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Physicists Calculate But Do Not Explain 5/7

The atrocities of physics' ordinary language.

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Abstract.-This article introduces the problems of contemporary physics with its mathematical and ordinary languages. It discusses the translation of mathematical equations into ordinary language, the necessity of primitive concepts, and the problems with infinities and dense order, as well as on the possible primitive nature and / or meaning of some basic concepts of physics: space, time, nothingness, vacuum, order, organization, entropy, information, mass and energy.

Keywords: formal language, ordinary language, primitive concepts, actual and potential infinity, dense order, mathematical language, ordinary language, primitive concepts, space, time, nothingness, vacuum, order, organization, entropy, information, mass, energy.

1. Science and language

The diversity of natural objects forced biology, geology, and chemistry to reach international agreements on the names of each of these objects. Bringing order to the nomenclature of these millions of natural objects was a necessary step for the international development of these experimental sciences. Physics does not have such a diversity of objects, it does not have this problem. But it has other problems, also related to language. And in my opinion they are just as serious, if not more so, than in the case of the sciences mentioned above, because here the words involved correspond to fundamental concepts for the formal development of physics. In T. Maudlin words [16, p. xiv]:

> Unfortunately, physics has become infected with very low standards of clarity and precision on foundational questions, and physicists have become accustomed (and even encouraged) to just "shut up and calculate," to consciously refrain from asking for a clear understanding of the ontological import of their theories.

I will give you an example taken from a good physics book written by a well-known physicist (it would be unfair to give the corresponding bibliographical details, because all the texts I know contain the type of error I am going to comment on, and the reader can find them in his own library):

> For undoubtedly "nothing" is just as material and physical as "something", especially if it is to be defined as the absence of something.

Which could be paraphrased:

> For undoubtedly the "dead" is just as alive and biological as the "living", especially if it is to be defined as the absence of life.

This ambiguous, even contradictory, use of words remains what it is: a violation of the First Law of logic: *a thing is what it is, and it is not what it is not.* Or in abstract terms:

$$p \implies p \tag{1}$$

where p is any sentence. So not only is it necessary to give a universal name to every natural object, but it is also necessary to reach international agreements (science is unique) on the meaning and use of the concepts necessary for the development of scientific theories. In addition to the confusing and imprecise use of certain concepts, physics has other problems with language:

1. The contradictory use of its ordinary language in relation to its mathematical language.

2. Ignoring the need for primitive concepts.
3. To define clearly and universally the most important non-primitive concepts.
4. To solve the problems posed by the relationships between its mathematical language and its ordinary language.

I have already dealt with the contradictory use of language in relation to the mathematical formalism assumed by physics in another article [14]. These contradictions, as I said there, are almost always related to the concepts of infinity and dense order: it is very common for physicists to speak (in ordinary language) of adjacent points, contiguous points, successive instants, etc., which is incompatible with the dense order that characterizes real and rational numbers. This article deal with the rest of the points just made.

2. Mathematical language and ordinary language

Mathematical language is still a human language, although much more compact and often more precise than ordinary language. Any mathematical expression is constructed with certain symbols, including symbols of elements (variables or constants) and symbols of mathematical relations between the elements. But each of these symbols had to be defined before in terms of ordinary language, and it is necessary to keep this definition in mind in order to know what this mathematical expression says. Therefore, each of these mathematical expressions can be translated into ordinary language. Otherwise, physical theories would be meaningless.

3. Primitive concepts are inevitable

As is known, the potentially infinite regress of arguments was introduced by Aristotle [1, I.3] and is the reason why all sciences need a basis of statements that are accepted (as true) without proof, they are the axioms and the fundamental laws and principles that are at the basis of all sciences. Aristotle's reflection naturally extends to definitions and causes. In the case of definitions, he explains the necessity of primitive concepts: undefined terms that must necessarily be used in both ordinary and formal language. One measure of the degree of immaturity of contemporary science is that none of the contemporary sciences has established what its inevitable primitive concepts might be.

If we take as a fundamental principle of science the directional evolution of the universe (its evolution towards states of increasing entropy), it is possible to prove two very significant results, the first of which establishes the formal consistency of the universe; the second (derived from the first) establishes that propositions do not prove themselves, concepts do not define themselves, and physical objects and processes are not the cause of themselves. I have the impression that contemporary scientists do not pay due attention to this important limitation of human knowledge that results from the potentially infinite regress of propositions, concepts, and causes. And as a consequence, the high level of linguistic corruption that is generated allows the permanence of erroneous theories, errors that would be immediately revealed by the correct use of ordinary language. This is the thesis this article defends, and that justifies its publication and distribution, even if the latter is highly improbable.

4. The infinities and the dense order

Since the beginning of the last century, the only infinity in mathematics, and therefore in physics, is the actual infinity; the potential infinity is not even considered. In addition, it is possible to prove that the infinity subsumed in the Axiom of Infinity can only be the actual infinity [15]. The problem is that it can also be demonstrated that the actual infinity is inconsistent [15, 13]. On the other hand, and in their ordinary language, when physicists talk about infinity they almost always seem to be talking about the potential infinity. I think that if physicists were forced to be consistent with what they say in both formal and ordinary language when they use the concept of infinity, they might find that the infinitist foundations of their mathematics are not the most appropriate. Hence the importance of making the use of ordinary language consistent with the mathematical language.

Even worse is the situation with the dense order of points and instants of the spacetime continuum. In the ordinary language of the primary and secondary literature of physics, points and instants always appear as if they were adjacent, contiguous, successive, one to one, one

after the other, and so on. None of this, of course, is possible because they are densely order. The inevitable consequence is that, for example, in a Planck volume ($4.2217 \times 10^{-96}\ mm^3$) there are as many virtual particles as in the whole three-dimensional universe (dimension problem proved by G. Cantor [3, 8, 19, 21, 9, 7, 5, 6]). This should be unacceptable to any physicist, and yet it is not. And this is not due to the lack of a formal critique of the infinitist mathematical language of contemporary physics. An unacceptable situation.

5. Mathematical definitions

The reader may find in his own library errors such as the following one[1]:

> Energy, as physicists know it, is a theoretical discovery and, contrary to what some school textbooks say, it is not a primary concept like distance, velocity or mass. As we shall see [...] its only definition is in mathematical terms.

A brief reflection on the quoted text is sufficient to understand the importance of putting some order and semantic coherence in the languages (ordinary and mathematical) of physics (and of all sciences). Indeed, a mathematical definition is a chain of symbols in which each symbol, at the end, has to be defined in terms of the ordinary language. Otherwise the definition would only be an arbitrary string of symbols devoid of meaning.

For an elementary reason of logical hygiene, the defined concept must never appear in its definition. And the same is true for each of the concepts included in the definition when, in turn, they are defined. Naturally this leads to an indefinite regress of definitions which, taking into account the finiteness of the vocabulary of all human languages, can only end up in one or more undefined primitive concepts. It is then essential that each science establishes which are its primitive concepts and how the rest of the concepts of that science are defined according to its primitive concepts. This is not currently the case in any of our contemporary sciences.

6. Space and time

In contemporary physics there is still a clear division of opinion on the ontological nature of space and time. For the majority they remain useful fictions. But the empirical detection of gravitational waves will change the ontological status of space, which as of 2015 should have been considered a real physical object, because what does not exist cannot really vibrate, nor can it really be the transmitting medium of its vibrations, nor can it really modify the state of the real instruments that interact with those vibrations. According to this physical reality, space could be defined as follows (just a suggestion):

> Space is a physical object, with physical properties that are empirically detectable and measurable, and whose substance is different from ordinary matter, which it contains and to which it is transparent and sensitive to its presence

Time does not seem to be a real physical object but a magnitude that measures the most basic property of all physical objects, which is why it could be a primitive concept. Although it could be defined in operational terms. For example: a magnitude that measures the ability of objects to persist in a certain state. At this point I cannot resist the temptation to quote Newton [18, p. 77]:

> I do not define time, space, place and motion, as being well known to all.

7. Nothingness and something

The concept of "*Nothingness*" could also be a primitive concept of which only operative pseudo-definitions could be given: *nothingness* is that which does not exist; that which has no properties; that which has no capabilities; that which is not part of the universe.... Obviously, the reference THAT WHICH betrays the pseudo-definitional character of such operational definitions. In any case, the conditions for the concept of "*nothingness*" could be established. Thus, for

[1] I do not give the bibliographic reference of the quotation when the quotation contain errors that also appear in other texts

example, popular statements as "*the universe arose from a quantum fluctuation of nothingness*" should not be allowed, because in such a case nothingness would not be nothingness but something with the ability to fluctuate universes in a quantum way.

8. Order and organization

Order and organization are two different properties that can be applied to physical objects and groups of physical objects. There is a rather widespread tendency in the scientific literature (not only physics) to consider that both properties are the same property, and the corresponding terms synonymous words, which is surely a serious mistake [17, p. 226]:

> In my opinion, the audacious attempt to reveal the formal equivalence of the ideas of biological organization and thermodynamic order. . . must be judged to have failed.

Order should be associated with the existence of periodic regularities, both spatial and temporal. Organization should be related to teleonomy, that is, to the existence of aims and purposes. Consequently, and a couple of years ago, I proposed the following definition [11, p. 28]:

> An object is said organized if its constituent parts are arranged and mutually related in order to achieve a goal or purpose.

With respect to the word “order” we have at least three scientific acceptations or meanings. The first is rather obsolete and refer to the Aristotelian natural order: each thing in the universe would have a natural place to occupy in accord with their gravity or levity and in accord with the existence of a center of the universe (according to Aristotle, the center of the universe would coincide with the center of the Earth) towards which the heavier bodies move and from which the lighter ones move away [2]. The second is the thermodynamic order, a measure of the number of microstates compatible with a given macrostate: the less the number of microstates the greater the thermodynamical order. The third meaning refers to the existence of periodic (spacial or temporal) regularities, as in the case of the internal structure of a crystalline solid: periodic spatial distribution of its elementary components: ions, atoms or molecules .

9. Entropy and information

The word “entropy” is one of the most polysemantic and confusing words in scientific literature. For this reason J. von Neumann advised its use to C. Shannon [20, p. 180]:

> No one knows what entropy really is, so in a debate you will always have the advantage.

Indeed, entropy has been proposed to define [4, p. 17]: disorder, unmixing, disorganization, confusion, chaos, probability, uncertainty, ignorance, missing information, negative information, inability to do work... And if that were not enough, I myself devoted a book to interpreting the entropy of an object as its degree of isotropy (defined in mathematical terms very similar to Boltzmann’s entropy [11]). The concept of information is not far from the concept of entropy in terms of confusion and semantic values. But here it is worth considering an aspect of information that is never considered, and that aspect is the ability of informed objects (such as living things) to produce arbitrary changes, changes compatible with physical laws but not deducible from physical laws [10, 11].

10. Mass and energy

Whatever mass is, and we don’t know what it is, it is one of the most universal, profound, and basic concepts in physics. It might even be that it is a universal property of all physical objects, although I know this sounds anathema. However, consider the following facts: All objects (even photons) are preinertial, i.e. they all inherit the velocity vector of the reference frame in which they are set in motion [12, p. 399-428]. And since mass is the property responsible for the inertia and gravitational functionalities of physical objects with mass, it is worth asking whether that same mass is also responsible for the preinertia of all physical objects. The problem is that photons are preinertial [12, p. 375-394], but they are considered as having no mass. Photons have only spin (+1).

It is time to consider the existence of extremely small masses compared, for example, with Planck mass, or with the mass of an electron. This is the case of what could be called quantum mass, defined in terms of universal physical constants. [12, p. 235]:

$$m_q = \sqrt{\frac{G\hbar^3 R_\infty^4}{c^5}} = t_p \hbar R_\infty^2 = 6.845023 \times 10^{-64} Kg$$

where t_p is the Planck time and R_∞ is the universal Rydberg constant, which is specific to each chemical element and varies slightly with its mass. Mass could also be the universal physical quality of all physical objects responsible for their universal preinertia.

Finally, and as is known, energy is directly related to mass, so either they are both primitive qualities, or they are not. Energy offers a new perspective of analysis: the energy of an object as its ability to produce changes in other objects. All kinds of changes. In this sense of physical changes, mass would be more restrictive than energy if, as it seems, it can only produce mechanical changes.

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