AN ESSAY

UPON

FORCE IN NATURE

AND ITS

EFFECTS UPON MATTER.

Matter is moved by the effect of force *on* it, not *inherent in it.*

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INTRODUCTION.

AMONG the chief principles received by, and as *science*, pertaining to the relations of force in nature to matter, is that laid down by Sir Isaac Newton, viz: that every particle of matter has the property of attraction for every other particle, and that the law is, that as between masses of matter, attraction is directly as the mass and inversely as the square of the distance. Is this a true statement? Has it ever been demonstrated so as to be beyond criticism? If it is not a true statement, it may serve a mischievous end in obstructing inquiry in a broad field of nature, perhaps capable of making large returns.

Perhaps as good a way as any of testing this principle, as to its truth, is to make the inquiry whether the *entirety* of planetary movements can in fact be produced by it. If it can not be, the principle must be defective, because planetary movement is claimed to depend upon it.

The following essay embodies an attempt to show that planetary movement can not be perfected by the theory of gravitation as received. Beyond this, suggestions are offered in support of the idea that planetary movements are caused by the effect of force *on* matter, not *inherent in matter:* and further, that the one primal force on which planetary movement depends, modified by special effects upon substances differing in kind, in arrangement, and in position, is that which, under the modified conditions, is called by the various names of force, as of *attraction and repulsion, cold and heat, electricity, magnetism, weight, etc.*—in other words, it is thought that differences of forces *by name* should be taken as being expressions of differences in manifestation of a same force, but not of specific differences of forces;—the differences as to manifestation arising from peculiarities of matter on which the one force acts.

Without making any claim that this idea, or the suggestions made under it, have scientific value, it can be asserted that upon statement, observed facts in nature come in, and lend them a support such that the mind seems willing to ascribe to them a higher value than that of a happy concurrence between supposed agency and observed conditions, which may be taken as obedience to it.

CONTENTS.

Force in Nature, and its Effects.

SECTION I.

THE Newtonian law is thus stated by Herschel: "Every particle of matter in the universe attracts every other particle of matter with a force directly proportioned to the mass and inversely to the square of the distance between them. Under the influence of such an attractive force mutually urging two spherical gravitating bodies toward each other, they will each, when moving in each other's neighborhood, be deflected into an orbit concave toward each other, and describe one about the other regarded as fixed, or both around their common center of gravity curves, whose forms are limited to those figures known in geometry by the general name of conic sections. It will depend, in any assigned case, upon the particular circumstances or velocity, distance and direction, which of these curves shall be described, whether an ellipse, a circle, a parabola, or an hyperbola; but one or the other it *must* be, and any one of any degree of eccentricity it may be; and that in every case, the angular velocity with which the line joining their centers moves, must be inversely proportional to the square of their mutual distance, and that equal areas of the curves described will be swept over by their line of junction in equal times."

This statement includes the first and second law of Kepler. His third law is, that "the squares of the periodic times of any two planets are to each other in the same proportion as the cubes of their mean distances from the sun."

The phenomenon of planetary motion is expressed as resulting from the operation of two recognized forces, viz: centripetal and centrifugal—one directed to and one from the center. It is usual to say that a body falling to the earth does so in obedience to the law of gravitation, or of centripetal force; and that in doing so, it falls in a line perpendicular to the surface of still water.

SECTION II.

For the purposes of this investigation let us take as given:

1. A force, simply, by which, if not resisted, a planet would be moved toward the sun, in direction of a right line connecting their centers; and
2. A portion of the curve of the planet's orbit in its approach toward the sun.

To find the relative value of the force, and its direction, which, with the force given, will produce that curve.

This force, as to its value and direction, being ascertained, it will be attempted to show that it, coöperative with the force given, will, among other effects, produce those on which the first and second laws of Kepler are founded, will not only give rise to the times and spaces of "falling" bodies agreeably to the Newtonian law, but will exhibit a reason why bodies must be accelerated in their "fall" agreeably to that law, and finally will not conflict with the third law of Kepler.

Incidentally, among other things, it will appear from the condition of conflict of force arising,

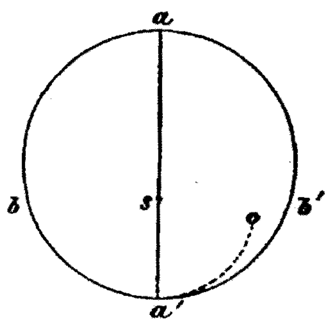
1. That the path of a circle is impossible in planetary motion.
2. That the argument, as to the third law of Kepler, gives rise to the curious result of a permitted libration in the eccentricities of planets, which (the forces in question remaining unchanged in their nature) can only arise from the interference of an extraneous cause.
3. That the phenomenon of gravitation, or, of "falling," does not exist, except as the result of a conflict of forces. It can only be considered as an isolated force by way of mental analysis or separation.

And under this seems to reside a very important condition, viz: That under the operation of those natural forces causing planetary motion, bodies and particles of matter are not *attracted* toward each other in direction of right lines connecting their centers, but are *forced* toward each other in the curves of spirals closing upon the centers each of the other. Among other things it would seem to result from this, that the *tidal wave* is not the result of attraction.

4. A further result appears that, as one of the effects of the conflict of force, a planet, from its aphelion to its perihelion point, should revolve upon its axis with increased rapidity; uniformity in times of revolution, as, for instance, of the earth, being preserved by increasing and decreasing friction of the moon upon it in its approach to, and its departure from, the sun.

If these are right results, it serves to show that the ascertainment of the nature and value of centrifugal force is of importance, as opening new features as to the effects of natural forces. It shows that there is no simple force as of gravitation by which a body must be accelerated, but that acceleration is the result of the antagonism of forces always equal, each perhaps always of a constant value, but exerted within limits constantly narrowing or expanding. In fact, the discussion of this antagonism of force may lead us to new ideas as to the very nature of that of which we speak as productive of planetary motion, even to realizing it as in close and inseparable relationship with the vegetable and animal life around us.

SECTION III.



Let *a b a′* represent the path of the earth in its orbit about the sun *s*, between the point in its entire orbit most remote from the sun at *a* and that nearest the sun at *a′*, or between the higher and lower vertices of the ellipse. In pursuing the path from *a* toward *a′*, the earth constantly approaches the sun until it arrives at *a′*, where there is exhibited the greatest predominance, if any, of the force of gravitation over that of repulsion, or of centripetal over centrifugal force, obeyed by a velocity of the earth in direction of the sun, greater than at any other point through which it has passed. If it is true that the approximation of the earth to the sun is occasioned by the predominance of the power of gravitation over that of repulsion, then, the earth increasing in velocity from *a* to *a'*, it is evident, that the predominance has been increasing from *a* to *a'*, and that the earth from the point *a'* must be impelled toward the sun by a force greater than has affected its movement in any other point of its orbit from *a* to *a'*.

Now, the path of the earth from *a* to *a'* is that of a spiral closing upon *s*, and if the nature of the forces acting upon the earth, resulting in that path, are supposed to be the same at *a'* as at *a*, the continued path of the earth should be upon the prolongation of the spiral in the direction *o*, in obedience to the constantly-increasing predominance of the power of gravitation, or the centripetal force. But at *a'* the earth begins to depart from the sun upon the path *a' b' a*; which, having accomplished, its entire orbit has become an ellipse composed of two spirals, *a a'* and *a' a*, one closing and one expanding, relatively to *s*, symmetrical with each other; for the completion of which the power of repulsion, or the centrifugal force, from *a'* to *a*, must exceed that of gravitation, by the same measure in which the power of gravitation exceeded that of repulsion to perfect the path *a b a'*. It follows that the forces of gravitation and repulsion expended in forcing the earth to the completion of its entire orbit have been equal.

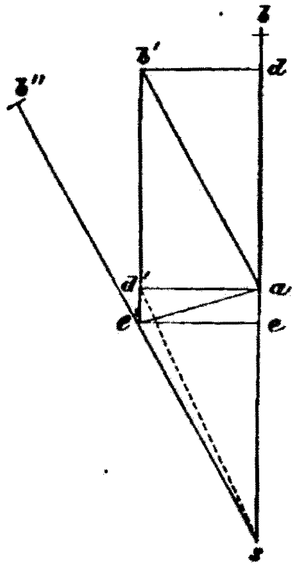
Since the power of gravitation is at its maximum at *a'* where the earth has acquired its greatest velocity in the direction of the sun, the fact, that at this point the earth begins to recede from the sun, shows that the power of repulsion at this point is equal to that of gravitation. At *a'*, from whence might have been expected the most rapid approach to the sun, the opposing forces have become equal, and *a'* has, in terms of mechanics, become a dead point as to motion, in direction of a right line passing through *a′* and the sun's center, and in direction of the sun generally as relates to that part of the orbit already accomplished. By a like process of reasoning *a* becomes another dead point in the reverse.

It necessarily follows, that the opposed forces affecting the point *a*, or the earth, at *a* and *a′* being equal, they must be equal at any and every intermediate point between *a* and *a′*; and as the peculiarity of the ellipse is, that as to its path it approaches to and departs from the sun, or the focus to which one of the opposed forces is always directed, the orbit, being the result of opposed forces always equal, can only result by reason of a constant change of position of those forces relatively to each other.

Corollary.—As two equal and directly-opposed forces can not be productive of motion, to result in any orbit whatever, these antagonistic forces must be exerted so as to form some angle greater or less with each other. From whence, since one of the forces is always directed toward an immovable point in space, the forces themselves can not be productive of a circle about such a point as a center; for, the circumference of a circle being for every point thereof perpendicular to the radius (which radius represents one of said forces) can only result from those forces when they form with each other an angle of 180°, which is impossible, for at that angle they become directly opposed.

Hence, it would seem that, on the conditions stated, the orbit of a circle is impossible in planetary motions.

SECTION IV.



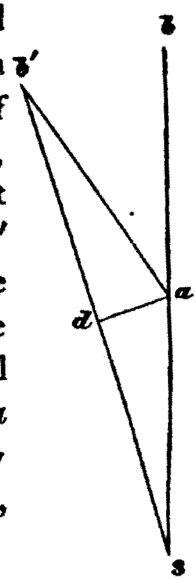
Let the point *a* be held in space by the two equal opposed forces *a s*, *a b*, of which *a s* for any position of *a b* shall always act in direction of the immovable focus of force *s*. Now, for the moment, dropping the consideration of the force *a s*, suppose the force *a b* to be suddenly deflected so as to hold the general direction *a b′*. The point *a* will be moved to *b′*, at a distance of *d b′* from *a b*, considered as a position of reference. If the force *a b′* is obstructed from moving the point *a* in direction *a b*, but is still free to move it in direction *d b′*, then the point *a* will be moved to *d′*, a distance *a d′* = *d b′*, where it will be affected by the force *d′ b′*, unexpended remnant of *a b*.

But resuming the consideration of the effect of the force *a s* we find that the expenditure of the force *d b*, in removing the point *a* to *d′*, has liberated an equal force *a e* to move the point *a* toward the immovable center of force *s*, and the point at which the forces to produce motion will cease to be effective for that purpose, will be where *a* will be held in equilibrium by two equal and directly opposed forces, remnants of *a b* and *a s*, and also, where the line of those forces shall be parallel with *a b′*, the general direction in which the deflected force is made to act.

Wherefore, that point will be found in a line representing two directly opposed forces, drawn from *s*, parallel to *a b'*. But by Prop. 1, Theor. 1, of Newton's *Principia*, if the point *a*, which otherwise would be moved in direction *a d'*, be moved by some centripetal force toward the immovable center of force *s*, the resulting direction and distance will be such that equal areas will be swept over by a line connecting the point *a* with the center of force, whether the point *a* be moved to *d'* or to the new point sought. Now *a d'* is given in position, and *a s* is common to both conditions, wherefore, for an area equal to *a d' s*, the point *a* must be found at a distance from the line *a s*, and perpendicular to it, equal to *a d'*, and nearer to *s* than is the point *d'*, and by construction *e'* is the only point which, in filling this condition, will be found in a line drawn from *s* parallel to *a b'*.

But *a d'* is perpendicular to *a s*, taken as a radius, and, considered as a point, becomes a portion of the circumference of a circle of which *s* is the center; therefore, in the same time that the point *a* would describe the arc *a d'* of a circle by the exertion of the force *d b*, it will, by the co-operative exertion of the liberated force *a e'*, in direction *s*, describe the curve of a spiral, closing upon *s* in direction *a e'*, equal to *a e'*; and this is as it should be by the terms of Sir Isaac Newton's proposition, because the areas *a d' s* and *a e' s* are equal, and the times of their description are equal.

Passing from the foregoing considerations, since the deflected force is always co-operative with that always in direction of the immovable center of force *s*, the resultant described must always be descriptive of a curve, with respect to the point *s* of a spiral; and, since the straight line *a e′* is a portion of the curve of a spiral it must be infinitely short, or, of itself, a point. The very inception of movement of the point *a* by two equal but opposing forces, forming with each other any angle, must bisect that angle, and the diagram *s a b′* must represent the ultimate effect of the deflective force *a b′* in co-operation with the force *a s*, by which we have the two equal but opposed forces *a s*, *a b′*, productive of *a d*, and the point *a* removed to *d* affected by the two equal and directly opposed forces *d s*, *d b′*, remnants of *a s*, *a b′*.



SECTION V.

The force *a s*, or that of gravitation, has, since the time of Sir Isaac Newton, been recognized as one of the forces affecting a planet, compelling it to the completion of the path of its orbit. The path of the orbit, then, necessarily results from the action of this with some other force, and this latter force, from the consideration in Section III, *must*, at every point of that path, be equal to the force of gravitation; from whence it results that the continuing pathway of the orbit of the planet can result only from a continuing and relative change of position of these equal and opposed forces, one toward the other. Now, the diagram of the ultimate effect of the exertion of these forces for any one point of the path of the planet's orbit, Section IV, must be that for every other point, at least, for that portion of the orbit between the higher and lower vertices of