# *Inertial Motions and Time Paradoxes*

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***Abstract***

*In this paper an elaboration of the physical concept of inertia is presented and it leads to a definition of the Generalized Principle of Inertia and of inertial motions in the order of a wider view that considers also the presence of the gravitational field. At last the paper terminates with the examination of a few paradoxes of time that certainly represent evident contradictions inside theories that prove the existence of relativistic effects of time that would be generated by imaginary changes of spacetime due to the inertial speed.*

## 1. Introduction

The concept of inertia was introduced in classical physics by Galileo, in the fundamental work "Dialogue Concerning the Two Chief Worlds Systems"[1], for representing the typical property of physical systems to keep their state of motion and to resist changes of motion. This property was observed by Galileo in experimental way in concordance with his scientific method. Afterwards the concept of inertia was formalized mathematically by Newton in the order of the second principle of dynamics from which the principle of inertia is deduced when the applied total force is zero. In modern physics the concept of inertia had alternating lucks: in fact Einstein himself, though he accepted the concept of inertia above all in the beginning of his research in the order of SR with reference to inertial systems of coordinates, nonetheless later he had a controversial relation with that concept above all because he theorized a contradiction between the concept of inertia and the concept of field. In a famous statement Einstein said: "If we imagine to abolish the field there isn't space, because space doesn't have an independent existence". This identification of field with space isn't appropriate because the field has physical nature and it exists only if there are sources and in spaces without sources or at great distances from sources there isn't field but there is vacuum or empty space. That identification of space with field doesn't represents the physical reality because where there isn't field however there is empty space and besides space has only a geometrical structure while field has a physical structure besides geometrical. The geometrization of physics, like the mathematicization of physics, is an attempt that is doomed to fail when it attends to replace physics.

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Physics is an autonomous science with respect to all other sciences, the concept of interdisciplinarity is valid in general and every science profits from the exchange of views with other sciences but no science can aim to reduce other sciences to its own parts.

## 2. Conversion mass-energy

In 1905 Einstein raised the question if inertia of a body depended on its content of energy and he concluded radiation emitted by a body tranferres inertia from the emitting body to the receiving body, answering positively his question. In the order of that paper Einstein demonstrated the famous equation

$$\Delta m = \frac{E_r}{c^2} \qquad (1)$$

in which c is the speed of light and $E_r$ is the radiant energy. It is manifest that in this interpretation the inertia of body coincides with mass of body and because the variation of mass corresponds to the radiant energy it follows that inertia of body depends on its content of energy. It needs nevertheless to specify the demonstration is enough controversial because it is valid only in first approximation after having neglected terms of fourth order and of greater order with respect to $v^2/c^2$. The weak point of this demonstration is therefore the approximation that concerns terms of energy that have been neglected and that nevertheless become important when the approximation $v^2/c^2 \ll 1$ isn't valid, i.e. when the speed of the emitting body isn't negligible with respect to the speed of light. In the order of the Theory of Reference Frames the equation (1) has been demonstrated for charged elementary particles that are accelerated into a force field[3]. In TR elementary massive particles have an electrodynamic mass that is different from inertial mass of ordinary bodies. Let us consider in fact a charged massive elementary particle with resting electrodynamic mass $m_o$. Under the action of field force the particle accelerates and it emits an electromagnetic radiation in quantum shape at particular values of speed. That radiation propagates with the physical speed c of light with respect to the reference frame of the particle. Because accelerated ordinary bodies with inertial mass don't emit e.m. energy, it is manifest that this radiation originates necessarily from the electrodynamic mass of the particle that consequently decreases and therefore a conversion of electrodynamic mass $dm<0$ to e.m. energy $dE>0$ happens so that

$$dE = - c^2 dm \qquad (2)$$

The emission of e.m. energy happens in actuality in the shape of two equal quanta of energy that propagate at the physical speed of light and they are emitted for two particular values of speed of particle: the physical speed c of light and the critical speed $v_c=1.41c$. The first quantum of energy $E_1$ is emitted at the physical speed of light and it corresponds to the half of the resting mass of the particle, as that

$$E_1 = - c^2 \int_{m_o}^{m_o/2} dm = \frac{m_o c^2}{2} \qquad (3)$$

while the second quantum of energy $E_2$, that is exactly equal to the first, is emitted at the critical speed

$$E_2 = - c^2 \int_{m_{o/2}}^{0} dm = \frac{m_o c^2}{2} \qquad (4)$$

At the critical speed electrodynamic mass of particle is zero because it has been emitted completely in the shape of two quanta of e.m. energy in consequence of the conversion, but the particle exists still with its charge into a state on the limit between stability and instability. This physical conversion of electrodynamic mass to radiant energy happens also in another important physical process: the annihilation particle-antiparticle. In the event of annihilation electron-positron the collision of the two particles, that have the same electrodynamic mass and the same intrinsic energy E=0.51MeV, produces at low energy two equal photons into the gamma band with frequency $f=1.2 \times 10^{20}$Hz. The inverse process, called also materialization of photon, consists in the conversion of one photon or more photons to a pair of massive particles, for instance electron-positron, and this conversion can happen only with photons of total energy E≥1.02MeV.

## 3. Principle of Inertia and Generalized Principle of Inertia

The Principle of Inertia was formulated firstly by Galileo, together with the Principle of Relativity, in the fundamental work " Dialogue Concerning the Two Chief World Systems" (1632). In consequence of his experimental observations, Galileo noticed the tendency of bodies to maintain the state of initial motion in the absence of applied forces and of external impediments to motion. Later Newton gave a mathematical definition of the Principle of Inertia that can be deduced, in the event of uniform rectilinear motion, from the Newtonian fundamental equation $\mathbf{F}=m\mathbf{a}$ in which if **F**, that represents the resultant of all applied external forces and of resistant forces, is null then it is $\mathbf{a}=0$ and consequently the body moves with constant velocity maintaining in inertial way the state of initial motion.
A classical formulation of the Principle of Inertia for mechanics is:

**"Every physical system tends to preserve its state at rest or its state of rectilinear uniform motion with respect to a reference frame, supposed at rest, until an external cause or force changes its state".**

In the Theory of Reference Frames[4] the following **Generalized Principle of Inertia** is valid:

**"Every physical system tends to preserve its state at rest or its state of inertial motion, that can be rectilinear uniform or rotary uniform or orbital, with respect to a reference frame, supposed at rest, until an external cause changes its state".**

This first generalization of the Principle of Inertia regards also electrodynamic systems and cosmological systems besides mechanical systems and it allows to extend the concept of inertia from the state supposed at rest and from rectilinear uniform motions to rotary uniform motions and to orbital motions. A further generalization[5] of the principle regards all types of systems and it says:

**"Every physical system tends to preserve its state at rest or its state of inertial motion or its state of stationary equilibrium with respect to a reference frame, supposed at rest, until an external cause changes its state".**

This further generalization allows to extend the Principle of Inertia to any type of physical system, including thermodynamic and biophysic systems, through the concept of stationary equilibrium. It allows to pass from systems, that are characterized by a state of motion, to more general systems, characterized by a stationary state, that include thermodynamic and biophysic systems.

## 4. Inertia and mass

Inertia is one of fundamental concepts of classical physics. Inertia of a system indicates in general the tendency of a physical quantity of the system to resist any change in time and to remain constant. In mechanics the physical property that describes the dynamic behaviour of systems is mass. There are numerous definitions of mass[6] : the basic concept of mass must start however from the methodology that is used for measuring mass of a body that consists in the use of an instrument that allows to measure the weight $\mathbf{P}$ of the body when it is subject to the action of gravitational force. In that case because $\mathbf{P}=m\mathbf{g}$, where $\mathbf{g}$ is the known acceleration of gravity, it is possible to calculate m that represents therefore the "gravitational mass" of the body. Recently it has been proposed a quantum definition and consequently a quantum measurement of mass but it doesn't change the physical nature of things. This concept of mass can be generalized for any type of force, not only the gravitational force, as per Newton's fundamental equation $\mathbf{F}=m\mathbf{a}$. The question is if mass m that is present in the Newtonian law of dynamics is the same that is present in the Newtonian Law of gravitation. The answer is positive because in the two laws what changes is only the type of force, but it is manifest that the physical system (body in our case) behaves always similarly for any type of force. Besides we deduce from Newton's law of dynamics that when $\mathbf{F}=0$, the system is into an inertial state because $\mathbf{a}=0$ and consequently it moves with constant velocity.
Therefore it is admissible to call in general "inertial mass" the mass that is present in the Newtonian law of dynamics and because in the Newtonian law of gravitation it is present the same mass, it means that **"inertial mass = gravitational mass"**. Consequently we

can conclude that in mechanics inertia of a system is effectively connected with the concept of mass.
It is valid for mechanical systems for which in TR it has been demonstrated inertial mass of ordinary bodies is independent of the velocity. For electrodynamic systems (charged massive elementary particles) it needs to consider a different physical behaviour with respect to mechanical classical systems. The fundamental difference consists in the fact that accelerated elementary particles emit electromagnetic energy and it doesn't happen for classical mechanical systems. Besides the emission of e.m. energy by accelerated particles happens in quantum shape. Massive elementary particles are characterized in TR by electrodynamic mass that changes with the speed[3][4][7] and it is given by

$$m = m_o \left(1 - \frac{v^2}{2c^2}\right) \qquad (5)$$

It is manifest that for null speeds (v=0), electrodynamic mass coincides with the resting mass that is equal to the inertial mass. While nevertheless the inertial mass of ordinary bodies is independent of the speed, electrodynamic mass of particles changes with the speed because of the emission of electromagnetic energy in quantum shape for particular values of speed. Consequently electrodynamic mass of elementary particles is connected with the concept of inertia only when particles are into an inertial state.

## 5. The inertial field

In the inertial field[8] there aren't masses that generate gravitational fields and therefore there aren't gravitational potentials. Alternatively the considered inertial field is at great distance from masses as that the effect of those masses is fully negligible. Besides there aren't further forces that accelerate reference frames and systems that they represent. In the inertial field reference frames are characterized by constant velocities with respect to a reference frame supposed at rest, and besides relative velocities of systems, whether vector or scalar, are constant.
In that case any physical event that happens inside one any of reference frames of the inertial field, because of the Principle of Relativity, is described by the same physical law in all reference frames of the inertial field. Nevertheless it doesn't mean also all physical quantities that characterize the event are invariant with respect to reference frames of the field. In order to clarify this important concept let us consider a physical event described by Newton's law with respect to the reference frame S[O,x,y,z,t] supposed at rest and let us consider then another reference frame S'[O',x',y',z',t'] that has uniform velocity **v** with respect to S (fig.1)
Newton's law is invariant in the two inertial reference frames because of the Principle of Relativity, for which we can write

$$\mathbf{F} = m\mathbf{a} \qquad (6)$$

$$\mathbf{F'} = m'\mathbf{a'} \qquad (7)$$

in which **F**, m and **a** are force, inertial mass and acceleration with respect to the reference frame S and **F'**, m' and **a'** are the same quantities with respect to S'. Because the two reference frames belong to the inertial field, necessarily it must be

$$\mathbf{F'} = \mathbf{F} \qquad (8)$$

and consequently

$$m'\mathbf{a'} = m\mathbf{a} \qquad (9)$$

Because inertial mass (for ordinary bodies) is invariant in the inertial field, i.e. m'=m, we deduce

$$\mathbf{a'} = \mathbf{a} \qquad (10)$$

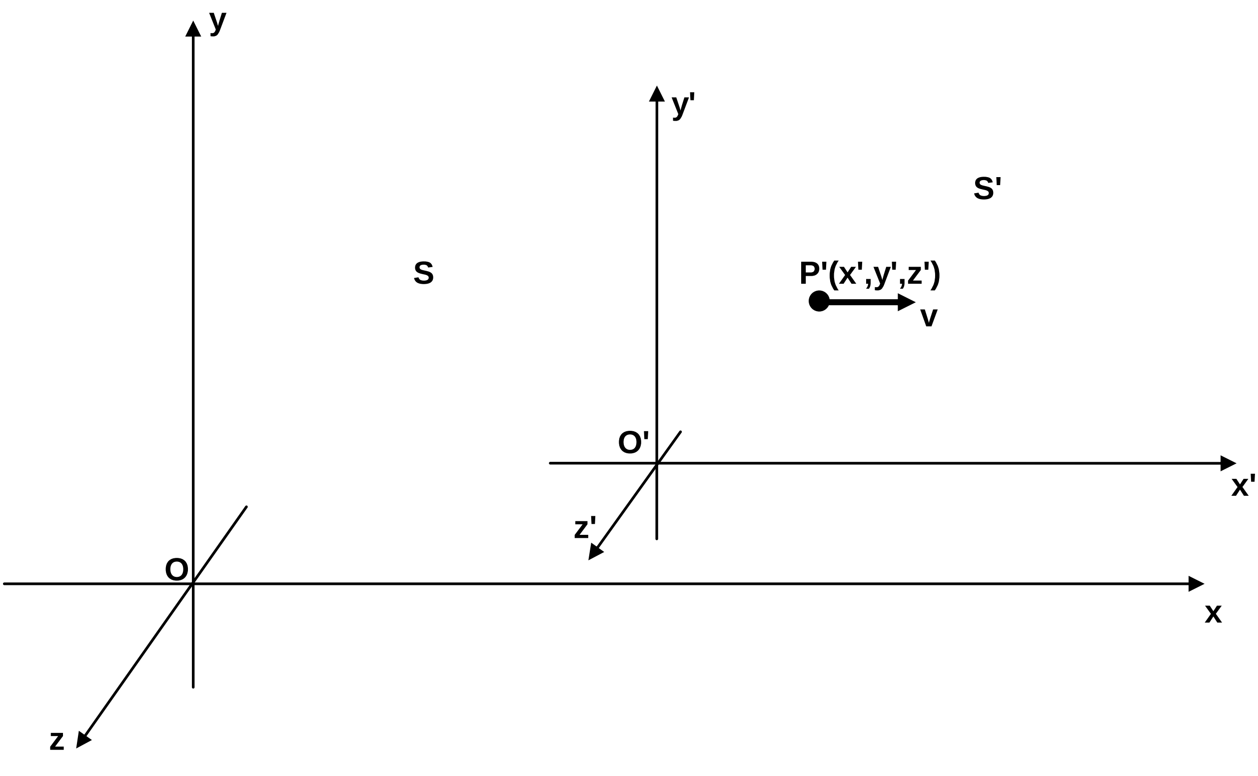


Fig.1 The reference frame S[O,x,y,z,t] is supposed at rest in the inertial field while the reference frame S'[O',x',y',z',t'] of the same inertial field moves with rectilinear and uniform velocity v with respect to S.

It follows that in the event of Newton's law the invariance of the law in the inertial field involves also the invariance of inertial mass and of accelerations, but we know also the invariance doesn't regard velocities. In fact whether in Galilean Relativity or in Einsteinian Relativity, if **v** is the relative speed between the two reference frames, the velocities with respect to S and S' of mass are different. In the Theory of Reference Frames the following equations of transformations of space-time[4][7][8][9] are valid for two reference frames with relative velocity **v**

$$
\begin{cases} \mathbf{P}[x,y,z,t] = \mathbf{P'}[x',y',z,t'] + \int_0^t \mathbf{v}\, dt & (11) \\ \\ dt = \dfrac{m}{m'} dt' & (12) \end{cases}
$$

Because m'=m for ordinary bodies, from (12) we deduce

$$t = t' \qquad (13)$$

that is S and S' and all reference frames of the inertial field proceed synchronous (inertial time). Besides always in the inertial field in which relative velocities **v** are constant, from (11) we deduce

$$\mathbf{P}[x,y,z,t] = \mathbf{P'}[x',y',z,t'] + \mathbf{v}t \qquad (14)$$

Because for the sake of argument, the velocity **v** is parallel to axes x and x', from (14) considering the (13) we have

$$
\begin{aligned} x &= x' + vt \\ y &= y' \\ z &= z' \\ t &= t' \end{aligned} \qquad (15)
$$

The (15) represent transformations of space and time coordinates from the reference frame S' to the reference S, from which it is possible to obtain the inverse transformations from S to S'. In the considered physical conditions, i.e. inertial field and ordinary bodies with invariant mass, we observe the (15) are equal to Galilean kinematic Transformations, in which the common time t'=t of the two reference frames represents the "inertial time". Scalar components of the vector velocity **v** are $(v_x',0,0)$ with respect to the reference frame S'. From (15) we deduce

$$
\begin{aligned} v_x &= \frac{dx}{dt} = \frac{dx'}{dt'} + v = v_x' + v \\ v_y &= \frac{dy}{dt} = \frac{dy'}{dt'} = v_y' = 0 \\ v_z &= \frac{dz}{dt} = \frac{dz'}{dt'} = v_z' = 0 \end{aligned} \qquad (16)
$$

Let us observe whether the coordinate or the component of velocity with respect to axes x and x' are non-invariant physical quantities with respect to inertial reference frames.
We have clarified frequently in the Theory of Reference Frames the inertial mass, equal to gravitational mass, is a physical property of ordinary bodies.

Charged massive elementary particles don't have a defined inertial mass because we know they emit electromagnetic energy when they are accelerated and besides that emission of energy happens in quantum way. Charged massive elementary particles are characterized by the "electrodynamic mass" that changes with the speed. On this account the (13) is valid only for ordinary bodies. Considering in TR electrodynamic mass changes with the speed according to the following relation

$$m = m'\left(1 - \frac{v^2}{2c^2}\right) \qquad (17)$$

for every constant value of velocity v, assuming when t=0 also t'=0, from (12) we derive

$$t = t'\left(1 - \frac{v^2}{2c^2}\right) \qquad (18)$$

When the physical event regards charged massive elementary particles, even if the two reference frames proceed synchronous with the same time t=t', nonetheless the time t of elementary particle that is at rest in S' and moves with velocity v with respect to S, is subjected to a relativistic slow-down, given by the (18), with respect to the time t' of the moving reference frame S'. Let us repeat this effect doesn't modify the synchronism of the two reference frames but it is the consequence of the fact that the electrodynamic mass of particle changes with the speed. From (17) and (18) we deduce then for velocities v<c electrodynamic masses and relativistic times decrease when the speed increases, for velocity $v=v_c=\sqrt{2}c$ the electrodynamic mass and the relativistic time become null and for velocities $v>v_c$ electrodynamic masses and relativistic times become negative generating instability in the physical behavior of the particle.

## 6. Inertia of the Gravitational Field

In the gravitational field that is generated by a mass with central symmetry[10][11][12] , along equipotential surfaces of the field the gradient of the gravitational potential is zero and consequently total forces of field that act along these equipotential surfaces are null: it is necessary and sufficient condition so that equipotential surfaces can be defined like inertial states. It happens in the event of rotary motions and of circular or elliptic orbital motions. It is suitable therefore to distinguish two cases:

6.1 Rotary celestial bodies
6.2 Orbital celestial bodies

### 6.1 Inertia of rotary celestial bodies

For a rotary celestial body with spherical symmetry and mass M, all points revolve around the axis of rotation with the same constant angular velocity $\omega$. Fixed points with the same distance with respect to the centre of mass, in which it is possible to suppose that all mass

M is concentrated, have the same gravitational potential and the same tangential velocity and consequently they are in an inertial state. Instead points with different altitude have different gravitational potentials and different tangential velocities. Even if the difference of velocity (relative velocity) between two points with different altitude is constant and therefore from a kinematic viewpoint they are into an inertial state, nonetheless the gravitational potential depends on r, i.e. on the distance of the considered point with respect to the centre of mass, then from the gravitational viewpoint the points with different altitude aren't inertial.
In fig.2 the points $\mathbf{P_1}$ and $\mathbf{P_2}$ are inertial each other whether in the kinematic state or in the gravitational state. In fact velocities $\mathbf{v_1}$ and $\mathbf{v_2}$ are equal in module (scalar velocity) and the difference of vector velocity is constant during the whole circular motion. Besides the two points maintain the same state of gravitational potential during the circular motion because the their distance from the centre of mass is always the same and equal to r. The points $\mathbf{P_1}$ and $\mathbf{P_3}$ instead are inertial each other in the kinematic state because the difference of scalar velocity is constant during the circular motion but they aren't inertial in the gravitational state because gravitational potentials in the two points are always different. It follows that the Principle of Relativity is valid for the points $\mathbf{P_1}$ and $\mathbf{P_2}$. For the points $\mathbf{P_1}$ and $\mathbf{P_3}$ instead the Principle of Relativity isn't valid because, even if they are in an inertial kinematic state, nonetheless the gravitational potentials in the two points

$$U_1 = -\frac{GM}{r_1} \qquad (19)$$

$$U_3 = -\frac{GM}{r_3} \qquad (20)$$

are different being $r_1 < r_3$. In fact in the two points there is a different force of gravity unlike the two points that are along the same equipotential surface in which the gravitational force is the same.

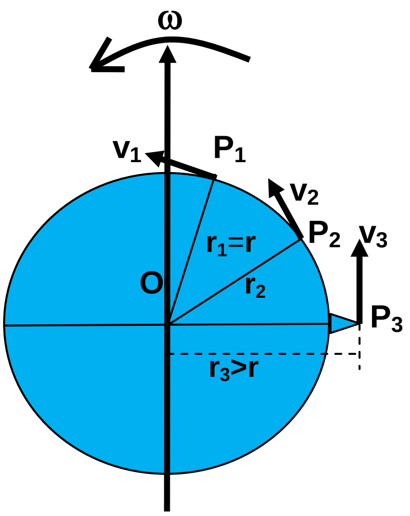


Fig.2 Points $\mathbf{P_1}$ and $\mathbf{P_2}$ are at the same altitude while the point $\mathbf{P_3}$ is at a different and greater altitude.

## 6.2 Inertia of orbital celestial bodies

Let us consider a complex celestial system composed of one central star (for instance the Sun) and of orbital planets (in fig.3 three planets, for instance Mercury, Venus and Earth). The central star is supposed at rest and represented by the reference frame S[O,x,y,z,t], the three planets are identified by the three reference frames $S_1[O_1,x_1,y_1,z_1,t_1]$, $S_2[O_2,x_2,y_2,z_2,t_2]$, $S_3[O_3,x_3,y_3,z_3,t_3]$.
The **Generalized Principle of Inertia** allows to extend the principle of inertia also to orbital motions for which the three planets are into an inertial state each other and with respect to the central star. From the physical viewpoint it is warranted by the fact that the central star generates the central gravitational field in which the single planets cover orbital trajectories determined by elliptic geodesic lines characterized by the fact that these geodesics are equipotential lines. Consequently along those geodesics there isn't variation of force and therefore of the inertial state. The fact then that the orbital velocity isn't strictly constant doesn't change the inertial state because elliptic orbits, in place of circular orbits, are due to reciprocal interactions among planets and the central star that in actuality isn't still in the point O just because of those reciprocal interactions.

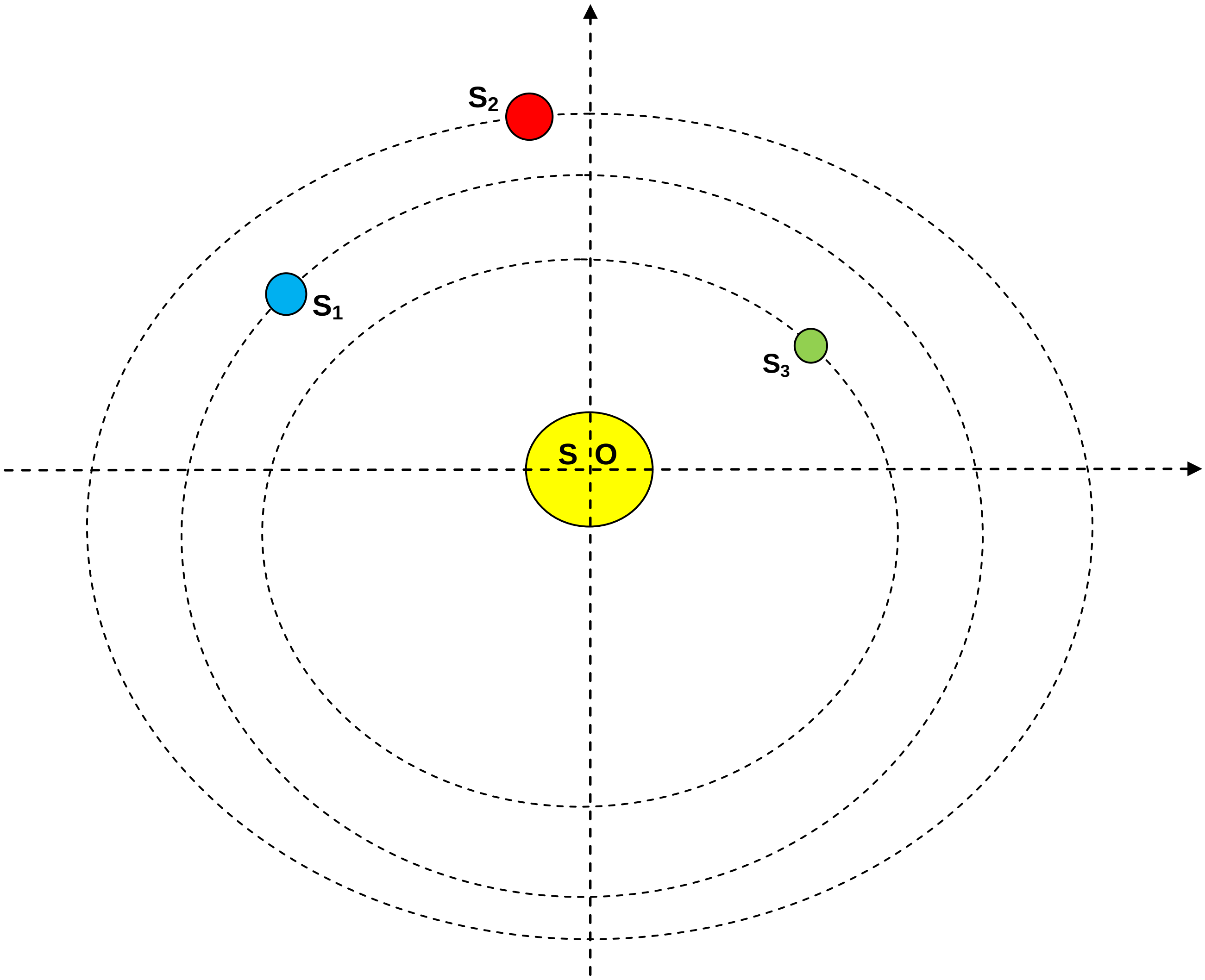


Fig.3 Orbital motions of three planets around the central star S.

## 7. Inertial motions

As per our previous considerations deriving from the Generalized Principle of Inertia the following motions are inertial:

1. Rectilinear motions with constant speed with respect to a reference frame supposed at rest
2. Rotary motions with constant angular speed relative to points with the same altitude with respect to the centre of mass of rotary body
3. Orbital motions around a central star

## 8. Time paradoxes

A few physicists, starting from 1905 in which A. Einstein published the paper "On Electrodynamics of Moving Bodies", have pointed out frequently numerous contradictions of Special Relativity. Let us want now to consider those contradictions that regard the time dilation that a fixed observer detects with respect to a moving observer for whom for the resting observer time would go more quickly. Let us consider now four paradoxes that in actuality are true contradictions that are present inside the theory:

1. Langevin's twin paradox
2. Raftopoulos' triplet paradox
3. Suleiman's travelling twin paradox
4. Asymmetric observers paradox

### 8.1 Twin paradox

The French physicist Langevin in 1911, six years after the publication of Special Relativity, pointed out a contradiction that was present inside the dilation time by the famous twin paradox. He considered two twins with the same age, who at an initial time t=0, referred to the reference frame S of the Earth, decided to go one's separate ways. One of the two twins departed with a spaceship that travelled with the constant and rectilinear speed v in order to reach a star placed at a distance d from the Earth, while the second twin stayed at Earth. The twins are in an inertial physical situation because of the inertial motion of the travelling twin with respect to the fixed twin. In Special Relativity a time dilation is theorized in this situation for which if the travelling twin spends a time T', measured with respect to his moving reference frame S', for completing his round trip, twin's clock who stays at Earth measures a dilated time T>T' for the same trip.
Naturally it seemed a contradiction to Langevin because if t=t'=0 is the departure time of the travelling twin, on his return he has spent a time t'=T' for completing the round trip in concordance with his clock, while the clock of the fixed twin would measure a time t=T>T' with respect to his reference frame S. In the moment of reunion of twins, after that the trip

is terminated, the twins are both again into the fixed reference frame of the Earth and consequently the spent time for the twins is the same, independently of prospective different times measured by the two clocks for which necessarily it is T'=T. It follows that the two reference frames proceed synchronous. Supporters of SR have criticized this paradox asserting that in actuality it needs to consider trip intervals in which the spaceship doesn't have constant speed but it would undergo acceleration periods and deceleration periods in the starting time, in the turn time of motion and in the arrival time, but these considerations have no sense because anyway, also in the presence of accelerations and decelerations, at last the twins hovewer reunite and the spent time is the same for both.

### 8.2 Raftopoulos' triplet paradox

Raftopoulos' Paradox[13] (2013) presents in different and innovative way the time contradiction that in Special Relativity regards inertial physical states. In fact the triplet paradox confirms further the existence of that fundamental contradiction, already pointed out by the twin paradox. The paradox considers three triplets: John stays fixed at Earth, Jim and Jack instead set off on a different but perfectly symmetric journey, characterized in fig.4 by pathways (1, Jim) and (2, Jack). During the whole trip the travelling twins have always the same constant speed v, that represents the module (or scalar speed) of the two vector velocities $\mathbf{v_1}$ and $\mathbf{v_2}$ ($|\mathbf{v_1}|=|\mathbf{v_2}|=v$). Consequently between every travelling brother and the brother that is fixed at Earth there is a difference of speed given by v. In the order of SR it follows that the fixed brother undergoes the same time dilation with respect to the travelling two brothers. Nevertheless now it is possible to observe between the two travelling brothers there is a difference of velocity $\mathbf{v_d}$, with $|\mathbf{v_d}|\neq 0$, given by (fig.5)

$$\mathbf{v_d} = \mathbf{v_1} - \mathbf{v_2} \qquad (21)$$

Consequently between the two travelling brothers there is an effective difference of velocity, whether vector or scalar, even if they travel at the same speed v with respect to the fixed brother John. It follows that between the two travelling brothers there is also a difference of time synchronization and it generates an evident contradiction. In fact the fixed brother at Earth, according to SR, would undergo the same time dilation with respect to the two travelling brothers and consequently the two travelling brothers would have the same time, but at the same time they have different times each other because of the relative speed $v_d$ that is different from zero. It represents an evident contradiction.
D. Raftopoulos summes up the paradox with these clear words:

*“Uniformly moving clocks slow-down and this slowing-down is due to motion alone, which, nevertheless is relative”*, while it holds true for the pairs John-Jim and John-Jack, **does not hold true for the pair Jim-Jack**.

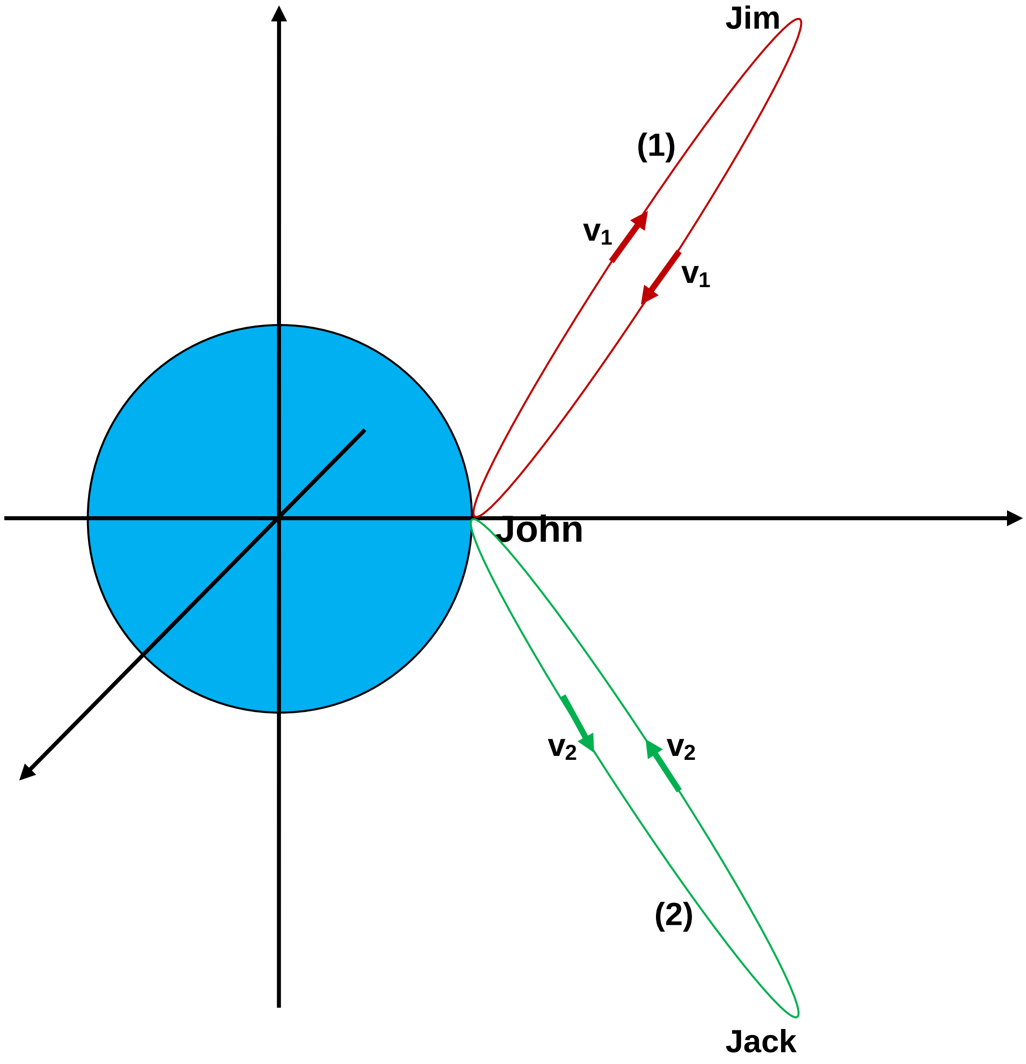


Fig.4 Graphic representation of the triplet paradox in which John is the fixed brother at Earth while Jim and Jack are the two brothers travelling along different and symmetric paths.

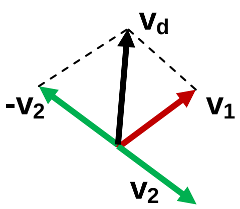


Fig.5 Vector composition of velocities of the two travelling twins.

### 8.3 Suleiman's travelling twin paradox

Suleiman has refuted[14] (2016) objections of SR supporters who affirmed in the twin paradox there are phases of acceleration and phases of deceleration that prejudice the validity of the paradox. To that end in fact he has considered a physical situation in which

two twins both travelling depart from two opposing positions A and B with respect to the central position O of the axis x.
The two brothers after a symmetric transitory phase of acceleration ($\Delta$d) reach the same speed v into reverse at the same distance d from O and they maintain this constant speed (fig.6). The two twins are now in an inertial situation of perfect symmetry because they move with a constant relative speed equal to 2v. Every twin supposes that he is at rest while the other twin moves with approach speed equal to 2v. As per SR every twin, supposed at rest, deduces to be older than the other who is in motion. It represents an evident contradiction that is a direct consequence of the time dilation theorized in the order of Lorentz's Transformations, because every brother deduces to be older than the other and it is impossible.

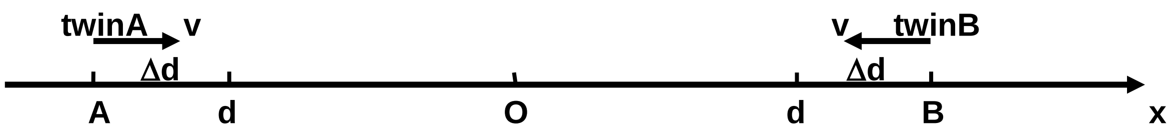


Fig.6 Graphic representation of the travelling twin paradox

R. Suleiman concludes his paper with these manifest words:

"The TTP (Travelling Twin Paradox) poses an unsolvable problem within the framework of SR. We know that the twins approaching each other will meet sometime, somewhere, and compare clocks. The inability of SR to produce one prediction, instead of two contradictory predictions, should be highly disturbing to current physics".

### 8.4 Asymmetric observers paradox[4][15][16][17]

In Special Relativity the simultaneity of two events that happen in two different points of the physical space is defined by pathways that light travels with respect to two identical and synchronized clocks that are placed in the two points. Let us observe this definition doesn't consider possible breakings of the symmetry condition that is necessary for the validity of that definition (fig.7).
In fact let us suppose that at time t=0 two synchronous rays of light leave the points A and B and they reach the central point O=M at the time $t_o$, where A, B and M are fixed points of the same physical space of a resting reference frame S. Because light travels with the same physical speed c in the two directions, it is manifest that because of the symmetry state of the considered physical process the two rays of light reach the central point M at the same time $t_o$.
The observer O notes the two rays of light are simultaneous confirming the initial hypothesis, in fact

$$\frac{AM}{c} = \frac{BM}{c} = t_o \qquad (22)$$

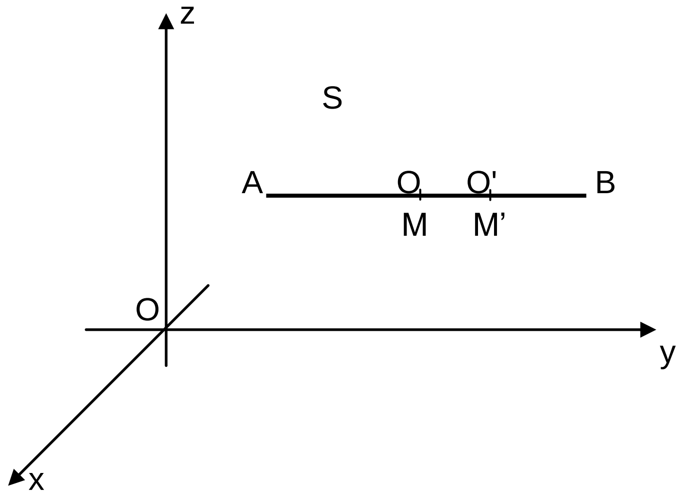


Fig.7 The observer O placed in the middle point M of the path AB is symmetrical with respect to the points A and B that the two rays of light leave. The observer O' placed in the non-middle point M' instead isn't symmetrical with respect to the two points A and B.

The observer O', placed in the non-middle point M', because of the symmetry breaking into the physical space of S, notes the two rays of light aren't simultaneous because in this situation the ray coming from the point B reaches him first, in fact

$$\frac{BM'}{c} < \frac{AM'}{c} \qquad (23)$$

Therefore the observer O' doesn't confirm the initial hypothesis of simultaneity measuring an event that from his asymmetrical viewpoint isn't simultaneous contradicting the starting real condition. Because the whole physical process happens inside the same physical space, it is manifest that only the symmetric observer O measures a real datum while the observer O' measures a distorted datum due to the symmetry breaking of the considered physical process because of his asymmetrical position.
If we repeat the same reasoning supposing the observer O isn't fixed, but in the same time t=0 in which the two rays leave the points A and B he moves with speed v towards the point B, this same observer who in the resting condition measured simultaneous rays, now he measures non-simultaneous rays because he detects first the ray coming from the point B, because of the finite speed of light (fig.8). Then we understand the motion of the observer O produces the same outcome measured by the fixed non-symmetrical observer O' and therefore the motion, involving a breaking of the symmetry situation, has to be considered like the resting non-symmetrical state of the observer O' (Asymmetric Observer Paradox). Besides it is also possible to demonstrate in fig.7 that two events that are non-simultaneous in A and B with respect to O, can be simultaneous with regard to O'.

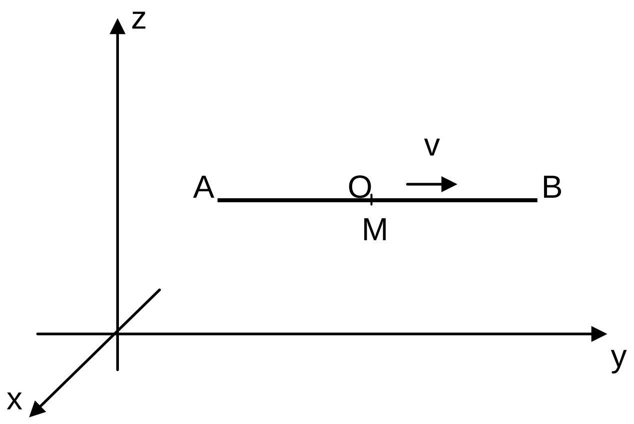


Fig.8 If the observer O placed in the middle point M of the path AB, at the time t=0 in which the two synchronous rays of light leave the points A and B, has constant speed v towards the point B, then he is in the same conditions of non-symmetry of the observer O' in fig.7.

These considerations prove the concept of simultaneity is connected with the time behaviour of events but they prove also the space situation of symmetry of the process has a decisive importance on the assessment of simultaneity by observers.
The paradox of asymmetric observers consists fundamentally in the fact that two events that are simultaneous for the sake of argument and initial conditions can be non-simultaneous for asymmetric observers and on the contrary two events that are non-simultaneous for the sake of argument are simultaneous for asymmetric observers.

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