



The Conceptual Framework of Formulations in Physics

(An Article)

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Abstract

This physical world, within us and around us as well, is made up of same thing known as *Universal Consciousness* which is omnipresent in form of a *Tensor-Field* of infinite dimensions. The observable forms of this physical world are energy and matter which are distributed in this omnipresent field constituting the space and time. There is continuous interaction between energy and matter, energy and energy, matter and matter and continuous conversion between energy and matter. The quest of human knowledge and understanding about this physical world and happening within it in form of natural philosophy is termed as *Physics*. Physics is not only the natural philosophy; it is also the mother of all physical sciences. The idea, concept, logic and intuition in physics have two aspects: qualitative aspect and quantitative aspect. Objectively, these two aspects are presented in form of: what? how? why? Where, when and how much? In this communication, an attempt has been made to present a fundamental approach to understand the existing knowledge about the physical laws, principles, concepts and their mathematical formulations on one hand and on the other hand by reasoning how to create a new knowledge along with applying them to solve a problem.

Keywords: Physical laws, Principles, Physical Expressions, Mathematical Formulation.

1. Introduction:

The origin, composition, constitution and functioning of and within this physical world is full of purpose, intellect, logic and reasoning. Understanding developed about it from all possible angles is known as "*knowledge, laws, principles, rules, axioms and theorems*". This systematic compilation of understanding is termed as "*scientific gadget*" and the way of doing it is termed as "*science*". Fundamentally, every discipline the quest of knowledge and such knowledge created: subjectively as well as objectively is the science. For example, social science, political science, computer science, mathematical science, biological science and physical science. There is a systematic understanding and knowledge created in each. The basic difference in physical science and other sciences is that in a physical science there is an organic view from small scale to the universe as a whole: definite and well-defined concepts are established where the organic unit as a system is fixed and does not have its will and wish, while in other sciences human will, wish, subjectivity and objectivity all are involved. The mathematical science, commonly known as mathematics, is the soul of all sciences and it is the language to formulate a concept/idea and quantify as: limits of possibilities and numerically how much?

2. The Physical Observables:

Under the path of quest of knowledge, the various happenings in nature have been termed as a “*phenomenon*” which involves intrinsic characteristics and interaction patterns of “*energy, matter and the physical conditions*” under which a phenomenon takes place. These aspects are experimentally measured in terms of some parameters termed as “*physical observables (quantities)*”. The nature of a physical observable may be a *scalar* or a *vector* or a *tensor*. A scalar is that physical quantity which is described completely and uniquely by magnitude alone and follows the algebraic addition rules. A vector is that physical quantity which obeys the triangle law of addition and can be completely and uniquely described only when it's both the aspects are known as magnitude and direction. It may happen that a physical quantity has magnitude and direction both but it is treated as a scalar. A tensor has magnitude, direction and orientation. It has multiple directions and used to express those physical properties of a system that vary with orientations. This physical world has 3-orthogonal dimensions for a given orientation at an interface. It is the *rank* of a tensor which gives the total number of dimensions. If rank is **n** the total number of dimensions are **3ⁿ**. In physics, the isotropic properties are described in terms of scalars and vectors which are actually rank-0 and rank-1 tensors respectively. But to model the anisotropic (direction dependent) properties of various physical quantities such as stress, strain, electrical conductivity and curvature of spacetime, tensors are required.

The physical observables, based on their fundamental origin, are classified as: independent variables and dependent variables. Say Y is a dependent variable and X_i, i = 1, 2, 3...N are independent variables then we express the relation as

$$Y = f(X_i, i = 1, 2, 3 \dots N) \dots \dots \dots (1)$$

The independent variables have the meaning that they do not change unless and until they are changed. The dependent variable means only this will change when an independent variable(s) is changed.

3. The Concepts of Physics:

The happenings of the various phenomenon in this physical world are expressed in form of different:

- Laws of physics.
- Conservation Principles.
- Theorems

Laws of Physics:

These are the well-established facts about a phenomenon which relates the independent physical quantities involved to gauge qualitative aspect of the dependent physical quantity under the given conditions and formulated in form of laws of physics. For example,

- Newton's laws of motion and Newton's law of gravitation.
- Kepler's laws of planetary motion.
- Laws of Thermodynamics: (Zeroth Law, First Law, Second Law and Third Law).
- Laws of Electrodynamics: (Gauss Law of Electrostatics, Gauss law of Magnetism, Maxwell-Ampere Circuital Law and Faraday's laws of Electromagnetic Induction)
- Ideal and Real gas equation and various gas laws and Planck radiation Law.
- Quantum-Mechanical Laws: (Quantisation of energy, Wave-Particle Duality, Quantization of energy states in a bound system and many more).
- Newton's Law of Cooling, Biot-Sawart Law, Coulombs Law and Bragg's Law.
- Hubble's Law, Hooke's Law, Ohm's law, Pascal's law and Poiseuille's law.
- Sommerfeld-Kossel displacement law and Stoke's law.
- Wein's displacement law, Zener-Hollamon law, Titius-Bode law, Stoletov's law and such many more laws of physics.

Conservation Principles:

Consider a physical observable. There may be certain rules followed by all the systems regarding the physical observable in which it is constant in totality. These rules are formulated in terms of conservation principles which may be conditional or universal like:

- Principle of conservation of linear momentum
- Principle of conservation of angular momentum
- Principle of conservation of charge
- Principle of Conservation of energy
- Principle of conservation of baryons, etc.

Theorems:

These are the statements/propositions which have a premise (if) and a conclusion (then). They can be formulas, rules or laws. These are based on assumed truths, established statements with full of logic and rigorous arguments. In physics, it connects the related physical observables like:

- Work and energy in form of *Work-Energy Theorem*.
- For a stable system the average total kinetic energy to its average total potential energy in forms of *Virial Theorem*.
- For a system approaching in its thermal equilibrium, the behaviour of its entropy in form of *H-Theorem*.
- In physical systems, the link between symmetry and conservation laws in form of *Noether's Theorem*.
- For a given system the sources as a cause and its effect as a field is given in form of *Gauss Theorem* of electrostatics and magnetism and many more such theorems.

4. The Formulation Concept:

Let us consider the independent variables p, q and r and the dependent variable y. Then in experiment we take only one independent variable at a time keeping other independent variables constant and see the variation of dependent variable upon it. Let us say that experimental finding is as:

$$y \propto p^\alpha ; y \propto q^\beta ; y \propto r^\gamma$$

where α , β and γ are the real numbers may be positive or negative excluding zero. Then together this experimental finding is expressed as

$$[y] \propto [p^\alpha \cdot q^\beta \cdot r^\gamma] \dots \dots \dots (2)$$

The question is, why we take the independent variables as factors not the terms as

$$[y] \propto [p^\alpha \pm q^\beta \pm r^\gamma] \dots \dots \dots (3)$$

Here comes the **first formulation concept** as *principle of homogeneity of dimensions* for independent variables. According to this, only those physical quantities can become terms in a physical expression which have same dimensions. But in case of factors any physical quantities may involve together to have an expression. That's why we express the relations in form of Equ. (2) and not in form of Equ. (3).

Now, to construct Equ. (2) in form of exact value equation from the proportionality form, here comes the **second formulation concept** as the "*proportionality constant*" which may be "*local*" (i.e. dependent on physical conditions, nature of the medium, type of the material, shape and size of the design) or "*universal*" which is same for all the conditions and for ever. Let this proportionality constant is K. Then, this means that the terms [y] and $[p^\alpha \cdot q^\beta \cdot r^\gamma]$ vary in such a way that their ratio is always constant and equal to K. Then in form of an exact value equation, the expression in form of Equ. (2) will be expressed as:

$$[y] \div [p^\alpha \cdot q^\beta \cdot r^\gamma] = K$$

Where K may appear as on as the value of the ratio. In a simple way it can be written as

$$[y] = K. [p^\alpha. q^\beta. r^\gamma] \dots\dots\dots(4)$$

This Equ. (4) becomes the mathematical form of the physical law obtained. Now, from understanding and application point of view of the physical law formulated, we must know the exact appearance of different types of physical quantities involved as: independent variables dependent variable and the proportionality constant (local or universal). This is so because mathematically all these relations:

$$\text{➤ } y = K[p^\alpha \cdot q^\beta \cdot r^\gamma]$$

$$\text{➤ } K = y / [p^\alpha \cdot q^\beta \cdot r^\gamma]$$

$$\text{➤ } p^\alpha = y / [K \cdot q^\beta \cdot r^\gamma]$$

$$\text{➤ } q^\beta = y / [K \cdot p^\alpha \cdot r^\gamma]$$

$$\text{➤ } r^\gamma = y / [K \cdot p^\alpha \cdot q^\beta]$$

are identical but we must know which parameter represents what and of is of which type. This invites the basics of the subject matter as: the *conceptualization of the subject matter; formulation concept; nature of a physical quantities; what is proportionality constant* in the expression and *derivation* of the law/principle/theorem/relation.

5. Conclusions:

- In physical terms, the observables are the physical quantities and their togetherness in an expression of a law/ principle/theorem is decided by the principal of homogeneity of dimensions. Their exponents are decided by the nature of the phenomena.
- When an independent variable is varied it is the dependent variable and only the dependent variable will change irrespective of where it falls in the expression.
- In a given expression, the proportionality constant is independent of both independent variables and the dependent variable. If it is universal constant or purely a constant number it is always constant in space and time. But in case of being a local constant it depends on physical conditions, nature of the medium, material properties, shape and size of the design.
- The theorems are always conditional in form of “if” and “then”. Physical laws and the principals may be conditional or universal. Regarding this, it is very important to know the conditions which govern the said law and principle and assure their validity. Then only we can decide in which types of problem solving they can be applied.

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