On String (or M) Theory and Higher Dimensions

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Abstract

1. Planck's doctrine somehow says that all of physics should be reduced to *h*, G, and *c*. Since this leads to a smallest length, objects like zero-dimensional points, one-dimensional strings and higher dimensional zero-thickness branes are outlawed to describe physical reality.
2. Non-compactified higher dimensions lead to a violation of the first and second law of thermodynamics in the 3+1 dimensions of physics.
3. From a final theory one should be able to derive quantum mechanics, relativity and the three dimensions of space. This cannot be done with string (M) theory.
4. A theory unable to account unambiguously for 96% of the non-baryonic matter in the physical universe (70% negative pressure energy, 26% cold dark matter) in unlikely to be final.

The author was privileged to ask Dirac what he had thought about Heisenberg's nonlinear spinor theory, after Heisenberg with his staff of competent theoreticians had worked for more than fifteen years on this theory, by Heisenberg believed to be the final theory, or world formula. Dirac's answer was very simple. He said: "If the theory is correct it would have become obvious by now." With a much larger number of highly competent theoretical physicists (actually some of them mathematicians) having worked on string theory much longer, or its latest version M-theory, now advertised as the final theory, the same question should be raised. Instead we are told that "string theory is part of twenty-first century physics that fell by chance into the twentieth century."

The theory has come under strong criticism by P. Woit [1], and we quote from his paper:

> The strongest scientific argument in favor of string theory is that it appears to contain a theory of gravity embedded within it. It is not often mentioned that this is not yet a consistent quantum theory of gravity. All that exists at the moment is a divergent series that is conjectured to be an asymptotic perturbation series for some as yet undefined non-perturbative string theory (the terms in the series are conjectured to be finite, unlike the situation in the standard quantization of general relativity). String theorists actually consider the divergence of this series to be a virtue, since otherwise they would have an infinity (one for each compactification of six dimensions) of consistent theories of gravity on their hands, with no principle for choosing from it.

T. Borne, G. Lochak, and H. Stumpf [2] have criticized string theory with the following comments:

> A comparable attempt, for instance, at describing the atoms of the periodic table as the members of a representation of a higher symmetry group and their reactions

> by a corresponding dynamical law for this group may illustrate the dubiousness of this strategy. Not enough with that, the efforts in this direction were even continued by the design of new mathematical "machines," the strings and membranes, in order to streamline and automate the production of elementary fields.

A detailed criticism of the theory has also been made by F.W. Hehl, J.D. McCrea, E.W. Mielke, and Y. Ne'eman [3].

Not much has come out of the theory. It has not given even an approximate value of the typical elementary particle mass in terms of the Planck mass, and the cosmological constant it predicts is wrong by about 55 orders of magnitude. The theory can reproduce the many symmetries actually observed, but because the group of the theory is so large, this should not be taken too seriously. The space of nature is three-dimensional as are all physics laboratories. It is often overlooked that in physical reality there is not even a two (surface)-, one (line)-, or zero (point) – dimensional space, because a surface, line, or point are just abstract elements of Euclidean geometry, void of any physical meaning. Physics is what can (at least in principle) be measured, excluding what is infinite or zero, like the zero diameter of a surface, line, or point. Embedded in three-dimensional space, a surface, a line, or a point is a singularity in three-dimensional space, and as any other singularity excluded from physical reality. And if three-dimensional space is embedded in a higher dimensional space, this implies a singularity in the higher dimensional space, something which cannot be measured. What is true for three-dimensional position space is also true for the four-dimensional space-time embedded in higher dimensions. Form this perspective the third dimension of natural space is the first and last dimension. It should therefore be of no surprise that most recently a large number of physicists (estimated to be ~500) have found no evidence for more than the three dimensions of natural space [4].

Planck's doctrine, that all of physics should be reduced to *h*, G and *c*, sets a smallest length outlawing contact interactions like those in QED, QCD, but also those in string theory. Here, I believe, string theory is inconsistent. True, it assumes the radius of a closed string is about equal to Planck length, but the diameter of the string itself is zero. The same applies to membrane theories with a vanishing thickness of the membrane. In a relativistic theory a smallest length violates microcausality, which is the reason why in QED or QCD one needs contact interactions. The infinities resulting form these contact interactions can there be eliminated with the trick of renormalization, which does not work for quantum gravity. A finite length though, can be introduced in an exactly nonrelativistic theory, where Lorentz invariance can be understood as a dynamic symmetry for large wave lengths, resp. low energies. If, as claimed, a consistent formulation of GRT and quantum mechanics is not possible in three space dimensions, this can only mean two things: Either we must accept that nature really has more than three space dimensions, or that GRT, quantum mechanics or both are "wrong" resp. approximations for energies small compared to the Planck energy. Since the idea of higher dimensions in physics is something so fantastic, it should be taken as a last resort and only if everything else fails.

Most recently it has been proposed that there may be large extra dimensions to manifest themselves by a departure of Newton's $1/r^2$ law for sufficiently small distances [5-10]. With a heat bath (or sink) in the higher dimensions, the first and second law of thermodynamics are

violated. The argument that such a violation would be small with the interaction only going over the gravitational force is unconvincing.

There are two other objections:

1. From the theory one cannot derive relativity and quantum mechanics, as it would be expected form a final theory.
2. The theory cannot tell us what the cosmological quintessence and cold dark matter (making up 96% of the physical universe) really is.

The replacement of the bosonic strong theory in 26 dimensions to describe the strong force (dual resonance model) with QCD in 3+1 dimensions of everyday physics, raises the question if string theory should be replaced by something else as well. The analogies between Yang-Mills theories and vortex dynamics [11] suggest that string theory should perhaps be replaced by some kind of vortex dynamics at the Planck scale [12]. This conjecture is supported by the analogies between GRT and condensed matter physics [13-19], and the recent success by the author to derive the finestructure constant at the Planck scale from such a model [20].

It is argued that even in the absence of any direct experimental verification, the mathematical beauty of string (M) theory is "proof" enough for it to be the ultimate theory describing the physical universe. But the same can be said about number theory which is the most beautiful of all mathematical theories. Sure, we count on a daily basis, but numbers per se do not occur in nature and are an invention by man.

I close with a statement by Planck (Wege zur Physikalischen Erkenntnis, Verlag Hirzelin Leipzig 1944): "But as the more daring and enthusiastic sky-high phantasies are confirmed, the more sober one should remain and never forget that sometimes side by the greatest insight lurks the greatest nonsense." Planck then continues, warning the theoretician (if they do not wish to suffer the fate of Icarus), that all thoughts must be tested, not only by what is mathematically permissible, but also what is experimentally verifiable. According to Planck, string theorists may have erected a grandiose mathematical edifice, but not yet new physics, verified by experiment or observation.

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