anything that disagrees with an experiment, they cook up an explanation." (see Smolin, p. 125) Sheldon Glashow, Nobel prize winner for his work on the Standard Model, also concluded:

> "But supersting physicists have not yet shown that their theory really works. They cannot demonstrate that the standard theory is a logical outcome of string theory. They cannot even be sure that their formalism includes a description of such things as protons and electrons. And they have not yet made even one teeny-tiny experimental prediction. Worst of all, superstring theory does not follow as a logical consequence of some appealing set of hypotheses about nature. Why, you may ask, do the string theorists insist that space is nine-dimensional? Simply because string theory doesn't make sense in any other kind of space…" (see Smolin, p. 125)

The current state of the supersting theory is described by former theoretical string physicist Lee Smolin, as follows. "String theory…purports to correctly describe the big

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[8] For example, an electron is a string with one specific vibrating pattern, and a photon is a string with a different specific vibrating pattern. (Greene, p. 347)
[9] Again, "we don't see the extra dimensions." (Greene, p. 372)
[10] However "it is now accepted that the theory needs seven extra dimensions." (Greene, p. 370, F.N.)
[11] "Without a successful union between general relativity and quantum mechanics, the end of collapsing stars and the origin of the universe would remain forever mysterious." (Greene, p. 17)

and the small—both gravity and the elementary particles." (Smolin, p. xiii) Thus, it purports to unify General Relativity with quantum theory, a theoretical result called 'quantum gravity.' (*Id*., p. 5) "It posits that the world contains as yet unseen dimensions and many more particles than are presently known." (*Id*., p. xiii) "It claims to be the one theory that unifies *all* the particles and *all* the forces in nature." (*Id*.) String theory is really only:

> "a large collection of approximate calculations, together with a web of conjectures…[A] theory has never actually been written down. We don't know what its fundamental principles are. We don't know what mathematical language it should be expressed in…We cannot even say that we know what string theory asserts…[In effect it is] just a hunch." (*Id*., pp. xiv & xv)

As David Gross, Nobel laureate and a strong advocate of string theory, once stated: "we don't know what we are talking about." (*Id*., p. xv)

"For a theory to be believed, it must make a <u>new</u> prediction…" (Smolin, p. xiii) However, "string theory makes no <u>new</u> predictions," because *inter alia* "it appears to come in an infinite number of versions." (*Id*., p. xiv) To be taken seriously, a theory must also be confirmable or falsifiable. However, because string theory makes no <u>new</u> predictions, it is also not testable. "String theory cannot be disproved…[and] no experiment will ever be able to prove it true." (*Id*., p. xiv)

In spite of all the aforementioned problems, superstring theory has become "the primary avenue for exploring the big questions in physics." (Smolin, p. xx) "Even as string theory struggles on the scientific side, it has triumphed within the academy." (*Id*., p. xxii) "String theory now has such a dominant position in the academy that it is practically career suicide for young theoretical physicists not to join the field." (*Id*., p. xx) "How is it possible that string theory, which has been pursued by more than a thousand of the brightest and best-educated scientists, working in the best conditions, is in danger of failing?" (*Id*., p. xxii)

One reason that we have briefly described superstring theory in this book is because it is the epitome of the *ad hoc* mathematical theory described in the Forward. Like most of the ether theories, Special Relativity, General Relativity (see Einstein, *Relativity*, pp. 67 – 116, 141 – 151) and Einstein's mathematical theory of the universe (see Einstein, 1917 [Dover, 1952, pp. 177 – 188]; Einstein, *Relativity*, pp. 119 – 129), superstring theory is neither founded upon nor confirmed by empirical observations. All of such theories and concepts are strictly based upon mathematical computations, imagination, conjecture and/or scientific agendas. There are uncountable other *ad hoc* mathematical theories just like them. This, to a great extent, is the current state of theoretical physics.

There is another reason why we mention the superstring theory. "String theory assumes that special relativity is true, exactly as written down by Einstein a hundred years ago." Therefore it "would be bad news for string theory," if Special Relativity were demonstrated to be wrong. (Smolin, p. 223) If this occurred, "certainly all known string theories would be proved false, since they depend so heavily on special relativity…" (*Id*.)

We now ask the questions: How could any theory (let alone the Superstring theory) that is so dependant upon a contrived *ad hoc* theory like Special Relativity ever hope to succeed? Moreover, why would the advocates of an established theory, such as electromagnetism or quantum mechanics, even desire to be unified with Special or General Relativity?