‘CENTRAL FORCE’

According to ‘MATTER (Re-examined)’

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

Abstract: Currently, ‘central force' — an apparent effort between two free macro bodies along the line joining them — is estimated in relative frames of reference. It is also assumed that an action by the ‘central force’ directly corresponds to its magnitude. The estimation of the magnitude and direction of the ‘central force’ on the planetary bodies or a central body in a planetary system assumes that the centre of the planetary system is static in space. While considering a satellite’s orbital path, the centre of the corresponding planet is assumed to be static in space. Although such calculations help to determine the relative positions of these macro bodies, they obscure the causes and magnitudes of many other important phenomena related to planetary motion. Determining the magnitude and direction of the ‘central force’ and its action with respect to absolute reference can give us logical explanations for many puzzling phenomena in planetary motions and systems.

Keywords: Central force, planetary motion, planetary orbits, planetary spin.

In Newtonian mechanics, the centre of a multi-body system is usually assumed to be absolutely steady in space. This static point is used as a reference for all motions in the system. Accordingly, we have circular or elliptical orbital paths for the planets with respect to the sun and similar circular orbital paths for satellites with respect to the planets. These apparent orbital paths justify our observations. However, since the central body is a moving macrobody, this view cannot provide real parameters of planetary motions except their relative positions. The shape of the real orbital path of a planet or satellite (in space) is wavy about the median path of its central body. A planetary body moves alternately to the front and rear of the central body. Because of the wavy nature of the planetary orbital paths, the relative direction between central and planetary bodies varies continuously, and these variations affect the actions of the ‘central force’ on both macro bodies. Actions in any direction are strictly limited to the work-done in that direction. These may not always correspond to the magnitudes of the ‘central force’, determined as per gravitational laws. All conclusions expressed in this article are taken from an alternative concept presented in the book ‘MATTER (Re-examined) [1]. For details, kindly refer to the same.

Attraction on a macro body, moving parallel to surface of a large macro body:

Gravitational attraction between two 3D material bodies is an apparent action derived from separate gravitational push actions on these objects, which compels them to move towards each other. Gravitational attraction between two macrobodies is the result of separate gravitational attractions between each of the basic 3D matter particles in one macrobody and each of the basic 3D matter particles in the other macrobody. However, in the following description, gravitational attraction is treated as a real force for clarity of explanation.

However, in practice, gravitational attraction between two macrobodies is determined as an effort in a straight line between their centres of gravity. The 3D matter content of each macrobody is assumed to be concentrated at its centre of gravity. The magnitude of gravitational attraction, determined by this method, gives the resultant of gravitational attractions between each of the 3D matter particles in both macrobodies without considering the directions of gravitational attractions on separate 3D matter particles. When the difference in the sizes of the macrobodies is very large, this method is not rational for determining the actions in any particular direction. The gravitational attraction between a smaller macrobody and the major part of a larger macrobody may not be in the direction of the line joining their centres of gravity. Where the direction of action by gravitational attraction is important, this factor should be taken into consideration.

Only those 3D matter particles in the larger macrobody, situated directly under the smaller macrobody (in planes parallel to the line joining the centres of gravity of the macrobodies and passing through both macrobodies), contribute towards gravitational attraction between the macrobodies that acts in the direction of the line joining their centres of gravity. Gravitational attractions towards all other 3D matter particles in the larger macrobody act in various other directions, which make different angles to the line joining the centres of gravity of the macrobodies. These may appear to subscribe their resultant action along the line joining the centres of gravity of the macro bodies. However, additional work invested in each plane of their matter-fields (structural distortions in the universal medium, in and about the macrobodies) is in various other directions, and they act in their own planes. They cannot subscribe to additional work or action by the gravitational attraction between the macro bodies in the direction joining their centres of gravity.

The action of 'central force' between two free macro bodies (especially those with large differences in their sizes) in space is highly directional. Hence, averaging gravitational attractions or their actions in various directions to give a resultant magnitude of work-done in any particular direction is bound to introduce errors in results.

The magnitude of total action by gravitational attraction between two macro bodies in the direction of a line joining their centres of gravity is contributed by the 3D matter particles located in common planes passing through both macro bodies and being parallel to the line joining their centres of gravity. Hence, part of the 3D matter content (rest mass) of the larger macrobody that is in these planes has to be substituted in the equation to determine gravitational attraction between them in place of the total matter content of the larger macrobody. The solution does not give the magnitude of total gravitational attraction, but the result gives the value of gravitational attraction between the macrobodies, acting in a direction parallel to the line joining their centres of gravity and doing work in that direction.

The gravitational attraction between two macrobodies in each common plane is distinct and separate. Gravitational efforts in each spatial plane, enclosing parts of both macrobodies, act separately in the same plane. Separate inertial actions in all common spatial planes, together, contribute towards total or resultant inertial action on participating macrobodies.

According to the alternative concept presented in 'MATTER (Re-examined)', all efforts act in straight lines. Hence, action by gravitational attraction between two macrobodies in each common plane or direction is distinct and separate. Gravitational efforts in each spatial plane, enclosing parts of both macrobodies, act separately. Separate inertial actions in all common spatial planes, together, contribute to total or resultant inertial action on the participating macrobodies.

Let us consider the work introduced by gravitational attraction in the matter-field of a small spherical macro body, moving in a straight line parallel to the surface of a very large macro body. A small part of the surface of a very large spherical macrobody can be considered a plane, and a small part of a line parallel to this surface may be considered a straight line. We shall assume the very large macrobody has a straight-line perimeter of infinite length and the small spherical macro body is moving parallel to its surface at constant relative speed 'v' units per second with respect to a point on the surface of the very large macrobody on a radial line, YY, passing through its centre and perpendicular to the direction of motion of the small macro body.

In figure 1, the curved line SS represents the surface of a very large spherical (free) macrobody. Grey circle B represents a small spherical (free) macro body, moving along the straight line X_1X_2. Circles in dotted lines A and C show two instantaneous positions of the small spherical body B before reaching line YY and after leaving line YY, respectively. The vertical plane YY is perpendicular to the straight-line path of the small macro body, X_1X_2, and passes through the centres of gravity of the very large macro body and the small macro body at position B.

Considering the gravitational attraction between the macrobodies, acting along the plane joining their centres of gravity and all parallel lines passing through both macrobodies, the total magnitude of gravitational attraction considered here as acting on the small macro body is contributed by the whole 3D matter content of the small macro body and part of the 3D matter content of the very large macro body directly under the small macro body in its current location at B (3D matter content of the very large macro body, enclosed by a tubular volume with a cross-sectional area equal to the cross-sectional area of the small macro body and extending through the very large macro body).

Only this part of gravitational attraction between two macro bodies (which invests additional structural distortions in the universal medium in and about the macro bodies) acts strictly in a direction parallel to line YY. Gravitational attractions in all other directions are neglected, as they provide for inertial actions in different directions.

Let us consider the actions by gravitational attraction between the two macro bodies, shown in figure 1, strictly in planes parallel to the line YY and perpendicular to the line of motion of the small macro body. Concurrently, gravitational attractions between the macro-bodies in many other parallel planes are also active. However, they cause no inertial action in the direction of YY, but each action causes inertial action in its own direction. We shall concentrate only on the gravitational attraction in this direction. Resultant actions of gravitational attractions in various other directions may be considered

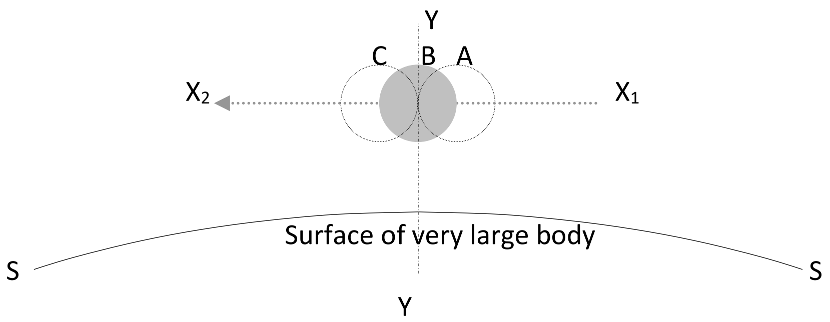

Figure 1

using the same principles.

The radial line YY, passing through the centre of gravity of the very large macrobody, is perpendicular to the tangential line X_1X_2. Macrobodies have no common planes parallel to the line YY and perpendicular to the tangential line X_1X_2, before the small macro body reaches the line YY. Hence, there is no action by the gravitational attraction between the macro-bodies in the direction of line YY.

As the forward edge of the small macro body touches the line YY (the small macro body in position A), both macrobodies start to have common planes of existence, which are parallel to the line YY and perpendicular to the line X_1X_2. Action by gravitational attraction between the macrobodies commences to do additional work in the universal medium in common planes in and about the macrobodies. As the small macrobody moves forward, the macrobodies have an increasing number of common planes of existence, which are parallel to the line YY and perpendicular to the line X_1X_2. Gravitational attraction between the macrobodies introduces additional work, progressively, in the universal medium in all common planes in and about the macrobodies.

As the small macrobody moves forward and crosses the line YY (the small macrobody in position C), the macrobodies have no common planes of existence, which are parallel to the line YY and perpendicular to the line X_1X_2. Macrobodies cease to have action by gravitational attraction between them in the direction of line YY.

As and when the foremost plane of the small macrobody touches the line YY, the universal medium in and about it in this plane receives additional work. When the small macro body has moved forward, in the next instant, by a distance equal to the thickness of a plane, the foremost plane in the small macrobody would have shifted forward, leaving behind additional work introduced in the universal medium in and about it, to the plane immediately behind the foremost plane. Now the plane immediately behind the foremost plane also becomes a common plane through both macrobodies. Both of these planes are common to both macrobodies, and they have additional work invested in the universal medium in and about them by gravitational attraction. The universal medium in the plane, immediately behind the foremost plane, in the small macro body has freshly invested additional work as well as additional work invested during its existence at the previous instant. The universal medium in the foremost plane has only recently invested additional work.

As the small macro body moves forward, it will have more and more planes (which are parallel to line YY and perpendicular to line X_1X_2) in common with the very large macro body. The universal medium in its foremost plane has the least additional work in it (subject to the magnitude of 3D matter content in it), compared to the universal medium in successive planes. This process continues, and the universal medium in all planes about the small macrobody receives additional work, which causes its inertial motion in a radial direction along or parallel to line YY towards the very large macrobody.

The magnitudes of additional work received in various planes, which are parallel to the line YY and perpendicular to the line X_1X_2, in the matter-field of the small macrobody have a gradient, increasing towards the rear of the small macrobody. Inertial motion and corresponding acceleration of the small macrobody continue until additional work, introduced by gravitational attraction in the direction of line YY, is lost from the universal medium in planes in and about it. Loss of additional work happens due to the displacement of the whole small macro body away from the plane containing line YY and perpendicular to X_1X_2. Since the small macro body is under linear motion at constant speed along line X_1X_2, it moves out of the common planes containing line YY and loses all additional work invested in the planes of universal medium in and about it (in the direction of line YY and perpendicular to line of motion X_1X_2.

At any instant, the universal medium in the foremost plane, perpendicular to the direction of the small macro body's linear motion, has the least magnitude of additional work and hence has the least inertial action compared to the planes towards the rear of the small macro body. Uneven distribution of additional work by gravitational attraction amounts to an effective shift in the 'centre of gravity' of the small macrobody to the rear of its centre of 3D matter-content. Uneven action of external effort about the free small macrobody's centre of 3D matter-content simultaneously produces its linear as well as spin motions.

Long before gravitational attraction along the line YY ceased, similar radial action would have commenced along the adjacent diameter of the very large macrobody. In certain balanced conditions, the direction of the smaller macrobody's path is continuously modified so that it moves in a curved path parallel to the surface of the very large macrobody (assumed static). Gravitational effects on the small macro body (in a perpendicular direction to its line of motion) have continuous action towards the very large macro body. Since gravitational attraction between macrobodies is simultaneously effective on both macrobodies, similar actions take place on the very large macrobody as well.

If the very large macro body has a flat surface, the direction of line YY at any relative position of the macrobodies always remains perpendicular to the direction of linear motion of the small macro body. Although there are differences in the magnitudes of additional work introduced into the universal medium in different planes about the small macrobody, inertial action continues in the same direction.

Let us consider another plane containing line YY and line of motion, X_1X_2, of the small macro body. As soon as the small macrobody reaches position A, the foremost points in the plane start to receive additional work in the universal medium about it, in the direction of line YY, due to gravitational attraction between the macrobodies. The universal medium in the rest of the plane does not receive similar additional work. As the small macrobody moves forward, more and more areas of universal medium in the plane receive additional work. At position B, the universal medium in the whole of the plane receives additional work.

When the small macrobody is at position B, the universal medium in the foremost part of the plane has the most magnitude of additional work, and the universal medium in the rearmost part of the plane has the least magnitude of additional work. The forward part of the plane has greater inertial action compared to the rearward part of the plane due to gravitational attraction between the macrobodies.

As the small macro body moves forward, the universal medium in the fore-most part of the plane does not receive additional work, and it starts to lose the additional work present in it in the direction of line YY. As the small macrobody continues its forward motion, gradually the whole of the plane moves out of alignment with the very large macrobody in the direction of line YY. During the small macrobody's displacement from position B to position C, the magnitude of additional work in the universal medium of the plane has a gradient of additional work, increasing towards the rear. Hence, it has greater inertial action towards its rear.

From position A to position B, the plane not only experiences inertial motion towards the large macrobody, but it also has a torque about the centre of the 3D matter-content of the macrobody in an anti-clockwise direction (in relative positions as shown in the figure). From position B to position C, the plane not only experiences inertial motion towards the large macro body, but it also has a torque about the centre of 3D matter-content of the macrobody in a clockwise direction (in relative positions as shown in figure). However, over certain time taken by the small macro body to cross line YY, inertial actions by these torques in opposite directions neutralise, and no resultant appears.

All other planes, perpendicular to the surface of the large macrobody and passing through the small macrobody, parallel to line YY, have similar inertial actions in them in the direction of line YY. The magnitudes of inertial actions that produce straight-line motion or torque on the small macrobody vary and depend on the relative direction of a plane with respect to the line of motion, X_1X_2, of the small macrobody.

'Central force' on a planetary body:

As a planetary body moves along its real orbital path, its relative position with respect to the central body changes through π radians on both sides of the central body's median path. Figure 2 shows part of a planetary body's real orbital path, $O_1EADO_2BO_3C$, about a central body's median path, X_1X_2. Grey circles represent the central body at various positions in its median path, and black circles represent the planetary body at corresponding positions on its real orbital path. Little more than one cycle of the orbital

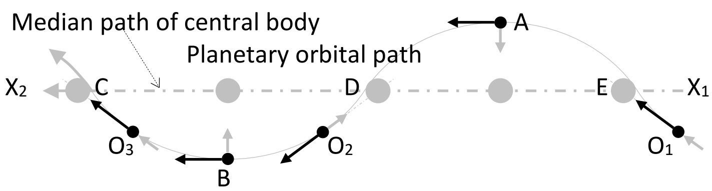

Figure 2

path is shown in the figure. The back arrows represent directions of linear motion of the planetary body along its real orbital path. Arrows in grey lines show directions of radial motion of the planetary body towards the central body under the 'central force', corresponding to their relative positions.

Point A is the outer datum point on the planetary body's real orbital path. At the outer datum point, the direction of the planetary body's linear motion is parallel to the direction of the linear motion of the central body, as shown by the black arrow. The 'central force' on the planetary body acts in a direction perpendicular to its linear motion, towards the central body, as shown by the grey arrow.

At points O_1, O_2 and O_3, situated very near the median path on the inner side of the central body's median (curved) path, the 'central force' and hence the planetary body's linear motion in the radial direction is co-linear with its linear motion along the real orbital path. Hence, the planetary body has no linear motion across the radial line from the central body. This means that as long as a planetary body is at these points, it cannot reach a steady, constant radial velocity and will continue to accelerate or decelerate as per physical laws. However, the duration of its stay at these points is too small before the inertial properties of the universal medium about the planetary body carry it across the radial line from the central body.

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Magnitude of 'central force':

Action by the 'central force', between a planetary body and its central body, is provided by gravitational attraction between them. Usually, the action of 'central force' on the central body is ignored, and the whole of action is considered only in relation to the planetary body. The magnitude of action by 'central force' depends on the magnitude of additional distortions (work) stored in the universal medium about the planetary body at any instant. 'Central force' continuously invests additional distortions (work) in the universal medium of the planetary body. Simultaneously, additional structural distortions are lost from the universal medium in and about the planetary body. In this paragraph, we shall consider only the additional work invested by the 'central force' in the universal medium about the planetary body. The magnitude of the active part of 'central force' is considered rather than the total magnitude of 'central force', as per gravitational laws.

As an illustration, we shall consider the magnitude of the active component of 'central force' on the planetary body (in planes passing through central and planetary bodies, parallel to the direction of the line joining their centres, and perpendicular to the real orbital path of the planetary body). The bifurcation of its action into a linear motion of the planetary body towards the central body and a spin motion of the planetary body is shown. Similar actions are present in all other sets of parallel planes, within the restrictions about their relative directions. We shall ignore similar actions on the central body by the same effort. Mathematical descriptions allude to the actions of the 'central force' on a planetary body when it is at the outer datum point of its real orbital path.

Figure 3 shows a spherical (homogeneous) planetary body of radius 'r' and mass 'm' with its centre at O_2 and moving to the left (in relation to a central body). At the instant represented by the figure, the planetary body (moving at absolute linear speed, v_1) is overtaking the central body, which is moving at absolute linear speed, v_2. Point C is the foremost point in the planetary body. Central body, not shown in figure, is assumed below planetary body, in figure. The central body is also moving in the same linear direction as the planetary body, at absolute linear speed v_2. When the planetary body is between the outer datum point and the inner datum point on its real orbital path, its absolute linear speed, v_1, is higher, and when it is between the inner datum point and the outer datum point on its real orbital path, the planetary body's absolute linear speed, v_1, is lower than the central body's absolute linear speed, v_2.

We shall consider the forward (left) half of the spherical planetary body. The magnitude of structural distortion-density in the universal medium in the region (the density of additional structural distortions introduced) depends on the duration of the action of gravitational attraction. The planetary body moves in the direction of O_2 to C. The density of additional structural distortions in the radial direction in the universal medium in the region increases as the centre point O_2 of the planetary body is displaced from its current location to point C, occupied by its foremost plane.

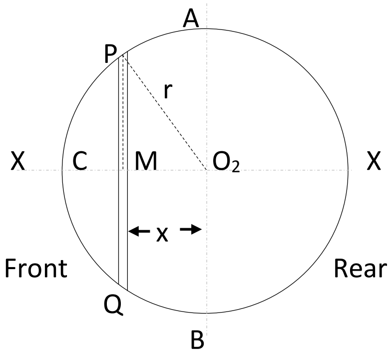

Figure 3

Relative linear speed of the planetary body with respect to the central body, at the outer datum point, being V m/sec, the whole planetary body takes 2r/V seconds to pass a point on the central body's surface in a tangential direction. Gravitational attraction ('central force') on the planetary body is in a radial direction, towards the central body and parallel to AB, for the whole of this duration. Additional (radial) work introduced by the 'central force' in the universal medium about any cross-sectional plane of the planetary body depends on time, during which it is under the influence of gravitational attraction in that particular direction. The density of additional structural (radial) distortions, in the region in and about the planetary body gradually increases in planes from C to O_2. The degree of structural distortion-density may be considered uniform. The magnitude of additional distortions in the matter-field in the universal medium in any part of the planetary body is proportional to its volume.

Consider an elementary circular section PQ (cut by planes parallel to AB and perpendicular to axis XX, at distances x and x+dx from AB) of thickness dx.

$$PM^2 = O_2P^2 - O_2M^2 = r^2 - x^2 \,,$$

$$CM = r - x$$

$$\text{Volume of } PQ = \pi \times PM^2 \times dx = \pi\left(r^2 - x^2\right)dx$$

$$\text{Matter density of planetarybody} = m \div \frac{4\pi \times r^3}{3} = \frac{3m}{4\pi \times r^3} \qquad \textbf{(1)}$$

$$\text{Matter content of section} PQ = \frac{3m}{4\pi \times r^3} \times \pi\left(r^2 - x^2\right)dx = \frac{3m\left(r^2 - x^2\right)dx}{4r^3}$$

Using inverse square law for gravitational attraction;

$$\text{'Central force' on section } PQ = \frac{3m\left(r^2 - x^2\right)dx}{4r^3} \times \frac{MG}{D^2} = \frac{3MGm\left(r^2 - x^2\right)dx}{4r^3D^2}$$

Where M is the rest mass of part of the central body's 3D matter-content that is directly under the planetary body, G is the gravitational constant in the 3D spatial system, and D is the distance between the centres of section PQ and part of the central body. Due to the large size difference between central and planetary bodies, magnitude M remains constant during the planetary body's displacement through its own length. The force on section PQ of the planetary body by the 'central force' is the rate of investment of additional (radial) structural distortions into the universal medium in and about it.

'Central force' acts on Section PQ for the time during which it exists under the effort in the same direction. Since we are considering the motion of a planetary body across the central body, we are only interested in those common planes that are perpendicular to the planetary body's orbital path and contain both central and planetary bodies. [At other points (except at datum points) on the orbital path, common planes are not perpendicular to the orbital path]. As soon as the front edge of the planetary body reaches a perpendicular line passing through the rear edge of the part of the central body in consideration, both macrobodies start to have common planes. The number of common planes increases as the planetary body moves forward to overtake the central body.

[At the inner datum point, the central body overtakes the planetary body. In the relative reference frame, it appears that the planetary body has reversed its direction of motion and is moving in the opposite direction].

The duration of action of ‘central force’ on the planetary body, in perpendicular direction to its real orbital path, is from the instant the planetary body’s forward edge enters the common plane with part of the central body to the instant the planetary body’s rear edge leaves the common plane with the central body in consideration. The duration of action of ‘central force’ on the planetary body, in perpendicular direction, real orbital path, before section PQ comes into common plane with part of the central body in consideration is from the time the planetary body’s forward edge enters the common plane with part of the central body to the time when section PQ enters common plane.

As both macrobodies are moving in the same direction, the duration of overtaking depends on their relative linear speeds in the tangential direction to the surface of the central body. We are considering the planetary body as a faster macrobody.

Distance between the front edge of planetary body and section, $PQ = (r - x)$

Time duration = displacement / speed $= (r - x) \div V$

The planetary body takes this much time to overtake the central body in a tangential direction to the central body’s surface.

Let the constancy of proportion between external effort and the magnitude of additional structural distortions introduced in the universal medium in and about Section PQ be ‘k’. This constant of proportion for different macrobodies at different linear speeds (and directions of motion) is different. It depends on the size of the macrobody in the direction of the effort, consistency, and distribution of the macrobody’s 3D matter-content and 3D matter-density.

Magnitude of additional (radial) structural distortions, invested in the universal medium in and about Section PQ

$$= \frac{3MGm(r^2 - x^2)dx}{4r^3D^2} \times \frac{(r-x)}{V} \times k \quad = \frac{3MGmk}{4r^3D^2V}(r^2 - x^2)(r - x)dx$$

Magnitude of total additional (radial) structural distortions in the universal medium in and about the forward hemisphere $ACBO_2A$ of the dynamic planetary body when the whole planetary body has common planes with the central body in a perpendicular direction to the tangential direction of linear motion,

$$W_1 = \sum_{x=0}^{x=r} \frac{3MGmk}{4r^3D^2V}(r^2 - x^2)(r - x)dx \quad = \frac{3MGmk}{4r^3D^2V}\int_{x=0}^{x=r}(r^2 - x^2)(r - x)dx$$

$$= \frac{3MGmk}{4r^3D^2V}\int_{x=0}^{x=r}(r^3 - r^2x - rx^2 + x^3)dx = \frac{3MGmk}{4r^3D^2V}\left| r^3x - \frac{r^2x^2}{2} - \frac{rx^3}{3} + \frac{x^4}{4} \right|_0^r$$

$$= \frac{3MGmk}{4r^3D^2V}\left(r^4 - \frac{r^4}{2} - \frac{r^4}{3} + \frac{r^4}{4} \right) = \frac{3MGmk}{4r^3D^2V} \times \frac{5r^4}{12} = \frac{5MGmkr}{16D^2V}$$

Since the value of the gravitational constant G, in a 3D spatial system, is determined experimentally, we can take that operation by the constant of proportion, k, which is also automatically accounted for in the value of G. Hence, we may neglect the factor k in the above equation.

Thus, $$W_1 = \frac{5MGmr}{16D^2V} \qquad \textbf{(2)}$$

This is the highest level of total additional (radial) structural distortions invested in the universal medium in and about the forward half-part of the planetary body, in the planes considered, when it is at the outer datum point in the real orbital path. As long as the planetary body maintains its absolute linear speed and other parameters, total additional (radial) work cannot exceed this value (in the plane), irrespective of the duration of action by the ‘central force’. In other words, action by the ‘central force’ on a planetary body has a saturation limit.

Acceleration of a macrobody takes place only during changes in the magnitude of additional work in the universal medium in and about it. In this case, there is no change in the magnitude of additional (radial) work in the universal medium in and about the planetary body, and hence, it cannot accelerate but can only move at a constant linear speed as provided by the existing magnitude of additional (radial) work towards the central body. Accelerating and decelerating stages of the planetary body, in every radial direction, are very short and take place during the initial and final stages of action by the 'central force'.

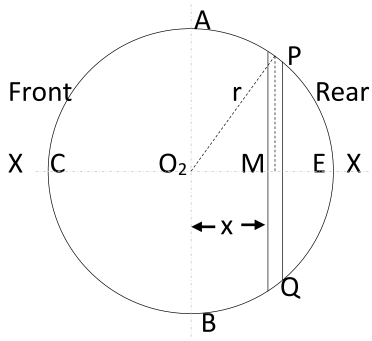

Figure 4

Similarly, taking the other (rear) hemisphere, AO_2BEA, of the planetary body, as shown in figure 4, we may determine the magnitude of additional (radial) work invested in the matter field of the planetary body by 'central force' as follows:

Take an elementary circular section PQ (cut by planes parallel to AB at distances x and x+dx from AB) of thickness dx, perpendicular to axis XX. The magnitude of additional structural distortions in the universal medium in and about any part of the planetary body is proportional to its volume and its distance from the fore-most edge, C.

$$(PM)^2 = (O_2P)^2 - (O_2M)^2 = r^2 - x^2, \qquad CM = r + x,$$

$$\text{Volume of section PQ } = \pi\left(r^2 - x^2\right)dx$$

$$\text{3D matter-density of planetary body } = m \div \frac{4\pi \times r^3}{3} = \frac{3m}{4\pi \times r^3} \text{ kg/m}^3$$

$$\text{3D matter-content of section PQ} = \frac{3m}{4\pi \times r^3} \times \pi\left(r^2 - x^2\right)dx = \frac{3m\left(r^2 - x^2\right)dx}{4r^3}$$

$$\text{'Central force' on section PQ } = \frac{3m\left(r^2 - x^2\right)dx}{4r^3} \times \frac{MG}{D^2} = \frac{3MGm\left(r^2 - x^2\right)dx}{4r^3D^2}$$

'Central force' is the rate of investment of additional (radial) structural distortions in universal medium in and about section PQ, in the direction towards the central body.

$$\text{Time duration, in which section PQ is under 'central force' } = (r + x) \div V$$

(Taking a constant of proportion k); Magnitude of additional (radial) structural distortions invested in

$$\text{the universal medium in and about section PQ } = \frac{3MGmk\left(r^2 - x^2\right)dx}{4r^3D^2} \times \frac{(r + x)}{V}$$

$$= \frac{3MGmk}{4r^3D^2V}\left(r^2 - x^2\right)(r + x)dx$$

Total magnitude of additional (radial) structural distortions in the universal medium in and about the hemisphere AO2BEA of dynamic planetary body,

$$W_2 = \sum_{x=0}^{x=r} \frac{3MGmk}{4r^3D^2V}\left(r^2 - x^2\right)(r + x)dx = \int_{x=0}^{x=r} \frac{3MGmk}{4r^3D^2V}\left(r^2 - x^2\right)(r + x)dx$$

$$= \frac{3MGmk}{4r^3D^2V}\int_{x=0}^{x=r}\left(r^3 + r^2x - rx^2 - x^3\right)dx = \frac{3MGmk}{4r^3D^2V}\left|r^3x + \frac{r^2x^2}{2} - \frac{rx^3}{3} - \frac{x^4}{4}\right|_0^r$$

$$= \frac{3MGmk}{4r^3D^2V}\left(r^4 + \frac{r^4}{2} - \frac{r^4}{3} - \frac{r^4}{4}\right) = \frac{3MGmk}{4r^3D^2V} \times \frac{11r^4}{12} = \frac{11MGmrk}{16D^2V}$$

Since the value of the gravitational constant G in the 3D spatial system, is determined experimentally, we can take that operation by the constant of proportion, k, which is also automatically accounted for in the value of G. Hence, we may neglect factor k in the above equation.

$$\text{Thus,} \qquad W_2 = \frac{11MGmr}{16D^2V} \qquad \textbf{(3)}$$

Sum total of additional (radial) work held in the universal medium about the planetary body; from equations (16/6) and (16/17),

$$W = W_1 + W_2 = \frac{5MGmr}{16D^2V} + \frac{11MGmr}{16D^2V} = \frac{MGmr}{D^2V} \quad \textbf{(4)}$$

The difference in magnitudes of additional work invested by gravitational attraction at different parts of the planetary body effectively shifts its centre of gravity. As the gradient of work-density increases towards the rear of the planetary body, it appears as if the rearward parts of the planetary body have greater gravitational attraction towards the central body in comparison with its forward parts. The magnitude of the shift in the centre of gravity from the centre of 3D matter-content varies as the planetary body moves in its real orbital path (and with respect to the relative directions of the planes of the planetary body, as considered). The magnitude of the shift is highest at the outer and inner datum points on the real orbital path. There is no shift of the centre of gravity, from the centre of 3D matter-content at points on the real orbital path, where 'central force' acts along the direction of linear motion of the planetary body (this happens at two points on the inner side of the central body's path, shown by positions O_2 and O_3 in figure 2).

Unequal momenta of efforts about the centre of 3D matter-content, of a free planetary body cause its simultaneous radial and spin motions. Equal momenta on either side of the centre of 3D matter-content, together, cause its linear motion in a radial direction towards the central body. Equal parts of 'central force', on either side of the centre of 3D matter-content, act as a single set of efforts through the centre of 3D matter-content of the planetary body. The remaining one-sided part of 'central force' produces a couple about the centre of 3D matter-content and causes the planetary body's spin motion.

Additional work in the forward hemisphere and an equal part of additional work in the rear hemisphere, together, produce the planetary body's linear motion in a radial direction towards the central body. Directions of linear motion in the radial direction, at datum points, are perpendicular to the planetary body's orbital path. This has effectively shifted the centre of gravity of the planetary body into its rear hemisphere.

The total magnitude of additional (radial) work when the planetary body is at the outer datum point, acting through its centre of 3D matter-content,

$$W_g = \frac{5MGmr}{16D^2V} \times 2 = \frac{5MGmr}{8D^2V} \quad \textbf{(5)}$$

Additional work of magnitude, $5MGmr \div 8D^2V$, in these planes, acts through the centre of 3D matter-content to produce the planetary body's linear motion in a (radial) direction towards the central body (centre of revolution).

Similarly, the total magnitude of additional (radial) work in the same planes when the planetary body is at its inner datum point, acting through its centre of 3D matter-content,

$$W_g = \frac{5MGmr}{16D^2V} \times 2 = \frac{5MGmr}{8D^2V}$$

Additional work of magnitude, $5MGmr \div 8D^2V$, acts through the centre of 3D matter-content to produce the planetary body's linear motion in a (radial) direction towards the central body and away from the central body's centre of revolution. Remaining additional (radial) work in the matter-field of the planetary body, in these planes, act about its centre of 3D matter-content as torque to spin the planetary body.

Magnitude of part of 'central force', causing torque on the planetary body,

$$W_s = \frac{MGmr}{D^2V} - \frac{5MGmr}{8D^2V} = \frac{3MGmr}{8D^2V} \quad \textbf{(6)}$$

There are points on the real orbital path at which the planetary body experiences 'central force' in the same direction or in the opposite direction to the direction of its linear motion along the real orbital path. At these points, the whole of 'central force' acts through its centre of 3D matter-content, and the planetary body's radial velocity is higher and the magnitude of the spin component of 'central force' is much smaller or zero. At all other points in the real orbital path, the magnitudes of action by the 'central force’ and its components vary cyclically as the planetary body moves along its real orbital path.

The name ‘central force’, is a misnomer. It is understood as an effort on the planetary body towards the centre of its elliptical or circular apparent orbital path. In a circular apparent orbital path, the direction of the ‘central force’ is always perpendicular to the direction of the planet's linear motion. Circular or elliptical orbital paths are apparent geometrical structures created by relative considerations in mechanics.

In real orbital paths, ‘central force’ is not directed to any central point; it is directed towards the central body. The direction of ‘central force’ becomes perpendicular to the planetary body’s linear motion only at datum points in the orbital path. At all other points in the real orbital path, the direction of ‘central force’ varies through a full circle during every two subsequent segments of the real orbital path. Although ‘central force’ is directed towards the central body, its direction is very rarely perpendicular to the planetary body’s linear motion or towards any fixed central point.

Magnitude of radial velocity:

Gravitational attraction between central and planetary bodies, in any radial direction joining their centres of 3D matter-content, commences as soon as the forward part of the planetary body comes in line with the central body and continues to be present as the planetary body advances in its real orbital path, moving across the central body. ‘Central force’ in that particular radial direction ceases when the planetary body has fully crossed the central body in a considered tangential direction. At the end of this time, all additional work invested into the universal medium in and about the planetary body for the production of its radial velocity in this direction has been utilised (to change the direction of linear motion and spin the planetary body), and actions (of motion) on the planetary body in this radial direction have ended.

Actions by ‘central force’ on the planetary body overlap for near-by points on the real orbital path. The radial displacement of the planetary body towards the central body, at every consecutive instant, is along different directions, and it stops (in any radial direction) as soon as additional work introduced into the universal medium in and about the planetary body (for motion in that particular direction) is lost. Consequently, despite its continuous displacement towards the central body, a planetary body never reaches any nearer to the central body (disregarding the variations required for the eccentricity of the orbital path).

Equation 5 gives the total magnitude of additional (radial) structural distortions (or work) held in a set of parallel planes in the universal medium in and about the planetary body and producing its radial motion towards the central body. Unlike in normal cases, where an external effort introduces additional structural distortions in the matter-field of a macrobody during its action, the case of a planetary system is different. This is because of constant changes in the direction of motion of the planetary body. In any radial direction, the magnitude of additional structural distortions in the matter-field remains constant.

For acceleration or deceleration of a macrobody, changes in the magnitude of additional structural distortions in the universal medium in and about it are essential. Hence, there is no natural accelerating stage for the planetary body in the radial direction, towards the central body. A planetary body moves at a constant linear velocity in a radial direction towards the central body along any radius in consideration (this consideration lasts only for an instant). The acceleration stage, required to develop this constant velocity, took place before the planetary body came in line with the direction considered.

When the direction of ‘central force’ and the direction of the planetary body’s linear motion (along the real orbital path) coincides, for an instant, the planetary body has no motion across the central body. The directions of both of its motions (linear and radial) are along the same line. At this point, the planetary body is under acceleration or deceleration towards or away from the central body. The value of motion perpendicular to the orbital path, becomes zero, but radial motion towards or away from the central body is maintained as additional acceleration or deceleration in linear speed along the real orbital path, provided by the whole of ‘central force’.

Additional work, causing linear velocity in a perpendicular direction to the orbital path, is being renewed at every instant. Additional work is consumed, and new additional work of equal magnitude is invested throughout the universal medium in and about the planetary body. The continuous loss of additional work from the universal medium in and about it keeps the linear velocity of the planetary body constant (without acceleration), despite the continuous investment of additional work into the universal medium in and about it.

As long as gravitational attraction is active in the direction considered, it continues to invest additional work in the universal medium in and about the planetary body. The investment of additional work into the universal medium should produce the planetary body's acceleration. Yet, in this case, the final velocity is constant irrespective of the planetary body's acceleration. This is because of the limitation on the universal medium's (in and about the planetary body's) ability to store additional work (in a radial direction) of more than a constant maximum magnitude due to the planetary body's linear motion.

The planetary body starts to accelerate at a rate in its planes towards the central body when it starts to cross a common plane with the central body. Acceleration in this direction ceases when the whole planetary body has crossed common planes with the central body in that radial direction. Thereafter, it is unable to store more additional work of this nature. Long before this time, similar actions would have started in nearby planes as well.

The constancy of linear velocity in a perpendicular direction to the orbital path is mentioned only to emphasise that continuous action of a certain magnitude of 'central force' (at any relative position) does not change a planetary body's linear velocity in that direction beyond a limit corresponding to its linear speed across the line of action of 'central force'. Depending on the present position of the planetary body in its real orbital path, the linear velocity of the planetary body in a perpendicular direction to the orbital path varies continuously and cyclically.

At outer datum points in the real orbital path, due to the planetary body's highest (absolute) linear speed parallel to the central body's surface (the situation used for the above calculations), the magnitude of additional work in the radial direction received by the universal medium in and about the planetary body is the least. As seen in the above calculation for one set of parallel planes, three-eighths of this additional work is used to spin the planetary body. As the planetary body moves along its real orbital path and approaches the median path, the time duration for the planetary body to overtake the central body in a tangential direction increases. This increases the magnitude of additional work invested in the universal medium in and about the planetary body.

A longer duration of acceleration or deceleration increases or reduces linear velocity towards the central body steadily. However, the angular difference of shift in the centre of gravity of the planetary body decreases to reduce its torque component on the planetary body. For some time, after the planetary body has crossed the median path of the central body to the inner side of the central body's path, the direction of its linear motion is in opposition to the direction of the 'central force'. During this time, the magnitude of linear velocity due to 'central force' towards the central body is highest, and the deceleration of the planetary body is continuous. For some time, before the planetary body is about to cross the median path of the central body to the outer side of the central body's path, its direction of linear motion is the same as that of the 'central force'. During this time, the magnitude of linear velocity due to 'central force' towards the central body is highest, and the acceleration of the planetary body is continuous. At both of these points, the centre of 3D matter-content and the 'centre of gravity' of the planetary body lie on the line of action of the 'central force', and hence, no torque is available on the planetary body.

Due to the continuous change in relative positions of central and planetary bodies, the linear motion of the planetary body due to 'central force' towards the central body can be bifurcated into two components. One component, in a collinear direction with the planetary body's linear motion, tends to increase or reduce the planetary body's linear speed in its real orbital path. Hence, a planetary body tends to accelerate during its displacement from the outer datum point to the inner datum point and in its real orbital path. A major part of 'central force' is used for this purpose.

Other components of the linear motion of the planetary body due to 'central force' towards the central body tend to displace it across its real orbital path, towards the central body. During the planetary body's motion from the point of intersection between the central body's median path and the real planetary orbital path near position E in figure 2 to the point of intersection of their paths near position D, the planetary body's orbital path is deflected towards the galactic centre. During the planetary body's motion from the point of intersection between the paths near position D in Figure 2 to the point of intersection of the paths near position C, the planetary body's orbital path is deflected away from the galactic centre. It is this part of motion that deflects a planetary body's real orbital path into a wavy shape.

In all physical activities, it is the magnitude of actions that counts, rather than the magnitude of efforts causing the actions. Hence, the magnitude of 'central force', determined by different methods, is less important than the action it can cause. As seen from the above explanations, planetary motions are related to actions of 'central force' rather than to their magnitude. The action of 'central force' is limited by the relative speeds and directions of motion between central and planetary bodies.

By determining actions by 'central force', in each set of planes (parallel to the radial line from the central body and perpendicular to the planetary body's linear motion) on earth, the magnitude of action by 'central force' towards the moon is 2.3 times the magnitude of the magnitude of action by 'central force' towards the sun. This relation corresponds to the relation between lunar tides and solar tides on earth. It may be noted that the magnitude of the lunar tide on earth is 2.3 times the magnitude of the solar tide on earth.

By accepting the concept explained above and determining the magnitude and direction of 'central force' and its actions in relation to a wave-shaped real planetary orbital path (with respect to a point in the universal medium, outside a planetary system), many phenomena (like planetary spin, the common spin plane of all bodies in a planetary system, tides, the deflection of tide from the local meridian, the apparent lengthening of terrestrial days, the higher equatorial spin speed of certain planets, etc.) can be logically explained.

Conclusion:

Actions of the central force on planetary bodies are never steady or constant, as suggested by (Newtonian) relativistic considerations, which profess circular or elliptical planetary orbits. They also do not always correspond to the magnitude of the 'central force' between them. Apparent circular or elliptical orbits may be used to determine the relative positions of moving bodies. For all other phenomena, the real motions of macro-bodies in a planetary system, as they are related to an absolute reference frame, give logical results.

Reference:

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

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