the general science journal
The General Science Journal. May 2025.

Preinertia And Special Relativity

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Abstract.-This paper demonstrates in formal terms that Galilean preinertia is a universal property of all physical objects which allows us to demonstrate, also in formal terms, the impossibility of detecting absolute motion and that motion can only be absolute in nature.

Keywords: Galileo Galilei, preinertia, relative motion, absolute motion, detection of absolute motion, linear momentum, physical space, absolute rotations.

1. What is preinertia?

The best, and almost the only, way to begin an article on preinertia is to define this physical concept, which is a consequence of the fact that preinertia has been, and still is, completely ignored by physicists of all times, with the exception of Galileo, its true discoverer. Indeed, and referring to the fall of a stone dropped from the top of the mast of a ship in motion, he wrote in 1632 (color and italic are mine) [1, p. 228]:

> Sagredo. If it is true that the impetus with which the ship moves *remains imprinted on the stone after it has separated from the mast*, and if it is also true that this motion does not hinder or slow down the straight downward motion natural to the stone, *it is bound to follow a marvelous effect in Nature*

That *wonderful effect of Nature* is preinertia, a property of all physical objects that can be provisionally defined as the ability of every physical object, including photons, to inherit the velocity vector of the reference frame (another physical object) from which it is set in motion. The final definition will be given at the end of the article, which will be justified by the reasons that will be given throughout the article.

Galileo was also about to discover that preinertia would make the detection of absolute motion impossible, because also in 1632 and in the same book [1], now referring to the fall of a ball dropped from the top of a tower, he wrote (color and italic are mine) [1, p. 250]:

> Sagredo. *But the part of all this motion that is common to the stone, the tower and us, is imperceptible to us and as if it did not exist, and only the part that neither the tower nor we are participants in is observable*, which in the end is that with which the stone, in falling, traverses the height of the tower.

But unfortunately he failed to discover that preinertia (his marvelous effect in Nature) makes the detection of absolute motion impossible, if there were an absolute motion to detect. An impossibility that follows almost immediately from preinertia, as will be proven at the end of this article.

There is an overwhelming empirical evidence of preinertia. Here on Earth it manifests itself millions of times a day: every time any physical object falls to the ground, it will always fall just below the position it occupied before it started falling, and not several kilometers further. And the same happens with any physical object, e.g. a ball of any sport, every time it temporarily loses its mechanical contact with the Earth and does not shoot off at 370 km/s[1]. For the Aristotelians this obvious fact was a proof of the immobility of the Earth: *every time we jump, we fall in the same place where we started the jump*. A good example to illustrate that, from a physical point of view, being obvious does not imply being irrelevant.

And besides making the detection of absolute motion impossible, preinertia makes the absolute nature of motion inevitable as will also be demonstrated at the end of this article. Preinertia, in short, is a universal property of all physical objects with overwhelming empirical evidence, discovered by Galileo and not yet rediscovered by contemporary physics. It is, moreover, a very relevant physical property for the reasons that have just been given and for those that will be given in the rest of this paper.

[1] The speed of the Earth trough the cosmic microwave background.

2. Preinertia and relative motion

In this and the next two sections we will use two inertial reference frames RF_o and RF_v in relative motion such that their respective three spatial axes are parallel, and from the point of view of RF_v, the frame RF_o moves with a velocity vector $\vec{\mathbf{v}}$ parallel to its X_v axis and in the increasing direction of that axis. Suppose that in RF_o an object A is set in motion with a uniform velocity $\vec{\mathbf{u}}_{oa}$ in the direction parallel to its Y_o axis, and let P and Q be any two points on the rectilinear trajectory of A in RF_o. The points P and Q are fixed in RF_o, but they are not fixed in RF_v: from the reference frame RF_v, the motion of the object A from P to Q takes a certain RF_v-time $t_v > 0$, and during that time the point Q moves a distance vt_v in the direction parallel to X_v. Therefore, from the perspective of RF_v, that distance has to be a component of the total distance traveled by A with respect to RF_v during the time t_v, which requires that the relative velocity $\vec{\mathbf{v}}$ of RF_o with respect to RF_v be a component of the total vector velocity of object A with respect to RF_v. Therefore, the object A inherits (preinertia) and maintains (inertia) the relative velocity vector $\vec{\mathbf{v}}$ of the reference frame RF_o (from which it has been set in motion), with respect to RF_v. A relativistic obviousness that would be impossible without the preinertia of A.

Although this argument is sufficient to demonstrate the impossibility of special relativity without preinertia, its simplified conditions can be easily extended to other relative velocity vectors parallel to any other direction in RF_o, and to other inertial reference frames with relative motions in any spatial direction. Thus, and although preinertia has never been considered by special relativity, nor by any other physical theory, special relativity would be impossible without preinertia. The following theorem is then verified:

Theorem 1 (of Special Relativity) *Special relativity requires that all physical objects in the observable universe be preinertial.*

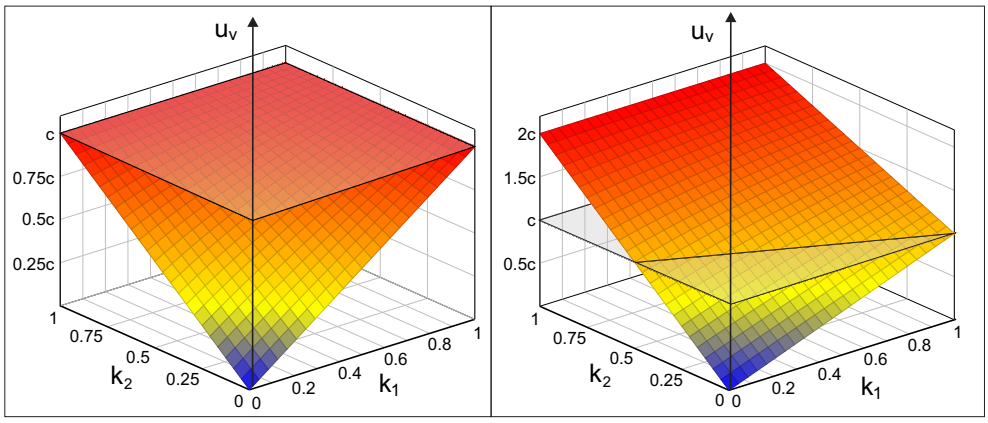

Figure 1 – Left: Relativistic sum of velocities with preinertia. Right: Relativistic sum of velocities without preinertia.

3. Preinertia and relativistic sum of velocities

In the theories of relativity (special and general) the spacetime continuum plays a fundamental role accepted by the vast majority of contemporary physicists. Although with some exceptions [2, 11, 14], it is also accepted that the speed of light is the maximum speed that can be reached in the observable universe. In discrete space and time, with indivisible minimum units of space (qusits, quantum space units) and time (qutits, quantum time units), there is also an insurmountable maximum speed of 1 qusit per qutit: it is not possible to travel less than one qusit, nor to do so in less than one qutit. The following argument is valid for both alternatives, although for the sake of simplicity I will only refer to the speed of light alternative.

It is evident that the existence of an insurmountable maximum velocity makes it impossible for the sum of velocities to define the velocity of an object if that sum is a simple algebraic sum, which is why it is necessary to define the relativistic sum of velocities, applicable not only in the theories of relativity but in all those in which the existence of an insurmountable maximum velocity is inevitable, as is the case with discrete space and time (qusits and qutits).

Let us consider again the two inertial reference frames RF_o and RF_v of the previous section and the same object A set in motion in RF_o now with a uniform velocity vector $\vec{\mathbf{u}}_{oa}$ parallel to the X_o axis of RF_o. Suppose that the modulus of the velocity vector $\vec{\mathbf{u}}_{oa}$ of A with respect to RF_o is $k_1 c$, where $0 < k \leq 1$ and c is the speed of light. Suppose also that the modulus of the relative velocity vector $\vec{\mathbf{v}}$ between the two reference frames is $v = k_2 c$, where $0 < k_2 < 1$. The relativistic sum of

both velocities (which is the velocity $\vec{\mathbf{u}}_{va}$ of object A with respect to RF_v) in scalar terms will be:

$$u_{va} = k_1 c \ +_{\mathbf{R}} \ k_2 c = \frac{k_1 + k_2}{1 + k_1 k_2} c \tag{1}$$

where the symbol $+_{\mathbf{R}}$ means relativistic sum of velocities (special relativity). As can be seen in figure 1 (left), assuming preinertia, the speed of light is never exceeded, even in the extreme (and surely impossible) case $k_1 = k_2 = 1$. On the contrary, without preinertia, the modulus of the velocity vector $\vec{\mathbf{u}}_{va}$ of the object A with respect to RF_v would be:

$$u_{va} = \frac{k_1 + k_2}{1 + k_1 k_2} c - k_1 c = \frac{k_1 + k_2 - k_1(1 + k_1 k_2)}{1 + k_1 k_2} c = \frac{(1 - k_1^2) k_2}{1 + k_1 k_2} c \tag{2}$$

which is the same velocity obtained from:

$$u_{va} = \frac{\gamma^{-1} PQ}{\gamma(t_0 + vPQ/c^2)} = \frac{\gamma^{-2} PQ/t_0}{1 + vPQ/t_0/c^2} = \frac{\gamma^{-2} u_{oa}}{1 + v u_{oa}/c^2} = \frac{(1 - k_1^2) k_2}{1 + k_1 k_2} c \tag{3}$$

Without preinertia, and as can be seen in Figure 1 (right), the modulus of the relative velocity vector $\vec{\mathbf{u}}_{va}$ of object A with respect to RF_v can greatly exceed the speed of light. Thus, relativistic addition of velocities would also be impossible without preinertia. Which can be expressed in the form of the following:

Theorem 2 (of the Sum of Velocities) *Relativistic sum of velocities requires that all physical objects in the observable universe be preinertial.*

4. Preinertia and the speed of light

Suppose that the object A from the previous two sessions is a photon. In this case $k_2 = 1$. Without preinertia, and according to (3), we would have:

$$u_v = \frac{(1 - k_1^2) k_2}{1 + k_1 k_2} c = \frac{1 - k_1^2}{1 + k_1} c = (1 - k_1) c \tag{4}$$

Which, as shown in Figure 2, implies a decrease of the speed of light as the relative speed $v = k_1 c$ of RF_o with respect to RF_v increases, which means a violation of the Second Principle of special relativity. We can then affirm, that without preinertia this fundamental relativistic principle is violated. And the same is true for the maximum velocity in a discrete space and time. Which can be expressed in the form of the following:

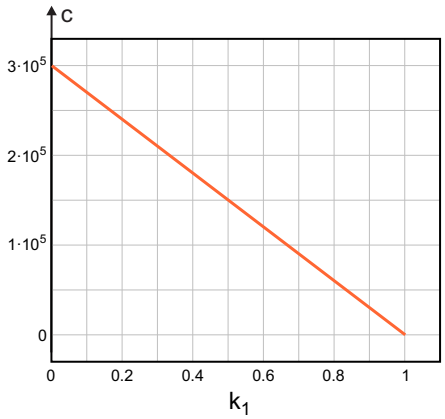

Figure 2 – Without preinertia the Second Principle of Relativity is violated.

Theorem 3 (of the Maximum Velocity) *The existence of a maximum velocity in the observable universe requires that all physical objects in the observable universe be preinertial.*

5. Preinertia and linear momentum

In addition to its overwhelming empirical evidence and the relativistic necessities of its existence that have been exposed in the previous three sections, preinertia is also necessary for the conservation of linear momentum. Indeed, and recalling Galileo Galilei, suppose that from the top of the highest tower in Italy a lead ball of mass m_G (Galileo's ball) is dropped and takes time t_G to reach the ground. Without preinertia, and assuming that during time t_G the velocity vector of the Earth through the cosmic microwave background is $\vec{\mathbf{v}}_t$, there would be a variation of the linear momentum $\delta\vec{\mathbf{p}}$ of the system Earth + Galileo's ball given by:

$$\delta\vec{\mathbf{p}}_t = -m_G \vec{\mathbf{v}}_t \tag{5}$$

Therefore, without preinertia these violations, however minuscule, would be occurring billions of times a day here on Earth (every time an object momentarily loses its mechanical contact with the Earth). The above argument allows us to establish the following:

Theorem 4 (of the Linear Momentum) *The conservation of linear momentum requires that all physical objects in the observable universe be preinertial.*

6. The physical reality of preinertia

Despite its overwhelming empirical evidence, and its illustrious discoverer Galileo Galilei (who made it public, although not under that name, in 1632 [1, p. 228;]), preinertia remains the great unknown of contemporary physics. According to its overwhelming empirical evidence, one can affirm the physical reality of preinertia as a universal property of all physical objects. And from the four above theorems 1, 2, 3 and 4 the same conclusion formally follows, which can be expressed in the form of the following:

Theorem 5 (of Preinertia) *All physical objects of the observable universe are preinertial.*

7. Physical space and rotations are real and absolute.

As a preamble to the conclusive final section of the article, this penultimate section considers two real and absolute physical entities that are not usually considered in this way in contemporary physics: physical space and rotational motions. The intention is to pave the way to the heterodox mechanics conclusion with which this article ends.

As is well known, since 2015 when they were detected for the first time, gravitational waves have been detected about a hundred times. Being those waves transverse and quadrupole vibrations of physical space itself that are transmitted through the same physical space at the speed of light and interact with real scientific instruments, modifying the distance that separates the real mirrors of the real interferometers that detect them. Since fictions are not capable of really performing these mechanical feats, it must be concluded that physical space, which does perform them, must be a real physical object; a physical object that contains all ordinary physical objects, transparent to their motions and sensitive to their presence (gravitational fields and gravitational interactions); a real and absolute object THROUGH WHICH all physical objects move, including elementary particles such as photons [3, Ch. Photons are preinertial]. Conclusion summarized in the following:

Theorem 6 (of Physical Space) *Physical space is real and absolute, the same for all ordinary physical objects contained in it and moving freely THROUGH it.*

Note that in this article I also consider as theorems those statements, such as the previous one, whose veracity is deduced both from the laws of logic (formal deduction) and from observed empirical data (formal induction). Concerning the real and absolute nature of rotational motions, I reproduce here the following argument of the author [6]:

In the case of the Earth, the first rotation to be considered is its rotation around an internal axis (the Earth's rotation axis). It is a real rotation because it produces observable and measurable effects: the apparent rotation of the Sun and the rest of the cosmic objects around the Earth. In each rotation of the Earth around its internal axis of rotation, each of its points describes a unique circle, with a unique center of rotation that will be a unique point on the unique Earth's rotation axis. And since in a single rotation a point cannot rotate at the same time around two different centers of rotation without being in different places at the same time, the motion of rotation of each of the points of the Earth around its corresponding center of rotation is unique and can only be referred to that unique center of rotation, which will therefore be an absolute center of absolute rotation. And this is true for every point of the planet. The rotation of the Earth around its internal axis of rotation is, therefore, a real and absolute rotation. Although, as we shall see, that absolute internal axis of absolute rotation is in turn rotating around other centers of absolute rotation external to the planet.

Instead of considering the points of the Earth, let us now consider the Earth as a whole, the Earth as a planet. The planet Earth, as a whole, now rotates in an elliptical orbit around the Sun (which occupies one of the two foci of the ellipse). That (so-called) translational motion of the Earth around the Sun also produces apparent motions in the rest of the cosmic objects. And although they are apparent, not real, appearances as such appearances are real: they are observable and measurable. And for the same reason as in the case of the points in the rotation of the Earth around its absolute internal axis of absolute rotation, the elliptical orbit of the Earth is also a unique orbit around its two unique foci (although it is not stable and in time may oscillate with respect to certain equilibrium positions). So, also in this case, the rotation of the Earth around the Sun is a real and unique motion that can only be referred to the absolute geometrical elements of its unique absolute elliptical orbit (its two foci). It is therefore another real and absolute motion.

According to everything we know about the observable universe, the vast majority of its trillions of physical objects are subject to rotational motions (from one revolution every 100 quadrillion

years in the case of some galaxies, to one quadrillion revolutions per second in the case of electrons). And the above argument applies to all of them. Therefore cosmic objects do not rotate WITH RESPECT to the sphere of fixed stars, as advocated by E. Mach. [12, p. 83-84] [13, p. 45] and many contemporary physicists, but each of their rotations is a motion AROUND a unique and absolute axis, or center/foci, of rotation. They are, therefore, real absolute rotations, real absolute motions [4]. Thus, the vast majority of motions in the observable universe are absolute, not relative.

According to the above argument, the following theorem can be stated:

Theorem 7 (of Absolute Rotations) *All rotational motions of all celestial bodies are real and absolute motions around unique and absolute axes, centers or foci of rotation.*

8. The nature of motion

I will establish as the initial hypothesis of this last section that absolute motion does not exist, that is to say, that all motions are relative. This is what is assumed in contemporary physics, although not as a hypothesis but rather as a dogma that does not admit of discussion:

Hypothesis 1 (of Relative Motion) *Absolute motion does not exist in the observable universe. All motions in that universe are relative.*

All the calculations and mechanical deductions of modern physics that have worked correctly have always done so without taking preinertia into account, simply because, with the exception of Galileo, no one in the history of physics has ever considered it (a conclusion that can be quickly confirmed using any artificial intelligence). One can, therefore, state the following:

Theorem 8 (of Correct Mechanics) *The mechanical correctness of modern physics is achieved without making use of preinertia.*

But preinertia is real (Theorem 5). Consequently, and according to the Hypothesis 1 of Relative Motion and to the Theorem 8 of Correct Mechanics, in all theoretical and practical cases in which any object B is repeatedly set in motion from another object A, the object B must always inherit the same relative velocity vector $\vec{\mathbf{v}}_{ac}$ of A with respect to the same third object C external to A. Indeed, if that were not the case, i. e. if B inherited different relative velocity vectors $\vec{\mathbf{v}}_{ad}$, $\vec{\mathbf{v}}_{ae}$, $\vec{\mathbf{v}}_{af}$, ... of A with respect to different objects D, E, F, ... external to A on the different occasions when B is set in motion from A, different results would be obtained for each different relative velocity vector $\vec{\mathbf{v}}_{ad}$, $\vec{\mathbf{v}}_{ae}$, $\vec{\mathbf{v}}_{af}$, ... of A inherited by B, which has never been the case because the same results have always been and are always obtained. And A being any object from which any other object B that was at rest on A is put into motion, the following can be established:

Theorem 9 (of the Unique Vector Velocity) *Under the Hypothesis 1 of Relative Motion, every object B, at rest on another object A, which is set in motion from A, must always inherit the same relative velocity vector $\vec{\mathbf{v}}_{ac}$ from A with respect to the same third object C external to A and B.*

Therefore, and as a consequence of the above Theorem 9, each of the trillions of cosmic objects in relative motion, as is the above case of the object A, must have its own unique cosmic object C exterior to A and in relative motion of velocity vector $\vec{\mathbf{v}}_{ac}$ with respect to A, so that all objects B at rest on A, and set in motion from A, always inherit the same relative velocity vector $\vec{\mathbf{v}}_{ac}$ of A with respect to C. But, I will prove now this conclusion, deduced from the only hypothesis of the argument (Hypothesis 1 of Relative Motion), is impossible in the observable universe.

Indeed, the object C can and will undergo changes in its relative velocity vector with respect to A, changes due to the great diversity of mechanical interactions to which C is exposed in the observable universe, interactions that may even imply the disappearance of C. These interactions are suffered by C and not by A (which will suffer its own). Consequently, there are three possibilities:

1.- Symmetry breaking between the relative velocity vectors of A with respect to C ($\vec{\mathbf{v}}_{ac}$), and of C with respect to A ($\vec{\mathbf{v}}_{ca}$). From the symmetry $\vec{\mathbf{v}}_{ac} = \vec{\mathbf{v}}_{ca}$ we would pass to the asymmetry $\vec{\mathbf{v}}_{ac} \neq \vec{\mathbf{v}}_{ca}$.

2.- If the symmetry $\vec{\mathbf{v}}_{ac} = \vec{\mathbf{v}}_{ca}$ is not broken, the object A must undergo the same velocity changes as C but without any real physical cause to produce them, only C undergoes those velocity changes by a real physical cause.

3.- A is left without its only physical object of mechanical reference, so it will have to choose a new one.

The first is impossible in relativistic mechanics. The second is also impossible because it violates conservation principles and fundamental laws of mechanics. As for the third, nothing we know about physical objects (including elementary particles, atoms and molecules) would explain the ability of those objects to choose a new object among the trillions of cosmic objects available to define a new inheritable relative velocity vector. Therefore the Hypothesis 1 of relative motion is false, and taking into account Theorem 6 of Physical Space and Theorem 7 of Absolute Rotations, the following theorem can be stated:

Theorem 10 (of Absolute Motion) *The motion of all physical objects through the same real and absolute physical space is also real and absolute.*

It is immediate now to explain the reason for preinertia: while any object B remains at rest on another object A, both move THROUGH the same real and absolute physical space with the same real absolute motion; real and absolute motion that B maintains and adds to the motion with respect to A when it is set in motion from A. And since that motion inherited and maintained by B when it is set in motion from A must have a direction, a sense and a modulus, the following definition of preinertia can be given:

Definition 1 (of Preinertia) *Property of every physical object by virtue of which it inherits the absolute velocity vector of the physical object from which it is set in motion.*

The universality and importance of preinertia makes reasonable the proposal to include it in Newton's First Law:

Fundamental Law 1 (Newton First Law) *Every physical object is preinertial and maintains its state of uniform motion as long as no external force acts on it.*

An immediate consequence of preinertia is the impossibility of detecting the absolute motion of an object A by setting other objects in motion from A. Indeed, and put in a very simplified way, it is not possible to detect the absolute motion of a physical object A by setting in motion from A other physical objects B, C, $D\ldots$ at rest in A, because all these objects inherit (preinertia) and maintain (inertia) the same unknown absolute motion of A that one is trying to detect, so that regarding that unknown absolute motion of A they all move in the same unknown way as A, exactly the same as when they were at rest on A. Therefore, the data they can offer about that unknown motion of A are the same being at rest in A or in relative motion with respect to A: no data. Therefore the only thing that can be detected are the relative motions of B, C, $D\ldots$ with respect to A, exactly the same as if there were no absolute motion to detect (most formal proofs can be found in [5, 6, 7]).

Another immediate consequence of preinertia is the relative motion deduced from the different absolute motions of the different cosmic objects, although when four or more of them are considered, mechanical inconsistencies appear (Problem of the Three Vectors [9], and Problem of the Four Reference Frames [10], both unknown to contemporary physics). And naturally, all the above is only possible in a consistent universe. Consistency that can be demonstrated starting from the fundamental laws of logic and from an inductive principle that generalizes and extends the Second Law of thermodynamics:

Principle 1 *The universe evolves independently of its observers and always in the same direction of increasing its global entropy.*

However, the most serious problem for the foundations of physics, apart from using an inconsistent mathematical language [8], is the intolerance of contemporary orthodox physicists to any significant dissent, such as the one exposed and reasoned in this article. As always, the arguments are less important than the academic relevance of their authors. The Principle of Authority (magister dixit) remains in force, blocking any dissent. Consequently, and given my lack of relevance, I must end by asking for help from all those who consider that they should lend it.

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