PLANETARY ORBITS

According to 'MATTER (Re-examined)'

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Abstract: It is an established fact that sun is a moving macro body in space. By simple mechanics, it is physically impossible for a free planetary body to orbit *around* a moving central body, in any type of geometrically closed path. Both, a circle and an ellipse, are closed geometrical figures. Hence, elliptical planetary orbital paths (closed geometrical figures) around sun are false or apparent. A planetary body moves in same direction and along with its central body. It is only when we imagine reversing the direction of planetary body's motion, on one side of central body's path; we can get a geometrically closed figure for planet's apparent orbital path. Use of a reference frame, related to a static central body, causes planetary orbital paths to appear as closed geometrical figures around central body. As central body is a moving body, this does not reflect physical reality. Although they help to explain apparent phenomena, all properties attributed to elliptical/circular planetary orbital path are unreal. Real physical actions are restricted to real entities and they have to be understood with reference to an absolute reference. Since elliptical shape of a planetary orbit is an imaginary aspect, it has its limitations to explain real actions in nature. Mechanism of orbit-formation and limitations of orbiting macro bodies, described in this article, are based on a radically different dynamics from an alternative concept presented in book, 'MATTER (Re-examined)'.

Keywords: Planetary orbits, apparent orbit, real orbit.

Apparent orbital path:

Real orbital paths of all macro bodies, in a galaxy, is around galactic centre. It is very large and contains many points of similar appearance in relation to central body of respective planetary system. Hence, it is convenient for us to use much smaller structure, the 'apparent orbit', with unique reference points on it for all practical purposes. Apparent orbit is a small part of real orbital path, between two identical appearances of central body, looking from planetary body (e.g.: one solar year). It is an imaginary concept, where shape of path, speed of planetary body and directions of motions are manipulated to suit observations. As such, it has no logical mechanical basis. It depicts appearance of a system, where it is assumed that central body by some imaginary mechanism (change of reference frame) is held stationary at centre of apparent orbit and planetary body moves at a (constant) linear speed by an equally imaginary mechanism.

Only cause of actions, within a planetary system, is 'central force', due to gravitational attraction, which accelerates planetary body towards centre of apparent orbit – the central body. Parameters of this action are mathematically manipulated to produce the required orbital motion around central body that matches observations. [In case of earth, they are also used to establish proofs of validity for "Laws of motion" and "Laws of universal gravitation"]. While doing this, greater motions of planetary body before it became a planet and motion or path of central body are ignored. Apparent orbit is convenient to predict cyclic features that take place annually. However, taking apparent orbit as real orbit of a planetary body is highly illogical and incorrect.

Mathematical treatments of apparent planetary orbit, around a central macro body, assume direction of 'central force' on planetary body is always (almost) perpendicular to direction of its linear motion. This is an essential requirement for all laws derived from apparent orbits. In real orbital motion, it is not so. Radial motion of planetary body is perpendicular to orbital path only at 'datum points', situated farthest and nearest to galactic centre. At all other points on orbital path, angle between radial motion and orbital path varies as sine of relative angular position of planetary body with respect to central body and median path. In circular (elliptical with no eccentricity) orbits, 'central force' does not affect planetary body's linear motion at all. It can produce only centripetal acceleration and displacement towards central body. Centrifugal displacement by an imaginary 'centrifugal force' is essential to nullify centripetal displacement of planet towards central body.

Unlike in apparent orbit, in case of real (wavy) orbital motion, direction of action of 'central force' on planetary body changes through a full circle, during its passage through two subsequent segments of (one wave of) orbital path. This behaviour will not sustain mathematical proofs derived from calculations, using parameters of apparent orbit. 'Central force' not only produces centripetal acceleration of planetary body towards central body but also affects its linear speed. Magnitudes of these effects depend on relative positions of planetary body and central body. Since direction of centripetal acceleration changes through full circles, depending on relative positions of macro bodies, it has its components assisting or opposing planetary body's linear motion.

A non-circular apparent orbit has two reference points on it, periapse and apoapse. They are situated diametrically opposite on apparent orbit. Apoapse is the point on apparent orbital path, where planetary body is considered slowest and farthest from central body and periapse is the point on apparent orbital path, where planetary body is considered fastest and nearest to central body. In real orbital motion of planetary body, periapse is a point on its path, where it is nearest to central macro body but it needs not be fastest at this point. And apoapse is a point on its path, where it is farthest from central body, but it needs not be slowest at this point. In case of earth, these points are called perihelion and aphelion, respectively.

Although perihelion(s) are points on orbital path, at which planetary and central bodies approach nearest, highest linear speed of planetary body occurs at points on orbital path, farthest from galactic centre. Similarly, although aphelion(s) are points on orbital path, at which distance between planetary and central bodies' is farthest, lowest linear speed of planetary body occurs at points on orbital path, nearest to galactic centre. While considering apparent planetary orbits (around static central body), linear speed of planetary body is reduced to a small fraction of its real speed in space (equal to its linear speed relative to central body), with corresponding reduction in planet's kinetic energy. Action, by associated kinetic energy on a planet is likely to show up in miniature form.

Figure 1 compares real path of an orbiting macro body and its apparent orbit for duration of one apparent orbital period. Grey central line shows central body's path. Black, wavy line is path of planetary body. Larger black circle shows central body and circles in dotted line show its future positions. Small black circle shows orbiting macro body and grey circles show its future positions. Double headed arrows show 'central force' between macro bodies at various positions as they move along their paths.

Apparent orbit of planetary body, when it is at position P with central body at S, is shown by the oval in figure 1. As planetary body moves, its apparent orbit moves along with central body. Planet's perihelion is at P and aphelion is at E. In real motion, highest and lowest linear speeds of orbiting macro body occur, when it is at 90° away from path of central body, at M and position B (represented by N on apparent orbit), respectively. All parameters of apparent orbit and orbital motion are related to perihelion and aphelion. From its position at C, until B, orbiting macro body is in front of central body and hence it is retarded in its linear motion. From B to A, orbiting macro

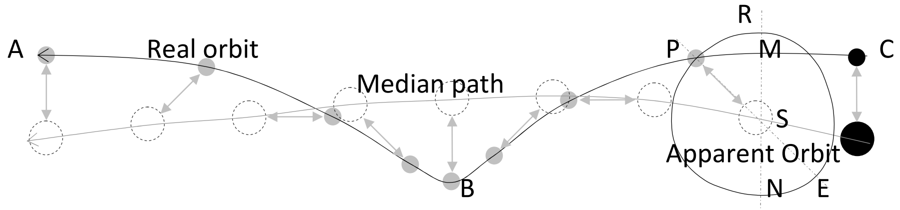

Figure 1

body is behind central body and hence it is accelerated in its linear motion. Line RST is radial line connecting central body to centre of its curved path (galactic centre). Acceleration and deceleration of planetary body change over at points M and B. These points are fixed relative to path of central body. Point M, on outer side of central body's path, is 'outer datum point' and point B (corresponding to point N on apparent orbit), on inner side of central body's path, is 'inner datum point'. Datum points have only a vague relation to apparent orbit. A circular apparent orbit around static central body is 'datum orbit'.

Real orbital path:

In figure 2, planetary body is at point P on its real orbital path, represented by curved arrow X_1PP_1. XX_1 is tangent to orbital path at P. Line xx_1 is parallel to line XX_1. Arrow PA represents absolute instantaneous linear speed of planetary body, V, in magnitude and direction. Due to inertia, planetary body tends to maintain present direction of its linear motion. Angle between V and path of planetary body varies as planetary body moves in its curved path. Total angular displacement, W, produces curvature of planetary body's path and hence its orbital motion. Direction of planetary body's present instantaneous linear speed, V, is deflected outwards from curved path (from tangent XX_1). At any instant, V is deflected from XX_1 by angle $-\alpha$ ($-$ sign indicates outward deflection), which is outward 'drifting rate' of planetary body.

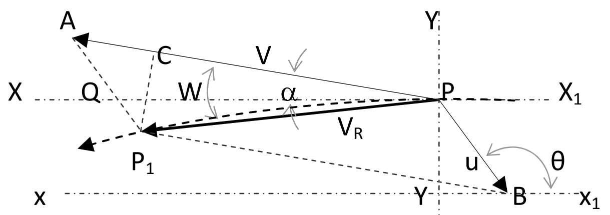

Figure 2

Arrow PB represents 'central force' on planetary body towards central body. Magnitude of radial speed due to 'central force' is PB = u. Direction of u is towards central body. Angle between u and parallel line xx_1, angle XPB, is equal to angle $PBx_1 = \theta$.

Arrow PP_1 is resultant instantaneous speed of planetary body, V_R, and it makes angle W with V. Due to action of 'central force' (radial motion u), instantaneous linear motion of planetary body is deflected from PA to PP_1 at the rate of angle W per unit time.

$$\text{Angle between V and } V_R = \angle APP_1 = W,$$

$$\text{Direction of radial motion with respect to tangent } XX_1,\ \angle QPB = \angle PBx_1 = \theta$$

$$\angle APB = \theta + \alpha\ ,\quad \angle P_1Bx = \angle APX = \alpha\ ,\quad \angle PAP_1 = \angle PBP_1 = (180 - \theta - \alpha),\quad AP_1 = PB = u\ ,$$

Line CP_1 is perpendicular to line PA. In $\Delta^{le}ACP_1$, $AP_1 = u$,

$$\angle CAP_1 = \angle PAP_1 = \angle PBP_1 = (180 - \theta - \alpha)$$

$$CP_1 = AP_1\ \text{Sin}\ \angle CAP_1 = u\,\text{Sin}(180 - \theta - \alpha) = u\,\text{Sin}[180 - (\theta + \alpha)] = u\,\text{Sin}(\theta + \alpha)$$

$$CA = AP_1\ \text{Cos}\angle CAP_1 = u\,\text{Cos}(180 - \theta - \alpha) = u\,\text{Cos}[180 - (\theta + \alpha)] = u \times -\text{Cos}(\theta + \alpha) = -u\ \text{Cos}(\theta + \alpha)$$

$$PC = PA - CA = V - (-u\,\text{Cos}(\theta + \alpha)) = V + u\,\text{Cos}(\theta + \alpha)$$

$$\text{Tan}\ W = \frac{CP_1}{PC} = \frac{u\,\text{Sin}(\theta + \alpha)}{V + u\,\text{Cos}(\theta + \alpha)} \qquad \textbf{(1)}$$

In parallelogram $APBP_1$, Diagonal $PP_1 = V_R = \sqrt{(AP)^2 + (PB)^2 - 2\,PB \times AP \times \text{Cos}\left(\frac{\pi}{2} + \alpha\right)}$

$$V_R^{\ 2} = (AP)^2 + (PB)^2 - 2 \times PB \times AP \times \text{Cos}\left(\tfrac{\pi}{2} + \alpha\right) = V^2 + u^2 - 2V\,u\,\text{Cos}\left(\tfrac{\pi}{2} + \alpha\right)$$

$$V_R^{\ 2} = V^2 + u^2 - 2\,V\,u(-\text{Sin}\alpha) = V^2 + u^2 + 2\,V\,u\,\text{Sin}\alpha \qquad \textbf{(2)}$$

Factors; deflection rate, W, and radial velocity, u, are inward (towards centre of circular path) and drifting rate, α, is outward (away from centre of circular path). Hence, relative directions may be assigned to these factors. W and u are assigned positive direction and α is assigned negative direction. Thus, equation (1) becomes:

$$\text{Tan}\,W = \frac{u\,\text{Sin}\ [\theta + (-\alpha)]}{V + u\,\text{Cos}[\theta + (-\alpha)]} = \frac{u\,\text{Sin}\ (\theta - \alpha)}{V + u\,\text{Cos}(\theta - \alpha)} \qquad \textbf{(3)}$$

W is rate of inward angular deflection between directions of present velocity, V, and resultant velocity, V_R. It is 'deflection rate'. Rate of outward angular deflection, α, between direction of present motion, V, and tangent at P is 'drifting rate' of planetary body, away from tangent to orbital path. In order to make orbital path curve towards median path of planetary (and central) body, resultant of inward deflection rate, W, and outward drifting rate, α, should be in the same direction as that of radial motion of planetary body, u, with respect to tangent XX at P. [As shown in figure 2, magnitude of W should be more than magnitude of α]. Vertical component (to tangent XX) of present speed V is a real motion, substituting for effect of (presently) imaginary 'centrifugal force'. This real motion produces drifting rate, α.

Circular orbit:

Circular orbit is a possible path that can be traced only around a central body that has no translational motion. Centers of stable galaxies are the only points (entities in universe) without translational motion. In all other cases, circular orbit is an apparent orbit related to a central body that is assumed static. For motion in a circular path, instantaneous resultant linear speed, V_R, should be equal to present instantaneous linear speed, V. Both linear speeds are with respect to absolute reference. That is, at any instant, resultant linear speed of a planetary body in its curved path is equal to its present linear speed. In a circular orbit, deflection rate, W, is constant. Planetary body has no angular acceleration in orbital path. It maintains constant distance from central body. Hence, drifting rate remains constant and equal to $-\alpha$ all around orbital path. If value of negative (clockwise) drifting rate, $-\alpha$, can be maintained constant at half the value of positive (anti-clockwise) deflection rate, W, by external means or by natural process, direction of resultant linear motion of

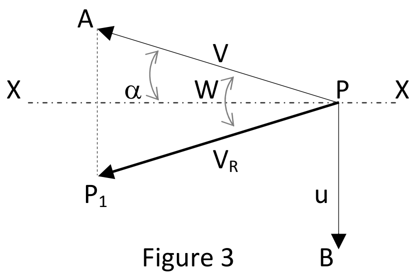

Figure 3

planetary body along its curved path will deflect at a constant rate. Magnitude of resultant linear speed of planetary body remains constant, equal to its present (instantaneous) linear speed.

In figure 3; arrow PA represents present (absolute linear) speed, V, of a planetary body P. Direction of its present linear motion is deflected from tangent XX to planetary body's curved path at P by an angle, $-\alpha$. Arrow PB represents planetary body's radial motion, u, perpendicular to tangent XX to its curved path at P. Instantaneous resultant speed of planetary body, V_R, is represented by arrow PP_1. Its direction is deflected from present linear speed, V, by an angle $+W$.

$$AP_1 = PB = u. \qquad \angle APB = \tfrac{\pi}{2} + (-\alpha),$$

For circular path, $V = V_R$; Substituting V for V_R in equation (2); $V^2 = V^2 + u^2 + 2\,V\,u\,\text{Sin}\alpha$

$$u = -2\,V\,\text{Sin}\alpha \qquad \textbf{(4)}$$

$$\text{Sin}\alpha = -\frac{u}{2V}$$

$$-\alpha = \text{Sin}^{-1}\frac{u}{2V} \text{ radian} \qquad \textbf{(5)}$$

When orbital path is circular, 'central force' acts in perpendicular direction to tangent at any point on it. Hence, $\angle\theta = \tfrac{\pi}{2}$,

Substituting value of 'u' from equation (4) in equation (3),

$$\text{Tan}\,W = \frac{(-2\,V\,\text{Sin}\,\alpha)\text{Sin}\left(\frac{\pi}{2}-\alpha\right)}{V + (-2\,V\,\text{Sin}\,\alpha)\text{Cos}\left(\frac{\pi}{2}-\alpha\right)} = -\frac{2\,V\,\text{Sin}\,\alpha\,\text{Sin}\left(\frac{\pi}{2}-\alpha\right)}{V - 2\,V\,\text{Sin}\,\alpha\,\text{Cos}\left(\frac{\pi}{2}-\alpha\right)} = -\frac{2\,\text{Sin}\,\alpha\,\text{Cos}\alpha}{1 - 2\,\text{Sin}\,\alpha\,(\text{Sin}\alpha)}$$

$$= -\frac{\text{Sin}\,2\alpha}{1-2\,\text{Sin}^2\alpha} = -\frac{\text{Sin}\,2\alpha}{\text{Cos}^2\alpha + \text{Sin}^2\alpha - 2\,\text{Sin}^2\alpha} = -\frac{\text{Sin}\,2\alpha}{\text{Cos}^2\alpha - \text{Sin}^2\alpha}$$

$$= -\frac{\text{Sin}\,2\alpha}{\text{Cos}\,2\alpha} = -\text{Tan}\,2\alpha\,, \qquad \therefore W = -2\alpha$$

For circular orbit, where deflection rate W is positive, drifting rate α is in negative direction, with magnitude $\alpha = W \div 2$

$$\text{Substituting from equation (5), } W = -2\alpha = 2\,\text{Sin}^{-1}\frac{u}{2V} \qquad \textbf{(6)}$$

$$\frac{W}{2} = \text{Sin}^{-1}\frac{u}{2V}, \qquad \text{Sin}\frac{W}{2} = \frac{u}{2V} \qquad \textbf{(7)}$$

For a circular orbit, where direction of W is positive: Drifting rate, $\alpha = W \div 2$ in negative direction. **(8)**

This is the condition, required for circular orbital path of a planetary body *around* a static central body or circular parts of other orbital paths at points on their orbital path, where they exhibit properties of circular orbit. Resultant linear speed of planetary body, along curved path remains a constant, whose magnitude is equal to its present (instantaneous) linear speed. Angular speed of planetary body about centre of circular path (deflection rate) is equal to twice its drifting rate (in opposite angular direction) and its magnitude is constant.

Direction of linear motion of a planetary body that desires to enter circular orbital path has to be outward from tangent at the point of entry. Drifting rate of a planetary body at the point of initial entry on datum orbit (clockwise from tangent at P, as shown in figure 3), required to achieve circular orbital path (in this case) is precisely equal to half of deflection rate produced by 'central force' at present distance between centre of orbital path and point of entry. Hence, planetary body is required to approach entry point P from within datum orbit. These conditions can be fulfilled only in cases, where orbital path is formed around a static central body.

All natural planetary bodies are much smaller than their central bodies and they approach their orbital paths from outside datum orbits. A planet in real orbital motion, traces segments of curved paths on either sides of its median path (which is also the median path of central body). A circular orbital path requires semi-circular paths on either sides of median path. Due to constantly changing relative direction of 'central force', it is also impossible to maintain constant angular speed by a planetary body about a moving central body. Consequently, natural planetary bodies cannot have circular orbital paths. However, certain points on their orbital path may exhibit properties of circular orbital path.

Exceptions to the above are probable cases of static binary systems at the centers of stable galaxies or other planetary systems formed by explosion of a static parent macro body, also at the centre of a stable galaxy, where planetary bodies are thrown away from a static central body to enter their orbital paths from within. Since, no macro body, except stable galaxies, can remain in space without translational motion; this is only a theoretical consideration.

Circular orbit is a critical condition. Parameters of planetary body (maintained in circular orbit by external means, in addition to 'central force') are very precise. Once in orbit, its drifting rate can be easily changed by external factors. Changes in matter-contents of planetary and central bodies or their linear speeds due to external influences are bound to affect stability of circular orbit, due to changes in drifting rate. Collision with debris in space or even uneven distribution of matter contents of planetary bodies can influence state of a circular orbit. It should also be noted that no macro bodies smaller than a stable galaxy can remain static in space.

To form a circular apparent orbit, parameters of an orbiting planetary body should apparently satisfy equation (6); $W = 2\mathrm{Sin}^{-1}(u \div 2V)$, at every point on its orbital path. All factors in equation should remain constants. This is achieved by ignoring state of motion of central body and original state of motion of planetary body. Apparent circular orbit of a planet is its smallest apparent orbit. It is the datum orbit of a planetary body for present parameters of central and planetary bodies. This equation is also applicable to (apparently) circular parts of non-circular orbits.

Elliptical Orbit:

Like circular orbit, elliptical orbit, around a static central body, is also an apparent orbit. Variations in parameters of an orbiting planetary body change its datum orbit. Consequently, even if a planetary body was in an apparent circular orbit, its datum orbit changes on variation of any parameter. Such changes or difference in magnitude of drifting rate change shape of its orbital path. Non-circular apparent orbits are based on datum orbits of planetary bodies. A deformed datum orbit becomes non-circular apparent orbit. Deformation of datum orbit is with respect to two points (mid-points) that are on diametrically opposite sides. Either forward or rearward part of non-circular apparent orbit is placed within and other part is placed outside datum orbit, as shown in figure 4.

Figure 4 shows two possible representative deformations of datum orbit of into elliptical apparent orbits. Circle in dashed line shows planetary body's datum orbit around static central body. Oval shapes in red and green show elliptical apparent orbits of planetary body, around static central body, formed corresponding to its parameters during entry into orbital path. Since a planet apparently moves in a non-circular path, tangent to a point on apparent orbital path is not perpendicular to its instantaneous radius, along which 'central force' is acting. But, there are two points that lie on apparent orbital path, at which conditions required for circular apparent orbits are satisfied. At these points, direction of radial motion (action of 'central force') is perpendicular to tangents to apparent orbital path and variation in length of its radius reverses direction.

If radius of apparent orbit was increasing before planet reaches the point, it will gradually decrease after crossing this point, till planetary body reaches a similar point on diametrically opposite side of the apparent orbit. At this point, direction of change in distance between central and planetary bodies reverses and radius of apparent orbit gradually increases till planetary body reaches original point on apparent orbit. Periodic changes in length of radius of apparent orbit, about a mean value, sustain planetary body in its non-circular stable apparent orbital path. Points, where reversals of changes in radius of apparent orbit occur, are periapse (perihelion) and apoapse (aphelion) at which planetary body is nearest or farthest from central body. Other reference points on real orbital path are outer datum point and inner datum point, where planetary bodies attain highest and lowest linear speeds.

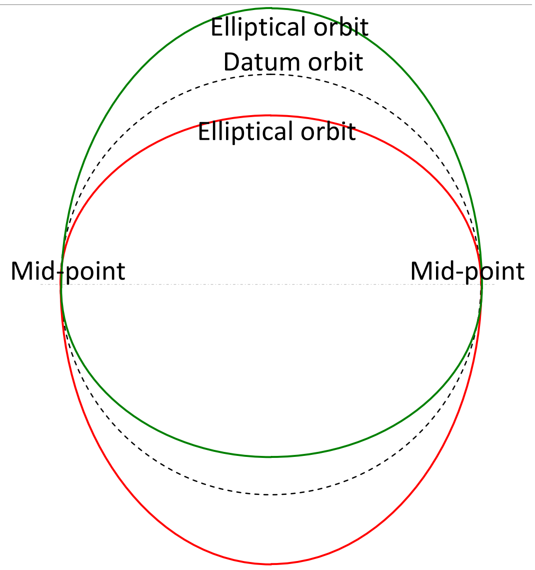

Figure 4

In case of real orbital motion, planetary orbital path is not around central body but it oscillates about a common median path, shared by central and planetary bodies. Angular speed of planetary body does not correspond to motion in circular or elliptical path. Deflection rate of orbital path from median path is limited, alternating on both sides; whereas, total deflection of 2π radians in same direction is required for every apparent orbit.

Planetary body accelerates upto outer datum point, where it moves to front of central body or it decelerates upto inner datum point, where it moves behind central body. Highest and lowest linear speeds of planetary body occur at datum points. Datum points need not coincide with either perihelion or aphelion of apparent orbit, assumed above. Datum points of orbital path are situated on radial lines of galactic radius (line perpendicular to median path of central and planetary bodies), passing through centers of both, central and planetary bodies.

Periapse and apoapse indicate points, on orbital path of a planetary body, which are nearest and farthest from central body. They have no other relations to motions of orbiting planetary body. Periapse and apoapse may be displaced along orbital path without affecting other parameters (excepting planetary spin speed) of orbital motion. But points, at which planetary body's linear acceleration and linear deceleration changes-over, are fixed in space, with respect to median path of central body and depend on relative position of planetary body.

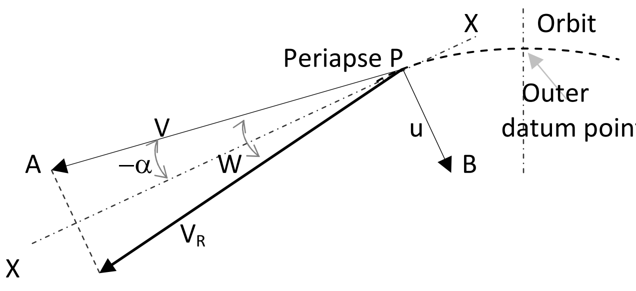

Figure 5

Figure 5 shows a planetary body P at periapse of apparent orbital path. Arrow PA represents present instantaneous linear speed, V, of planetary body. Arrow PB represents its radial speed, u. Arrow PP_1 represents its resultant (future) instantaneous linear speed, V_R. Outward drifting rate is equal to $-\alpha$. W is inward deflection rate of resultant motion. Changes due to angular acceleration and deceleration add to drifting and deflection rates. Motion of planetary body, at perihelion of its non-circular apparent orbit, exhibits properties of motion in circular apparent orbit. Angle between PB and tangent XX at periapse is 90°.

Figure 6 shows a planetary body P at apoapse of apparent orbital path. Arrow PA represents present instantaneous linear speed, V, of planetary body. Arrow PB represents its radial speed, u. Arrow PP_1 represents its resultant (future) instantaneous linear speed, V_R. Outward drifting rate is equal to $-\alpha$. W is inward deflection rate of resultant motion. Changes due to angular acceleration and deceleration add to drifting and deflection rates. Motion of planetary body, at aphelion of its non-circular apparent orbit, exhibits properties of motion in circular apparent orbit. Angle between PB and tangent XX at apoapse is 90°. Conditions for circular orbital paths exist at aphelion and perihelion.

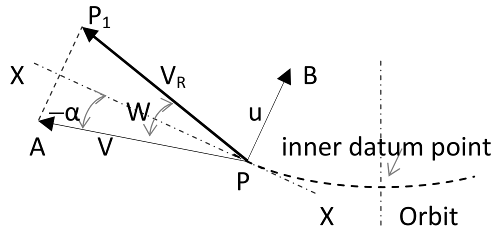

Figure 6

Angle between tangent to orbital path and 'central force' = θ = π/2

Putting $\operatorname{Tan} W = \frac{\operatorname{Sin} W}{\operatorname{Cos} W}$ and θ = π/2 in equation (3)

$$\frac{\operatorname{Sin} W}{\operatorname{Cos} W} = \frac{u \operatorname{Sin}\left(\frac{\pi}{2} - \alpha\right)}{V + u \operatorname{Cos}\left(\frac{\pi}{2} - \alpha\right)} = \frac{u \operatorname{Cos} \alpha}{V + u \operatorname{Sin} \alpha} \qquad \textbf{(9)}$$

During circular orbital conditions, drifting rate $(-\alpha)$ is equal to half of deflection rate W.

Putting drifting rate, $-\alpha$ = W/2 in equation (9);

$$\frac{\operatorname{Sin} W}{\operatorname{Cos} W} = \frac{u \operatorname{Cos}\left(-\frac{W}{2}\right)}{V + u \operatorname{Sin}\left(-\frac{W}{2}\right)} = \frac{u \operatorname{Cos} \frac{W}{2}}{V - u \operatorname{Sin} \frac{W}{2}}, \; V \operatorname{Sin} W - u \operatorname{Sin} W \operatorname{Sin} \frac{W}{2} - u \operatorname{Cos} W \operatorname{Cos} \frac{W}{2} = 0$$

$$V \sin W - u\left(\operatorname{Cos} W \operatorname{Cos} \frac{W}{2} + \operatorname{Sin} W \operatorname{Sin} \frac{W}{2}\right) = 0, \; V \operatorname{Sin} W - u \operatorname{Cos}\left(W - \frac{W}{2}\right) = 0$$

$$V \sin\left(2 \frac{W}{2}\right) - u \operatorname{Cos}\left(\frac{W}{2}\right) = 0, \; V \times 2 \sin\left(\frac{W}{2}\right) \operatorname{Cos}\left(\frac{W}{2}\right) - u \operatorname{Cos}\left(\frac{W}{2}\right) = 0$$

$$2V \operatorname{Sin} \frac{W}{2} \operatorname{Cos} \frac{W}{2} - u \operatorname{Cos} \frac{W}{2} = 0, \; 2V \operatorname{Sin} \frac{W}{2} - u = 0,$$

$$\operatorname{Sin} \frac{W}{2} = u \div 2V \qquad \textbf{(10)}$$

$$W = 2 \operatorname{Sin}^{-1} \frac{u}{2V} \qquad \textbf{(11)}$$

Equation (10) is same as equation (7) for circular apparent orbit. Therefore, a non-circular apparent orbital path has two points on it, where it behaves like a circular path. Since curvature of orbital path varies continuously, behavior of non-circular apparent orbit as circular apparent orbit lasts only for an instant. As soon as point of periapse or point of apoapse is passed, planetary body will pursue its non-circular apparent orbital path.

Drifting rate at periapse, α_{peri}, is half of deflection rate, W_{peri}, and at apoapse; drifting rate, α_{aphe}, is half of deflection rate, W_{aphe}, in magnitudes. As shown in figures 5 and 6, directions of drifting rates, with respect to radial motion, are always same. Included angles between u and direction of approach of planetary body are of same sense. In a non-circular orbit; equation (11) gives deflection rate. Equation (7) for circular apparent orbit is applicable to a non-circular apparent orbit at its periapse and apoapse, where circular apparent orbital conditions exist.

Deflection rates, W, for periapse and for apoapse are in opposite directions. If planetary body entered its datum orbital path from within (with negative drifting rate), it will move towards its apoapse, where conditions of circular apparent orbit take place. Similar conditions (required for circular apparent orbit) should also repeat at a point 180° away from periapse / apoapse, as the case may be. A stable apparent orbit can be formed only if these conditions are met. At periapse, direction of change in distance between central and planetary bodies reverses. Planetary body moves towards apoapse, where condition for circular apparent orbit is fulfilled once again.

At mid-points between periapse and apoapse, inward deflection rate, W, becomes equal to outward drifting rate, $-\alpha$. Resultant angular speed of planetary body becomes zero. For an instant, planetary body moves in straight line. Direction of linear motion of planetary body is tangential to apparent orbital path at these points but directions of radial motion, u, are not perpendicular to tangents at those points. Therefore, conditions for circular apparent orbit are not fulfilled at mid-points in non-circular apparent orbits. Tangents at mid-points are not parallel to major axis of non-circular apparent orbit.

In a theoretical elliptical path, tangents at the ends its minor axis are parallel to major axis. In cases, explained above, they are not so. Hence, apparent orbital path of a planet is oval (with its narrower end towards apoapse) in shape rather than elliptical. However, due to very small eccentricity of apparent orbits, we come across in nature; they are usually considered as elliptical or circular. Present laws on planetary motion are formed for elliptical apparent orbits.

In real orbital path, points at which orbital path of planetary body crosses median path of central body may be considered as mid-points. After mid-point in real orbital path, between periapse and apoapse, angular difference between radial and linear motions of planetary body diminishes. When planetary body has moved from mid-point by angular displacement equal to deflection of periapse or apoapse from datum points, linear and radial motions of planetary body become co-linear. At this point, deflection rates, W, of planetary body due to 'central force' become zero. However, planetary body continues to move in its curved orbital path under influence of drifting rate, $-\alpha$, which continues to decrease in magnitude.

Once, this point on real orbital path is passed, direction of angular difference between linear and radial motions of planetary body reverses. Deflection rate, W, and drifting rate, α, are in same direction for a short while until drifting rate, α, changes its sense. Planetary body angularly accelerates till it reaches another point, where conditions for circular orbital motion are fulfilled, where deflection rate, W, and drifting rate, α, are in opposite directions and magnitude of W is twice that of α. This point is apoapse of real orbital path. Thereafter, similar processes continue to sustain stable orbital motion of planetary body in its real orbit about its central body.

$$\text{Resultant orbital angular speed at perihelion } = W_{peri} - \alpha_{peri} = \omega_{peri}$$

$$\text{Resultant orbital angular speed at mid-point } = W_{mid} - \alpha_{mid} = 0$$

$$\text{Resultant orbital angular speed at aphelion } = W_{aphe} - \alpha_{aphe} = \omega_{aphe}$$

$$\text{Time to move from periapse to apoapse} = T \div 2 .$$ Where, T is orbital time period.

Resultant orbital angular speed of a planetary body, in its real orbital path, decreases from ω_{peri} at periapse to zero at mid-point, increases in opposite direction from zero at mid-point to ω_{aphe} at apoapse, decreases from ω_{aphe} at apoapse to zero at mid-point and increases in opposite direction from zero at mid-point to ω_{peri} at periapse. Total angular deflection of a planetary body during every cycle of real orbital motion is zero. [Total angular deflection of a planetary body during every cycle of apparent orbital motion is full circle − 2π radians]. Therefore, real orbital path of a planetary body is wavy about median path of central body.

Location of 'periapse' or 'apoapse' of real orbital path depends on location of point of entry of planetary body on datum orbit and drifting rate at the time of entry. For appropriate drifting rate, point of entry can be at periapse or apoapse of orbital path. Location of periapse and apoapse can shift later due to external influences, whereas, locations of datum points remain at their relative positions with respect to central body.

Limits of angular speeds at the point of entry:

Real orbit of a planetary body is a path in space, whose strictures are related parameters of central and planetary bodies. It is improbable for planetary bodies to originate in their orbital paths. They have to come to their orbital paths from space, away from orbital paths. For smooth transition from a planetary body's motion outside into motion in an orbital path, all parameters of central and planetary bodies', at the time and at the point of entry should be same, as if the planetary body was moving in a stable orbital path, at that point.

Every potential planetary body has a datum orbit about its central body. Parameters of datum orbit depend on matter-contents of central and planetary bodies, present linear speeds of centre and planetary bodies and relative direction of approach of planetary body. Planetary body has to approach datum orbit in near-tangential direction, rather than in collision course towards central body. If planetary body's parameters do not suit appropriate datum orbit, it will be unable to move in a stable orbit about the central body.

'Central force' on a planetary body (towards central body) is active even when it is very far from its future orbital path. Hence, parameters of a planetary body's motion are modified continuously, even before it enters orbital path about the central body. A planetary body enters its orbital path in near-tangential direction, subject to following limits. Macro bodies, approaching point of entry into their datum orbits (outside certain limits of angular speeds with respect to central body), are unable to form stable planetary bodies.

To approach a moving central body, potential planetary body from rear has to move at a greater linear speed in a direction almost parallel to direction of central body's motion. Magnitude of (outward) drifting rate of a planetary body depends on angle of approach and linear speed of planetary body. Magnitude of (inward) deflection rate depends on magnitude of 'central force'. As magnitude of drifting rate, α, increases to a limit in negative (outward) direction, deflection rate, W, becomes insufficient to overcome drifting rate and direction of macro body's resultant motion, V_R, becomes parallel to (or deflected outward from) tangent to datum orbit at the point of entry. Macro body will fly away in tangential direction to (or away from) datum orbit. Such a macro body is not able to form a stable orbital path about central body.

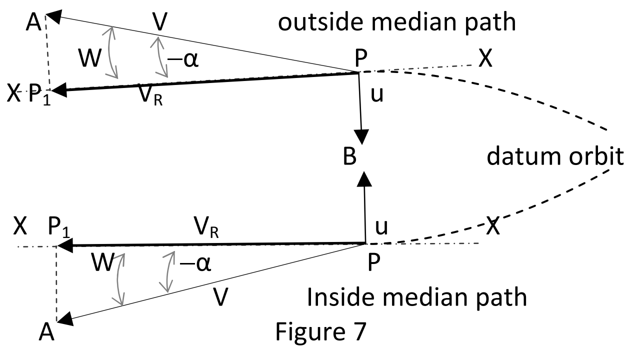

Figure 7

Figure 7 shows angular speeds of planetary body at point of entries near outer datum point and inner datum points on datum orbit. Upper figure shows planetary body entering datum orbit outside median path and lower figure shows planetary body entering datum orbit inside median path. Curved dashed lines represent parts of datum orbit. P is point of entry. PA is present instantaneous linear speed, V and PP_1 is future instantaneous linear speed of planetary body, V_R. $PB = u = AP_1$ is motion due to 'central force'. PB = AP_1, in figure. Future instantaneous linear speed, V_R is resultant of present instantaneous linear speed V and motion due to 'central force' u.

In both cases, deflection rate W is equal to drifting rate $-\alpha$ and direction of resultant linear speed PP_1 is along tangents XX at point of entry. Hence, present drifting rate $-\alpha$ is the highest angular speed for any prospective planetary body. Only those macro bodies, approaching with angular speed less than $-\alpha$, can form a stable orbital path about the central body.

When resultant linear speed of planetary body, V_R is along tangent to datum orbit at point of entry, deflection rate W is just sufficient to overcome outward drifting rate α. W = − α.

$$\text{From figure 7,} \qquad \text{Sin}\,W = \frac{AP_1}{PA} = \frac{u}{V} = \text{Sin}(-\alpha)$$

$$\text{Highest permitted drifting rate, } -\alpha = \text{Sin}^{-1}\tfrac{u}{V} \text{ radian} \qquad \textbf{(12)}$$

Equation (12) gives higher limit of (outward) drifting rate at point of entry for a macro body, which approaches datum orbit from within and may enter into successful orbital path about a central body. Macro bodies, approaching datum orbit from within, which have greater outward drifting rate than this value will fly away from central body.

Equation (5), $-\alpha = \text{Sin}^{-1}\frac{u}{2V}$ radian, gives condition required for an orbiting planetary body to have periapse and apoapse in its orbital path. This equation should be satisfied two times in every completed cycle (apparent orbit) of orbital path. If planetary body is entering its datum orbit from outside, by time it reaches its periapse, drifting rate of planetary body should attain a value of $\text{Sin}^{-1}\frac{u}{2V}$. As long as this value is not reached, planetary body will continue to move towards periapse in its orbital path. That is, distance between central and planetary bodies continues to reduce, until planetary body reaches periapse in its orbital path.

Should drifting rate exceeds value of $\text{Sin}^{-1}\frac{u}{2V}$, planetary body will move presumably towards periapse in its orbital path. However, drifting rate, being greater than the value required for stable orbital path, planetary body will move towards central body at a higher rate and spiral down into it, without ever attaining the condition required for periapse. Even if planetary body were to enter datum orbit at the point of periapse, its drifting rate should not exceed this limit. Thus, $\text{Sin}^{-1}\frac{u}{2V}$ is the outer limit of drifting rate during entry (for a planetary body entering datum orbit from outside) to form a stable orbital path about a central body.

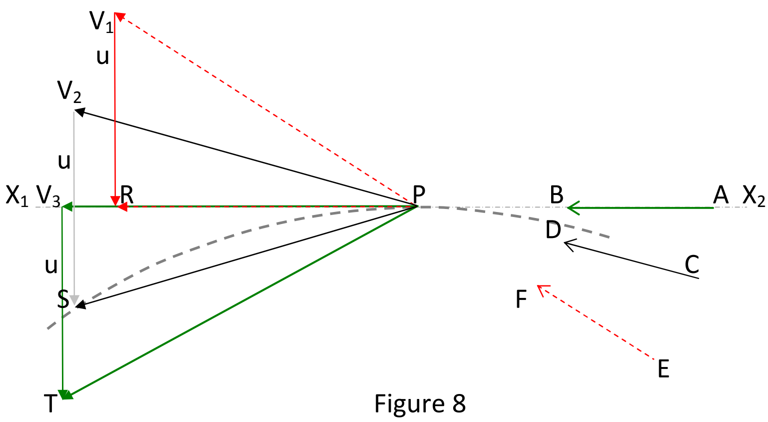

Figure 8

Figure 8 shows angular limits of a planetary body's approach to its datum orbit. Grey dashed curve shows part of datum orbit, near point of entry of planetary body. Only one possible point of entry on outer side of median path is discussed. Point of entry on inner side of median path is also similar.

Point P is point of entry of planetary body in datum orbit. Central line X_1X_2 is tangent to datum orbit at point of entry. Directions of planetary body's approach along arrows AB, CD and EF are shown in figure 8. Present instantaneous linear speeds of macro bodies are shown by arrows PV_1, PV_2 and PV_3 in magnitude and direction. Arrows V_1R, V_2S and V_3T show radial linear speeds, u, of macro bodies due to 'central force'. Considering parameters of approaching macro bodies are identical and parameters of central body do not change, magnitudes and directions of u are identical. Resultant linear speeds of macro bodies are shown by arrows PR, PS and PT.

Macro body, approaching in the direction of arrow EF has outward drifting rate equal to angle V_1PX_1. Part of 'central force' acts in opposition to macro body's linear speed and resultant linear speed is reduced to PR. Macro bodies, which have greater outward drifting rate than angle V_1PX_1 will fly away from central body. For greater drifting rate, reduction in resultant linear speeds will be larger. Unless, approaching linear speed is very high, macro body will be retarded sufficiently to return it towards central body and fall into it.

Macro body, approaching in the direction of arrow CD has outward drifting rate equal to angle V_2PX_1. This is the lowest limit of outward drifting rate for a macro body approaching datum orbit from within and highest limit of outward drifting rate for a macro body approaching datum orbit from outside. Magnitudes of drifting rate, lower than this value are for macro bodies approaching datum orbit from outside. Therefore, direction of arrow CD is the border between approach angles for macro bodies from within and without datum orbit. All macro bodies approaching in directions between arrows EF and CD can form stable orbital paths about central body, by proceeding towards their apoapse.

For macro bodies approaching in the direction of arrow CD, present linear speed and resultant linear speed are equal in magnitude. Radial motion of macro body is used solely to change its direction of motion. Macro body will trace semicircular orbital paths, alternately on either side of median path (circular apparent orbit).

Macro body, approaching in the direction of arrow AB, same as tangent X_1X_2 at point of entry, has outward drifting rate equal to zero. This is the lowest limit of outward drifting rate for a macro body approaching datum orbit from outside. Part of radial motion is used to increase resultant linear speed, PT. Macro bodies approaching datum orbit between directions of arrows CD and AB (from outside datum orbit) may form stable orbital path about central body by proceeding towards their periapse.

A macro body, approaching datum orbit with negative drifting rate (inward deflection from tangent) cannot form stable orbital path about a central body. It will spiral down into central body.

Considering above limits together; to form stable orbital motion about a central body, planetary body has to enter its datum orbit with values of drifting rates between $\text{Sin}^{-1}(u \div V)$ and zero. Angles, between $\text{Sin}^{-1}(u \div V)$ and $\text{Sin}^{-1}(u \div 2V)$ are for macro bodies, which are approaching datum orbit from within. Angles, between $\text{Sin}^{-1}(u \div 2V)$ and zero are for macro bodies, which are approaching datum orbit from outside.

Planetary bodies with (outward) drifting rate between $\text{Sin}^{-1}(u \div V)$ and $\text{Sin}^{-1}(u \div 2V)$ have their aphelion in front of entry point. When (outward) drifting rate is equal to critical value $\text{Sin}^{-1}(u \div 2V)$ (when magnitude of resultant linear speed is equal to magnitude of present linear speed), planetary body traces semi-circular orbital paths or either sides of median path.

Planetary bodies with (outward) drifting rate between $\text{Sin}^{-1}(u \div 2V)$ and zero have their periapse in front of their point of entry. Limits between $\text{Sin}^{-1}(u \div 2V)$ and zero are for those macro bodies approaching from outside datum orbit. From point of entry they can move only towards periapse of their orbital path.

These stringent restrictions, in conjunction with restrictions on direction of approach (as explained in the next sub-section on 'Orbits about moving central body'), considerably lowers number of macro bodies, which are able to form stable orbital paths and prevents profusion of planetary bodies about a central body.

Curvature of orbital path and tangential speed of a planet, at any time, depend on its location on orbital path. Center of curvature at any point on orbital path is its focus. In real orbital motion, centre of curvatures for alternate half cycle of orbital motion lie on opposite sides of median path. Magnitude of orbital path's curvature is zero at mid-points and increases as planetary body moves towards periapse or apoapse. However, while considering apparent orbit, imaginary curved orbital path is assumed to close-in on itself to provide circular or elliptical nature.

A planetary body, approaching its datum orbit from outside, approaches on convex side of orbital path. Hence, it is not possible for this planetary body to enter its datum orbit within angles between $\text{Sin}^{-1}(u \div 2V)$ and zero to tangent to datum orbit during its first entry. Practically, planetary body has to cross datum orbit to reach the point of entry

Orbits about a moving central body:

It is unlikely that macro bodies of considerable sizes move away from a central body to enter into orbital path about it. All larger macro bodies, like planets, have to come from outside planetary system. Planets could enter into orbital paths in any direction around a static central body. However, if central body is moving (as is the case with all natural macro bodies), directions of approach of their planets are restricted. Following description is about planetary bodies approaching a central body from outside their datum orbits. It is quite practical that many planetary bodies approaching a central body from outside their datum orbits may have to cross part of datum orbit before their entry into orbital path. That is, instead of approaching point of entry, directly, they may have to enter datum orbit, first and then on their way out they reach the point of entry, proper. Somewhat similar conditions are applicable to planetary bodies that may approach datum orbit from within. To make explanation simpler, apparent orbit is used as a reference and real orbital path is compared with it, later.

All large macro bodies, in space, move at very high linear speed. (It is estimated that sun moves in a circular path around galactic center at a relative speed of about 250000 m/sec, much greater than relative speed of earth with respect to the sun, which is about 30000 m/sec, in its orbital path about sun). Relative speed between central body and a planetary body, trying to enter into orbital path about central body, depends on relative directions of their linear motions, with limitation that linear components of motion of both macro bodies are always in identical direction.

Planetary bodies, approaching a central body in opposite direction to its linear motion will find action of 'central force' is to enhance their present linear speeds. Relative speed of macro bodies becomes too large for them to form a planetary system. Consequently, no macro body that is approaching a moving central body in opposite direction to central body's linear motion can enter into a successful orbital path about the central body.

Similarly, macro bodies approaching from sides (all around) of a moving central body will be left far behind. Such macro bodies have very little or no linear motion in the direction of linear motion of central body. Hence, their relative speeds are too large to be controlled by relatively small 'central force'. They cannot form stable orbital paths about a moving central body.

In order to enter into a successful orbital path about a moving central body, a planetary body has to approach central body from the rear and nearly in orbital plane, at a linear speed greater or lesser (within very small margin) than linear speed of central body. During approach, relative speed of planetary body varies only by a small fraction with respect to central body's absolute speed.

All macro bodies, in a galaxy, move in curved paths around galactic centre. Directions of their linear motions may be modified slightly by gravitational interactions with other macro bodies in the galaxy. A central body usually has a curved path as shown by line NOM in figure 9, where direction of approach of a planetary body is shown with respect to its apparent orbit, prevailing at the time of planetary body's entry into orbital path.

A planet approaching its datum orbit from inside of curved path, NOM, will find that it has an additional relative motion away from galactic center. This is produced by curvature of central body's path. Planetary body's drifting rate is enhanced by curvature of central body's median path. Additional relative motion enhances radial motion produced by 'central force'. These factors prevent a macro body, approaching from concave side of central body's path, to enter into a successful orbital path (about central body that itself is moving in a curved path).

Above mentioned factors leave only two small windows, shown by APEC and aQec in figure 9 (widths of windows shown are highly exaggerated), through which a planetary body may enter into successful orbital path about a central body. As central body is assumed static, similar windows could be anywhere around apparent orbit. Hence we shall limit discussion only to one window APEC on outer side of central body's path NOM. This window is on outer (convex) side of curved path, NOM, and to the rear of central body. Window, APEC, in 3D space, is somewhat conical in shape, with its apex towards outer datum point in planetary body's orbital path. Girth of conical window restricts entry to macro bodies, whose orbital plane can be gradually stabilized into central body's orbital plane. Similar window, aQec, available on opposite side of apparent orbit is described later with respect to real orbital path.

All macro bodies, entering into successful orbital paths about a central body, enter through this window. Entry is further restricted by limits of drifting rate of planetary body's angular speed during entry. Therefore, there are no planets orbiting in opposite to direction of central body's own orbital motion around galactic centre or having its orbital plane too far from central body's orbital plane. Direction of displacement of apparent orbit of a planetary body is same as the direction of central body's orbital motion about galactic center. Thus, all orbiting planetary bodies in a planetary system move in same apparent angular directions and in planes not much different from central body's orbital plane.

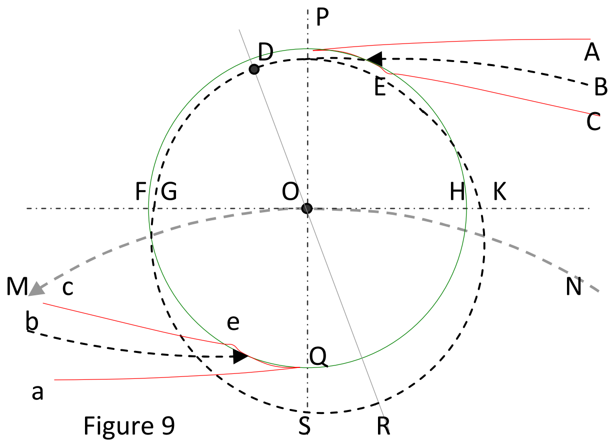

Figure 9

As shown in figure 9, O is the center of datum orbit around (static) central body. Circle in green line, PFQHP, is datum orbit corresponding to central and planetary bodies' parameters, at the instant, when planetary body enters datum orbit. Datum orbit is smallest possible circular apparent orbit suitable to parameters of central and planetary body, when magnitude of outward drifting rate is half the magnitude of inward deflection rate. Black circle at O is central body and black circle at D is the planet at its periapse. Elliptical figure, DGRKD, in dashed line is planetary body's apparent orbit, corresponding to position of central body at O.

P and S are datum points, where highest and least linear speeds of planetary body occur. D is periapse and R is apoapse of orbital path, shown on apparent orbit. Extension of line, POS, joins central body with galactic centre. At any instant, datum points, central body and galactic centre are situated on line POS. Curved arrow, BE, shows direction of linear motion of planetary body, while it is entering datum orbit corresponding to apparent orbit DGRKD. Planetary body may enter into datum orbit through conical window shown by region between A and C (shown in plane of paper by space between APEC).

Relative position of periapse on apparent orbital path, D, depends on location of point of initial entry, E, and magnitude of drifting rate. Greater the drifting rate, farther from point of entry is periapse. Location of apoapse is always diametrically opposite on apparent orbit. Distance between central and planetary body is least, when planetary body is at periapse and it is highest, when planetary body is at apoapse. Linear speed of planetary body is fastest, when it is near outer datum point, P and it is slowest at point S (shown on apparent orbit), when it is near inner datum point, Q.

Only those macro bodies, from outside datum orbit, whose outward drifting rate at the time of entry into datum orbit is within limits; $0 < \alpha < \text{Sin}^{-1}(u \div 2V)$ and whose direction of entry is through permitted windows can produce stable orbital paths about central body that is itself moving in a curved path. Changes in rest mass or linear speed of an orbiting planetary body may change size of its orbital path but not its eccentricity and angular position. In order to change eccentricity or relative angular position of apparent orbit, separate external effort has to act on orbiting planetary body to deflect it from its course and change deflection rate of instantaneous present linear speed, V, while moving in stable orbital path.

Figure 10 shows entry zones for planetary bodies on their real orbital paths. Both windows of entry are depicted in figure. Thick dotted arrow NOM represents path of central body. Wavy arrow KDQK represents one full cycle of real orbital path of planetary body about central body, moving along median path NOM. Part KD of orbital path, shown in dotted line, represents extension of orbital path before point of entry to show one full cycle.

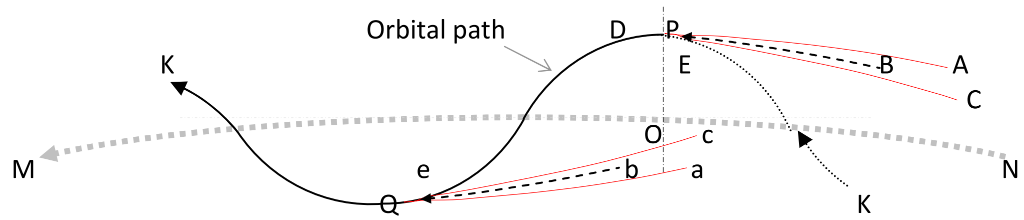

Figure 10

Entry zones are represented (in plane of paper) by regions between APEC and aQec. Arrows BE and 'be' represents directions of approach of a macro body that may become successful planetary body about central body that is moving along median path NOM. This figure may be compared with figure 9. Description of window aQec is also similar to window APEC, given above.

When figure 10 is used to depict real orbital path of a planetary body, instead of apparent orbital path, as is used presently, it is clearly evident that a planetary body approaching a central body from any quarters other than through the entry windows APEC and aQec cannot enter into successful orbit about the central body. Entry window APEC is outside apparent orbit of planetary body. Entry window aQec could be represented on (opposite side) outside apparent orbit, but in opposite direction. Therefore, it is not described, as shown in figure 9.

Hence, all macro bodies entering into stable orbital paths about a central body have to come from outside the planetary system. Unlike planets, comets have very large and highly eccentric apparent orbits. Their periapse occur within central body's curved path and their highest absolute linear speed occurs nearer to their apoapse. Hence, it may be deduced that they enter their orbital paths from within their datum orbits.

Anomalies:

Ideal cases of orbital motions of a planetary body and its central body are considered in above explanations. However, in space, there are many macro bodies in the vicinity of a planetary body and none of them are in steady state of motion or without translational motion. Orbital motion of a planetary body is affected by nearby macro bodies and their motions. These effects usually produce what may appear as anomalies in orbital motions of a planetary body with respect to its central body. Mostly, a central body may have number of planets, each one with its own satellites. Additionally, there may be macro bodies, occasionally visiting planetary systems. All these macro bodies affect orbital paths of all planetary bodies in a planetary system.

Many anomalous behaviors are noticed during observations of orbital motions in cosmology, with respect to apparent orbits of planets, satellites and artificial satellites. Explanations, usually given, on these anomalies are based on rationale of apparent planetary orbits around static central bodies, in conjunction with currently used illogical assumptions. Current laws of (empirically determined) planetary motion are also based on apparent orbits. Explanations, based on planetary laws devised for apparent orbit, are often too complicated and illogical. On many occasions they fail to provide convincing arguments.

It should be noted that apparent orbit is an imaginary construct, devised solely for the purpose of finding relative positions of planets in a planetary system with respect to its (presumably static) central body. It cannot give accurate information on any phenomenon related to orbital motion, except relative positions of macro bodies in a planetary system. A small macro body (artificial satellite), within a planetary system, that approaches or leaves an orbiting planet cannot be expected to behave in a manner that satisfies laws of planetary motion devised for finding relative positions of planets with respect to a static central body.

From the time an artificial satellite leaves earth (earth's matter-field) it is not linked to earth any more. It acts as a free macro body orbiting about galactic centre, with its intrinsic motions , gained from motion on earth. Perturbations to its path due to proximity of earth may have an appearance that it is orbiting around earth. This is only in appearance. Hence relative linear speed of artificial satellite may have apparent accelerations or apparent retardations, when it is related to earth, which itself is orbiting about sun.

A macro body, trying to leave a planetary system, has to do so to the rear of central body. If it tries to leave planetary system in forward direction, gravitational attraction towards planetary system will retard and slow down its linear speed. At the same time, due to very high linear speed of central body, distance between central body and macro body will reduce at very high rate. If a macro body tries to leave a planetary system in direction perpendicular to direction of linear motion of central body, it will be soon left behind due to very high linear speed of central body. As this macro body is not moving in an orbital path, it is not bound by laws of planetary motion. Paths of such macro bodies, determined according to laws of planetary motion, may show discrepancies.

Depending on locations of artificial satellites, sun and earth in their respective real orbital path, linear speed of an artificial satellite could apparently increase or decrease, when observed from earth, without external causes. These phenomena are quite logical and there are no mysteries about them. There are no puzzling actions or anomalous effects. There is no increase or reduction in (kinetic) energy, associated with them. Many of apparent anomalies with respect to motions of artificial satellites will vanish if geometry for real orbital motion about moving central body is used instead of geometry for apparent orbit around static central body.

Another fallacy, often discussed is multi-body problem, in the light of various theories and laws related to apparent orbits. To define an apparent orbit, a static central body and a moving planetary body are essential. If there are only two macro bodies in consideration, one of them can be considered as static central body and the other as moving planetary body. However, if there are more than two macro bodies in consideration, in same problem, essential requirement of apparent orbital motion (one static macro body and one moving macro body) cannot be fulfilled. It is impossible for at least two macro bodies in a three-body problem to behave as static as well as moving entities at the same time, in same problem. This is the conundrum, required to sustain multi-body problem, alive.

Apparent loss of orbital motion:

While a planet is performing its orbital motion about a central body, it is also orbiting around centre of central body's orbital centre (galactic centre). Galactic centre is a static point in space, around which constituent macro bodies of galaxy revolve. Consider a planetary system as a single unit (of revolving macro bodies about a central body) that is orbiting around galactic centre. Galaxies are static spinning bodies but they have no orbital motion about any other macro body.

We shall consider apparent orbit of a planet around its central body. Let the planet maintain a steady relative position with its central body. Similarly let central body maintain steady relative orientation with galactic centre. A point on surface of central body is always facing towards galactic centre. These conditions make it essential for central body to spin once every revolution around galactic centre. However, as the point on its surface continues to face galactic centre, an observer at the point does not notice central body's spin motion.

Similarly, even when central body completes one revolution around galactic centre, planetary body remains in same relative position with respect to central body. That is, planetary body has no apparent orbit around central body. Although, no apparent orbital motion with respect to central body is noticed, in real motion, planetary body has completed one cycle of orbital motion in space around galactic centre. Hence, number of apparent orbits, completed by a planetary body about its central body is one less than number of real orbital motion it has to complete during one revolution of central body around galactic centre.

By the time central body completes an orbit around galactic centre, every planetary body in the unit apparently loses one (cycle of) real orbital motion each, about central body. This provides apparent loss of one orbital motion to a planet. A planet apparently loses part of its apparent orbital motion, about its central body, at a constant rate.

By the same reasoning, a satellite of a planet loses one apparent orbit around its planet, every planetary year. However, with respect to its real orbital motion, a satellite loses only one apparent orbit during its revolution around galactic centre, which may take several planetary years.

Precession due to eccentricity:

If there is a large difference in magnitudes of matter-contents of central body and planetary body that has highly eccentric apparent orbit, difference between linear speeds of orbiting planet ary body, during its acceleration and decelerating stages in orbital path, is considerably large (efficiency of an external effort depends on linear speed of a macro body [1]). Difference in linear speeds influences actions by 'central force' on planetary body. Such actions can apparently rotate (precess) apparent orbit without changing its shape or size. Rotation of apparent orbit means forward or rearward shifting of real orbital path of planetary body in relation to central body's location on median path.

In real orbital motions, both central and planetary bodies move about same median path. Perturbations of planetary body's path are more apparent and perturbed path appears as its real orbital path. While a planetary body is moving along with central body, it is in front of central body for half its orbital period (during its motion from outer datum point to inner datum point) and it is behind central body for the next half of orbital period (during its motion from inner datum point to outer datum point). When planetary body is in front of central body, 'central force' acts to decelerate it and when planetary body is behind central body, 'central force' tends to accelerate it. (Actions by 'central force' on central body are of opposite natures).

Inertial actions are slower and hence, less effective when external efforts are in the direction of motion of a macro body. Consequently, it takes longer for a planetary body to traverse its real orbital path from inner datum point to outer datum point; compared to other half. Longer time period causes larger radial displacement of planetary body, taking it nearer to median path (during its travel from inner datum point to outer datum point). Planetary body's perpendicular distance from median path during this period becomes shorter than its distance in opposite direction during next half of real orbital path. Difference between distances from median path provides a resultant displacement of real orbital path towards center of central body's path (galactic centre). Planetary body, in its path is displaced nearer to center of central body's path (galactic centre).

Unlike in elliptical apparent orbit (which has two foci), an oval apparent orbit has only one focus. Central body is located at focus of oval apparent orbit. Consequently, there is only one point in apparent orbit that is nearest to its focus. This point is called periapse. If apparent orbital path of a planetary body is displaced, such that another point in orbital path comes nearest to focus, effect is as if periapse of apparent orbit has shifted to new location.

As different points on apparent orbit come nearest to central body, on successive apparent orbits, periapse shifts along apparent orbit. Continuous displacement of periapse appears as rotation of apparent orbit of planet around central body, with respect to (static) central body. Displacement of point of perihelion gives rise to apparent phenomenon of 'precession' of orbit. Orbital precession is an illusion provided by displacement of 'point of nearest approach' of central and planetary bodies. In reality, no changes take place in relative motions of planetary body, except that periapse (point in space at which central and planetary bodies come nearest) shifts along perturbed path of planetary body. Magnitudes of perturbations to orbital path or their time periods are not affected.

If orbital motion is considered with respect to a planetary body (central body orbiting a planet), orbit of central body appears to precess in opposite direction, with respect to planetary body. Apparent orbits of all planetary bodies, with highly eccentric orbits have appreciable precession about their central bodies. In case of a central body, having two or more planetary bodies in highly eccentric apparent orbits around it, the central body will have different rates of precessions simultaneously; a different rate of precession with respect to each of the planetary bodies. This is an impossible situation, if precession is linked to real motion of planet. Direction of this precession is the same as direction of motion of planet in its apparent orbit.

Assorted perturbations:

Wandering macro bodies in open space may fall into planetary bodies or into central body during their attempt to form orbits about either of them. A foreign macro body falling-in brings-in additional matter-content and additional work associated about it. Such additions are likely to modify orbital parameters of planetary bodies in a planetary system. Over extended period in space, modifications of orbital properties of planets are very probable due to collisions with other macro bodies.

Orbital motions of planetary bodies are also influenced by nearby macro bodies. These changes may be either temporary or permanent. Very large differences in orbital properties of a planetary body may cause its gradual displacement towards another planetary body in same planetary system and result in their collision. An accurate picture of planetary orbital motion can be developed only when all other macro bodies in space are considered.

Once steady state of a planetary orbit is established, it will maintain its constant parameters, unless affected by external influences. Planetary bodies can neither change orbital linear speeds nor change distances towards central body. As there is no direct physical link between planetary bodies and central body, additional work (energy) associated with one of them cannot be transferred to another.

All apparent inconsistencies in planetary orbital motion are created by using apparent orbital paths around central body rather than real orbital paths about central body in space. If we consider sun as a moving macro body, most anomalies (stellar aberration, pioneer anomaly, multi-body problem, etc.) in cosmology, in and around solar system, may disappear.

Conclusion:

Elliptical/circular planetary orbits around a central body are apparent geometrical structures, developed from relative considerations and appearance of planetary motions to an observer (assumingly) based on the static central body. They are created to explain relative positions and observed movements of planets about a static central body. We are able to predict certain cyclic phenomena from apparent orbits. However, they do not provide logical and physically correct explanations to many phenomena. In reality, a planet moves along with the central body in a wavy path about median path of planetary system around galactic centre, alternatively moving to front and rear of central body. A planetary body enters into its orbital path, straight away as it approaches central body; there is no gradual development of orbital motion. All planets and satellites in a planetary system orbit in same direction, which is same as central body's orbital path about galactic centre. Direction of entry of planetary bodies is limited through two extremely small regions. In order to enter successful orbital path, a planetary body has to approach central body in (almost) parallel direction to its path at right distance away and from rear. Right distance is determined by linear speed and matter content of planetary body.

Reference:

[1] Nainan K. Varghese, MATTER (Re-examined), http://www.matterdoc.info

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