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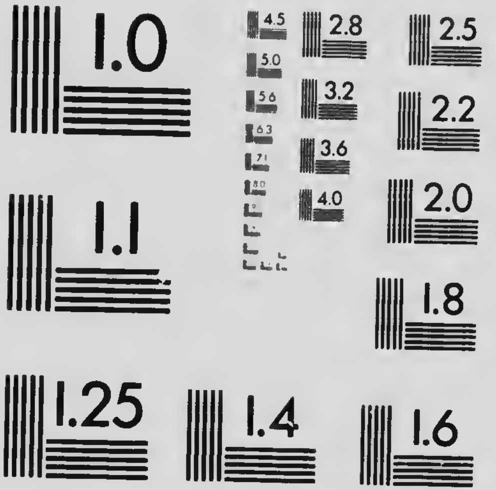

THE EVOLUTION

OF

PLANETARY MOTION

A NEW SYNTHESIS OF
FAMILIAR FACTS AND ASSUMPTIONS

EMBRACING AN ANALYSIS OF
SOME CURRENT VIEWS ON TIDES

BY

KENNETH McINTOSH

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PREFACE

If I am called upon to explain my unheralded presence within the sacred precincts where none but those bearing after their names the hall-marks of stereotyped distinction have a prescriptive right to be seen, my reply is, that the cause of scientific truth and scientific perspicuity is, I trust, more dear to the human race than the perpetuation of bombastic title whose principal function, up to this time, has been to give countenance to the most grotesque absurdities.

Had a nameless writer stated that reducing the speed of the earth's rotation would have the effect of shortening our day; had the most acute and profound reasoner, if untitled, shown his ignorance of the history of events by stating that we do not know what La Place would have said to the movements of the Satellites of Uranus, alleging that these Satellites were not discovered when the eminent Frenchman wrote, I have no doubt that both would naturally be read, if at all, with considerable distrust.

These remarkable statements, however, the first of which may be found repeated on page 334 of Sir Robert Ball's "The Earth's Beginning," and the second on page 341 of the same book, have, so far as I am aware, been read with supposed edification by a numerous class, to whom, apparently, the main consideration was not whether a statement is palpably true or palpably false, but how many meaningless capital letters may be strung along after the name of the man writing it

With reference to the matters upon which I am at issue with the current doctrines, I would only say that I await the decision arrived at by a ripe and enlightened judgment untrammelled by spurious "authority."

KENNETH McINTOSH.

St. Peter's, C. B., June 11th, 1908.

THE EVOLUTION OF PLANETARY MOTION

Introduction.

When a boy first watches the eddying water as it passes through a small circular opening in the bottom of a shallow vessel, and wonders why it invariably assumes a circular or spiral motion before passing through, he little dreams that the principle underlying the action of the water in the case he is observing, is, with important modifications, the same that has through the aeons of time developed the movements of the planets.

The vortex above referred to, which seems so fascinating to his youthful mind, is so simple and so inevitable withal, that its absence under the circumstances stated, would indeed be "passing strange." For in order that it should be absent, we should have to conceive of a condition in which the forces advancing from all points to meet at the centre of the orifice, should meet so truly as to give no lateral resultant—a thing scarcely imaginable under the conditions.

But simple as is the principle that compels vortex motion, yet to study all the dynamical manifestations incident to it, might perhaps require eternity to accomplish.

Passing over the field of investigat n here pointed o we will at once take up a section f the solar system, viz., the Sun, the Earth and the Moon.

Omitting some particulars which are immaterial so far as our pr t purpose is concerned; the Earth and the Moon may both be said to revolve about the Sun in 365 days and 6 hours. The Moon in the meantime revolves 13 times about the Earth.

If we could be privileged to watch from the depths of space, the joint motion of the Earth and Moon, while following their magnificent elliptical path about the Sun, we should witness a phenomenon which I would describe as follows:—The Earth, so far as the unaided eye co l observe, would appear to have a uniform speed of motion along its orbital path. The progress of the Moon would, however, be noticeably fitful. It would pass by the Earth on the side furthest from the Sun, outstripping the Earth's speed. Soon it would be seen to be in line directly in front of the Earth. Then it would gradually get slower in its motion than the Earth, and dropping between the Earth and the Sun, would be found to be directly behind the Earth, just about a fortnight later than the time when it was seen directly in front.

The Moon's movements outside and inside of the Earth's path, however, are so small compared with the distance over which both Earth and Moon travel, that its path is differentiated from that of the Earth only by a gentle waviness, which, according to Young, is so slight, comparatively, as to leave the Moon's path, at all times convex externally.

The laws, therefore, which control the motion of the Earth in its progress about the Sun, should also control the Moon in its movement about the same centre—the Sun.

Let us now see what are the conditions, keeping in mind Kepler's Law—"equal areas in equal times." The "equal areas" here quoted is made intelligible by imagining that the particle supposed to be obeying this law, has a string connecting it with the central body about which it revolves, and whose attraction is the cause of its revolution. If the string be resting upon a plane, the motion of the particle about the centre of revolution causes the string to "sweep" the plane. The shape of the area swept, may, for practical purposes be regarded as a triangle, whose apex is at the centre about which the particle is moving. The base of the triangle is the distance over which the particle moves in a given time; and the altitude of the triangle is the distance between the particle and the centre about which it is moving.

Kepler discovered that if we decrease either one of the factors—base or altitude—the other increases proportionately, and vice versa, i. e., if we make the particle come nearer to the central body whose attraction causes it to move forward, then the motion of the particle becomes *greater* in a given time, and its increase of motion in a given time is in the exact proportion in which we decreased its distance from the central body. A little knowledge of Geometry will enable us to see that the conditions stated above determine that our imaginary string must sweep "equal areas in equal times."

Reference to the description of the Moon's movements about the Sun given above, will show that Kepler's Law is therein clearly violated. For the Moon moves slowest when nearest to the Sun, and fastest when furthest away.

It will at once be seen that if the Moon revolved about the Earth in the opposite direction, then Kepler's Law would be much more nearly conformed with.

This violation of Kepler's Law, so clear in the case of the Moon, is also true with regard to the particles that make up the mass of the Earth while it continues to rotate as at present.

Chapter I.

THE RECEDING MOON.

We now approach a subject concerning which much has been written: I refer to the statement that the Moon is receding from the Earth.

A fundamental axiom of all reasoning in connection with the movements of the heavenly bodies is that "the moment of momentum of any planetary system must forever remain unaltered." I will endeavor to explain the meaning of the expression.

It is assumed by the most eminent students of our Solar System, that the Earth and the Moon at one time formed one orb, and that the Moon by centrifugal action of the then rapidly rotating Earth, was thrown out, and that it has all along since that time been increasing its distance from the Earth. Now, the Earth at the time it gave birth to the Moon, is assumed to have had a fixed and unalterable moment of momentum, that is to say: the mass of the Earth multiplied by the radius of gyration of that mass, and this product multiplied by the speed of gyration of the mass; gives a result that must eternally remain constant.

Upon the birth of the Moon, however, the factors that went to make this constant became more numerous and their inter-relation became more complex. We now have as the elements in the case, the following: A motion of the Moon about some central point; a motion of the Earth about the same point, and the dinmal motion of the Earth about its own axis; the last named being the poor remnant of the fierce gyratory motion postulated in the premises. The reader will observe that this proposition (supported by the most eminent authority), ignores any action or interference by the Sun. This treatise is in a measure devoted to the work of showing that no "system" of primary and satellite, can have any exclusive commerce in which the central Sun does not take part, and that the rotating motion of the planet, in its integrity as well as in its fragmented condition, must be vitally influenced by the direction and velocity of its revolution about the central propelling agent.

It can be seen at once that velocity (one of the factors in the constant above referred to), having waned in one quarter, we must increase some other factor proportionately, in order that the constant may be maintained: the popular way of accomplishing this result is by increasing the distance of the Moon from the Earth.

In order to bring about this result, some remarkable devices have been employed. I will refer to one of them: About the latter part of the article on "Tides," in Young's Astronomy, may be seen a diagram in which the Earth, as an ellipse of revolution, has its longer axis so disposed that it forms an angle of about 60 degrees with the line joining the centre of the Earth with the Moon. The direct tide occupies one end of the longer axis of the ellipse, and the antipodal tide the other, and the forward end lies nearest to the Moon.

This peculiar disposition of the mass of the Earth is represented as being capable of driving the Moon away from it, at the same time increasing the Moon's velocity. The statement is so striking that I fear some fundamental misunderstanding as to the axiomatic basis of our respective attitudes on the point, is likely to cause the author and myself to differ eternally, and so I pass it over.

We are constrained, however, to ask why the direct and antipodal tides can remain in this peculiarly convenient relation to the attracting and attracted Moon? Newton assumed the Earth (as aeffcted by tides), to be an ellipse of revolution with its longer axis directed towards the Moon and Sun. The coincidence of both (moon-produced ellipse and sun-produced ellipse), caused spring tides, their quadrature produced neap tides. The more modern investigator (probably in deference to observed facts, which are to be reckoned with after all), has postulated that the friction of the Earth in its daily motion carries both the direct tide and the antipodal tide around to about quadrature from their positions of origin, but the expositor cited by Young, contented himself with about 60 degrees. Now, it is plain that if we postulate friction as being a factor in the case, the direct tide was carried around until the Moon's attraction upon the protuberant water, just balanced the drag of friction: there the tide stopped. The antipodal tide was also carried around by friction, but friction in the case of the antipodal tide not being opposed by the attraction of the Moon, it should advance around by a much greater angle than the direct tide, but, startling to relate, it remains as per diagram, diametrically in opposition to the direct tide, despite the fact that the Moon's attraction is now vigorously assisting the drag of friction to carry the antipodal tide around under the Moon! In short, the Moon's attraction, valiant in combatting the frictional drag, seems utterly powerless to assist it.

The quaint absurdity so modestly obtrusive in the scheme of tides above reviewed, is inherent and ineradicable in every current theory on this much-elaborated subject, when it grapples with the stubborn fact that tides are always about at quadrature with the direction of the forces which are supposed to produce them.

The belief that the Moon is receding from our earth however seems to have something to support it, and we shall therefore point to some apparently plain reasons why it should do so.

It must be assumed that so far as the mutual attraction of Earth and Moon is concerned, there is no greater tendency on the part of the Moon to be draw towards the Earth at one time than at another. It is otherwise, however. with regard to the mutual relations existing between the Sun and the Moon.

It has already been demonstrated that the Moon is considerably nearer the Sun at some times than at others. It has also been demonstrated that when nearest to the Sun, it moves slowest, and that when furthest away, it moves fastest. It is a well-established principle, that for a given amount of attraction towards the central orb, a certain rate of orbital speed is required, otherwise the revolving body must be drawn towards the central attracting body. Any slowing-down, therefore, on the part of the revolving body, to a less speed than is guaranteed by its distance from the attracting central orb, must result in causing it to move nearer the central body. The Moon, therefore, while in conjunction with the Sun, is drawn towards the Sun and therefore away from the Earth.

Again, any impulse that increases the speed of a planet in its orbit beyond what is guaranteed by its distance from the attracting body, tends to drive the planet along a tangent, and therefore further away from the attracting body, consequently the moon when in opposition is driven away from the Sun and therefore from the Earth.

Chapter II.

A PLEA FOR THE "PERVERTS" OF OUR SOLAR SYSTEM.

In the Introduction to this treatise, there is set forth, how, according to Kepler's Law —"equal areas in equal times"—there is an inherent antagonism in the concurrence of rotation and revolution in the case of any planet of appreciable diameter.

This is but another way of saying that the most economical condition as to the conservatism of energy in any planetary system, is not arrived at, until the movement of rotation is in a direction *contrary* to that of revolution, and the *rate* of rotation is (as nearly as can be obtained in a rigid body), that which enables all the particles at all points in the diameter of the rotating planet, to obey Kepler's Law above cited.

To better illustrate the principle I am here presenting, let us suppose that three particles are made to "toe the mark" on a radial line drawn from the centre of some celestial body, about which the three particles are destined to revolve. Pursuant to Kepler's law above cited, the particles nearest to the central orb will leave the other two behind, and the outermost will be the hindmost.

The particles, however, are assumed to have mutual attraction, and as a result, the way in which they will arrange themselves, will be a resultant of the force that impels them along their orbits and the force that keeps them together.

As the result, the inner particle will tend to move across the path and partially in front of the particle next outside, and the outermost particle will tend to pass inwards behind the middle particle.

We will now introduce two other particles, and we will place them in the same relation to the middle particle that was occupied by its two companions in the first instance, namely, radially, one outside and the other inside the middle particles. Now, before the introduction of the two latter particles, our system of three particles was assumed to be in equilibrium, but immediately upon the two latter being placed as stated, a rotary motion of the whole mass of five particles is set up, and in a direction *contrary* to the general movement of the whole mass, this rotation being due to the lagging behind of the outer particle and the forging ahead of the inner one.

This antagonism of movement must begin to assert itself as soon as any nebulous mass attains consistency, and the friction or adhesion of its particles prevents each one of them from following its individual destiny as declared by Kepler's Law above cited, and "the whole heavens declare it" in the fact that planets are slower and slower in their orbits as their distance from the Sun increases.

If we grant the persistence of Kepler's Law of "equal areas in equal times," this antagonism is always present in our Solar System, and the concurrence of rotation and revolution is only another instance of the prodigal waste of energy, which, to our way of thinking is so apparent in the whole cosmic machinery.

We shall now proceed to investigate the so-called anomalies of our Solar System in the light of the above simple but manifest demonstration.

On the frontier of our Solar System, there revolves a planet—Neptune—about which revolves a solitary satellite. The plane of revolution of this satellite is inclined at angle of thirty-five degrees to the plane of the orbit of Neptune, but the fact that startles the advocate of the Nebular Theory, as at present propounded, is, that its motion is opposed to that of nearly all the other orbs of the Solar System.

I have said *nearly* all, for revolving in the path next inside that of Neptune, is another planet—Uranus—about which revolve four satellites, whose planes of revolution have an inclination of eighty-three degrees to the plane of revolution of Uranus, but, (in so far as these planes differ from being at right angles to the plane of revolution of their primary), they also revolve contrarily.

This has been a stumbling block to all advocates of the Nebular Hypothesis, who, for some reason, not at all clear to me, have assumed concurrence in direction of all the planetary movements as being the more advanced condition in the evolutionary process, through which our Solar System, is, according to the most convincing circumstantial evidence, now proceeding.

To quote Sir Robert Ball: "If the orbits of these satellites had all lain close to the plane of the ecliptic, and if the direction in which the satellites revolve had also conspired with that of the revolution of Uranus around the Sun, and with all the hundreds of movements which are in the same direction, there can be no doubt that we should in this place be appealing to the Satellites of Uranus as confirmatory evidence of the Nebular Theory.

The fact that they move in a manner so totally at variance with what might have been expected, cannot therefore be overlooked. (Ball in "The Earth's Beginning," page 339.)

The eminent astronomer then proceeds to postulate that the plane of revolution of the Satellite of Neptune has already made a start thirty five degrees towards the desired al, and that those of Uranus have already ved around, eighty-three degrees.

The sceptical objector might well ask: What peculiar bad fortune had overtaken the Satellite of Neptune to be thus "turned wrong" and why, being the oldest in the evolutionary process, it did not adjust itself to a greater extent than thirty-five degrees, since it had the advantage of being a concrete orb when the other planets were still but a "haze of light"?

And he might add still more force to the objection by asking: Why the Satellites of Uranus had made so much more progress, although so much more recent in the order of evolution.

The antagonism of rotation and revolution in the same direction in any planet being for the present granted, and the movement of a secondary planet about its primary, being regarded as a case of rotation of a particular particle of the whole mass of the primary about the centre of the latter, let us see if the so-called anomalous motions of the Satellites of Uranus and Neptune, are not just what we must conclude to be in the nature of things, eventually inevitable.

When any two forces antagonize each other, their antagonism is either partial or absolute, i. e.: the resultant force either lies absolutely in the direction of one of the forces, or it does not so lie.

It is almost infinitely improbable that the resultant can lie absolutely in the direction of either force, and it is to the same degree probable that the resultant must form an angle with both forces.

The terms of Kepler's Law of "equal areas in equal times" makes the antagonism above referred to, persistent through the whole cycle of the Moon's revolution about the earth excepting at the points of quadrature, i. e., when crossing the earth's orbital path. For, outside this orbital path, the moon moves more rapidly, as is plain from the fact that its inward motion, (towards the Sun), is *in front* of the Earth. And inside of the Earth's orbital path, the Moon moves more slowly, as is plain from the fact that its outward motion, (away from the Sun), is *behind* the Earth.

In that undulating path which the Moon is now describing about the sun, the fundamental laws of motion are therefore in a measure constantly violated. But Kepler's Law is slowly working its revenge The antagonism is perpetual, and victory will ultimately be for the stronger.

The obliquity shown to be all but inevitable in all antagonistic forces, is slowly pulling the plane of revolution of the Moon around, and eventually, like the riper Satellites of Neptune and Uranus, these prodigals of cosmic energy must economize, until all the motions approach as nearly as possible to the condition that leaves each individual atom to work out its own particular destiny in accordance with the law of "equal areas in equal times."

Chapter III.

TIDES—THEIR PROBABLE CAUSE.

To the student of Nature who instead of accepting passively the dicta of mere authority, does some thinking on his own account, the theory of tides as at present propounded, must surely appear unsatisfactory. This theory so clearly traverses some well-observed facts, as to suggest grotesqueness rather than profundity. The theory of tides, which asserts that the Moon produces them by raising a lump of water under itself by its own attraction, seems to have been propounded in apparent obliviousness to the fact that the mutual attraction of celestial orbs, is not devoted to the wor kof raising lumps, but to developing velocities, many or all of which are mutual.

And still the tides observe their times of rising, not under the Moon, not even at a little distance behind the Moon's apparent progress across our meridians, but possibly at about a full quadrant ahead of the Moon's position.

While the capacity of the Moon for raising protuberances on the Earth's surface, presumably by reason of its greater attraction, is extolled all around, that of the sun is only touched upon as a minor affair.

This breezy way of disposing of the matter is taken in defiance of the fact that the attraction of the Sun is so great as to compel the Earth to pierce the ether to a greater distance in one day than the Moon travels in one month, as the result of its attraction for the Earth.

I submit the following considerations in connection with this subject, feeling confident that whether or not they may explain tides on a new basis, they should at least repay the trouble of investigation, owing to the inferences they compel on the basis of our present accepted astronomical and physical axioms:

"Kepler's Law," familiar to every student of astronomy, is, that: a secondary planet in its path always "sweeps out" equal areas about its primary, in equal times.

This law, if obeyed, determines that any celestial body must move more slowly in its path of revolution whenever it goes further away from the other celestial body about which it revolves, and whose attraction is the cause of its revolving motion:

Starting with this axiom, we are met both in the Earth-Moon system, and in the Earth-Sun system, by the following propositions: Points on the surface, both of the Earth and of the Moon, are constantly changing their radii of revolution, so that according to Kepler's Law, the orbital speed of such points should be constantly changing. Even at the enormous distance that the Earth lies from the Sun, the dieffrence of speed demanded by Kepler's Law due to the whole diameter of the Earth, should be quite appreciable, and its reaction upon a plastic body such as the waters of our globe, must to my mind, produce results which can scarcely be negligible, although, so far as I know, no investigation has hitherto taken this factor into account.

I would also submit whether or not this principle would compel the cessation, in time, of axial rotation in planets, and even demand a slow rotation in the opposite direction as the eventual result. The water upon the opposite side of the Earth to that upon which the Sun may be at any given time, should, according to Kepler's Law, move more slowly along its orbita lpath than does the water in quadrature, but the concurrence of the Earth's rotation and revolution demands that this side should move more rapidly.

On the other hand the waters on the side of the Earth nearest to the Sun are required by the same law to move more rapidly than the waters at quadrature, while the conditions of concurrent revolution above referred to.

compel this near side to have a less orbital speed than the point of quadrature.

If Kepler's Law be obeyed, then, practically a "brake" is applied to two opposite sides of the Earth, compelling a slowing-down of the Earth's diurnal motion and giving the plastic ocean a tendency to "pile up" at the points of quadrature.

We will now consider the case of the Earth-Moon system in which the problem is more complex. It is assumed that the Earth and the Moon both move about a point situated somewhere between the Earth's centre and its equatorial zone; called the centre of gravity of the system.

The period of revolution of the system about this point is the well-known Lunar month of the almanac. The complex motion thus developed, may perhaps, best be illustrated, by imagining that the Earth's pole of rotation is the wrist-pin of a crank-shaft about which the Earth rotates once in 24 hours. The length of the crank is supposed to be less than the Earth's radius, and the crank-shaft revolves once in a lunar montth. The centre of the Earth's diurnal motion is thus, as stated represented by the wrist-pin, while the centre of monthly revolution of the Earth-Moon system is represented by the crank-shaft of our illustration.

Assuming that the centre of motion of the Earth-Moon system is situated at a depth of 1,000 miles below the surface of the equatorial zone of the Earth: the peripheral speed of the Earth on the equatorial zone at the point furthest from the Moon (or opposition) is about 65 1-3 miles per hour, due to Earth-Moon revolution.

The peripheral speed of the Earth on the equatorial zone at the point nearest to the Moon (conjunction) due to Earth-Moon revolution, is about 9 1-3 miles per hour.

A particle on the Earth's surface, therefore, while being carried around from the first-named point to the latter by the [illegible]'s daily rotation, is compelled to "slow down" 56 miles in 12 hours or about 4 2-3 miles per hour: an amount which, in my judgment should cause a much more violent tide than we have.

Having established the fact that the changes of peripheral speed above referred to, are inevitable, due to the revolution of the Earth-Moon system, we have now to determine at what point or points there occurs the greatest change of speed in a given time: this must be the point of greatest "heaping up" of the water of the ocean.

The greatest change of speed must occur in a given time at the point whose radius of revolution about the centre of the Earth-Moon system makes the least angle with a tangent to the earth's surface at that point. It can easily be proved geometrically that this point is either extremity of the shortest chord within the Earth's circumference passing through the centre of gravity of the Earth-Moon system, and lying in the plane of revolution of the system. As the maximum change (at the points above indicated) is probably not far from double of the average change, it suggests that the centre of the Earth-Moon system should be nearer the centre of the Earth than is commonly assumed. In fact, if the greatest and the least radii be assumed to have only a difference of 1,000 miles, an observation of the conduct of water would suggest that it would warrant all the tide we now have. This would also make the high tides about at quadrature with the moon, which seems to be about the actual condition.

In order to meet the honest doubts of earnest searchers after truth, as well as the self-sufficient prejudice of those who are satisfied with the current views, I subjoin the following illustrations:—

Let us suppose that a flat-bottomed pan, containing water to the depptth of one inch is gently laid upon the bosom of a stream whose current has varying velocities at different points. As soon as the current catches the bottom of the pan, the water in it is liable to gather more or less towards its upstream end.

Owing to the hold of the pan upon the contained water the latter soon becomes reconciled to its newly-acquired velocity and becomes placid. Soon the pan reaches a point on the stream where the current is less rapid than where it was at first placed. At once the water in the pan tends to gather towards its down stream end. This well-known sensitiveness of water to changes of velocity and of direction of motion in the vehicle that carries it, furnishes a theory of tides that must appeal to all observant men. The lowest tides will occur at the points where change of velocity in a given time is least.

Let us now imagine a huge horizontal circular disc revolving eccentrically. . . Let us imagine a man walking from its edge towards its centre, he will tend to fall on his side, with his head in the direction towards which the disc is revolving.

If he should walk from centre to circumference he will tend to fall in the opposite direction. Let us now suppose that a small tramway is fitted to the circumference of the eccentric circular disc upon which a carriage travels, performing the circuit in the same direction as that in which the disc revolves and in (say) one-tenth of the time in which the eccentric disc performs one revolution on its own eccentric axis. A person sitting upon the fast moving carriage above referred to, is virtually travelling from the centre of the disc towards its circumference and vice versa, and as a result reactions will be set up that will disturb the equilibrium of his body to an extent depending upon the amount of eccentricity of the revolving disc and the speeds of disc and of travelling carriage.

Exactly such reactions are set up in particles on the Earth's surface, whilst moving with the daily rotation of the Earth, and with its monthly motion about the centre of gravity of the Earth-Moon system.