PIONEER ANOMALY

(According to "*Hypothesis on* MATTER")

Nainan K. Varghese, matterdoc@gmail.com
http://www.matterdoc.info

Abstract: Observed locations of pioneer 10 and 11 spacecrafts, after they left the solar system, are displaced from their predicted positions in space and the discrepancy, which could not be explained by current physical laws, is termed as 'pioneer anomaly'. This article attempts to show that noticed discrepancy is an apparent phenomenon, produced by faulty geometry used in contemporary laws of planetary motion. In reality, the space crafts and external efforts on them behave normally. There is no cause for assumption of strange forces or mysterious effects on these space crafts.

Keywords: Pioneer anomaly, planetary orbits, Hypothesis on MATTER.

Introduction:

On completion of their destined roles, both space crafts, Pioneer 10 and Pioneer 11, were set sailing farther into space, away from solar system. These space crafts had sufficient impetus to carry themselves away from solar system, against deceleration caused to their motion by gravitational attraction towards macro bodies in solar system. Calculations to determine these space crafts' current locations are based on existing laws on gravitational attraction and laws on planetary motion. On establishing their present locations on various occasions, certain progressive but unaccounted discrepancies were noticed. Retardations of both space crafts were in excess of predicted values. This phenomenon gave rise to numerous speculations and exotic theories. However, none of them could, so far, logically explain the anomaly, satisfactorily.

Hypothesis on MATTER:

'Hypothesis on MATTER' [1] is an alternative concept that logically explains all physical phenomena. It is based on a single type of postulated matter particle – the quanta of matter. No other postulated entities or properties are used in this concept. Everything else in the universe is developed from quanta of matter and all properties are continuation of inherent property of quanta of matter. Development of this concept proposes a universal medium (made up of real matter) that can provide an absolute reference for all actions in nature [3]. In complete sense, all actions can be fully understood only in terms of their absolute nature. This concept does away with 'actions at a distance through empty space' and shows that all 'natural forces' are fundamentally the same. It follows strict 'cause and effect' relations in all explanations.

Contemporary laws on planetary motions are derived from empirical data collected about relative positions of few planets in solar system, with respect to assumed static state of sun. Therefore, these laws can be true only to determine relative positions of macro bodies in a planetary system with respect to their central body. Using these laws to determine other parameters of macro bodies in the solar system are not right. Relative positions of a planetary body, moving in stable orbital path about a central body may be predicted by contemporary laws of planetary motion.

All conclusions, expressed in this article, are from the "*Hypothesis on* MATTER" [1]. For details, kindly refer to the same. In this article, the word 'force' is used in its general sense to indicate an effort or cause of an action. Word 'inertial' is used to mean 'related to inertia'. Figures are drawn not to scale. They are depicted only to facilitate illustration of phenomena described.

Planetary orbits:

All text books (and other literature) teach that shape of a planetary orbital path is elliptical (or circular) around its central body. Simultaneously, simple mechanics tells us that no free macro body can orbit around another moving free macro body in a closed geometrical path. Elliptical (or circular) orbital path is an apparent structure that suits observation by an observer on a static central body. This is not the real path of planetary body in space. Unfeasibility to find a static macro body in space confirms impracticality of real circular/elliptical orbit. (Stable galaxies may remain static in space). With respect to an absolute reference, a planetary body does not orbit around its central body. Real path of a planetary body's motion (about its central body) is wave-like, along central body's path, with the planet periodically moving to the front and to the rear of the central body, as shown in figure 1. A brief description on true orbital motion may be found in article 'Planetary orbits' [4] at http://vixra.org/abs/1008.0010. In this article, we shall ignore eccentricity of apparent planetary orbits and consider them as circular.

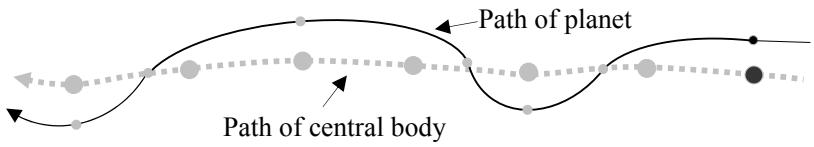

Figure 1

In figure 1, path of central body is shown by the arrow in grey dotted line. This curved path, also, is wavy to a smaller extent, curving in the same directions as the path of the planetary body. Arrow in black wavy-line shows planetary body's real orbital path in space. Unevenness of curvatures and magnitudes of departure of path on either side of central body's path (in the figure) is due to different scales used in the figure for linear and radial displacements. Path of a planet's satellite is a wavy-line about planet's path. Central body and the planetary body are shown by black circles and their future positions are shown by grey circles. In this sense, it can be seen that a planetary body (or a satellite) orbits around the centre of the central body's curved path and the wave pattern in its path is caused by the presence of the central body. Such changes in the path of a free macro body may be attributed to perturbations caused by presence of nearby macro bodies. These perturbations look like orbital motion around a central body, only when they are referred to an assumed static state of central body in a relatively small system of macro bodies.

Figure 2, compares between real and apparent orbital paths. Blue arrow in the centre of figure shows linear (curvature ignored) path of central body. Central body, in its present position is depicted by large black circle in the centre of apparent orbit. Large grey circles show future and past positions of the central body. Planetary body is shown in its present position by small black circle and grey small circles show

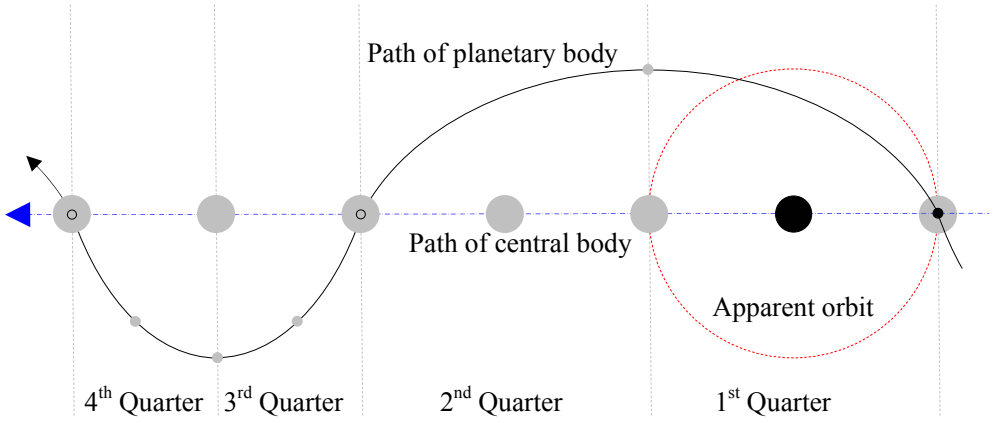

Figure 2

planetary body's future positions. Real orbital path of the planetary body is shown by black curved line with an arrow in the direction of its motion. This may be divided into four quarters as shown separated in

the figure by vertical dotted lines. Unevenness in the width of quarters is due to different scales, used in the figure for vertical and horizontal measurements. Large circle in dashed red line show apparent orbit of planetary body around the central body, in its present position. This apparent orbit travels along with central body in its path. Apparent orbit shows an imaginary path around the central body on which every point is equidistant from central body. In order to obtain an apparent orbital path, we need to split the real orbital path into two curved paths, one on either side of central body's path and recombine them by changing direction of planetary body's motion in one of the curved path. Apparent orbital path gives accurate information on relative positions of central and planetary bodies and no other parameters.

'Hypothesis on MATTER' stipulates that;

Circular/elliptical orbital paths of planetary bodies are apparent orbits around another free macro body, which the observer assumes as static in space.

A planetary system can develop and sustain only (nearly) in the plane of central body's curved path.

All planetary bodies enter into orbital path from external space. Entry of a planetary body into its stable orbital path is a one time process. There is no gradual development of stable orbital path.

Every planetary body has an ideal 'datum orbital path' about its central body. Datum orbital path is a circular apparent orbit around a central body, assumed in static state. Parameters of a datum orbital path depend on masses of central and planetary bodies, angle of approach and linear speed of planetary body.

A planetary body may enter into its stable orbital path only through a small conical window in space, on datum orbit, facing to the rear on the outer (convex) side of linear path of central body.

Five eighth part of 'central force' on a planetary body is utilised for its orbital motion and the rest three eighth part of 'central force' is utilised for its spin motion. [5 and 6].

Equation (7), in article 'Planetary Orbits' [4], $-\alpha = \mathrm{Sin}^{-1}\frac{u}{V}$, gives the lower limit of drifting rate at the point of entry (from within the datum orbit) for macro bodies, which may form successful stable orbits about a central body. Where, α is angular drifting rate (rate of change of $\angle$ TbE in figure 3) between planetary body's current direction of absolute linear motion and tangent to the orbital path, u is magnitude of planetary body's radial velocity towards central body by part of 'central force' and V is planetary body's absolute linear speed.

Macro bodies, approaching datum orbit from within, with higher (negative / clockwise) drifting rate, $(-\alpha)$, than the value, given by above equation, will fly away from its central body. This is current states of both space crafts, Pioneer 10 and Pioneer 11. They are moving away from solar system. At the instant, when these space crafts left the surface of earth, they had their absolute linear speed, inherited from earth. As absolute linear speed of space craft increased due to various impetuses provided, while it was inside solar system, within and without earth's influence. Its datum (apparent) orbital path around sun continued to enlarge due to increase in absolute linear speed, angle of approach to datum orbit and increase in distance from sun. By the time the space craft reached the limit of solar system, its absolute linear speed has attained a magnitude that could over-compensate its displacement due to gravitational attraction towards the sun. Once outside the solar system, there are no external influences on the space craft that could increase its absolute linear speed. From then onwards, absolute linear speed of space craft is continuously reduced by gravitational attraction towards the sun. As distance from the sun increases, gravitational attraction on the space craft gradually reduces. If absolute linear speed of space craft survives even after gravitational attraction towards the sun becomes negligible, the space craft will be wholly free from the solar system to become a free macro body in the galaxy.

Space craft, leaving solar system:

Before space crafts, pioneer 10 and Pioneer 11, reached outskirts of solar system, they were moving in (sort of) unstable orbital paths, constantly under control of various external efforts that guided them. Any discrepancy in their displacements was readily corrected by guiding efforts. Anomalous behaviour of their displacements was noticed after the spacecrafts passed about 20 au on their way out of solar system. At this distance, the space crafts had no guiding forces other than gravitational attraction towards solar system (sun). From this part of space, with respect to the space crafts, whole mass of solar system may be considered as concentrated at the centre of Sun.

When a space craft is at this distance, it is under two separate moving efforts.

1. Inertia associated with its matter content and inertia gained from the motion of solar system (and earth), before the space craft was launched, tends to move it along with the solar system in the direction of motion of sun. During space crafts' travel through the solar system, this inertia is modified by various efforts, which guided them away from the solar system. Associated inertia of the space craft tends to move it at a constant linear speed in a straight path, deflecting outward from the sun. Path of the space craft, at any instant, may be regarded as part of an unstable real orbital path.
2. Simultaneously, gravitational attraction between the sun and the space craft tends to accelerate the space craft towards the sun (decelerate its outward motion due to inertia).

Direction of motion (deceleration) due to gravitational attraction is always towards the sun. However, direction of motion due to inertia depends on the curvature at its current location on unstable real orbital path. Location of this point in the path of space craft is bound to make considerable variation in future actions on it. In current theories, direction of linear motion of a space craft along its apparent orbital path is ignored. Only displacement of space craft in the direction, away from central body is considered.

A space craft, when on earth, shares earth's linear speed in its orbital path. Once the space craft leaves the influence of earth, it becomes an independent macro body, flying towards and trying to enter into its datum apparent orbit around the sun. However, in case of space crafts Pioneer 10 and Pioneer 11 (and any other space craft, designed to fly away from solar system), they became independent macro bodies, only after all external influences on them are ceased. In order to make the explanations simpler, we shall consider a space craft is rocketed from a central body in a two-body planetary system consisting of the space craft and its central body (representing the solar system). If space craft's linear speed is greater than escape velocity on central body and its direction of motion is right, the space craft will be moving towards its datum apparent orbit around the central body. Since space craft's datum apparent orbit is around and away from the central body, the space craft is approaching the datum apparent orbit from within. As mentioned above [5], an external macro body, trying to enter its datum apparent orbit has to do so through a window at the rear and on the outer side. Therefore, a space craft, designed to leave the solar system has to enter its datum apparent orbit, somewhere in the first quadrant of its real orbital path (as shown in figure 2), preferably nearer to second quarter.

Pioneer Anomaly:

Establishment of stable orbital path by a space craft depends on its parameters. If the space craft is designed to leave the solar system, magnitude of drifting rate of its orbital path, $-\alpha$, will be more than that given by equation (7), $-\alpha = \mathrm{Sin}^{-1}\frac{u}{V}$, in article 'Planetary Orbits' [4] and up to value given by equation $-\alpha = \mathrm{Sin}^{-1}\frac{u}{2V}$. Drifting rate, $-\alpha$, may be increased either by increase in space craft's radial speed, u, towards the sun or by a reduction in its absolute linear speed, V. Since the space craft is moving away from the sun, magnitude of gravitational attraction between them gradually reduces. Hence, radial velocity, u, (or radial acceleration) due to gravitational attraction cannot increase. It can only diminish in magnitude. Other option, left to increase the drifting rate, is to reduce absolute linear speed of the space craft. This is achieved by gradual deceleration of the space craft, caused by gravitational attraction (acceleration) towards the sun. Because of higher drifting rate ($\angle$ TbE in figure 3) and larger deflection angle ($\angle$ HBE in figure 3), space craft will be slowed down in its linear motion. The space craft will move away from the sun and simultaneously, it will loose effects of inertia derived from its parent body and received from other sources during its travel within the solar system. As the space craft is destined to leave the solar system, its absolute linear speed will not be reduced to such an extent as to provide a drifting rate, suitable for a stable real orbital path. Nevertheless, attempt will continue until influence of solar system on the space craft will become negligible.

Magnitude of space craft's deceleration is directly related to gravitational attraction between central body and the space craft, which is given by equation in Newtonian gravitational laws. This equation needs slight modification to reflect reduction in gravitational attraction in proportion to distance between space craft and the sun. Only five eighth part of 'central force' is utilised for space craft's acceleration towards the sun [5]. Rest, three eighth part of 'central force', is used to spin the space craft about an axis perpendicular to its orbital plane. Radial speed of space craft towards the sun is combined with its absolute

linear speed to get resultant speed of the space craft in space. Magnitude of resultant speed not only depends on magnitudes of constituent speeds but also on angular difference between them.

Anomalies in parameters of Pioneer space crafts were noticed, when they were more than 20 au farther from boundaries of solar system. As this distance is too large compared to distribution of massive macro bodies in the solar system, it will be convenient to assume whole of solar system's mass is concentrated at the centre of sun. Sun travels in circular path around galactic centre. Since the period considered is too small (less than 100 years) compared to time required for the sun to travel through one full circle, we may consider sun's path (a small part of circular path) as a straight line. Distance, measured between an observer on earth and the space craft may be taken as the distance between space craft and centre of sun.

Figure 3 represents general layout of a planetary system that has solar system (represented by the sun) as the central body and a space craft (leaving the solar system) as its planetary body. Figure 4 is part of figure 3, enlarged to highlight actions relating to space craft's real orbital motion.

In figure 3, blue arrow XX shows linear path of sun (small part of its curved path). A is one of its past position and C is one of its future position. B is sun's current position. a, b and c are positions of space craft corresponding to positions A, B and C of the sun. Curve SS in red dashed line shows part of apparent orbital path of the space craft, corresponding to current position of sun at B and space craft at b. TT in red dotted line shows tangent at point b to apparent orbit SS. Present position of space craft is at b.

Considering motion of space craft in relation to its apparent orbital path; the space craft is situated at b on its apparent orbital path SS. Space craft has a radial velocity, u, represented by arrow bd towards the sun. At the same time, space craft is moving away from the sun, under centrifugal action. Magnitude of space craft's outward velocity is represented by red arrow bD. Taking resultant of these two motions (in

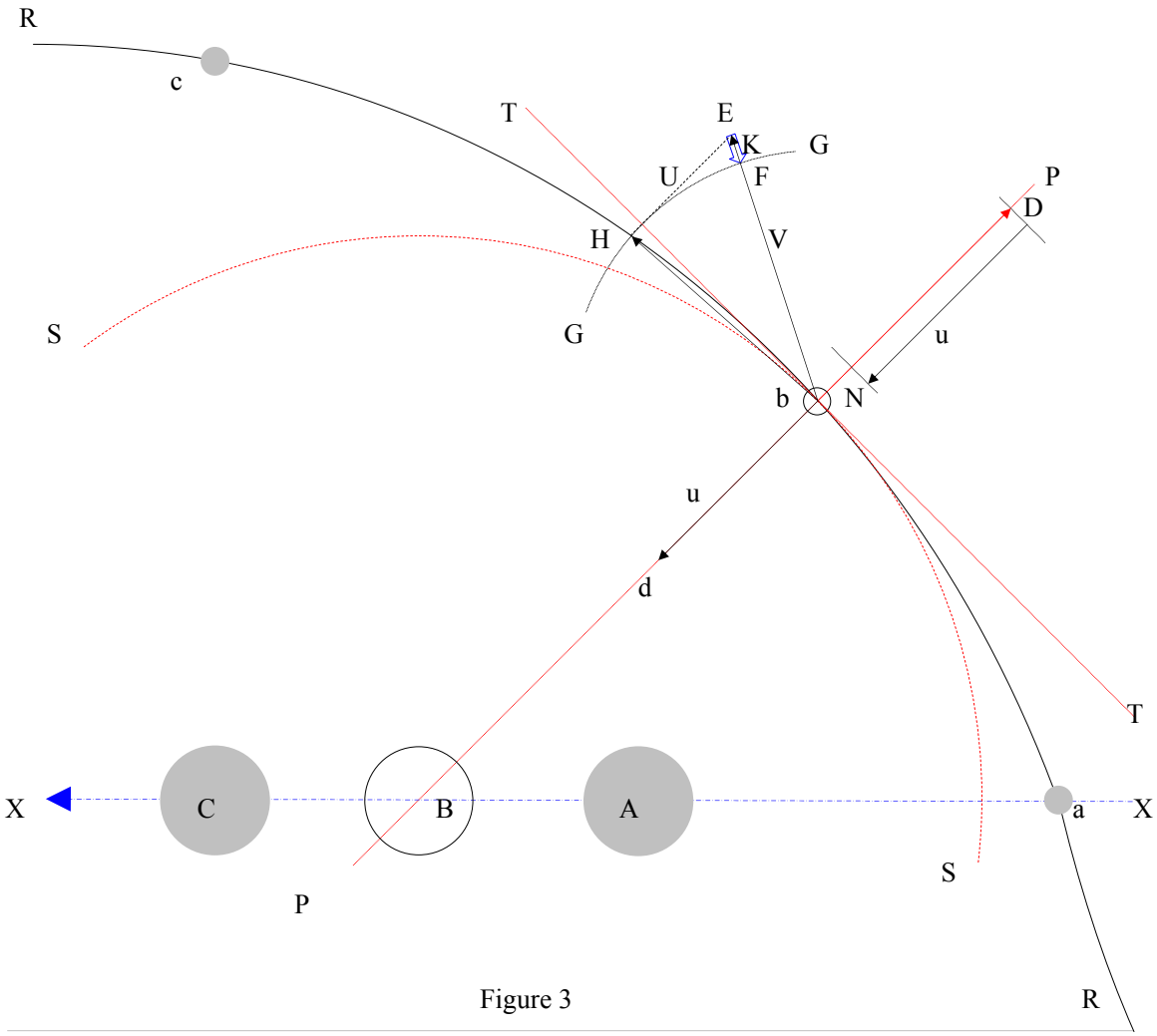

Figure 3

opposite directions), space craft has a resultant motion equal to bN, away from the sun. Rate of space craft's outward motion is given by bN. As distance between sun and space craft increases, magnitude of gravitational attraction between them and hence space craft's radial velocity towards the sun decreases. As long as space craft's outward velocity is more than its radial velocity due to gravitational attraction towards the sun, the space craft should continue to move away from solar system at a rate corresponding to resultant of inward and outward velocities. However, in this case, space craft's inward velocity appeared to over-compensate and effectively reduce its outward velocity. This brings about an unaccounted apparent radial acceleration towards the sun.

Calculations to determine parameters of space craft's motion, on these bases, do not allow any discrepancy in magnitudes of space craft's displacements. They should always be in accordance with the calculations. Ultimately, the space craft may enter into a stable apparent orbit around the sun, unless the outward impetus that drives the space craft away from the sun lasts until gravitational attraction between the two has become negligible. Pioneer space crafts are still under the influence of gravitational attraction towards the sun. However, this gravitational attraction is not sufficient to move the space craft along a stable apparent orbit. As long as this state of affairs continues, apparent orbit of space craft around the sun will gradually enlarge to take the space craft away from the sun. Parameters of its motion will always adhere to calculations, made in this regard. Nevertheless, a discrepancy is noticed in distances from the sun, determined by direct observation. Space craft is found nearer to sun than distance determined by calculation and this discrepancy is termed as 'Pioneer anomaly'.

Considering motion of space craft according to 'Hypothesis on Matter'; As shown in figure 4, the space craft is situated at b on its real orbital path RR. Space craft has radial velocity, U, represented by EH corresponding to bd towards the sun. Radial velocity U is 5/8 part of calculated radial velocity, u (corresponding to full gravitational attraction) and acts in the same direction on space craft at b. Magnitude of radial velocity U is produced by 5/8 part of total gravitational attraction between space craft and the sun.

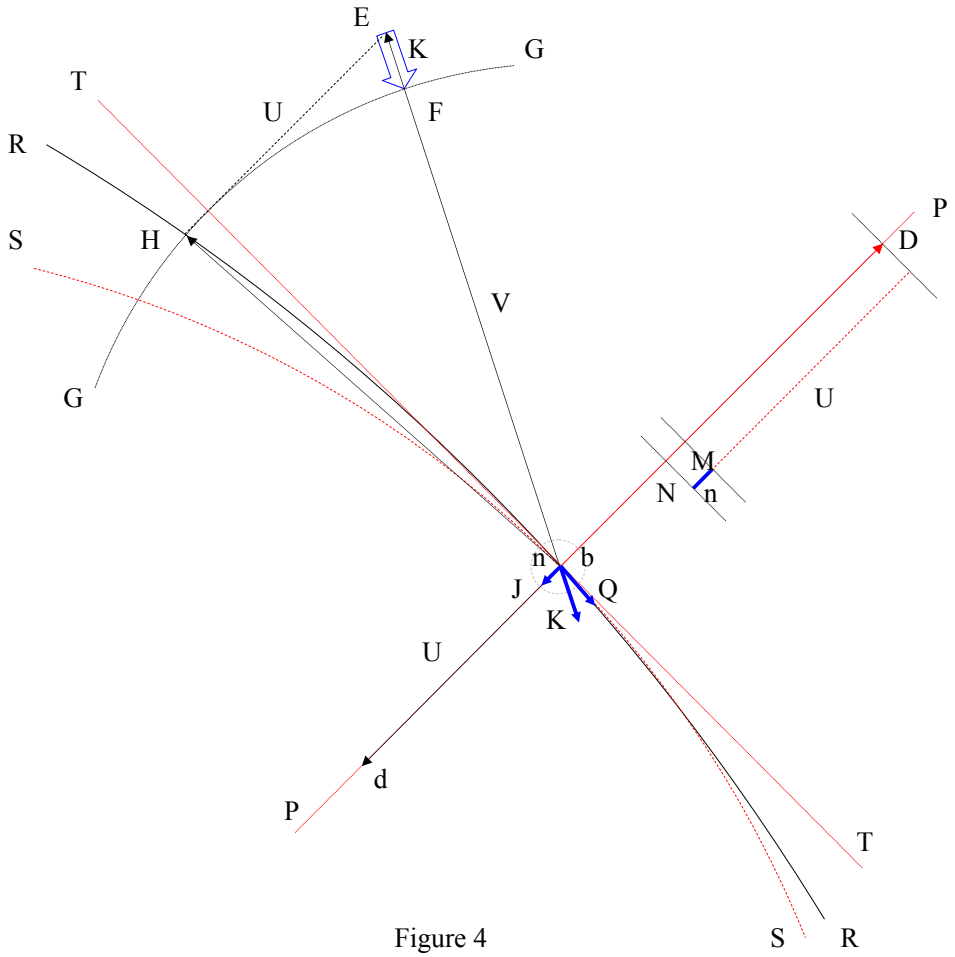

Figure 4

Present absolute linear velocity of the space craft, under inertia, is represented by bE in magnitude, V, and direction. It is deflected outward from real orbital path by ∠ HbE (deflection angle). Resultant of bE and EH gives bH, which represents resultant absolute linear speed of space craft in magnitude and direction. Magnitudes of present absolute linear speed bE and resultant absolute linear speed bH is compared by circular segment GG, centred at b. Combination of present absolute linear speed and radial speed reduces absolute linear speed of space craft by EF, shown by blue block arrow K.

Blue arrow K at b represents reduction in absolute linear speed of space craft at b. Resolving K in line with and perpendicular to U, we get bJ in the direction of U and bQ perpendicular to U. bQ has reduced absolute linear speed of space craft to bH, to move the space craft along its real orbital path. The component, bJ, in the direction of U increases radial velocity of the space craft by n towards the sun. Hence, the space craft will be displaced towards the sun by an additional distance corresponding to n in addition to displacement due to gravitational attraction, U.

Let bD be the observed outward radial velocity of space craft from the sun. Matching inward and outward radial velocities (and corresponding displacements); bD is the outward displacement. Inward displacements DM = U and MN = n are in opposite directions to bD. As a result, the space craft will move only up to N instead of up to M. This difference appears as a result of an unknown acceleration towards the sun and causes the 'anomaly'.

Magnitude of reduction in space craft's absolute linear speed depends also on the position of space craft with respect to sun, in the first quarter of its real orbital path. Hence, magnitude of anomaly depends on relative positions of sun and the space craft in its real orbital path. It is variable.

In the case of apparent orbits, inward radial velocity of planetary body, due to mutual gravitational attraction, is assumed always to act perpendicular to planetary body's linear speed. Linear motion of planetary body is assumed along tangents to apparent orbits. Changes in distance between central and planetary bodies are affected only by deflection of direction of planetary body's linear motion.

In case of real orbital paths, depending on relative positions of planetary and central bodies, angle between absolute linear motion of planetary body and its radial velocity towards the central body changes through full circle. Absolute linear motion of planetary body is taken in its true direction, in space. Therefore, a component of radial inward motion directly reduces planetary body's absolute linear motion in addition to deflection of planetary body's direction of absolute linear motion. This additional reduction in absolute linear speed of space craft will account for discrepancies, currently noticed as 'pioneer anomaly'.

Conclusion:

'Pioneer anomaly' is the result of using geometry of apparent orbital path of the space craft around the sun instead of geometry of its real orbital path (in space) about the sun. Additional retardation to absolute linear motion of planetary body, as seen in the real orbital motion of a planetary body in certain parts of its real orbital path, can account for this anomaly.

Reference:

References are self-published by the author. They are neither reviewed nor edited.

[1] Nainan K. Varghese.: Hypothesis on MATTER (second edition). BookSurge Publishing, North Charleston, NC. (2008) http://www.booksurge.com/Hypothesis-on-MATTER-Second-Edition/A/1419689789.htm

[2] Nainan K. Varghese. : Gravitation. CreateSpace (On-demand publishing Company), Scotts Valley, CA. (2010). http://www.createspace.com/3428742

[3] Nainan K. Varghese, Universal medium, http://vixra.org/abs/1007.0042

[4] Nainan K. Varghese, Planetary Orbits, http://vixra.org/abs/1008.0010

[5] Nainan K. Varghese, Central Force, http://vixra.org/abs/1006.0068

[6] Nainan K. Varghese, Planetary Spin, http://vixra.org/abs/1008.0029

* ** *** ** *