The physical nature of the basic concepts of physics

Introduction: The need for a natural elucidating physics (i)

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Abstract

The scientific method is based on experiments and on the mathematical processing of the obtained data in the form of mathematical equations. The fact that this method allows us to predict the outcome of experiments with mathematical accuracy, gives us the feeling that we completely grasp the physical processes.
In this introduction to his papers on the physical nature of the basic concepts of physics such as length, time, velocity, mass, linear momentum, energy, etc., the author demonstrates that this self-confidence is based on a circular reasoning: the experimental data agree with our mathematical equations, because the mathematical equations are quantitative expressions of the experimental data. In that way, the mathematical formulation is not necessarily a description of the physical process, but any description that fits in with the mathematical equation.
It is clear that in that way the 'laws' of physics, which consist of the mathematical equations expressed in spoken words, will rather give us a logical insight in the mathematical equations than in the underlying physical mechanism.

This quantitative approach has thereby led to the use of an impenetrable, trivial terminology, with weird concepts, such as 'force field', 'energy field', 'curved space-time', 'dark matter', 'dark energy', 'creation' and 'annihilation' of particles, 'multiverses', etc. .
To come to a real understanding of the physical processes, the author proposes the approach of a natural elucidating physics' that allows him to define the physical nature of the basic concepts.

1. The success of the scientific method

The present theory of Physics has been gradually established over the last 400 years on the basis of the "scientific method". This method is based on four distinct steps:

1 The meticulous observations, tests and measurements of the parameters of reproducible physical phenomena.
2 The mathematical processing of the obtained data into a numerical a relationship in the form of a 'mathematical equation'.
3 The expression of the most important mathematical equations in spoken words,

(i) Updated edition of my paper "The purpose of physics" of April 1992.

which are given the status of 'physical laws'.
4 The permanent verification of these physical laws on all measurable data, as a continuous verification of their reliability.

The success of the scientific method lies in the fact that this approach has led to a limited number of relatively simple physical laws, such as the law of the conservation of energy, Newton's law of universal gravitation, Planck's energy equation, Einstein's theories of Special and General Relativity, etc., which make it possible to predict the outcome of nearly all reproducible physical phenomena and which has led to the incredible achievements of the present technology and the material wealth of modern society.

2. The pitfalls of the present scientific method

The scientific method, although very successful in its practical applications, carries in itself however a number of hidden pitfalls that imperceptibly leads to a distorted image of the physical world.

On the one hand the scientific method is based on tests and measurements.

- The first consequence of this approach is that the only meaningful way to define a quantity is to describe how to measure it. This view was first expressed by Lord Kelvin (William Thomson: June 26, 1824 – December 17, 1907), who wrote: "*I often say that when you can measure what you are speaking about and express it in numbers, you know something about it; but when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely advanced to the state of science, whatever the matter that may be*". Lord Kelvin's principle was largely utilized by Einstein and Niels Bohr who wrote that [1] "*the purpose of science is not to describe nature but to give us rules for manipulating it, and that those who are disappointed about this and think that the purpose of science is to describe how things really are, have the wrong idea of what science is for*".
  According to the renowned physicist Lee Smolin, this approach of science means that "*the only meaningful way to define a quantity, like e.g. 'time' is to stipulate how to measure it. .. When you're approaching science operationally, you ask not about what is real, but about what an observer can observe*" and he cites quantum mechanics as "*the typical example of operationalism because it gives no picture of what is going on in an individual experiment*".
- The second consequence is that the test and measurement procedures must be written down in detail, so that anyone at any place and at any time, must be able to reproduce your tests and verify your measurements. The consequence of this is that the scientific method is necessarily limited to reproducible phenomena. There hare however interference and resonance phenomena that depend on a great number of coincident interactions and that are therefore difficult, if not impossible, to reproduce.

This approach has however the tremendous advantage that the obtained results are directly applicable for the establishment of mathematical relationships between the measured values. This approach has however a strong self-fulfilling power by the fact that the method to study a given phenomenon will be chosen in function of its perceived appearance, so that there is direct feedback between our perception (with or without the use of measuring devices) of a physical phenomenon and the approach of our research, so that this procedure will inevitably confirm our subjective view. This is largely illustrated by the present division of physics in areas that correspond wonderfully to our sensory perceptions, such as velocity, force, work, heat, electricity, vibrations, acoustics, optics, radiation, gravitation, etc.

On the other hand, the scientific method is based on the mathematical processing of the observed physical data.

The success of mathematical processing of obtained data is based on the fact that the underlying logic of mathematics is based on the first law of thermodynamics, which states that (in closed systems) nothing is lost and nothing is created. The success of this mathematical physics has been so overwhelming, that over the years its role has evolved:

- from a simple use of directly measurable physical data, such as ‘length’, ‘time’, ‘velocity’, ‘mass’, ‘force’, etc.,
- to the use of calculated physical data, such as ‘work’, ‘kinetic energy’, ‘potential energy’, ‘power’, ‘enthalpy’, ‘entropy’, etc.,
- to the introduction of mathematical concepts, such as e.g. ‘potential energy field’, ‘space-time curvature’ etc., that are defined in analogy with physical objects such as a mountainous landscape, a stretched rubber sheet, an inflated balloon, etc.,
- and finally, to completely unintelligible concepts, such as ‘n-dimensional’ space, ‘dark’ matter, ‘dark’ energy, etc., that are invented to fit with the obtained physical data.

The fact that our mathematical approach and the thereupon based theory allows us to calculate physical phenomena with mathematical precision, gives us the self-confidence that we completely grasp the physical mechanism. This success carries in itself however a number of hidden pitfalls.

- According to Stanley Goldberg [2] “*the role of mathematics in physics is that of a language and any given language favours the emergence of certain concepts over others*”. Mathematics is as a matter of fact so extremely accurate for the processing of continuous relationships between numerical data, that it has automatically led to a preferential interpretation of the observed phenomena by means of a continuous mathematical model, known as a ‘the field’.

  The modern concept of ‘the field’ was invented by Michael Faraday (1791 – 1867) in order to explain the results of the electromagnetic experiments that he performed between 1820 and 1845. According to Robert K. Adair [3] “*It was actually due to Faraday’s lack of formal mathematical training, that he invented the strong visual concept of ‘the field’. In that sense, Faraday’s field arrows can be considered as the precursors of the Feynman diagrams, which also allow a strong visual presentation of what otherwise would be rather arcane mathematical equations*”.

  In Faraday’s and later in Maxwell’s (1831-1879) electromagnetic theory however, the field continuous field model has become the ultimate physical reality and ‘particles’ are considered as ‘condensates’ of the field. It isn’t therefore any wonder that in that period, when all physicists were hooked on fields, Ludwig Boltzmann (1844 – 1906) encountered insurmountable problems to convince the scientific community of his ‘particle’ thermodynamics, in which there is no need for ‘fields’ and which was, since the work of the French engineer Sadi Carnot’s (1796 – 1832) on steam engines, considered to be a mere engineering’s subject.

  The ‘field’ approach became thereby so successful that it finally resulted in the present theory of physics in which all the fundamental forces - electromagnetism, the weak and the strong nuclear interaction are described by fields. And also in Einstein’s general theory of relativity, the gravitational distortion of space and time, is described by means of a four dimensional (and even a more) tensor field. And even in quantum field theory, actual particles are viewed as "excitations of underlying (quantum) fields".

These mathematical field models don't necessarily correspond to the physical reality because, contrary to these continuous fields the physical world presents itself as a dynamic system of vibrating 'particle-waves' in relatively empty surroundings.

According to Robert K. Adair, "*a field is a collection of the values of a given quantity of something associated at each point in space*". The 'relief' of a land, the 'temperature of the air' or the 'intensity of a shower', can all be represented by 'a field', but that doesn't alter the fact that these 'fields' consist in realty of (sand-, air-, water-) particles.

Lisa Randall is also rather sceptical about the concept of 'fields' when she writes [4]: "*.. such an elementary particle mass relies on the existence of what particle physicists call 'a field' - a quantity that exists throughout space, but that doesn't necessarily involve any actual particles. Admittedly, the concept of a field is a bit esoteric and confusing, especially as the word field outside of physics conjures images of cows grazing*" (ii)!

This means that the field concept seems above all a mathematical tool that attributes a numerical value to each point in space. This continuous field concept is moreover incompatible with the dynamic wave-particle model of quantum physics. The efforts to eliminate this incompatibility between general relativity and quantum mechanics, have thereby led to an increasing complexity of the theoretical models, with alien concepts such as 'wormholes', 'multiple worlds', etc.

- A second danger consists when the mathematical equations are established on the basis of curve-fitting of the experimental data. Quasi identical curves can be caused by totally different underlying mechanisms. This is in particular the case when fast evolving phenomena have to be measured in extreme conditions, or when the data are restricted to a relatively small region. In those cases, slight deviations of the obtained data can lead to completely different mathematical equations and therefore to the formulation of an irrelevant physical theory.
- The biggest problem is however that our self-confidence is based on a circular reasoning: the experimental data agree with our mathematical equations, because the mathematical equations are mathematical expressions of the experimental data. In this way, any explanation that fits in with the mathematical equation will sound acceptable, and the laws of physics will consist of mathematical equations expressed in spoken words, so that our scientific theory will rather give us a logical insight in the mathematical equation than in the real physical mechanism.

The last years, there is however a growing number of physicists that begin to share the point of view that physics has a problem. In his book "The Trouble with Physics", Lee Smolin writes [5] "*We had a few visionaries at the beginning of the twentieth century: Einstein, Bohr, Schrödinger, Heisenberg, and a few others. They created partially successful theories - quantum mechanics and general relativity. The development of these theories required a lot of hard technical work and so for several generations physics was dominated by master craftspeople.*" And he writes further: "*It is a fantasy to image that foundational problems can be solved by technical problem solvers within existing theories. Deep, persistent problems are solved by people who are compelled by their desire for clarity, to grapple with the deepest problems in the foundations of physics*".

(ii) The physical nature of 'fields' will be analyzed in my paper on "Potential Energy".

3. The vagueness of the present physics

The exactitude of experimentally established mathematical equations, combined with the poorly defined fundamental concepts of physics, has led to the present physics, which allows us to calculate with incredible accuracy, the value of physical phenomena that nobody really understands. It is indeed a fundamental problem that the fundamental concepts of physics, such as e.g. distance/length, time, velocity, mass, etc. are mathematically defined in function of one another. In his book “Understanding Relativity” Stanley Goldberg writes in this regard [6] that these basic concepts have traditionally been the ‘primitives’ in physics, and “*that the primitives, such as the concept of length and time are not defined, but rather are the standing points for analysis*”.
It is obvious that in that way, the derived fundamental concepts such as ‘momentum’, ‘force’, ‘kinetic energy’, ‘potential energy’, etc., which are defined by means of combinations of these ‘primitives’, are on their turn based on ignorance.

1. A typical example is Newton's law of universal gravitation. Due to scrupulous observation, mathematical discernment and physical insight, Isaac Newton has succeeded to establish a simple mathematical equation that allows us to calculate with extreme accuracy, the acceleration of falling objects. The problem is however that:
   - we don’t know what ‘mass’ is,
   - we don’t know the physical nature of ‘velocity’
   - we don’t know the physical nature of potential energy
   - we don’t know why and how masses spontaneously accelerate to each other with increasing speeds

2. Another example are Bohr's postulate that the orbits of the electrons in an atom are quantized, so that only discrete orbits and energies are permitted. The electron can make a discontinuous transition, called a "quantum jump", from one orbit to another. During this quantum jump, the excess energy of the electron is released as a photon. Bohr's postulates have allowed us to build the present electronic devices, such as transistors, lasers etc.. . The problem is however that:
   - we don’t know what "photons" are (the ambiguous wave-particle character of photons and electrons)
   - we don’t know how “massless” photons can have linear momentum, exert pressure on a surface, and are deflected by gravitation in a direction perpendicular to their invariable speed
   - we don’t know how elementary pointlike particles can have internal spin and can emit photons.

3. Still another example is the nature of ‘potential’ energy and the transformation of ‘kinetic’ energy into ‘potential’ energy and vice versa. It allows us to calculate the height at which a thrown up object comes at rest, as well as the speed with which an object that is dropped from a certain height hits the ground. The problem is that we don’t know where and how this so-called ‘potential’ energy (which was originally called ‘energy of configuration’) is physically present and how vacuum space can store these huge amounts of energy.

4. Another example is physical law of "the conservation of energy". This postulated law allows us, in complicated thermal, mechanical, chemical, electrical or gravitational processes, to calculate with extreme exactitude, where all the energy comes from and where it has gone to. As Richard Feynman wrote in his “Lectures on Physics”, the problem is that [7]: “I*n physics today, we have no knowledge of what energy is. We do not have a picture that energy comes in little blobs of a definite amount. It is not that way. However, there are formulas for calculating some numerical quantity, and when we add it all together it gives always the same number. It is an abstract thing in that it does not tell us the mechanism or the reasons for the various formulas”*.

5. Yet another typical example is Einstein's Theory of Special Relativity which gives us the exact value of the invariable speed of light and allows us to calculate with mathematical exactitude, “the length contraction”, and “the time dilatation” of a moving object in function of its speed. The problem is that:
   - we don’t know what ‘mass’ is. We don’t know what causes it and we don’t know what causes gravitational, inertial or relativistic “mass”. The ‘Higgs boson doesn’t really reveal the nature of mass, because it has mass itself.
   - we don’t know what ‘velocity’ is. This has led to a theory of relativity in which speed is considered a relative characteristic which has however an absolute, invariable upper limit, known as the speed of light!;
   - we don’t know what the ‘invariable’ speed of light physically represents? Is it a physical characteristic of space-time, or is it a fundamental property of massless particles?
   - we don’t know what ‘time’ is. We define velocity as the covered distance divided by the elapsed time, but we don’t really know what ‘time’ is and why an increasing (relative) velocity matches with a decreasing time progression (the so-called twin paradox). In chapter 7 of his book “Reality is not what it seems” [8] Carlo Rovelli demonstrates that ‘time’ simply does not exist.
   - we don’t know what the ‘length contraction’ the ‘time-dilation and the mass increase of an moving mass is (which has e.g. led to the twin paradox) physically means. Are it purely observational or real "physical" phenomena, that produce physical tensions and dislocations in moving objects?

6. The “bending of space-time” in Einstein’s theory of General Relativity, is another typical example. It allows us to explain gravitational acceleration without Newton’s gravitational pulling forces, whereby the increasing kinetic energy of the gravitational acceleration of two bodies to each other is caused by an increased curvature of space-time between these bodies.
   The problem is, that nobody knows the physical nature of this ‘warping’ of space-time” and how it can produce the enormous amounts of energy necessary to accelerate planets, stars and even whole galaxies. This lack of knowledge is known as “the vacuum catastrophe” which indicates the huge discrepancy between the estimations of the vacuum energy of free space that varies from 10^{-9} to 10^{113} joules per cubic meter [9]!
   The classic picture of General Relativity, in which a curved space-time is represented as a downwards pointing funnel in which matter falls down, is visibly based on a circular reasoning, because a funnel as such does not increase the speed of any mass, unless one presupposes a downward attraction underneath the funnel!

7. But nothing beats the theory of Quantum Mechanics as the ultimate example of

'operationalism'. It is as a matter of fact, a piling up of incomprehensible laws, rules and principles that are invented to describe the equally incomprehensible behaviour of matter at its smallest level. In his famous book "QED – The strange theory of light and matter" [10] Richard Feynman writes: "*What I am going to tell you about is what we teach our physics students in the third or fourth year of graduate school – and you think I'm going to explain it to you so you can understand it? No you're not going to be able to understand it. .. That is because I don't understand it. Nobody does.*"
In fact, the problem is that Quantum Theory is a piling up of concepts, that nobody really understands, such as

- the internal structure of photons
- why the wave character disappears when a detector is present
- why the notion of a path is no longer valid
- the wavelike behaviour of matter
- the physical foundation of the Schrödinger equation
- the physical meaning of quantum tunnelling
- etc.

In this way it isn't surprising that this lack of clarity of the basic, everyday concepts of physics, has led to a total blackout with regard to the more exotic phenomena such as 'dark' matter, 'dark' energy, black holes, etc.

- and how can you possibly know what gravitation is that makes two masses proceed spontaneously to each other with increasing velocities, if you don't know what 'mass' is and what 'velocity' is.
- and how can you possibly know whether the length contraction, the time dilation and the mass increase of an accelerating mass are relative, or real physical phenomena, if you don't know the physical nature of length, mass and time?
- and how can you possibly know what an invisible mass like a 'black hole' is, that accelerates approaching mass particles to the speed of light, if you don't know what 'velocity', what 'mass' is and what happens if mass is accelerated to the speed of light?

In recent years, there are papers and scientific magazines that begin to realize our lack of understanding of the meaning of the fundamental concept of physics!

- In his paper "Something is fundamentally wrong with our understanding of the quantum universe" [11] Michael Brooks writes about entanglement "*Is it a connection outside space-time, or is quantum theory itself the problem?*"
- In his paper "Spin Revolution" [12] Jon Cartwright writes "*Spin was first proposed in the early 1920's by Wolfgang Pauli. When you send a stream of electrons through an uneven magnetic field the particles are deflected as though each one has an intrinsic rotation. .. This picture of electrons as spinning balls rotating on their own axis is useful, but also misleading. .. In fact we don't really know what spin is. The only thing we know for sure is that it has something to do with magnetism*".
- In his paper "Warning Light" [13] Stuart Clarck writes about space-time: "*Developed by the physicist Herman Minkowsky in the 20th century and used by Albert Einstein in his general theory of relativity, space-time has become one of the most powerful concepts in all physics. There is just one nagging problem: no one knows what it is. .. Although the mathematics of relativity describe space-time's properties very well, it is silent on its underlying nature.*"

These examples, and many others, oblige us to conclude that the present theory of physics is in fact a piling up of mathematical relationships between the quantitative data, which allow us to calculate with mathematical accuracy, the exact quantity of badly understood physical entities.

The biggest problem thereby is that in this way, the present theory doesn't even offer us the possibility to prove that a scientific theory is wrong, as long as it fits in with the experimentally established equations.

4. The need for a natural, elucidating physics

Most physicists have no problem with 'operational physics' and think in the same way as Niels Bohr, that the difference between "practical knowledge" and "real insight" is of minor importance, as long as we are able to find satisfactory solutions for our technical problems. This viewpoint is based on the fact that most people associate a deeper insight with some sort of philosophic state of mind, that hasn't brought us any material benefit. The difference with the philosophic approach is however that in the present physics, a better understanding of the physical nature of matter will automatically lead to new applications.

In order to come to a profound understanding of the real physical processes, we must improve the existing scientific method. The medieval philosopher William of Ockham (Ockham 1280 – Munich 1349) has demonstrated that language contains a large number of "secondary" concepts, which he defined as "words that do not refer to real existing things or events and that are pure results of our mind, our imagination and our subjective mental processing of observed phenomena". According to William of Ockham, our description of the world will be the more accurate, in the way that we succeed to cut out those imaginary concepts of our mind and make only use of genuine physical concepts. This 'cut out' principle has since then become generally known as 'Ockham's Razor'.
We have demonstrated before that the present theory of physics uses multiple concepts, going from simple, measurable material data such as e.g. length, velocity, mass, etc. to more and more complex, calculated mathematical concepts such potential energy field, space-time curvature, etc..
To make a clear distinction between the real, observed data on the one hand and, and the imaginary concepts on the other hand, we must adjust the scientific method by integrating "Ockham's razor" and use only real physical concepts.

In the present physics, the conduct of matter is often represented as if it "obeys" some unwritten laws. In application of "Ockham's Razor" we must however bear in mind that material objects don't have any 'knowledge' of laws, they just interact 'naturally' with each other, according to their respective natures. It must be clear that the concept of physical 'laws' is a medieval concept.
Since the work of the Belgian Scientist Monseigneur Georges Lemaître, who proposed what later became known as the "Big Bang theory", and the work of the Belgian 1977 Nobel prize winner Ilya Prigogine on self-organising molecular systems, we have gradually realized that if in an evolutionary, self-organising universe.

We must thereby be aware that the introduction of even one tiny unproven supposition, considerably undermines the correctness of our explanation. This means that for each physical fact, we must resolutely search for the simplest explanation that doesn't need any unproven supposition. We will see that when we give clear, ambiguous definitions of

the basic concepts of matter, such as extent, velocity, mass, force, energy, .., this will automatically lead to a natural elucidating physics.
That doesn't mean at all that the mathematical approach must be abandoned. On the contrary, it will remain necessary to calculate the exactness of the obtained data.

In his book "Gravity does not exist" [14] the Dutch professor of Astrophysics, Vincent Icke writes that "*In order to come to an original insight, one has to think what nobody has ever thought, about things that everybody sees*".

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