‘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 action by ‘central force’ directly corresponds to its magnitude. Estimation of magnitude and direction of ‘central force’ on planetary bodies or central body, in a planetary system, assumes that the centre of planetary system is static in space. While considering a satellite’s orbital path, centre of corresponding planet is assumed static in space. Although such calculations help to determine relative positions of these macro bodies, it obscures causes and magnitudes of many other important phenomena, related to planetary motion. Determining magnitude and direction of ‘central force’ and its action with respect to absolute reference can give us logical explanations to many puzzling phenomena on planetary motions/systems.

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

In Newtonian mechanics, centre of a multi-body system is usually assumed as absolutely steady in space. This static point is used as a reference for all motions in the system. Accordingly, we have circular/elliptical orbital paths for the planets with respect to sun and similar circular orbital paths for satellites with respect to planets. These apparent orbital paths justify our observations. However, since central body is a moving macro body, this view cannot provide real parameters of planetary motions, except their relative positions. Shape of real orbital path of a planet or satellite (in space) is wavy about median path of its central body. They move alternately to front and rear of central body. All conclusions expressed in this article are taken from alternative concept, presented in ‘MATTER (Re-examined) [1]. For details, kindly refer to the same.

Because of wavy nature of planetary orbital path, relative direction between central and planetary bodies varies continuously and these variations affect actions by ‘central force’ on both macro bodies. Actions in any direction are strictly limited to work-done in that direction. These may not always correspond to magnitudes of ‘central force’, determined as per gravitational laws.

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

Gravitational attraction between two macro bodies is determined as an effort in a straight-line between their centers of gravity. Matter-content of each macro body is assumed as concentrated at its centre of gravity. Magnitude of gravitational attraction, determined in this method, gives resultant of gravitational attractions between 3D matter-particles in both macro bodies, without considering

directions of gravitational attractions on separate 3D matter-particles. When difference in sizes of macro bodies is very large, this method is not rational to determine action in any particular direction. Gravitational attraction between smaller macro body and major part of larger macro body may not be in the direction of line joining their centres of gravity. Where direction of action by gravitational attraction is important, this factor should be taken into consideration.

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

Action of 'central force' between two free macro bodies (especially with those with large difference 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 error in results.

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

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

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

Let us consider work, introduced by gravitational attraction in matter-field of a small spherical macro body, moving in a straight line, parallel to surface of a very large macro body. A small part, on surface of a very large spherical macro body, can be considered as a plane and a small part of a line parallel to this surface may be considered as a straight line. We shall assume very large macro body has straight-line perimeter of infinite length and 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 very large macro body on a radial line, YY, passing through its center and perpendicular to the direction of motion of small macro body.

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

Considering gravitational attraction between macro bodies, acting along the plane joining their centres of gravity and all parallel lines passing through both macro bodies, total magnitude of

gravitational attraction (considered here as acting on small macro body) is contributed by whole matter-content of small macro body and part of matter-content of very large macro body directly under small macro body in its current location at B (matter-content of very large macro body, enclosed by tubular volume with cross sectional area equal to cross sectional area of small macro body and extending through very large macro body).

Only this part of gravitational attraction, between two macro bodies (invests additional distortions in universal medium about the macro bodies) acts strictly in 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 actions by gravitational attraction between two macro bodies, shown in figure 1, strictly in planes parallel to line, YY, and perpendicular to line of motion of small macro body. Concurrently; gravitational attractions between 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 gravitational attraction in this direction. Resultant actions of gravitational attractions in various other directions may be considered using the same principles.

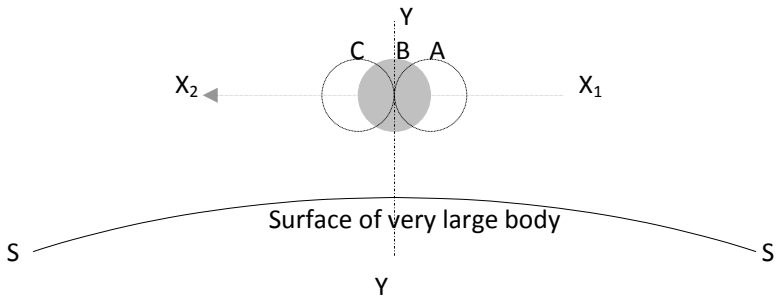

Figure 1

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

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

As small macro body moves forward and cross line YY (small macro body in position C), macro bodies have no common planes of existence, which are parallel to line YY and perpendicular to line X_1X_2. Macro bodies cease to have action by gravitational attraction between them in the direction of line YY.

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

As 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 very large macro body. Universal medium in its foremost plane has least additional work in it (subject to magnitude of matter-content in it), compared to universal medium in successive planes. This process continues and universal medium in all planes about small macro body receive additional work, which cause its inertial motion in radial direction along or parallel to line YY, towards very large macro body.

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

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

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

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

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

When small macro body is at position B, universal medium in fore-most part of the plane has most magnitude of additional work and universal medium in rear-most part of the plane has least magnitude of additional work. Forward part of the plane has larger inertial action, compared to rearward part of plane, due to gravitational attraction between macro bodies.

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

From position A to position B, the plane not only experiences inertial motion towards large macro body, but it also has a torque about centre of matter-content of macro body in anti-clockwise direction

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

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

'Central force' on a planetary body:

As a planetary body moves along its real orbital path, its relative position with respect to central body changes through π radians on both sides of central body's median path. Figure 2 shows part of planetary body's real orbital path, $O_1EADO_2BO_3C$, about central body's median path X_1X_2. Grey circles represent central body at various positions in its median path and black circles represent planetary body at corresponding positions on its real orbital path. Little more than one cycle of orbital path is shown in figure. Back arrows represent directions of linear motion of planetary body along its real orbital path. Arrows in grey lines show directions of radial motion of planetary body, towards central body under 'central force', corresponding to their relative positions.

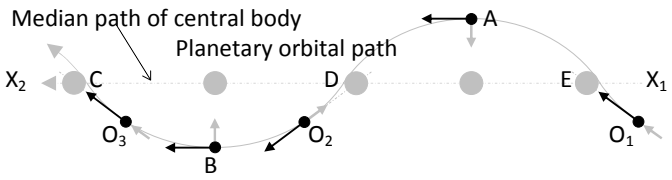

Figure 2

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

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

Magnitude of 'central force':

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

As an illustration, we shall consider magnitude of active component of 'central force' on planetary body (in planes passing through central and planetary bodies, parallel to direction of line joining their centres and perpendicular to real orbital path of planetary body. Bifurcation of its action into linear motion of planetary body towards central body and spin motion of planetary body is shown. Similar actions are present in all other sets of parallel planes, within restrictions about their relative directions. We shall ignore similar actions on central body, by same effort. Mathematical descriptions allude to actions of 'central force' on planetary body, when it is at outer datum point in 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 left (in relation to a central body. At the instant, represented by figure, planetary body (moving at absolute linear speed, v_1) is overtaking central body, which is moving at absolute linear speed of v_2. Point C is fore-most point in planetary body. Central body, not shown in figure, is assumed below planetary body, in figure. Central body is also moving in same linear direction as planetary body, at absolute linear speed v_2. When planetary body is between outer datum point and inner datum point on its real orbital path, its absolute linear speed, v_1, is higher and when it is between inner datum point and outer datum point on its real orbital path, planetary body's absolute linear speed, v_1, is lower than central body's absolute linear speed, v_2.

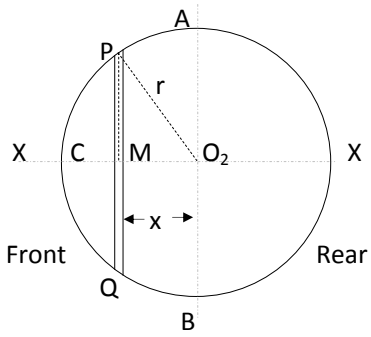

Figure 3

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

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

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

$$CM = r - x$$

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

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

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

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 rest mass of part of central body's matter-content that is directly under planetary body, G is gravitational constant in 3D spatial system and D is distance between centres of section PQ and part

of central body. Due to large size difference between central and planetary bodies, magnitude M remains constant during planetary body's displacement through its own length. Force on section PQ of planetary body by 'central force' is the rate of investment of additional (radial) distortions into universal medium about it.

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

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

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

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

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

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

Planetary body takes this much time to overtake central body in tangential direction to central body's surface.

Let constancy of proportion between external effort and magnitude of additional distortions introduced in universal medium about section PQ is 'k'. This constant of proportion for different macro bodies at different linear speeds (and directions of motion) is different. It depends on size of macro body in the direction of effort, consistency and distribution of macro body's matter-content and its matter-density.

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

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

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

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

Since value of gravitational constant G, in 3D space system, is determined experimentally, we can take that operation by constant of proportion, k, is also automatically accounted for in value of G. Hence,

we may neglect the factor k in the above equation.

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

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

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

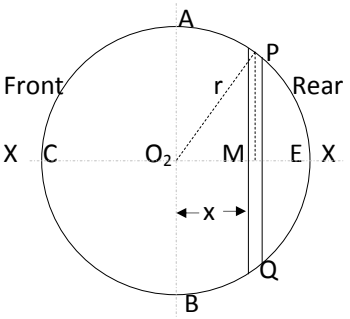

Figure 4

Similarly, taking other (rear) hemisphere AO_2BEA, of planetary body, as shown in figure 4, we may determine magnitude of additional (radial) work, invested in matter-field of 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. Magnitude of additional distortions in universal medium about any part of planetary body is proportional to its volume and its distance from fore-most edge, C.

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

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

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

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

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

'Central force' is the rate of investment of additional (radial) distortions in universal medium about section PQ, in the direction of 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) distortions invested in universal medium about section PQ $= \frac{3MGmk(r^2 - x^2)dx}{4r^3D^2} \times \frac{(r+x)}{V} = \frac{3MGmk}{4r^3D^2V}(r^2 - x^2)(r+x)dx$

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

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

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

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

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

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

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

$$W = W_1 + W_2 = \frac{5MGmr}{16D^2V} + \frac{11MGmr}{16D^2V} = \frac{MGmr}{D^2V} \tag{4}$$

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

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

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

Total magnitude of additional (radial) work, when planetary body is at outer datum point, acting through its centre of matter-content,

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

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

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

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

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

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

$$W_s = \frac{MGmr}{D^2V} - \frac{5MGmr}{8D^2V} = \frac{3MGmr}{8D^2V} \tag{6}$$

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

Name, 'central force', is a misnomer. It is understood as an effort on planetary body, towards center of its elliptical or circular apparent orbital path. In a circular apparent orbital path, direction of 'central force' is always perpendicular to direction of 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 central body. Direction of 'central force' becomes perpendicular to planetary body's linear motion only at datum points in orbital path. At all other points in real orbital path, direction of 'central force' vary through a full circle during every two subsequent segments of real orbital path. Although, 'central force' is directed towards central body, its direction is very rarely perpendicular to 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 centre of matter-content, commences as soon as forward part of planetary body comes in line with central body and continues to be present as planetary body advances in its real orbital path, moving across central body. 'Central force' in that particular radial direction ceases when planetary body has fully crossed central body in considered tangential direction. At the end of this time, all additional work invested into universal medium about planetary body, for production of its radial velocity in this direction, has been utilized (to change direction of linear motion and to spin planetary body) and actions (of motion) on planetary body in this radial direction ends.

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

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

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

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

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

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

Planetary body starts to accelerate at a rate in its planes towards central body, when it starts to cross a common plane with central body. Acceleration in this direction ceases when whole of planetary body has crossed common planes with 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 also.

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

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

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

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

Other component of linear motion of planetary body due to 'central force' towards central body tends to displace it across its real orbital path, towards central body. During planetary body's motion from point of intersection between central body's median path and real planetary orbital path near position E in figure 2 to point of intersection of their paths near position D, planetary body's orbital path

is deflected towards galactic centre. During planetary body's motion from point of intersection between the paths near position D in figure 2 to point of intersection of the paths near position C, planetary body's orbital path is deflected away from galactic centre. It is this part of motion, which deflects planetary body's real orbital path into wavy shape.

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

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

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

Conclusion:

Actions of central force on planetary bodies are never steady or constant as suggested by (Newtonian) relativistic considerations, which profess circular/elliptical planetary orbits. They also do not always correspond to magnitude of 'central force' between them. Apparent circular/elliptical orbits may be used to determine relative positions of moving bodies. For all other phenomena, real motions of macro bodies of 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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