Fundamental Theorems of Physics

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Abstract
We show that the time must be quantized in a classical world, and therefore all other physics parameters must also be. We propose to build a classical physics theory that uses only theorems, but no postulate. The foundation are build on five elementary theorems, that lead trivially and straight forward to the description of the Planck's constant, the Planck-Einstein relationship, and the speed of light as the maximum speed, although we remain on a classical point of view.

Introduction

One of the most problematic aspect of the physics theories is the use of postulates instead of theorems. A postulate is a weak point, because it can not be proven, so there will always be a doubt about its validity. At the contrary a theorem can be proven, and then used with no doubt. It appears then interesting to revisit the classical physics by building it only from theorems, and trying to exclude the postulates as much as possible. This is the purpose of this work.

Of course all the postulates can not be excluded. The most fundamental one of physics for instance, that we can write as so : *The real and physical part of the universe can be described by the mean of mathematics.* May be this assumption is wrong, may be we also need love, faith, or whatever. May be yes, but at the present time, as far as we can see, this assumption is reasonable, and enables to build the physics.

We will propose two basic postulates, and five elementary theorems, as the basement of the physics. Each theorem has a statement, a proof, and consequences.

The first theorem that we propose is the one of time quantization, because it appeared the most fundamental. If the time must be quantized, all other parameters of the physics must also be quantized. This is what we show with the theorems 2 to 5.

This very simple approach forecasts the existence of a minimum of action, that should be the Planck's constant, the Planck-Einstein relation, and a maximum possible speed in the universe, that should be the speed of light.

The postulates

Postulate 1 : Foundations of physics

Statement
The real and physical part of the universe can be described by the mean of mathematics.

Explanation
Looking at the geometric equations that drives the motions of planets, for instance, it comes smartly to the mind that nature works with the mathematics. From the ancient ages the humans have made the same finding, nearly everywhere in nature.

At the contrary there are things that does not follow any mathematical scheme, as far as we understand, as the religion, the art, the love, … These issues are then not considered as "real and physical" by the physicist, and it is not his matter of concern.

A "real and physical" system is a one that can be measured by any "real and physical" mean. Consequently, a system that can not be measured by a "real and physical" mean, is not a system that enters into the field of physics. It could get into mathematics, faith, love, science fiction, … but not into physics.

Take care, although the physics require some parts of the global mathematics, both can not be confused. A very large part of the mathematics uses objects that have no reality because they are only virtual concepts. By the way, all the game in physics is to understand why physical nature chooses only a particular part of the mathematics, rather than an other one. Among the infinite virtual possibilities that mathematics offers, nature chooses only one of them.

The mathematical function that is able to embed all the physical properties of a physical system is called Lagrange's function, or Lagrangian. We do not know yet its mathematical structure, but the present postulate assumes that it exists.

Postulate 2 : Universality of physics

Statement
The laws of physics are the same in all frames of reference in the universe.

Explanation
As far as we can measure, even from the most remote galaxies, nature seems to follow the same laws everywhere. This assumption is therefore reasonable, but can not be strictly proven nowadays at all scales and everywhere, so it has to be set up as a reasonable postulate.

The theorems

Theorem 1 : Time quantization

Statement

The time is quantized in all frames of reference.

Proof

A physical system, in any frame of reference, can only be measured either at rest, either in motion, but never simultaneously at rest and in motion. Calling t_0 the last time at which the system is still at rest, and t_1 the first time at which the system is in motion, we must have $t_0 \neq t_1$, and no physical reality can exist inside the interval $\Delta t_0 = t_1 - t_0$, that must possess a universal non null minimum.

Consequences

We call Δt_0 "quantum of time", it is the universal non null minimum of time interval. Obviously all interval of time Δt can only be a multiple of the quantum of time :

$$\Delta t = n \Delta t_0 \qquad (1)$$

where n is a non null positive integer.

Theorem 2 : Least existence

Statement

To exist physically in any frame of reference a system must have at least one non null physical property that can be measured.

Proof

A system having no physical property has no position, no speed, no mass, no charge, nothing at all. No physical measure could then detect any physical reality for such a system. At a physical point of view it does not exist.

Consequences

The lagrangian is the mathematical function that describe the physical properties of a system, therefore a system exists physically if its lagrangian is not null. It must then exist a minimal lagrangian of existence, which must be a least possible non null constant. We note L_0 this minimum lagrangian of existence and call it "quantum of Lagrange". It must be identical in all frames of reference.

Theorem 3 : Least action

Statement

To exist physically in any frame of reference a system must exhibit at least the minimum possible action.

Proof

The action S is the integral of the lagrangian with respect to time. This definition applies to a physical system, having the minimal property L_0 during the elementary time interval Δt_0 , as follows : $\Delta S_0 = L_0 \Delta t_0$. If the action of the system is null, either L_0 or Δt_0 must be null, i.e. the system can not exist, because of the theorems of time quantization and least existence. Therefore ΔS_0 must be a universal non null constant.

Consequences

We call ΔS_0 "quantum of action". In all frame of reference it shall exist a non null universal minimum of action ΔS_0 . The Planck's constant[1] h has all the characteristics to be this minimum, we may then write $\Delta S_0 = h$.
Note also that L_0 having the dimension of an energy, we shall verify the Planck-Einstein relation[2] :

$$L_0 = \Delta S_0 / \Delta t_0 = h \nu_0 \qquad (2)$$

Theorem 4 : Space quantization

Statement

To exist physically in any frame of reference a system shall exhibit at least an elementary space interval.

Proof

The action ΔS_0 has the dimension of a lagrangian multiplied by a time interval, but it has also the dimension of a momentum multiplied by a space interval :

$$\Delta S_0 = \mathbf{P_0} . \Delta \mathbf{r_0} \qquad (3)$$

where $\mathbf{P_0}$ is the vector momentum and $\Delta \mathbf{r_0}$ is the vector space interval. Both $\mathbf{P_0}$ and $\Delta \mathbf{r_0}$ must be universal non null minimum constants.
As far as ΔS_0 can not be null, neither $\mathbf{P_0}$, nor $\Delta \mathbf{r_0}$ can be null, otherwise the action would be null and the system could not exist, as stated by the theorem of least action.

Consequences

We call $\Delta r_0 = \|\Delta \mathbf{r_0}\|$ "quantum of space", it is the universal non null minimum of space interval. Obviously all interval of space $\Delta\mathbf{r}$ can only be a multiple of the quantum of space Δr_0 multiplied by a unit vector **u** indicating its direction :

$$\Delta\mathbf{r}=\Delta r_0\sum_1^n \mathbf{u_i} \qquad (4)$$

Note that the quantum of space Δr_0 can not be null, but $\Delta\mathbf{r}$ can be, by adding at least two quanta of space with opposite directions.

We call $P_0=\|\mathbf{P_0}\|$ "quantum of momentum".

Theorem 5 : Universal maximum speed

Statement

There exists a maximum possible speed in the universe, identical in all frames of reference.

Proof

The theorems of time quantization and space quantization state that any system will exhibit at least a space and a time quantum, otherwise the system would not exist. In all frames of references it must then exist the same elementary speed $v_0=\Delta r_0/\Delta t_0$.

Consequences

We call v_0 "elementary speed". All velocities in all frames of reference can be written as follow :

$$\mathbf{v}=\frac{\Delta\mathbf{r}}{\Delta\mathbf{t}}=v_0\frac{1}{n}\sum_1^n \mathbf{u_i} \qquad (5)$$

where $\mathbf{u_i}$ are unit directional vectors.

Note in this formula that for each quantum of time, it must correspond a non null quantum of space, otherwise the system would not exist in this interval of time.

We see trivially from the relation (5) that no speed can be superior to the elementary speed : $v\leq v_0$.

The speed of light c has all the characteristics to be the elementary speed : $v_0=c$.

Obviously it will also exist an "elementary acceleration" defined as $a_0=\Delta r_0/\Delta t_0^2=v_0/\Delta t$, in m/s^2 an "elementary kinematic moment" defined as $M_0=v_0\Delta r_0$, in m^2/s and an "elementary keplerian constant" defined as $k_0=\Delta r_0^3/\Delta t_0^2$, in m^3/s^2.

Note that we must verify the following relationship : $a_0 = k_0 / \Delta r_0^2$, which is consistent with the expression of the acceleration for a system in a Newtonian field.

As we know the value of the quantum of action, and the value of the maximum speed, we can calculate the quanta of space and time :

$$\Delta r_0 = h/c = 2.208\,10^{-42}\,\mathrm{m} \quad \text{and} \quad \Delta t_0 = c/\Delta r_0 = 7.362\,10^{-51}\,\mathrm{s} \qquad (6)$$

Conclusion

We demonstrated the quantization of time, and the subsequent quantization of the physical parameters (lagrangian, action, space, momentum, ...), only by the mean of very simple and obvious theorems. Doing so we were able to turn the postulates of the Planck's constant, the Planck-Einstein relation and the maximum speed limit, into laws based on proven theorems.

This approach of the classical physics reveals a quantized world in excellent agreement with the experiment. The reproach was made to the classical mechanics to be unable to forecast the quantum structure of the world, but we see here that it is the complete contrary. Fundamentally the classical physics must be quantized. Of course at a human classical scale the quantum of time is so short ($7.362\,10^{-51}\,\mathrm{s}$) that is might appear invisible, but this shall not be the case if we study a more microscopic scale.

Because this approach of the classical physics, by the mean of theorems, is so fruitful, we will use it in further works. We hope that banning the most possible postulates of the theory can only produce a stronger and more efficient physical description of the world.

References

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[2] A. Einstein, *Über einen die Erzeugung und Verwandlung des Lichtes betreffenden heuristischen Gesichtspunkt*, Annalen der Physik (ser. 4), 17, 132–148, 1905.

[3] – A. Einstein, *Über einen die Erzeugung und Verwandlung des Lichtes betreffenden heuristischen Gesichtspunkt*, An. Phys., [17], no 6, 1905, p. 132–148