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## GALILEO GALILEI, THE TRUE DISCOVERER OF PREINERTIA

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**Abstract.** This article reproduces a text in which Galileo describes preinertia, although without using this word but the expression "marvelous effect in Nature." Preinertia is a universal property of all physical objects by virtue of which they inherit the motion of the proper reference frame from which they are set in motion, making it impossible to detect the possible absolute motion of that frame, an impossibility to which Galileo also refers. It is surprising that 393 years after Galileo's publication, physicists (prisoners of mechanical relativism) have not yet re-discovered preinertia. The article includes bibliographical references dealing with preinertia as the fundamental property of all physical objects that makes it possible to demonstrate in formal terms that motion is really absolute, and **THROUGH** the same real physical space.

**Keywords:** Galileo Galilei, preinertia, uniform relative motion, absolute motion, detection of absolute motion..

### 1. Galileo Galilei, the first theoretical physicist

Galileo Galilei is rightly considered one of the founders of modern science, especially of physics. With him began the so-called Scientific Revolution of the sixteenth and seventeenth centuries. His views on the relationship between mathematics and the physical world, and on the need for experimentation, are well known. But Galileo was, at least in my opinion, the first great theoretical physicist in history. Beyond the occasional experiments he may have performed, his book *Dialogue Concerning the Two Chief World Systems -Ptolemaic and Copernican* is an excellent treatise on theoretical mechanics. And yet in it mathematics is conspicuous by its absence, except for the sparse use of a small number of geometrical figures (32) and some numerical calculations.

As is well known, Galileo's Dialogues are divided into four days or dialogues. The Second Day (Dialogue) includes a magnificent refutation of the Aristotelian ideas about motion, defended by the character Simplicio against the opinions of the other two Galilean characters of the dialogues, Sagredo and Salviati. Obviously, preinertia does not appear in Aristotle's philosophy of motion, which is why he defends the immobility of the Earth.

But in that Second Day, the concept of preinertia appears clearly, although not with that name nor explicitly defined. There is no doubt that the *marvelous effect in Nature* defended by Galileo is what we have called preinertia in previous works. The preinertia introduced and defended in those works has, therefore, the illustrious Galileo as its true original author.

Unfortunately, the new physical concept (preinertia) remained fossilized in the pages of Galileo, without modern physics having rescued it, named it or used it in any mechanical discussion or argument. In contemporary physics, preinertia remains as ignored as in Aristotelian physics. The only difference is its implicit (we usually say unconscious in this case) use in numerous mechanical arguments. And naturally, the opportunity to use it in other extremely significant arguments has so far been missed, as can be seen in other works by the author, for example in [2, 3], [8, Ch. 11]. In effect, preinertia proves the impossibility of detecting absolute motion and the absolute nature of all motions. Nothing less!

### 2. Preinertia is incompatible with the Aristotelian theory of motion

The following words of Galileo, through the character Salviati, explain the arguments defended by the Aristotelians (practically all the thinkers of Galileo's time) about the natural motion of objects and the immobility of the Earth. Arguments all of them incompatible with preinertia.

SALVIATI. The best argument is that of heavy bodies falling from top to bottom in a straight line perpendicular to the surface of the Earth. This is considered an irrefutable argument that the Earth is motionless. For if the latter had a daily rotation, a tower from the top of which a stone is dropped would be transported by the rotation of the earth, in the time it takes for the stone to fall, many hundreds of fathoms eastward, and the stone should fall to earth in a corresponding space away from the base of the tower. [1, p. 195].

This effect is confirmed by another experience, that is by dropping a lead ball from the top of the mast of a ship that is still, noting the sign of where it strikes, which is near the foot of the mast. But, if from the same place the same ball is dropped while the ship is moving forward, its point of percussion would be away from the other by so much space when the ship would have slipped forward at the time of the fall of the lead. And that is due solely to the fact that the natural motion of the ball released to itself is in a straight line toward the center of the Earth. [1, p. 195].

SALVIATI. This argument is strengthened by the experience of a projectile thrown upwards an enormous distance, as would be the case with a bullet fired from a cannon raised perpendicularly above the horizon, which in the ascent and return takes so long that in our parallel, the cannon and we together will be displaced by the earth many miles to the east, so that the bullet, falling, can never return to the cannon, but as far westward as the earth has advanced. [1, p. 195].

SALVIATI. But the shots to the south and to the north confirm, no less than the previous ones, the stationarity of the Earth, since, in these, one would never hit the target at which one would have aimed, but the shots would always be deflected to the west by the displacement that would have the target carried by the Earth towards the east while the bullet is in the air. [1, p. 196].

SALVIATI. Indeed, Aristotle says that the most certain argument against the mobility of the Earth is that we see that projectiles launched upward return perpendicularly along the same line to the same place from which they were launched, and this happens even when the motion reaches very high. If the Earth were moving this could not happen, because in the time when the projectile moves upward and downward, separated from the Earth, the place where the motion of the projectile started would move, due to the Earth's spin, a considerable distance upward and when falling the projectile would hit the Earth at the same distance away from that place. [1, p. 209-210].

### 3. Galileo and preinertia

The concept of preinertia, exactly the same as the one explained and defined by the author of this work, appears very clearly, among others, in the following quotations from Galileo, all of them included in the text of the Second Day, or Second Dialogue) of his *Dialogue Concerning the Two Chief World Systems -Ptolemaic and Copernican* [1, p. 171-371]. On different occasions, Galileo refers to this quality of physical objects by the name *marvelous effect in Nature* (italic and color are mine).

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*. [1, p. 228].

SIMPLICIO. And it seems to me that if, *as you say, the motion in which the stone participated when it was on the mast of the ship should be indelibly preserved in the latter, even after it is seen to be separated from the ship*, it would be necessary that, in a similar way, if someone on a horse running swiftly were to drop a ball from his hand, the ball, having fallen to the ground, should continue its motion and follow the horse's race without lagging behind. And I do not believe that such an effect would be seen except if the one on the horse were to throw it with force in the direction of the race. But, if this were not the case, I believe that the ball would remain on the ground in the place where it hits. [1, p. 230].

SALVIATI. I think you are very much mistaken, and I am sure that experience will show you the contrary, and that the ball, once it has reached the ground, will run along with the horse, and will not be left behind him except in case the roughness and irregularity of the road should hinder it. For if you, standing still, were to throw the same ball on the ground, would it not continue the motion even out of your hand, and the more regular the surface, so that, for example, on ice it would go very far away? [1, p. 230].

SIMPLICIO. There is no doubt about that, if I give it momentum with my arm, but in the other case the one on the horse is supposed to just drop it. [1, p. 230].

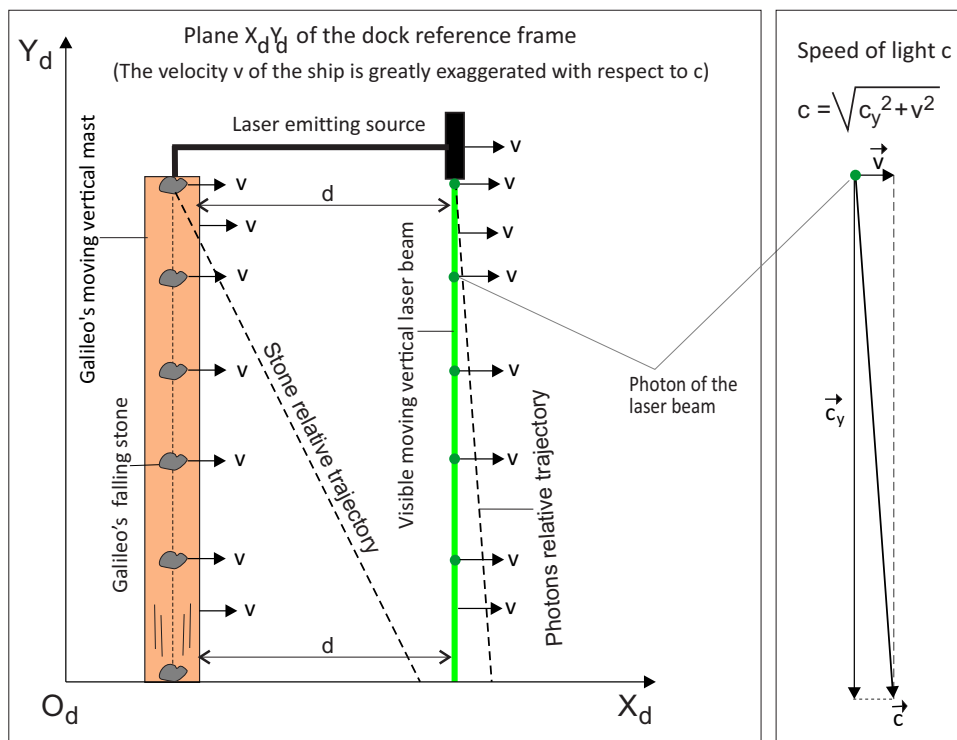
SALVIATI. That's how I want it to happen. But if you throw it with your arm, what remains in the ball, once it leaves your hand, but the motion created by your arm? Now, what does it matter whether the impetus is given to the ball by your arm or by the horse? *While you are on the horse, does not your hand, and consequently the ball,*

run as fast as the horse itself? Certainly yes, therefore, by merely opening your hand, the ball sets off with the motion already created not by the particular motion of your arm, but by the motion depending on the horse itself, which is communicated to you, to the arm, to the hand, and finally to the ball. I will tell you even more. If the rider when running throws with his arm the ball in the opposite direction of the race, the ball, once arrived on the ground, sometimes although thrown in the opposite direction, will follow the race of the horse, sometimes it will remain still on the ground, and will only move in the opposite direction to the race in the case that the motion received from the arm exceeds in speed that of the race. [1, p. 230-231].

SALVIATI. [Referring to the fall of a ball dropped from the top of a tower.] ... we see only the simple downward [movement], since the other, circular, common to the earth, to the tower and to us, is imperceptible and as it were null, and *we can only perceive that of the stone, in which we do not participate. And from this, downward, the senses show us that it is in a straight line, always going parallel to the tower that has been built straight and perpendicular on the earth's surface.* [1, p. 238].

SAGREDO. So it is equally true that, as the earth moved, the motion of the stone as it descended was really a long line of many hundreds or even thousands of fathoms, and if it could have marked on still air or any other surface the outline of its course, it would have left a very long transverse line. *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. [1, p. 250].

Although he came very close to discovering it, unfortunately Galileo did not discover that from preinertia, his *marvelous effect in Nature*, of physical objects, the impossibility of detecting absolute motion can be inferred almost immediately (See Figure 1). 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  $B, C, D \dots$  because all these objects inherit (preinertia) and maintain (inertia) the same absolute motion of  $A$  that one is trying to detect, so that the only thing that can be detected are the relative motions of  $B, C, D \dots$  with respect to  $A$  (most formal proofs can be found in [5, 6, 7]).



**Figure 1** – A modern version of the case of the stone dropped from the top of the mast of Galileo's ship, which moves at uniform velocity  $v$  with respect to the dock. Left: All ship and dock observers observe that the stone dropped from the top of the ship's mast falls in parallel to the ship's mast. And all ship and dock observers will also observe a vertical visible laser beam parallel to the ship's mast, which for the dock observers moves exactly the same as the ship's mast, which is only possible if the stone and the laser beam photons inherit (preinertia) and maintain (inertia) the ship's velocity  $\vec{v}$ . Right: The photon velocity vector  $\vec{c}$ , with its two components  $\vec{c}_y$  and  $\vec{v}$ , a vector whose modulus is always the universal constant  $c$ .

#### 4. A visual proof of preinertia

At this point, and by way of comparative reference with the Galilean concept of preinertia explicitly included in the above Galileo's quotations, it seems appropriate to advance the definition of preinertia proposed by the author, first in terms of relative velocity, and then in terms of absolute velocity:

1. Preinertia: universal property of every physical object by virtue of which it inherits the relative **VELOCITY VECTOR**, with respect to any other reference frame, of the reference frame in which it is set in motion.
2. Preinertia: universal property of every physical object by virtue of which it inherits the absolute **VELOCITY VECTOR** of the reference frame in which it is set in motion.

Preinertia being precisely the universal property of all physical objects, including photons, which makes the detection of absolute motion impossible (see above and [2]), it is also the property that makes it possible to demonstrate in formal terms that all motions are absolute and through the same real physical space [5, 6, 7]:

Indeed, the same preinertia that makes impossible for us the detection of absolute motion, serves us to demonstrate, now in formal terms, the absolute nature of the motion of all physical objects in the universe. Indeed, let us consider any one of these physical objects  $A$  and suppose that another physical object  $B$ , which is at rest in  $A$ , is set in motion, obviously from  $A$  (or is created in  $A$  just before being set in motion, as could be the case with photons, which are also preinertial [2, p. 385-404]). If all motions are relative,  $A$  maintains literally trillions of such relative motions, one for each of the trillions of cosmic objects with respect to which it moves. And if  $B$  is to inherit the relative motion of  $A$  when it is set in motion (preinertia) which of those trillions of relative motions will it inherit, and why not another? What memory and what mechanism determines that inheritance? From everything we know about the physical world, neither that memory nor that mechanism exists. Therefore, if there is neither memory nor mechanism for that inheritance of relative motion, the only motion that  $B$  can inherit from  $A$  is the absolute motion of  $A$  **THROUGH** (NOT WITH RESPECT TO) the same real physical space, which was also the absolute motion of  $B$  when  $B$  was part of  $A$ , before it was set in motion from  $A$ . It must be concluded that preinertia, whose physical reality is unquestionable, demonstrates the absolute nature of motion (more details in [2, 4]).

It is surprising that modern physics has not yet discovered the preinertia discovered by Galileo in the seventeenth century, and being as obvious as it is, could it have been due to an excess of evidence? It is worth asking, for example, what the history of physics would have been like, if Newton had discovered the preinertia described and published by Galileo in 1632. Considering that from this universal quality of all physical objects one can almost immediately deduce the impossibility of detecting the absolute motion of a reference frame with the objects of that reference frame, would the theory of special relativity have been written? would the way of detecting and measuring absolute motions have been found?

And above all, and taking into account that the rediscovery of preinertia was made public already more than four years ago ([2]), what academic authority will have to rediscover it for physics to finally consider its very significant existence?

Soon, we will present a new scientific instrument, currently under development: the inertioscope. As its name suggests, with the inertioscope it is possible to empirically demonstrate the universal reality of preinertia, even photons are preinertial!

(Forgive the abuse of self-references, but we do not know of other authors working on preinertia.)

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