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Article 6:

Inertia

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Abstract

I indicate that the key factor in the mechanism of inertia is the proximity of any elementary particle to itself, and consequently show that Newton laws of motion are derivatives of Newton's inverse square law of gravity. Inertia is originated in the microscopic realm, in the particle's diameter scale of reality, and is the response of an elementary particle to the gravitational field of itself, nothing more or less. Experimental evidences and several consequences of the discovery are discussed.

Inertia, the conventional approach

According to Newton, motion is relative to absolute space[1]. The empty absolute space is stationary, immovable, and always there. The roots of Newton's invention of absolute space are in his famous thought experiment, "Newton's bucket".

Mach's alternative, also derived from the same thought experiment, was that any motion is relative to the distribution of the universal mass. Mach ruled out Newton's notion of absolute space, solely by making a guess in the dark (up to date without experimental support) that in an otherwise empty universe there will be no sign in the surface of a water to its spinning, i.e. if there is no reference to which the spinning of the water in the bucket can be gravitationally related, the surface of the water will not take a concave shape. Moreover according to Mach, inertia is in a kind of correlation with the amount of mass in the universe[2]. The amount and distribution of the universal mass determines the inertia of individual masses.

Mach's alternative for Newton's absolute space has been widely accepted, in one interpretation or another[7], by the 20th century physicists, including by Albert Einstein which at least agreed that "inertia originates in a kind of interaction between bodies"[3] and that the universal mass determines the spacetime, an Einstainian entity which is as absolute in notion as was empty space for Newton.

A loophole in Mach's notion

I find Mach's approach flawed in several of its aspects, one of which need to be discussed for a better comprehension of my own view of inertia.

According to Mach, Einstein and any other physicist which live in peace with Mach's approach, inertia is possibly a function of the distribution of the universal mass. Since the universal mass is constituted of masses of individual particles, it follows that the mass of an individual particle is a means (or a measure of a means) capable of interacting with other particles for providing them with inertia (hereafter capable of 'inducing inertia').

Examination of this approach inevitably reveals that the inertia inducing capability of each individual particle is utilized by all the other universal particles such that every particle in the universe enjoys a tiny fraction of the capability of every one of all other particles which collectively and accumulatively provide for its inertia. Speaking of the average, every universal particle of a given mass can enjoy no more than the inertia inducing capability in its entirety, of a particle of the same mass. For making this point more clear, I suggest the following thought experiment: let the whole universal mass divided into two distant halves. Of course according to Mach, they will have the same inertia per mass unit as in our universe, and according to Mach each half universal mass will contribute a predetermined portion of the inertia of the other. It follows that a half universal mass cannot enjoy more inertia than what is contributed by a half universal mass, and generally speaking a mass cannot have more inertia than it contributes.

Given the understanding that on an average a particle cannot enjoy more inertia than it can contribute to others, why in the world, should a physicist be obliged to Mach's twist and assume a particle requires the contribution of the entire particles in the universe for creating its own inertia if it is anyway admitted that said particle must posses a mass of its own origin which is capable of (or indicative of the particle's capability of) inducing inertia?

Shouldn't it simply be assumed that the mass of the particle itself determines its own inertia? If it is good enough to provide for other particles' inertia why shouldn't it be sufficiently beneficial for providing the same for itself, dispensing with the need of receiving contributions from all the others?

Bearing in mind the inclination of physicists to identify particles inseparably from their associated fields, I can appreciate why Mach and his followers missed this point. After all, if a particle **is** its fields, then its gravitational field constitutes an inertial entity, and as such requires something external with respect of which it can inert and which actually contributes its inertia. Mach's invention was that the universal mass plays the role of the external something.

In contrast with this and as I stress in Articles 1[4] and 2[5], differently than being a field, a particle is a mechanism which creates its associated field/s. Accordingly, the inertial entity in my approach is the mechanism, while the external something is the gravitational field within which the mechanism is immersed. Being subjected to external forces the mechanism can change location **within** the field created by itself, since the field rather than moving with the particle is recreated cyclically by the particle as suggested in Article 2[5]. Before recreation of the field in a next cycle, the particle can be forced to move by an external enforcer, within the gravitational field created in the current cycle.

Assuming my postulation of above is true, the whole twist assumed by Mach **should** be dispensed with, because regardless of any preferences we are left with a beautiful mechanism of inertia, which naturally and **inevitably** emerges.

Inertia, a sub class of free fall

Following the understanding of above, inertia can be defined as the response of a particle to the gravitational field of itself.

Since a mass responds to a gravitational field by moving from a field region of a given magnitude toward a field region of a greater magnitude, the particle, having been forced (by an external action force) to deviate from the center of the field it has just created, responds to such deviation by trying to freely fall back toward its previous location, where its axis of symmetry is equidistant from regions of equal magnitude of its gravitational field. I define this response a subclass of a free fall, which differs from a regular free fall only in the respective positions of the particle and the gravitational field. While in the inertial subclass of free fall the gravitational field is generated by the particle itself thus symmetrically distributed about the particle, in a regular free fall it is generated by masses external to the particle thus asymmetrically distributed about the particle. The following figures demonstrate the notion of inertia as a subclass of free fall:

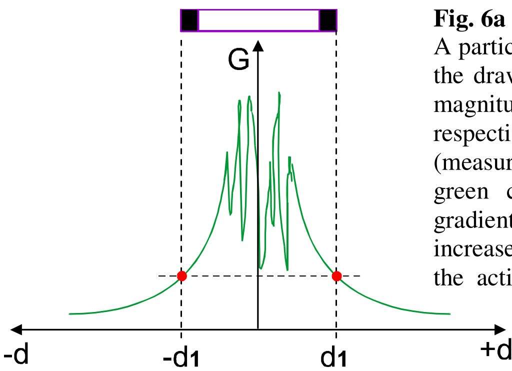

Fig. 6a
A particle is represented by a rectangular* shape at the top of the drawing. The particle generates a gravitational field, the magnitude of which (measured along the vertical axis) respective to a distance *'d'* from the center of the particle (measured along the horizontal axis), is demonstrated by the green curve. The gravitational field takes a Newtonian gradient as the distance from the center of the particle increases, but is chaotically jittering near the center, due to the activity of the gravity generating mechanism, activity which is partially described in Articles 4[9] and 5[10] and which its full description is not essential for the understanding this present article. As can be appreciated, the magnitude of the gravitational field is equal near opposite ends of the particle which their distance from the center of the gravitational field ***G*** is ***d1*** ; ***-d1***.

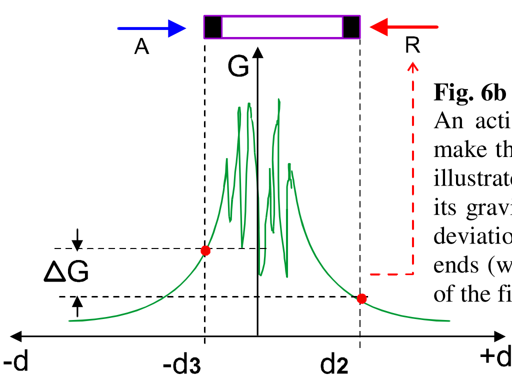

Fig. 6b
An action force represented by the blue arrow ***A***, tends to make the particle deviate to the right, from its initial position illustrated by Fig. 6a. It takes time to the particle to recreate its gravitational field in its new location, and thus, due to its deviation from the center of the existing field, its opposite ends (which are now respectively at ***d2; -d3*** from the center of the field) feel gravitational fields of different magnitudes, as demonstrated by the red dots on the graph. The ***ΔG*** differential between the two levels of magnitude makes the particle to react by a reactive force ***R*** represented by the red arrow, which actually is a gravitational force pointing from right to left, i.e. from the particle's side experiencing a lower magnitude of the field toward the side experiencing a greater magnitude. This is because the particle's side that feels a smaller magnitude gravitational field, always pushes harder towards the center then the particles side which feels a greater magnitude gravitational field.

* The particle in these figures is represented by a rectangular shape just for the purpose of demonstrating in a cross section view the mechanism of inertia of a particle having a ring shaped symmetry, along a single axis of motion. The particle responds to gravity only in regions near its outer ends, represented in the figure by the black areas. Actual particles are of spherical symmetry, and can thus be understood as structures comprising a huge number of such ring shape members distributed in all directions about a common center, thereby providing for inertia along any axis of motion.

As a young teenager, I wondered how can two touching objects be separated, since according to the inverse square law of gravity the gravitational force between the atoms in their contacting surfaces should increase to infinity because the distance between them must be zero at the microscopic contact points. I later realized that atoms are not point masses and that they are separated by electrical fields orders of magnitude greater than gravity, but the anecdote still worth mentioning here, because the distance of an elementary particle from **itself** is truly zero, and therefore we should really expect that despite the smallness of its mass, the home made gravitational field of an elementary particle will have a greater impact on its originator than the impact of the gravitational field of any external mass, including that of the entire universe.

It should be appreciated that by presenting the simple reasoning of above I have just united, once and forever, the identity of the gravitational mass with that of the inertial mass. They represent one and the same mechanism, one that responds to a gravitational field in a manner merely depending on the characteristics of the field. The nature of distribution of foreign gravitational fields make particles to accelerate, the nature of distribution of self gravitational fields make particles to inert.

Inertial motion as a sub class of free fall

Once the notion of inertia as a sub class of gravitational free fall is comprehended, another unification immediately emerging is between inertial motion and gravitational acceleration. While gravitational acceleration is a motion of a mass through a gravitational field of a varying potential, inertial motion is nothing more or less than a motion through gravitational fields of a constant potentials generated by the particles constituting the mass in their course of motion. The following figure demonstrates the gravitational field of a particle performing inertial motion at some set velocity:

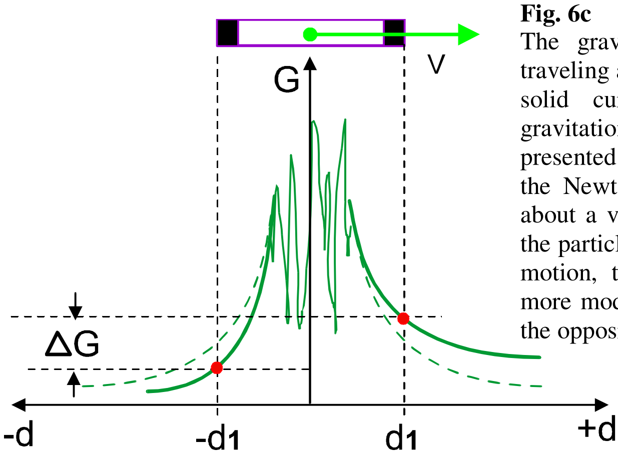

Fig. 6c
The gravitational field generated by a particle traveling at a constant velocity ***V*** is presented by the solid curved lines, in comparison with the gravitational field of the same particle at rest, presented by the dashed curved lines. While at rest the Newtonian gradient of the field is symmetric about a vertical axis passing through the center of the particle, in a particle which has been forced into motion, the gradient of the generated field falls more moderately in the direction of motion than in the opposite direction.
The result is a constant differential ΔG between the magnitude of the field experienced by opposite ends of the particle which are arranged parallel to the direction of motion.

The constant differential gravitational magnitude ΔG thus experienced by the particle makes it to maintain its constant velocity, which in turn maintains the constant differential magnitude. The inertial velocity of a mass expresses an equilibrium between (i) the ΔG distortion in the gravitational field generated during a successive particle's cycle at different locations of any of the particles constituting the mass and (ii) the response of the particles to such ΔG, in terms of extent of displacement during one particle's cycle. The greater the velocity the greater the differential magnitude, it is yet appreciable (and will be explained in detail in articles to follow) that the differential magnitude ΔG is limited to a maximum which will always be approached before the particle can approach the speed of light.

Another issue is that as far as small velocities are concerned the graphical description of the field deformation is exaggerated. It is appreciated that for small changes in velocity the deformation as expressed by ΔG is linearly related to the velocity, which is in conformation with a linear increase in the momentum demonstrated by slowly moving bodies. It is appreciated as well from the Figure, that the growth in ΔG as the velocity increases, is exponential due to the Newtonian nature of the curve. A virtual increase in the mass of the particle is therefore predicted, since as the velocity grows, pushing harder the particle to furthermore increase its velocity, is translated more into increasing ΔG (gravitational potential energy) than into increasing the velocity (kinetic energy). Indeed, what physically increases with the velocity is the momentum of the particle, which is in direct ratio with ΔG, while the mass of the particle remains unchanged.

A "Newtonian" (i.e. non-relativistic) increase in the momentum as an exponential function of the velocity, which tends to infinity as the velocity of the mass it is approaching toward **C** is thus predicted. GR unjustifiably attributes the increase in the particle's momentum to a relativistic increase in the mass.

As will be discussed in later articles, gravitational field is a matter-controlled equilibrium in space. Inertial motion can thus be understood as a Le Chatelier like phenomenon, in which the particle responds to an accelerating force (such as ***A*** in Fig. 6a) tending to increase ΔG in one direction, by deforming the gravitational field in the opposite direction in trying to eliminate the change. Once the accelerating force is removed, the magnitude of deformation achieved is maintained in equilibrium with the currently achieved velocity which caused the deformation. The velocity thus maintains the deformation which in turn maintains the velocity.

Newtonian "Space tells matter how to move":

It should be noted that the mechanism described by Figs. 6a-6c is actually a mechanism by which space (in terms of the gravitational field it expresses) tells a particle how to move. This is how it works: the ends of the particle are sensitive to the magnitude of the gravitational field, in a manner causing the particle to displace itself as a whole from a given magnitude towards a greater magnitude region of the field. For small displacements ***dX*** (which is equal to $\boldsymbol{d_2}$ *minus* $\boldsymbol{d_1}$, see Figs 6a&6b), where ***X*** is the radius of the particle (d_1) and ***a*** is the power of the exponent of the field (which is equal -2 according to Newtonian dynamics, but I have reasons to prefer a more generalized approach, thus refer to it as ***a***), ***ΔG*** is closely in linear relationship with the displacement ***dX***, as can be figured out from the following algebra:

$$\Delta G \propto (X - dX)^a - (X + dX)^a \tag{3.1}$$

Since for small displacements ***dX*** is small relative to ***X***, and once dispensing accordingly with polynomial terms of insignificant magnitude, you will find

$$\underset{dX \to 0}{(X - dX)^a - (X + dX)^a} \cong -2aX^{a-1} \cdot dx \tag{3.2}$$

Since the unknown radius ***X*** of a given particle is constant and so is the power ***a*** of the exponent, it follows that the gravitational potential resulting from a small displacement is substantially proportional to the displacement:

$$\Delta G \propto dX \tag{3.3}$$

The displacement, in turn, is proportional to the change in a velocity of the particle, since always a displacement is taken once within a particle cycle of a predetermined duration. It follows that gravitational potential is equivalent to acceleration:

$$\Delta G \propto \frac{dX}{dT}$$

{3.4}

By normalizing the units used and then multiplying both sides of {3.4} by the mass of the particle, Newton laws of motion emerge: (i) external accelerating force acting on a particle is equal to a reactive force originated by the gravitational potential resulting from the acceleration; (ii) The acceleration, i.e. the extent of the displacement of a particle during one particle's cycle minus the extent of displacement during the previous cycle, is proportional to the accelerating force (true for particles in small velocities but takes relativistic like exponent for large ones). These are one face of inertia: the resistance of a mass to changes in its velocity.

Once a displacement has been enforced by an external force which is then has been removed, a deformation of a given magnitude $\boldsymbol{\Delta G}$ in the particle's gravitational field will occur in the next portion of the particle's cycle, when the center of the regenerated field will be created by the particle off the center of the previously generated field, due to the displacement. The displacement, in turn, is proportional to the velocity of the particle, since always a displacement is taken once within a particle cycle of a predetermined duration. In macroscopic scale, if the displacement of the particle is the same (both in extent and in direction) in a multitude of successive particle cycles, a constant velocity will be observed. In the absence of external forces, a deformation of a given magnitude $\boldsymbol{\Delta G}$ in the gravitational field of an elementary particle, is always associated with a given displacement of the particle during one cycle, and a displacement of an elementary particle to a given extent within one cycle is always associated with a given deformation magnitude, $\boldsymbol{\Delta G}$, in the gravitational field of the particle. A displacement thus maintains the deformation during a next cycle, which in turn displaces the particle in yet another cycle and so forth. This is another face of inertia: the constancy of velocity in the absence of external forces.

Summing up, the phenomena of inertia is (i) a particle responding to an accelerating force with a reactive force proportional to the magnitude of a $\boldsymbol{\Delta G}$ resulting from and proportional to the amount of displacement of the particle from the center of its own gravitational field, and (ii) a particle moving in a constant velocity $\boldsymbol{v}$ proportional to the magnitude of a $\boldsymbol{\Delta G}$ resulting from a constant deformation in its own gravitational field due to its velocity $\boldsymbol{v}$.

The conclusion is inevitable: Newton laws of motion are derivatives of Newton's inverse square law of gravity, and naturally take relativistic-like form as the particle's speed approaches that of light!

Inertia as a gravitational phenomenon versus the special principle of relativity

An immediate consequence of the equivalences between free fall and inertia is the invalidity of the special principle of relativity. While Einstein insisted inertial motions are relative, that is an observer in an inertial frame of reference is in principle prevented from detecting its absolute velocity (i.e. there is no such a thing absolute velocity, a Galilean assumption dubious by virtue of its own), once comprehended that inertial motion is a gravitational effect, an observer in an inertial frame of reference can (at least in principle) measure the magnitudes of gravitational fields from all spatial directions of massive bodies resting in the reference frame, for determining accordingly whether and to what extent and direction the gravitational fields of these massive bodies contain a constant gravitational potential component distorting their gravitational field in comparison with what expected at rest. I claim that the results of such measurements are currently known in the name "flyby anomaly"[6] , and that the anomaly measured is nothing more or less than the response of spacecrafts to the constant differential gravitational magnitude resulting from the inertial motions of planet Earth[I], a differential magnitude which is in superposition with the magnitude of Earth's regular gravitational field.

Flyby anomaly as a norm

As can be appreciated from the above, a mass in inertial motion moves from a lower magnitude region of a gravitational field toward a higher magnitude field region, the same as does a mass in a conventional gravitational field, with the exception that by its constant velocity motion it is reproducing the field created by itself in a new location every cycle, thereby maintaining an unchanged differential magnitude. Accordingly, the superposition of this differential magnitude with the regular gravitational field of the mass in motion yields a gravitational field that is of a greater magnitude ahead than from the trailing side. Additionally, in case the mass has an angular velocity about its own axis, the constant differential gravitational magnitude in the direction of rotation will cause a virtual shift in the location of the center of gravity of the mass, in a direction opposite to the direction of rotation as seen by a remote observer[II] (i.e. a test body located above the equator of a spherical rotating body of uniform mass distribution will be attracted towards a point shifted from the geometrical center of the rotating mass, in a direction opposite to the direction of rotation and perpendicularly to both the axis of rotation and the straight line connecting between the test body and the geometrical center of the rotating mass). It is expected that the influence of this effect will be orders of magnitude greater than the hypothesized influence of Lense Thirring frame dragging effect (Machian, to some interpretations)[7].

In our planet, however, since the max cross-radial velocity of Earth (~0.5 Km/sec equatorial surface velocity, corresponding to a much smaller weighted cross-radial velocity of Earth's mass) is small comparing to its orbital velocity (~30Km/sec), the impact of the latter is the dominant. As depicted in the following figure **6d**, the orbital velocity of Earth should be referred to as a cyclic vector component to be added to the solar system absolute velocity (i.e. in the sense of this present article after dispensing with the special principle of relativity), before the magnitude of the gravitational effect resulting from the inertial motion of Earth can be deduced. It can be predicted, however, that when a spacecraft maneuvering for a gravity assist by Earth is approaching Earth more from the trailing side of Earth's absolute motion than from the heading, it will gain momentum when escaping from Earth's heading side gravity, and vice versa. Exposure of the spacecraft to different sides of the planet should be accounted for in terms of altitudes, latitudes, declinations and the durations of these.

[I] lack of accurate data prevented recognition of possible anomalies during other planets' flybys [6]

[II] See Fig. 6e on page 9

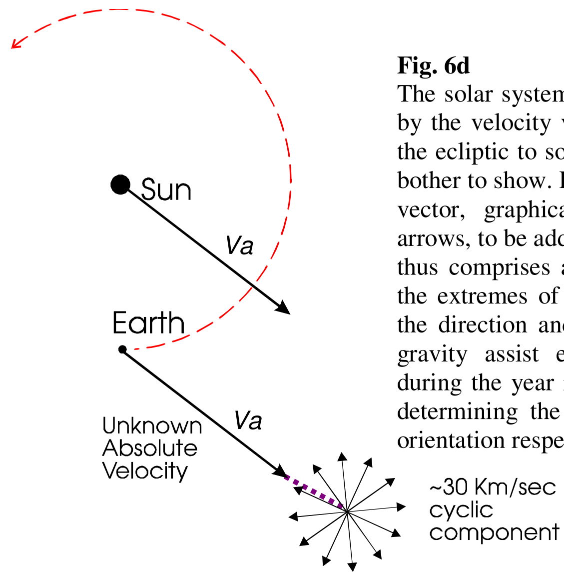

Fig. 6d
The solar system has some absolute velocity represented by the velocity vector *Va*, which is probably inclined to the ecliptic to some degree, though the drawing does not bother to show. Planet Earth has an annual cyclic velocity vector, graphically represented by the twelve radial arrows, to be added to Va. The gravitational field of Earth thus comprises a cyclically changing deformation, from the extremes of which, once experimentally discovered, the direction and magnitude of *Va* may be deduced. A gravity assist experiment repeated at different times during the year is one example of what can be done for determining the extremes of the deformation and their orientation respective of the absolute motion vector.

Of course the absolute velocity of the solar system is currently unknown, but flyby anomaly tests can be used for detecting it. Assuming the magnitude of the inertial based component in the gravitational field of a planet is proportional to the absolute velocity causing it, annual variations in the magnitude of a flyby anomaly are predicted. By measuring the flyby anomaly per a given spacecraft maneuvering about Earth in similar conditions at different times during a year, the direction and magnitude of the absolute velocity ***Va*** of the solar system may be calculated from the periodic differences in the detected anomaly and their attribution to a sinusoidal component of ±30Km/sec amplitude expected on top of the average absolute velocity due to Earth's orbital motion. The impact of such peak to peak ~60Km/sec differential velocity on the anomaly *ΔVi* as measured at extremes, is expected to be similar to the impact of ***Va*** on the total anomaly as measured on average:

$$\frac{60\text{Km/sec}}{\text{Va}} = \frac{\Delta[\Delta Vi]}{\Delta Vi}$$

If for example the anomaly is expressed in an average anomalous increase (or decrease) *ΔVi* of 10 mm/sec in the velocity ***Vi*** *(V at infinity)* of a spacecraft as measured during numerous annually distributed experiments, and the extremes of the anomaly measured with 6 months separation in between are 10.5 mm/sec and 9.5 mm/sec respectively (i.e. *Δ[ΔVi*]=1mm/sec), then the absolute velocity ***Va*** of the solar system (just for simplicity assuming its direction is parallel to the ecliptic) is 600Km/sec, and the absolute direction of motion of the galaxy is the tangent to Earth's orbital velocity vector at the time of max anomaly. The whole calculation may actually become more complicated bearing in mind that the absolute velocity vector of the solar system is probably inclined to the ecliptic in some unknown direction which may or may not be aligned toward the great atractor.

Annual and diurnal components in the gravitational field of planet Earth

The annual term on top of the gravitational field of Earth resulting from Earth's orbital motion as discussed above, is further accompanied by a diurnal term resulting from the angular velocity of Earth about its own axis. Though this diurnal term is undetectable as sinusoidal by a stationary observer located outside the planet[III], for an

[III] As mentioned in the beginning of the previous section, for a stationary test body outside of Earth the consequence of such diurnal term will be a constant virtual deflection in the location of the center of gravity of Earth, in the direction of rotation.

observer located on the surface of Earth there will be a diurnal term detectable on top of the gravitational field projected from Earth trough the observer. The magnitude of the diurnal term will vary from a maximum for observers on the equator, toward zero for observers on the poles. The variation in the gravitational field due to the diurnal and annual terms is so tiny, however, thus cannot be detected by conventional ***g*** probing. Fortunately, it has probably been detected by accident, as follows.

In a following article I will discuss a mechanism (which is fully comprehended yet unnecessary for postulating and comprehending the following) by which the speed of photons is very slightly varying as a function of the magnitude of the gravitational field through which it is passing. The predicted variation is extremely small, thus cannot be detected by conventional methods for gravitational fields generated by the solar system, bearing in mind that the current uncertainty in speed of light measurements is not less than 10^{-9}. It is predicted based on the above, that the diurnal and annual terms of the gravitational field of Earth emerging from a given point on the surface of Earth will be detected by an observer located on that point, as a diurnal and annual terms in the frequency of electromagnetic waves transmitted to and returned from a distant test body. The expected shift in the frequency of such electromagnetic wave is the result of two factors: (i) a different geodesic path traversed by the electromagnetic wave due to the virtual deflection in the center of gravity of Earth (this virtual deflection has been discussed in the previous section), with respect of which the observer on the surface of Earth is diurnally changing its position relatively to the test body (see Fig. 6e); and (ii) different speed of the electromagnetic wave passing through gravitational fields which slightly differ in their magnitude. It should be noted that the first factor is affecting only the diurnal term (since the observer on the surface of the Earth changes its location diurnally respective to the Earth's virtual center of gravity as seen from the test body, which is not the case for a remote stationary observer located at infinity), while the annual term is independent of the virtual deflection in the location of the center of gravity of Earth, thus affected only by the second factor.

Anderson et. al. reported[8] of Earth related unmodeled annual and diurnal terms detected on top of the anomalous deceleration experienced by both Pioneer 10 & Pioneer 11 spacecrafts, and expressed as periodical Doppler shifts in the frequency of the electromagnetic waves transmitted to and returned from said spacecrafts:

> mas.) At their great distances, the trajectories of the Pioneers are not gravitationally affected by the Earth. (The round-trip light time is now $\sim$ 24 hours for Pioneer 10.) This suggests that the sources of the annual and diurnal terms are both Earth related.

The unmodeled annual term reported:

> The resulting Doppler amplitude for the annual angular velocity $\sim 2 \times 10^{-7}$ rad/s is $\Delta\nu/\nu = 5.3 \times 10^{-12}$. At the Pioneer downlink S-band carrier frequency of ~ 2.29 GHz, the corresponding Doppler amplitude is 0.012 Hz (i.e. 0.795 mm/s).

The unmodeled diurnal term as expressed in Fig. 9 of the currently discussed Anderson [2002] article, is of an amplitude about 0.28 mm/s, corresponding to a Doppler magnitude of approximately 0.004 Hz[IV].

Bearing in mind that the frequency of the S-band carrier is ~2.29 GHz, the variations to be attributed to the speed of light for explaining the annual and diurnal terms as a gravitational influence, are between 3 to 4 orders of magnitude smaller than the minimal uncertainty in speed of light measurements.

It should be noted that said unmodeled terms have been weighted out of the modeled terms, based on conventional approach accounting for relativistic effects. Once accepting inertia is a gravitational phenomenon and upon recognizing said annual and diurnal terms as anti relativistic evidence, a non relativistic weighing of said terms is required for determining their true physical magnitudes and before possibly using them as benchmarks for further studies.

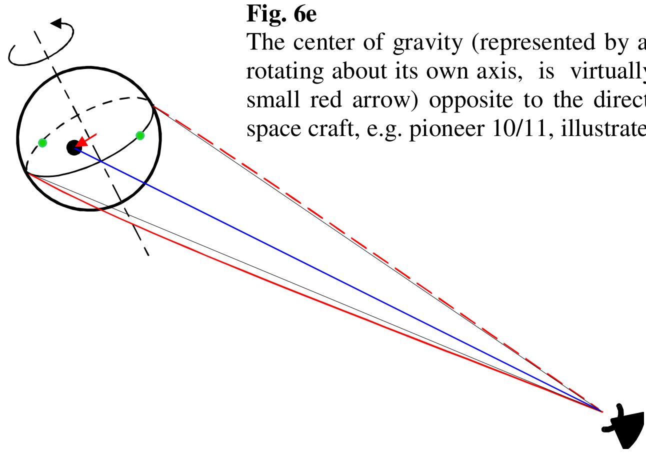

Fig. 6e
The center of gravity (represented by a bold black dot) of a planet, e.g. Earth, rotating about its own axis, is virtually shifted in a direction (indicated by the small red arrow) opposite to the direction of rotation, as seen from a remote space craft, e.g. pioneer 10/11, illustrated on the bottom right.
The trajectory of photons traveling between the spacecraft and observers (represented by green dots) will be exactly straight when an observer is located not necessarily on the equator rather on a straight line (colored blue) connecting between the spacecraft and the virtual center of gravity, but will be gravitationally bent to different extents according to the position of the observer outside said line.
The distance between the observer and the virtual center of gravity as seen from the spacecraft, is shorter at a first extreme point immediately after the observer is appearing from the hidden face of the planet, than in a second extreme point immediately before the observer is disappearing (about 12 hours later, in case of planet Earth) toward the hidden side. It is thus expected that the path followed by photons between the space craft and the first extreme point will be more gravitationally bent then the path followed by photons between the space craft and the second extreme point This predicted effect is exemplified by the greater deviation of the solid red line compared to the deviation of the dashed red line from the respective straight black lines connecting between the extreme points and the spacecraft. A Doppler-like shift in the frequency of electromagnetic waves transmitted to or returned from the space craft is expected accordingly. It is also predicted (based on a mechanism which I will present in a separate article) that the Doppler like shift will be magnified furthermore due to a tiny increase in the speed of photons passing through a gravitational field of a smaller magnitude, comparing to their speed through a gravitational field of a greater magnitude. This latter effect is also the cause of an annual term in the frequency of electromagnetic wave transmitted from the pioneer spacecrafts to Earth.

[IV] Doppler amplitude of 0.004 Hz respective of a carrier of 2.29GHz will result from a difference as small as about 8m per a trajectory of 30AU.

The excessive precession of mercury

The calculations made up to date for describing motions in the solar system should be revised to include gravitational influences resulting from inertial motions, e.g. a virtual shift in the sun's center of gravity.

It is suggested that the excessive precession of mercury is in its entirety due to inertial motion related gravitational fields of the sun (mainly), mercury itself, and of the planets.

CMB anisotropy

It is suggested that certain aspects of the ecliptic alignment of cosmic microwave background anisotropy are associated with the gravitational impact of inertial motions aligned with the ecliptic, since these are expected to cause differential gravitational bending of the CMB radiation.

Article sum up

Newton laws of motion are derivatives of Newton's inverse square law of gravity.

Inertia is the response of an elementary particle to the gravitational field of itself.

Inertia and gravitational acceleration are responses of a single mechanism to gravitational fields of different characteristics.

Inertia results from a special relation between a particle and a gravitational field: a case where opposite ends of a single elementary particle are located from opposite sides of a peak magnitude of the gravitational field created by the particle.

Inertial motion is a gravitational phenomenon: it is a free fall of a particle in a gravitational field of a constant potential generated by the particle itself in its course of motion.

The distribution of foreign gravitational fields make particles to accelerate, the distribution of self gravitational fields make particles to inert.

The inertia of a multi particle body is the sum of the inertia of its individual particles.

The inertial velocity of a mass expresses an equilibrium between (i) the ΔG distortion in the gravitational field generated during successive particle's cycle at different locations of any of the particles constituting the mass and (ii) the response of the particles to such ΔG, in terms of displacement during one particle's cycle.

Flyby anomaly is the norm to be expected when a spacecraft exercising a gravity assist is exposed asymmetrically to a constant gravitational potential associated with the inertial motion of the assisting planet.

Tiny annual and diurnal terms are predicted in the gravitational field of Earth emerging from its surface through an observer located there. The terms are detectable as Doppler shifts in the frequency of electromagnetic waves transmitted to the observer from a test body located outside the solar system.

It is suggested that the excessive precession of mercury is in its entirety due to inertial motion related gravitational fields of the sun and the planets.

Certain aspects of the ecliptic alignment of CMB anisotropy are due to inertial motion related gravitational field of the solar system.

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[1] THE FABRIC OF THE COSMOS, Brian Greene, First Vintage Books edition, 2005 (see chapter 2)

[2] THE FABRIC OF THE COSMOS[1] (see chapter 2, page 36).

[3] A. Einstein, letter to Ernst Mach, Zurich, 25 June 1923, in Misner, Charles; Thorne, Kip S.; and Wheeler, John Archibald (1973) "Gravitation" textbook. San Francisco: W. H. Freeman.

[4] MCS Physics Article 1: Particle (2011); Meir Amiram; viXra:1106.0008 ([184] Quantum Gravity and String Theory)

[5] MCS Physics Article 2: EMP and Time (2011); Meir Amiram; viXra:1106.0016 ([186] Quantum Gravity and String Theory)

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