THE FUNDAMENTAL NATURE OF THE FUNDAMENTAL

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Abstract

The discovery of the nature of the fundamental may be strongly guided by our core mathematical philosophy. And, for platonists say, it can be true that mathematical objects are perfectly real and that they exist independent from us. In the following discussion, with the dichotomy between the two types of realms of naturalism that I discuss, it may be further shown that both of these can be true at the same time, and thus deepening our search for the nature of the fundamental.

1 What is Fundamental!?

Conventionally, we believe that we have quite a well defined idea of what property a fundamental thing should have, which is simply- minimum number of objects/axioms/processes/ ... in order to complete the structure of the physical law. And, we may further question ourselves - Where would the so called fundamental reside- a) in the count b)in the symmetry c) in the representation of the structure itself and so on. However, the notion of the fundamental is also largely biased towards what we want to observe and towards the nature of observables we want to create. At times, it becomes difficult for us to distinguish if any physical theory that predicts something, uses its variables (for example : metric in GR or Wave function in QM) just as an instrument to arrive at the results/predictions and/or if the variables themselves depict the reality. Then, the entire notion of fundamental may change and become largely biased depending on the sole discretion of the thinker. For instance, the results of GR could also be obtained from String theory, Loop Quantum Gravity or Shape dynamics. But, the background assumptions of those theories are so radically different that we can no longer stick to any single idea of fundamental. However, if something as fundamental really exists, and if we have the slightest idea about its nature, then we should be able to relieve ourselves from these relative notions of the fundamental as experienced from the above arguments.

2 The character of the physical law

To start with, I am defining Realm1 and Relam 2 as follows [1] -

Realm 1 -
Governed purely by timeless mathematical laws, and these operate from outside our Universe. However, there is an agreement that such a setting is possible under the general framework of timeless Naturalism.

Realm 2 -
Nothing is outside our Universe, and the laws of the Universe themselves evolve in time; although what is true for now, may only be true for that moment or only for some bounded region of the Universe. The task is to figure out the mechanism by which the laws evolve and thereby striving to predict for the next immediate future. It also comes under the framework of Naturalism but is of a different kind from the first one above.

Now, there may be a dichotomy between the true character of the Physical law as it "is", and the form in which it is "observed". Now, since we have access only to those laws that can be observed, and also, since at times there may not be an obvious connection between those two realms, therefore, one may say that the existence of the former realm may be conditional and subject to the discretion of the thinker. However, if the Universe is indeed governed by the timeless mathematical laws, the possibility of the existence of the first realm may exist. And, these laws may operate from outside of the Universe. Thus, in a way, there will always be a possibility of the co-existence of these two realms.

It is certainly possible that our intuitively envisioned efforts towards the understanding of our Universe are guided by our evolutionary history, thereby, making certain types of observables such as "motion" more peculiar than the rest of the possible ones. Thus, I doubt that, if describing the time evolution of any physical system is the same as understanding the form of

reality in its full breath.

Following the Time contained Naturalism(Realm2), the deductive or an inductive approach may depict the starting point/operation as fundamental, thereby, discovering the intermediate elements(which were already there in our Universe) in the process of deduction or induction. Certainly, this philosophy of the exploration of the nature of reality limits the nature of fundamental as something - least set of axioms/ assumptions/elements which may reproduce the whole structure. However, then each theory would have its own fundamentals, and plaguing the arena with as many fundamentals, as there are robust theories at different scales.

However, under the intuitive apriori belief in the reality of the existence of Realm 1 now, the questions may arise:
1) How can its(Realm 1) existence influence us and how can we know if it exists at all, if all that we can ever know are only the theories which operate on our limited scale of observation inside our Universe?
2) What is the nature of the fundamental in that timeless naturalism?

However, I put forth my case that although, there is a strict dichotomy between the two realms mentioned above, there can be a reconciliation (in the form of projections from Realm 1 to Realm 2) on the common grounds if we bring in/acknowledge the fundamental as something, which facilitates the existence of both the realms.

Before I bring in one major proposition which may help in the reconciliation of the two relams, I would like to pose a question -
What makes it intuitively so hard for us to discover the nature of the fundamental if its really ever present in our Universe? Part of it is understandable given that one of the influential ways we learn is by observing the "change" between the arbitrary things. Thus its not unlikely to find physicists using this simple property of "change" to attack the problem of Time in Quantum Gravity.

3 Observation

Let me depict the process of deduction in my model by establishing relations between the apriori set of elements/nodes which I will use in my model.
Consider a finite set of nodes. A deductive methodology can be constructed out of them. Thus for the Realm 2, the following pictorial depiction can be approached at-

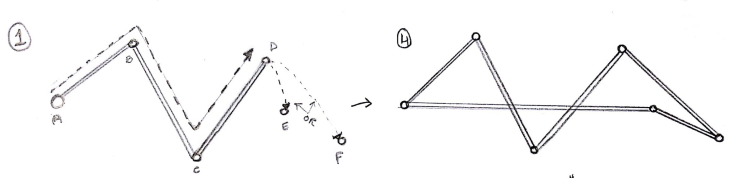

Figure1: Deductive methodology in Realm 2

Explanation-
1) Each link represents a very general operation involved in the process of deduction. So, it is really pertaining to the conventional idea where I start with A(here) and end up deducing E(A-B-C-D-F-E)

2) A "parameter" is invariably included which guides the direction of our conditionality and conclusions.

3) Each node/element of the set are depicted as the following -

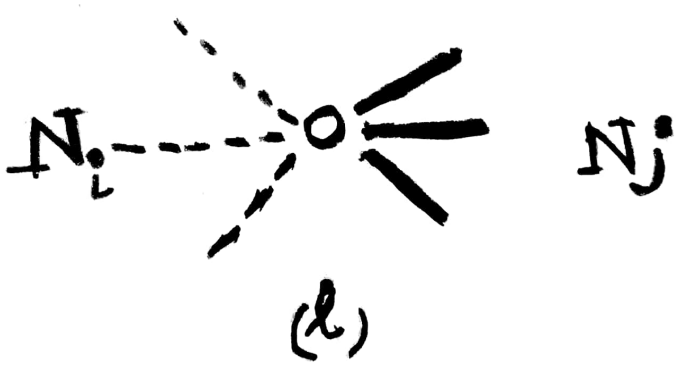

Figure2: A node, an element of a set

1) Each dashed line represents all the possible operations/processes that could result in the given node as a final state

2) Bold lines represent all the possible operations that can be acted upon the respective node to migrate from one node to other node.

Where, a node is termed as non-degenerate if $N_{i \neq} N_j$ and degenerate if $N_i = N_j$.
Since, due to the complexity built up in this progression, it may only be possible to give preferences to some nodes over others (thereby breaking the degeneracy) and so only the node which has $max(N_j - N_i)$, where $N_i < N_j$, can be regarded as fundamental in this Realm2.

Now, the dichotomy between the logical structures we built in fig1,(Realm-2) and in the Realm-1(below), becomes clear in the following depiction-

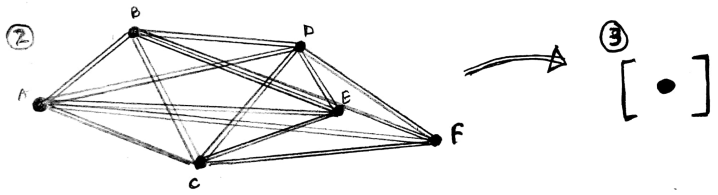

Figure3: Existence of Mathematical Structure in Realm1 in context of the Realm 1

Where,
1) Each node is degenerate, and so, it is certainly possible to start from any node and reach at any node

2) Also, since, whatever we conclude also exists as an element in this realm, one can project it on a single element of the set. And, vice versa, the resolution of any element could be unfolded(not uniquely though) by going from 3 to 2.

3) No such "parameter" exists in this case.

Now, based on the strong hypothesis that there should be a reconciliation and co-existence between these two realms where, we can project our deep apriori intuitions from the realm 1 on the experiential landscape of Realm2 a proposition can be made about adding a single property to the Realm 2 by which the structure 4 can be projected on the structure 3, thereby negating the dichotomy. And, this may help us understand and bring forward what could be the true nature of the fundamental.The property is hereby termed as - Observation.

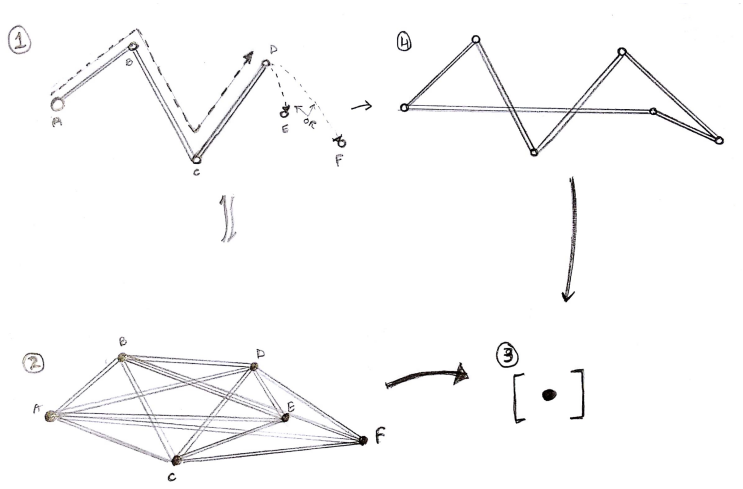

Figure4: Depiction of the projections and consistencies between both the Realms

The possibility of the scale dependent laws of our Universe may loosely attack the dream of deeper unifications in physics. However, it can be commented that irrespective of that fact, we still observe the emergent phenomenon(if we can call them so!) in our day to day lives. So, truly, all those scales do exist, and the question may just be if there can be a deeper unity between them in the form of the physical laws. This is where, I would pitch in the notion of Interaction (classical or quantum) being different from the notion of Observation. Where the interactions on one hand are confined in their own domains/scales, whereas, by the property of observation, we can smear through (may not be in an experiential landscape at times) different scales, thereby, forming relations between them, and constructing the noble observables, which could be tested but may not belong exclusively to any of the scales. This property of observation allows to project completed structure no.4 onto the structure no.3. The mysterious role of consciousness have not been taken into consideration as a part of our observation process.

4 Conclusion

Thus, although it is proposed that observation (which is not a choice of an observer anymore) may be the key for fulfilling the requirement of the co-existence of both the realms, but we may go one level deeper to question ourself, what property could facilitate observation at the first place? That "property" may be rightly be called the fundamental. I would take this opportunity of participating in the FQXI contest to speak and intuitively claim few more things boldly- It could be very well in fact be "Time" (not the - Newtonian one, Proper time in GR). But, it is still trying to pin down more signatures of this "Time" besides the classical ones where conventionally "change" is only seen as the sole signature of time.
I have deliberately avoided to give any specific form to the nature of sets in the models, or even to the nature of operations that I have explained, but that was just an attempt to be able to describe the mathematical philosophy in the most generic formless manner, as when one approaches to explain in the context of some form, it invariably limits the landscape needed to truly illuminate the nature of reality. The model has a scope of further improvement by constructing more mathematically rigorous arguments within the context of the model. The guiding principles of this model can ultimately contribute to the progress of scientific understanding, especially in Quantum Gravity.

References

[1] Lee Smolin *Time Reborn*. 2013