

# POSSIBILITY OF A THEORY OF EVERYTHING

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## Abstract

In recent years, many particle physicists have joined in search of a theory called the Theory of Everything (TOE) which will explain all forces within a single framework. This has brought up a dispute about the possibility of such a theory. In this article several arguments against a TOE, such as testability, Godel's theorem, existence problem, possibility of unobserved forces, historical similarity, reductionism, etc. are discussed, and their weak points are shown. A TOE in physics is possible; however, the borders of the "everything" will be determined by the capacity of the human mind.

# 1 Introduction

The universe looks very complex in appearance. However, since very old times, some philosophers and scientists have believed that nature has a simple foundation, and all matter and energy are governed by a small number of basic substances and principles. The ancient Greeks, for example, believed that the universe is composed from air, water, fire, and earth. In some sense Plato's philosophy, which describes our world as the shadow of the "ideal" world was the first system trying to explain the entire universe. In this century many physicists have looked for such a theory, and now there is a good proposal called the M-Theory. In this theory M may stand for miracle, mysterious, myth, magic, membrane or mother.

The dream of a Theory of Everything (TOE) was popularized by Einstein, who devoted the last thirty years of his life to this project, and failed [1]. Nevertheless, his attempt attracted attentions of many physicists to this aim, which can be defined as explaining all forces of nature within a single theory that unifies quantum mechanics (QM) and general relativity (GR) [2].

In nature there are four forces. Gravity and electromagnetism are the most common two. Strong force is the force that binds protons and neutrons inside the atom, whereas the weak force is responsible for radioactive decays. Unlike the previous two forces the last two have a very short range, and this is why we do not notice them in our daily life.

At first thought, it would seem that these forces possess very different features, and the unification of them is a hopeless task. However, in 1967 Weinberg and Salam were able to unify the electromagnetic and the weak force. Combining electroweak theory with quantum chromodynamics, which explains strong interactions, established the Standard Model(SM), which is in very good agreement with current experimental data. Even though SM is a highly successful model, it left some important questions, like the equality of the magnitude of charges of an electron to a proton, unanswered. Also SM has many free parameters which are fixed from experiments and it does not include the gravitational force. All these reasons motivated some physicists to look for a more unified theory.

The most difficult part of the unification scheme is to reconcile GR, which explains gravity, with QM, which is the essence of the SM. In the latter theory, forces are explained as an exchange of particles, whereas in GR, gravitation is a result of space-time deformations caused by matter. Imagine that a heavy object is put on a soft bed. When a marble is shot across the bed, it will follow a curved path since the bed is warped. This is how gravity is explained in GR. The String/M-Theory has succeeded in relating these fundamentally different pictures and caused great excitement among most physicists.

When unification is achieved, this will be the TOE in physics. All physical phenomena will be explained from the same basic principles. This theory will show the origin and the future of the universe, and it will answer the question that was first risen by Schelling: "why is there something rather than nothing ?" [3]. Despite the difficulty of obtaining this theory, a TOE is possible; however, it will be limited due to the human mind.

## **2 Some doubts about a TOE and responses to them**

Not all physicists are convinced about the possibility of a TOE. They claim that this theory is not testable and thus not scientific [4]. The proposals for a TOE suggest that all forces were unified at the beginning of the universe, and later this symmetry was broken down. This implies that to see unification, one needs energy of the magnitude that created the universe, which is unattainable [2]. It is true that one can not reproduce the conditions of the beginning of the universe. However, there are other results of these proposed theories like supersymmetric particles, gravitinos, axions, etc., which can be observed after the construction of more powerful accelerators. Moreover, a perfect TOE should explain the open problems in the Standard Model of particle physics such as differences in particle masses, number of particle generations etc. [5]. These verifications will be enough to trust the TOE. After the completion of TOE, more predictions may be possible.

The second argument is that GR and QM may not be complete explanations of nature. QM, especially, has many conceptual difficulties including the Einstein-Podolsky-Rosen paradox, the measurement problem, etc. [6]. For example in the double slit experiment a single photon seems to be passing from two slits simultaneously. Meanwhile GR allows singular points inside which all physical laws are invalid. On the other hand, until now QM and GR have passed every experimental test with remarkable accuracy, and those conceptual puzzles may be arising from the inadequacy of our logic with regard to atomic events.

Of course, there may also be some unobserved forces which are very weak or which couple to some unobserved particles [7]. In fact, a repulsive gravitational force which is effective in very short distances was claimed; however, this is not supported by experiments. Nevertheless, this is just a speculation, and if an additional force is found, then to tie it up with the current TOE will be the problem for future physicists.

Another objection to a TOE is related to Godel's incompleteness theorem, which states that in any axiomatic system that is broad enough to contain natural numbers, there are some unprovable statements [8]. Critics of the TOE claim that since mathematics is the tool of physics and it is incomplete, then physics can not describe nature adequately. However, Godel's theorem applies only to the systems containing whole natural numbers, and our universe may not be such a system. Besides, Godel's theorem is a limitation of the formalist approach to mathematical problems. Human creativity is, hopefully, beyond this limitation [9].

The String/M-Theory assumes that the universe has 10 or 11 dimensions about which some physicists are suspicious. We are unfortunately incapable of visualizing spatial dimensions beyond three. However, this does not exclude the possibility of extra dimensions which are mathematically conceivable. A pipeline will look like a line when it is observed from far away. Similarly, if the extra dimensions are small enough, they can not be perceived.

At the end of the 19th century some physicists were in the opinion that

physics was close to its end, and this turned out to be completely wrong. Now some physicists believe that this situation is similar to today's position [10]. Although history is in general a good teacher, it is not always a good guide. In this century knowledge of physics has tremendously increased, and a possibility of a TOE is accepted by the majority of physicists, unlike the previous century.

Philosophers have also directed several arguments against a TOE. The first criticism is related to the "existence" of such a theory; there may be no or infinitely many theories of everything [7]. Generally, the hardest questions are the existence questions. One may even reject the existence of an outer world or matter quite reasonably, as Berkeley did. Or one may skeptically argue, as Hume did, the validity of the causality principle which is the heart of all sciences. The only way to answer this type of questions is to continue to investigate without too much bothering about a possible negative answer.

Their second and very reasonable objection is that the human mind may not be clever enough to solve eternal problems of the universe. As Noam Chomsky noted, "A rat can learn to turn left every second fork in a maze, but not at every fork corresponding to a prime number" [11, page 152]. All our perceptions depend on our brains, and whether or not we sense the external reality truly is almost impossible to tell.

Some opponents of the TOE accused this approach as being reductionist. The basic assumption of reductionism is that a complex structure can be explained from its underlying simpler structure. It is like explaining a building from its bricks. This implies that, since everything is made of elementary particles, once a TOE in physics is established all problems of biology, chemistry and all other sciences can be solved. In principle this is possible. However, knowledge of basic laws is not enough to explain everything. One needs to construct a chain of explanations in order to reach a conclusion. In Euclid's geometry there are just five axioms and a few definitions; however, sometimes ingenious connections are necessary to solve a simple-looking problem. Furthermore, all sciences use reductionist approaches. Invention of the periodic table or DNA was resulted from reductionism, and they are extremely helpful [7].

Lastly, some methods of physics have been questioned [12]. If an analogy is made between a clock and an atom, particle physicists smash the clock to understand its working principles. However, they argue, a clock is something more than its constitutes, i.e., it has an organization. This is a fair argument with the exception of one point; for human beings there is no other way than breaking the atom for investigating its structure, and if somebody is smart enough, he or she can figure out the entire system from the observed portions. The success will again depend on our mind's capacity.

### 3 Conclusion

In his controversial book "The End of Science", John Horgan asserts that physics is approaching to its end with the TOE [11]. On the contrary, a new era is beginning. Having a map of a city does not guarantee understanding of that city. After the completion of the TOE, physicists will concentrate on interpretations and relations of this theory with other branches of physics and sciences. Definitions of consciousness and life can also be added to physics.

The TOE is a very ambitious goal and can not be conquered by physicists alone. As Einstein indicated, "What is the use of describing a Beethoven symphony in terms of air-pressure waves?" [11, page 172] All sciences and arts should incorporate physics in order to reach the ultimate answer.

After the examination of the major objections concerning the TOE, it is safe to conclude that a TOE is possible in physics. However, what the "everything" includes will depend on the capacity of human comprehension. Since the mind is also a part of the universe, it is difficult to determine its boundaries. The future will reveal its surprises.

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