17. Motion

(Chapter of the book Apparent Relativity (pdf))

17.1 Introduction

I never thought I would have to write such a text. Not even for this book, whose main protagonist is motion. But while reading a popular book on relativity, I came across a sentence that made me change my mind (see below). I understood the seriousness of the damage caused by the infinitist mathematization of physics. And I thought it appropriate to point it out.

I discuss here, from a physical and logical (not mathematical) point of view, the perception and description of motion and the concept of velocity, an intrinsic quantitative property of motion. The reader will find here a very significant surprise concerning the existence and nature of motion itself: the demonstration of something that is a real anathema in contemporary physics.

The chapter was written after the revision of the second edition of the book was completed, and is included here because the following chapter introduces and uses for the first time the concept of double relative velocity. Although this concept is fully defined and justified there, the considerations in this chapter are more general and profound, and will be useful for the rest of the book.

17.2 Does motion really exist?

An important consequence of the mathematization of physics is the confusion between the description in symbolic languages of physical phenomena and the physical phenomena themselves. If a certain description of a phenomenon, or of a property, is impossible with a certain language (in our case the language of infinitist mathematics), then the existence of the phenomenon, or property, is denied, no matter how real and evident its existence may be. And here comes the motivating quote of this chapter (I recognize a certain level of ambiguity in the original Spanish expression, see below) [3, p. 41]:

> ... the concept of velocity does not make sense if we do not specify a concrete reference frame. There is no such thing as velocity at all.

Where we will interpret reference frame as any object that allows to describe motion as the changes of position relative to that object, because it would be ridiculous to think that no physical objects of the universe had velocity until Descartes invented the coordinate systems. It is obvious that for many hundreds of millions of years there were no observers in the universe who could describe the motion of its objects. But those movements necessarily had to occur to make possible the directional and consistent evolution of the universe itself (see Chapter 46) that finally produced the rational observers who now try to explain it. So, one thing is motion and another thing its description. Motion does not need to be described in order to exist, to assume otherwise is an unacceptable excess of human arrogance. It is clear that in order to describe motion we need observers to describe it and the necessary instruments for the description, among which we include reference objects and reference frames.

Suppose that two VISUALLY ISOLATED spacecrafts A and B moves uniformly and relative to each other in the intergalactic space free of gravitational interactions. A and B are equipped with a signal transmitter and a signal receiver that allow each of them to detect the presence of the other spacecraft and calculate its relative position with respect to the other spacecraft, without the signals received being able to modify their relative velocities. Assume that after a while B turns *off* its signal transmitter, can we affirm that the motion of A disappears? According to the Principle of Inertia the answer can only be no, it cannot disappear. Only the possibility of describing it INSIDE VISUALLY ISOLATED spaceship A has disappeared. If after another while, the spaceship B turns *on* again its signal transmitter, the ability to describe the motion of A inside A is recovered, but the motion itself had not disappeared: existed even if it was not possible to describe it with external references (the signals sent by B).

It happens, as Galileo would surely say, that we do not have sensors for uniform motion, as we do for heat, humidity, sound, pressure, etc. So the only way to perceive uniform motion and quantify it in temporal terms (velocity) is to measure our successive changes of position with respect to any external object. But this is describing motion, not explaining motion. The fact that we need external references to describe motion does not imply that motion does not exist if those external references are not available. Blind people do not see because their visual sensors fail, but objects still exist and move. If we could see the points of the spacetime continuum, or the qseats of discrete spaces, we would not need macroscopic external references to describe motion.

Let us go back to the spacecrafts A and B and include n other identical INSIDE VISUALLY ISOLATED spacecrafts, all in uniform relative motion to one another. Whatever the number of spacecrafts, their relative motions are all *logically consistent*:

> Knowing the relative motion of one spacecrafts relative to all the others, we will also know the relative motion of all the spacecrafts relative to each other.

If we add a new spaceship Z, it is only necessary to know its motion with respect to any of the other spaceships to know the motion of Z with respect to all the others spaceships.

And if all these spaceships turn *off* their respective signal transmitters and become undetectable, do they keep moving, or do they stop moving? If they stop moving, and in addition to violating the Principle of Inertia, how do they recover their corresponding motions when all spaceships turn *on* their respective signal transmitters if nothing happens in any of the spaceships, except turning *off*/on their respective signal transmitters? What universal law causes them all to stop and then regain their motion in the same condition in which they lost it? On the other hand, if they keep moving, relative to what do they move if there are no external references? Remember that the only observers are the observers inside the INSIDE VISUALLY ISOLATED spaceships, just as the only observers in our observable universe are the observers inside our observable universe, whose exterior, if any, is not observable.

Moreover, and again leaving aside the Principle of Inertia as an inevitable attribute of uniform motion, it is worth asking for each spacecraft in the group whether, during the time it was not receiving signals from the other spacecrafts, it changed or did not change its position relative to the other spacecrafts. In other words, one can ask whether its position relative to the other spacecraft when it stopped receiving their signals is different from its position relative to the same spacecraft when it starts receiving their signals again. And there is only two alternatives:

1. Their relative position has changed. Therefore, the motion of each spacecraft has existed in spite of having no external references to describe it, of its description being impossible. Consequently, we must conclude that uniform motion exists whether or not it can be described with respect to external references. But if the motion of each of these spaceships exists without reference to any external reference, then its motion is not relative to anything; it is not relative motion. So, it can only be absolute motion!
2. Their relative positions has not changed. Therefore they have been stationary during that time interval, which implies that each spaceship instantaneously stopped when it stopped receiving signals, and instantaneously resumed its motion when it resumed receiving signals from the other spaceships. This alternative is impossible because the received signals cannot modify the velocity of the spacecrafts, apart of the violation of the Principle of Inertia and the necessity of impossible infinite decelerations and accelerations without a force causing them.

I can think of only two ways to explain the situation posed by the above spacecrafts when they stop emitting signals and then resume emitting signals. The first of these is anathema to most contemporary physicists (who, by the way, have not yet discovered the most universal property of all physical objects: preinertia). The second at the level of certain explanations and theories of contemporary physics. They are the following:

1. All spacecrafts move in the same absolute space (absolute motion) but with

different absolute velocities, which consistently determines all their relative velocities.

Comment: Preinertia, which is a property of all physical objects (including photons) for which there is the maximum empirical evidence, makes the detection of absolute motion impossible (a matter that is discussed in Part IV of this book).

2. Like space and time, motion is only an illusion. So, is there anything real in the universe?

The author of the motivating quotation of this chapter (page 162) says a few pages later in the same book and in an expression somewhat less ambiguous than the first one, although more difficult to translate:

> ... it is precisely because, in the absence of relative indicators, there is no way to tell the difference between rest and motion: they do not exist.

In the same line of what exists or does not exist, now in relation to time, the Nobel Prize in Physics (1954) Max Born wrote [54, p. 226]:

> Now, the concept of simultaneity is a fallacy of this type [due to a confusion of habits of thought with logical consistency].
>
> But there is certainly no such time for the quantitative physicist. He sees no meaning in the statement that an event at A and an event at B are simultaneous, since he has no means of deciding the truth or falsity of this assertion.

That is to say, those things that we humans cannot observe or measure simply do not exist, or have no meaning. But some alternative questions on this issue can be raised: Why cannot we observe or measure or decide on certain things? because they do not exist, or for other reasons? Would not it be interesting to solve this dilemma? Can we be so sure of our science as to rule out the existence of anything that does not fit into it? Was there nothing consistent in the universe until human observers appeared?

But returning to motion, the fact that we cannot *sensorially* perceive uniform motion, and that the spatial elements (points or qseats) through which motion occurs are not visible for us, does not necessarily mean that uniform motion does not exist if there is no external reference, BUT THAT WE CANNOT DESCRIBE IT WITHOUT THE HELP OF SOME EXTERNAL REFERENCE. And these are two very different things! On the other hand, the consistency of all relative motions of all objects in the universe has a very simple explanation: their absolute differential motion. There is no other rational alternative to that explanation. What would Mr. Ockham think of all this?

17.3 The concept of velocity

As noted above, velocity is an intrinsic quantitative attribute of motion. It is a basic key concept in classical and modern physics that can be unequivocally defined in simple and precise words:

$$\begin{cases}\text{Velocity is the ratio between the distance tra-}\\ \text{veled by a body and the time taken to travel it.}\end{cases} \tag{1}$$

or with mathematical symbols:

$$v = \frac{x}{t} \quad \text{(Average speed)} \tag{2}$$

$$v = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} \quad \text{(Instantaneous velocity)} \tag{3}$$

where x denotes the traveled distance and t the time taken to travel it.

Note that it is not always necessary to use a mathematical reference frame as a coordinate system to describe and measure motion. Indeed, imagine a ball b moving inside a tube T from one of its end A to its other opposite end B. Being at rest with the tube, we can measure the length L_o of the tube with a ruler, and with a clock the time t_o that b takes to go from A to B at a uniform velocity. So, according to (1), the velocity u_o of the ball with respect to the tube T will be:

$$u_o = \frac{\text{distance travelled}}{\text{time spent on the crossing}} = \frac{L_o}{t_o} \tag{4}$$

This will be the way to measure the double relative velocity that will be introduced in the next chapter. Now let RF_o be the proper reference frame of the tube T. Being T at rest in RF_o the distance the ball moves with respect to RF_o when going from A to B coincides with the length L_o of the tube. In consequence, the velocity u_o of the ball with respect to RF_o is the same as the velocity of the ball with respect to the tube, i.e. the ratio between the traversed length L_o to the time t_o taken.

But consider now the reference frame RF_v, which, as always in this book, coincides with RF_o at a certain instant and from whose perspective RF_o moves with a uniform velocity v parallel to the direction of the increasing x_v. In this frame it is possible to measure:

1. The velocity v of the frame RF_o with respect to RF_v, which is the same as the velocity of the tube with respect to RF_v.
2. The velocity u_v of the ball with respect to RF_v.
3. The velocity u_{vT} of the ball with respect to the tube T.

Special relativity only deals with the first two velocities. Although the third velocity is as legitimate as the first two, being possible to measure in RF_v all the quantities involved with the own RF_v measuring instruments. Obviously the distance b travels with respect to RF_v is greater than the length $\gamma^{-1}L_o$ of the tube T, but the time t_v the ball b travels with respect to RF_v is the same time the ball lasts in traversing the tube from A to B, because both motions begin at the same instant and end at the same posterior instant. The distance d_v that b travels with respect to RF_v is the sum of the distance $\gamma^{-1}L_o$ it travels through the tube plus the distance vt_v the tube travels with respect to RF_v while b moves from A to B. Therefore, according to the Lorentz Transformation and being $v = kc$, $(0 < k < 1)$, we can write

$$d_v = \gamma^{-1}L_o + kct_v \tag{5}$$

$$t_v = \gamma t_0 + \frac{\gamma L_o k}{c} \tag{6}$$

$$u_v = \frac{\gamma^{-1}L_o + kct_v}{t_v} \tag{7}$$

$$= \frac{\gamma^{-1}L_o}{t_v} + kc \tag{8}$$

$$= \frac{\gamma^{-1}L_o}{\gamma t_o + \frac{\gamma L_o k}{c}} + kc \tag{9}$$

$$= \frac{c\gamma^{-1}L_o}{c\gamma t_o + \gamma L_o k} + kc \tag{10}$$

$$= \frac{c\gamma^{-2}u_o}{c + u_o k} + kc \tag{11}$$

$$= \frac{cu_o(1-k^2)}{c + u_o k} + kc \tag{12}$$

where u_v is the velocity of b with respect to RF_v. According to (1), the third velocity, i.e. the velocity u_{vT} of b with respect to the tube T calculated in RF_v will be:

$$u_{vT} = \frac{\gamma^{-1}L_o}{\gamma t_0 + \frac{\gamma L_o k}{c}} \tag{13}$$

$$= \frac{cu_o(1-k^2)}{c + u_o k} \tag{14}$$

which, obviously, is less than u_v. Note that u_{vT} coincides with the first term of (12). In consequence, the relative velocity of b with respect to the inertial reference frame RF_v is the *algebraic* (not the relativistic) addition of the velocity of b through the tube T and the velocity of the tube T with respect tot RF_v. In the following chapter we will call u_{vT} double relative velocity. It is, in fact, a doubly relative velocity: the velocity u_{vab} of an object A relative to another object B which in turn moves relative to a reference frame RF_v, calculated from this reference frame. As we shall see in that and other subsequent chapters, it is an important source of conflicts with special relativity.

17.4 Galilean, relativistic and double relativistic sum of velocities

Let u_o be the velocity of an object A with respect to a reference frame RF_o which in turn moves with a velocity $v = kc$, $(0 < k < 1)$, parallel to the X_v axis of another reference frame RF_v. As is well known, the classical, Galilean, sum of both velocities (symbolically $+_G$) is simply the algebraic sum $u_o + v$. It is also well known that the relativistic, Einsteinian, sum of both velocities (symbolically $+_E$) is no longer the algebraic sum, but the algebraic sum multiplied by the relativistic factor $1/(1 + u_o v/c^2)$:

$$u_o +_G v = u_o + v \tag{15}$$

$$u_o +_E v = \frac{u_o + v}{(1 + u_o v/c^2)} \tag{16}$$

$$= \alpha_{u_o v}(u_o + v) \tag{17}$$

where $\alpha_{u_o v} = 1/(1 + u_o v/c^2)$. It is almost immediate to calculate the sum of a double relative velocity with that of a relative velocity. Indeed, let u_{vab} be the relative velocity of an object A relative to another object B which in turn moves relative to a reference frame RF_v with a relative velocity $v = kc$, $(0 < k < 1)$. The double relative velocity u_{vab} calculated in the reference frame RF_v is given by (14), and can be rewrite as:

$$u_{vab} = \frac{cu_o(1 - k^2)}{c + u_o k} \tag{18}$$

$$= \frac{cu_o(1 - v^2/c^2)}{c + u_o v/c} \tag{19}$$

$$= \frac{u_o(1 - v^2/c^2)}{1 + u_o v/c^2} \tag{20}$$

So, the double relativistic sum (symbolically $+_{dr}$) of u_{vab} an v will be:

$$u_{vab} +_{dr} v = \frac{u_o(1 - v^2/c^2)}{1 + u_o v/c^2} + v \tag{21}$$

$$= \frac{u - uv^2/c^2 + v + uv^2/c^2}{1 + uv/c^2} \tag{22}$$

$$= \frac{u + v}{1 + uv/c^2} \tag{23}$$

$$= \alpha_{uv}(u + v) \tag{24}$$

There are, therefore, the following relationships between the three types of velocity sums:

$$u +_G v = u + v \tag{25}$$

$$u +_E v = \alpha_{uv}(u + v) \tag{26}$$

$$u +_{dr} v = \alpha_{uv}(u + v) \tag{27}$$

So that $u +_{dr} v = u +_E v$.