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This document presents a discussion and conceptual derivation of Einstein's postulates of special relativity. The perceptron approach appears to be a fundamentally new manner of regarding physical phenomena and it is hoped that physicists will interest themselves in the concept. (Author)

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A CONCEPTUAL DERIVATION OF EINSTEIN'S POSTULATES OF SPECIAL RELATIVITY

Thomas E. Bearden

8 October 1975

U.S. ARMY MISSILE COMMAND
Redstone Arsenal, Alabama

Thomas Bearden

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This report presents a discussion and conceptual derivation of Einstein's postulates of special relativity. The perceptron approach appears to be a fundamentally new manner of regarding physical phenomena and it is hoped that physicists will interest themselves in the concept.

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CONTENTS

1. Introduction

In the theory of relativity, space and time are conceived as being two different aspects of the same entity, "spacetime", similar to the manner in which matter and energy are regarded as different aspects of the same entity, "energy" [1]. Further, matter, and therefore energy also, is viewed as a curvature, i.e., a nonlinearity, in linear space. However, literally interpreted this view denies that matter, and hence physical phenomena, are comprised of anything physical at all. Rigorous interpretation excludes definite length and definite location from free space itself, and more important, it also excludes definite time intervals from free space per se in the absence of operating mechanisms (clocks).

Rigorous application of the concepts of relativity thus seems to annihilate the physical nature of the phenomena of physics, and therefore "physics" itself. Relativistically, the phenomena of physics are conceived of as being comprised of events, which themselves are difficult to define, but which are rigorously interoperational (relative). Relativity returns the physicist to the age-old questions of whether a universe of objects exists, and if so, whether we as subjects can gather valid information about it [2].

Having challenged the immutability of the concepts of length, time, space, and matter, relativity accentuates the fundamental issue of the nature of existence itself, and of the relation of the existence of objective phenomena to that existence. Thus the fundamental philosophical questions of being, time, space, mass, and change are directly raised anew by relativity theory. Relativity theory accentuates the unresolved metaphysical basis of physics rather than merely physics itself [3].

To gain new insight into these fundamental questions, the basic concepts involved in the present physics theoretical paradigm must be excruciatingly examined to discover simpler, more fundamental concepts from which the basic paradigm concepts have been constructed. Specifically, a specialized application of Occam's razor is proposed by the author as a creative tool; this method consists of ascertaining the one most elementary idea involved in a fundamental concept. That is, each basic paradigm concept should be deliberately condensed into the single most fundamental idea it contains [4]. This method, which is quite similar to the "method of elementary abstraction" discussed by Lindsay and Margenau [5], will be used in this paper to deliberately derive the concepts of relativity.

2. Perception of Change

Begin with the problem of change and the problem of the observation of change.

(1) All observers and all observing instruments have mass and are therefore physical detecting systems.

(2) Any physical detecting system detects only change to itself, i.e., to some part of itself.

(3) The absolute minimum portion of the detector involved in the detection of change is that portion of mass that itself changes in the detection.

(4) Thus the limiting case of the physical detection process is reached when the mass of the detecting system is made so small that the entire mass must change in any detection of change. This limit can be said to define a fundamental particle.

(5) Therefore, in the ultimate analysis, detection is synonymous with change itself; i.e., with change to the detecting mass itself.

(6) Therefore "perception" can be exactly defined as the physical detection by a mass of change to itself.

(7) Ultimately, perception is physical change and physical change is perception, from statement (5). Perception may therefore be said to generate physical change itself.

(8) We abstract the concept of a physical detecting system (mass) and call it a "perceptron". Thus a perceptron can be a fundamental particle, a laboratory instrument, or the physical sensory apparatus of a living body.

(9) By statements (2) and (5), only changes are perceived.

(10) Therefore perception is a differentiating process.

(11) Think of perception as a process having inputs and outputs. The outputs of perception are what is perceived; collective outputs are called physical phenomena. By definition, the input to perception is not perceived since it is not output. The word "output" is merely the statement that perception has occurred, and the word "input" is merely the statement that perception has not occurred.

(12) Therefore a perceptron may be said to differentiate its unperceivable input to derive its perceived output.

(13) Physical phenomena, the perceptron's output, are said to be real and to exist. Specifically, they are perceived to exist.

(14) The perceptron's input is said to be real and to exist although it cannot be perceived to exist [6].

(15) Since the output reality of a perceptron is derived (differentiated) from a more fundamental input reality, the input reality is said to be ultimate reality (in the sense that it is more fundamental than perceived reality).

(16) From the perceptron viewpoint, ultimate reality is unperceivable.

(17) Physical phenomena are, therefore, first derivatives of ultimate reality.

(18) The most fundamental (ultimate) fact (ultimate reality) is existence itself.

(19) But fundamental (ultimate) reality is the input to the perceptron and is unperceived. Therefore, by statement (11), ultimate reality is undifferentiated.

(20) Therefore, existence (being) is undifferentiated, and that is its "total definition" [7].

3. Space and Time

There is no separation without relation, and there is no relation without separation. Therefore,

(21) Relation <=> separation,

where the doubled arrow symbol means "if and only if." Further, there is no operation without separation, and there is no separation without operation, so

(22) Operation <=> separation.

Combining statements (21) and (22),

(23) Operation <=> separation <=> relation.

A difference can now be between "free" (undefined) space and what will be called a "Cartesian" space [8]. In a Cartesian space, definite lengths are considered to have been established for each "point" in the space [9]. But such a definite length to each point from each other point is rigorously operational by statement (23); i.e., such a specific length is defined by an operation, and only by an operation. Therefore, a Cartesian space is one for which all possible lengths have already been operationally defined, and in fact, these lengths have been defined in a linear manner; i.e., by the same type of operation, identically repeated [10].

Specifically, all lengths have been operationally defined in a "field" manner; i.e., as if there were a perceptron at the origin, and as if there were a perceptron at each point to which a linear length is defined (perceived) [11].

Also note that, literally, differentiation is separation, so

(24) Differentiation <=> separation.

Since it is the perceptron which differentiates, then the perceptron produces separation itself. Since there are fundamentally two types of separation, namely ΔL and Δt, then

(25) The fundamental mass perceptron produces (creates, outputs) ΔL and Δt in its operation. ΔL and Δt are entirely relative to the perceptron which created them.

(26) Thus the specific length and specific time to each point in an inertial reference frame are linearly created by the mass perceptron at the origin. A nonlinear, (non-inertial, non-Cartesian) spatial reference frame is operationally created in such nonlinear fashion by the origin perceptron; i.e., by its nonlinear operation.

(27) Thus simultaneity itself is operational, entirely relative to its creating perceptron (fundamental observer mass), and quite changeable from one perceptron to another under appropriate conditions, as Einstein showed [12].

ΔL and Δt, being operationally created by a perceptron, are relatively variable; i.e., the two kinds of separation, length and time, are intertransposable in the same manner as are kinetic energy and potential energy in an oscillating spring/mass system. The ratio of transfer or switching of ΔL into Δt and vice versa is determined by a parameter (i.e., a "switching" parameter) called "velocity". That is,

(28) $v \equiv \Delta L/\Delta t$.

Note that

(29) Physical phenomena are finite (limited).

(30) Thus perception is finite, otherwise it would output (create) infinite phenomena.

(31) Therefore, there must exist a limit to the rate at which the perceptron and the perception process can operate, and this limit must be finite.

(32) But by statement (7), perception is identical to change. Specifically, perceptron operation is identical to perceived change. Therefore the limiting rate of perceptron operation must be the limiting rate of perceived change.

(33) The greatest velocity (change) observed (measured) in nature is c, the speed of light in vacuo.

(34) Therefore the perceptron's operational limit is at $v = c$. For normal perceptron operation, $v_{max} = c$.

(35) But this is true for any perceptron.

(36) Therefore the speed of light is the same for every observer [13]. This is merely the statement that all mass perceptrons have the same operational limit.

(37) Further, at maximum operation rate, from the definition of v the following is obtained:

a) $\Delta L = c\Delta t$

b) $\Delta t = (\Delta L)/c$.

The linearity of a spacetime frame can now be discussed. A spacetime frame is operationally derived from the operations of the origin perceptron. Therefore,

(38) A spacetime frame is operational.

A linear spacetime is derived from linear operation of the origin perceptron; a nonlinear spacetime is derived from nonlinear operation of the origin perceptron.

(39) The word "linear" means "everywhere the same operationally," or "identically repeated."

(40) Thus a linear spacetime frame is created by identically repeated operations of the origin perceptron. It follows that a nonlinear spacetime frame is created by change or difference in the repeated operations of the origin perceptron.

(41) In one perceptron operation, a specific ΔL and Δt are outputted (created). Thus a specific value of v is outputted, from statement (28).

(42) Identically repeated perceptron operations thus output the same value of v. That is, a linear spacetime frame is an unaccelerated spacetime frame since the velocity is constant.

(43) Similarly, a nonlinear spacetime frame is the result of nonidentical perceptron repetitions; hence the velocity changes. Therefore a nonlinear spacetime frame is an accelerated frame. Similarly, an accelerated frame is a nonlinear frame.

4. Derivation of Einstein's First Postulate

Einstein's second postulate has already been conceptually derived, ending at statement (36). Now proceed to derive the first postulate.

The concepts of dimensional molecule and absolute value of a dimensional molecule will be introduced first. The dimensions of a quantity will be regarded as having been operationally created by the perceptron and the expression of these dimensions as an ordinary fractional expression will be viewed as a "dimensional molecule." For example, the dimensions of energy are

$$(44) \quad E = ML^2/T^2$$

and both E and the right side of equation (44) are said to be dimensional molecules of energy, each composed of MLL/TT.

Since perceptron operation is the most fundamental operation, and since it is purely differentiation, the most fundamental possible units are regarded as being separation (i.e., ΔL and ΔT) [14], and as being created by perceptron operation. All other units are regarded as "molecules" somehow composed of these units. That is, the basic quantum of spacetime ($\Delta L \Delta t$) is supposed to be the fundamental quantum, and perceptron operation is supposed to differentiate (simply "split" or fission) this basic quantum of spacetime into ΔL and Δt in each operation.

If two quantities have the same units, the absolute value of their dimensional molecules must be equal. For example, since kinetic energy and any other kind of energy have the same dimensions, then

$$(45) \quad |K.E.| = |E|.$$

Similarly, since mechanical action and angular momentum have the same basic units MLL/T, then

$$(46) \quad |A| = |PL|,$$

where A denotes mechanical action, P denotes momentum, and L denotes length.

From experiment, it is known that matter and energy are intertransposable, specifically, from photon emission and photon absorption. Then

$$(47) \quad |M| = |MV^2|,$$

where the dimensional molecule of kinetic energy, MV^2, has been deliberately used for the energy molecule. Dividing out the M,

$$(48) \quad 1 = |V^2|.$$

Taking the square root,

$$(49) \quad 1 = |V|.$$

From statement (49), velocity is dimensionless in the absolute sense; therefore, it does not affect the perceptron's linear operation. That is, velocity is a constant in the perceptron operational sense, and because the perceptron differentiates, a constant velocity input to it does not result in any relative change in its outputs' relationships. Thus a constant velocity difference between two perceptrons does not affect the relative relationships they output. Operationally speaking, this is the same as a statement that the derivative of a function and the derivative of that same function plus a constant are equal, or

$$(50) \quad D[f(x)] = D[f(x) + C].$$

So the laws of physics (i.e., the relationships between repeated operations of one perceptron) are the same for all observers (i.e., for all perceptron masses) moving at constant velocities relative to each other [15].

As a bonus, from statement (49) the following can be written

$$(51) \quad 1 = |\Delta L/\Delta t| = |\Delta L|/|\Delta t|,$$

and so, disregarding constants of proportionality,

$$(52) \quad |\Delta t| = |\Delta L|,$$

which directly establishes that time and length are synonymous in the absolute (perceptron operational) sense, disregarding constants of proportionality, and thus the two kinds of separation, ΔL and Δt, must indeed be intertransposable [16].

5. Closing Remarks

It appears that the equivalence principle, necessary to the general theory of relativity, can also be derived from the perceptron approach, as indeed can a fundamental, new definition of mass, but these are not included in this report [17]. The perceptron approach appears to be a fundamentally new manner of regarding physical phenomena, and it is hoped that physicists will interest themselves in the concepts.

Since laboratory instruments and human sensory apparatuses are perceptron assemblages and can differentiate reality, the laws of perceptron operation should be studied as well as the laws of physical phenomena.

NOTES AND REFERENCES

1. But neither spacetime nor energy can be precisely defined.

2. Bergmann, Peter G., "Foundations Research In Physics," Delaware Seminar in the Foundations of Physics, Volume 1, Springer-Verlag, 1967, p. 2.

3. Quantum physics raised fundamental questions pertaining to the metaphysical basis of physics. Quantum physics regards interactions of "object" and "observer" as the "ultimate reality," and so confines itself to describing the relations among perceptions. Causality itself is seriously challenged, if not well nigh annihilated, in the quantum domain (smallest perceived reality). However, it makes use of an unperceived, probabilistic, "subquantum" domain that is rigorously causal. Quantum physics transfers causality from the perceived (selected) to the unperceived (unselected).

4. Specifically, the method proceeds by discovering and eliminating superfluity and redundancy in basic concepts.

5. Lindsay, Robert Bruce and Margenau, Henry, Foundations of Physics, Dover Publications Inc., New York, New York, 1963, p. 30.

6. Neither can a field, a photon, or velocity be perceived to exist.

7. There are rich philosophical implications of perceptron theory, but they are not discussed in this report.

8. By "Cartesian space" a three-dimensional Cartesian coordinate system imposed on an inertial reference frame is referred to. A tiny mass particle is considered to be at the origin of the Cartesian coordinate system, and the defining operations for the coordinate lengths to all points are considered to be totally internal operations of the origin mass. Each point at the end of an operational length (from the origin) is considered to be established as if there were a tiny mass particle at that point. The sets of lengths are considered to be defined in a linear (identically repeated) manner, so that Euclidean geometry holds.

9. The general concept of "space" is intended to be nonoperational, just as is the general concept of "length." However, a particular space is operational, as is a particular length. In fact, a particular space is "particular" because it is composed of particular lengths. "Space" in general is not particular (it is undefined, unperceived), and thus contains no lengths nor time separations. A Cartesian space, however, is particular, defined, and "perceived."

10. It is the linear operational nature of definition of a Cartesian space that determines an inertial reference frame, and thus is responsible for all conservation laws if one adds the additional condition that all Δt's are positive and linearly defined about the origin in a symmetric manner. That is, given a ΔL at any position and a fixed Δt to correspond to it, the negative of ΔL connects the same two points as ΔL, and has the same magnitude of Δt associated with that length segment. Thus any two "points" in the Cartesian space are connected by a $\Delta L\ \Delta t$ and a $-\Delta L\ \Delta t$ of equal absolute value. Thus the operational Cartesian space is conservative of spacetime, $\Delta L\ \Delta t$. This is a slight extension of special relativity, but valid nonetheless. Relativity views ΔL and Δt as existing only between events, which are then taken to be spacetime points. But an event, being operational, must possess a ΔL and Δt of its own; hence it can scarcely be a "point." Further, it is the observer's mass (which is ignored in special relativity) which gives the "observer" an operationally defined "space" in which to measure or observe the events in the first place. As an example of the misunderstanding on this point, we quote from Mario Bunge, Foundation of Physics, Springer Tracts in Natural Philosophy, Vol. 10, Springer-Verlag, New York, 1967, p. 226: "RIEMANN, CLIFFORD and their modern followers have conjectured that matter is just a warping of space (or spacetime). This may well be so, but it is not what GR [general relativity] holds: this theory states only that matter and gravitation are associated. This association is as loose as the one between charged bodies and e.m. fields: in fact although whenever there is matter there is a field (because the metric deviates then form the flat form), the converse is as false in GR as in CEM [classical electromagnetism] ..."

    Our comment is that the converse is true in both GR and CEM, because the observer's mass is there whenever there is a field; i.e., try as one may, whenever one has an "observer," and "observation," or an observing (measuring, detecting) laboratory instrument, one has the mass of that which is observing, measuring, or detecting. Both "thing" and "nothing" rigorously exist only with relation to the perceiving device that is operationally creating and sustaining them. That is, presence and absence of a thing are entirely operational and relative to the creating sustaining operation.

11. A "field" is a description of an effect, not a cause. In science, it is widely interpreted to be a description of a cause. For a discussion of this quandry, see Bearden, Field, Formon, Superspace, and Inceptive Cyborg: A Paraphysical Theory of Noncausal Phenomenon, December 1974, (available through the Defense Documentation Center, AD/A-005579/8G1), p. 5. For a brief but precise description of the rationale by which this fundamental error is made, see Demetrius T. Paris and R. Kenneth Hurd, Basic Electromagnetic Theory, McGraw-Hill, New York, 1969, pp. 32 and 33-34.

12. Einstein, A., "On the Electrodynamics of Moving Bodies," Ann. Physik. 17. 891, 1905.

13. Einstein's second postulate.

14. This is not an assumption. Differentiation is separation. Perceptron operation is the most basic differentiation. ΔL and Δt are the most basic separations. Hence perceptron operation literally is the production of ΔL and Δt.

15. Einstein's first postulate.

16. We have ignored constants of proportionality.

17. Perceptron theory derives a fundamental generating mechanism for force itself, i.e., for any force, no matter what type. The fundamental "resistance" to force, mass, becomes the same in all cases. Hence inertial mass and gravitational mass are identical. One kilogram mass is defined as 17.053×10^{50} perceptron operations per second, where each perceptron operation differentiates one action quantum of $h/4\pi$ magnitude. See Bearden, Thomas E., Quiton/Perceptron Physics: A Theory of Existence, Perception, and Physical Phenomena, March 1973, Defense Documentation Center (AD 763 210), for an elementary theory and model of the perceptron, and for derivations of Newton's laws of motion (relativistic form) and the law of gravitation.