On Time : Trying to Go Beyond Endless Confusions ... Comment on the Paper arXiv:0903.3489

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Dedicated to Marie-Louise Nykamp

Abstract

It is mentioned that in physics, much like in everyday life, we are vitally interested in certain abstract concepts, such as, geometry, number, time, or for that matter, monetary value. And contrary to usual views, we can never ever really know what such abstract concepts are. Instead, all that we may know are specific models of such concepts. This state of affairs has direct relevance upon the long ongoing disputes related to time in physics. In particular, the paper indicates the exaggeration in claims according to which "time as an independent concept has no place in physics".

"History is written with the feet ..."

Ex-Chairman Mao, of the Long March fame ...

Science is not done scientifically, since it is mostly done by non-scientists ...

Anonymous

A "mathematical problem" ?
For sometime by now, American mathematicians have decided to hide their date of birth and not to mention it in their academic CV-s.
Why ?
Amusingly, Hollywood actors and actresses have their birth date easily available on Wikipedia.
Can one, therefore, trust American mathematicians ?
Why are they so blatantly against transparency ?
By the way, Hollywood movies have also for long been hiding the date of their production ...

A bemused non-American mathematician

1. Preliminaries

It is a widespread amusing failure not only among physicists, but also mathematicians not to realize the fundamental difference between *abstract ideas*, and on the other hand, one or another of their *mathematical model* which happens to be chosen upon specific reasons, or rather, upon mere historical circumstance.

From the start it is important to note that such a view need not be instantly and superficially classified as Platonist or Neo-Platonist. Indeed, it is an essential feature of human language, and above all, human thinking, that abstraction is accessible to us. And then, quite

inevitably, the usual immense gap between an abstract idea, and on the other hand, any of it more palpable realizations.

As for mathematics, its two characteristic feature are abstraction and precision. And to a good extent, the same happens with physics. Therefore, it should not come as a surprise to see in the latter manifested often the fundamental difference between abstract ideas, and on the other hand, one or another of their mathematical model.

Regarding mathematicians, we are by now in the fortunate situation to be aware of the following, [3] :

- We do not - and can never ever - know what *geometry* is !
- And instead, all we may know are various mathematical models of it.

Indeed, for about two centuries by now, ever since Lobachevski and Bolyai, we know about non-Euclidean geometries. Not much later, Riemann introduced us to manifolds. And clearly, general relativity could not have been possible to set up without such a fundamental realization that geometry is an abstract idea which has any number of specific instances given by mathematical models.
And to highlight the depth of the difficulties involved is the realization of that fundamental difference one can recall that - a mere few decades before the mentioned discovery of Lobachevski and Bolyai - a philosopher of the greatness of Kant saw the abstract idea of geometry as being reduced to, and perfectly identical with, one single mathematical model, namely, that of Euclidean geometry. And as if to aggravate the error in such a view, Kant considered Euclidean geometry as an a priori concept.

Well, as it happens, nowadays even physicists can do better than Kant. And in fact, related to quantum gravity, there is a clear awareness that foundational theories in physics can be seen as falling in two significantly diffferent categories, namely, *background dependent*, and on the other hand, *background independent*. Classical physics and special relativity, as much as string theory are of the former kind, while general relativity is of the latter. And there is a strong suggestion that

quantum gravity should be set up rather as a background independent theory, this being the basis of one of the more relevant criticisms of string theory.

Regardless of the above, however, among physicists there seems not to be an appropriate awareness of the above kind of fundamental difference between abstract ideas, and on the other hand, what happens to be their various specific mathematical model, or merely, conventional or simply tacit interpretation.
And the respective utter lack of awareness happens to include such basic concepts as :

- number
- geometric straight line
- time

2. On Barbour's Fight with Time ...

Here we shall present a few comments on the paper [2]. Similar comments regarding the concepts of geometry, number and the geometric straight line were presented in [3].

The stated aim of [2] is to "persuade you that time as an independent concept has no place in physics", as seen in its introduction.

What happens, however, in the rest of [2] is the listing of a series of events in history which led to several successive operational definitions of time, such as that of Ptolemy in his Almagest, around 150 CE, and ending with the defintion by Clemence of "ephemeris time", adopted in 1952, to be replaced in 1979 by the presently used "atomic time". Then [2] ends with an example of "timeless time" given by the Principle of Least Action in Jacobi's formulation.

And what is that which is quite amusingly missed in all that argumentation claiming to prove that, well, "time as an independent concept

has no place in physics" ?

Let us start with a simple and most widely known and used analog, namely, that of the concept of *monetary value*.

Much of present day monetary value is expressed around the globe in US Dollars, or in short, US$.

Well now, do we really know, can we really ever know what the *value of the US$* is ?

Or much rather, when asking that questions, we are in a similar situation with never ever being able to know what space, number, the geometric straight line, or for that matter, time is ?

Until August 1971, while the Bretton Woods agreement had been valid, the value of the US$ had been fixed to gold at the ratio of 36 US$ per ounce. That had of course been a definition of the value of the US$ in terms of gold, an operational procedure commonly called the gold standard.
Ever since, the value of the US$ is allowed to float with respect to other currencies, and of course, with respect to gold or whichever other commodity as well.

So that, what is the *value of the US$* ?

Or does that floating means that the US$ does not have a monetary value ?
But perhaps, one should decide that the US$, and for that matter, all other currencies ... have no place in ... economics ... ?!?
Certainly, it is most likely that our ancestors had for long ages lived without any currency and practiced barter when exchanging what we call nowadays goods and services ...

And it seems very much that we are facing the same situation with time, namely, we can keep asking what is *time*... ?

Well, as [2] recalls quite clearly some of the major moments in his-

tory when time was defined or redefined operationally, that is, by its relation to certain specific natural phenomena, we can note the same overall process as with the value of the US$, namely :

- above all, we hold very much to the idea that the abstract idea of time, just like that of the value of the US$ is most meaningful and vitally necessary in our everyday life,
- therefore, we do our best to model it, express it, and thus quantify it in certain specific terms which are not at all abstract, and on the contrary, are easily accessible practically,
- and we would never dream of deciding that time, or for that matter, the value of the US$, "has no place in physics", respectively, in our everyday lives ...

3. A Less Unfriendly Look at Time ...

Certainly, there are important problems with time in physics. For instance, already in special relativity, one can see the Minkowski space-time as an amalgamation of space and time in which space can turn into time and the other way round, a view advocated by Minkowski himself. Further, one can see space-time as given at once in its entirety, a view called often the block universe.

As for general relativity, the various space-time manifolds which are solutions of the Einstein equation happen to come with their own times, this being one of the consequences of the background independence of that theory.

In [1], for instance, time is seen as a mere collection of instant three dimensional frames, and not much detail is given about the ways, reasons, and so on, of the hard to dismiss fact that at least locally in space, those frames happen to string themselves up along a one dimensional chain ...
A most simple and obvious fact which appears to indicate that there is more to space-time than a mere collection of instant frames which

happen to constitute themselves into a chain is our awareness of musical harmony. Indeed, certain successions of musical sounds appear to us as being harmonious, while by far most of the other successions do not, and instead, rather sound like abstract, atonal music.

However, what should make those advocating the expulsion of time from physics stop for a moment and think again is the following : stating that "time has no place in physics" does itself take some ... time ...
And on top of it, arguing in favour of such a venture, as done in [2], let alone in [1], takes even more time ...
Not to mention that the details of the respective argument encompass what in the terms of the rest of us mortals - those who happen not to advocate the excommunication of time from physics - amounts to more than two millennia, that is, to quite a long time ...

Certainly, given the existence of background independent theories in physics, instead of simply trying to eliminate time, or for that matter, space, from physics, one should rather study the extent time or space may be avoided in certain aspects of various theories.
In this regard, the ending argument in [2] is edifying with respect to the Principle of Least Action. However, the way the respective trajectories are given recalls to a certain extent a block universe view, and as such, has on occasion elicited objections about the seeming assumption of what may amount to an ability of the moving material particle to foresee into the future ...

In conclusion, given the relevance of special and general relativity, one should not so much focus on time alone, and leave space, even if by default, as above discussion.
Furthermore, given the relevance of background independent theories in physics, one could, so to say, place oneself beyond both space and time, and start seeing physics from such a situation ...

Time, as experienced in everyday human life, thus more or less in classical physics, is no doubt rather strange when compared with space, for instance.
Yet singling it out and then trying to subject it to an expulsion form

physics may be more than warranted ...

References

[1] Barbour J : The End of Time. Oxford Univ. Press, 2000

[2] Barbour J : The nature of time. arXiv:0903.3489

[3] Rosinger E E : Microscopes and Telescopes for Theoretical Physics : How Rich Locally and Large Globally is the Geometric Straight Line ?