Theoretical schematic of interacting forces of gravity to review the law of universal gravitation

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Newton theorized that a force of a particle reaches out to another particle to cause attraction. Schematic of forces shows that a force of a particle reaches out to a force of another particle to cause attraction. These forces are spent to keep the particles bonded. For a spherical body, unspent forces of particles on its surface alone act to attract adjacent bodies, and in no way, the whole attracting force is issued from its center. Therefore, unlimited increase in mass of the larger lead ball in Cavendish experiment does not cause proportional increase in the force of attraction. $gD^2 = K$ (constant) drawn from equations of planetary motion shows that g of a free-falling body increases as the body travels from a distance (D) towards the center of Earth. It indicates existence of a unique formation at the center of Earth for creation of gravity. Hence, determination of G from a two-body interaction and its application in $F = Gm_1m_2/r^2$ to find the mass of a celestial body is an incorrect procedure as attraction of a body on Earth and gravity of a celestial body are two different phenomena in respect of the nature of their sources.

1. Introduction

Inverse square law distance dependence is well established in celestial mechanics, but is yet to be comprehensively proved in laboratories for two adjacent masses, particularly at submillimeter ranges. Report of inverse square law violation (ISLV) at distances of 4.5 cm – 29.9 cm was made by Daniel Long [1, 2] but was not supported by subsequent tests [3, 4, 5]. With several theories supporting the existence of other interfering forces that are weak and insensitive to present experimental setups, full-proof ISLV tests are yet to be accomplished and enquiries on ISLV continue to exist [6]. Besides whether unlimited increase in the mass of the larger test object causes proportional increase in the force of attraction is yet to be verified. Finally, the similarity between the source of attraction of an object towards another on Earth and that of a celestial body towards another is unverified though the equation $F = Gm_1m_2/r^2$ is used for both. Taking note of the unproven points, this paper analyzes the interaction between the particles in spherical objects from the schematic of their forces and draws inferences that contradict some of the theorems on spherical bodies and gravity in 'Principia' [7] and the equation of gravitation as well.

Newton's view of a spherical body consisting of numerous particles exerting equal forces in all directions [7] is accepted. Newton theorized that a force of a particle acts on another particle by covering the distance between them. In Fig. 1, the schematic of interacting forces of gravity shows that when a force of a particle meets a force of another particle around the mid-point of the distance between them, attraction between the particles takes place. It is something like a person extending his arms to pull the extended arms of two other persons standing on his two sides.

2. Definitive actions of forces in two-particle interaction

Pair of forces in Fig. 1 (a) act independently of each other in diametrically opposite directions like stretched arms of a person ready to pull two adjacent ones. In Fig. 1 (b), line XY joining the centers of particles X and Y, which lie adjacent to each other, is the shortest distance between them. Force XA of particle X and force YB of particle Y meet each other first as they act along XY. Upon conjunction of the forces, each particle exerts a single pull to the other, resulting in the convergence of the particles along XY by equal, tiny distances.

The convergence of the particles causes forces XC and XG of particle X to intersect with forces YD and YH of particle Y respectively. Assuming the magnitude of each of the forces of the particles to be F, the horizontal components of the forces XC, XG, YD and YH are $F\cos$ (CXY), $F\cos$ (GXY), $F\cos$ (DYX) and $F\cos$ (HYX) respectively, where $\angle$CXY = $\angle$GXY = $\angle$DYX = $\angle$HYX. The resultant of $F\cos$ (CXY) and $F\cos$ (GXY) acting simultaneously, is $2F\cos$ (CXY). Since $\angle$CXY is less than 60^o, $2F\cos$ (CXY) is greater than F. Similarly, $2F\cos$ (DYX) being the resultant of $F\cos$ (DYX) and $F\cos$ (HYX) to pull particle X, too is greater than F. So, particles

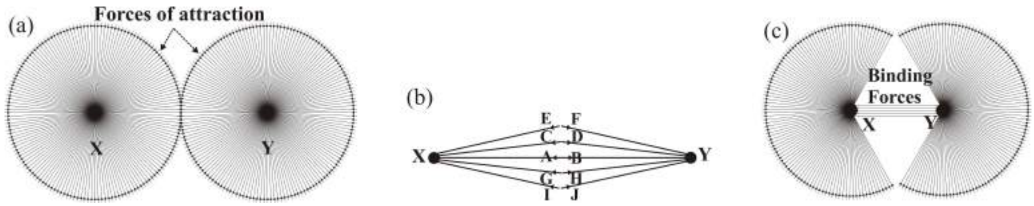

Figure 1. (a) Vertical cross-section of particles X and Y. (b) Intersection of forces of X and Y results in their convergence along the line XY. (c) Intersecting forces of X and Y transformed into binding forces.

X and Y converge by equal distances which are greater than those covered earlier by them due to the forces XA and YB. The convergence results in intersection of forces XE and XI of particle X with forces YF and YJ of particle Y respectively. As shown in Fig. 1 (c), the process continues till the resultant of a pair of horizontal components of forces (called binding forces hereafter) of each particle is so small that it fails to pull the other particle towards it. For example, when the angle between the horizontal component of a force and XY is more than 60^o, the cosine of that angle is less than $\frac{1}{2}$ and the magnitude of the resultant of the two horizontal components acting simultaneously is less than F. So, when the resultant force is less than F, it is unable to pull the other particle further.

3. Schematic of many-particle interactions

In a three-particle interaction as shown in Fig. 2 (a), the particle in the middle is attracted by the other two with equal and opposite forces that nullify each other while its forces acting upon the two bring them closer to it. In case of interaction between two balls having say, seven particles each as in Fig. 2 (b), the resultant of the binding forces of the particles closest to each other acts along the line joining the centers of the balls as they converge along that line, providing a wrong impression that the forces emanate from their centers.

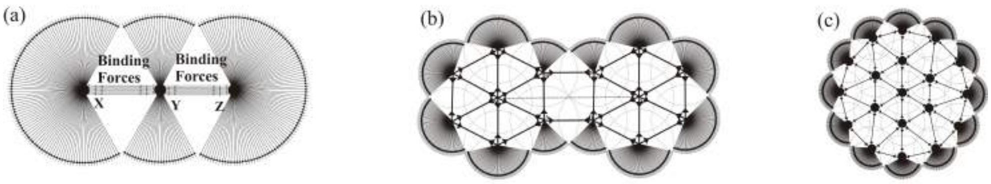

Figure 2. (a) Particle Y creates binding forces with particles X and Z and hence spends most of its forces of attraction. (b) For two interacting balls, particles closest to each other interact. (c) All forces of the particles under the surface of the ball are transformed into binding forces whereas unspent forces on the surface attract adjacent bodies.

With more particles interacting from all directions to form a larger cluster, the number of forces of the interacting particles diminishes due to their conversion into binding forces. As shown in Fig. 2 (c), the particles under the surface of a tiny ball spend all of their forces to create binding forces whereas those on the surface have unspent forces which act as forces of the ball to attract another ball adjacent to it.

4. Results and Discussion

The finding in Section 3 contradicts explanatory note to theorem 35, proposition 75, book I of 'Principia' [7], which says that the attraction of every particle of a sphere is the same as if the whole attracting force is issued from one single corpuscle placed in the centre of the sphere.

Like the forces of the particles under the surface of a ball, all forces of the particles under the surface of the Earth are transformed into binding forces. The particles on the surface of the Earth have unspent forces of attraction, which are feeble. These particles just under a persons feet and those of his feet, which are in contact, undergo a negligibly small mutual attraction between them. Hence the forces of the mass of the Earth can not be said to be its gravitational forces that extend beyond its Moon to attract celestial bodies. This inference contradicts theorem 7, proposition 7, book III of 'Principia' [7], which expresses that the Earth's gravitational force is proportional to its mass.

Experiments conducted in mine shafts and bore holes reportedly yielded values of G which are significantly higher than those in laboratory tests [8, 9] and it is necessary that the source of Earth's gravity is examined.

Kepler's 3rd law [10] for circular motion of an artificial satellite around the Earth is represented by: (1) $D^3 = kT^2$; other equations used in orbital motion are: (2) $T = 2\pi D/V$ and (3) $g = V^2/D$, where D is the distance between the center of the satellite and that of the Earth, T the orbital time period of the satellite, V its orbital velocity and k a constant. The equations give:

$$gD^2 = K, \quad (1)$$

where K (constant) $= 4\pi^2 k$.

The values of gD^2 for an object of any mass at rest on the Earth, for an artificial satellite and for the Earth's Moon are same. This also means that 'g' of a free falling body is zero at an infinite point above the Earth's surface but constantly increases as the body travels from the infinite point towards the center of the Earth. Hence, the value of G in mine shaft/borehole can be found to be higher than that on Earth. The deduction contradicts theorem 9, proposition 9, book III of 'Principia' [7], which states that 'g' of a body decreases as it goes down from the Earth's surface to its center. The Earth comprises of solid, liquid and air particles, all having mass and forces of attraction. There is no sensible reason why 'g' of a freefalling body, which increases during its passage through air, would abruptly change property by decreasing below the surface of the solid part of the Earth. The relationship $g \propto 1/d^2$ (equation (1)) shows that the gravity of the Earth is independent of its mass. It further indicates that a unique particle or formation of particles in the innermost core of the Earth exists, creating attraction towards all particles in and around the Earth.

It is also essential to examine how unlimited increase in the mass of a ball affects its magnitude of attraction towards a smaller ball.

In Fig. (3), vertical cross-section of lead balls P, Q and R having centers on the same line is drawn. R is the largest and P is the smallest of the balls that have identical, uniform densities. The cross-sections of Q and R touch each other at point M that lies on the line joining the centers of P, Q and R. BF || CG || MX where X is the center of P is drawn.

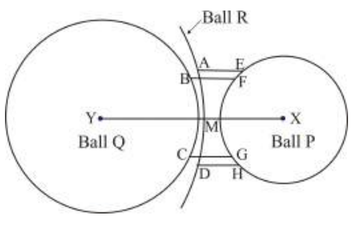

Figure 3. Particles on the surface of Q and R attract only those on the surface of the adjacent hemisphere of P.

Let's assume that in the absence of R, the forces of attraction of the particles in arc BMC intersect with those in arc FG resulting in mutual attraction between the cross-sections of Q and P. Arc AMD = arc BMC and AE || DH || MX are drawn so that in the absence of Q, the forces of attraction of the particles in arc AMD intersect with those in arc EH resulting in mutual attraction between the cross-sections of R and P. As drawn, arc AMD = arc BMC. Or, the number of the particles of lead in arc AMD = the number of the particles of lead in arc BMC. The particles in arc EH of P and those in arc AMD of R are mutually attracted while the particles in arc FG of P and those in arc BMC of Q are mutually attracted.

But arc EH $>$ arc FG. Or, the number of the particles of lead in arc EH $>$ the number of the particles of lead in arc FG. Therefore, the number of the particles in the cross-section of P that attract the particles in arc AMD of R $>$ the number of the particles in the cross-section of P that attract the particles in arc BMC of Q. Or, magnitude of the resultant force of P towards R $>$ magnitude of the resultant force of P towards Q.

So, the mutual attraction between two lead balls increases if the mass of the larger lead ball is increased but becomes constant once the particles on the surface of the larger lead ball manage to attract all particles on the surface of the nearer hemisphere of the smaller lead ball. This inference contradicts corollary 1 to theorem 29, proposition 69, book I of 'Principia' [7], which states that the force of gravity of a spherical body is directly proportional to its mass.

5. Conclusion

Theoretic observations in this paper do not support some of the theorems on spherical bodies and gravity in 'Principia' [7], particularly those related to force-mass proportionality. The findings further indicate that attraction between the bodies on the Earth and the gravity of the celestial bodies are two different phenomena in respect of the nature of their sources. Hence, determination of G from a two-body interaction on Earth and its application in $F = Gm_1m_2/r^2$ to find the mass of a celestial body is an incorrect procedure. Besides, if $g = GM/D^2$ drawn from Newton's law of universal gravitation is compared with $g = K/D^2$ of the equation (1), GM is seen to be equal to K which is an Earth-specific constant and is true even if hypothetically, a body under the surface of the Earth orbits around the Earth's center or for a body stationed under the Earths surface.

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