the general science journal
The General Science Journal. September 2023.

The Shame Of Physics

Antonio León Sánchez
Retired Professor. Independent researcher in the foundations of science.

Abstract.-This paper develops an argument about the nature of motion based on preinertia, a universal property of all physical objects that physics has not yet discovered. The argument is closely related to the historical Clarke-Leibniz epistolary debate, which is now considered settled in favor of Leibniz's relativistic thesis, the same thesis that modern physics has adopted and enforced in an absolutist manner since the beginning of the twentieth century. The brief preinertial argument developed in this article proves that the debate may indeed be settled, but in the opposite direction. This really justifies the title of the article, not because of the probably wrong solution imposed (science is trial and error), but because of the totalitarian way of imposing it. And, of course, for not having yet discovered preinertia, surely the most universal property of all physical objects.

Keywords: preinertia, absolute motion, relative motion, physical space, gravitational waves, special relativity.

1. Introduction

As is well known, the enigma of parallels was called *the shame of mathematics* in the 18th century, among others by the "prince of mathematics" C.F. Gauss (quoted in [25, p. 9]). It may have been an exaggeration, for as E. Beltrami proved in the following century, non-Euclidean geometries are formally consistent, implying that Euclid's fifth postulate cannot be deduced from the other four [3, 4]. So it was not an embarrassment, but an impossibility. What would have been possible was to change Euclid's postulates (including a productive definition of a straight line) and prove the famous postulate on the new formal basis [15] [16, pdf].

It is appropriate to ask whether there is anything similar in physics that could be called "the shame of physics". In my opinion the answer is yes. Like geometry with its unsolved problems of parallels, physics has its own similar problem with the relative or absolute nature of motion, also discussed for centuries and only seemingly resolved, as the reader of this article will see. The novelty of the argument developed here is the use of a new concept (which should be classical because of its overwhelming empirical evidence): preinertia, a universal property of all physical objects by virtue of which each of them inherits the velocity VECTOR of the object on which it is at rest when it is set in motion (the absolute/relative nature of this inherited velocity will be discussed below).

It can be formally demonstrated that even photons are preinertial [17, pp. 337-356], although the demonstration is not necessary given the overwhelming empirical evidence for preinertia, for example, every time one of our objects falls to the ground; or every time we land on the same place we jumped (an argument used by some classical Greeks to defend the immobility of the Earth); or every time we start walking; or every time we throw a stone, a ball, an arrow, a rocket... In all these cases, a physical object is set in motion from another physical object (the Earth) moving at 370 km/s (1332000 km/h) in the direction of galactic coordinates (264.4±0.3, 48.4±0.5). If an object set in motion from the Earth did not inherit this motion from the Earth, it would shoot out in the opposite direction at about 1332000 Km/h, which obviously never happens. And the reason it never has and never will is preinertia, the shame of physics, because physics has not yet discovered preinertia, the most universal property of all physical objects, as will be seen here.

On the other hand, it is remarkable that physics has always used preinertia implicitly (I would say that more than implicitly it has always been used unconsciously) in almost all its arguments and theories. Let us recall, for example, the following words of Galileo (referring to the fall of a stone dropped from the top of the mast of a moving ship) published in 1632 [12, p. 226]:

> **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.

This marvelous effect in Nature is, of course, the universal property I have just called preinertia, a universal physical property of all physical objects that physics should begin to consider, make

its existence explicit, and use it in the discussions about the nature of motion, and even in the discussions about the nature of objects with the ability to move.

The main argument developed in the fourth section of this article is an example of how the concept of preinertia can be used, and at the same time a proof of its enormous importance. As you will see, it is an unexpected argument with strong historical resonances ranging from the Clarke-Leibniz controversy to the relativistic spacetime continuum of our own day. Besides being unexpected, it is, in my opinion, far from irrelevant for the future of physics: preinertia proves that absolute motion is undetectable and that motion is absolute, being the relative motions, the only observable motions, obvious consequences of the different unobservable absolute motions.

Apart from this introduction, the paper consists of four sections and two appendices. The second section introduces the concept of preinertia and briefly discusses some of its more immediate implications, such as the impossibility of detecting absolute motion; or the relation that preinertia might have to inertial mass and gravitational mass. The third section is a short argument on rotations, which serves as a preamble to the fourth section, which develops the main argument of the paper on the absolute or relative nature of motion. The conclusion of the argument is confirmed by another, even shorter, argument on the real nature of physical space. The fifth section briefly discusses the consequences of this conclusion for the real or apparent nature of relativistic inertial deformations of space and time. Obviously, if the argument developed in the fourth section is consistent, these deformations can only be apparent. The last two appendices deal with questions of mathematical infinity, which may be essential to establish the finite and discrete nature of space, time, and motion.

2. Preinertia: the vectorial inheritance of motion

Preinertia is a universal property with much more empirical evidence than inertia. The problem is that its existence and importance for understanding the nature of motion, and even of the physical objects, had not occurred to us. It can be defined in the following terms:

Definition 1 (of Preinertia) *Capacity of a physical object to inherit the velocity vector of the proper reference frame in which it is set in motion.*

The penultimate section of this paper (section 4) proves that the inherited velocity can only be absolute in nature. And although it can be formally demonstrated from the Lorentz Transformation that even photons are preinertial [17, pp. 337-356], it seems appropriate, in view of their enormous empirical evidence, to suggest their inclusion in the statement of the Principle of Inertia:

Principle 1 (of Inertia) *All physical objects are preinertial and maintain their state of motion as long as no external agent acts upon them.*

The universal reality of preinertia can also be demonstrated experimentally. A forthcoming article on the experiment being carried out in Santiago del Collado (Avila, Spain) will confirm this is the case. Preinertia is also consistent with the conservation principles of physics, to which it may be closely related.

On the other hand, it is logical to think that preinertia makes it impossible to detect the absolute motion of a reference frame by setting in motion its own objects. And the reason could not be clearer: the objects used in the detection attempt, including photons, would have the same (inherited) component in their motion as the motion to be determined. Or to put it in an elementary example: it is impossible to detect the velocity of a train by dropping an object on the floor of the train: the object inherits the velocity vector of the train when it is dropped (preinertia), maintains it while falling (inertia), and will always fall in the same place, regardless of the velocity of the train. Preinertia is also consistent with the conservation principles of physics, to which it may be closely related. The formal proof that follows is also very simple (taken from [17, p. 328-330]):

Assume, just for a moment! that there exist an absolute reference frame RF_a (perhaps made of the indivisible quantum space units qseats) through which physical objects can move in absolute terms. Let RF_o be a reference frame at rest in RF_a, and let A be any physical (point) object at rest in RF_o, where it is placed in the position (x_1, y_1, t_o) of RF_o (for simplicity, we dispense with the z-coordinate). Let A be set in motion at t_1, ($t_o < t_1$) with a uniform velocity $\overrightarrow{u}$ so that at the instant t_2 it is placed in the position of coordinates (x_2, y_2, t_2).

Consider now that RF_o moves in RF_a with an absolute and uniform velocity $\overrightarrow{v}$, and let A be set in motion under the same above conditions when RF_o was at rest in RF_a. Thanks to preinertia,

A inherits the absolute velocity vector $\overrightarrow{v}$ of RF_o with respect to RF_a, and thanks to the Principle of Inertia, *A maintains* $\overrightarrow{v}$ along its own motion with respect to RF_o. Let O_o be the origin of coordinates of RF_o. This point O_o moves with respect to RF_a at a velocity $\overrightarrow{v}$, while A moves with respect to RF_a at a velocity:

$$\overrightarrow{w} = \overrightarrow{u} + \overrightarrow{v} \tag{1}$$

The object A (that moves with respect to RF_a at the velocity $\overrightarrow{w}$ given by (1)) will move with respect to O_o (that moves with respect to RF_a at the velocity $\overrightarrow{v}$) at a velocity $\overrightarrow{u'}$ given by:

$$\overrightarrow{u'} = \overrightarrow{w} - \overrightarrow{v} \tag{2}$$

$$= \overrightarrow{u} + \overrightarrow{v} - \overrightarrow{v} \tag{3}$$

$$= \overrightarrow{u} \tag{4}$$

which is the same velocity as if RF_o were at rest with respect to RF_a. In consequence, the coordinates of A in RF_o at t_2 will be the same as in the first case when RF_o was at rest in RF_a. So, the coordinates of A at t_2 will also be (x_2, y_2, t_2), and they cannot be used to detect the absolute motion of RF_o.

Since RF_o is any reference frame, A any physical object initially at rest in RF_o, and $\overrightarrow{u}$ any uniform velocity, we must conclude that the absolute motion of a reference frame is undetectable by setting into motion any physical object (or objects) of that reference frame.

The impossibility to detect any possible absolute motion due to preinertia is already a sufficient reason to consider this universal property of all physical objects. And there is still the most important reason, which will be discussed in section 4 of this paper.

Another important aspect of preinertia is its possible relationship to inertial mass and gravitational mass. Remember that:

1. Every material object offers resistance to change its state of motion (inertial mass).
2. Every material object alters the properties of physical space (gravitational mass).
3. Every material object is sensitive to the gravitational fields created by other objects (gravitational mass).
4. Every physical object inherits the velocity vector of the reference frame in which it is set in motion (preinertia).

And the inevitable question is: do these four properties of material objects have the same common cause? The possible affirmative answer could be a fundamental mass, from which inertial mass, gravitational mass, and preinertia are derived. Note, however, that photons, which are supposedly massless, are also preinertial. But photons, as such particles, have only spin 1. Other particles have a different spin (1/2) and yet all have the same preinertia. So it does not seem reasonable to think that spin is the fundamental cause of preinertia. On the other hand, it is also worth considering that there are extremely small universal masses, such as the mass I have called QUANTUM MASS or RYDBERG MASS. [17, p. 235]:

$$m_q = \sqrt{\frac{G\hbar^3 R_\infty^4}{c^5}} = \hbar\, t_p R_\infty^2 = 6.845023 \times 10^{-64} Kg$$

where t_p is the Planck time and R_∞ is the universal Rydberg constant, which is specific to each chemical element and varies slightly with its mass. It then seems reasonable to propose some fundamental rest mass for photons, such as the quantum mass mentioned above, as the cause of their preinertia, and we would have the same cause as all other preinertial objects. Moreover, if photons had rest mass, one could analyze the possibility that their gravitational interaction with very massive objects bends their trajectories, rather than those very massive objects bend the physical space itself, as general relativity proposes, a bending much more bulky than that of photon trajectories.

In any case, it seems reasonable to propose that all, absolutely all, physical objects capable of motion have the same property (fundamental mass?) responsible for resisting changes in their state of motion; for modifying the state of motion of other objects at a distance by changing the properties of the surrounding space; and for inheriting in vector terms (!) the state of motion of the object on which they were at rest when they were set in motion. Obviously, it would be a key property in the evolution of the universe.

3. An elementary preamble on rotations

The Newton's Bucket experiment [23, p. 131-132] [22, p. 80-81] is, in my opinion, one of the most important real experiments in the history of physics, both for its results (which are not sufficiently appreciated in our relativistic days) and for the controversies that it gave rise to, especially the one between Clarke (absolutist) and Leibniz (relativist) [19, p. 34-46][20, p. 67-86]. Two hundred years later, E. Mach revived the controversy by proposing that the water in Newton's bucket was in fact rotating WITH RESPECT TO the sphere of fixed stars (SFS) in the place of AROUND an internal axis of rotation [19, p. 83-84] [20, p. 45].

Consider the daily rotation of the Earth around its internal axis of rotation. As a result of this rotation, from the Earth, the Sun is observed to rotate around the Earth daily. But this daily rotation of the Sun is not only apparent, it is impossible: for the same reason as in the case of the Earth, the Sun would also have to rotate around each of the bodies that orbit around it and revolve around an internal axis of rotation (Mercury, Venus, Mars, etc.). Therefore, each point of the Sun would have to describe a large number of different circular trajectories around different centers of rotation at the same time, which is physically and geometrically impossible. But the appearance, as such appearance, is real. Therefore the rotation of the Earth that produces it can only be a real rotation.

Consider again the Earth rotating around its internal axis of rotation, the axis Ax. Each point of the Earth describes a circle around a unique point, its center of rotation on the axis Ax. Consequently, and since in a single rotation a point cannot rotate around two or more centers of rotation at the same time, the rotation of the Earth can only be referred to its internal axis of rotation Ax. Thus:

1. The rotation of the Earth is real, as evidenced by the apparent rotations it causes in other celestial bodies as the Sun.
2. The rotation of the Earth can only be referred to its own axis of rotation.
3. Therefore, the rotation of the Earth can only be an absolute rotation, i.e. an absolute motion.

The same conclusion, and for the same reasons, must apply to the billions of celestial bodies that rotate around an internal axis of rotation. The vast majority of these celestial objects have motions defined by multiple components, one of which is an absolute rotation around an internal axis. The question is how can a motion, one of whose components is an absolute motion, be relative? The following section points to a very simple answer.

4. A preinertial argument on the nature of motion

As we will see, preinertia reopens the classic Clarke-Leibniz epistolary debate about the absolute/relative nature of motion, albeit in very different non-theological terms. Indeed: Suppose that at a given instant t_o a cosmic object A is uniformly moving with respect to any other cosmic object X with a given relative velocity vector $\vec{v}_{XA}$. According to the principle of inertia, all objects at rest on A move with the same relative velocity vector $\vec{v}_{XA}$ with respect to X, and thanks to preinertia they inherit this relative velocity vector when they are set in motion from A itself.

Suppose then that at the precise instant t_o one of these objects at rest on A, say B, is set in motion with a rectilinear and uniform velocity vector $\vec{v}_{AB}$ with respect to A. And let us also suppose that all motions are relative, that absolute motion does not exist, as is assumed in the hegemonic relativistic stream of contemporary physics, for which absolute motion is meaningless [9, p. 341], is anathema. The preinertia of B implies that B inherits the relative velocity vector $\vec{v}_{XA}$ of A with respect to X as a component of its own velocity vector $\vec{u}_B = v_{XA} + v_{AB}$, so that B moves with respect to X with a velocity vector $\vec{u}_B$.

Now then, A has billions of relative velocity vectors (most of them variable with time due to different cosmic incidents) with respect to the billions of different objects in the universe (photons, neutrinos, electrons, planetesimals, planetoides, planets, stars etc.). Although (in principle) it could be sufficient to inherit only one of them, for example the relative velocity vector $\vec{v}_{XA}$, there is no physical or logical reason to inherit one of them and not any of the others. But things are much more complicated because we also have to take into account:

1. The continuous variation of all the billions of relative motions due to continuous interactions of all kinds (collisions, accelerations, decelerations, explosions, etc.) that produce changes in the billions of the relative velocity vectors of the corresponding objects.
2. In addition to the storage system of the information corresponding to all these billions of relative velocity vectors, and taking into account that the vast majority of these objects are

not quantum entangled, there would have to exist in each object a mechanism of emission and reception of the information corresponding to all those billions of changes in the relative velocity vectors of the different cosmic objects, and in addition there would have to exist a way to propagate that information through distances of billions of light years.

3. The object that is set in motion could in turn be the object from which other objects are set in motion.

Under these conditions, each object O set in motion with the ability to set other objects in motion (including, for example, electrons that could emit photons) would have to inherit the information of all the billions of relative velocity vectors of the object A from which it was set in motion, in order to transmit them in turn to the new objects O' that could be set in motion from the object O. Otherwise, the object O would not have the necessary information to update the successive changes in the relative velocities of the billions of objects whose relative velocity with respect to the first object A would have changed in the past and not yet been updated in A when O was set in motion from A.

Consequently, every natural object (including living organisms!) would have to have a system for storing information about all the relative velocity vectors of all the billions of other physical objects moving with respect to it, as well as a system for transmitting and receiving all those inevitable changes in relative velocity. In addition, and as indicated above, there would also have to be a way to propagate throughout the billions of light-years of all space the information of all the changes in velocity that the billions of cosmic objects may undergo as a result of all kinds of cosmic interactions. Obviously, none of this seems to exist, nor does it seem reasonable to assume that it could exist in any of the objects of the universe that can be set in motion from another moving object on which they were at rest. This is simply absurd, and there is an extremely simple alternative:

> The unique velocity vector inherited in preinertia is the absolute velocity vector (THROUGH the real physical space) of the object from which any other object at rest (in the first object) is set in motion.

The only real motions would be the absolute motions THROUGH absolute space, as Newton defended [22]. The different absolute motions of the different objects being the cause of their different relative motions, which are the only motions we can detect for the time being, just because of preinertia.

The above conclusion about motion is confirmed by another completely independent argument concerning the physical reality of space (which is still denied by many contemporary physicists). Indeed, the empirical detection of gravitational waves proves the physical reality of space, the existence of a space matter, since what does not exist cannot vibrate, nor can it transmit its own vibrations, nor can it modify the size of other physical objects as the arms of the interferometers that detect those space vibrations. The only objects with empirically detectable physical properties are real physical objects; fictional objects have no empirically detectable physical properties. Consequently, and once the vibrations of space (gravitational waves) have been empirically detected [1, 2, 5, 6, 7, 8, 10, 11, 13, 14, 21, 24, 26, 27, 28], it must be admitted that space is a real physical object with real and empirically detectable physical properties. This real space is the unique common space for all real physical objects (except space itself). Consequently, motion THROUGH a real and unique common space can only be considered as absolute motion. Therefore, the entire argument of this section proves the following theorem:

Theorem 1 (of Absolute Motion) *The universality of preinertia and the reality of absolute physical space prove that all motion through that absolute space is absolute motion.*

On the other hand, everything would be much simpler if that were the case. And it is worth remembering that the physical world bears in its essence the signature of simplicity, as we are reminded by Ockham's Razor and the following words of Galileo, with which I concluded the previous argument about preinertia and the nature of motion [12, p. 183-184]:

> Now, if in order to achieve the same effect in a precise way, it is just as important that the Earth alone should move, stopping all the rest of the Universe, as it is that the whole Universe should move with a single movement, who would want to believe that Nature (which, according to common agreement, does not do by the intervention of many things what it can do by means of a few) has chosen to make an immense number of very large bodies move, with inestimable velocity, in order to achieve what can be obtained by the moderate movement of a single body around its own center?

5. Consequences on the theory of special relativity

The above Theorem of Absolute Motion would be confirming the apparent, not real, nature of the inertial deformations of spacetime deduced from special relativity (actually from the Lorentz Transformation). Indeed, the spacetime deformations of special relativity could be only apparent, as apparent as the refractive deformations: no matter how many times we experimentally confirm Snell's Law, the rod partially submerged in water is not really bent. In the case of the relativistic FitzGerald-Lorentz contraction, a good part of relativists think that it is not real, but apparent, because an object cannot have different sizes at the same time; nor can an elastic band at rest be more stretched in some parts than in others if it is free of external forces (see the elastic band argument, and many more in [17, pdf]). Now then, if one of the consequences of the Lorentz Transformation is apparent, are the other consequences also apparent? If the answer is no, what part of the theory of special relativity determines which of these deformations are apparent and which are not? and why should some be apparent and others real? Moreover, let us not forget that the experimental confirmations of special relativity must be:

1. Symmetric: If from an inertial reference frame RF_A a spacetime deformation is observed in another inertial reference frame RF_B, then *at the same time* and from the reference frame RF_B the same deformation must be observed in the reference frame RF_A. A symmetry that, as far as I know, has never been confirmed.
2. Universal: All objects contract in the direction of relative motion in exactly the same way, regardless of their composition and internal structure: wood, paper, steel, elastic bands, glass, etc., all contract in the same way and without any external force explaining the contraction. And the ticking of clocks also expands in the same way in all imaginable types of clocks: mechanical, electrical, electronic, biological, etc., without any cause that explains the change in the corresponding mechanisms that cause their respective periodic events (tic-tac) used to measure time. Of course, modern clocks that display time on large alphanumeric displays call into question inertial time dilation and relativistic local simultaneity, unless those displays simultaneously display as many different times as different relative velocities at which they can be observed [17].
3. Acausal: The relativistic spacetime deformations have no specific physical cause that produces them. The only cause of their existence would be the relative velocity at which the corresponding objects and events are observed. The problem is that we can observe and measure deformed objects that are not really deformed but apparently deformed, a deformation that also depends on the way in which these apparently deformed objects are observed, in this case partially submerged in water.[1]

All this points to the fact that the relativistic inertial deformations of space and time, as mentioned above, could only be apparent. Not to mention the more than possible inconsistency of the infinitist spacetime continuum, if any of the more than 40 proofs of the inconsistency of the Hypothesis of the Actual Infinity in [18, pdf] is correct. Let me end by recalling one of those iconic images of a mad, genius-looking scientist proudly posing in front of a blackboard full of mathematical signs. Doesn't the reader think that science has too much ego, too much author mania? And what will happen if this infinitist mathematics turns out to be wrong? The reader can get an idea of this possibility by taking less than five minutes to read the two final appendices to this article.

AMH A.C.L.M.

Bibliographical References

[1] BP Abbott, Richard Abbott, TDea Abbott, S Abraham, F Acernese, K Ackley, C Adams, RX Adhikari, VB Adya, Christoph Affeldt, et al. Gwtc-1: a gravitational-wave transient catalog of compact binary mergers observed by ligo and virgo during the first and second observing runs. *Physical Review X*, 9(3):031040, 2019.

[2] M. Bartels. First Evidence of Giant Gravitational Waves Thrills Astronomers. *Scientific American*, June 2023.

[3] E. Beltrami. Note fisico-matematiche. *Rendiconti del Circolo Matematico di Palermo (1884-1940)*, 3(1):67–79, 1889.

[4] Eugenio Beltrami. Saggio di interpretazione della geometria non-euclidea. *Giornale di Matematiche*, pages 285–315, 1868.

[1] Are we really so idiot?

[5] D. Blanco Laserna. *Las ondas gravitacionales*. RBA Editores, Mexico, 2017.

[6] R. T. Cahill. Quantum Foam, Gravity and Gravitational Waves. *Relativity, Gravitation, Cosmology*, pages 168–226, 2003.

[7] Reginald T. Cahill. A new light-speed anisotropy experiment: absolute motion and gravitational waves detected. *Progress in Physics*, 4:73–92, 2006.

[8] A Chalumeau, S Babak, A Petiteau, S Chen, A Samajdar, R N Caballero, G Theureau, L Guillemot, G Desvignes, A Parthasarathy, K Liu, G Shaifullah, H Hu, E van der Wateren, J Antoniadis, A-S Bak Nielsen, C G Bassa, A Berthereau, M Burgay, D J Champion, I Cognard, M Falxa, R D Ferdman, P C C Freire, J R Gair, E Graikou, Y J Guo, J Jang, G H Janssen, R Karuppusamy, M J Keith, M Kramer, K J Lee, X J Liu, A G Lyne, R A Main, J W McKee, M B Mickaliger, B B P Perera, D Perrodin, N K Porayko, A Possenti, S A Sanidas, A Sesana, L Speri, B W Stappers, C Tiburzi, A Vecchio, J P W Verbiest, J Wang, L Wang, and H Xu. Noise analysis in the European Pulsar Timing Array data release 2 and its implications on the gravitational-wave background search. *Monthly Notices of the Royal Astronomical Society*, 509(4):5538–5558, 11 2021.

[9] John Daintith, editor. *Dictionary of Physics*. Oxford University Press, New York, 2009.

[10] A. Einstein and N. Rosen. On Gravitational Waves. *J. Franklin Inst.*, 223:43–54, 1937.

[11] Fabrizio Fiore, Luciano Burderi, Tiziana Di Salvo, Marco Feroci, Claudio Labanti, Michelle R. Lavagna, and Simone Pirrotta. HERMES: a swarm of nano-satellites for high energy astrophysics and fundamental physics. In Jan-Willem A. den Herder, Shouleh Nikzad, and Kazuhiro Nakazawa, editors, *Space Telescopes and Instrumentation 2018: Ultraviolet to Gamma Ray*, volume 10699. International Society for Optics and Photonics, SPIE, 2018.

[12] G. Galilei. *Diálogo sobre los dos máximos sistemas del mundo ptolemaico y copernicano*. Círculo de Lectores, Barcelona, 1997.

[13] S. Hacyan. *Ondas gravitacionales*. Fondo de Cultura Económica, México, 2019.

[14] G. Herrera Corral. *Agujeros negros y ondas gravitacionales*. Editorial Sexto Piso, Madrid, 2019.

[15] A. León Sánchez. Proving unproved Euclidean propositions on a new foundational basis. *International Journal of Scientific Research in Mathematics and Statistical Sciences*, 7(3):61–68, 2020.

[16] A. León Sánchez. *New Elements of Euclidean Geometry*. Amazon's Kindle Direct Publishing, 2021. PDF.

[17] A. León Sánchez. *Apparent relativity*. Amazon's KDP, 2022. PDF.

[18] A. León Sánchez. *Infinity put to the test*. Amazon's KDP, 2023 (2021). PDF.

[19] Tim Maudlin. *Filosofía de la física I. El espacio y el tiempo*. Fondo de Cultura Económica, México, 2014.

[20] Tim Maudlin. *Philosophy of Pysics. Space and Time*. Princeton University Press, New Jersey, 2015.

[21] Christopher J. Moore and Alberto Vecchio. Ultra-low-frequency gravitational waves from cosmological and astrophysical processes. *Nature Astronomy*, 5(12):1268–1274, 2021.

[22] Isaac Newton. *Mathematical Principles of Natural Philosophy*. Daniel Adee Publishing, New York, 1846.

[23] Isaac Newton. *Principios matemáticos de la filosofía natural*. Alianza, Madrid, 1987.

[24] Carlos Garcia Nu nez, Gavin Wallace, Lewis Fleming, Kieran Craig, Shigeng Song, Sam Ahmadzadeh, Caspar Clark, Simon Tait, Iain Martin, Stuart Reid, Sheila Rowan, and Des Gibson. Amorphous dielectric optical coatings deposited by plasma ion-assisted electron beam evaporation for gravitational wave detectors. *Appl. Opt.*, 62(7):B209–B221, Mar 2023.

[25] J.J. O'Connor and E.F. Robertson. Non-Euclidean Geometry History, 1996. McTutor History of Mathematics. Accesed: 2016-02-16.

[26] Tony Rothman. The Secret History of Gravitational Waves. *American Scientist*, 106(2):95, 2018.

[27] Wolfgang Steinicke. Einstein and the Gravitational Waves. *Astronomische Nachrichten*, 326(7):640–641, 2005.

[28] Heng Xu, Siyuan Chen, Yanjun Guo, Jinchen Jiang, Bojun Wang, Jiangwei Xu, Zihan Xue, R. Nicolas Caballero, Jianping Yuan, Yonghua Xu, Jingbo Wang, Longfei Hao, Jingtao Luo, Kejia Lee, Jinlin Han, Peng Jiang, Zhiqiang Shen, Min Wang, Na Wang, Renxin Xu, Xiangping Wu, Richard Manchester, Lei Qian, Xin Guan, Menglin Huang, Chun Sun, and Yan Zhu. Searching for the nano-hertz stochastic gravitational wave background with the chinese pulsar timing array data release i. *Research in Astronomy and Astrophysics*, 23(7):075024, jun 2023.