
THE NEWTON'S BUCKET AND PHYSICAL SPACE

Antonio Leon

Retired Professor. Independent researcher in the foundations of science.

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Abstract.-This paper introduces a new argument about the absolute nature of rotations of celestial bodies revolving around an internal axis, and extends the discussion to uniform motion.

Keywords: absolute rotation, Newton bucket, Newton rotating balls, planet rotations, space matter, absolute space, absolute and relative motion.

1 Introduction: Physics and mathematics

I agree with T. Maudlin that it is impossible to overstate the importance of space in physics. [2, p. 4]. But there are other issues in physics whose importance is also impossible to exaggerate. Some of these issues are forgotten (such as the hypothesis of actual infinity, or the problem of change); some are somewhat forgotten (such as Newton's bucket experiment); and some are always present (such as the infinitist spacetime continuum). I have dealt with the issue of infinity on numerous occasions. And it seems so important to me that I recall it again in this brief introduction. To paraphrase Maudlin again, it is difficult to exaggerate the importance of infinity in physics: the spacetime continuum is modeled by a non-numerable actual infinite set.

But it is even more difficult to exaggerate the irresponsibility of physicists who for more than 120 years have not fulfilled their obligation to falsify the Actual Infinity Hypothesis subsumed in the Axiom of Infinity, one of the axioms that underlie their infinitist mathematics. What will happen when it is proven that, in fact, that mathematics is inconsistent? Physics would remain what it really is: an operational, functional science, which accounts for observations and measurements made in the physical world, but which does not explain what the physical world really is.

Neither of the other three problems just mentioned has a definitive solution, although many contemporary physicists believe otherwise. In one of my last articles I dealt with the question of Newton's bucket. It is possible that in that article the absolute nature of the rotation of the water molecules in the famous bucket was proved. Although Newton's intention went beyond what happened in the bucket: he was aiming at the absolute nature of space and time, those entities that he did not define because *they are well known to all* [3, p. 77]. In this article new arguments are offered that point in the same absolutist-Newtonian direction.

But first it is worth considering the enormous consequences for physics of the detection of gravitational waves, because this detection proves the physical reality of space: what does not exist has no empirically detectable properties. Space is therefore as real as ordinary matter, although made of a sub-

stance, space matter, which must be different from ordinary matter and dark matter due to simple gravitational considerations [1]. This physical reality of space will surely change many things in the physics of the future, it will be a very important advantage that was not available to the physicists of previous centuries.

2 Newton's bucket and relativity theories

The Clarke-Leibniz controversy and the subsequent criticism by E. Mach of the Newtonian bucket arguments are well known. Less well known are the relativistic discussions (special and general) of the accelerated motion of water in Newton's bucket, and the theoretical variant of two massive globes connected by a cord rotating in empty space around their common center of gravity [4, p. 133] [3, p. 82]. Obviously, the accelerated motion falls outside special relativity, except in the thought experiment of the two globes connected by a cord rotating in a completely empty universe and thus without gravity.

Two questions arise in the matter of these rotations: with respect to what do the water molecules in the bucket at rest rotate, and with respect to what do these same molecules accelerate? And the same questions are asked about the rotating globes connected by the cord. The relativistic answer to the first question almost coincides with the opinion of Leibniz and Mach: Like all motions, the motion of the water molecules in the Newton bucket and that of the globes connected by the cord is RELATIVE to all objects external respectively to the water molecules themselves and to the globes themselves.

In the case of the second question there is a partial agreement between Mach's answer and the relativistic answer. According to Mach, the acceleration of the water in the bucket occurs because of the external stars (Mach's Principle); and with respect to the globes connected by the cord rotating in empty space around their common center of gravity, Mach states that it is outside our possibilities of analysis because it is based on an unreal situation of which we have no experience to guide us, and so we cannot analyze the situation. Instead relativity (special and general) replies that acceleration occurs with respect to absolute spacetime, which in a way partially agrees with Newton, although now it is the absolute

spacetime of relativity as opposed to Newton's absolute space.

3 Earth, Venus and Newton's bucket

As will be seen below, there is an important and unbridgeable asymmetry between the relativism of uniform motion (rectilinear or constant linear velocity) and the relativism of uniform rotation (circular or constant angular velocity). In the case of uniform motion, if an object A moves with a uniform velocity \vec{v} with respect to another object B, object B moves with respect to object A with the same velocity and opposite direction $-\vec{v}$, and, above all, it is impossible to prove that one of the motions is real and the other is false. However, and as will be seen in the elementary argument included in the rest of this section, that is exactly what happens with uniform rotations.

Recall that all the planets of the solar system orbit the sun in the counterclockwise direction (as seen from above the Earth's north pole). Most of them rotate on their axis in the same direction in which they rotate around the Sun, as is the case of the Earth; but not Venus, whose rotation is retrograde and 243 times slower than that of the Earth. In these conditions, on the Earth it is observed that the Sun describes a complete rotation around the Earth and in the clockwise direction approximately every 23.56 Earth Sidereal Hours (ESH). In contrast, on Venus, the Sun is observed to make one complete revolution around Venus in the counterclockwise direction approximately every 5725.08 ESH.

Of course, it is impossible for the same object, the Sun, to describe two such different rotations at the same time. And the same conclusion, and for the same reason, applies to the billions of celestial objects in apparent rotation around Venus and around the Earth. These apparent rotations of celestial bodies around the Earth and Venus are only apparent. Or to put it more clearly, they are non-existent rotations, they are false rotations. Because they could be apparent but real in some sense. But what has just been proved is that they are formally false.

Now then, the apparent rotations of the Sun and those of the rest of the stars and galaxies around the Earth and around Venus, as such appearances, are real and measurable: 24.56 ESH in the case of the Earth and 5725.08 ESH in the case of Venus. Therefore, the axial rotations of the Earth and those of Venus that produce them can only be real and absolute rotations. Each point of the Earth, and of Venus, describes a real and absolute circular path AROUND a single point on its corresponding axis of rotation.

The rotations of Venus and the Earth around their respective axis of rotation, and that of billions of other objects that also rotate around an axis of rotation, are thus absolute motions that can only take place THROUGH an absolute space and AROUND an absolute axis of rotation. Naturally, this is the Newtonian conclusion of an argument developed in the 21st century, but strongly inspired by Newton's 17th century bucket.

4 Two Newton's buckets

It is immediate to extend the previous argument about the rotations of the Earth and Venus to Newton's bucket. To do this we need only consider two Newton's buckets instead of one. Two Newton's buckets rotating in opposite directions and with different angular velocities, which is in fact a simple extension of Newton's experiment to which the reader can immediately apply the above argument about the Earth and Venus. And the conclusion he will draw will be the same as Newton's: the absolute rotation of the water molecules of both buckets through a real and absolute space and around their respective axes of rotation.

5 Conclusion

All motions of all objects in the universe, including uniform inertial motions, would be motions THROUGH the same space in which absolute rotations occur. They would therefore be absolute motions THROUGH absolute space. Although they are undetectable motions due to preinertia and the fact that we cannot observe (at the moment) absolute space to use it as a reference. Instead we use visible objects as reference and speak of relative motions. But in reality the motion we observe, whatever it is, is always a motion THROUGH the same real and absolute space, THROUGH the real space matter. Another thing is that in order to quantify these motions we need to use visible references, but it does not seem acceptable to use this need to establish that relative motion is the only motion. The relativistic explanation of motion may be operative and functional, but it is not fundamental.

In conclusion, it is worth recalling the following words of Newton in the Scholium of Book 3 of his Principia, changing the word God for the word space, and the word virtue for the word attribute [3, p. 505]:

Space is omnipresent not virtually only, but also substantially; for attributes cannot subsist without substance. In it are all things contained and moved; yet neither affects the other: Space suffers nothing from the motion of bodies; bodies find no resistance from the omnipresence of space. It is allowed by all that space exists necessarily; and by the same necessity it exists always and every where. Whence also it is all similar.

Bibliography and References

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