Determinism and the Theory of Every Thing

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Abstract

Recently Gerard ’t Hooft proposed a structure for a universe overwhelmed with a control by a Theory of Everything (arXiv:1709.02874). He concludes, among many other things, that such a universe could be fully deterministic and that, accordingly, the divine intervention will be eliminated. Here I discuss such a possibility and show that a fully deterministic universe will turn out to become the divine himself, thus verifying the consistency of Einstein’s belief.

1 Introduction

The present status of theoretical physics, which is something like a stalemate is provoking physicists to speculate about the possibilities of getting out of this dilemma. The incompatibility of quantum mechanics and general relativity on the theoretical level stands as a firewall that cannot be breached, whereas any further major development in black hole physics, particle physics, and cosmology would require solving this enigma. Several proposals are on the table but none seem to work. It was claimed more than three decades ago that we are at the verge of a Theory of Everything which may solve many problems of contemporary physics [1], but the years have shown that we are still far a way from achieving such a goal. The problem seem to be more fundamental than we thought, and as ’t Hooft beautifully remarks ”we are just baboons who have only barely arrived at the scene of science” [2].

The problem of understanding the universe and the role played by the laws of nature in controlling events and in driving the phenomena taking place in this universe goes beyond the task of science at this stage of the development of our mind. Philosophy and religion may provide some help to widen our scope in looking for a solution, however, not many physicist have faith in philosophical methods and very few of them believe that religion can inspire anything at all in science. This attitude may have resulted from the historical experience gained during the last two centuries or so and from the naive personal figure of God offered by religions. Nevertheless one may find that the pioneering generation of the seventeenth century had much more faith-inspired motivations to view the world. In this respect we find Leibniz quoted saying ”the imaginary numbers are a wonderful flight of God’s spirit; they are almost an amphibian between being and not being” [3]. Indeed we may need to extend our vision so as to cover the wider range of

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existence which include the imaginary space and the space-like universes on the same footing as we have considered the multi-dimensional space-time. The point that may cause some disturbance is that our attitude could be the question of the objectivity of such entities, nevertheless it remains a fact that such entities like imaginary numbers, though not measurable, are part of our mathematical description of our world playing an essential role in our world of electromagnetic radiation and quantum tunneling (a purely real quantum state will not tunnel through potentials).

Resolving the present big problems in physics, like quantum gravity, requires a new perspective in our mathematical formulations as well as the physical realization of some basic concepts. We should remind ourselves that we have no consensus as of yet on interpreting the problem of measurement in quantum mechanics. String theory might appear to be promising on the conceptual level, but the formal treatments of the strings through differential calculus by adopting the assumption of spacetime continuum, hinders the breaching into new area and, in most cases, aborts generating new predictions.

2 Setting the Theater

In an article entitled ”Free will in the Theory of Everything” [2] Professor ’t Hooft imagined a scenario of thought by which he placed a being playing the role for running the universe. He identified some basic demands for such a God helping reduce his duties and making it more efficient. However, it is not clear whether such a being himself is going to formulate the laws of Nature or if such laws are to be given by his computer scientists and mathematicians. Beside this, there is no clear distinction between the Laws of Nature and Laws of Physics, an issue which I have discussed in a pervious work [4]. The basic problem in this context is the sustainment of the universe, and the question remains will be whether God is directly intervening in every motion of every particle in the universe or should he do so by delegating secondary agents? ’t Hooft finds that God has chosen to adopt certain laws of Nature that makes his work in sustaining the universe more efficient. The algorithms by which the computers work are some basic demand and a set of rules.

2.1 Limitations

There are several embedded limitations in the proposed model for the universe by ’t Hooft, such as

1. The type of the imposed causality makes this universe time-like, thus may deny the possibility that some space-like events might contribute to the event happening in our time-like universe.

2. It is required that spacetime is continuous and local, a requirement which prevent the possibility of having intrinsically quantized spacetime, beside the fact that non-locality is a natural requirement of quantum mechanics.

3. The universe is superdeterministic, an idea that remains to be absurd no matter how it is defended.

4. The rule of the imposed speed limit leaves no room to deal with space-like patches of the spacetime through which we can explain certain phenomena of our time-like
universe (e.g. magnetic monopoles and the tachyonic behavior of some events). Instead one may require the presence of the principle of invariance, out of which many sub-rules could naturally emerge.

Despite that "it may lead exactly to our universe" as ’t Hooft is suggesting, such limitations will captivate our mind to work within the rules of the present game of knowledge about the universe. This is certainly something which is not expected to lead us to the Theory of Everything.

2.2 Alternatives

Some alternative rules to those suggested by ’t Hooft might be proposed. These might help open the way for a new realization of the world around us and help in formulating better mathematical as well as physical perspective for the world.

1. Causality is an apparent relationship between the variables involved in an event or a series of events. Causality is not a single attribute but a process indicating chronological order as well as a result.

2. Locality may not be a good choice to be a rule, instead we may require the principle of invariance as a good demand by which laws, specifically conservation laws, become the product of the invariance under certain symmetries. This applies to Rule #2 of ’t Hooft concerning the ultimate velocity. It is actually a presentation of the non-locality and the invariance of spacetime under translation.

3. It might be of help to assume that all physical entities in the world, including spacetime, are atomistic and are under continued re-creation process [8]. This may resolve the basic problem of quantum measurement and explain many phenomena like quantum entanglement and the quantum Zeno effect.

4. The universe is indeterministic, as viewed by us, but obeys certain set of rules (laws) which help making it comprehensible and predictable.

3 Indeterminism and the Hidden Variable

The indeterminism of quantum phenomena is a well established experimental fact, however the orthodox interpretation of such a fact is not yet well accepted as many physicists including ’t Hooft himself, are not happy with the Copenhagen interpretation [5]. Among the other alternatives to the Copenhagen wavefunction collapse interpretation comes the suggestion by David Bohm of some sort of hidden variable that may come at the play. Such a hidden variable could present the case of quantum measurement to become deterministic according to Bohm’s scheme [6]. Again very few physicists believe that such an approach would be successful in adding anything to quantum physics beside that many of them where stunned by John Bell’s theorem ruling out the local hidden variable theories [7]. However, in this respect there remains the question whether quantum mechanics is an ensemble theory that is reflecting a statistical nature of the microscopic world or is it suitable for applications to a single particle case. This is the essence of the measurement problem in quantum mechanics.
One approach for understanding quantum states is to notice that it is generally an ever-changing state, a feature which was originally known for the wave-mechanical description, and in fact this is one reason for the success of wave-mechanical description of the quantum states. As such is the state of a particle, one may alternatively suggest that the quantum states are under continued re-creation allowing them to be regenerated anew in each shot. One may further assume that the re-creation rate is proportional to the energy content of the system, perhaps it might be plausible to suggest that the frequency of re-creation may be calculated from the basic form

\[ f = \frac{E}{\hbar}, \]

where \( \hbar \) is Planck’s constant. It is clear then that systems with high energy content will have high rate of re-creation. An electron at rest will have a rate of re-creation of about \( 1.23 \times 10^{20} \, \text{s}^{-1} \). With this assumption of re-creation we can glimpse that there will be some inherent uncertainty in measuring any pair of complementary observables of the system. For example if the position is re-created then an infinitesimal shift in the position is expected, which correspond to the generation of momentum. Then, upon re-creating the momentum an inherent generation of position would take place. If we demand that the system to develop unitarily, that is to say that the state of the system remains the same, up to a phase factor, then

\[ \left( x \frac{\partial}{\partial x} - \frac{\partial}{\partial x} x \right) = 1, \]

using the definition of the momentum operator, \( p = -i\hbar \frac{\partial}{\partial x} \), this would imply that

\[ [x, p] = i\hbar \]

Accordingly, the uncertainty relationship between position and momentum is established. This proposal of re-creation has many implication shown in a previous work [8].

4 Determinism and the Divine Intervention

Does determinism lead to the elimination of the divine intervention? Most people think that divine intervention is needed only upon the creation of the universe, an event after which the creator became redundant. They think that laws of Nature can stand alone and can perform the world’s phenomena taking place without the need for any other agency. This, in fact, is a sort of unsubstantiated assumption normally embodied in our argumentation. In fact we need to prove that laws of Nature can act on their own before using such an assumption. If we agree to define the laws of Nature as being those events happening regularly without specifying any cause or explanation for it, then we would recognize the fact that the laws of nature are the regular phenomena taking place as it happens. But quantum mechanic tells us that such phenomena are generally indeterministic. This means that there should be some kind of an agency playing with the probabilities and so controlling the phenomena. Such an agency cannot be thought of as being part of the world, because in such a case it has to abide by the basic rules of indeterminism again and so will need another agency to drive it. This would be compelling reason to assume that if such an agency would ever exist then it has to be something beyond our physical world.
Once we try to explain any natural phenomena we are devising a Law of Physics. These laws are our own imagination, our own comprehension of the phenomena. The puzzle is that our understanding of the laws of Nature appears to follow certain logical structure we call mathematics, which was shown over the ages to have a strong deductive power. Since then we thought that the laws of physics are not only descriptive of Nature, but also are prescriptive.

By the fact that laws of nature are probabilistic we can confidently suggest that no self-driven system can be achieved. So, if one thinks that a deterministic universe would leave God redundant, he need to cover the incompleteness suggested by Gödel’s theorem, beside the need for a driver to fuel the dead equations. Taking into consideration the suggestions of ’t Hooft we conclude that the deterministic universe will turn to be the divine himself, a conclusion which turns to be in agreement with Einstein’s concept of God; standing for all the order in the universe.

References

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