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ON THE EVOLUTION OF THE RELATIVITY PRINCIPLE FROM COPERNICUS TO EINSTEIN

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Abstract

An analysis is carried out which breaks the closed circle of the logic snare of Poincare-Einstein, related to mutual substitution of such notions, as *dynamic relativity principle, kinematic relativity principle, invariance and covariance* of equations of motion. With this in mind, it becomes necessary to revise the physical contents of the basic principles of Einstein's special and general relativity theories.

Introduction

After you have read this article, you may think: "*Everything, which is spoken about here, is trivial and known for a long time*". To convince yourself that this is not true, you may wont to first read the questions in appendix 1 to this article and underline the answers which in your opinion are correct. Then come back to your answers after having studied this article. As will be shown, even such eminent scientists as Poincare′ and Einstein would have discovered with surprise that they failed to answer most of the questions.

From Copernicus to Newton

Mechanical motion is a displacement of bodies in space with passing of time in respect to each other. From this definition, it follows that mechanical motion is a relative statement in the sense that, for its definition, one has to specify that body (and the reference system, related to it), with respect to which the motion of the bodies is considered. But mechanical motion is relative in another sense as well: from the statement, that the body A is moving relative to the body B, there follows as an equal to it, the reverse statement, that the body B is moving relative to the body A. That is why in kinematics, where only space-time relations of the bodies are considered, the choice of the reference system is arbitrary, i.e. any one of the bodies of the mechanical system under consideration may be chosen as "unmovable". These concepts were developed long time ago. Thus, Vergil (1-st century BC) already wrote: "*In the sea we are sailing from port, and land and towns are moving away*". But as a governing idea of the scientific system, this *kinematic relativity principle* was first proclaimed and applied by Copernicus (1473-1543). The essence of this principle is the following: "*The mutual motion of bodies does not depend on the way how this movement is considered relative to any one of them, but consideration and description of this motion will be different at the same time*". For example, in the world system of Ptolemy (2-nd century AD) it is stated that the Earth is at rest, and all celestial bodies are moving relative to it. Whereas in the heliocentric world system of Copernicus the movement of all celestial bodies is considered in relation to the nonmoving Sun. While in the geocentric system of Ptolemy the planets are moving along complex loop-like trajectories, according to Copernicus they perform concentric circles around the Sun. It is evident that, from the kinematic point of view, both reference systems are identical in the sense that due to change of the "point of view" the mutual motion of celestial bodies is not altered. However the world system of Copernicus is preferable, should one use the heuristic "simplicity principle" for the description of the process of motion, proclaimed later by Poincare' (1854 -1912) and which became the governing principle for Einstein (1879-1955). For substantiation of his kinematic relativity principle Copernicus gives this example: "*When the ship moves in calm weather, everything outside seems to the seamen as moving, as being a reflection of the ship's movement, while the observers themselves, on the contrary, deem themselves in the state of rest with everything being with them. The same, without any doubt, may take place on the moving Earth, making us think, that the entire Universe is orbiting around it"* [1].

Using the kinematic relativity principle, it is impossible to tell what body is "unmovable indeed". This was clear already to Ptolemy, and that is why, in refuting the thought about the possibility of movement of the Earth (Heraclidus, 4-th century BC) relative to the Sun and spheres of the distant stars, he gives the following arguments: should the Earth be orbiting around its axis and Sun, its surface should be moving with enormous speed, and all roughnesses and buildings should be removed, clouds and birds should remain far behind, the stone, being thrown from the tower, should not be dropped at its basement, and so on. Since these things do not take place, Ptolemy says, that is why the Earth itself is at rest and represents the center of the world. But during the struggle for the heliocentric world system Galilei (1564-1642) convincingly disproved these arguments. For this purpose he considered certain experiments in a windowless cabin of a ship at rest. *"Now let the ship move with any speed, - writes Galilei, - and then (provided the movement is uniform and without change in direction), you will be unable to discover even a minor change in the experiments mentioned, and you will be unable to find, using any one of them, whether the ship is moving or staying at rest... . And the reason for all these phenomena to be coordinated consists in the fact that the movement of the ship is common to all the objects within her, and air as well"* [2].

These experiments, carried out by Galilei in the closed cabin onto the ship, differ in principle from the observations of the phenomena outside the ship, made by Copernicus. They enabled Galilei to formulate the *dynamic relativity principle: "No mechanical experiments inside closed physical laboratories can reveal their uniform, rectilinear and translatory motion relative to each other"*. We shall note at once, that the dynamic relativity principle, as well as the kinematic, does not allow to reveal "really nonmoving " reference systems.

The dynamic relativity principle not only refuted arguments of Ptolemy's adherents against the geliocentric world system, but until Newton it served as the governing principle in proving various statements of mechanics. Let us trace, for example, how Huygens (1629-1695), using both relativity principles, develops impact theory in his memoir "On the Movement of the Bodies, Influenced by Impact" [3]. Firstly, the hypothesis is introduced: *"In the case of straight impact of two similar bodies, being in motion one towards the other, any of them jumps backward with the same velocity as it was hit"*. Then, the dynamic relativity principle is used, which is formulated by Huygens in the form of the following hypothesis: *"Should the passenger on the ship, which moves uniformly, cause an impact of two balls with equal (again in respect of the passenger and the ship) velocities, then these balls should jump backwards with equal (in respect to the passenger and the ship) velocities, absolutely in such way, as if the passenger had caused an impact of these balls on the ship at rest or on the shore"*. At last, the kinematic relativity principle is applied, impact and mutual movement of the above mentioned balls onto the moving ship are observed by a person ashore. In the case when the balls are moving along the ship, and the ship is moving at the same speed, as one of the balls, then for the observer ashore the following statement is valid: *"When the body in rest is hit by a similar body, then the body which hit becomes motionless, and the body previously being at rest, starts to move with a velocity equal to that of the body which hit it"*. Similarly, Huygens proves a series of other statements of the impact of elastic balls. In comparison to Copernicus, Huygens, on the one hand makes the kinematic relativity principle narrower, as he relates it merely to mutual uniform, rectilinear and translatory movements of the reference systems, but on the other hand he widens it, as he relates this principle not only to mutual motions of the bodies of the system under consideration, but also to their mechanical interactions.

Newton, by summarizing and improving the knowledge, gained from his predecessors, created a consistent theory of mechanical motions and mechanical interactions of bodies, [4]. His theory includes, of course, the kinematic relativity principle, as well as the dynamic. There was no need to refer to these principles when proving any statement of mechanics after Newton, as they, being included in his principal concepts, definitions and laws, are obtained as consequences. *To leave the labyrinth of equal, in the kinematic sense, reference systems, Newton distinguished one, privileged reference system, which he called the absolute one.* To a rather high accuracy it is simulated by the geliocentric world system of Copernicus, which is related to the sphere of remote stars, relative to which Newton formulated his laws.

Applying Newton's laws one can describe any mechanical interactions in this absolute reference system. To know how these very phenomena will be considered and described in any other reference system, it is sufficient to perform the formal-mathematical operation of transformation of the coordinates and time from one reference system to another. According to the kinematic relativity principle, the physical process itself does not depend on (i) the form in which equations describing any mechanical process are written and (ii) relative to what reference system this process is considered

In case the equations of motion retain their form after some transformation between reference systems, but do not preserve the expressions for functions contained in them, then these equations of motion are *covariant* with respect to the said transformation. In case the equations of motion preserve not only their form, but also expressions for functions, contained in them, after transformation, one can say, that they are *invariant* with respect to this transformation.

Only from the heuristic point of view of "simplicity of writing down" equations of motion, one can prefer such forms of their appearance and such reference systems for which transformations of the spatial and time coordinates during transition from one of them to another keep these equations invariant. The flow of mechanical process is indifferent to our subjective perception of this process - choice of the reference system and form of writing down the equations of the process.

Such is the state of the art concerning the kinematic relativity principle in Newton's classical mechanics. What concerns the dynamic relativity principle of Galilei, it is a backbone of Newton's first or inertia law: *physical properties of space and time are such, that movement of an isolated material particle does not depend on its location relative to the sphere of remote stars, or its velocity relative to them, nor, at what instant of time this motion started*. It is clear from this, that the mutual motion of the system of material particles, interacting with each other, will be independent of their common movement with the same transport velocity. This statement is formulated by Newton in Corollary V after explanation of his laws: *"Relative motions of the bodies, contained in any space, one relative to another, are equal, irrespective of whether this space is at rest or moves uniformly and straight without rotation"*. In this connection, this statement of Newton is worth mentioning: *"The body, moving in space, participates also in the movement of this space; that is why the body, moving away from the moving place, participates in the movement of this place"*. In Corollary V Newton concludes with the comment: *"This is confirmed by abundant experiments. All motions within the ship occur in the same way, independent of whether she is at rest or moving uniformly and rectilinearly"*. This Corollary is extremely important, as it enables to apply Newton's laws not only to the "absolute" reference system, related to the sphere of the distant stars, but also to all physical laboratories (reference systems), which are moving uniformly and rectilinearly in respect of the sphere of the distant stars (thus, relative to each other as well). All these reference systems are named inertial. Thus, inertial reference systems are distinguished not by the kinematic, but by the dynamic relativity principle: *they represent reference systems, in each of which identical mechanical processes are going on in the same way.*

Should the definition of inertial reference system be made in such manner, then it had to be clear already to Newton, that there exists, besides the above defined, one more class of inertial reference systems. These are all reference systems, related to the physical laboratories, which are "falling down" with acceleration in the uniform gravitational field, and which were mentioned by Newton in Corollary VI: *"Should several bodies, moving in any way relative to each other, be exposed to the action of equal accelerating forces, aimed at mutually parallel straight lines, then these bodies will continue to move relative to each other, as if the said forces were not acting on them"*. For the substantiation of this principle Newton refers to equality of inertial and gravitational masses and his dynamic laws.

In the "falling down" reference systems the gravity force, common for all of them, "drops" from the equations of motion of material particles. The definition of this gravity force during "falling down" of all the planets on the Sun, and Moon and apple on the Earth, i.e. the formulation of the law of the universal gravitation, was one of the principle goals of Newton. That is why this class of reference systems is not used by Newton any further.

One should pay attention to the identity of formulations and proof, as well as to the Corollaries V and YI. This is not due to chance. Consequence VI is a *generalization of the dynamic relativity principle* of Galilei. Corollary VI reads: *"No mechanical experiments inside closed physical laboratories can reveal their translatory, uniform and rectilinear motion relative to each other, or their "falling down" with common acceleration in the uniform gravitational field"*. It follows from this, that not only "absolute" velocity, but "absolute" acceleration as well can not be discovered inside of "falling down" closed physical laboratories. Only velocities and accelerations of the bodies relative to each other are subject to measurement.

From all the above one can draw the following conclusions about the principal distinction, which exists between the dynamic and kinematic relativity principles.

The dynamic relativity principle is an objective law controlling processes in nature. Whereas the kinematic relativity principle reflects a subjective act of perception and description of these processes.

The dynamic relativity principle considers identical processes in different physical laboratories, when these laboratories are moving relative to each other uniformly and rectilinearly. Whereas in the kinematic relativity principle, we consider the same process relative to different physical laboratories, moving relative to each other, generally speaking, in arbitrary way.

The dynamic relativity principle, being an experimental fact and reflecting objective law of nature, requires application of the same equations of motion with the same initial conditions for the description of identical processes in each of the physical laboratories, moving relative to each other uniformly and rectilinearly. Whereas the kinematic relativity principle is connected with formal-mathematical transformation of equations of motion and initial conditions, which describe the same process, from one reference system to another. In particular, these equations of motion may be invariant or covariant relatively to some transformations.

The dynamic relativity principle is a physical notion, and its implementation is not related in any way to the form of writing the equations of motion. In particular, it is not necessary to write these equations in invariant or covariant form relatively to one or another mathematical transformation between reference systems. The dynamic relativity principle, as objective law of nature, can not change due to alteration of the form of writing of equations, describing one or another process, as well as due to alteration of transformation formulae for transition from one reference system to another.

Invariance and covariance of the equations of motion relative to some transformations is a *mathematical* statement. Even in the case when some process is described by equations in invariant form, it is not yet sufficient to mean its identity in reference systems, moving relative to each other, in relation to which these equations are invariant. Moreover, one can state *a priori*, that in different reference systems a process will, in general, not be identical (recall experiments of Huygens with balls), as their mutual movement does not allow to formulate identical initial conditions, at least, in respect of initial velocities. Only experiment can show, whether the dynamic relativity principle in the sense of Galilei-Newton implements or not. Being a statement (in the accessible part of the Universe) about physical properties of space and time or about physical properties of the gravitational field- in which our Earth is "falling down", together with our Solar system, together with our Galaxy, together with our group of Galaxies, and so on- the dynamic relativity principle is not subject to logistic, formal-mathematical proof.

Accordingly, invariance of *equations* of motion in relation to one or another reference system does not follow from the dynamic relativity principle. Furthermore, from their invariance the dynamic relativity principle does not follow, since these are different notions.

Regretfully, this elementary (at first sight) truth was not strictly understood, even 200 years after the "Mathematical Principles of Natural Philosophy" by Newton were published. When it became necessary to comprehend, from the positions of the relativity principle, the gained results in that field of knowledge, which was not yet embraced by classical mechanics, namely electrodynamics, the scientists of our century found themselves not ready for this task. And there happened a surprising metamorphosis with this principle, to say the least.

From Poincare′ to Einstein

Summarizing all the attempts to discover " absolute motion" with the aid of optical experiments, Poincare′ concludes: *"At first sight it seems that aberration of light and related to it optical and electrical phenomena give us a tool for the definition of the absolute motion of the Earth, or rather its motion not relative to other celestial bodies, but relative to the ether. It is not true indeed, and Michelson, who invented an experiment, in which terms dependent on the aberration quadrature are revealed, failed in turn. Inability to reveal the absolute motion of the Earth represents evidently the total law of nature"*[5].

And further: *"We naturally come to the fact, that we adopt this law, which we shall call the relativity postulate"* [6].

Thus, the development of science led to the necessity of extension of the dynamic relativity principle of classical mechanics to electromagnetic processes. Poincare′ was the first to make this generalization. But, unfortunately, Poincare′ was also the first to identify the dynamic relativity principle with the kinematic relativity principle and formulate the principle, according to which:

"*The laws of physical phenomena must be the same for a nonmoving observer and for an observer, performing a uniform translatory motion, that is to say we do not have and can not have any means to discover, whether we find ourselves in a similar motion or not"* [7]. And finally, Poincare′ was the first to identify the dynamic relativity principle with the invariance of the equations of motion relatively to transformation of the space-time coordinates when passing from one reference system to another. *"Poincare′ obtained full invariance of the equations of electrodynamics and formulated the "relativity postulate", a term first introduced by him"* [8].

Thus, entrance in to the logical snare of substitution of the statements - dynamic relativity principle - kinematic relativity principle - invariance - was opened. And following Lorentz (1853-1928), Einstein had unwittingly found himself in this snare and finally led the science of the 20-th century into it.

"Even superficial analysis of processes, - writes Einstein, - which we call motion, teaches us, that we can perceive only relative motion of subjects. Let us enter a railway car and watch another car, which passes us (by parallel road)... . An observer, which is in the "moving" railway car, has the same right to say, that the car is at rest, while Earth or telegraph poles are moving" [9].

We recognize in this quotation the figurative example, which illustrates the kinematic relativity principle. But let us continue the citation.

"Imagine again a railway car, which is uniformly moving along the straight track. Let its windows not pass air and light; let rails and wheels be absolutely smooth. Let there be a physicist inside the car, who is equipped with all conceivable eqipment. Then we know, that all the experiments, carried out by the physicist, are going on absolutely in the same way, as if the wagon was at rest or moving with another speed. This is indeed that statement, which is called by physicists "the relativity principle". In a rather more general formulation this principle may be proclaimed in this way: "The laws of nature, which are noticed by the observer, are independent of his state of motion" [9].

Of course, in this last statement Einstein gives an absolutely true formulation of the dynamic relativity principle. But in reality for Einstein both aforementioned statements about moving railway cars express the same relativity principle:

"This statement sounds harmless and naturally. It should never excite people, should the laws of light propagation, to which the modern development of electrodynamics has led, be found not complying with this principle. The fact is that optical phenomena in moving media led to the conclusion that light is propagating in vacuum with constant velocity, which is absolutely independent of the motion of the light source. But this result seems to be in contradiction with the recently introduced relativity principle" [9].

Let us think for a moment! What relativity principle is in contradiction with the mentioned optical phenomenon? If the dynamic one, then this is not true. Similarly to experiments of Galilei, in which the velocity of movement of billiard ball does not depend on the uniform and rectilinear movement of the ship, in the experiment conducted by Michelson the light velocity relative to the Earth does not depend on the latter's velocity. In other words, not only mechanical, but also optical experiments do not allow to discover *"absolute"* velocities of motion of the Earth, i.e. the optical experiment of Michelson does not contradict the dynamic relativity principle, but confirms it. Hence, if the statement *"light propagates in vacuum with constant velocity being absolutely independent of the motion of the light source"* does contradict the*″relativity principle″*, then Einstein can mean by the latter only the kinematic relativity principle:

" ... if the light ray propagates with constant velocity relative to some observer, it seems, that relative to another observer, who moves in the direction of light propagation, the velocity of this light ray must be less, than relative to the first observer" [9].

And then Einstein follows up with a specimen of wrong logic, where one notion (dynamic relativity principle) is substituted for another one (kinematic relativity principle): *"But should it take place in real-*

ity, then in contradiction with the above mentioned relativity principle [evidently, the dynamic one - A.P.] the law of light propagation in vacuum should not be the same for observers (but according to kinematic relativity principle it should not be the same- A.P.) moving uniformly relative to each other" [9].

Thus, the postulate of the constancy of the light velocity, if it is understood as a demand for the constancy of the light velocity, originating from the same light source, relative to all observers, moving relative to each other uniformly and rectilinearly, certainly contradicts the kinematic relativity principle of classical mechanics. But this postulate requires even more precise experimental confirmation, then the highly precise experiment of Michelson-Morley, which has nothing to do with Einstein's postulate of the constancy of the light velocity (in this experiment, length contraction end time dilation in the ether flow compensate each other, so that no fringe shift occurs upon rotation of the interferometer [10]).

In addition Einstein widens his notion of the relativity principle and identifies it with invariance: ''*If any general physical theory is formulated in the system K, then, with the help of transformation equations..., one can obtain equations related to the system K'. In accordance with the relativity principle, this system of equations must coincide closely with the system of equations related to the system K* '' [11]. But in this case: *"Then the question arises, whether this principle is restricted to the uniform movement. Maybe, the laws of nature are such, that they are equal for two observers, moving relative to each other not uniformly? In recent years it became known, that such generalization is possible, and it leads to the general relativity theory"* [9]. Einstein, writes, *"we mean by the general relativity principle the statement that all reference bodies K, K' and so on are equivalent in relation to the description of nature (formulation of general laws of nature), regardless of their state of motion"* [12]. Here the relativity principle is identified with covariance, i.e. with formal-mathematical demand to write equations of motion of physical processes in covariant form relative to transformations when passing from one reference systems to another.

Einstein comes to the necessity of formulating the laws of nature in covariant form also from another side - via the principle of equivalence of inertial and gravitational forces, and *"in this respect the experiment conducted by Eoetvoes (1848-1919) plays a role, similar to that of the experiment conducted by Michelson concerning the feasibility to discover physically uniform motion ... . The circumstance, that in non-accelerated reference systems the behavior of bodies in the presence of a gravitational field is essentially the same as in the case of an accelerated reference system, causes us to undertake an attempt to extent the relativity principle to the case of accelerated reference systems"* [13]. This statement of Einstein can hardly be disputed, as this is merely another formulation of the generalized dynamical relativity principle of Newton, formulated by him in Corollary VI [4]. Helas, Einstein identifies the dynamic relativity principle with kinematic one: *"From the mathematical point of view it amounts to the fact, that from the equations, which express the laws of nature, we require covariance not only in relation to linear orthogonal transformations, but also in relation to more general, in particular nonlinear transformations, as soon as only nonlinear transformations correspond to a transition to relative[! -A.P.] accelerated systems"* [13].

From this logistic labyrinth of mutual substitution of notions, *dynamical relativity principle - kinematic relativity principle - invariance - covariance,* Einstein failed to find his way out until the end of his life. And modern scientific and educational literature leads into this labyrinth yet new and new generations of thinkers, despite a sufficient number of critical articles on this subject. To show that this is true, it is referred to the world wide known physics encyclopedias: "Course on Theoretical Physics" by Landau and Lifshitz ("Field theory" in particular), "Feynman Lectures on Physics", "Berkeley Course of Physics" and so on. Even authors, critically disposed to Einstein's theory, do not recognize that they are prisoners in this labyrinth.

Space-time of the physical world, where we are "falling down", is homogeneous and isotropic. There is no possibility of getting away from this fact, that is why a return to Newton and Maxwell in this sense is inevitable. The foundations to this return, in our opinion, in the field of the STR were laid by H.E.Wilhelm [14-15], and in the field of the GTR by A.A.Logunov [16]. An alternative gravitational experiment proposed by us, [17], [18], may play a significant role in this effort.

In the development of hadronic physics, R.M.Santilli extended and generalized the space-time transformations of the STR and GTR, as *mathematical* tools for the solution of realistic (difficult) *interio*r and *exterior* hadronic problems [19, 20]. E.g., explanation of the observed, anomalous (i) spins and magnetic moments of neutrons and protons in densely packed atomic nuclei and (ii) blue end red shifts of spectral lines from quasars and dense cosmic plasmas (see original Refs. in [20-II]. I am convinced that Einstein's transformations in flat (STR) and curved (GTR) space-time will survive as useful *mathematical* instruments.

Does it follow from the above analyses that we must discard Einstein's STR and GTR in their entirety? Of course not! But everything rational, contained in these theories, must be isolated and revalued from an unprejudiced point of view. And this will be one of the principle tasks of the physic's of the 21-st century.

Conclusion

1. The basis of the STR of Einstein is the formal-mathematical requirement of invariance of the formulation of laws of nature, which was compulsorily demanded by Einstein : *"All the content of the special relativity theory is concluded in the postulate: the laws of nature are invariant relative to the Lorentz transformations"* [21].

2. The basis of the GTR of Einstein is the formal-mathematical requirement of covariant formulation of the laws of nature, which was compulsorily adopted by Einstein: *"It* (GTR - A.P.) *represents a merely formal point of view, but not some definite hypothesis concerning nature. Because any system of laws, making sense in general, may be expressed in the general covariant form"* [22].

3. Neither the special relativity principle of Einstein (invariance) nor his general relativity principle (covariance) have anything in common with the dynamic relativity principle of Galilei, or with the generalized dynamic relativity principle of Newton. That is why experiments, confirming the relativity principle of Galilei and Newton, do not represent an experimental-physical basis for Einstein's STR or GTR.

4. It does not follow from the experiment conducted by Michelson - Morley that light, originating from the same source, is propagating with a velocity of constant value relative to all reference systems, moving relative to each other uniformly and rectilinearly. For this reason the experiment of Michelson - Morley does not form the experimental-physical basis for Einstein's STR.

5. It does not follow from the experiment of Eoetvoes that *"for the explanation of equality of inertial and gravitational masses in theory it is necessary to assume a nonlinear transformations of four coordinates"*, i.e. that *"the equations, which express laws of nature, must be covariant with respect to all continuous transformations of coordinates"* [23]. That is why the experiment of Eoetvoes does not represent an experimental-physical basis for Einstein's GTR.

6. No experimental-physical basis exists, which confirms the demand of Einstein's STR that the laws of nature have to be formulated in Lorentz-invariant form relative to all reference systems, moving uniformly and rectilinear relative to each other.

7. No experimental-physical basis exists, which confirms the demand of Einstein's GTR that the laws of nature have to be formulated in his covariant form relative to all reference systems, moving arbitrarily relative to each other.

Appendix 1

Test Questions on Knowledge of the Relativity Principle of Classical Mechanics and its Application in Einstein's STR and GTR

> "*Salviati*. I want nothing more, than you tell or answer only what you know enough and understand adequately.
>
> *Simplicio*. I shall answer what I know, and I am sure, that I shall meet minor difficulties" [2].

1. Does there exist any difference between the dynamic and kinematic relativity principles? /*Yes. No* /.

2. Is the relativity principle of Galilei,- described by him in such picturesque manner on phenomena, that take place on two ships, one of which is moving uniformly and rectilinearly relative to another,- dynamic or kinematic? /*Dynamic. Kinematic*/

3. What relativity principle (dynamic or kinematic) is expressed by the Galilei transformations, $\bar{r} = r' + \bar{v}t, \quad t = t'$, when transforming from one reference system to an other, which is moving relative to the first uniformly and rectilinearly? /*Dynamic. Kinematic*/.

4. The basic equation of dynamics of the relative motion of a material particle has the form: $m\bar{a}^{rel} = \bar{F} + \bar{N} + \bar{J}^{tr} + \bar{J}^{cor}$. Is it true, that Galilei's relativity principle follows from this equation as a particular case? /*Yes. No.*/.

5. The optical experiment of Michelson - Morley made it possible to extend the relativity principle of classical mechanics of Newton to electrodynamic processes. What relativity principle is generalized in this case -the dynamic or kinematic? /*Dynamic. Kinematic*/.

6. May one affirm that it follows from the optical experiment of Michelson-Morley, that the electrodynamic equations of Maxwell must be invariant relative to some transformation of the space-time coordinates when passing from one reference system to an other, which are moving relative to each other uniformly and rectilinearly? /*Yes. No* /.

7. The equations of Maxwell are not invariant relative to the transformations of Galilei when passing from one reference system to an other, which are moving relative to each other uniformly and rectilinearly. Does it follow that the electrodynamics of Maxwell does not comply with the dynamic relativity principle, extended to all physical processes? /Yes. No /.

8. The Maxwell equations are invariant relatively to the Lorentz transformations when passing from one reference system to another, which are moving relative to each other uniformly and rectilinearly. Does it follow that Maxwell's electrodynamics complies with the dynamic relativity principle, extended to all physical processes? /*Yes. No*/.

9. Among the principles, postulated by Einstein while constructing the STR, there is a relativity principle. What relativity principle is really used in this case - the dynamic or kinematic? /*Dynamic Kinematic*/.

10. What experimental fact is the basis of that relativity principle, which is used in the STR? /*Michelson - Morley Experiment. Other Experiments* /.

11. In the optical experiment of Michelson - Morley the source and receiver of the light are fixed relative to the Earth (analogous to the mechanical experiments of Galilei in the moving ship). May one come to the conclusion from this experiment that the velocity of light, originating from one source, has a constant value relatively to all reference systems, moving relative to each other uniformly and rectilinearly? /*Yes. No* /.

12. What experimental fact forms the basis of the principle of the constancy of the light velocity, which is actually used in the STR? /*Michelson - Morley Experiment . Other Experiments /.*

13. It is demonstrated experimentally, that inside all closed physical laboratories (inertial reference systems, related to them), which move relative to each other uniformly and rectilinearly, identical physical processes occur in the same way. Does it follow that equations, describing the same physical process, must be invariant relative to all reference systems, which are moving relative to each other uniformly and rectilinearly? /*Yes. No* /.

14. From the experimental fact of the equality of inertial and gravitational masses Newton concluded that inside of falling down lifts (in the reference systems, related to them), identical mechanical processes are going on in the same way. Does the conclusion hold that equations, which describe the same physical process, must be covariant relatively to all reference systems, moving relative to each other in an arbitrary way, in particular with acceleration? /*Yes. No* /.

15. From the experimental fact of the equality of the inertial and gravitational masses Einstein made a conclusion about the identical equivalence of the gravitational field and the inertial force field in accelerated reference systems, and demonstrated this by the following example [24]: "The absolutely smooth ball on the absolutely smooth table moves away from the axis of rotation, if the table starts to rotate". Does this experiment confirm that ball really moves away from the axis of rotation? /Yes. No /.

Appendix 2

Comparative Characteristics of Two Relativity Principles

KINEMATIC PRINCIPLE	DYNAMIC PRINCIPLE
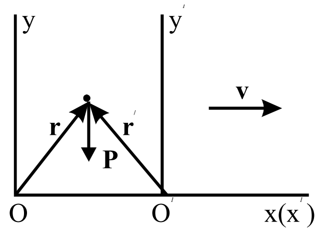	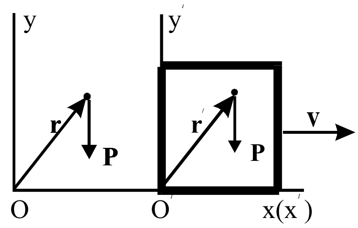
Fig1. The same process relative to different RS.	Fig2. The identical processes in different physical laboratories.

Number of Reference Systems (RS):

Two and more.	Two and more.

Number of the Observed Phenomena:

One, common for each RS.	Individual in each RS.

The Nature of Mutual Motion of RS:

$\bar{v} = \text{const.}$	$\bar{v} = \text{const.}$

Space- Time Transformation:

Transformation of Galilei $\bar{r} = r' + \bar{v}t, \quad t = t'$	$\bar{r}, t$ must be replace by $\bar{r}', t'$

Differential Equations of Motion:

Invariant due to structure of the equations of point dynamics.	Are the same, if phenomena are identical as consequences of the experiment.

Initial Conditions:

Interrelated and can not be equal in different RS as a consequence of the Galilei transformation.	May be stipulated independently for each phenomenon in its RS, particularly, n the same way.

Laws of Motion in each RS

Can not be equal, for example, if in one RS the body falls vertically, then in the other RS this movement will be Implemented by parabolic trajectory.	Equal, if the phenomena are identical (including initial conditions), as a consequence of experiment.

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