Epistemology and Special Relativity

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It is shown that Special Relativity has three epistemological errors. A new interpretation of the Lorentz transformation shows that real velocities have no limits. The real velocity of any body can be greater than the velocity of light. An epistemological classification of physical laws is given.

Introduction

The history of science testifies to the pernicious influence of epistemological errors on the progress of science. Such errors lead to incorrect interpretations of scientific facts and applications of natural laws.

Epistemology has two significant objectives:

1. Epistemology studies the processes, methods and laws of knowledge and objective truth.
2. Epistemology seeks and studies indications which may be reduced to the attributes of objective (scientific) truth. Using attributes as criteria, we can recognize objective truth. When we make hypotheses, epistemology analyzes these hypotheses and identifies epistemological errors. If there are no errors, the hypothesis acquires the status of a scientific truth. Otherwise, we must consider that the thesis is an error.

For example, we consider the Copernican heliocentric system and the Ptolemaic geocentric system. We ask the question: What epistemological error caused Ptolemy's system to collapse?

We answer this question by appealing to modern epistemology. The geocentric theory describes the motions of the planets which ordinary man sees. The theory describes the *phenomenon*. If we observe the planets' motions from Mars, the theory must be changed. The heliocentric theory describes the *essence* of relative motions of planets. The description is independent of the planet on which the observer is located.

Ptolemy committed a classic epistemological error. He interpreted the phenomenon as essence. Ptolemy considered the observed motions of the planets as the real motions of the planets on the surface of the firmament. We will show that Einstein repeated this same epistemological error.

Phenomenon and Essence

The philosophical categories "phenomenon" and "essence" are defined in all philosophical dictionaries. The problem of the connection between these two categories is discussed in philosophical textbooks. However, real investigations are often of a scholastic and speculative nature. They are often little informed by principles of epistemological analysis. Therefore, we must identify the indications which separate the phenomenon from its essence, and thereby avoid epistemological errors.

We shall consider one ordinary example. Imagine a spherical globe placed on a thick glass plate. The sphere appears deformed (Figure 1). This is the phenomenon. If we change the angle of viewing a, then we see another visible height h of the globe.

The angle a is the condition. If a is fixed, we see a single fixed objective phenomenon. One phenomenon differs from other phenomena, which have different conditions. The original form of the spherical globe is invariant. This form is one of many parameters of the essence.

If we have only one phenomenon, we cannot discover an essence. We can only discover the essence if we have the set of phenomena that pertain to the fixed class of conditions (Figure 2).

Assume we have the set of phenomena. Any phenomenon is a combination of *specific* parameters (these pertain only to this phenomenon and separate this phenomenon from other phenomena) and *general* parameters (these are the invariant parameters for all phenomena).

Cognition of the essence begins with the phenomenon. From a set of phenomena we remove the specific parameters and preserve the general parameters. After investigating the general parameters, we may formulate the essence. The essence reflects internal causation and relationships. Cognition of the essence is a complex process, and we have no recipes that can lead us directly from a set of phenomena to the essence. However, we can write down one helpful rule:

A phenomenon depends on conditions.
An essence does not depend on conditions.

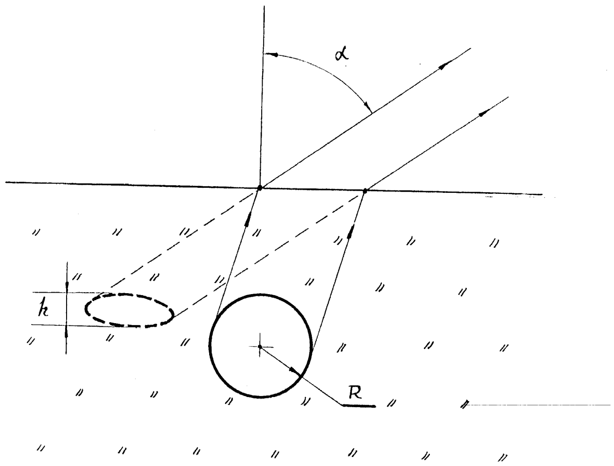

Figure 1

A detailed analysis of this problem is given by Kuligin, Kuligina and Korneva (1989).

We may nevertheless give a qualitative illustration here. In Figure 1, two objects are depicted. We can see only the apparent or imaginary object. This is the phenomenon or effect. The apparent object has apparent parameters. The parameters of the real globe are invariant, real parameters of the essence. At certain times, the real parameters agree with the apparent parameters.

The phenomenon and parameters of the phenomenon are considered to be imaginary and apparent, while the parameters of the essence are real, true and authentic. The essence is described by invariant parameters (*e.g.* the radius of the globe). Hence, the search for invariants and symmetries in physical theories has a strong epistemological foundation.

The Paradox of Time

This classical paradox is the hallmark of Special Relativity Theory. We shall examine this paradox in detail.

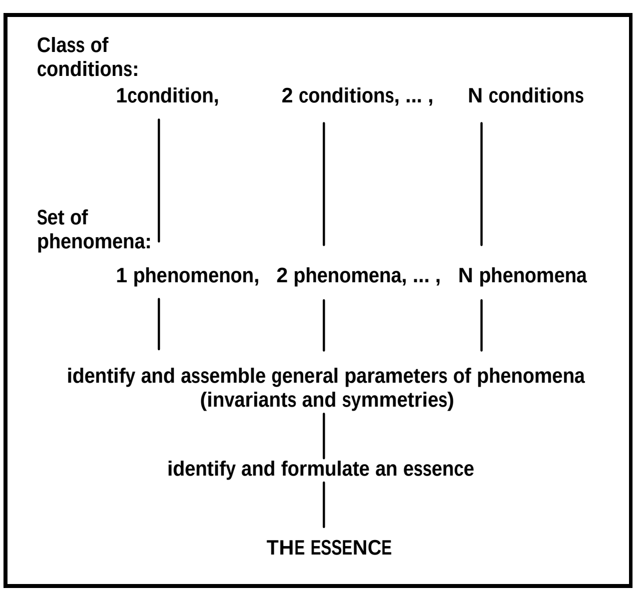

Figure 2

In Figure 3 we have two frames, K and K'. In each reference frame are a clock and a signal generator, which sends out light pulses at equal intervals of time.

If $v = 0$, we have (see Figure 3):

$$T = T' = \tilde{T} = \tilde{T}' = T_o$$

The clocks and generators in the frames are all identical.

Let the reference frames K and K' now be accelerated equally. The rate of time can then be changed for observers in the frames. However, the observers cannot discover the change.

The observer in frame K sees that $T = T_o$ and the observer in frame K' sees that $T' = T_o$. The time intervals T and T' do not depend on the relative velocity of the frames. Hence, $T = T_o$ and $T' = T_o$ are the parameters of the essence.

The observer in frame K sees that $\tilde{T}'$ depends on v and $\tilde{T}' > T$. The observer in frame K' sees that $\tilde{T}$ depends on v and $\tilde{T} > T'$. Hence, $\tilde{T}$ and $\tilde{T}'$ are the parameters of the phenomenon.

We have four parameters: $T, T', \tilde{T}$ and $\tilde{T}'$. The Lorentz transformation gives two inequalities:

$$T < \tilde{T}'; \quad T' < \tilde{T}.$$

We require two more conditions in order to obtain the full set of logical connections. Einstein assumed that

1. The time interval $\tilde{T}$ is the real interval in frame K.
2. The time interval $\tilde{T}'$ is the real interval in frame K'.

Here, Einstein repeated Ptolemy's error. He mistook the phenomenon (apparent time) for the essence (real time). Of course, Einstein did not consider this model and did not discuss its interconnections. Yet the logic in the papers by Einstein reveals that this was his interpretation of the problem.

Now we have the full set of logical connections:

$$T < \tilde{T}'; \quad T' < \tilde{T}; \quad T = \tilde{T}; \quad T' = \tilde{T}'.$$

But this set of connections is incompatible with logic, since it requires that $T < T'$ and $T' < T$ simultaneously. This incompatibility is the basis for all the logical contradictions and paradoxes of Special Relativity.

We shall write only one version of the logical connections which preserves the equality of inertial frames and presents no epistemological errors.

$$T < \tilde{T}'; \quad T' < \tilde{T}; \quad T = T'; \quad \tilde{T} = \tilde{T}'.$$

Now the interpretation of the connections is clear:

a) $T = T' = T_o$. The proper times in all inertial frames are common and identical to world time. "Time dilation" can be identified with the phenomenon of transversal Doppler effect.
b) $\tilde{T} = \tilde{T}'$. The inertial frames are equivalent and the phenomena are reflected from one frame to the other symmetrically.

We can write the same result for space. For all inertial frames, we have a common universal space. The decrease of scale in the direction of motion is just the phenomenon which we observe.

The aberration effect is an obvious illustration. Light velocity, which is the finite quantity, and the Lorentz transformation combine to produce aberration. At a fixed time we see the moving object at a point in space. In fact, at the same time, the object is located at another point in space. The two directions to the points form an aberration angle. Here we have the apparent object and the real object. The Lorentz transformation provides the apparent space-time parameters of the apparent object, if we know the real space-time parameters of the real object, and *vice versa*. Because it is like a distorting mirror, the Lorentz transformation reflects processes and parameters from one frame to another frame in the form of phenomena.

The main invariants of the Lorentz transformation are:

1. All inertial frames are equivalent.
2. The universal time is common and identical for all frames.
3. The universal space is common and identical for all frames.
4. The velocity of light is constant in all frames.

A New Interpretation

Our purpose is simplified as long as the mathematical formalism of the Lorentz transformation is preserved.

The length of a segment. We measure the real length of the segment l_o if the segment is at rest. This length does not depend on the number of observers or the number of moving frames. If the segment moves past the observer,

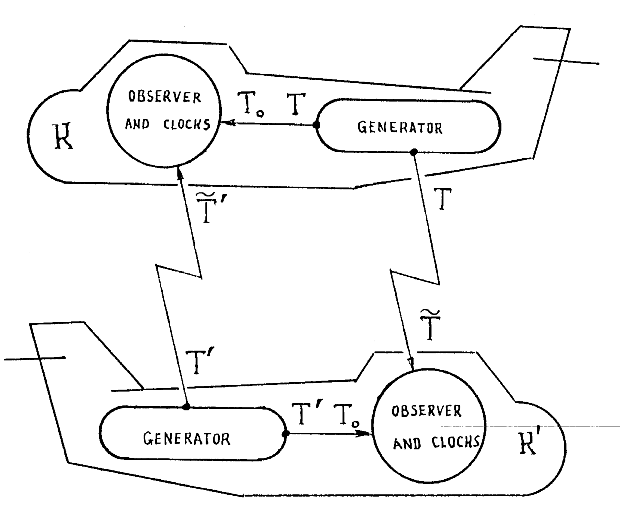

Figure 3

T, T' time intervals between light pulses produced by generators (in generator frames)
T_o proper time interval measured by observer in his own frame.
$\tilde{T}, \tilde{T}'$ improper time interval measured by observer with clocks in his own frame.

then the observer measures the apparent length of the segment l (the phenomenon). This apparent length depends on v.

$$l = l_o\sqrt{1-v^2/c^2} \qquad (1)$$

A time interval. We measure the real interval of time t_o in a rest frame between two events which take place at a fixed point of space. If the observer is in motion, then he sees:

1) the events are observed at different points;
2) the time interval t between the events is equal to

$$t = \frac{t_o}{\sqrt{1-v^2/c^2}} \qquad (2)$$

The main item of interest for us is the velocity of the moving point. Let the light pulse generator of be at rest in K. The pulse generator gives off flashes at equal intervals of time t_o. If the observer is at rest in the frame K' which is moving relative to frame K with velocity v, then he sees that the distance between flashes is equal to l (Figure 4) and that the time interval between flashes is equal to t.

The points x_1', x_2', ... are fixed in the frame K' and the distance l is at rest in K'. Consequently, l is the real distance l_o (the parameter of the essence). In K' the time interval t depends on the velocity v as in (1). Consequently, t is the apparent interval of time (the phenomenon).

The velocity v is equal to

$$v = \frac{l}{t} = \frac{l_o}{t} = \frac{[\text{essence}]}{[\text{phenomenon}]} \qquad (3)$$

This is the apparent velocity (the phenomenon).

The real velocity is equal to

$$v_o = \frac{l}{t_o} = \frac{l_o}{t_o} = \frac{[\text{essence}]}{[\text{essence}]} = \frac{v}{\sqrt{1-v^2/c^2}} \qquad (4)$$

The body is moving with real velocity v_o, but we observe that the body is moving with apparent velocity v.

The apparent velocity and the real velocity have a simple relationship to one another:

$$\frac{1}{v^2} = \frac{1}{v_o^2} + \frac{1}{c^2}$$

We obtain the surprising result that the Lorentz transformation does not limit real velocities. The real velocity can exceed the velocity of light. This fact supports action-at-a-distance theories. The second epistemological error is the limitation on light velocity. An analysis of the causation involved has been given by Kuligin (1987).

The Lorentz transformations may now be written using the real velocity.

$$x' = x\sqrt{1+v_o^2/c^2} - v_o t; \qquad y' = y$$

$$t' = t\sqrt{1+v_o^2/c^2} - v_o^2 x/c^2; \qquad z' = z$$

It is clear that the parameters m (a mass), $\vec{F}$ (a force), l (a distance), t (a time interval), *etc.*, are real parameters (parameters of essence) if the body is at rest in the observer's frame. However, the parameters are the apparent parameters (parameters of phenomena) if the body is moving relative to the observer's rest frame.

We may now give two interpretations of examples which have been used to justify Special Relativity. It is known that mesons are produced in the upper layers of the atmosphere. A meson has a real lifetime that is equal to $2 \cdot 10^{-6}$ sec. If mesons travel with the velocity of light, then they cover a distance

$$l = ct_o = 600 \text{ m}$$

However, mesons are known to reach the ground. Special Relativity concludes that this is explained by time dilation. The distance traveled by the mesons is equal to:

$$l_o = v\frac{t_o}{\sqrt{1-v^2/c^2}} \qquad (5)$$

where v is the velocity of the meson in the observer's frame and t_o is the lifetime of the meson in the observer's rest frame.

To properly interpret this result, we must write equation (1) in another form:

$$l_o = t_o\frac{v}{\sqrt{1-v^2/c^2}} = t_o v_o \qquad (6)$$

where t_o is the real lifetime of the meson and v_o is the meson's real velocity.

The real velocity of mesons is therefore much greater than the velocity of light. This is the reason why mesons are able to reach the ground. It is apparent that we must always use interpretations which are free of epistemological errors.

The Disk Paradox

Imagine a disk that can be turned on its axis. Along the edge of the disk 100 lights are mounted. The distance between each of pair of lights is equal to

$$d = 2p\frac{R_o}{N}; \qquad N = 100$$

If the disk turns, the lights have the velocity v. Let the velocity be equal to

$$v = 0.1\sqrt{2}c$$

Special Relativity states that the radius of the disk R_o has not changed, but the distance between each pair of lights has been decreased according to

$$d' = d\sqrt{1-v^2/c^2} = 0.99d$$

Now we take a photograph of the turning disk. How many lights will we see?

1. The decrease of distance is a fact (an essence). In this case, we expect to see 101 lights:

$$N' = 2p\frac{R_o}{d'} = N\frac{d}{d'} = 101$$

Was a new light created somehow? This would appear to be impossible.

The epistemological principle (Peshchevitsky 1992) states that "a discrete number of objects or events is invariant for any observer" ("principle of discrete counts"). The prognosis of Special Relativity is therefore false, since it contradicts epistemology and common sense. We have no cause for the appearance of a new real or imaginary light. This version must be relegated to the basket for mythical interpretations.

2. The decrease of distance is not real. But then which light has its photograph taken twice? In this case, Special Relativity gives another false prognosis.

Epistemology states that any concrete truth (a hypothesis or a theory) has a limited sphere of application. If we venture outside this sphere, then we obtain absurd results. This thesis certainly applies to the Lorentz transformation, as well. The paradox of the disk showed that the Lorentz transformation (and Special Relativity) cannot be used for rotating bodies and moments of momenta.

It must be confessed that the new interpretation of the Lorentz transformation has analogous difficulties. We will not consider any examples at this time, as these difficulties are discussed elsewhere (Panofsky and Phillips 1962, Kuligin *et al.* 1990). These discussions confirm our results. The third epistemological error is the use of the Lorentz transformation beyond its sphere of application.

Classification of Laws

After analyzing the philosophical categories (phenomenon and essence), we can propose an epistemological classification of physical laws. This classification has universal properties and does not depend on the nature of the physical process involved. It constitutes a philosophical generalization of the principle of relativity.

The essence of the matter is that the laws of nature

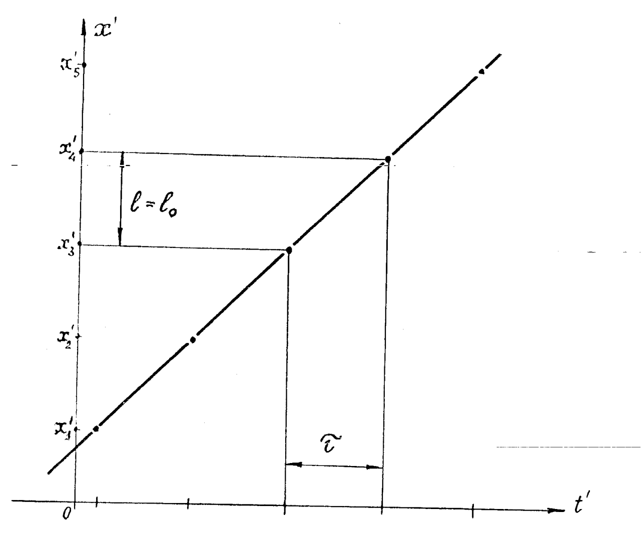

Figure 4

are objective, and do not depend on inertial frames, which are selected by observers, subjectively. In any inertial frame, the form of the laws must be invariant. This is an effect of the equivalence of inertial frames. We do not propose any specific transformation connecting two frames. The transformation may be the Galilean transformation, the Lorentz transformation or some alternate transformation. Classification relies on two types of physical variables:

1. Physical variables which are the parameters of phenomena. These depend on the observer's frame.
2. Physical variables which are the parameters of an essence. These do not depend on the observer's frame.

Laws of kinematics (equations of continuity). The form of these laws requires invariance of inertial frames; the form of the space-time operators acting on physical variables is invariant. But the physical variables themselves depend on the inertial frames. For example, in the Maxwell equations (if we use the Lorentz transformation)

$$\frac{\partial^2 A_K}{\partial x_i^2} = -\mu j_K$$

A_K and j_K depend on the observer's inertial frame. The space-time operator $\partial^2 / \partial x_i^2$, however, does not depend on inertial frames. Another example of this type is the continuity equation:

$$\mathrm{div}\left(\vec{v} j\right) + \frac{\partial j}{\partial t} = 0$$

The laws of dynamics (equations of interactions). The forms of these laws (or operators) are invariant relative to inertial frames. The components of the laws are also invariant (parameters of essence). The classical example of this law is the equations of Newton's mechanics (if we use the Galilean transformation):

$$m \frac{\mathrm{d}\vec{v}}{\mathrm{d}t} = \vec{F}$$

where $\mathrm{d}\vec{v}/\mathrm{d}t$ is the acceleration and $\vec{F}$ is the force. The magnitudes $m\left(\mathrm{d}\vec{v}/\mathrm{d}t\right)$ and $\vec{F}$ do not depend on inertial frames. The forces of Special Relativity are, therefore, the parameters of phenomena, while the equations of motion of Special Relativity are the laws of kinematics.

We know that interactions are objective. Two interacting bodies do not know what subjective forces are measured by observers in their own reference frames. Only one objective force acts on the interacting body. The forces measured by observers are the "projections" of the objective forces onto reference frames.

Newton's mechanics deal with objective forces only. The forces do not depend on the reference frames of any observers. This fact is constitutes the conceptual difference between the two species of mechanics.

We may now say that Newton's mechanics are not a corollary of modern Special Relativity mechanics. In fact, what we have is two incompatible models. Einstein's Special Relativity and Special Relativity mechanics break down at this point, but not the Lorentz transformation. Our goal must be to find a way to use the Lorentz transformation in mechanics. However, this is more than an epistemological problem.

For completeness, we must add two special laws:

1. Laws which do not depend on time, *i.e.* laws of statics.
2. Topological laws, in which space is degenerated. An example of a topological law is the theory of electrical circuits.

Conclusion

We have given a brief epistemological analysis of Special Relativity. This theory presents three basic epistemological errors.

1. Confusion between phenomenon and essence.
2. Mistaken limitation of real velocities of bodies.
3. Use of the Lorentz transformation outside its domain of applicability.

The epistemological errors of Special Relativity have created great difficulties for scientific investigation, and many scientists (Umoff, Brillouin, Bridgeman, *etc.*), have realized this in the past. Special Relativity should be abandoned, but unfortunately it has an independent existence. There are three reasons for this. First, Special Relativity uses the Lorentz transformation, which has experimental corroboration. Apologists of Special Relativity use the results of these experiments in defense of the theory. Worse, however, is the fact that scientific papers criticizing Special Relativity are suppressed: without criticism, science reverts to dogma. Finally, scientists are not accustomed to using epistemological analysis in their research.

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References

Kuligin, V.A., Kuligina, G.A. and Korneva, M.V., 1989. Lorentz Transform and Gnoseology, deposited with *VINITI*, Jan. 24, 1989, #546-V89, Moscow (in Russian).

Kuligin, V.A., 1987. Causality and physical interactions, in: *Determinism and Modern Science*, A.S. Kravets, ed., Voronezh University Press, pp. 89-105 (in Russian).

Peshchevitsky, B.I., 1992. Relativity theory: alternative or fiasco?, *Galilean Electrodynamics* 3:103-105.

Panofsky, W. and Philips, M., 1962. *Classical Electricity and Magnetism*, Addison-Wesley, Reading, Mass.

Kuligin, V.A., Kuligina, G.A. and Korneva, M.V., 1990. Paradoxes of Relativity Mechanics and Electrodynamics, deposited with *VINITI*, July 24, 1990, #4180-V90, Moscow (in Russian).