Ettinger Journals

Earth's Metamorphosis (EMM) Hypothesis, Edition 2

The Event and Aftermath of Earth's Collision with a Large Impactor that Changes its Orbit, Spin Axis and Surface Features

Star-Planetary Origins By Douglas B. Ettinger

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II. Preface to Edition 2

This edition has important changes, some that occurred after discovering a glaring error in the calculations for incorrectly applying the conservation of energy to achieve the Moon's present distance from Earth. A fresh new look was given to the capture mode and synchronization process for the Earth and Moon. Very new and insightful ideas with supporting calculations are added. A more detailed approach to how the Earth slowed its orbital velocity to match the Moon's is given. This approach utilizes impulse momentum and calculates the time for synchronization to occur. Then the synchronization process was expanded to show how the Moon actually begins orbiting the Earth and gaining very quickly more separation distance to balance the kinetic energy of the Moon's orbit and accompanying potential energy changes. Finally, the waning rotational periods of both bodies and the Moon's rate of receding are addressed.

Apologies are given for errors in the first edition. However, more importantly, a much better understanding has been gained in trying to fix these calculations. A mark-up copy going from Edition 1 to Edition 2 is provided for those readers of the first edition who were confused and perhaps disappointed. Hopefully, those readers can find their way sooner to remove their confusion by utilizing the document version with tracked changes. Thank you for your continued interest in these journals and hypotheses.

~~II.~~III. Introduction.

A new hypothesis is presented to support a new genesis for the Earth-Moon system. Both a major collision and a capture mode are proposed to bring these two bodies together after the pristine solar system was formed. The currently accepted idea is that a rogue planet (Impactor) the size of Mars struck a glancing blow on the young, fast spinning Earth and then was launched into an orbit around the Earth with the collision ejecta eventually being accreted by the smashed rogue planet to form the newly captured satellite. The Earth's spin had to be unreasonably very fast to achieve the Moon's angular momentum. The new hypothesis of this paper proposes a quite different scenario which better explains the data collected by the Apollo Missions, space probes, and space telescopes. Knowing the correct hypothesis does lead to answers of other mysteries about the Earth's composition, atmosphere, and geology.

The new Earth-Moon genesis follows. A rogue planet or satellite strikes the Earth in its first orbital location and creates the Earth-Moon system. The Sun's orbiting planets have already evolved in a nearly level plane going in one direction in nearly concentric circles around the star. The star is already fusing hydrogen and the proto-star disk has been mostly evacuated of gases and dust. This collision occurs in an almost pristine, young star system just beginning to enter the Main Sequence of stars with its yet undisturbed nine planets.

The nine planets starting at the closest orbit to the Sun are Mercury, Venus, Moon, Mars, Earth, Jupiter, Saturn, Uranus, and Neptune. The Plutonian or minor planets beyond Neptune are not counted because of their small size, their more elliptical and non-coplanar orbits. The original Earth had an orbital distance that approximates the center of the Asteroid Belt. ~~The~~ A major collision knocked the Earth inward along the plane of the planetary orbits toward the Sun. Its trajectory caused it to align with the same orbit as the Moon's orbit. The nature of the trajectory eventually created synchronized orbits for the Earth and Moon favoring the smaller Moon orbiting around the more massive Earth. Actually, the Moon moves in a wavelike pattern as it travels with the Earth in their orbits. The Moon orbits the Earth only from the perspective of an observer on this planet; otherwise, it moves in a wavelike fashion around the Sun being held in place mostly by the Sun's gravity.

Other telltale evidence of the collision is the existing Asteroid Main Belt with its smaller bodies that appear to be the break-up of an existing body or the debris created by the proposed collision. According to the Titius-Bode Rule, a planet should exist in this orbit, but only the asteroids reside here that have a combined mass much less than a typical smaller outer- planet satellite. And, then why did not the asteroids accrete to become a single body like the other rocky inner planets? These rocky bodies had some 4.6 billion years to do so since some of the oldest rocks in the solar system are found in meteorites which are fallen asteroids. A feeble answer is that Jupiter's strong gravity field and resonance prevents them from accreting, but modeling is not conclusive. However, there is a working model that predicts the two groupings of Trojan asteroids that were gathered in Jupiter's orbit and are about 120 degrees apart ~~from each other and the planet~~in their orbit around Jupiter. These asteroids were also created during the collision and were flung outward in Jupiter's direction. ~~My proposal~~This paper proposes ~~is~~ that any collisional debris that occurs after the formation of the pristine solar system remains as scattered debris unless: some debris ~~was~~ is originally flung too close to larger bodies and ~~fell~~ falls to its surface~~.~~; ~~Some~~ some of this debris ~~will~~ remains in the orbit where the collision occurred; some ~~will be~~ is flung outward to become the Trojan asteroid groupings; some ~~will be~~ is flung inwardly following the Earth's new trajectory and ends up either falling back to Earth or impacting its new neighbor, the Moon; ~~or~~ some debris ~~impacting~~ strikes other inner solar system bodies - labeled as the Late Heavy Bombardment (LHB) period~~,~~; and finally, some ~~will be~~ are flung randomly either into highly elliptical and non-planar orbits or into the Sun.

~~And~~ Tthen there is the Moon enigma: why did the Earth, the only inner planet, have a satellite with an unusually large satellite- to- planet mass ratio, about one to seven? Obviously, different factors created the Moon as compared with the typical satellites of the outer planets. Of course, the proposed collision is the creator of this Earth-Moon system and not the mechanism that created the outer planets' satellite systems. Numerous reasons and evidence for this newly proposed collision follow. Also discussed are reasons why the currently accepted collision-capture mode is not very probable, if not actually possible.

~~III.~~IV. The Moon as a Planet

The Moon is the only satellite held in its orbit by the Sun's gravity and not its parent planet's gravity. This little, not well known fact was brought to my attention in one of Isaac Asimov's books on astronomy.[a] ~~And~~ T~~t~~his satellite has the only orbit that is always concave toward the Sun in its entire orbit while it still orbits the Earth. In addition, the Moon is not in the plane of the Earth's equator nor is it in the plane of the ecliptic or the average plane shared by all the planets. Of course, the collision proposal addresses these issues by not requiring any common proto-star disk orbital plane. The Moon and Earth had separate origins and were both ~~held~~ captured in their individual orbits by the Sun's gravity and other forces at different times. The 23 degree tilt of the Earth's axis to the ecliptic plane was caused by the collision. The ~~impactor~~ Impactor struck the Earth at middle latitude some distance from the equatorial plane causing this yet unexplained tilt of the axis which causes the seasons. The impact forces of the collision quite possibly caused one of the Earth's minor wobbles, but not necessarily its precession that completes one rotation every 26,000 years. This is similar to pushing a spinning top with your finger to cause it to wobble and slow down its spin. When the battered Earth intruded into the Moon's orbit it possibly disturbed the Moon's orbital plane and shifted it by about 5 degrees from the ecliptic. According to the Titius-Bode Rule, a representation of gravity waves, any wandering planet that has not deviated too much from a circular path around the Sun should find another orbit per this mathematical series which is actually an approximation of a better known mathematical series.[b] More explanation of the reasons for this rule will come later. The rule is just not a fluke of numerology. Other evidence of the collision ~~is~~ are the craters on the Moon of a certain era, the original super-continent on young Earth, surface plate tectonics, and the Earth's geological hot spots. Another way of looking at this so-called evidence is that they can be explained by this one collision hypothesis and not by separate concocted models produced currently by ~~the current~~ the ~~-~~academic community. These four topics each have their own enigma that is not well answered by any current, serious common hypothesis. The geophysicists are just so happy to learn about the existence of super-continents, the tectonic plate theory of the Earth's surface, and geological hot spots in the recent past, the 1960's, due to global surveys both in the sea and on land. Answers to why they exist are very weak or non-existent. Exploration of the Moon in recent decades has revealed the age of various cratering and lava mares on the Moon's surface, but good explanations for these ages are not quickly forthcoming. This paper produces excellent answers to these conundrums.

~~IV.~~V. The Age of Celestial Bodies

Ages of the Moon's surface materials, asteroids, meteorites, and some of the oldest rock on the Earth's surface show a trend that peaks about 3.9 – 4.0 billion years ago which scientists call the Later Heavy Bombardment (LHB) period. This is about 600 million years after the birth of the solar system. The age of the oldest meteorites found on Earth, among other evidence, has produced this birth as 4.6 billion years ago. The new collision hypothesis predicts that a major impact of the Earth ~~occurs during~~created this LHB period which matches the age of the oldest cratons, the foundations of the oldest mountain chains, on Earth. The collision creates the melting and re-solidification of the asteroids and some of the oldest melted rock on both the Moon and Earth to mark the age of this heavy bombardment. This Impactor~~,~~ about the size of Mars~~,~~ was composed mostly of ices with a small rocky core, similar to the composition of some of the satellites of the outer planets. The young Earth had already cooled enough and differentiated its materials causing the mantle to be covered with an outer hard crust or sea floor covered with liquid water and gases. The water was more likely liquid and not steam or frozen ice. Even though the Earth at that time was not in the so-called habitable orbital region of the Sun, the heat from the young proto-star and the heat escaping from the mantle kept the water from freezing and aided the rapid cooling of the crust. There probably was even a water cycle where the water convectively moved to the hotter surface regions, evaporated, and then condensed as rain in cooler regions of the globe. The asteroids are broken shards or collections of shards that re-combined either through accretion or solidification. These asteroids are composed of a small fraction of both the Impactor's materials and a mixture of ices and rock of an already formed rocky crust and upper molten mantle on Earth.

Hence, it is postulated and to be proven later by space probes that the asteroids have a mixture of ages for their isotopes. The oldest rocks would be pieces of Earth's mantle and crust that did not melt during the collision; these materials should be closer to the age of the solar system, 4.6 billion years. The younger asteroids would be pieces of both the Earth and the Impactor that melted during the collision; the melted materials would soon solidify near the aftermath of the collision 3.9 billion years ago. These asteroids would retain their collisional characteristics and their orbital vicinity near Earth's first orbital position in the Asteroid Belt. Only a few of the debris components were large enough for gravity to reform them into spherical shapes such as the asteroid, Ceres. Possibly, Ceres was a satellite of Earth that broke away from Earth's gravity field after Earth was displaced from its orbit.

~~V.~~VI. The Birth of Continents

The young mantle was still very hot, less viscous, and very molten; when the rogue orb penetrated Earth's crust, the rocky, denser core of ~~the~~ this Impactor went deeply into the mantle while the lighter ices remained higher and became well mixed in the upper mantle. The heavier core if it was iron or nickel settled on the liquid surface of the Earth's iron core causing it to enlarge. The combined denser core and lighter volatiles of the Impactor bloated the Earth's size. This growth or displacement of the Earth's mantle caused the young crust to crack like an egg shell. The fluid mantle mixing with ices from the Impactor, the new mantle displacement, and rapid differentiation cracked the existing crust. Materials in the impact zone rebounded and oozed from the immense crater flowing over the surface of the adjacent, original ocean floor. This mixture of material of the denser mantle and some of the Impactor's volatile lighter materials rested on top of the original seafloor crust and caused it to sink ~~.~~

Earth's Second Differentiation

However, enough mantle material escaped to create land or rock above sea level that would become the first super-continent on Earth. This hypothesis supports a reason for an original super-continent and the various cracks occurring globally in the first ocean floor crust that would continue for future ocean floors as rifts and boundaries between migrating tectonic plates. This is why the continental crust is less dense than the ocean floor crusts. The ocean floor crust came from original differentiation where most of the lighter materials migrated when the completely molten Earth was first forming by accretion. After the collision, the denser mantle materials were mixed with the lighter volatile materials of the Impactor. This mixture of materials was then displaced to create the continental crusts of 2.7 g/cm^3 which are appreciably lighter than the original ocean crusts of 3.3 g/cm^3.[c] It is similar to boiling an egg in a pot and allowing the convection currents of the water to smash the shell causing egg white to ooze thru the most smashed area and cover a portion of the egg shell and also seep from small cracks. The current accepted thinking is that the continents are the result of the first differentiation of lighter materials; but why was not these lighter materials more equally distributed around the globe? Only the new collision model can answer this question.

Now the finely tuned spinning oblate, symmetrical Earth becomes off-balanced. Through Coriolis forces of the large raised areas of the super-continent floating on the very fluid, convective, molten mantle begin to move radially and spin slowly. This massive continent starts to slowly break-up and migrate trying to find a new equilibrium point. Global cracks are continuing in the ocean crust and rifts begin in the super-continent. This develops the process of global plate tectonics which is not found anywhere else in the solar system. Also, any planet or satellite with very high regions and low regions on its surface is unusual and only found principally on Earth and Mars. ~~These factors just discussed are thought by the current academic community to be a continuance of the differentiation process where the lighter materials mixed in the mantle and migrated to the surface.~~ The new collision hypothesis speculates that most differentiation of the original planet occurred very early in the history of the solar system prior to this proposed major collision. Then a secondary differentiation started after the collision via the Impactor's crater, volcanism at geological hot spots, and the subduction zones of tectonic plates at major crustal cracks.

~~However, this~~ This large collision created a new and strange phenomenon. The majority of ices of the Impactor that did not get blown into inter-planetary space ~~became~~ become mixed with the Earth's mantle material. Then a secondary differentiation process ~~occurred~~ occurs that took a new form. The ices and lighter volatile materials of the Impactor began to separate and rise only to be caught underneath the existing oceanic crust and the newly, partially ~~formed~~ solidified continental crust in the Earth's lithosphere. This entrapment gives a strong reason for random hot spots that are found randomly around the Earth. The reasons for these ambiguous geological hot spots are currently well debated by geophysicists.

~~VI.~~VII. Geological Hot Spots

These more volatile materials are ~~being~~ pushed by hydrostatic pressures and seek~~ing~~ a way to escape through the existing hardened crust. It is like pushing the air from an air mattress; if you push downward with your hands on the mattress only a certain amount of air is compressed causing a small amount ~~to be~~ removed at any one time through a leak or an exit valve. Other amounts of air are pushed to other parts of the air mattress. Likewise, the process of removing large pockets of volatiles trapped under the hardened sea crust or continental crust occurs in intermittent and random spurts whenever a hole is opened through the crust to the atmosphere. Some of the volatile materials will be displaced to different, adjacent areas and become a series of trapped pockets of lighter materials which will eventually be released to the atmosphere over very long and random periods of time causing island chains and migrating hot spots.

Some of these volatile materials make or find fissures in the deeper crust at random locations that then create magna cavities, upward movement of the crust, and eventually volcanic eruptions; other volatile or lighter materials will seep ~~out of~~ from oceanic crustal cracks or mid-ocean ridges created by the collision. These new volatile materials from the Impactor create pockets randomly under both the existing ocean crust,~~ and~~ the new continental crust, and at the crustal cracks. These volatile pockets of material trapped in the lithosphere under the hardened crust need not favor any particular location in this new hypothesis. Geophysicists are especially puzzled because hot spots occur in any location and do not reveal any particular mechanism or origin. The current thinking for hot spots is ~~that ~~hot plumes ~~migrate ~~migrating upward through the mantle from the surface of the liquid core.[d] ~~I am unsure~~It is difficult to conceptualize how a plume can stay together while moving upward through a very thick, viscous, convective mantle, but the claim of modern seismic tomography is that hot spots deep in the mantle and close to the liquid core can be detected. The liquid outer core is supposed to rotate or churn with respect to the lower mantle in order to create the observed Earth's magnetism. The outer liquid core movement with respect to the lower mantle is slow since its movement is obtained from hydraulic friction via the faster spinning inner solid core. It acts like a fluid clutch, but nevertheless, various motions between the upper liquid core and the bottom the mantle should occur. So how does a hot spot stay stationary for any length of time with respect to the crust resting on the lithosphere?

Another question arises about why many hot spots for millions of years migrate across the Earth's surface. The well-known hot spot, the Hawaiian Island Chain, has migrated from the Aleutian Islands and curved southward and eastward toward its existing location in the center of the Pacific Ocean. Current thinking is that the crustal plates are moving with respect to the hot spot's origin on the liquid core's surface. This is very erroneous thinking. The hot spot cannot stay stationary due to the rotating and churning liquid core, and still have some movement over long periods of millions of years. What can cause this ambiguous process?

Hot spots are fairly fixed with respect to plate motions. Plate movements typically are measured with modern geodetic positioning systems (GPSs) to move about 5 to 10 centimeters per year. Hot spots move only a few millimeters per year with respect to each other. This is why scientists believe hot spots are related to the mantle and not the crustal plates.[e]

The new collision hypothesis answers these questions about hot spots. The residual ices of the Impactor have randomly mixed and differentiated inside the mantle to be collected and trapped globally in different spots under an already hardened crust. These hot spots move slower with respect to the crust due to the movement of the crust with respect to the hot spot being compressed into the lithosphere at the top surface of the upper mantle. The compressed volatiles of the hot spot actually roll underneath with respect to both the more stationary lithosphere and the faster moving plates. Most of this movement is predicted to be caused by the Coriolis forces created by the spinning Earth. Other minor forces can be the potential elastic forces in the lithosphere and the potential viscous forces in the athenosphere due to the mountain building and wasting on continental plates.

It has been noticed by geophysicists that the chemistry of materials in the eruptions from hot spots and from mid-ocean ridges is consistently different. The hot spot flood basalts resulting from the solidifying magmas have higher rare earth ratios than the mid-ocean ridge basalts. [eee] This suggests to scientists that the origins are different such as one type of magna coming from a deeper level in the mantle. They are trying to support the mantle plume theory originally conceived by J. Tuzo Wilson with these facts.[f]

But, ~~my~~ the contention of this paper is that the difference in rare earth ratios is more appropriate to the new collision theory.

As was explained, the early Earth's mantle was already mostly differentiated prior to the great collision. After the collision the Impactor's ices were fragmented and randomly mixed into the Earth's mantle and were rather quickly differentiated. However, this second phase of differentiation caused the lighter volatile materials to collect or be lodged in various hot spots in the lithosphere under the hard tectonic plates. Naturally, the regular mantle material composition should be consistently different from the mixed material of lighter volatiles found at the various hot spots around the globe. The basalts of the mid-ocean ridges come directly from the regular mantle material and not necessarily from the Impactor ices. There are some exceptions such as Iceland, whose hot spot lies on the Atlantic's mid-ocean rift. The magna from the regular mantle is needed to displace or fill-in the rifts created by any cracks in the plates that are expanding instead of closing or subducting. The constant pressure on the mantle material causes upward movement when any part of the hard crust opens. There is no reason to have a different origin in the mantle for any basaltic materials that create oceanic crusts. The second phase of differentiation created by the new collision scenario was never allowed to be completed because its upward movement was interrupted by an already existing fully differentiated, cooled, and hardened crust.

The history of intra-plate volcanoes such as Yellowstone and underwater seamounts that are not near any mid-ocean ridges do not fit the other accepted theories of plate tectonics and mantle convection. The big debate is about why these intra-plate volcanoes occur? The sinking of material due to subduction of the plates and the creation of subduction volcanoes is well explained. But, what dominates the upward flow of material and what is the origin of extra, concentrated heat to create these intra-plate volcanoes? The new collision theory with trapped differentiated Impactor ices is the resolution. These bubbles of light volatile material are being constantly pushed against the underside of the various crustal plates for billions of years. These hot spot materials are intermittently seeping through to the atmosphere as intra-plate volcanic eruptions probably at a much lessor rate than in the distant past.

Some of these intra-plate volcanoes are known to be extremely explosive such as Yellowstone that exploded 2.1 million years ago and blanketed the North American continent with approximately 2450 km^3 of ash. It had other large eruptions 1.3 and 0.64 million years ago. The thought is that the magna of these volcanoes is more viscous due to more silica and a colder crust; also, water falling on the continental crust becomes mixed with the magna. These conditions cause the magna chambers to build up more pressure before erupting. [eee]

Another result of the trapped ices would be that the most volatile material such as water and carbon dioxide will be released first in hot spot eruptions. But if the hot spot is under a thicker, harder continental crust then its lighter volatile materials that create very explosive conditions can be retained for longer periods of time. It is more difficult for all the water and carbon dioxide to be all released under continental crusts in the first eruptions during the life of the hot spot.

Another observation is that moving hot spots do not always have a sequential age of eruptions along its line of travel. This is known from seafloor core drillings for determining the age of the rock at island hot spots. [eee] This fact creates another conundrum for geophysicists. Another contention from the theory of trapped volatile materials is the analogy of the air mattress. The pressure of the mantle pushes upward and releases gases and other lighter materials wherever the weakest crust occurs to allow a fissure. And there is no requirement that these fissures be in any sequence. The chances are more likely for weakened crust to occur directly over the center of the moving hot spot and cause sequential eruptions but this is not absolutely required. Similar to an air mattress as you push in one place and displace the air to adjacent areas while some air escapes from the opened valve, this happens to the lighter magna trapped between the crust and the lithosphere. No sequential eruptions comparable to the opening of a zipper are required.

Why have not geophysicists already adopted some form of ~~my~~ this new reasoning for trapped volatile materials under the crust? Planetary scientists have already gleaned the possibility of a major collision of Earth with some Mars-size body in order to create the Moon. Supposedly, the glancing collision and the resulting debris from the impact either fell back to Earth or re-combined onto the Impactor's core ~~in Earth's orbit~~ to form the Moon. The scientists already accept some form of differentiation prior to the collision to explain that the Moon is much lighter than the Earth with a small iron core. Their mental block probably results from the following current thinking:

1. Prior to the great collision the Earth's differentiation was minimal and the surface was still very hot and molten;
2. The Impactor material mostly melted and exploded in its collision path and was dispersed into space along with fragments of the outer Earth's crustal and mantle materials;
3. A sizable amount of material from the Impactor is required to make up the volume and mass of the Moon.

~~And I might add, that the~~ P~~p~~lanetary scientists still have the same problem that ~~I had~~anyone has with ~~my~~ any new collision hypothesis. Where did this Mars-size body come from? This question will be answered later by providing evidence for a source of a wandering, large, rogue body 600 million years after the birth of this pristine solar system.

Before ~~I leave~~ending this discussion of hot spots on Earth, ~~I will speculate~~speculation is given about one more ~~well-known~~ fast moving hot spot that in recent geologic time created the crashing of the Indian sub-continent into Asia to create the Himalayan Mountains. The most recent super-continent was Pangaea that broke into two lesser super-continents called Laurasia and Gondwanaland. The Indian sub-continent was originally part of a super-continent called Gondwanaland and was attached to Antarctica near the southern polar region. About 71 million years ago India broke away from Antarctica and starting moving northward across what is termed the Tethys Sea that separated the two super-continents of that time. [eee]

~~VII.~~VIII. The Indian Sub-Continent Movement

Fifty-five million years ago the Indian sub-continent traveled to what is now known as the southern Indian Ocean. Then, just 38 million years ago and with remarkable speed compared to geological time the Indian land mass ~~had~~ reached the middle of the Indian Ocean. And just 10 million years ago India collided with Laurasia or what is known as Asia and pushed Southeast Asia to the southeast. [e]. The Indian sub-continent swept up an island arc, a continental shelf, and deposits of an ocean basin, and pushed ~~then~~ them into an accretionary wedge that would become the young Himalayan Mountains. India then slid under Asia doubling the continental crust thickness. A normal continental crust from seismology is about 35 km deep, but the crust under the Himalayan Mountain is 80 km thick. ~~Isotacy~~ Isostasy or the displacement of floating continental crusts is attempting to balance the exceptional weight of the very high Himalayas. [eee]

So what is the root cause of this amazing event? There are few answers from the scientific community except for very generic reasons such as mantle convection and subduction and mountain building due to the collision of two continents. I will portray a scenario using the new collision model that creates trapped ices under the Earth's crust. These ices and volatiles act as rollers between the crust and upper more viscous mantle. Is there any better answer at this time? This postulation shows how easily very strange surface events on Earth can be explained armed with the concept of trapped ices and volatiles. Although this is still speculation, it is far better than the current speculation by geophysicists.

The Indian sub-continent being attached to Antarctica was in a very unbalanced condition in the lower southern latitudes. Antarctica had already found a balanced and stable position at the polar region. When the final rift occurred the reaction forces were similar to a rubber band being stretched until it breaks. The rebound propelled the Indian continent northward across the Tethys Sea where the oceanic crust was probably very thin and elastic. As the Indian continent moved over this crust it either piled the oceanic plate in front like pushing a carpet into ripples or stacking it underneath the continent in layers.

The accelerated movement of Indian sub-continent was caused by a rather large hot spot that either acted like a roller or lubricated sled. The hot spot was either under the continent before it broke away from Antarctica or it was northward in the path of the moving continent. If the hot spot was in its path it was more than likely located near the now existing hot spot of the Reunion Islands east of Madagascar. The Indian continent more than likely already had a hot spot under its plate and the combination of the elastic forces of its rift from Antarctica combined to give it unstoppable momentum.

Current evidence for this hot spot is the Deccan Steps located in eastern India where major flood basalts surfaced to create unusual geologic formations. Other evidence is the separation of Madagascar from Africa where possibly the hot spot in question under the Indian plate extended westward and lifted part of the African plate to dislodge a piece. The combination of the uplifting due to the hot spot and the northward movement of the Indian plate causing sidewise friction pulled Madagascar away from its super-continent. Geological conditions under the Indian Ocean between the Reunion Islands east of Madagascar and the Deccan Steps of western India indicate undersea ridges and seamounts that possibly show the residual effects of the hot spot as it moved northward and eventually terminated in the Deccan Steps. The fast moving Indian plate and its hot spot roller were stopped by the Laurasian super-continent; but not until the materials that were pushed ahead became wedged under the Laurasian continent to produce the very young and striking Himalayan Mountains.

~~VIII.~~IX. Continental Drift

A loose end of the Earth's trapped volatiles and ices needs to be addressed. The aforementioned reason for the Earth's super-continents and plate tectonics was the Earth's Impactor penetration of the crust and mantle to create mantle material oozing from the smashed opening to displace or cover the surrounding oceanic crust. Then the dynamics of the spinning Earth sought a new equilibrium by breaking apart, spreading and balancing the weight of the super-continent resting on top of the existing oceanic crust or floating on top of the mantle.

But why did this super-continent after breaking apart come back together again to create a new super-continent? In fact there is evidence through ancient orogenies and frozen directional magnetic data in different aged rocks that this breaking apart and coming back together happened numerous times. It is estimated that the oceanic crusts were re-created 20 times through continuing subduction processes and continental drift.[g] Pangaea, the last and best known super-continent, is still in the process of coming apart via the mid-Atlantic Ocean ridge and other minor rift regions throughout the globe.[h]

A question becomes apparent. If the Earth is seeking equilibrium, why is it continuing to reverse direction to seek this balance numerous times in its history? Why does not the Earth's plate tectonic process find an equilibrium point and eventually come to rest? In the engineering world of controls, the process is known as "hunting". The process keeps over-compensating and changing direction to find equilibrium. Why is the Earth's plate tectonics over-compensating and constantly seeking a new setting? Planetary science's answer is that the convective mantle is supplied by the heat energy of the inner mantle's and core's radioactive decay. This energy is dissipated through the action of plate tectonics on the Earth's surface along with the normal radiation heat transfer into interplanetary space. Current scientific thinking establishes that there is no ~~need~~ good reason for these denser, raised, granitic continental plates to seek a globally balanced condition.

A good critic should stand back farther and look at the whole picture. There are possible mechanisms that could cause the Earth's plate tectonics to continuously "hunt" for a balanced condition. Some of these mechanisms occur in combination over random periods of time that can be measured in millions of years. Their added affects could possibly cause reversals in the motion of plate tectonics. And once the direction of motion is changed or reversed it is difficult to change again until it comes against something to stop that motion. That stoppage is the coming together of the continents again. The breakup of the next supercontinent starts because the balancing process has over-compensated once again.

~~IX.~~X. The Unending Plate Tectonics

A listing of these mechanisms to create continual "hunting" follows:

1. The combination of tidal acceleration forces of the Sun and Moon could be main contributors. Due to the Earth's tidal forces on the Moon slowing its rotation ~~so that~~caused one side of the Moon ~~now faces~~to face Earth. Due to tidal forces on Earth, ~~causes~~ the Moon ~~to~~ recedes from the Earth as the Earth's rotational -period increases to preserve the conservation of angular momentum. ~~This in turn changes the combination of tidal forces acting on Earth.~~ Over long periods of time, changing forces on the Earth's crust and various plates are created by the Moon changing its distance and by the Earth changing its rotational period.

~~The Moon's distance from Earth is currently being measured as receding. The Moon had its own natural planetary spin similar to other planets and had to compensate for the slowing down of its spin and subsequent loss of angular momentum when it became tied to the Earth's gravitational force.~~ The creation of the synchronized orbits of the Moon and Earth must account for the Moon originally being substantially closer to Earth in the beginning of their marriage. The early, ~~slightly~~ larger tidal forces contributed to increased "hunting" by producing higher amplitudes and frequencies of tidal acceleration on the Earth's surface. ~~when the Moon was closer to the Earth.~~

2. The Earth could have suffered other major impacts but not as all-encompassing as the first major impact that changed Earth's orbit and created the first super-continent. But these sub-major impacts could have influenced the mass distribution in the Earth's crust and outer mantle, the Earth's tilt, the Earth's wobble, and the Earth's rotational speed. Any series or combination of these events can have major influences on re-setting the equilibrium and changing the tectonic plate directional characteristics.

3. Other influences could have been rogue bodies traveling inside the inner solar system that closely approached the Earth but did not impact its surface. Their gravitational and magnetic forces could have influenced the Earth's tilt, the Earth's wobble, and possibly shifted the lithosphere and/or mantle with respect to the core's liquid surface. This event would have shifted the position of oblateness (13 miles difference on radius) on the Earth's globe with respect to the spin axis and definitely created an upheaval in the Earth's crust and plates because of the resulting elevation changes. There is some good evidence that such an event of this mantle shifting occurred about 11,500 years ago that ended the last period of glaciation and caused the Great Deluge catastrophe of numerous legends – also called the post-Younger- Dryas Period.

   The magnetic poles are displaced about 10 degrees from the spin axis poles. These magnetic poles are currently being measured to be returning toward the direction of the spin axis.[i] The spinning inner core with respect to the outer liquid core more than likely provides the major input of magnetic properties to the Earth. If the mantle shifted with respect to the core,, its induced and/or frozen magnetic properties would be retained, but slowly re-align themselves with the current spin axis or parent magnetic source over time. I will provide more details about this very plausible event elsewhere. Nevertheless, here is another mechanism for the continuance of changes in the plate tectonic process and the drifting of continental crusts.

The continual but generally small migration of hot spots with their lighter materials can cause mass distribution changes in the lithosphere and upper mantle regions. Other mass re-distributions are caused by the planet's plates colliding with each other to generate mountain building. The two building processes are subduction between the ocean and continental plates and by accretion of wedges between two continental plates. Other small changes are caused by mass wasting, the tearing down of these mountains, with resulting changes in elevation of the floating plates due to ~~ecostacy~~ isostasy. The mass distribution of the various plates continually changes both laterally and vertically as plate tectonics is trying to seek final equilibrium. Similar to difficult cases in engineering controls, the Earth's plate tectonic process of finding surface mass equilibrium on Earth's surface has its own unending or "hunting" difficulties.

~~X.~~XI. Coriolis Effect on the Continents[j]

Finally, many scientists cannot sense how the very thin planetary crust with its irregularities can cause major movement of the continents and surface plates by an imbalanced condition. The crust represents only a tiny fraction of the overall mass and of Earth's radius. To their way of thinking it has no dynamical properties. They still want to depend solely on the convective mantle to cause movement of the plates on a continual and random basis. The movement of the plates certainly does involve a convective mantel but is driven more by the Coriolis forces setup by the spinning Earth. These are the same forces that create the weather patterns or cells at different latitudes and at opposite sides of the equator.

In Quito, Ecuador, on the equator line it is demonstrated to tourists how this Coriolis force acts. The demonstrator fills a sink with water and moves it about 12 feet on one side of the equator line; as the sink drains some floating leaves indicate the direction of the final vortex of draining fluid. Then the tourist guide performs the same experiment 12 feet on the opposite side of the equator line. The vortex spins in the opposite direction. On the northern side of the equator line it can easily be noticed that the leaves spin a little faster near the end of draining. The amazing reason is that the northern latitudes have larger and more massive continents creating a noticeably bigger Coriolis affect only 12 feet from the equator.

This experiment in Quito is testament to how powerful the Coriolis affect is when applied to an entire continental land mass. Once movement of a super-continent or plate is started the resulting momentum powers the initial direction of movement. It is like a large, weighted raft floating on thick honey and being moved laterally and also spun by a continuously changing wind.

The Coriolis affect creates the random spinning motion of weather cells of similar sizes because the gaseous atmosphere is easily sheared; this shearing cannot happen with hardened, rocky plates and dense, granitic continents. The whole continent must move together until a crack or rift is created where shearing or shoving can then very slowly begin between the two resulting plates. These powerful Coriolis forces are relentless and will only stop if the Earth stops spinning.

The most probable balancing of the continents on the Earth's surface would be a fairly equal distribution of the continents both in longitude and latitude on both sides of the equator. Also, the continents would have to be broken in smaller pieces to represent something similar to very large weather cells. Then most subduction processes, mountain building, expanding rifts, and plate tectonics would end.

But this static condition is very unlikely and definitely will not occur in human history. A more likely static condition of the surface plates will occur when planet Earth runs down on heat generated by radioactive decay and residual heat from its formation. Then the mantle loses its convection and fluid characteristics. In the analogy of the floating raft, the honey will dry out and become as hard as rock. Like the raft the continents will then be stuck in place for the remainder of the planet's life.

~~XI.~~XII. Source of the Earth's Volatile Materials

Planetary scientists have another aggravating problem of reasoning where Earth obtained all its water and atmosphere. All of the volatiles for the terrestrial planets should have boiled away since they were so close to the hotter regions of the proto-star disk and the source of the T-Tauri solar winds when the star begins to fuse hydrogen. This seems to have occurred on Mercury and to some lesser degree on Venus and Mars that only have CO_2 atmospheres and little water. The large amount of water and nitrogen gas found in the early atmosphere on Earth are a mystery that hopefully can be resolved by the subsequent collisions of comets that delivered these lighter volatiles after the Sun cooled down.

However, the most recent data of cometary probes reveals that comet composition is as dry as a bone. The coma and tail of comets is not water but charged dust particles that are emitted by jets of charged particles. This idea of comets bringing water to planet Earth has serious doubts if not already totally refuted. The "dirty snowball" comet has been supplanted by the "electric comet" that emits charged particles especially when it comes closer to the electrical field of the Sun.

The accretion mechanism that supposedly created the inner rocky planets of the solar system would not allow the build-up of volatiles; the majority of volatile materials would be driven-off before having a chance to be trapped inside the forming molten silicates of ~~the~~ any mantle. There is a better chance for the newly forming Earth to gather ices and gases from the proto-star disk if it resided in the neighborhood of the Main Belt of the asteroids which is about 2.7 AU, almost 3 times farther than where the Earth is now. The original differentiation process would bring the volatiles to the surface where they would remain as gases. As the surface crust begins to cool and solidify the increasingly thicker atmosphere shields the Sun's rays allowing water to condense and form the oceans and weather patterns on the surface. The convection process of water vapor and liquid water will also accelerate the transfer of heat from the Earth's surface helping to create an early, hardened crust.

When the Impactor, composed mostly of ices, struck Earth orbiting in the Asteroid Belt, it brought more volatiles such as water, carbon dioxide, methane, and ammonia to this planet. Much of these volatiles would become trapped inside the molten mantle to later be added to the atmosphere through secondary differentiation and volcanism. This new collision model provides more volatiles from Earth's original cooler position in the proto-star disk and adds more volatiles from its Impactor. The new orbital region, where the Earth was re-located 600 million years after the birth of the star was much cooler and could then sustain the Earth's atmosphere. No mechanism such as comets raining down on Earth to provide its water and other major gases of N_2 and O_2 are required, although ~~some~~ comet strikes are not ~~entirely~~ ruled out.

To further collaborate this concept that the Earth did not receive its majority of water from comets was verified after a space probe acquired materials from a comet and brought them back to Earth. The isotope ratio of water in the comets did not match the isotope ratio of water found on Earth seriously questioning that comets could be the primary source of Earth's water. [k] However, the death of the "dirty snowball" comet occurred after the newest space probes to nearby comets revealed extremely dry conditions with little water and other lighter volatiles. Lighter volatiles can only come from original sources formed beyond 2 to 3 AU's from the Sun. Earth with its lighter volatiles could only survive inside 2 AU's if it arrived well after the solar system was formed past the T-Tauri stage. This new collision hypothesis provides the answer to why this rare solar system event did occur.

~~XII.~~XIII. Reasons for a Martian-Sized Rogue Planet or Impactor

This unique collision hypothesis has some convincing threads of evidence that are all connected. But any respectable planetary scientist will argue as to where the rogue planet or planetary system with satellites came from. This basic gap in the hypothesis must be closed. Be reminded, the nebular hypothesis that tries to address the Earth-Moon system with its own Impactor has the same problem. The nebular theorists' answer is that this Impactor was the last vestige of large objects coming together after the main accretion phase that formed each planet. There is no computer model for this answer if the program starts with the proto-star disk conditions or 600 million years after the birth of the solar system. There are two current academic ideas for the origin of a Martian-sized Impactor that hit Earth and formed the Moon via the accretion of its debris. One is the Nice Model and the other is the Lagrangian satellite collision. Neither model can be connected consistently with computerized simulations to the overall nebular hypothesis. These models have other issues, too.

A. The Nice Model [l]

The Nice Model reveals the weaknesses of the nebular hypothesis of solar system formation that are virtually impossible to address in any ~~other~~ simple way. The Nice Model is a very recent computer simulation in 2010 that portrays the dynamical evolution of the early solar system by proposing the migration of the giant planets from an initial compact configuration into their present locations. This model attempts to explain the Late Heavy Bombardment of the inner solar system by combining the concept of the Oort cloud and the existence of populations of small solar system bodies found within the Kuiper belt. The Nice Model also attempts to explain the Neptune and Jupiter Trojans, and the resonant trans-Neptunian objects dominated by Neptune.

The Late Heavy Bombardment (LHB) using the Nice Model as its reason has difficulties re-producing a Martian size body that could be perturbed toward the inner solar system and provide the Impactor for Earth during that period when the solar system was about 600 million years old.

The Nice model also tries to patch a basic crack in the nebular hypothesis. How did Neptune form on the frozen edge of the solar system at 30 AU? Why was there so much material at this distance and what energy source created its rocky core? A typical proto-star disk dissipates in much less time than it would take materials at this orbital distance to accrete into a giant planet. Uranus at about 20 AU has the same issues.

The Nice model is very creative and intriguing, but presently is not favored by all planetary scientists. Among its numerous problems are:

1. No indication of how all the outer-system satellites and Kuiper belt objects are produced;
2. No modeling from the nebular hypothesis that gives a compact configuration of the outer planets being between 5.5 and 17 AU;
3. No supporting reasons for its initial configuration requiring a planetisimal disk totaling about 35 Earth masses and ranging from 20 to 35 AU from the Sun including observational data for proto-star disks;
4. Difficulties with about 50 % of the models having Neptune and Uranus exchanging orbits and weakening the concept; orbital crossings of planets of this size are highly unstable with perturbations ~~create~~ creating longer elliptical orbits; these perturbations increase the number of orbital crossings that keep increasing instability and the chances for removal from the solar system;
5. The Nice model does well in creating Main Belt asteroids and the Trojan asteroids at the Lagrange points of Jupiter and Neptune, but cannot explain their typical composition of heavier metals and minerals requiring very high temperatures;, and their consistent collisional characteristics.

In summary, the Nice Model very creatively reproduces many of the solar system's current conditions, if one can believe the initial conditions that were used. The initial conditions were merely chosen to try to match the present conditions after running the fastest numerical modeling hardware and software. It is questionable that these initial conditions match any points in the evolution of the solar system using the nebular hypothesis. The model reproduced planetisimals for the Late Heavy Bombardment, but not the required Martian-sized Impactor.

B. Trojan Satellite at Earth's Lagrangian Point[m]

Another very recent concept which surfaced about 2010 is a Trojan-type satellite that accompanied early Earth at its L4 or L5 Lagrangian point. This massive satellite was eventually perturbed by the other planets and moved toward Earth and collided creating the same Martian-size collision scenario with Earth. The idea has two basic problems:

1. The collision should have occurred during the late heavy bombardment (LHB) period 600 million years after the birth of the solar system. This satellite of such large mass would have been perturbed from its L4 or L5 point long before this time. For these Lagrangian points to be gravitational strong enough to collect such a massive object, the

Earth should have already been formed including the subject satellite and “wanna-be” Impactor. But, if the satellite was already formed then its mass would be too large to be corralled at these Lagrangian points. Evidence at the outer planets’ Lagrangian points reveal that only smaller planetisimals-sized objects are captured and maintained in these zones. Larger bodies would be too easily perturbed by neighboring planets.

2. If two such bodies of Earth and Martian-size did reside in the same orbit, the possibility of their collision is remote. Most likely, they would form a synchronized orbit similar to the Earth-Moon system. In fact, this is exactly what the new collision model is suggesting. The Earth is knocked into the Moon’s existing orbit and begins to synchronize with the Moon as they pass each other periodically. I will quote a paragraph from Wikipedia’s topic,~~-~~- Lagrangian Point, which reveals the mechanism for the Earth and Moon becoming a synchronized unit: “The Earth’s companion object 3753 Cruithne is in a relationship with the Earth which is somewhat Trojan-like, but different from the true Trojan. This asteroid occupies one of two regular solar orbits, one of them slightly smaller and faster than the Earth’s orbit, and the other slightly larger and slower. The asteroid is in the smaller, faster orbit; and as Earth approaches, it gains orbital energy from the Earth, and moves up into a larger, slower orbit. It then falls farther and farther behind the Earth, and eventually Earth approaches it from the other direction. Then the asteroid gives up orbital energy to the Earth, and drops back into the smaller orbit, thus beginning the cycle anew. The cycle has no noticeable impact on the length of the year, because Earth’s mass is over 20 billion (2×10^{10}) times more than 3753 Cruithne.” [mmm]

Neither the Nice model nor Earth’s Trojan satellite sufficiently address the source of a Martian-size body that collided and re-located Earth’s orbit. This treatise does explain and provide evidence for the source of this ubiquitous Martian-size object. The source is postulated to be captured by the Sun’s solar system near the beginning of its birth from interstellar space. This new explanation is a huge break from current academic thinking and will require a new hypothesis about star system formation to be presented later in these journals.

~~XIII.~~XIV. Other Origin Models for the Moon[n]

Four major categories of origin models exist: the binary model, fission model, collision model, and capture model. The collision model is currently favored although research from NASA leans heavily toward a special brand of the capture model. The new collision model favored by this paper actually incorporates a capture model since the falling Earth after being struck ~~gains new~~increases orbital velocity near the orbit of an existing planet, we now call our Moon. Their capture mode allowed for a slow transfer of energy so that a common synchronization occurred. The collision /capture model of this paper has not yet been considered by NASA.

A. Binary Model

The binary model is simply the same process that created the regular satellites of the other planets: Jupiter, Saturn, and Uranus. This process is what would be expected in the standard solar system formation with the Moon forming as part of the Earth's nebular formation. The situation of the Earth-Moon system is generally believed to be unique, thereby causing the development of the other three basic lunar origin models. The satellites of Earth, Mars, and Neptune are not considered regular due to the nature of their unusual orbital inclinations/distances, large mass ratios, and the irregular shapes for the Martian satellites.

B. Fission Model

The fission model was formed by the partial separation of the Earth's crust, specifically the Pacific Ocean. At the time of its acceptance during the Apollo era in 1969 the model of plate tectonics and mid ocean ridges was still a hypothesis. A rapidly spinning viscous body that is required was discovered not to be dynamically possible, and its speed of 2.5 hours per revolution could not possibly slow to a 24 hour day in 4 billion years.

C. Currently Accepted Collision Model

The current collision model of the 1980s had the main objective of explaining the similarity in the density of the Earth's mantle and the Moon's density. Their common origin could also explain their similarity in oxygen isotopes found in their crusts. A strong selling point of this model is that a computer simulation of a proto-moon impact into the Earth produced a desirable outcome of an accreted Moon. However, this simulation required a rapid spin rate of the Earth in order to achieve adequate angular momentum for the orbiting Moon. This rapid spin rate has the same problems as were mentioned for the fission model. Another problem with this model is that the Moon rocks did not show signs of vaporization in its chemistry. Vaporization of materials in such a collision ~~would~~ is expected, but no lunar material had been subjected to temperatures in excess of 1200^0 K.

Thus far the Moon lacks water bearing minerals which contradicts the common origin idea, since Earth has an aqueous nature. Later Moon landings and probes have revealed that water exists on the Moon; however, it is believed to be just a surface dusting. A major dichotomy develops with these facts. On one hand, the similar densities and oxygen isotopes beg for a common source; and, on the other hand, the aqueous Earth minerals verses the very dry Moon beg for different places of origin. The collision hypothesis of this paper answers this dichotomy. Oxygen for both bodies can come from the same cloud in similar times. Differentiated water was not driven off by the heat of the proto-star because Earth originally resided in a farther, cooler orbit between Mars and Jupiter. More water was then added to Earth by the cold, ices of its major Impactor coming from the outer reaches of the solar system. A dusting of the water mineral on Moon's surface is possible due to some aqueous minerals being part of the collisional debris that followed Earth and was swept by the Moon after Earth started sharing Moon's orbit.

D. Capture Model

The capture model has the Earth and Moon forming as totally independent bodies, sharing only a gravitational bond. The Moon's unusually large size, its non-equatorial orbits, its comparatively larger orbital distance, and its tidally locked orientation all suggest a possible capture origin. This capture model is NASA's favorite storyline in their Evolution of the Solar

System.[o] The model fell from favor about 1984. The greatest difficulty is the dynamics of the capture event itself.

"This event is typically imagined as a freely moving Moon nearing the Earth and the gravitational power of the Earth literally slowing the Moon to the point that it becomes permanently "captured" into a geocentric or Earth centered orbit. The difficulty with this proposition is primarily the relative size of the Moon compared with the Earth. The kinetic energy of the Moon which would be required to be dissipated in order to facilitate a captured Moon is immense. It is felt that the capture event window would be too brief to allow this amount of energy to be dissipated from the lunar motion." [nnn] (http://lunarorigin.com/lunar-origin-models by Powell)

A possible solution to the slowing problem is the gas drag model[p]. This model utilized a combination of unusually dense gas and a considerable number of sizable planetisimals. A denser hydrogen gas was first used because gaseous disks of gas were discovered by telescopes around some T-Tauri stars. The sizable planetisimals were chosen to simulate what is currently known about the minor planets and other planetisimals in the Kuiper Belt. The conditions in the Kuiper Belt were felt to comprise other regions of the early solar system. Clumping was observed better without the dense gas for a computer run of 1000 years.

When the gas drag model was added to the dissipation slowing process, capture was still found to be too energetic for the Earth-Moon system. The new collision hypothesis of this paper also requires a capture mechanism. The falling Earth after being ejected from its original orbit gained orbital velocity near the Moon's orbital region and was captured by its close encounter with a body of similar orbital characteristics. Then their orbital velocities and shapes became synchronized over ~~a long~~some period of time that did not require a fast slow-down.

The orbital velocities and elliptical paths did not match, but were close enough for gravitational forces to interact. Over a definite ~~long~~ period of time of the Earth passing the slower Moon each orbit an impulse momentum exchange from the interacting gravity forces was created. This momentum exchange caused the ~~Moon to move farther from~~ Earth's velocity to decrease incrementally and lessen the elliptical shape of its orbit. ~~, to~~The passing Earth eventually matched the Moon's orbit. The Earth indeed had plenty of time for transferring kinetic energy and angular momentum ~~to the~~between itself and the Moon. The process took ~~as~~ a certain determined amount of~~many~~ orbits ~~as were required~~ to achieve synchronization of orbital velocity since the two bodies remained much closer to each other than today.~~tidal locking and the current orbital distance of the Moon from Earth.~~ This new capture model also addresses the nature of Moon's orbital plane not matching that of Earth's equatorial plane. There is no need for them to match since these bodies were not created from the same vortex in the nebular disk region or from any secondary accreting disk.

The synchronization of the Earth and Moon orbits where the Moon's orbit moves in a wavelike fashion using the Earth as a focal point of each wave is demonstrated by Earth's Trojan asteroid 3753 Cruithne. 3753 Cruithne is synchronized by exchanging a slower outer orbit with a faster inner orbit each time the faster Earth passes. The difference between the Moon and 3753 Cruithne is their masses. The gravitational pull between the Earth and Cruithne does certainly exchange kinetic energy, but not enough to align the two bodies to achieve similar orbital velocities over time like what happened to the Moon and Earth.

~~XIV.~~XV. NASA's Origin and Evolution of the Earth-Moon System

NASA's article: "SP-345 Evolution of the Solar System"; chapter 24,. Origin and Evolution of the Earth-Moon System º , makes some very interesting points that actually corroborate the new collision hypothesis of this paper. These points are expressed as 1) narrow limits of capture, 2) the accretion of existing satellites by the captured body, and 3) actual dating records of rocks providing the most direct information on time and type of Earth-Moon encounter.

A. Capture within Narrow Limits

"Capture requires that the body approach the planet in an orbit with parameters within rather narrow limits**.** Thus if a body approaches a planet in a random orbit, the chance that the approach will immediately lead to capture is very small. The most likely result of the encounter is that the body will leave the region of the planet with its orbit more or less changed. It is probably this fact which is behind objections to the capture theory." ººº

From the laws of Kepler, it is known that a body leaving the neighborhood of a planet after a close encounter will move in an ellipse bringing it back to the vicinity of the orbit of the planet, once or twice for every revolution. NASA in attempting to save their capture model claims a subsequent encounter will occur a "horrendously" large number of times, thereby increasing the probability of final capture to approach unity. NASA even cites a general theorem (with specific exceptions): "if two bodies move in crossing orbits and they are not in resonance, the eventual result will be either a collision or a capture." ººº There are indeed issues with this thinking. The "horrendously ~~im~~probable" capture mode in fact ~~increases~~ decreases its probability because the long elliptical trajectories of the already perturbed body become increasingly perturbed by the crossing of other orbital paths in the solar system. The "specific exceptions" alluded to are indeed ~~another~~ this issue. After numerous elongated elliptical orbits the chances increase that the body will be perturbed by other planets and be ejected to infinity or outside the solar system.

NASA's approach to the capture model accepts that the captured Moon is both in a random orbit and does not possess resonance with the Earth. In this paper's capture model the orbit is not random. Earth's orbit is nearly co-planar and almost parallel within a close encounter of an assumed 90,000 kilometers ~~of~~ from the Moon. The nearly concentric orbits over a very large number of orbits can then produce the necessary ~~resonance~~ synchronization for capture and the Moon orbiting the Earth.

B. Accreting Existing Satellites

The NASA article does make an excellent point that a close encounter of a large body can possibly accrete existing satellites that Earth may already possess. Two examples of this type of scenario are cited as Earth and Neptune. Neptune's unusual satellite, Triton, may have been captured and accreted other satellites that Neptune possessed. This accretion could have dissipated enough kinetic energy to allow its capture. This accretion scenario also gives reasons for Neptune's lack of regular satellites similar to the other outer giant planets. For the same reasons Earth lacks normal size satellites with normal orbits. This accretion model can be the reason for Moon's slowing velocity for its capture and for large craters and mares filled with lava. This idea adds to the possibility of energy dissipation, but still requires something more than a random Moon orbit for celestial mechanics to perform its task.

In the case of this paper's new capture model, possible existing satellites of Earth can supply more ~~impactors~~ Impactors for the Moon assuming that some of these satellites were carried along with Earth as it fell inward toward the Moon's orbit. These satellites along with collisional debris would then eventually be swept into the Moon. The possibility exists that the Moon may also have had one or more existing satellites of its own. These satellites would eventually be perturbed to either be ejected from the system or collide with the Moon or Earth. This type of satellite could provide the unusual large crater found on Moon's face away from Earth that occurred much later than the LHB time period.

C. Actual Dating Record

Any possible scheme of a capture model for the Moon and Earth can be taken lightly unless it can produce reasons for the actual dating record in the Earth's rocks, meteorites, the Moon's surface, and the incidence of meteorite impacts. Standard lunar history is based on Apollo landings that revealed isotopic dating of the Moon's highlands at 3.9 billion years ago with intense bombardment over the next 100 million years. The filling in and solidification of the mares occurred over the next several hundred million years. The formed mares were then evenly and lightly cratered from that time until the present.

The oldest materials discovered in the solar system, 4.6 billion years old come from the radiometric dating of meteorites found on Earth which are thought to come from the break-up of asteroids. This is consistent with the ages of the oldest-known terrestrial and lunar samples. The oldest minerals analyzed to date on Earth are zircon crystals that are 4.4 billion years old. These oldest materials were part of the primordial soup or source material for the planets and satellites that were uniformly mixed within the original solar nebula. Hence, the birth of our star and its system including the Earth is indisputably given as 4.6 billion years.[q]

A small listing of the most prominent evidence of this age is:

1. Rocks returned from the Moon (4.4 to 4.5 by);
2. Martian meteorites landed on Earth (4.5 by);
3. The tracks of high energy cosmic ray particle impacts;
4. Dating of the decay of the earliest terrestrial lead reservoirs (4.53 to 4.58 by);
5. Helio-seismic methods for dating the Sun. [qqq]

Any history of the early solar system must not only deal with its birth but with the Late Heavy Bombardment (LHB) period occurring 3.9 to 4.1 bya. This LHB period is confirmed by crater counting that includes studies of their accretion through density distribution, size ranges, velocities of their impacts, overlapping, re-melting characteristics, and the related sizes of the impacted body. This crater counting is then compared to the age of melted materials on the Moon caused by this LHB or runaway accretion. Studies from space probes confirmed that this period of heavy bombardment occurred on the Moon, Mars, Mercury, and possibly the satellites of Jupiter. It is assumed that the entire inner solar system was affected by this intense bombardment. Both the recent Nice Theory and this paper's new collision hypothesis attempt to address in different ways this unexpected chaos in the 600 million-year old solar system.

The Apollo Mission also dated the mare formations at 3.2 to 3.8 bya. Science has produced no adequate theory for a heat source that could produce liquid mare flows for this long period of time. The Moon is considered too small to have retained its primordial heat of formation for much longer than a few 100 ~~billion~~ million years. The LHB period would certainly have heated the Moon's surface to substantial depths, but differentiation and solidification would have occurred at a considerably shorter time than 600 million years. NASA research attempts to justify such a long term event by using a hypothesis that tidal heating caused this prolonged heating because the Moon's original orbital distance was much closer to Earth. This proposition is also what happened according to this paper's new collision hypothesis, but for a very short period of time. The Earth kept passing the Moon on each orbit until the Earth slowed to match the Moon's orbital velocity. The Earth and Moon could initially have been less than 90,000 kilometers apart which would have produced immense tidal heating that could have maintained the Moon's mares in a semi-molten state.

However, computations later in this paper indicate that this synchronization of orbital velocities occurred over a very short time of about 30,000 years. The time for the Moon to then orbit the Earth and find a stable orbit at about 240,000 km was very brief. Due to the current receding rate for the Moon the distance would have increased to about 270,000 km at 2.9 to 3.0 bya. This amount of distance would certainly cause greater tidal accelerations but not enough to maintain molten mares on the Moon.

NASA's articles state that a good possibility for the Moon's orbital evolution is the result of the Moon residing close to the Earth for a considerable time and at a distance of 5 to 10 Earth radii. Energy dissipation would then take place at a more modest rate not requiring more runaway accretion. Data from Apollo missions support this scenario. Additional collaboration comes from the Earth's geology. "The paucity of preserved sediments on the continents dating from this period and earlier could possibly be the result of the extensive and long-lasting tidal effects associated with this proposed lunar orbital evolution." [ooo] The hypothesis of this paper ~~also~~ partially supports this idea of lunar orbital evolution, but adds an additional energy or heat transfer to slow the Earth's velocity before their orbits become synchronized. This paper uses a computation that indicates the Moon's orbit was displaced very rapidly from its close encounter of 90,000 km to a larger orbit of 240,000 km. Intense tidal heating certainly did not last as long as 600 to 800 million years to keep Moon's mares semi-molten unless the depth of heating was very substantial for slowing the Earth.

Apollo exploration led to other interesting discoveries: the external magnetization of the Moon's crust, the large positive gravitational anomalies called mascons found inside major impact basins, and the low velocity or subsonic impacts related to efficient differentiation of the surface materials. A scheme for the Moon's orbital evolution must account for these facts.

During the first encounter and first series of passes of the Earth with the Moon in their newly shared orbit, major impacts occurred on the Moon due to the collisional debris and possibly some of Earth's own satellites that were brought along. The time period of 3.8 to 4.1 bya for this event is recorded in the age of the continent's oldest rocks called cratons, the radiometric ages of impact-melted rocks collected during the Apollo mission, and corresponding crater counting on Mercury and Mars. The ages of some meteorites and asteroids created during this period have yet to be confirmed.

The Earth after its collision in the Asteroid Belt still retained its internal dynamo of interacting solid and liquid iron core parts. Hence, the youthful, stronger magnetic field with its magnetosphere was carried into the Moon's environment after Earth was dislodged from its original orbit. This terrestrial magnetosphere would then envelop the Moon during each early pass and lightly magnetize the Moon's molten crust during its long period of continual bombardment and gradual solidification. It was found by the Apollo mission that the natural remnant magnetization of lunar rocks are in the age range of 4 to 3 billion years ago which accords with this idea. The Moon's crust was possibly heated for this length of time due to continuing but considerable less frequent impacts of planetisimals as the Moon swept clean the material brought into its environment by Earth over a period of several million years. ~~However, the~~A primary source of heat would have come from the tidal heating created between the Earth and Moon due to their initial proximity of 5 to ~~10~~ 15 Earth radii but only for a very short period of time. The new collision hypothesis computes a distance of 90,000 km or about 15 Earth radii~~.~~ According to this paper's calculations this initial close proximity only lasted about 30,000 years. After the Moon finally began orbiting the Earth shortly after the 30,000 years the new orbital distance became 240,000 km and continued to gradually increase to 270,000 km by 2.9 to 3.0 bya. The heat generated by tidal acceleration on the Moon's surface during that time period is not sufficient to maintain partially molten mares. Other heat sources are necessary such as continual impacts which do occur according to this new hypothesis. ~~It would have taken~~

~~several hundred million years for the exchange of kinetic energies and angular momentum to move the Moon to its present distance. By then the Moon would become tidally locked to the more massive Earth.~~

This new type of capture model being described also helps to explain the Moon's mascons, efficient differentiation of the Moon's regoliths, and the trend for very circular craters and impact mares. The regolith is an unconsolidated residual or transported material that overlies the solid rock. The regolith of the Moon is considered very ancient since little erosion or plate tectonics is available to keep churning it as happens on Earth. All these phenomena require ~~a~~ Impactors with subsonic relative velocity in order to prevent a net loss from impact craters and avoid a wide dispersion of a dense Impactor core. A low velocity impact can create the mascons found in the center of impact basins. Due to the Moon's low mass the mantle is cooler than and not as molten as Earth's. Its higher viscosity retained these low velocity ~~impactor~~ Impactor core materials in much their present form and at higher levels under the crust and mare lava reservoirs. Some major impact mares do not have mascons which can be explained by some ~~Impactors~~ Impactors not having very large, dense cores. There is no need to expect homogeneity of ~~impactor~~ Impactor compositions and cross-sections. Since the Moon possessed no plate tectonics or a large heat sink in the lower portions of its core, no migration of these mascons would ever take place.

The lower relative impact velocities are set-up by the Earth's capture mode where its company of planetisimals roughly paralleled the orbital path of the Moon and roughly equaled its velocity. This combination caused rather consistent lower relative impact velocities as opposed to any random trajectory of an Impactor encountering the Moon. For this reason other continuing impacts for the next several hundred million years would also have lower relative velocities as the Moon swept the environment clean.

A NASA article concludes from the regular distribution of secondary bodies in the solar system, that the Earth had an original satellite system prior to Moon's capture. Extrapolation from the Uranus system to Earth suggests that Earth should have had a group of perhaps half a dozen small bodies. The article discusses additionally that this group can be larger by ~~continuing~~ to adding a group obtained by using an extrapolation of the Martian system. Hence, Earth may originally have had a total of 5 to 10 normal satellites. The new collision hypothesis supports this idea only partially. The Martian satellites are irregularly shaped and possibly resulted from the debris of Earth's collision with ~~a rogue body~~ its Impactor in the Asteroid Belt. Earth's regular satellites at that time were either left stranded in the Asteroid Belt such as Ceres, were carried by Earth to the Moon's orbit, or ejected to other parts of the solar system.

~~XV.~~XVI. Summary of Apollo Mission Findings

A summary of the previous presented facts shows how the new collision model stacks up with NASA's most currently accepted collision model. NASA's capture model has fallen from favor, but has important ideas that are compared with the capture phase occurring soon after the preceding collision phase of this paper's hypothesis.

NASA'S Collision and Capture Models Supporting the Facts Revealed by the Apollo Mission	**New Collision Model with Post-Capture Supporting the Facts Revealed by the Apollo Mission**
1. Requires narrow limits of capture for a random orbit; not enough time for necessary energy dissipation.	1. Mode of capture provides ample time for synchronizing orbital velocities. The slowing problem is resolved.
2. The closer the encounter the more difficult are the limits for capture.	2. The predicted closeness of original orbits allows for ~~eventual tidal locking of the smaller body~~repeated impulse momentum of the passing Earth thereby reducing its orbital velocity gradually over time.
3. Accretion of all existing Earth satellites by the captured Moon is possible after initial accretion of collisional debris.	3. Accretion of some of Earth's satellites and some of the collision debris can occur after Earth carries these bodies into Moon's orbital region.
4. Oldest age of Moon and oxygen isotope dating ~~do not~~ match Earth's placing origins at ~~different~~ similar places and times.	4. Matching the Earth's and Moon's place and time ~~or~~ of origin is not required. The Earth was captured/formed in a different orbital region from the Moon and times for various isotopes ~~could~~ can be as different as 50 to 100 my.
5. Dating of Moon's intense cratering, Late Heavy Bombardment (LHB) at 3.9- 4.0 bya after the initial formation by accretion 4.6 bya is caused by events explained in the Nice Theory. The LHB is not correlated to the current collision model.	5. The LBH is directly the effect of Earth's collision with another large body. Evidence is the matching age of the oldest cratons found on Earth's continents. These original granitic basalts solidified close to 3.9 to 4.0 bya. This collision created most of the planetisimals that bombarded other parts of the inner solar system. Other major planetary impacts are possible such as with Mars, but perhaps a little later than the LBH period.
6. NASA has proposed that the remnant magnetization of Moon's surface was created by the stronger helio-magnetosphere and/or the Earth's magnetosphere during its re-melting and re-solidifying period.	6. The new collision model supports a very molten and more magnetized early Earth. The proximity of the Earth's magnetosphere could have very possibly magnetized the Moon's ~~reheated~~ re-melted surfaces after the LHB and after intense tidal heating and during the long term sweeping of smaller Impactors for 600 milliion years or more.

NASA'S Collision and Capture Models Supporting the Facts Revealed by the Apollo Mission	**New Collision Model with Post-Capture Supporting the Facts Revealed by the Apollo Mission**
7. The results of mascons centered in impact basins, and circular rims are subsonic velocity impacts. There are no substantial reasons for these low velocities.	7. The post-collision capture model definitely provides a mechanism for both slowing the Earth and its accompanying satellites and debris stream. Also, their orbital paths would match.
8. Lunar rocks of the mare formations indicate melted surfaces lasting from 3.8 to 3.2 / 3.0 billion years after the LHB. The explanation is tidal heating during Moon's orbital evolution.	8. This capture model does not provide~~s~~ enough period of time and close proximity of the bodies to create sufficient tidal heating for longer periods. ~~Tidal heating was even accentuated because Earth's velocity had to slow to match the Moon's.~~ The stream of collisional debris brought by the captured Earth could very likely been swept by the Moon over a long period of 600 million years causing continuing re-heated, re-melted, and re-solified surfaces.
9. The "crater counting" method for determining the ages of impacted surfaces on the Moon and Mars do not entirely match the LHB period.	9. The "crater counting" need not match for the Moon and Mars. Mars had a larger orbit which needed much more time to perturb, attract, and sweep collision debris from an orbital span as large as the Asteroid Belt. Debris from Earth's collision followed Earth and more quickly concentrated a stream of planetisimals toward the Moon.
10. There are striking differences in composition between the Earth and Moon including, those of the outer planets and their satellites. The nebular hypothesis requires that the proto-star disk be uniformly mixed. This conundrum is "either left unexplained or ascribed to ad hoc processes without theoretical basis" ooo	10. The new collision model relies on another hypothesis called "Supernova Seeding" that creates celestial bodies of all sizes including the seeds for stars. "Supernova Seeding" does not require ~~accretion~~ accretion and homogeneous mixing inside a proto-star disk to birth the planets and their satellites. "Supernova seeding" creates its own differentiation of materials in a series of explosions and intersections of shock fronts inside expanding supernova remnants. Any newly formed planets in close proximity with newly formed proto-stars may become planetary systems.

~~XVI.~~XVII. Summary of the Two Contending Collision Hypotheses

The following comparative table ~~summary~~ lists the basic differences between the current idea of a Martian size body striking Earth and then forming the Moon with the ejected debris materials verses the new idea of a less dense Martian size body striking Earth and re-locating it to another orbit where it becomes synchronized with the Moon.

Current Hypothesis of a Moon-Forming Collision	**New Hypothesis of an Earth Relocating after Collision and Subsequent Capture of the Moon**
1. Coefficient of restitution almost equal to 1 (elastic conditions).	1. Coefficient of restitution almost equal to 0 (inelastic conditions)~~.~~ due to a young molten Earth.
2. Materials of Impactor more rocky than volatile.	2. Materials of Impactor more volatile, but possibly having a small rocky/iron core.
3. Ejected materials of both Earth's crust and mantle and Impactor accrete to form orbiting Moon.	3. Ejected materials are minimal forming the Main Belt and other asteroids. ~~The inner solar system~~This ejected debris creates the Late Heavy Bombardment (LHB) 3.9 bya. Most Impactor material remains with the Earth.
4. Kinetic energy of Impactor converted mostly to the ejection of materials and heat and angular momentum for the Moon. (NASA in 2013 proposed that the collision also caused the Earth's tilted spin axis.)	4. Kinetic energy of Impactor converted mostly to tilting and relocating Earth to another orbit.
5. Impactor's source either resulted from reasons of the Nice Model or from a Lagrangian Trojan satellite.	5. Impactor's source due to its size required a source outside the already formed mature solar system or a planetary object perturbed into an elongated elliptic orbit with a long period of return.
6. Does <u>not</u> explain or provides only a weak explanation:	6. Does help to explain:
a. Required angular momentum for the Earth-Moon system unless one accounts for a very rapidly spinning Earth.	a. The captured Earth gradually matches the Moon's orbital parameters. The already orbiting Moon ~~has~~ is thesource of the required angular momentum.
b. Creation of drifting continents and plate tectonics.	b. The expelling of mantle and Impactor materials to form continents and bloat the Earth to crack its existing young crust.

Current Hypothesis of a Moon-Forming Collision	**New Hypothesis of an Earth Relocating after Collision and Subsequent Capture of the Moon**
c. The Earth's axis tilt of 23 degrees. (NASA in 2013 proposed that the collision caused the Earth's tilted spin axis.)	c. Impact energy, the unbalance of captured material, and change in the center of gravity caused a tilt of the spin axis from the natural ecliptic.
d. Volcanic hot spots randomly occurring on the Earth's surface.	d. Provides the trapped volatiles to expel through the crust at random locations and times and over long periods of time.
e. Ages of the oldest rocks on the Moon and Earth do not exactly agree with the age of the oldest meteorites, the age of the solar system.	e. The ages need not agree since the Moon's rocks and Earth's oldest rocks on the continents can have differences of 50 million years or more ~~million years~~.
f. The Moon's iron core and faint residual magnetism of surface rocks is thought to be the result of an earlier stronger helio-magneticsphere.	f. The Moon as a typical planet can have an iron core and magnetic properties that were mostly destroyed during the LHB period. The remnant magnetization is due to the original close encounter with Earth during its period of having a very strong magnetosphere field.
g. Unexplainable differences in various isotopes between the Moon and Earth.	g. There is no need to explain these differences because the Moon can form at a different span of time during solar system formation.
7. The collision model has problems needing adequate material to form the Moon without destroying the Earth in the impact, but having enough energy to provide enough debris with escape velocity.	7. The model can demonstrate a plausible scenario with calculations that transfers energies during the impact, the Earth falling into a new orbit, and the evolution of the Earth-Moon system to present day conditions.

~~XVII.~~XVIII. New Collision Model Supported by Calculations

A. Abstract for the Earth's Metamorphosis (EMM) Model

This mathematical modeling starts with the following question. What size of an Impactor or Rogue Planet and its initial velocity is required to knock planet Earth from an orbit in the Main Belt of Asteroids to the Moon's orbit?

Assume that an Impactor between the size and mass of Ganymede and Mars struck the Earth when it originally resided in an orbit roughly the mean average of the present asteroids orbiting between Mars and Jupiter. Further, assume that the Earth's original orbital velocity was close to the current average orbital velocity of the asteroids.

Assume that most of the original Impactor's mass is added to the Earth's less some small mass for the ejected debris. This debris becomes the largest portion of the Main Belt asteroids' mass. The factor of four times this amount of debris is imposed to account for the other collisional debris that struck Mercury, the Moon, and Mars. Some of this debris may have become parts of the irregular orbiting asteroids outside the Main Belt, the Trojan asteroids in Jupiter's orbit, the moons of Mars, and collisions with the Sun and other planets. The volume of the Impactor is a calculated value after choosing a typical mean density from other solar system objects of similar ~~size~~mass.

The remaining partially assumed, but calculated value~~s~~ ~~are~~ is the velocity of the Impactor and the velocity of the Earth immediately after impact to create a synchronous orbit with the Moon at one astronomical unit, AU, from the Sun. Assume that the resulting velocity vector after impact was toward the Sun at an oblique angle and still in the ecliptic plane where the Earth orbited originally.

~~Naturally, the~~The following conservation of energy and momentum equations assume impact losses, ~~of~~ about 10 % of the total energy transferred. These losses are the energy required to aid in tilting the Earth, the energy to increase material pressures to penetrate the Earth's crust and mantle; energy to create noise, light, heat; and the kinetic energy to disperse the collisional debris.

The conservation of momentum equation for less than perfect inelastic collision such as an ice ball thrown at a snowman and penetrating it determines the resulting momentum vector and new velocity of the combined bodies. The conservation of energy equation sums the "before and after" kinetic and potential energies of the bloated Earth with its Impactor inside its mantle as it moves from its original orbit between Mars and Jupiter to its present orbit in the solar system. The new velocity of the impacted Earth immediately after impact is determined from the conservation of momentum equation and then used in the conservation of energy equation.

B. Values for Equations

1.	Earth's original mass before collision equals the Earth's current mass - less the Impactor's mass.	5.72 x 10^{24} kg
	(Earth's current mass)	5.97 x 10^{24} kg [r]
2.	Estimated total mass of dispersed debris created from the impact.	0.012 x 10^{24} kg
	(NASA's estimate of Main Belt asteroids' mass)	0.003 x 10^{24} kg [s]
3.	Avg. orbital velocity of bodies in the Asteroid Belt and the original orbital velocity of Earth.	18.5 km/sec [sss]
4.	Assumed mass for the Impactor	0.25 x 10^{24} kg = .25/5.97 = .042 of Earth's mass
	(Ganymede's mass of mostly ices – for reference)	0.15 x 10^{24} kg [t]
	(Mars' mass, which is 0.107 of Earth's – for reference)	0.64 x 10^{24} kg [rrr]
5.	Assumed velocity of Impactor prior to collision (see Impact Velocity Calculation)	45 km/sec
	(Orbital speed of Mars – for reference)	24 km/sec [rrr]
	(Fastest impacts occurring on Earth – for reference)	70 km/sec [u]
	(Impact velocity of Comet Shoemaker-Levy 9 with Jupiter – for reference)	60 km/sec [v]
6.	Assumed density of Impactor (this density indicates an iron core with a crust and outer mantle of mostly ices with a smaller silicate inner mantle)	2.500 g/cm^3
	(Ganymede's mean density for reference)	1.936 g/cm^3 [ttt]
	(Io's mean density for reference):	3.528 g/cm^3 [ttt]
	(Mars' mean density for reference):	3.934 g/cm^3 [rrr]
	(Common densities for reference: 1.00 for water; 2.7 for granite; 7.8 or iron; 5.52 for Earth; 13.0 for Earth's core) [w]	
	(see Table of Comparative Data for Solar System Objects for selecting Impactor parameters)	
7.	Volume of Impactor (determined by chosen density and mass)	10.0 x 10^{10} km^3
	Volume of Earth	108 x 10^{10} km^3
	(Volume of Mars is 16.3 x 10^{10} km^3; and Ganymede is 7.6 x 10^{10} km^3 for reference)	
8.	Distance between Earth's original and current orbits = (2.7 – 1.0) AU = 1.7 AU x 149 x 10^6 km / AU	2.53 x 10^8 km [sss]
9.	Assumed distance between Earth's ~~current~~ initial and Moon's original orbits = 0.~~24~~ 234 x 384,400 km (Moon's current distance)	~~92,400~~90,000 km
10.	Sun's current mass	1.99 x 10^{30} kg [rrr]
11.	Moon's current mass	7.34 x 10^{22} kg [rrr]
12.	Earth's and Moon's current orbital velocity	30 km/s [rrr]
13.	Gravitation constant (G)	6.674 x 10^{-11}

		$m^3kg^{-1} sec^{-2}$ or 6.674×10^{-11} $(Nt)m^2 kg^{-2}$ or 6.674×10^{-20} $km^3 kg^{-1} sec^{-2}$
14.	One AU = distance between Earth and Sun	1.49×10^8 km
15.	Conservation of momentum equation for a perfectly inelastic collision	$m_1 (u_1) + m_2 (u_2) = (m_1 + m_2) (v)$
16.	Kinetic energy equation	K.E. = K = $\frac{1}{2} m v^2$
17.	Potential energy equation	P.E. = $U_g = - G (m_1)(m_2) / (\Delta$ Radius)
18.	The conservation of energy used for the Earth with its captured Impactor falling from the orbit between Mars and Jupiter to its current orbit	Sum of energies = $K_0 + U_{g0} = K_f + U_{gf}$ where $K_0 + U_{g0}$ = energies of combined bodies near asteroid Main Belt orbit and $K_f + U_{gf}$ = energies of combined bodies near Earth's current orbit

C. Explanation of Assumptions

1. The Earth's original mass before collision is based simply on the difference of Earth's current mass and the assumed mass of the Impactor. The Impactor is assumed to penetrate and add most of its mass to Earth's mass.
2. The estimated cumulative mass of debris from the impact is more than the cumulative asteroid Main Belt mass of 0.003 to 0.0036 x 10^{24} kg [x] determined by a NASA survey and extrapolations. This Main Belt mass does not include the other asteroid masses that struck the Moon, fell back to Earth, possibly contributed to the Trojan asteroids of Jupiter, and other highly elliptical/inclined asteroids. Hence, more mass is added to the Main Belt mass and is assumed as a factor of 4 times more. However, this mass summation of 0.012 x 10^{24} kg is still negligible when compared to the total masses of the Earth and the Impactor. Therefore, this mass is ignored in the following calculations where the conservation of momentum and conservation of energy are utilized.

3. The Earth's original orbital velocity is assumed and chosen from the estimated average orbital speed of the asteroids found in the Main Belt. The velocities of the two largest asteroids, Ceres and Vesta are 17.88 km/s and 19.29 km/s, respectively [sss]. The assumed orbital velocity falls between the adjacent orbital velocities of Mars at 24 km/s [rrr] and Jupiter at 13 km/s[rrr]. It is sensible to choose 18.5 km/s as Earth's original velocity because any body at this orbital radius has a similar orbital velocity whether it existed in the distant past or in the present.
4. The choice of the assumed mass of the Impactor is more difficult. In combination with the value of its velocity, enough momentum diverts vectorally the original Earth's momentum from its original orbit into an inward trajectory that falls far enough to increase its velocity sufficiently for an inner orbit.~~before~~ Its ~~its~~final velocity vector must come~~s~~ very close to a tangent line with the Moon's orbit, and at the same time achieve~~s~~ approximately the Moon's orbital velocity.

   The hefty mass of Mars could be chosen first since certain academic theorists had no qualms using it to strike Earth and create debris that then accreted to form the Moon. My scenario is quite different and need not account for enough mass to create the Moon; but, Impactor momentum needs to be sufficient to divert Earth from its given orbit. The composition of the Impactor is also very different from Mars being made primarily of ices and silicates as opposed to a majority of rocky materials needed to make the Moon.

   The selection of ~~this~~ the assumed mass and density should be reasonably comparable to known ice/rocky bodies in our solar system. Two comparable bodies are Jupiter's moon, Ganymede, with a mass of 1.48×10^{23} kg and a mean density of 1.936 g/cm^3 [ttt] and Mars with a mass of 0.64×10^{24} kg and a mean density of 3.934 g/cm^3 [rrr]. Considerations for the volume and size of the Impactor are based on having a smaller mass and less density than Mars. The Impactor's mass of 0.25×10^{24} kg was selected by making a comparison study of various celestial bodies. See the Table of Comparative Data for Solar System Objects.
5. The assumed velocity of the Impactor is also a tricky choice. The value needs to provide sufficient momentum (m x v). The orbital velocity of Mars, the next inner planet to the Earth's original position, is 24 km/sec. The fastest orbital velocity for a planet is 48 km/sec for Mercury. The velocity of impact for Comet Shoemaker-Levy 9 was 60 km/sec [vvv]. These velocities can provide some guidance. Perhaps its normal orbital velocity was between 25 and 35 km/s; then it is assumed that the Impactor accelerated to 40 to 50 km/s as it was falling toward Earth.

   One possible scenario is that a large Neptunian-size rogue planet became captured and/or perturbed into a long elliptical orbit that crossed the Main Belt orbital path. One of its own larger satellites struck the Earth. The combined velocities of both the planet and the satellite could have created an unusually high overall velocity.

Another perhaps more accurate line of thought comes from the study of impact velocities. On Earth, ignoring the slowing effects of travel through the atmosphere, the lowest impact velocity with an object from space is equal to the gravitational escape velocity of about 11 km/s [uuu]. The fastest impacts occur at more than 70 km/s, calculated by summing the escape velocity from Earth, the escape velocity from the Sun at the Earth's orbit, the escape velocity from the Impactor if sufficiently large, and the motion of the Earth around the Sun [uuu]. During the early stages of the Earth's formation there was less atmosphere to slow an incoming object. Refer to the Calculation of Impact Velocity.

6. The assumed composition is more ice than rocky materials that is comparable to the make-up of Jupiter's moon, Ganymede. Its density is chosen to match an icy moon as opposed to a terrestrial planet. Hence, the density falls between Ganymede's 1.94 g/cm^3 [ttt] and the Moon's 3.34 g/cm^3 [rrr], but closer to Ganymede's density.
7. The Impactor's volume is simply the result of its chosen density and mass. However, this volume should have reasonable proportions to the volume of Earth, since most of the Impactor is embedded inside the Earth's mantle.
8. The assumed original orbital radius of 2.7 AU for Earth was determined to be close to the values of the two largest asteroids: Ceres at 2.77 AU [sss] and Vesta at 2.36 AU [sss] and fall between the orbital velocities of Mars and Jupiter.
9. It is assumed that the Earth did not align perfectly with the Moon's orbit when it was re-located. Otherwise, a collision would occur. The Moon was closer at 90,000 km ~~than today~~ during its first encounter with Earth. Angular momentum and energy was transferred between the two objects in various steps in order to move the Moon to its present orbit around Earth and make the Earth's orbit more circular and slower. A change of distance between the two bodies was computed that eventually reduced the calculated Earth's velocity of ~~31.7~~ 35 km/s ~~as~~ when it reached the Moon's orbit to today's orbital velocity of 30 km/s.
10. The energies expended in the collision include those that make noise, light, and heat; disperse debris into space; compress and/or displace both bodies' mantles; reduce the rotations of both bodies, tilt the spin axis, and most importantly the change in orbital radius and orbital directions. The conservation laws will only consider the change in orbital radius ~~directions~~ and velocity vectors and choose an assumed factor of 10 % losses for all the other energy expenditures. This factor of losses is the largest question in this list of assumptions and perhaps can be estimated better with more accurate calculations in the future.
11. The impact angle with respect to the Earth's surface is between zero and 20 degrees so that little angular momentum is transferred to alter spin of the Earth. Hence, only linear momentum is used for the momentum conservation calculation.
12. The Earth's tilt of its spin axis ~~primarily~~ is caused by the imbalance of the much lighter Impactor materials embedded inside the Earth's mantle offsetting the center of gravity and ~~not~~ by some assumed~~the~~ initial impact energy. The Earth's gyroscopic motion helps

to preserve its original spin axis. However, over a very short time this imbalance of the two different spinning masses causes the overall spin to seek equilibrium and tilt the axis by 23 degrees with respect to the ecliptic plane. The tilt is stabilized by the aid of the Moon's external gravity field after the two planets begin to share one orbital region. Diagram G helps explain the phenomenon of an imbalanced spinning mass seeking equilibrium.

I hope that these assumptions have not veered too far from the truth so that a plausible model develops to re-create this catastrophic event of our genesis story involving the Earth and Moon system. In fact, an important part of science is understanding uncertainty. When scientists say we know something, we mean we have tested our ideas with a degree of accuracy over a range of scales. Scientists also address the limitations of their theories and try to define and extend the range of applicability. If the method here is properly applied, similar but even more accurate results should emerge over time. This model with all its assumptions bravely attempts to address all the more important enigmas about the Earth-Moon system starting with one simple idea. The model incorporates all the necessary scientific disciplines of astrophysics, planetary science, geology, and non-computerized mathematics.

It is our responsibility to push reason as far as we can. Far from being isolating, a rational, scientific way of thinking could be unifying. Evaluating alternative strategies; reading data, when available; understanding hidden meanings of the space and sky explorations; and, understanding their uncertainties – all features of the scientific method – can help us find the right way forward.

D. Table of Comparative Data for Solar System Objects

Object	Volume 10^{10} km^3 (Earth's)	Mean Radius km (Earth's)	Density g/cm^3	Mass 10^{24} kg (Earth's)	Features
Ganymede [ttt]	7.6 (0.0704)	2634	1.94	0.148	Fe/FeS core; outer ice mantle; inner silicate mantle; fully differentiated.
Pluto [rrr]	0.639 (0.006)	1153 (0.18)	2.03	0.013 (0.00218)	50% ice 850 km tk. and 50% rock; has N_2, CH_4, and CO_2 ices.
Ceres [sss]	0.048	487 (0.076)	2.08	0.0009 (0.00015)	Water ice 100 km tk. with rocky core; ½ mass of asteroid main belt.
Moon [rrr]	2.19 (0.020)	1737 (0.273)	3.34	0.073 (0.0123)	Has mafic mantle and iron liquid and solid core; 2nd densest satellite in solar system behind Io
Io [ttt]	2.53 (0.023)	1821	3.53	0.089 (0.015)	Fe/FeS core; outer silicate crust; partially molten silicate mantle.
Mars [rrr]	16.32 (0.151)	3398 (0.533)	3.97	0.64	Fe/S core; silicate mantle; Earth's crust averaging 40 km is

					only 1/3 as thick as Mars' crust.
Earth [rrr]	108.3	6378	5.52	5.97	Fully differentiated with N_2 and O^2 atmosphere and liquid H_20.

E. Choosing the Parameters for Earth's Impactor

The table above provides a ~~study~~ brief study of asteroids, moons, and dwarf planets. From their characteristics the Earth's Impactor parameters are selected due to the range in sizes. The Impactor is assumed to be a normal or average celestial body presently found in the solar system or any other star system for that matter.

1. The ranges of sizes are Ganymede's radius of 2634 km to Ceres and Enceladus radii of 487 km and 252 km [ttt], respectively [sss ttt]. Mars' size of 3398 km is also in the running [rrr].
2. Typically the volumes of these bodies range from 0.006 to 0.070 Earths.
3. The maximum mean densities are about 3.34 g/cm^3 for the Moon, Io, and Europa [rrr ttt]. The average densities are around 2.0 g/cm^3 reflecting large mantles of ices and silicates with a rocky core or small iron core. Objects with densities between 1.6 and 1.0 g/cm^3 are composed mostly of ices and are the least differentiated.
4. Typically, bodies with lower densities have ~~thei~~r compositions ~~are~~ with smaller iron/iron sulfide/sulfur cores and with inner silicate mantles and outer ice mantles. The crusts are generally ices, except for the denser bodies that have rocky surfaces with traces of atmosphere. The outer ices are composed of the most common elements and compounds in the solar system: O_2, N_2, H_20, CO_2, NH_3, and CH_4. [sss ttt]

In order to provide enough kinetic energy to knock Earth into another orbit, but not too much energy to completely destroy the very molten, young Earth, the Impactor parameters were chosen to be:

Mean density = 2.50 g/cm^3,
Volume = 10.0 x10^{10} km^3,
Radius = 2880 km,
Mass = 0.25 x 10^{24} kg
Composition = soft small iron/iron sulfide core; molten silicate mantle of 1750 km radius and an outer mantle of hard ices.

~~These parameters must provide enough kinetic energy to knock Earth into another orbit, but not too much energy to completely destroy the very molten, young Earth.~~

F. Impact Velocity Calculation

A planetary impact velocity is the sum of the escape velocity from Earth, the escape velocity from the Sun at the Earth's orbit, the escape velocity of the impacting body if sufficiently large, and the motion of the Earth around the Sun. Hence,

$v_{e\text{-}Earth}$ = Earth's escape velocity = 11.2 km/s
v_{Earth} = Earth orbital speed = 18.5 km/s at 2.7 AU from the Sun
$v_{e\text{-}Sun}$ ≈ Sun's escape velocity ≈ 26.3 km/s at 2.7 AU from the Sun

$v_{e\text{-Impactor}} = \sqrt{(2GM/r)}$ where: G = gravitational constant;
M = mass of Impactor; and
r = radius of Impactor

$= \sqrt{(2 \times 6.674 \times 10^{-20}\ km^3\ kg^{-1}\ s^{-2} \times 0.25 \times 10^{24}\ kg / 2850\ km)}$

$= \sqrt{(11.82)}\ km^2/s^2$

$= 3.43$ km/s

v_I = impact velocity

$= \sqrt{[(v_{Earth})2 + (v_{e\text{-Earth}} + v_{e\text{-Sun}} + v_{e\text{-Impactor}})^2}$~~],~~]; the ~~sinc~~e Earth's orbital velocity is assumed to ~~be~~ be 90 degrees to the impact velocity; hence the two vectors are added. ~~90 degrees to the impact velocity~~.

$= \sqrt{[(18.5)^2 + (11.2 + 26.3 + 3.4)^2]}$ km/s

$= \sqrt{(342 + 1673)}$ km/s

$= 44.9$ km/s

Hence, 45 km/s becomes the Impactor's impact velocity. This velocity seems to be a reasonable value when comparing it with other known impact velocities.

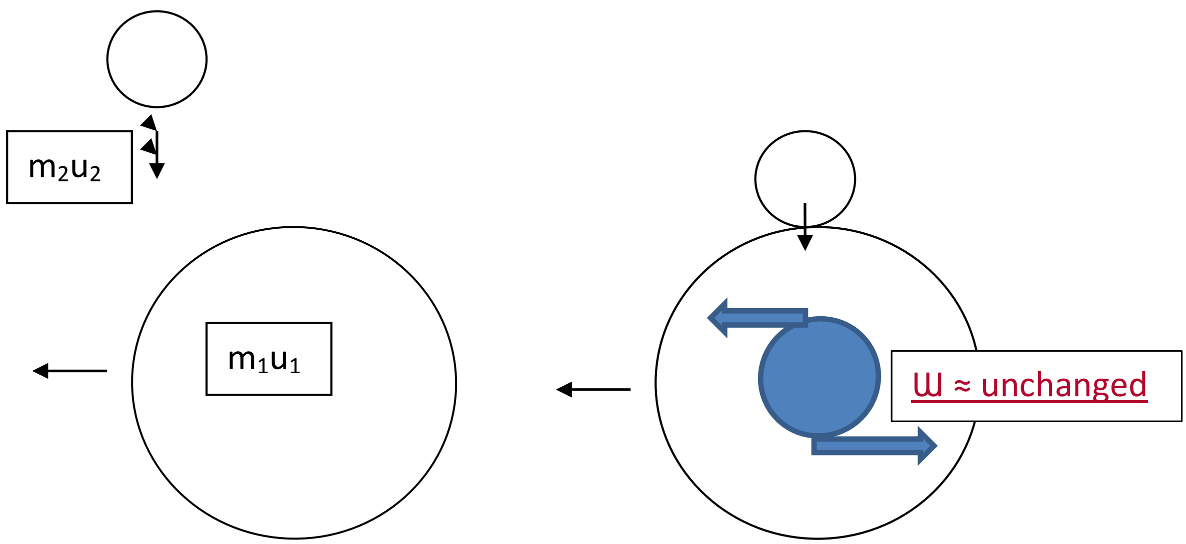
G. Calculations for the Collision Impulse and Linear Momentum Change

A sizable object called the Impactor strikes the Earth and embeds itself inside the Earth's mantle causing a resulting change in the linear momentum of the combined objects. Various linear momentums equal to the mass of the body (m) times the velocity of the body (u or v) are calculated. The impulse of collision is equal to the force times the length of time the force acts (F x t). However, the impulse will be determined by setting F x t = change in momentum = m (v_t – v_o)~~ where v_o is equal to zero~~. The original momentum of the Impactor is set equal to m_2u_2. The original momentum of Earth is set equal to m_1u_1.

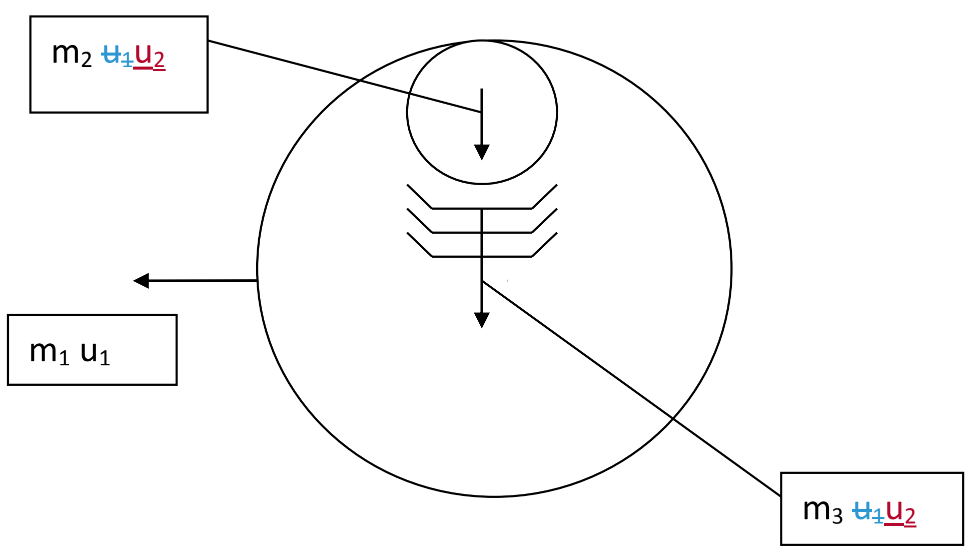
The impulse of the ~~impactor~~ Impactor completely penetrating the Earth's crust and mantle is estimated to be equal to m_2u_2. The impulse of the Earth's mantle being displaced by moving downward and mostly sideways is estimated to be equal to m_3u_2. The Earth's displaced mantle mass, m_3, is set equal to the Earth's mantle density times the Impactor's volume. The following Diagram A graphically represents the resolution of these momentum vectors.

Diagram A: Resolving Impulse of Impact and Momentum Vectors

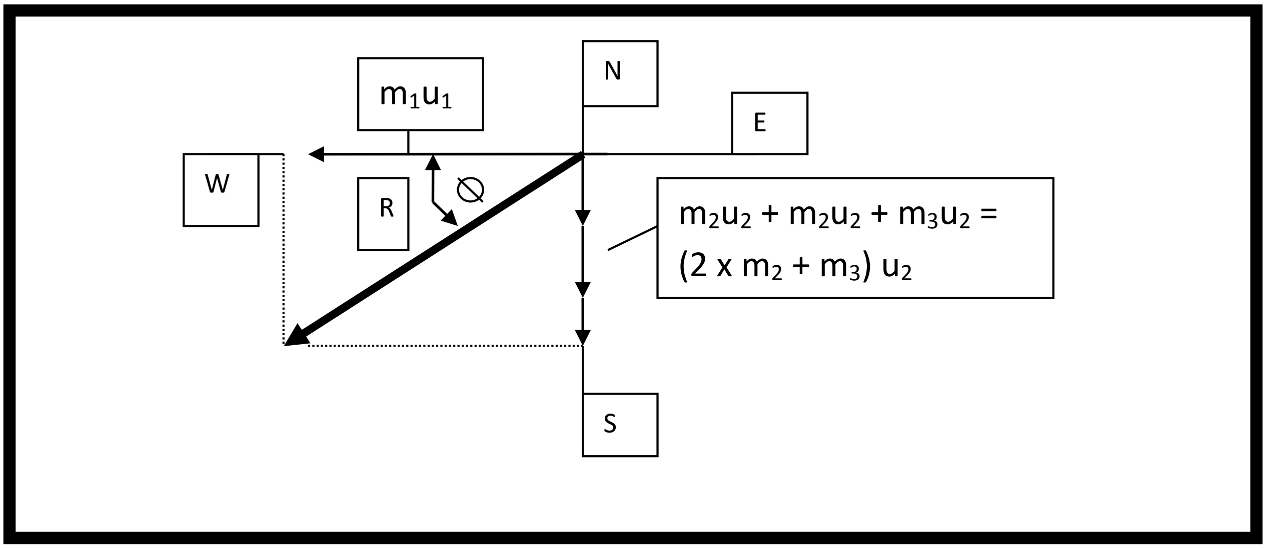
Condition before Impact:



Condition at End of Impact:



Resolution of Vectors:



m_1u_1 = $(5.97 – 0.25) \times 10^{24}$ kg x 18.5 km/s = Earth's momentum
= 5.72×10^{24} kg x 18.5 km/s
= 105.8×10^{24} kg km/s

m_2u_2 = 0.25×10^{24} kg x 45 km/s = Impactor's momentum
= 11.25×10^{24} kg km/s

V_2 = the volume of the Impactor
= m_2/σ_2 (mass/density)
= 0.25 kg x 10^{24} kg/2.50 g/cm^3
= 10.0×10^{10} km^3 (Ganymede is 7.6×10^{10} and Mars is 16.3×10^{10})

r_2 = radius of Impactor = $^3\surd[(3/4\pi) x\ V_2]$
= $^3\surd[0.239 \times 0.100 \times 10^{21}\ m^3]$ = $^3\surd[0.239 \times 10^{21}\ m^3]$
= 0.288×10^7 m
= 2880 km (Ganymede is 2634 km and Mars is 3398 km)

m_3 = $\sigma_1 \times V_2$ (average density of Earth's upper and lower mantle x volume of Impactor)
= $[(5.6 + 3.4)/2] \times 10.0 \times 10^{10}$ km^3
= 4.5 g/cm^3 x 10.0×10^{10} km^3 = 0.45×10^{24} kg

m_2u_2 = impulse to compress and push Impactor into Earth's mantle ≈ Impactor's original momentum
= 0.25×10^{24} kg x 45 km/s
= 11.25×10^{24} kg km/s

m_3u_2 = impulse to displace and/or compress Earth's mantle to make room for the Impactor volume

$= 0.45 \times 10^{24}$ kg x 45 km/s
$= 20.25 \times 10^{24}$ kg km/s

Resolving the components of linear momentum:

The north-south components of momentum after factoring 10% energy losses add to:

$\sum M_{ns}$ = 0.9 (11.25 + 11.25 + 20.25) kg km/s = 38.48 kg km/s

The east-west components of momentum after factoring 10% energy losses add to:

$\sum M_{ew}$ = 0.9 (105.8×10^{24}) kg km/s = 95.22 kg km/s

R = the resultant linear momentum
$= \sqrt{[(95.22)^2 + (38.48)^2]} = \sqrt{[10{,}548]}$
$= 102.7 \times 10^{24}$ kg km/s

v_R = resultant velocity of combined Earth and Impactor
$= R/(m_1 + m_2)$
= (102.7×10^{24} kg km/s) / ($5.97 \times 10_{24}$ kg)
= 17.20 km/s

Direction of R: tan Θ = 38.48/95.22 = 0.404

Θ = 22 degrees pointing inward from its present orbit and co-planar with the other planetary orbits.

The new resultant velocity with it inward direction needs to meet the restrictions of the Sun's gravitational field. Hence, the following concepts are discussed.

v_c = orbital velocity
$= \sqrt{(gr)}$
= lowest possible orbit which is circular where g is the acceleration of gravity and the orbital radius is r. [y]

v_e = escape velocity
$= \sqrt{2} \times v_c$
$= \sqrt{(2gr)}$
$= \sqrt{(2GM/r)}$
= minimum orbital velocity for an open orbit which has either a parabolic or hyperbolic trajectory. G is the gravitational constant and M is the Sun's mass. [yyy]

v_o = any velocity for closed elliptical or circular orbit where: $v_c \leq v_o < v_e$

Hence, ~~V_F~~ V_R for the new trajectory of this impacted Earth needs to meet this restriction; otherwise, the Earth will keep falling into the Sun or escape the solar system via an open orbit. When the impacted Earth comes close to the Moon's orbit it needs to be higher but closer to the value of V_C in order to retain an elliptical (almost circular) orbit with the Moon's orbit.

Refer to the plotted graph, Diagram B, which shows roughly to scale the inward spiraling trajectory and the source of some of the data used in the next set of calculations. Different points are selected along Earth's trajectory as shown in Diagram B. Energy conservation calculations are made for Earth's motion between each of the selected points #1 through #4.

The new trajectory of Earth brings it approximately 0.4 AU closer to the Sun at the intersection of its tangent line with a radius line from the Sun. At this point #1 escape velocity from the Sun's gravity is:

$$
\begin{aligned}
V_{e1} &= \sqrt{(2GM/r_1)} \\
&= \sqrt{(2GM)} \times \sqrt{(1/r_1)} \text{ where } r_1 = 2.7 - 0.4 = 2.3 \text{ AU} \\
&= \sqrt{(2 \times 6.674 \times 10^{-20} \text{ km}^3 \text{ kg}^{-1} \text{ s}^{-2} \times 1.99 \times 10^{30} \text{ kg})} \times \sqrt{\{(1/2.3\text{AU}) \times (1\text{AU}/149{,}597{,}870 \text{ km})\}} \\
&= \sqrt{(26.563 \times 10^{10} \text{ km}^2 \text{ s}^{-2}} \times \sqrt{(0.292 \times 10^{-8})} \\
&= \sqrt{(5.154 \times 10^5)} \times (0.539 \times 10^{-4}) \text{ km/s} \\
&= 27.8 \text{ km/s}
\end{aligned}
$$

At this same point #1 orbital velocity from the Sun's gravity is:

$$
\begin{aligned}
V_{c1} &= v_{e1} / \sqrt{(2)} \\
&= (27.8 \text{ km/s}) / 1.414 \\
&= 19.66 \text{ km/s}
\end{aligned}
$$

The Earth has fallen closer to the Sun by 0.04 AU at point #1. The conservation of energy is applied by summing the potential and kinetic energies before and after.

$$
\begin{aligned}
\sum E_i &= (K + Ug)_i \\
&= \text{sum of energies at initial point} \\
\sum E_1 &= (K + Ug)_1 \\
&= \text{sum of energies at point \#1}
\end{aligned}
$$

Hence:

$$
\begin{aligned}
\cancel{\sum E_i} &\cancel{= (K + U_g)_i} \\
&\cancel{= \sum E_1} \\
&\cancel{= (K + U_g)_1}
\end{aligned}
$$

$K_1 = K_i + (- U_1) - (-U_i)$

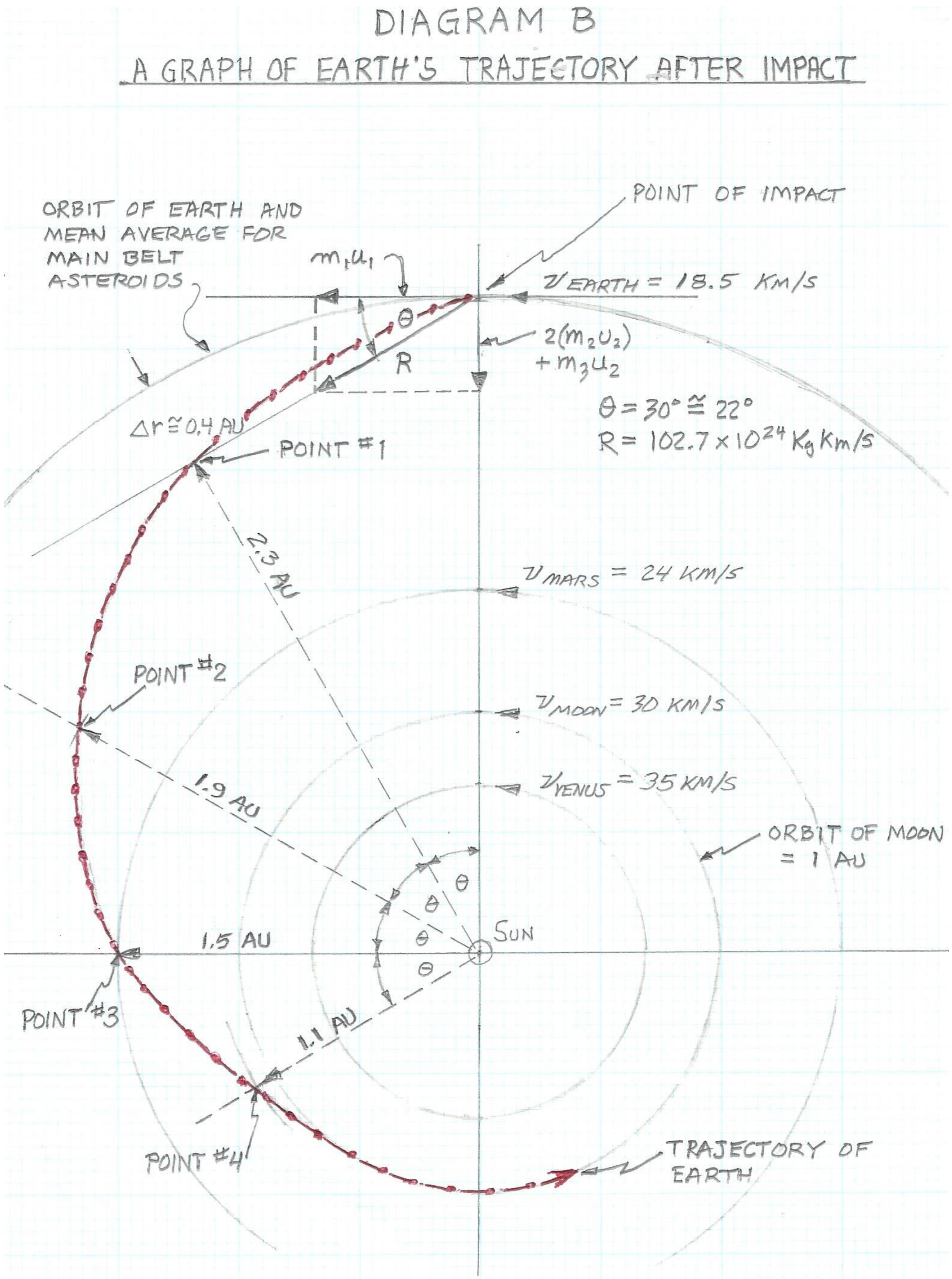
Then: $\cancel{K_i = K_1 + (-U_g)_1 - (-Ug)_i}$

$\frac{1}{2} m(v_1)^2 = \frac{1}{2} m(\cancel{v_i} v_R)^2 + \cancel{(-GMm/r_i)} (-GMm/r_1) - (-GMm/r_R) \cancel{= \frac{1}{2} m(v_1)^2 + (-GMm/r_1)}$

Canceling the "m's" and solving for "v_1" yields:

$v_1 = \sqrt{[\, v_R^2 + 2\,GM\,(1/r_1 - 1/r_R)\,]}$

Diagram B: A Graph of Earth's Trajectory after Impact



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Solving for v_1 = velocity at point #1 after canceling the "m" values :

v_1 = ~~$\sqrt{2} \times [- \sqrt{GM/2.7\ AU} + \sqrt{GM/2.3\ AU}] + \sqrt{17.20\ km/s}^2$~~

$= \sqrt{ [(17.2)^2 + (2 \times 6.674 \times 10^{-20}\ km^3\ kg^{-1}\ s^{-2} \times 1.99 \times 10^{30}\ kg) \times (1AU/149{,}597{,}870\ km) \times (1/2.3\ AU - 1/2.7\ AU)] }$

v_1 ~~$= 1.414 \times [- \sqrt{(6.674 \times 1.99 \times 10^{10})/(4.023 \times 10^8\ km)}$~~

~~$+ \sqrt{(13.28 \times 10^{10}) / (3.427 \times 10^8\ km)}] + 17.2\ km/s$~~

~~$= 1.414 \times [- \sqrt{330.1} + \sqrt{387.5}] + 17.2\ km/s$~~

~~$= 1.414 \times [-18.17 + 19.6] + 17.2 = 2.1 + 17.2\ km/s$~~

$= \sqrt{ [296 + (1775 \times \{ 0.4348 - 0.3704 \})] } = \sqrt{ [296 + 114.3] }$

= ~~19.3~~ 20.26 km/s

v_1 is ~~less~~ more than orbital velocity at point #1, and, hence, the displaced Earth continues to fall inward on a spiral path.

The Earth at point #1 continues to fall toward the Sun at v_1 = ~~19.3~~ 20.26 km/s. Point #2 is chosen where the Earth has fallen another 0.4 AU closer or 2.7 AU – 0.8AU = 1.9 AU from the Sun. The escape velocity is now:

$$
\begin{aligned}
v_{e2} &= \sqrt{2GM/r_2} = \sqrt{2GM} \times \sqrt{1/r_2} \text{ where } r_2 = 2.7 - 0.8 = 1.9\ AU \\
&= \sqrt{2 \times 6.674 \times 10^{-20}\ km^3\ kg^{-1}\ s^{-2} \times 1.99 \times 10^{30}\ kg} \\
&\qquad \times \sqrt{(1/1.9\ AU) \times (1AU/149{,}597{,}870\ km)} \\
&= \sqrt{26.563 \times 10^{10}\ km^2\ s^{-2}} \times \sqrt{0.352 \times 10^{-8}} \\
&= (5.154 \times 10^5) \times (0.594 \times 10^{-4})\ km/s \\
&= 30.6\ km/s
\end{aligned}
$$

The orbital velocity at point #2 is:

$$
\begin{aligned}
v_{c2} &= v_{e1} / \sqrt{2} = 30.6 / 1.414 \\
&= 21.64\ km/s
\end{aligned}
$$

The conservation of energy is applied again for going from point #1 to point #2 where r_1 = 2.3 AU and r_2 = 1.9 AU.

~~$\frac{1}{2} v_2 = GM/r_2 - GM/r_1 + \frac{1}{2} (v_1)^2$~~

$V_2 = \sqrt{ [v_1^{\,2} + 2\ GM (1/r_2 - 1/r_1)] }$

$= \sqrt{ [(20.26)^2 + (2 \times 6.674 \times 10^{-20}\ km^3\ kg^{-1}\ s^{-2} \times 1.99 \times 10^{30}\ kg) \times (1AU/149{,}597{,}870\ km) \times (1/1.9\ AU - 1/2.3\ AU)] }$

~~$v_2 = 1.414 \times [- \sqrt{(13.28 \times 10^{10})/(1.9 \times 1.49 \times 10^8\ km)}$~~

~~$+ \sqrt{(13.28 \times 10^{10}) / (2.3 \times 1.49 \times 10^8\ km)}] + 19.3\ km/s$~~

~~$= 1.414 \times [\sqrt{4.69 \times 10^2} - \sqrt{3.875 \times 10^2}] + 19.3\ km/s$~~

~~$= 1.414 \times [21.66 - 19.69] + 17.2$~~

$v_2 = \sqrt{ [410.5 + (1775 \times \{ 0.5263 - 0.4348 \})] } = \sqrt{ [410.5 + 162.4] }$

= ~~2.1 + 19.3 km/s~~
= ~~22.1~~ 23.93 km/s

Now Earth's velocity at point #2 is between the minimum escape velocity and orbital velocity. Hence, Earth is ~~beginning~~ continuing to ~~form a closed elliptical orbit~~ spiral inward.

A third point in its trajectory is chosen at another $\Delta r = 0.4$ AU closer to the Sun or 2.7 – 1.2 = 1.5 AU from the Sun which is now the orbital distance of Mars. Of course, a collision with Mars or a strong effect on its orbit or an effect on the Earth's trajectory was avoided since Mars' position was more than likely far enough away or even, probably opposite Earth's crossing.

The escape velocity with respect to the Sun at Mars' orbital position is:

$V_{e3} = 34.1$ km/s

The orbital velocity is:

$v_{c3} = v_{e3} / \sqrt{(2)}$
= 24.11 km/s which is the orbital velocity of Mars.

Applying the conservation of energy for Earth going from point #2 to point #3 where $r_2 = 1.9$ AU and $r_3 = 1.5$ AU.

~~$\frac{1}{2} v_3 = GM/r_3 - GM/r_2 + \frac{1}{2} (v_2)^2$~~

v_3 ~~$= 1.414 \times [\sqrt{(13.28 \times 10^{10})/(1.5 \times 1.49 \times 10^8 \text{ km})}$~~
~~$- \sqrt{(13.28 \times 10^{10}) / (1.9 \times 1.49 \times 10^8 \text{ km})}] + 22.1$ km/s~~
~~$= 1.414 \times [24.38 - 21.66] + 22.1 = 3.85 + 22.1$ km/s~~ $= \sqrt{[v_2{}^2 + 2 GM (1/r_3 - 1/r_2)]}$
$= \sqrt{[(23.95)^2 + (2 \times 6.674 \times 10^{-20} \text{ km}^3 \text{ kg}^{-1} \text{ s}^{-2} \times 1.99 \times 10^{30} \text{ kg}) \times (1\text{AU}/149{,}597{,}870 \text{ km}) \times (1/1.5 \text{ AU} - 1/1.9 \text{ AU})]}$
$= \sqrt{[572.6 + (1775 \times \{0.6667 - 0.5263\})]} = \sqrt{[572.6 + 249.2]}$
= ~~25.9~~ 28.67 km/s

Again, the Earth is still spiraling inward having a value between escape and orbital velocities.

The escape velocity with respect to the Sun near the approaching Moon's orbit is:

$v_{e4} = 42.1$ km/s

The orbital velocity is:

$v_{c4} = v_{e4}/\sqrt{(2)}$
= 42.1/1.414
= 29.77 km/s which is basically that of the current Moon and Earth.

Applying the conservation of energy once again for the Earth moving from point #3 to point #4 where $r_3 = 1.5$ AU and $r_4 =$ ~~1.1~~ 1.1 AU:

~~$\frac{1}{2} v_4 = GM/r_4 - GM/r_3 + \frac{1}{2} (v_3)^2$~~

v_4 ~~= 1.414 x [√{(13.28 x 10^{10})/(1.1 x 1.49 x 10^8 km)}~~
~~- √{(13.28 x 10^{10}) / (1.5 x1.49 x10^8 km)}] + 25.9 km/s~~
~~= 1.414 x [28.5 – 24.38] + 25.9~~
~~= 5.77 + 25.9 km/s~~ = √ [$(28.67)^2$ + (2 x 6.674 x 10^{-20} $km^3\ kg^{-1}\ s^{-2}$ x 1.99 x 10^{30} kg) x (1AU/149,597,870 km) x
(1/1.1 AU – 1/1.5 AU)]
= √ [822.0+ (1775 x { 0.9091 – 0.6667 })] = √ [822.0 + 430.3]
= ~~31.67~~ 35.39 km/s

A tabulation of the previous results of a falling Earth follows.

Point or position	Description	AU from the Sun	Earth's velocity, v km/s	Orbital velocity, v_c km/s	Escape velocity, v_e km/s
0	Original orbit in Main Belt	2.7	18.5(17.2)*	18.2	25.7
1	New trajectory tangent to radius from Sun	2.3	~~19.3~~ 20.26	19.7	27.8
2	Incrementing trajectory position every 0.4 AU	1.9	~~22.1~~ 23.93	21.6	30.6
3	Position when crossing Mars' orbit	1.5	25.9 28.67	24.0	34.1
4	Approaching Moon's orbit at 1 AU	1.1	~~31.7~~ 35.39	30.0	42.1

The escape velocity of Earth in its original orbit is -

v_{e0} = √($2GM/r_0$) = √{(2 x 13.28 x 10^{10})/(2.7 AU x ~~1l49 x 10^8~~ 149 x 10^6)}
= 25.7 km/s

Then the Earth's orbital velocity is -

v_{co} = v_{eo}/√(2)
≈~~=~~ 18.2 km/s

* Earth's velocity after it collided with a rogue planet is computed as 17.2 km/s with an inward trajectory.

The calculations and above tabulation ~~table~~ reveal~~s~~ a possible scenario. Also, refer to the graph of Diagram B; ~~As the Earth reached the point of tangency with respect to the Sun's radius it was too slow to attain orbital velocity and kept falling toward the Sun.~~ the velocity of Earth increased as it fell toward the Sun ~~until it exceeded~~ exceeding orbital velocity at all points #1, #2, #3, and #4, thus assuring an elliptical orbit but never exceeding escape velocity.

The Earth passed Mars' orbital region at an oblique angle with respect to the Martian orbital path. Perhaps ~~, too,~~ Mars was far enough away so as not to seriously perturb the Earth's trajectory or Mars' orbit.

At about 1.1 AU the Earth was vectorially very close ~~again~~ to a tangency with the Sun's radius as revealed by Diagram B. The calculation ~~indicated~~ indicates that Earth was traveling faster than the orbital velocity determined to be 30 km/s at one AU. The Earth was destined to follow a more elliptical orbit than the Moon at this position with its faster velocity ~~of about 32 to 33~~ computed at about 35 km/s. However, the Earth most probably passed close enough to the Moon on its first orbit for the two bodies to have a close encounter and become connected gravitationally. The first few thousands of passings of the two planets in parallel orbits slowed the Earth's velocity as it passed the Moon each time. This initial energy exchange is approximated in a following calculation.

The Earth and Moon would forever ~~assume a synchronized~~become captured within the same orbit after energy transfer took place as the faster Earth passed the Moon during ~~an un-~~a certain ~~determined~~ number of orbits. During each passing the Earth's velocity ~~reduces~~ reduced incrementally until their orbital speeds and orbital ellipses ~~are~~ became well matched. In turn, the Moon ~~gained more~~ exchanged higher and lower orbits during each passing to conserve the transfer of energy and momentum.

Another conservation of energy calculation checks the overall results of the Earth changing orbits immediately after its impact. This calculation accounts for the entire re-location of Earth from the asteroids' Main Belt to the Moon's orbit.

∑ Energies = $K_o + (-Ug)_o$ = initial energies = $K_f + (-Ug)_f$ = final energies

= $\frac{1}{2} m(v_o)^2 + (-GmM)/r_o$

= $\frac{1}{2} m(v_f)^2 + (-GmM)/r_f$, and then canceling the "m" values

= $(v_0)^2/2 + (-GM)\cancel{/(1/r_f - 1/r_0)}/r_o$

= $(v_f)^2/2 + (-GM)/r_f$ where r_f = 1.~~0~~1 AU; ~~and~~ r_0 = 2.7 AU; v_f = 35.39 km/s and v_o = 17.2 km/s.

= $(17.2)^2/2 + (-13.28 \times 10^{10}/1.496 \times 10^8)/2.7 \cancel{/(1/1.0 - 1/2.7) \neq (32)^2/2}$

= $(35.39)^2/2$ + (-13.28 x 1010 / 1.496 x 108)/ 1.1

= 148 + (-889)/2.7 = 626 + (-889) / 1.1

= 148 – 330 = -182 = 626 - 808 and re-inserting the value of the mass of Earth into both sides of the equation where m = 5.97×10^{24} kg. to obtain the units of energy.

K_o = $(5.97 \times 10^{24}$ kg) (148 ~~+ 583~~) km^2/s^2 = 884 kg km^2/s^2 = initial kinetic energy

$(-Ug)_o$ = $(5.97 \times 10^{24}$ kg) (330) ~~731 kg~~ km^2/s^2 ~~≠ (5.97 x 10^24) 512~~ = 1970 kg km^2/s^2

K_f = $(5.97 \times 10^{24}$ kg)(626) km^2/s^2 = 3737 kg km^2/s^2 = final kinetic energy

$(-Ug)_f$ = $(5.97 \times 10^{24}$ kg)(808) km^2/s^2 = 4823 kg km^2/s^2 = final potential energy

∑ Energies = $K_o + (-Ug)_o$ = 884 -1970 = $K_f + (-Ug)_f$ = 3737 – 4823 = -1086 kg km^2/s^2

~~Or:~~

~~∑ Energies = (884 x 10^24 + 3481 x 10^24) kg km^2/s^2 ≠ 3057 x 10^24 kg km^2/s^2~~

The initial and final ~~energies~~ values are equal and do ~~not~~ indicate conservation of energy~~.~~. But t~~T~~his single equation does not properly integrate the constantly changing kinetic energy, ½ mv^2~~;~~ and ~~the~~ potential energy, (G m M)/ ~~Δ~~r. The previous set of equations calculated the changes at various positions in the trajectory over smaller units of time thereby integrating better the changing energies as the Earth spirals toward the Moon's orbit. ~~The total potential energy expended by the falling Earth of 3481 km kg/s² and the final kinetic energy of 512 km kg/s² are changed accordingly to more closely match the final energies on both sides of the equation. See Diagram C.~~

The initial velocity of 17.2 km/s of impacted Earth that was previously computed is critical in determining the final velocity as the Earth enters the Moon's orbital region. If this initial velocity is less then, of course, the Earth's initial velocity passing the Moon is less. For the rogue planet hitting the Earth at a more oblique angle toward its orbital motion leads to less initial velocity – such as a 45^0 angle producing a velocity of 16.6 km/s and a 30^0 angle producing a velocity of 16.2 km/s.

The striking 90^0 angle of the rogue planet generates 17.2 km/s and produces a better trajectory of the Earth toward the solar system's center; however, the passing initial velocity of the Earth produces a larger difference between the Moon's orbital velocity of 30 km/s. The next topic will explore how the Moon slows the Earth's orbital velocity at one AU orbital radius to match the Moon's orbital velocity and allow synchronization of the two bodies.

Diagram C: Integrating Energy Changes with Time

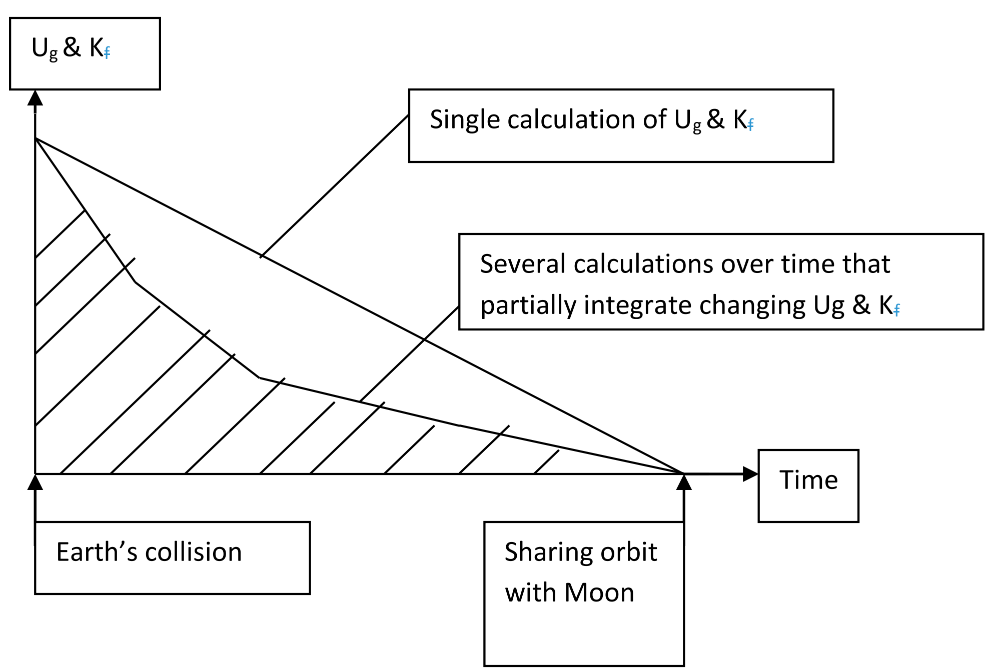

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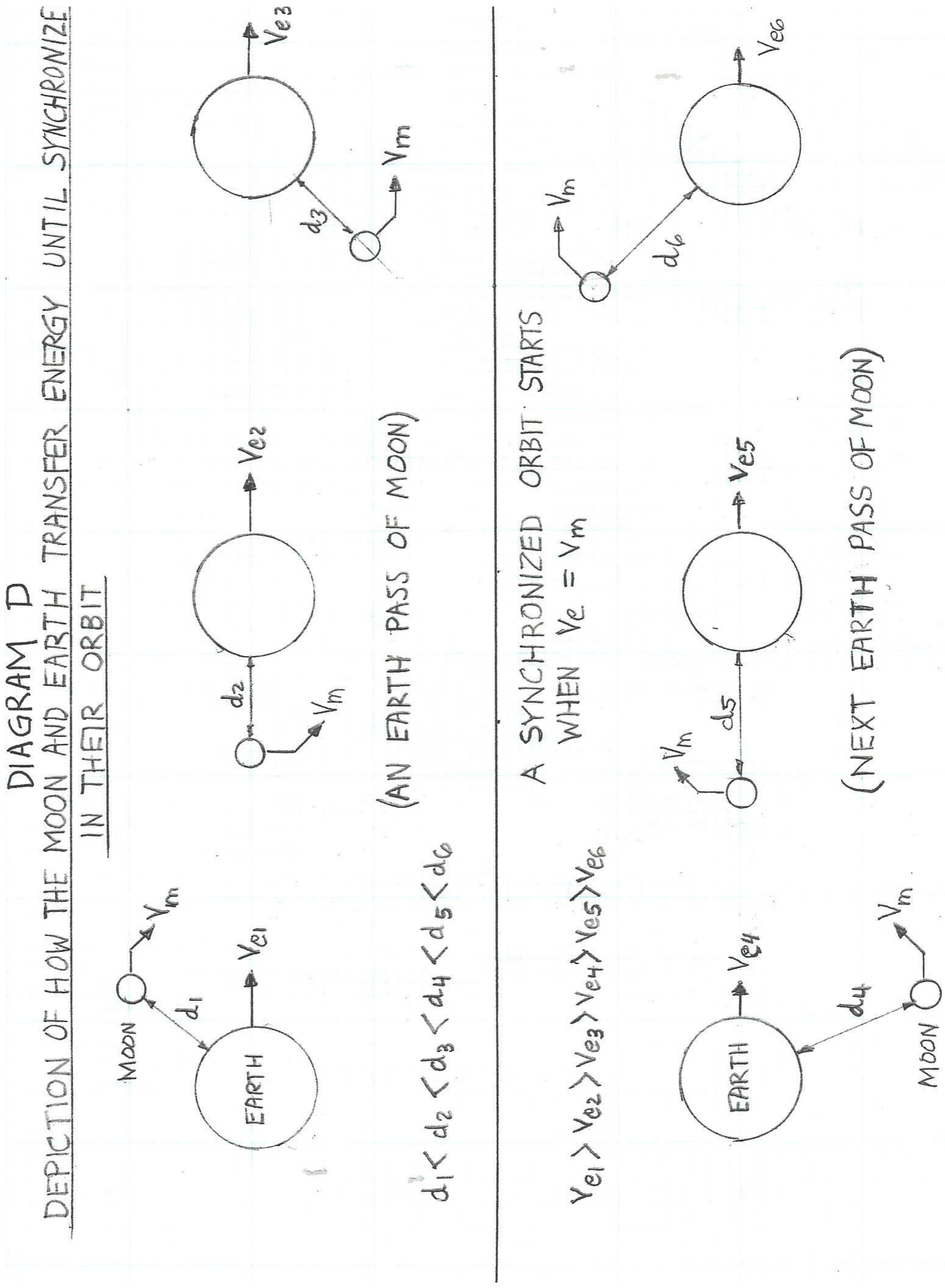
Diagram D: Depiction of How the Moon and Earth Transfer Energy Until They Become Synchronized in Their Orbits



H. Calculating the Energies Transferred Between the Earth and Moon

It is assumed that the Earth entered the Moon's orbital region at a velocity closer to orbital velocity of v_c = 30 km/s than to the escape velocity of 42.1 km/s. A previous series of calculations indicates a possible initial velocity of ~~31.7~~ 35.39 km/s. For the purposes of this calculation Earth's initial orbital velocity, v_o = ~~33~~ 35 km/s, is ~~conservatively~~ chosen. The following calculation shows how possible initial close encounters with the two passing bodies decreased the Earth's velocity from 35 km/s to 30 km/s by repeated impulse momentum created by the rapidly changing gravitational forces between the two bodies as one passed the other.

This ~~next~~ calculation attempts to show how the transfer of energies with the Moon ~~will~~ caused the Earth over a long span of time to slow down and match the velocity of the Moon. The primary angular momentum change to the Moon ~~will be~~ is the ~~affect~~ resulting effect of the Moon orbiting Earth 12 times for each orbit around the Sun.

There are also the angular momentum changes due to changes in rotation of both the Moon and Earth through tidal forces. These comparatively much smaller amounts of angular momentum changes likely offset each other and are neglected in ~~this~~ the first calculation.

However, when the two bodies become synchronized orbiting together at 30 km/s, these tidal forces become important for slowing the rotational velocities and eventually tidal locking one side of the Moon toward the Earth. Another energy conservation equation will then compute values in a second calculation for another important energy transfer after the synchronization process starts.

The first calculation begins with an important assumption of the Earth's capture being aided by a close encounter with the Moon when it entered the Moon's orbital region. This main assumption will start with 90,000 km = r_m for this close encounter which remains mostly the same for all of Earth's passings until synchronization occurs.

The following data, equations, and assumptions are listed and will be applied to **the first calculation set:**

m_M = Moon's mass = 7.3 x 10^{22} kg
m_E = Earth's mass = 5.97 x 10^{24} kg
v_{IM} = Initial Moon's velocity during one passing of the Earth
v_{FM} = Final Moon's velocity during one passing of the Earth
v_{IE} = Initial Earth's velocity during one passing
v_{FE} = Final Earth's velocity during one passing
1 AU = approx. orbital radius of Moon = 1.496 x 10^8 km
1 yr = 31.5 x 10^6 s (present time for one orbit of Earth)
ΔM_M = momentum change of Moon due to Earth's gravity force = m_M (v_{FM} - v_{IM})
ΔM_E = momentum change of Earth due to Moon's gravity force = mE (v_{IE} – v_{FE})
r_M = assumed close encounter distance between Moon and Earth = 90,000 km

v_o = orbital velocity ≈ √ (GM_{sun}/orbital radius)= √ (13.28 x 10^{10} /r_o)
r_{oH} = Moon's higher orbital radius = 149,597,871 km + 90,000 km = 149, 687,871 km
r_{oL} = Moon's lower orbital radius = 149,597,871 km - 90,000 km = 149, 507,871 km
v_{oH} = Moon's higher orbital radius velocity = √(13.28 x 10^{10}/149,687,871) = 29.77434 km/s
v_{oL} = Moon's lower orbital radius velocity = √(13.28 x 10^{10}/149,507,871) = 29.79226 km/s
Δv_0 = Moon's change in velocity when changing orbits = v_{oL} - v_{oH} = 0.01792 km/s

It is assumed that the Earth is captured in an elliptical orbit with a semi-major axis that is twice the semi-minor axis. The semi-major axis is the Moon's orbital radius.

a = semi-major axis of Earth's elliptical orbit = 2 x 149.6 x 10^6 km = 300 x 10^6 km.
C_{elip} = a/2 x √(93 + ½ √3) = 1.453 x 10^9 km = circumference of the ellipse
C_{circ} = π x 2r = 6.28 x 149.6 x 10^9km = 0.939 x 10^9 km = circumference of a circle with r=a/2
C_{ratio} = C_{elip} /C_{circ} = 1.547
$year_L$ = one average long year for the Earth in an initial elliptical orbit = (1.547 + 1)/2 = 1.27 yr.

Henceforth, momentum change is conserved between the two bodies and $\Delta M_{MOON} = \Delta M_{EARTH}$ and

ΔM_M = m_M x Δv_0 = = 7.3 x 10^{22} kg x 0.01792 km/s = 0.1308 x 10^{22} kg km/s = $m_E(v_{IE} - v_{FE})$
Δv_E = ($v_{IE} - v_{FE}$) = (0.1308 x 10^{22} kg km/s) / 5.97 x 10^{24} kg = 0.000219 km/s

Now the number of times the Earth passes the Moon to slow it from 35 km/s to 30 km/s can be determined.

Number of Earth passes = (35km/s – 30km/s)/ Δv_E = (5 km/s)/ (0.000219 km/s) = 22,830 times.
Number of years for synchronization ≈ 22,830 long years x 1.27 years ≈ 29,000 years.

The Moon covers a total vertical distance of = 2 x 90,000 = 180,000 km for each passing of Earth. Assume the Moon takes about ½ year or 0.5 x 31.5 x 10^6 s = 15.75 x 10^6 s to move between orbits. The vertical velocity component then becomes $V_{vertical}$ = 180,000 km / 15.75 x 10^6 s = 0.011429 km/s. This velocity vector component is imperceptible to the lateral or horizontal components of v_{oH} = 29.77434 km/s and v_{oL} = 29.79226 km/s and is ignored in setting the total summation of the velocity vector components. Hence, the balancing of the total change of Earth's kinetic energy = K.E.(Earth) and the total change of Moon's kinetic energy = K.E.(Moon) is now determined.

K.E.(Earth) = ½ m_E x ($v_{FE}^2 - v_{IE}^2$) = ½ (5.97 x 10^{24}) x ($35^2 - 30^2$)
= 2.985 x 10^{24} x (1225 – 900) = 970 x 10^{24} kg km^2/s^2 , and
K.E.(Moon) = ½ m_M x ($v_{FM}^2 - v_{IM}^2$) = ½ (7.3 x 10^{22}) x [(29.79226 km/s)^2 – (29.77434 km/s)^2]
= 3.65 x 10^{22} x (887.57888 – 866.51145) = 3.65 x 10^{22} x 1.067386
= 0.03896 x 10^{24} kg km^2/s^2 for each passing of Earth.

K.E.(Moon) = K.E.(Earth) = 970 x 10^{24} kg km^2/s^2

Hence, the number of passings of Earth = 970 x 10^{24} kg km^2/s^2 / 0.03896 x 10^{24} kg km^2/s^2 = 24,897 times. The number of years for synchronization ≈ 24,900 long years x 1.27 years ≈ 31,600 years.

In conclusion, transfer of momentum between the Moon in its established orbit and the faster passing Earth is dependent upon the mass difference between the two bodies, the Sun's gravity, the close-encounter distance, and the Earth's initial velocity vector leaving its original orbit between Mars and Jupiter. The main variables or parameters are the close-encounter distance of 90,000 km and the Earth's initial orbital velocity of 35 km/s produced by a very rough computational analysis. These assumed parameters yield about 29,000 years by the conservation of momentum method and about 32,000 years by the conservation of kinetic energy method for the Moon and Earth to become synchronized at the same orbital velocity of 30 km/s. At the point of synchronization the Moon begins to orbit the Earth using a wavelike trajectory around the Sun.

The second calculation will analyze what occurs within the Earth-Moon system almost immediately after synchronization occurs. Both the Earth's and Moon's rotations will be slowed by the immense changing tidal forces caused by the varying gravity forces on their surfaces as they spin. These forces are estimated to cause 1000 meter tides and hurricane winds which thoroughly mix the oceans with the rocky surfaces of the newly formed continents. The forces also cause increased earthquakes, volcanism and tectonic plate movements. Conditions for life are unlikely until the two bodies separate enough to reduce tidal forces for a more livable condition. The calculation will estimate how many years is needed to arrive at present day conditions and at conditions around 3 billion years ago when the origins of life started and about 2.8 billion years ago when multi-cell animals emerged on Earth's surface.

More very basic assumptions are needed to start this next calculation. The original rotation of the Moon is assumed as 24 hours per day which is comparable to present- day Mars. Some studies in the past 10 years have estimated that the Earth rotated every 6 hours. Of course, Earth's present complete rotation is 24 hours and the Moon's rotation has been greatly reduced to 12 times every year which is considered as virtually zero spin.

The following data, equations, and assumptions are listed and will be applied to **the second calculation set:**

~~Let:~~

$\cancel{I_M}$ I_{EM} = the moment of inertia of the Moon and Earth about the Earth's axis

= $\cancel{I_G}$ I_E + $m_M h^2$,

Where:

h = approximate perpendicular distance between the two parallel ~~axis~~ axes through the centers of gravity of the Moon and Earth.

= present distance between Moon & Earth ≈ 384,400 km-[r], and

m_M = total mass of body = Moon's mass = 7.3 x 10^{22} kg [rrr], and

~~I_G~~ I_E = moment of inertia about the axis through center of mass for the ~~Moon~~Earth

= 2/5 ~~$m_M r_M^2$~~ $m_E r_E^2$ for a sphere where

~~r_M~~ r_E = ~~Moon's~~ Earth's mean radius = ~~1737~~ 6371 km [rrr]

~~I_G~~ I_E = 2/5 (~~7.3~~ 5.97 x ~~10^{22}~~ 10^{24} kg) x (~~1737~~ 6371 km)^2

= ~~8.8~~ 9.69 x ~~10^{28}~~ 10^{31} kg km^2

$m_M h^2$ = (7.3 x 10^{22} kg) x (384,400 km)^2

= 1.08 x 10^{34} kg km^2

Hence,

~~I_M~~ I_{EM} = 9.69 x 10^{31} kg km^2 ~~8.8 x 10^{28}~~ + 1080 ~~1,080,000~~ x ~~10^{28}~~ 10^{31} kg km^2 ~~≈ 1,080,000 x~~

≈ 1090 x ~~10^{28}~~ 10^{31} kg km^2

~~I_E = 2/5 (5.97 x 10^{24} kg) (6371 km)^2~~

~~= 9.67 x 10^{31} kg km^2~~

ω_{EF} = 2π radians/ one day = 6.28 rad/86,400 s = 7.27 x 10^{-5} radians/second = 0.727 x 10^{-4} radians/s = present angular rotation

angular rotational velocity of Earth

ω_{EI} = initial angular rotational velocity of Earth

= 2π radians/6 hour-day proposed for the Giant Impact Hypothesis which is too fast

= 6.28 rad/21,600 s

= 2.91 x 10^{-4} radians/s

= 29.10 x 10^{-5} radians/s

ω_{EI} = to be determined

ω_{MF} ≈ 0

ω_{MI} = initial angular rotational velocity of Moon

≈ ω_{EF} = 0.727 x 10^{-4} radians/second

ω_{EM} = angular orbiting velocity of Moon

≈ 1 revolution / 27.3 days

= (2π radians)/ (27.3 x 24 x 60 x 60 seconds) = 0.0266 x 10^{-4} radians/s

Applying the conservation of kinetic energy of rotation ~~energy~~:

$\sum$ ~~E_i~~ $_I$ = sum of all initial rotational energy and potential energy in the Earth-Moon system

= ~~$\frac{1}{2} m_E v_{iE}^2$ +~~ ½ I_E ~~ω_{iE}^2~~ ω_{EI}^2 ~~+ ½ $m_M v_{iM}^2$~~ + ½ I_M ~~ω_{iM}^2~~ ω_{MI}^2 + $(G m_E m_M / h_I)$

$\sum \cancel{E_f}\,_F$ = sum of all final rotational energy and potential energy in the Earth-Moon system

$= \cancel{\tfrac{1}{2} m_E v_{fE}^2 +} \tfrac{1}{2} I_E \cancel{\omega_{fE}^2}\omega_{EF}^2 \cancel{+ \tfrac{1}{2} m_M v_{fM}^2} + \tfrac{1}{2} I_M \cancel{\omega_{fM}^2}\omega_{EM}^2 + \tfrac{1}{2}\ 1/2\ \ I_{EM} \times \omega_{EM} + (Gm_E m_M / h_F)$

$\tfrac{1}{2} I_E \cancel{\omega_{iE}^2}\omega_{EI}^2$ = initial K.E. of rotation for the Earth

$= \tfrac{1}{2} (9.\cancel{67}\,69 \times 10^{31}\text{ kg km}^2) (\cancel{7.27 \times 10^{-5}}\,2.91 \times 10^{-4}\text{ rad/s})^2$

$= 4.10 \times 10^{24}\text{ kg km}^2/\text{s}^2 = \cancel{3.52 \times 10^{22}\text{ kg km}^2/\text{s}^2}$

$\tfrac{1}{2} I_E\, \omega_{EF}^2$ = final K.E. of rotation for the Earth

$= \tfrac{1}{2} (9.69 \times 10^{31}\text{ kg km}^2) \times \tfrac{1}{2} (7.27 \times 10^{-5}\text{ rad/s})^2$

$= 0\ .2561 \times 10^{24}\text{ kg km}^2/\text{s}^2$

~~And:~~ $\tfrac{1}{2} I_M\, \omega_{MI}^2$ = initial K.E. of rotation for the Moon

$\tfrac{1}{2} I_M \cancel{\omega_{iG}^2}\omega_{MI}^2 = \tfrac{1}{2} (8.8 \times 10^{28}\text{ kg km}^2)$

$= \tfrac{1}{2} (8.8 \times 10^{28}\text{ kg km}^2)(7.\cancel{09}\,27 \times 10^{-5}\text{ rad/s})^2$

$= \cancel{3.12}\ 0.000232 \times \cancel{10^{19}}\ 10^{24}\text{ kg km}^2/\text{s}^2$

$\tfrac{1}{2} I_M\, \omega_{MF}^2$ = final K.E. of rotation for the Moon = 0

The potential energy loss by the Moon moving away from the Earth is actually determined by the Sun's gravity field or the gravity force between the Sun and Moon. The Moon is the only satellite in the solar system that is held in its orbit by the Sun and not its parent planet.

$M_{sun} = 1.99 \times 10^{30}\text{ kg}$

$Gm_M M_{sun} = (6.674 \times 10^{-20}) \times (7.34 \times 10^{22}\text{ kg}) \times (1.99 \times 10^{30}\text{ kg}) = 9.695 \times 10^{33}\text{ km}^3\text{ kg s}^{-2}$

$(Gm_M M_{sun} / h_I) = (9.695 \times 10^{33}\text{ km}^3\text{ kg s}^{-2}) / (149{,}600{,}000 + 90{,}000)\text{ km}$

$= 292.5 \times 10^{26}\text{ km}^3\text{kg s}^{-2} / 149{,}690{,}000\text{ km} = 64.767 \times 10^{24}\text{ km}^2\text{ kg s}^{-2}$

$(Gm_M M_{sun} / h_F) = (9.695 \times 10^{33}\text{ km}^3\text{ kg s}^{-2}) / (149{,}600{,}000 + 384{,}400)\text{ km}$

$= 292.5 \times 10^{26}\text{ km}^3\text{kg s}^{-2} / 149{,}984{,}000\text{ km} = 64.640 \times 10^{24}\text{ km}^2\text{ kg s}^{-2}$

The term, $\tfrac{1}{2} I_{EM} \times \omega_{EM}$, drops away since this kinetic energy of the orbiting Moon already is accounted since the impulse momentum of the faster orbiting Earth created the Moon's orbit when synchronization occurred. The energies are now added and balanced to solve for the unknown value of the initial Earth's rotation found in the term, $(\tfrac{1}{2} I_E\, \omega_{EI}^2)$.

$\sum$ Energies $= (\tfrac{1}{2} I_E\, \omega_{EI}^2\ ?) + \tfrac{1}{2} I_M\, \omega_{MI}^2 + (-Gm_M M_{sun} / h_I) = \tfrac{1}{2} I_E\, \omega_{EF}^2 + (Gm_M M_{sun} / h_F)$

$= (\tfrac{1}{2} I_E\, \omega_{EI}^2\ ?) + 0.000232 \times 10^{24} + (-64.767 \times 10^{24})$

$= 0.2561 \times 10^{24} + (-64.640 \times 10^{24})$

$(\tfrac{1}{2} I_E\, \omega_{EI}^2\ ?) = -\ 0.000232 \times 10^{24} + 64.767 \times 10^{24} + 0.2561 \times 10^{24} - 64.640 \times 10^{24}$

$= 0.3829 \times 10^{24}\text{ km}^2\text{ kg s}^{-2}$

ω_{EI} $= \sqrt{(2 \times 0.3829 \times 10^{24} \text{ km}^2 \text{ kg s}^{-2} / 9.69 \times 10^{31} \text{ kg km}^2)}$
$= \sqrt{(0.790 \times 10^{-8} \text{ radians /s})} = 0.889 \times 10^{-4} \text{radians /s}$

time / 1 rev $= (2\pi \text{ radians}) / (0.889 \times 10^{-4} \text{radians /s})$
$= 70{,}641$ seconds

The Earth's initial rotation after finding its new orbit is computed to be 70,641 s /3600 s /hour = 19.6 hours. After the Earth became synchronized with the Moon the Earth's rotation gradually slowed to its present 24 hours per rotation. The Moon's rotation stopped probably rather quickly within thousands of years to become tidally locked with the Earth, because the Moon's kinetic energy of rotation from the computations is a very small fraction of the other energy transfers that are involved.

This rotational speed has good agreement with other known spin speeds in the solar system. Mars' rotation period is 24.6 hours. The outer planets with their larger masses would reasonably have greater rotational periods ranging from 9.8 to 17.4 hours. When Earth was in its original orbit it more than likely had a slightly faster rotational period until its major impact with a rogue planet occurred. Mercury's and Venus' almost non-existent rotational periods are the result of the combination of partial tidal locking with the Sun and large impacts.

The controversial Giant Impact Hypothesis requires a very fast rotational period for the young Earth of 5 to 6 hours. This model proposes a large Martian-size body struck Earth with a glancing blow in order to gain enough angular momentum for the impact debris to accrete into an orbiting Moon. Unfortunately, this type of impact and the required angular momentum of the Moon creates a very high and inappropriate rotational period for the Earth. This accelerating spin-up would have torn the planet apart. In the EMM hypothesis the Earth is struck almost head-on, but at an oblique angle to the equator. This type of inelastic collision absorbed most of the Impactor's mass and contributed to the axial tilt and orbital displacement. This type of collision would have a much smaller effect on the existing rotational period. The previous calculation, that results in 19.6 hours for one rotation that provides for the planet to slow down after exchanging energies with the Moon, supports very well the EMM hypothesis and other existing parameters of our current solar system.

Well respected scientific studies proposed that a day in the Devonian geological period occurring 419 to 360 million years ago was 2.2 hours less. In a later period, the Pennsylvanian of 358 to 298 million years ago, the day length was about 22.4 hours. The geological and paleontological evidence that the Earth rotated faster in the remote past is well supported, but this paper seriously questions the amount of slowing of the rotation. If the Earth's spin was continually decaying for the past 3.8 billion years at the rates purported for the above geological periods then the Earth would have almost stopped spinning a long time ago.

Other more believable data collected from astronomical studies indicates that the Moon is receding approximately 38 mm per year. As the system's kinetic energy of rotation decreases, the potential energy between the Moon and Earth also decreases. The Earth's rotation is slowing approximately 2 seconds for every 100,000 years based on the previous geological data. These phenomena are due to the land and ocean tides raised by the Moon called tidal acceleration; those forces collectively reduce the Earth's rotation. These rates of receding and rotational period reduction presumably were in affect 3.8 bya since the Moon began orbiting the Earth.

Hence, the total distance for receding is –

d_{total} = (38 mm/yr) x 1 km/10^6 mm x 3.8 x 10^9 yr = 144,400 km

Δd = the present distance of (384,400 km) – the initial close-encounter distance of (90,000 km) - 144,400 km = 150,000 km

Δd = 150,000 km that is not yet explained. There must be a reason for this unexplained separation distance.

Now let's assume the Earth has been slowing down 2 seconds every 100,000 years for the past 3.8 billion years, then the total amount of seconds since that time is –

Δt = (2 s / 100,000 yrs) x 3.8 x 10^9 years = 76,000 seconds or
= 76,000 s x 1 hr /3600 s = 21.1 hours which is considered impossible.

The Earth should not be super-spinning at (24 hr – 21.1 hr) = 2.9 hour rotational period; this spin speed is much too fast. This data of 2s /100,000 years is based on geological evidence of the Devonian Period that occurred 420 mya. Hence,

$\Delta t_{Devonion}$ = (2 s / 100,000 yrs) x 420 x 10^6 years = 8400 seconds = 2.33 hours

As already mentioned this geological and paleontological data is questionable. The Earth cannot sustain a slowing rate of (2 s / 100,000 years) for 3.8 billion years unless its starting rotation period is about 2.9 hours. This super- fast rotation rate would almost produce an oblate object like a hockey puck. There is no experience of such an object in our solar system.

However, it is difficult to refute the unexplained separation distance of 150,000 km. Why did not the Earth and Moon keep moving away from each other over the entire period after becoming synchronized ? How did this this discrepancy occur ? In fact, the rate of separation should have been even higher in the initial stages when the Moon was much closer. Let's examine a possible process that caused this extra 150,000 km of separation. The synchronization event is re-visited.

The Earth has been passing the Moon each time pulling the Moon between either a lower or upper orbit. Eventually, the Earth is slowed to the same orbital velocity as the Moon. During a very short time period the Moon begins orbiting the Earth. The force of gravity between the two bodies now causes the Moon to fall toward the Earth. The Moon must now gain kinetic energy of rotation to both orbit the Earth and keep orbiting the Sun along with the Earth. The process is comparable to twirling a stone on the end of a string. The more rotational energy given to the string, the more the stone rises into a larger diameter orbit with faster velocity.

The Moon did not originally have an orbital velocity around Earth except for a slightly increased velocity when it was changing orbits while orbiting the Sun. Now the Moon must add a vector to its overall velocity to orbit the Earth that now stays in its vicinity instead of passing. This orbital velocity is currently 1.022 km/s. The radians/s of this orbit is ω = orbital velocity /orbital radius = (1.022 km/s) / 384,000 km = 2.66×10^{-6} rad/s. The average orbital velocity is assumed as (0 + 1) /2 = 0.5 km/s when the Moon was moving outward from its initial distance from the Earth at 90,000 km. Hence, the following computations and assumptions follow:

The distance the Moon moved outward while generating its orbit around the Earth is assumed to be the questionable 150,000 km mentioned previously. So its final orbital radius after synchronization is assumed to be –

h_f = 90,000 + 150,000 = 240,000 km, and of course the existing orbital radius is

h_e = 90,000 + 150,000 + 144,400 = 384,400 km where the 144,400 value represents the unrelenting 38 mm/year that the Moon is moving away from Earth for the past 3.8 billion years assuming an approximate constant rate.

$v_{M\ avg}$ ≈ 0.5 km/s during Moon's displacement from 90,000 to 240,000 km/s.

ω_f = final radians/s of Moon's orbit around Earth = $v_{M\ avg}/h_f$

= (0.5 km/s) / (240,000 km) = 2.083×10^{-6} rad/s

$K.E._{ri}$ = initial kinetic energy of orbiting Moon did not exist = 0

$K.E._{rf}$ = final kinetic energy of orbiting of Moon and Earth rotating around the Earth's axis after the Moon attains an orbital radius of 240,000 km.

$= \frac{1}{2} (I_E + m_M \times h_f^2) (\omega_f)^2$

$= \frac{1}{2} [9.69 \times 10^{31} \text{ kg km}^2 + 7.3 \times 10^{22} \text{ kg} \times (240,000 \text{ km})^2] \times (2.083 \times 10^{-6} \text{ rad/s})^2$

$= \frac{1}{2} [430.19 \times 10^{31}] \times (4.339 \times 10^{-12}) = 933.3 \times 10^{19}$

$= 0.933 \times 10^{22} \text{ kg km}^2/\text{s}^2$

$P.E._i$ = initial potential energy between the Earth and Moon = Gm_Mm_E / h_i

$= (6.674 \times 10^{-20} \times 7.34 \times 10^{22} \times 5.97 \times 10^{24}) / 90,000$ km

$= (292.5 \times 10^{26} \text{ km}^3 \text{ kg/s}^2) / 90,000$ km

$= 32.50 \times 10^{22} \text{ kg km}^2/\text{s}^2$

$P.E._f$ = final potential energy between the Earth and Moon = Gm_Mm_E / h_f

$= (292.5 \times 10^{26} \text{ km}^3 \text{ kg/s}^2) / 240,000$ km

$= 12.19 \times 10^{22} \text{ kg km}^2/\text{s}^2$

$K.E._{rf\,(total)}$ $= \text{factor M} \times 0.933 \times 10^{22}\ \text{kg km}^2/\text{s}^2 = K.E._{ri} + P.E._i - P.E._f$

$= 32.50 \times 10^{22} - 12.19 \times 10^{22}$

$= 20.31 \times 10^{22}\ \text{kg km}^2/\text{s}^2$

Factor M $= 20.31 \times 10^{22} / 0.933 \times 10^{22} = 21.76$ where "Factor M" represents the approximate number of total orbits of the Moon required to achieve an energy balance due to the gravity force and given motions.

In other words, the Moon spiraled outward for about 22 orbits before acquiring a stable orbit around the Earth - almost immediately after the Earth eventually slowed within close range of 30 km/s and was traveling parallel at 90,000 km from the Moon. This outward motion covered about 150,000 km in about two years. At this location of 240,000 km the Moon slowly recedes over the next 3.8 billion years at 38 mm / year to cover an additional separation distance of 144,400 km due to steady tidal accelerations between the two bodies. Currently at 384,400 km away from Earth the Moon continues to move away every year as the Earth very slowly reduces its rotational period. The measurement of this reduction rate is very much in question.

Now a total scenario or timeline can be created to outline the Earth-Moon system capture mode and synchronization process from the time the Earth moved into the Moon's primordial orbit 3.8 billion years ago to the present time.

Summary and Timeline for the Earth-Moon Capture Mode and Synchronization Process

Event	**10^9 yrs ago**	**Distance Apart - km**	**Moon's/Earth's Velocity – km/s**	**Earth's Rotation**	**Moon's Rotation**	**Milestones**
Earth enters Moon's orbital region	3.9	90,000	30 / 35	19.6 hrs	24 hrs	Earth's land surface red hot; oceans boiling
Earth slows to match Moon's orbital velocity	+ 29,000 years	90,000	30 / 30	19.6 hrs	24 hrs	Earth cooled, but active volcanism and tectonics
Moon begins to orbit the Earth spiraling outward	Approx. 22 Moon orbits around Earth	90,000 + 150,000 = 240,000	30 / 30	19.6 hrs	24 hrs	Severe tides: hurricane winds and 1000 m ocean tides
Steady tidal accel. occur between Earth & Moon;	2.9 to 3.0	270,000	30/30		> > 24 hrs	Collisional debris(asteroids) mostly swept away;

Moon's mares begin to solidify						bacterial life starts
Moon becomes tidally locked	2.7 to 2.8	278,000	30/30	> 20 hrs	≈ 0 hrs	Multi-cellular animals appear
Present time	0	384,400	30/30	24 hrs	0 hrs (27.3 day orbit around Earth)	Moon receding @ 38 mm/yr & orbiting Earth @ 1.022 km/s

~~The initial and final rotations of the Earth are insignificant values compared with the other energy values although its rotation is affected. Hence, ½ $I_E\ \omega_{iE}^2$ and ½ $I_E\ \omega_{fE}^2$ are set to zero. Initially, the Moon had no orbit around Earth and its initial rotation is assumed equivalent to the present day Martian rotation of 24.6 days, and its energy value is also insignificant. Hence, ½ $I_M\ \omega_{iG}^2$ is set to zero. The initial and final linear momentums of the Moon, ½ $m_M\ v_{iM}^2$ and ½ $m_M\ v_{fM}^2$, cancel each other since the Moon's linear orbital velocity is assumed unchanged or insignificantly unchanged.~~

~~Balancing the energy components remaining:~~

~~½ $m_E\ v_{iE}^2$ = ½ $m_E\ v_{fE}^2$ + ½ $I_M\ \omega_{fM}^2$~~

~~Let:~~

~~ω_{fM} = the final angular orbital speed of the Moon = 12 revolutions/year~~

~~And~~

~~One year = 31.55×10^6 seconds~~
~~= $12(2\pi)$ radians / 31.55×10^6 s~~
~~= 2.4×10^{-6} radians/s~~

~~Or:~~

~~ω_{fM} = 1 revolution / 27 days~~
~~= $(2\pi$ radians$)$/ 27 x 24 x 60x 60 seconds~~
~~= 2.69×10^{-6} radians/s~~

~~½ $m_E\ v_{iE}^2$ = ½ $(5.97 \times 10^{24}$ kg$)$ $(33$ km/s$)^2$~~
~~= 3251×10^{24} kg km^2/s^2~~

~~½ $m_E\ v_{fE}^2$ = ½ $(5.97 \times 10^{24}$ kg$)$ $(30$ km/s$)^2$~~
~~= 2686×10^{24} kg km^2/s^2~~

~~$\frac{1}{2} I_M \omega_{fM}^2 = \frac{1}{2} (1{,}080{,}000 \times 10^{28}\ kg\ km^2/s^2)(2.69 \times 10^{-6}\ rad/s)^2$~~
~~$= (540{,}000 \times 10^{28})\ (7.24 \times 10^{-12})\ kg\ km^2/s^2$~~
~~$= 391$~~0.0391 ~~$\times 10^{24}\ kg\ km^2/s^2$~~

~~Returning to the equation of summation:~~

~~$3251 \times 10^{24}\ kg\ km^2/s^2 \neq 2686 \times 10^{24}\ kg\ km^2/s^2 + 391 \times 10^{24}\ kg\ km^2/s^2$~~

~~Or:~~

~~$3251 \times 10^{24}\ kg\ km^2/s^2 \neq 3077 \times 10^{24}\ kg\ km^2/s^2$~~

~~In order to balance the energy equation the difference of $174 \times 10^{24}\ kg\ km^2/s^2$ is attributed to the potential energy to move the Moon outwardly from both the Earth and the Sun. Hence, the potential energy change of the Moon is set to $174 \times 10^{24}\ kg\ km^2/s^2$ and the resulting change in distance is computed.~~

~~The Moon actually moves around the Sun in a wave-like fashion. The Moon at its conjunction with the Earth is 384,400 km closer to the Sun on the near side and 384,400 km farther from the Sun on the far side. Therefore, the potential energy changes due to the movement of the Moon away and toward the Sun cancel each other. Hence, the only possible potential energy for the Moon is that of moving away from the Earth.~~

~~Let:~~

~~U_{gM} = the potential energy of the Moon's outward movement~~
~~= the amount of energy to balance the previous conservation of energy equation~~

~~Then:~~

~~$U_{gM} = (Gm_M M_E)/\Delta h = 174\ kg\ km^2/s^2$~~
~~$= (6.674 \times 10^{-20} \times 7.34 \times 10^{22}\ kg \times 5.97 \times 10^{24}\ kg) / \Delta h$~~

~~And:~~

~~$\Delta h = 292 \times 10^6\ km = 292{,}000\ km$~~

~~Hence, the original distance between Moon and Earth was:~~

~~384,400 km – 292,000 km = 92,400 km~~

The values for Earth slowing from ~~33~~ 35 to 30 km/s; ~~for~~and for the Moon moving outward by ~~292,000~~294,400 km; and for the Moon to become synchronized with Earth ~~by~~ after orbiting 29,000 to 32,000 times or approximate years of time; and for the Earth's original rotation of 19.6 hours ~~it~~ are all reasonable values. This scenario provides the angular momentum for the Moon orbiting Earth and why the Moon acts more like a planet instead of a planetary satellite. No current models can provide this necessary angular momentum for the Moon and an adequate capture mode except for the Earth's Metamorphosis (EMM) hypothesis with its collision and capture modes.

I. Drawing of Cross-Section of the Earth and Rogue Planet Impactor after Collision

See Diagram E for this cross-section.

The moon, Ganymede, is the guide for determining the assumed cross-section of the Impactor body. This Moon has a mean radius of 2634 km (0.413 Earths) and a volume of 7.6 x 1010 km3 (0.0704 Earths). Ganymede has a rigid ice crust with an outer ice mantle 800 to 1000 km thick and an inner silicate with a 950 to 1150 km thickness. The iron sulfide and iron core has a solid portion 500 km radius and a liquid portion of 800 km radius. [ttt]

The Impactor's assumed mean radius is 2880 km with a volume of 10.0×10^{10} km^3. Hence, the Impactor/Ganymede ratio is 2880/2634 = 1.093. The core structure of the two bodies remains the same. The ratio is applied to the inner and outer mantle radii.

The data for the Earth is 6378 km for the mean radius with a volume = 1.083×10^{12} km^3. The solid core is 1280 km radius, the liquid portion of the core is 3490 km radius, and the mantle is 5680 km radius. What remains is a 700 km thickness that includes the lithosphere with the crust and the athenosphere. [rrr]

The cross-section indicates the Earth's original mean radius at 6080 km is determined by the following calculation.

V_2 $= V_1 + V_0$ = Earth's volume = Impactor's volume + Earth's original volume

$V_0 = V_2 - V_1$
$= 108 \times 10^{10}\ km^3 - 10 \times 10^{10}\ km^3 = 98 \times 10^{10}\ km^3$

$V_0 = 4/3\ \pi\ r_0^3$

$r_0 = {}^3\sqrt{[3/(4\pi)V_0]}$
$= {}^3\sqrt{[0.23 \times 98 \times 10^{10}]}$ km
$= 6082$ km

$r_1 - r_0 = 6378\ km - 6082\ km = 296$ km increase in radius

The resulting increase in the Earth's radius after impact includes the lithosphere that comprises the tectonic plates; and, a large portion of the athenosphere, a low viscosity and highly ductile layer on which the lithosphere rides. The mixing of the ice and silicate mantles of the Impactor created this athenosphere layer. Further differentiation of the ice and silicates of the Impactor collected under the already existing lithosphere, and created a highly viscous material on top of the upper mantle that aids in the movement of the tectonic plates.

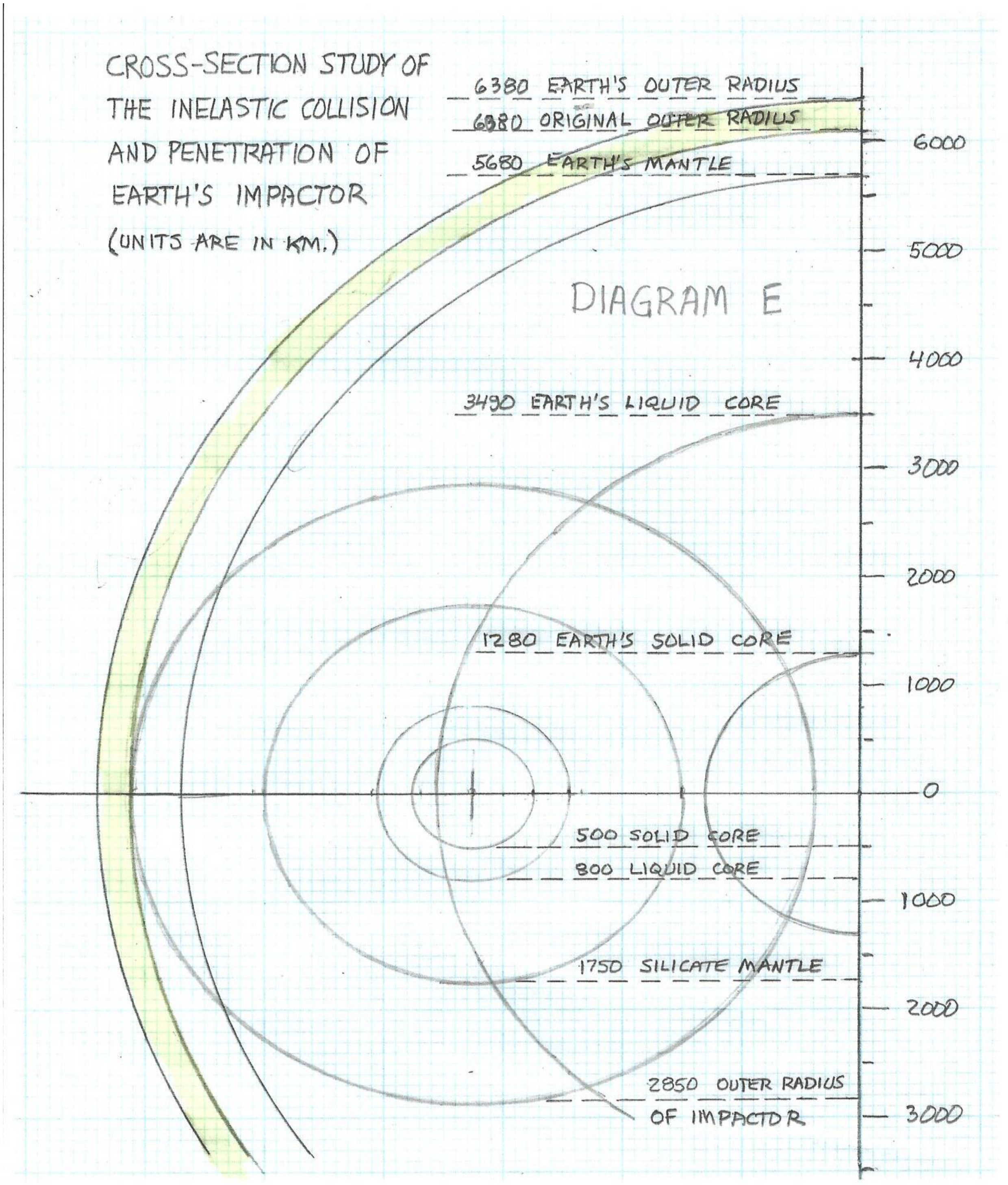
The cross-section study reveals that the Impactor might have reached the Earth's core. More than likely, the spheroid was compressed and flattened and probably only penetrated ½ of the liquid core. The iron and iron sulfides of the Impactor's core would eventually sink and combine with the Earth's core. A mixture of the Impactor's icy and silicate mantles and the Earth's silicate mantle were ejected onto the surrounding oceanic crust. These mantle materials also oozed from the center of the huge crater to fill the void of the crater. The Earth's original continent was formed this way. The materials of this continent are less dense than the original crust and any future oceanic crusts because it chemically combined with lighter elements and compounds of the Impactor's ice and silicate mantles.

The solidified continental crust material would forever remain less dense~~r~~ than the oceanic crusts. The oceanic crusts develop from the rise and cooling of the Earth's original mantle materials which are denser and increase in density through thermal contraction. During any movements of the oceanic plates against continental plates, they will subduct and always go under the lighter continental crusts, thereby preserving cratons of original rock near the centers of most continents that were part of the first super continent. These cratons solidified 3.9 to 3.5 billion years ago [z] after the first continent rose from the crater of Earth's Impactor to mark the time of impact.

Many of the more volatile materials such as CO_2, H_2O, and CH_4 from the Impactor would be dispersed throughout the Earth's very molten mantle, eventually differentiate, and rise to the Earth's surface only to be trapped underneath by the existing hardened oceanic crust and newly crystallized continental crust. These trapped pockets of volatiles would then create migrating hot spots that would continue to present times to cause volcanic eruptions not connected to subduction zones.

Further proof of the creation of the first super continent on Earth is the distinctively different compositions of the most abundant compounds found in the oceanic and continental crusts. From computations based on 1672 analyses of all kinds of rocks, a geochemist, F.W. Clark, deduced that 99.22% were composed of 11 oxides [aa]. In another book, The Inaccessible Earth, by Geoff C. Brown and Alan E. Mussett the percentages of these oxides were compared for both continental and oceanic crusts. These percentages were consistently different for each type of crust proving that differentiation of these molten materials came from two different sources [bb].. Those sources were the mantles of the Earth and its major Impactor.

Diagram E: Cross-Section Study of the Inelastic Collision and Penetration of the Earth's Impactor



J. Conservation of Energy Before and After the Collision

Our primary interest in this conservation of energy during the collision stems from what rotational kinetic energy possibly remains after considering the "before" and "after" linear kinetic energies of the collision. This rotational kinetic energy is then applied to how the Earth obtained its spin axis tilt. An assumption makes the angle of impact approximately perpendicular to the Earth's orbital velocity. Then any change to the rotational spin velocity is neglected; any remaining energy necessary to balance the conservation of energy goes into only rotating the spin axis perpendicular to its direction thus causing the Earth's tilt. See Diagram F, "The Creation of Torque to Tilt the Earth's Spin Axis".

Do not forget that energy losses due to heat, dispersal of debris, etc. are already in a previous equation that balanced the components of linear momentum. Hence, the resultant linear momentum that is used in this following equation accounts for ~~the~~those other energy losses.

Consider now the balancing of kinetic energies before and after collision:

$K_{initial}$ = $\frac{1}{2} m_e u_e^2 + \frac{1}{2} m_i u_i^2$ = initial kinetic energies

$\frac{1}{2} I_f \omega_t$ = final kinetic energy of rotation

$\frac{1}{2} (m_e + m_i)\ \cancel{v_F^2}\ v_R^2$ = final linear kinetic energy

K_{final} = $\frac{1}{2} (m_e + m_i)\ v_{R\cancel{F}}^2 + \frac{1}{2} I_f \omega_t^2$ = final kinetic energies = $K_{initial}$

Hence:

$$\frac{1}{2} m_e u_e^2 + \frac{1}{2} m_i u_i^2 = \frac{1}{2} (m_e + m_i)\ v_r^2 + \frac{1}{2} I_f \omega_t^2$$

Where the individual values are:

ω_t = the average angular velocity to be determined
m_e = initial Earth's mass = 5.72×10^{24} kg
m_i = Impactor mass = 0.25×10^{24} kg
u_e = initial orbital velocity of Earth = 18.5 kg
u_i = initial velocity of Impactor normal to spin axis of Earth = 45 km/s
$m_e + m_i$ = $5.72 \times 10^{24} + 0.25 \times 10^{24} = 5.97 \times 10^{24}$ kg
v_R = resultant velocity of combined Earth and Impactor = 17.2 km/s
Note: This computed resultant velocity has already accounted for energy losses due to heat, noise, light, dispersion of debris, and reductions in both bodies' spin created during the collision. The assumed value of 10% is one of the larger questions of this model but is probably the right scale considering that the Earth's orbit and tilt are changed.
I_f = final moment of inertia after Impactor is imbedded in Earth's mantle
I_f = $I_e + I_i$ = moment of inertia of Earth assuming perfect sphere and constant density + moment of inertia of Impactor about center of the Earth's axis

$= 2/5\ m_e\ r_e^2 + (m_i r_i^2 + m_i h^2)$ where

h $=$ perpendicular distance between two parallel axes of the two center of gravities

Set

h $=$ 3500 km (with aid of Diagram E)

$=$ approximate distance of center of imbedded Impactor from the center of the Earth

$K_{initial}$ $= ½\ (5.72 \times 10^{24}\ kg) \times (18.5\ km/s)^2 + 1/2\ (0.25 \times 10^{24}\ kg) \times (45\ km/s)^2$

$= 978.8 \times 10^{24}\ kg\ km^2/s^2 + 253.1 \times 10^{24}\ kg\ km^2/s^2$

$= 1232 \times 10^{24}\ kg\ km^2/s^2$

K_{final} $= ½\ (5.97 \times 10^{24}\ kg) \times (17.2\ km/s)^2 + ½\ [\ 2/5\ (5.72 \times 10^{24}\ kg) \times (6380\ km)^2$

$+ (0.25 \times 10^{24}\ kg) \times (2850\ km)^2 + (0.25 \times 10^{24}\ kg) \times (3500\ km)^2\ ] \times [\omega_t^2]$

$= (883.1 \times 10^{24}\ kg\ km^2/s^2) + ½\ [\ 9.31 \times 10^{31}\ kg\ km^2 + 0.20 \times 10^{31}\ kg\ km^2$

$+ 0.31 \times 10^{31}\ kg\ km^2\ ] \times [\omega_t^2]$

$= 883.1 \times 10^{24}\ kg\ km^2/s^2 + [\ 4.91 \times 10^{31}\ kg\ km^2\ ] \times [\omega_t^2]$

And then:

$K_{initial}$ $= K_{final}$

$= 1232 \times 10^{24}\ kg\ km^2/s^2$

$= 883.1 \times 10^{24}\ kg\ km^2/s^2 + [\ 4.91 \times 10^{31}\ kg\ km^2\ ] \times [\omega_t^2]$, and solving for ω_t

ω_t $= \sqrt{\ [\ (1232 \times 10^{24}\ kg\ km^2/s^2 - 883.1 \times 10^{24}\ kg\ km^2/s^2\ )\ /\ (\ 4.91 \times 10^{31}\ kg\ km^2\ )]}$

$= \sqrt{\ [\ (349 \times 10^{24}\ kg\ km^2/s^2) / (4.91 \times 10^{31}\ kg\ km^2\ )]}$

$= \sqrt{\ [\ 7.1 \times 10^{-6}\ (radians/sec)^2]}$

$= 2.66 \times 10^{-3}$ radians/sec = rotation velocity about the tilt axis

$= 2.66 \times 10^{-3}$ radians/sec x 57.3°/radian = 0.152°/sec = 9.12°/minute

$=$ angular velocity (radians/s) = Θ/t

t $= \Theta/\omega_t$ = .401 radians (for 23° tilt) / .00266 radians /s = 154s = 2.6 minutes -

This~~Which~~ which is very fast; the time for the Impactor to break through the lithosphere and penetrate the mantle and become compressed is not included,~~. Neither~~ nor is additional time for angular impulse considered.

I_f $= (9.31 + 0.20 + 0.31) \times 10^{31}\ kg\ km^2/s^2 = 9.82 \times 10^{31}\ kg\ km^2/s^2$

$½\ I_f \omega_t^2$ $= ½\ (9.82 \times 10^{31}\ kg\ km^2) \times (2.66 \times 10^{-3}\ radians/s)^2$

$\approx 349 \times 10^{24}\ kg\ km^2/s^2 = (1232 - 883) \times 10^{24}\ kg\ km^2/s^2$ = kinetic rotational energy.

This computed kinetic rotational energy generated by the collision can now be applied to tilting the Earth.

K. Calculation for the Tilt of Earth's Spin Axis

Now the necessary parameters are available for calculating the possible amount of tilt of the Earth's spin axis caused by the impact. Some new assumptions are presented (see Diagram F). The Impactor's path is set for an offset of r_{offset} = 3000 km south of the Earth's equator. The amount of work available to create the force acting on Earth's mass equals the total kinetic rotational energy available or 349 x 10^{24} kg km^2/s^2 determined from the previous section. This rapidly changing force and torque acts over a certain distance that resists penetrating the Earth's mass. This distance is set at s = 1200 km for the first large decrease in velocity, since the remaining motion energy for the Impactor to penetrate the Earth goes into the compression and sideways dispersal of the Impactor's materials inside the Earth's mantle. The energy also goes into expanding the mean average of the Earth's radius to about 300 km thereby creating the various plates in the Earth's crust. Hence, the further speed reductions are estimated in steps to realistically portray the varying or differential rate of rapid de-acceleration. The total distance of penetration is assumed at 5200 km which in reality is a combination of penetration of the Earth's mantle and the compression of both the Impactor and the Earth's mantle. The work to tilt the Earth is divided into two parts. The first part of work is to penetrate the Earth's mantle and the second part is to create angular movement from the build-up of torque on Earth's sphere. These two parts of work are set equal to the previously computed kinetic rotational energy. The energy of a body is its ability to do work. Both work and energy are scalar quantities.

~~W_L~~ W_{total} = the work to provide the force that begins the Earth's rotation about its tilt axis orientation = 349 x 10^{24} kg km^2/s^2
= F (force) x s (distance that approximates a constant force acting on boring through the Earth)
= Energy of a body in terms of the work it can do
= F_1 x s_1 + F_2 x s_2 + F_3 x s_3 + …….. + F_n x s_n, where

F_n = $m_{impactor}$ x a_n
a_n = de-acceleration of Impactor = $(v_i^2 – v_n^2) / 2s$
t_n = $2s / (v_i – v_n)$

The first de-acceleration is from 45 to 10 km/s~~^{2}~~ over a distance of 1200 km.; the second de-acceleration is from 10 to 2 km/s ~~^{2}~~ over a distance of 3000 km.; the third de-acceleration is from 2 to 1 km/s ~~^{2}~~ over a distance of 500 km.; and the fourth de-acceleration is from 1 to 0 km/s~~^{2}~~ over a distance of 500 km. The selection of these values is strictly intuitive. A better basis for this modeling may eventually become available.

a_1 = [(45 km/s)^2 – (10 km/s)^2)] / 2 x 1200 km = 0.802 km/s^2

t_1 = 2 x 1200km / (45 km/s – 10 km/s) = 69 seconds

F_1 = 0.25 x 10^{24} kg x 0.802 km/s^2 = 0.201 x 10^{24} kg km/s^2

W_{L1} = F_1 x s_1 = (0.201 x 10^{24} kg km/s^2) x 1200 km = 241 x 10^{24} kg km^2/s^2

a_2 $= [(10\ km/s)^2 – (2\ km/s)^2)] / 2 \times 3000\ km = 0.016\ km/s^2$

t_2 $= 2 \times 3000km / (10\ km/s – 2\ km/s) = 750$ seconds

F_2 $= 0.25 \times 10^{24}\ kg \times 0.016\ km/s^2 = 0.004 \times 10^{24}\ kg\ km/s^2$

W_{L2} $= F_2 \times s_2 = (0.004 \times 10^{24}\ kg\ km/s^2) \times 3000\ km = 12 \times 10^{24}\ kg\ km^2/s^2$

a_3 $= [(2\ km/s)^2 – (1\ km/s)^2)] / 2 \times 500\ km = 0.003\ km/s^2$

t_3 $= 2 \times 500\ km / (2\ km/s – 1\ km/s) = 333$ seconds

F_3 $= 0.25 \times 10^{24}\ kg \times 0.003\ km/s^2 = 0.0007 \times 10^{24}\ kg\ km/s^2$

W_{L3} $= F_3 \times s_3 = (0.003 \times 10^{24}\ kg\ km/s^2) \times 500\ km = 1.5 \times 10^{24}\ kg\ km^2/s^2$

a_4 $= [(1\ km/s)^2 – (0\ km/s)^2)] / 2 \times 500\ km = 0.003\ km/s^2$

t_4 $= 2 \times 500\ km / (1\ km/s – 0\ km/s) = 333$ seconds

F_4 $= 0.25 \times 10^{24}\ kg \times 0.003\ km/s^2 = 0.0007 \times 10^{24}\ kg\ km/s^2$

W_{L4} $= F_4 \times s_4 = (0.0007 \times 10^{24}\ kg\ km/s^2) \times 500\ km = 0.4 \times 10^{24}\ kg\ km^2/s^2$

a_{total} $\approx 45\ km/s^2$ de-acceleration over a distance of $s_{total} \approx 5200$ km total distance

t_{total} $\approx t_1 + t_2 + t_3 + t_4 = (69 + 750 + 333 + 333)$ seconds ≈ 1485 seconds = 24.8 minutes

F_{total} $\approx F_1 + F_2 + F_3 + F_4 = (.201 + 0.004 + 0.0007 + 0.0007) \times 10^{24}\ kg\ km/s^2 \approx 0.207 \times 10^{24}\ kg\ km/s^2$

$W_{L(total)}$ $\approx (241 + 12 + 1.5 + 0.4) \times 10^{24}\ kg\ km^2/s^2 \approx 255 \times 10^{24}\ kg\ km^2/s^2$

L $=$ torque to rotate Earth about the tilt axis orientation $= F_{total} \times r_{offset}$
$= (0.207 \times 10^{24}\ kg\ km/s^2) \times (3000\ km) = 6.21 \times 10^{26}\ kg\ km^2/s^2$

W_R is the work to rotate the Earth from its initial spin axis orientation that is perpendicular to the ecliptic to a certain angle equal to the Earth's tilt with respect to the ecliptic plane. This work starts after the angular impulse is completed.

W_R $= L \times \Theta$ $kg\ km^2/s^2$, where Θ = angular displacement in radians

$W_{total} = W_{L(total)} + W_R = 349 \times 10^{24}\ kg\ km^2/s^2$, since the work to slow the Impactor within the Earth's molten mantle is added to the work to rotate the Earth's spin axis orientation; these types of work occurred sequentially.

W_R $= W_{total} – W_{L(total)} = (349 \times 10^{24}\ kg\ km^2/s^2) - (255 \times 10^{24}\ kg\ km^2/s^2) = 94 \times 10^{24}\ kg\ km^2/s^2$

Θ $= W_R / L = (94 \times 10^{24}\ kg\ km^2/s^2) / (6.21 \times 10^{26}\ kg\ km^2/s^2) = 0.151$ radians x 57.3^o /radian $= 8.7^o$ of tilt

To achieve $\Theta = 0.401$ radians x 57.3^o /radian $= 23^o$ tilt, the torque is decreased by choosing less offset. Let $r_{offset} = 1130$ km below the Earth's equator. Then the new torque ~~=~~ is

L $= (0.207 \times 10^{24}\ kg\ km/s^2) \times (1130\ km) = 2.\cancel{48}\ 34 \times 10^{26}\ kg\ km^2/s^2$

Θ $= W_R / L = (94 \times 10^{24}\ kg\ km^2/s^2) / (2.34 \times 10^{26}\ kg\ km^2/s^2) = 0.401$ radians

Of added interest is the angular impulse time ~~to start~~span for the Earth's tilt after the Impactor almost comes to rest inside the depths of Earth's mantle.

L x t = unbalanced angular impulse
= $I(\omega_t - \omega_o)$ = change in angular momentum and hence,
t $= I\ (\omega_t) / L$ where $\omega_o = 0$
$= (9.82 \times 10^{31}\ kg\ km^2) \times (0.00266\ radian/s) / (2.34 \times 10^{26}\ kg\ km^2/s^2)$
= ~~1110~~ 1116 seconds = 18.5 minutes

The total time computed for this collision scenario is the time for the Impactor to penetrate the Earth, t = 25 minutes; the time for the angular impulse, t = 18.5 minutes; and the time to make the angular displacement, t = 2.5 minutes determined from the previous section. The sum of times is 46 minutes. No observers would ever survive to see this one-time event of the stars moving at supersonic speeds across the sky as Earth made probably the only major angular displacement in its history. The solar system does reveal other large planetary bodies brutally struck and heeled over. This event is common, but hopefully not too frequent.

This angular displacement occurred very quickly and helped to spread the materials that were ejected and/or spilled from the crater over a large area and on top of the Earth's already hardened surface. Any forming huge crater rim is destroyed. The small iron core of the Impactor eventually sinks toward the Earth's center to join the much larger liquid/solid iron and nickel core.

A depiction of how the Earth stabilized its new tilt axis is shown in Diagram G. In View A of Diagram G the Impactor is making initial contact with the Earth's original atmosphere and crust creating a dispersal of debris from the Impactor's surface materials, the Earth's hardened crust, and from the Earth's original lithosphere.

View B depicts the impulse force beginning to tilt the Earth's spin axis, cause an initial crater, and displace the Earth's mantle materials. This mantle displacement will create Earth's original rifts or cracks throughout its hardened surface.

View C indicates how the remaining rotational energy continues to tilt the Earth after the translational and rotational kinetic energies transfer. The original spin axis assumed to be close to the ecliptic plane changes by 23^0 after de-accelerating to zero angular velocity. This process is similar to pushing a spinning toy top just enough to tilt it but not enough to knock it over.

Much of the material of the frozen volatiles of the Impactor are melted and either mixed with the Earth's mantle, or ejected outward from the crater into Earth's hot atmosphere, or mixed and flowed over the Earth's original crust to form the first continent.

In View D and Section D-D the lighter embedded materials of the Impactor create an imbalance since the center of gravity no longer goes through the spin axis. The imbalance is significant since the average estimated densities of the Impactor and the Earth's mantle are 2.5 g/cm^3 and 5.5 g/cm^3 respectively. The trapped, forced, now gaseous volatiles spread outward circumferentially under the Earth's crust and the newly formed super-continent. Various forces are at work to perform that spreading and outward pushing. The hydrostatic pressures due to gravity push the volatile materials upward. The combination of centripetal forces, the forces from torque-induced precession, and the Coriolis forces spread the volatile materials radially from the central point of impact. All these forces are working together to adjust the center of gravity so it again goes through the center of the Earth's spin axis.

Section D-D indicates how the radial spreading of the Impactor's materials initiates the break-up and spreading across the Earth's surface of the first super-continent. After the partial solidification of the supercontinent, the trapped volatiles underneath act as rollers to move the newly formed continental crust radially outward from the central point of impact.

The Earth's core, which is much more massive than the Impactor, maintains the new spin axis until the different densities become more distributed and homogeneous through forces previously described. The change in Earth's orbital position brings it closer to the Sun and very close to its new neighboring planet, the Moon. The combination of these added changes of gravity forces help to stabilize the tilted spin axis.

Diagram F: The Creation of Torque to Tilt the Earth's Spin Axis

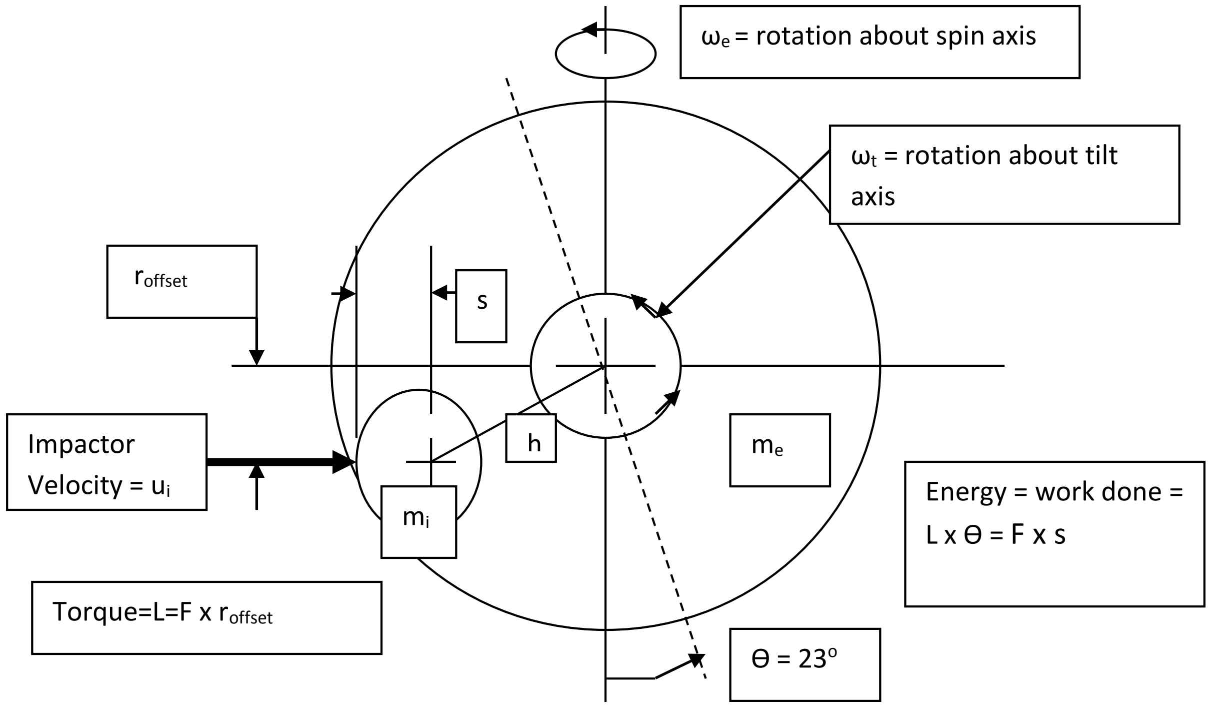


Diagram G: Depiction of How the Earth Stabilized its Tilt

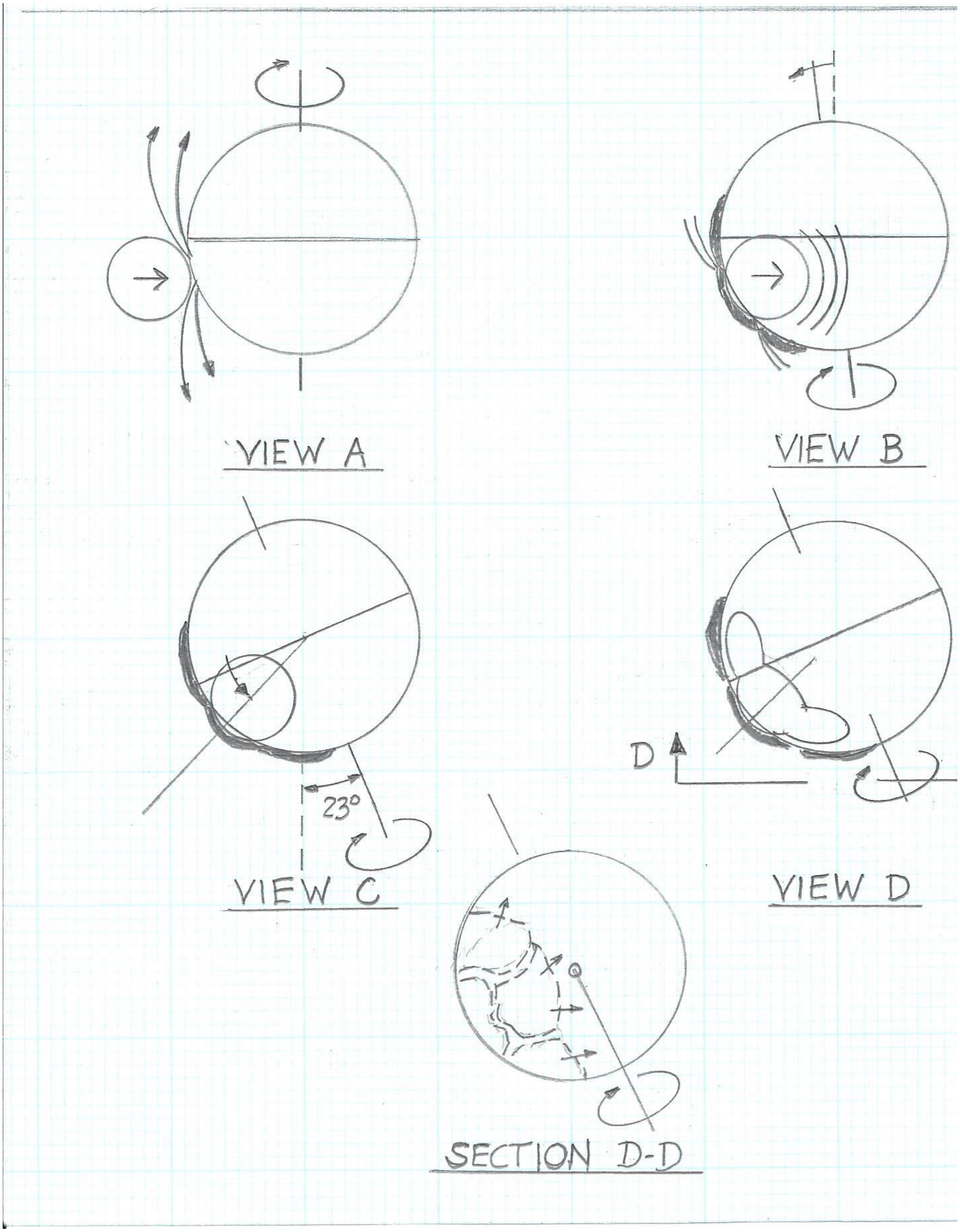
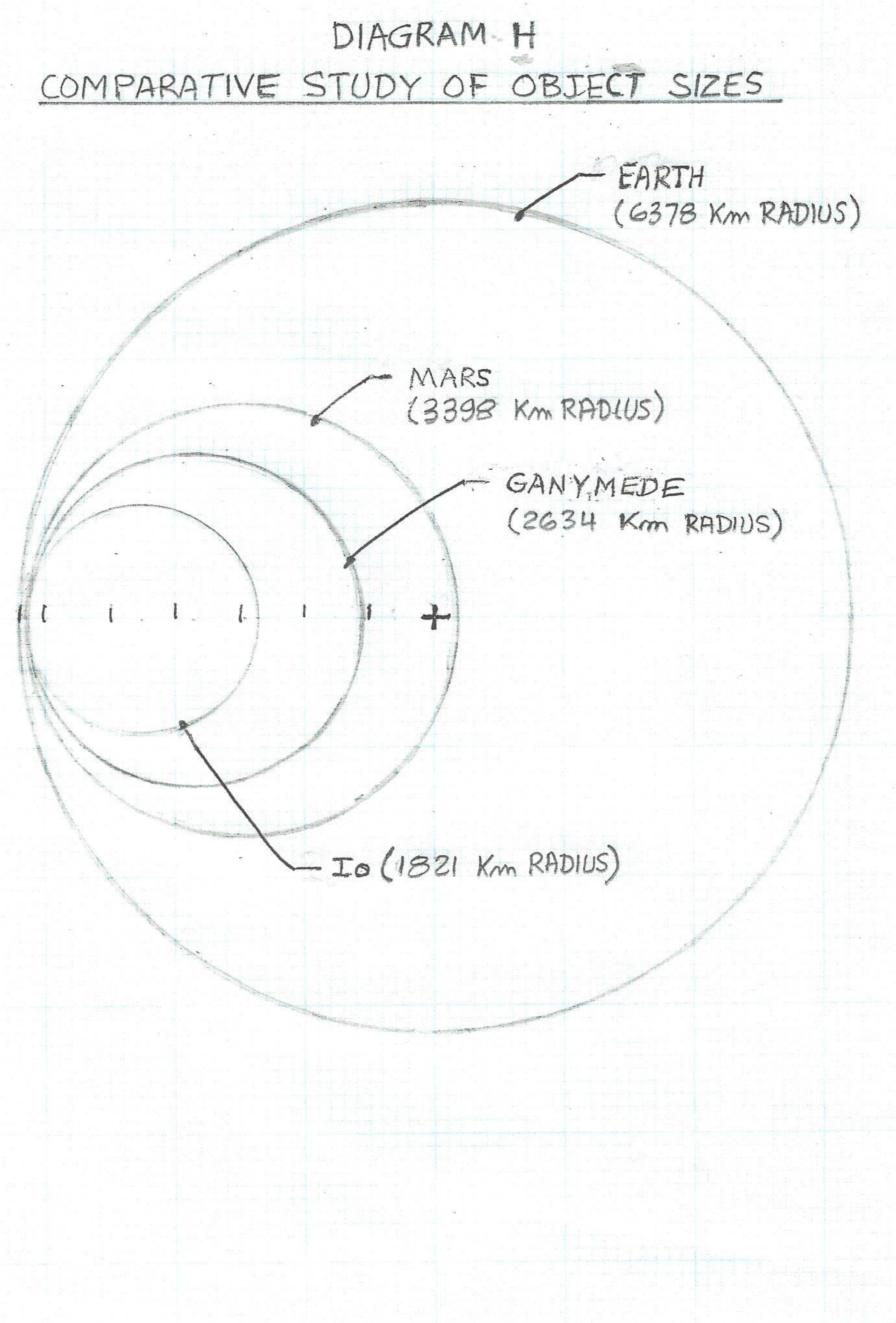


Diagram H: Comparative Study of Object Sizes



L. Conclusions

These calculations are an approximation and do not account for all the details. I did not use any computerized analysis. A computerized analysis is certainly welcomed. This case study does indicate a certain probability for Earth's Impactor and the ~~following~~ portrayed post-collision events.

From the conservation of momentum, a certain linear momentum vector, R, determines the Earth's motion immediately after collision. An almost inelastic collision where most of the Impactor embeds inside the Earth is used. The equation assumes vectors are closely in one plane, that of the ecliptic. An impact angle of 90 degrees to the Earth's orbit produces a reasonable resultant velocity of 17.2 km/s and a vector angle of 22 degrees inward toward the Sun. The final linear momentum vector of Earth after collision could be further enhanced if it includes the gravity field of the much larger postulated planet that carried one of its satellites, the Impactor, into the Earth's orbital region, if indeed the rogue planet was a satellite of another planet with a very large elliptical or a non-returning hyperbolic orbit. ~~Very possibly, the affected changes in this momentum vector increase the probability of this event.~~

Utilizing the conservation of energy, various ~~falling~~ increasing velocities of the falling Earth determine different points along its trajectory in going from a 2.7 AU orbit to a 1.0 AU orbit, the existing one for the Moon. The initial energy components, $K_i + U_{gi}$, are set equal to the final components, $K_f + U_{gf}$. $U_{gf} - U_{gi}$ represent the potential energy lost by the masses falling toward the Sun. K_i assumes the initial velocity is v_R immediately after impact. K_f is computed initially to have an orbital speed higher than what Earth currently has. The computed velocity of ~~31.7~~ 35.4 km/s is reasonable in that it falls between Earth's orbital velocity of 30 km/s and Earth's escape velocity of 42.1 km/s. The initial velocity of ~~33~~ 35 km/s is assumed to conservatively account for the effect of other gravitational fields such as the Impactor's parent planet, possibly Mars, and the Moon that may have ~~increased~~ initially decreased the velocity of Earth.

In order to account for ~~this~~ a reduction in orbital velocity, the Earth exchanged energy with the Moon to achieve a synchronous orbit. ~~Angular~~ Impulse momentum energy is added to the Moon each time as the Earth passes thereby slowing the Earth's velocity incrementally. The impulse momentum pulled the Moon into alternating higher or lower orbits for each passing. ~~in order to produce an orbit around Earth every 12 times for about each orbit of the Earth.~~ This process as computed occurred for 29,000 to 32,000 years until the Earth's velocity became synchronized with the Moon's orbital velocity of 30 km/s. Very close to the time of synchronization the Moon falls toward the Earth gaining an orbital velocity around the Earth of about 1 km/s. In performing this step with kinetic and potential energy conserved the Moon spiraled outward from 90,000 km to 240,000 km where a stable orbit was attained. As computed, approximately 22 spiraling orbits achieved this separation distance of 240,000 km using the conservation of kinetic and potential energies.

All these events occurred before 3.8 bya. Now the Earth and Moon have steady tidal forces or accelerations that eventually slow the rotational period of the Earth from 19.6 to 24 hours.

The Moon, in turn, stops spinning and becomes tidally locked to the Earth very quickly compared to the solar system lifetime. The new tidal forces help stabilize the Earth's spin axis which is now tilted; aids in volcanism that releases volatiles of the Impactor that are trapped under Earth's primordial crust; and induces plate tectonics and the resulting continental break-up and drift. Continuing tidal forces become lesser but still cause the Moon to recede about 38 mm each year as the Earth imperceptibly increases its rotational period. ~~The Moon is raised in its original orbit by a computed distance of 292,000 km to its current orbital distance of 384,400 kilometers. This change adds potential energy to the Moon and removes energy from the Earth in order to preserve the conservation of energy. As it turns out, the computed potential energy of 174 x 10^{24} kg km/s^2 is less than the angular momentum energy of 391 x 10^{24} kg km/s^2.~~

~~These calculations attest to the Earth originally having a faster orbital speed than the Moon and having a distance of only 92,400 km from the Moon. The Earth also had a more elliptical orbit because its velocity was higher than the orbital speed. The Moon and Earth transferred energies thereby slowing Earth on each pass and making its orbit rounder. The Moon moved farther away and became synchronized with Earth by moving back and forth in its orbit as their orbital velocities became matched. This synchronized motion makes it appear that the Moon is orbiting the Earth. Hence, the mystery of how the Moon gained its angular momentum is resolved.~~

Many mysteries of the Earth-Moon system can now be resolved. No bizarre collision mode and rotational period is required to accrete debris for the Moon and provide the desired angular momentum. The Moon was already a planet in the pristine solar system and possessed its own angular momentum before the Earth was captured. The answer is automatically given to why the Moon is the only satellite in the solar system that acts like a planet and is held in its orbit by the Sun's gravity and not the parent planet's gravity. Most questions that arose during the Apollo Missions can be answered by this hypothesis such as the dating of Moon rocks and the much later cooling of the surface mares.

~~Other bonuses of this new system of the Earth and Moon are the tides that over time slowed the Earth's rotation and eventually caused Moon's one side to face Earth. These tides aided in developing life on Earth and breaking apart the original super continent. The sharing of gravity fields preserved the Earth's axis tilt and gave stability to the spin axis.~~

All the calculated values seem reasonable and plausible. The losses due to the impact are estimated at 10 % of the total initial linear momentum of the two bodies which is very plausible when comparing the amount of debris left behind from the impact. The collisional debris was negligible compared to the other masses involved and is neglected in the equations. But, this debris does explain the reason for the asteroid Main Belt, the Trojan asteroids, other random non-coplanar bodies, major later impact periods of the inner planets, captured satellites with collisional properties, and very importantly the Late Heavy Bombardment (LHB) period.

The impact location in all probability was at a latitude well below the equator line thereby causing the tilt of the Earth. A basic trend for solar system formation indicates that all the major bodies have similar rotational vectors that all mostly perpendicular to the ecliptic plane. Major impacts including Earth's impact certainly can explain why some planetary bodies deviate from this trend.

Other factors enter the picture to aid the Earth in finding the Moon's orbit. The falling Earth crosses the orbit of Mars. The fuzziness of the overlapping gravity fields of the Moon and Mars give gravitational flow to the inward moving Earth to help slow and guide its approach to the Moon's orbit. Refer to Course No. 1333, Chaos, Lecture 19, The Chaos of Space Travel, in the Teaching Company's Lecture Series [cc].

The Titius-Bode law is another factor that ~~aided~~ coaxed the Earth in settling into its current orbit. The Titius-Bode law represents a mathematical prediction for the planetary orbital distances from the Sun. Of course, this mathematical phenomenon predicts the average orbital distance of the asteroids [dd] where Earth resided prior to its collision with a major Impactor. This law actually represents the so-called gravity waves [ee] created by a massive object, our Sun, moving through a medium of neutrinos and photons that are the most probable constituents in the so-called vacuum of space. This medium has not yet been detected by man in its waveform structure. Man's instruments are not sensitive enough, but a massive object such as a planet can detect and respond to these gravity waves. The waves become shallower and exponentially farther apart from their source similar to a stone dropped into water and causing circular ripples that radiate outward. The difference in this similarity is we only see the waves on the surface of the ~~medium~~water which rapidly dissipate. However, these ripples or waves are maintained in space as long as the object, ~~planet or stone~~ especially a super massive star, maintains its velocity through the medium. These waves are different in their frequency and amplitude for different masses and velocities and interstellar mediums (ISM's) such as is the case with the main satellite orbital distances around Jupiter and Saturn and distances of exo-solar planets orbiting other stars. And predictably, not all these gravity troughs are filled with orbiting bodies, especially the more shallow troughs farthest from the source body.

Once an orbiting planet or satellite moves into the trough of one these waves and its velocity is between orbital velocity and escape velocity it is generally held in this orbit similar to a speeding race car being held in a turn because of a banked race track. If the orbiting or turning speed is too high and the vector difference is too high for the tangent line of the curve, the body will escape the groove or wave trough and seek ~~the next~~ another wave trough. The general theory of relativity predicts the bending of photons around a massive object, but does not yet test the concept of waves of photons and other so-called massless particles of leptons. These massless particles ~~moving~~ move outward radially due to a wake in the medium caused by ~~from~~ a moving, massive object. These leptons are also emitted from stars themselves and are added to the wake of the star. ~~Perhaps, only the neutrinos do this trick, although I suspect these undetectable, so-called massless objects respond similarly as photons.~~These leptons emitted by the Sun or any star are either charged electrons or chargeless neutrinos and are the major suspects for creating gravity waves that aid in capturing and locating lessor objects around much more massive objects. Celestial mechanics needs to recognize such possibilities.

When the Earth was knocked inward from it pristine orbit around the Sun only certain options can occur:

1. Find a co-orbital residence with one of the inner planets: Mars, Moon, Venus, or Mercury.
2. Collide with one of the inner planets or fall into the Sun.
3. Be slung around the Sun into the outer solar system into a highly elliptical orbit and be dangerously perturbed each time during its annual orbit that crosses other planetary orbits.

It was very fortuitous for mankind that Earth chose the Moon's orbit. The distance from the Sun would place it in the warmer part of the liquid water belt and the Moon's tidal forces would be just enough to promote primitive life after the Moon sufficiently receded. ~~and not~~The initial close distance caused huge pulls on Earth's crust ~~to~~ that created too much heat and ~~movement~~ crustal activity for more organized life forms. But these severe tidal accelerations end well before 3.8 bya to provide ample time for living organisms to start and begin evolving in a more settled and friendly environment. Since the Earth ~~had~~ has a serious tilt in its rotation to its orbital plane from the impact, the Moon's gravity field ~~would~~ provides stability to the Earth's spin so that only a constant, repeatable 26,000-year precession or wobble would occur along with some other trivial wobbles. ~~The tidal forces acting on the Earth's crust aided the tectonic plate movements and caused the separation and spreading of the original continent formed by the collision and abetted further differentiation of trapped volatiles via volcanism.~~ The original, single continent located in high southern latitudes and around the South Pole was created by the mantle and ~~impactor~~ Impactor materials oozing through the ~~impact~~Impactor's immense crater hole in the crust. The lighter mantle materials then displaced or moved outward and over the top of the existing oceanic crusts. The heavier oceanic crusts then sank farther into the mantle to create subduction zones. The tidal forces continued acting on the Earth's crust and aided the tectonic plate movements and caused the separation and spreading of the original continent formed by the collision and abetted further differentiation of trapped volatiles via volcanism.

This hypothesis for the Earth-Moon system provides a marvelous concept, but has a serious incongruence. Where did the Impactor and/or its parent planet come from? The pristine solar system was completed. The planets were mostly differentiated and interplanetary space was mostly evacuated by the Sun's youthful solar winds. How did such a large body, the size of Mars, survive all those years between 4.6 billion years ago (bya), the beginning of the solar system, and the Late Heavy Bombardment period 3.9 bya without being destroyed, ejected or taught to behave by orbiting in some stable, coplanar, almost circular orbit? The present modeling and observations for proto-star disks point to an accretion formation process or some other formation process for the planets that occurs within 100 thousand years or less for a one-solar mass which is not near enough time to accrete the outer planets [ff]. This rapid accretion formation process certainly cannot explain the existence of more planets forming 600 to 700 million years after the star and its original planets formed.

If you stand back and look at the solar system as a whole, you know that other major disruptions have occurred since its original formation. Evidence of these disruptions are planets with spin tilts, retrograde spins, Uranus' spin axis almost 90 degrees to the ecliptic plane, meteor bombardments of different time periods, satellites having collisional properties, satellites having non-coplanar and retrograde orbits, and the gas giants having large spots more than likely caused by collisions into their frozen surfaces [gg].

The only answer for these solar system anomalies -- features that deviate from the general trends of coplanar, almost circular, same directional orbits and spins -- are disruptions by major collisions or near misses of bodies that do not obey the general trends. Where did these massive bodies come from? How did they form? Why did bodies not accrete with others much earlier during the period between the formation of the solar system, 4.6 billion year ago, and the ~~late~~ Late ~~heavy~~ Heavy ~~bombardment~~ Bombardment period of 3.9 billion years ago?. This is a span of 700 million years. If accretion was the major mode of planetary formation, why did the asteroids themselves not accrete over the past 4.6 billion years? Why have not the materials in the rings of the outer planets accreted or fallen into the planet? Why do the comets orbiting the Sun still have volatiles or charged particles that produce comas for these past 4.6 billion years? These volatiles should have been boiled away millions of years ago after a few thousand orbits close to the Sun.

The answer is simply that these "later bodies" of the solar system may not have formed during the early period of the solar system. These "later bodies" as large as Mars and Pluto and as small as grains of dust around Saturn may have been captured at much later periods by the various gravity fields of the Sun and its already existing outer planets. In fact, as proposed this process of capturing interstellar materials and orbs continues to this day. ~~as evidenced by~~The evidence are the rings around the outer planets, the comets of both regular and irregular orbits, and the recently discovered Plutonian minor planets or Kuiper Belt Objects (KBOs). The Kuiper Belt and the non-proven Oort Cloud [hh] cannot begin to address all the unusual early events in our solar system. The new claim is that our spaceship, solar system, moving around the galaxy at 250 km/second every 230 million years is constantly running into and capturing interstellar materials that may either enter the inner solar system or perturb existing Kuiper Belt Objects that then begin to orbit closer to the Sun.

The next hypothesis, "The Collocation of Stars and Planets" (CSP) will deal with the original Kuiper Belt Objects (KBO's). These objects were initially gathered by the proto-star disk and eventually ejected to the outer perimeters by larger planetary-size objects. Their elongated, elliptical orbits can occasionally be perturbed by the outer planets, if not~~-~~ intruders from interstellar space. Then these original objects of the proto-star disk can also become the so-called "later bodies" that visit the inner solar system~~s~~ between large intervals of time and cause havoc. More generally, the KBO's follow more prograde orbits whereas interstellar intruders may just as well follow retrograde orbits causing more damage in a collision due to the higher kinetic energy of their combined orbital velocities.

Hopefully, this dissertation resolves the Moon's enigma. For future discussions a name will be given to this hypothesis concerning the creation of the Earth-Moon system – "Earth's Metamorphosis (EMM) Hypothesis". The Earth definitely went through a metamorphic process after this major impact.

1. The Earth moved to a warmer orbit and a safer orbit more out of reach of dangerous rogue planets.
2. The Earth's spin axis tilted causing seasons and atmospheric and ocean current changes.
3. The Earth gained a ~~moon~~ Moon that provided life-giving tides.
4. The Earth gained more needed volatiles such as CO_2, H_20, NH_3, and CH_4 that enhanced the oceans and atmosphere and produced abiogenic petroleum, an abandoned hypothesis that needs re-visiting.
5. The Earth gained high ground above sea level, the continents, providing more opportunities for life forms.
6. The Earth gained entrained volatiles in the upper mantle that created plate tectonics and volcanism to re-supply more volatiles to the atmosphere.

~~6.~~7. The Earth provided a sustainable platform for life based on liquid water and carbon molecules unlike the other planets and satellites of the solar system.

The Earth truly went through a metamorphic stage.

This dissertation leads to another important question. How are these materials and sizable orbs formed that collided with Earth and other planetary objects? These bodies do not have the aid of a large interstellar molecular cloud gravitationally collapsing into a proto-star disk. ~~Is an~~Are a interstellar collapsing giant molecular cloud (GMC) and a proto-star disk really necessary for massive bodies to form? Is it possible for random collections of highly dispersed, very cold molecular materials, mostly hydrogen, to collapse gravitationally into a proto-star disk? ~~My~~ This paper's emphatic answer is "no". The current nebular hypothesis is very questionable and does not provide all the answers for one coherent story line. The nebular hypothesis certainly does not address the Moon's enigma.

Very recently, over the past 30 years new, questionable concepts have been proposed to help the struggling nebular hypothesis. The period of heavy bombardment lasting several 100 million years and supposedly ending around 3.9 mya was caused by an outer planet migration, the Nice Theory [ii], that disrupted asteroids in the Kuiper Belt. Another concept is the Oort Cloud, the source of comets that keep arriving into the inner solar system [hhhhhh]. However, problems with the nebular hypothesis still persist [jj].

For the Earth-Moon theory to be satisfying, the "later bodies" that caused all the havoc including Earth's Impactor must be addressed. A second hypothesis is proposed that counters the most recent ideas of the Oort Cloud, the Nice Theory, and Lagrangian satellites for supplying "later bodies". In considering these "later bodies" a new hypothesis by various paths of reasoning and deduction will lead us away entirely from the present ideas of solar system formation, the nebular hypothesis and accretion disks, and into a new concept and realm for forming stars, their binary brethren, and their planets.

~~XVIII.~~XIX. Endnotes

Apologies are given for the majority of cited sources coming from Wikipedia; for those readers desiring more depth in references, consult Wikipedia online. One can expect that Wikipedia's tabulated references for these journals are dated the same as the submittal dates of the journals.

[a] Asimov, Isaac; Asimov on Astronomy; 1975; Anchor Press/Doubleday
[b] Wikipedia; Titius-Bode law
[c] Wikipedia; Continental Crust; Oceanic Crust
[d] Wikipedia; Hot spot (geology)
[e] Wysession, Michael E.; "How the Earth Works" by Professor of Geophysics at Washington University in St. Louis; presented by the Teaching Company
[f] Wikipedia; Mantle plume
[g] Tobin, Harold J.; "Oceanography: Exploring Earth's Final Wilderness"; Professor at University of Wisconsin-Madison; 2011; presented by The Great Courses of the Teaching Company
[h] Wikipedia; Supercontinent cycle
[i] Wikipedia; Earth's magnetic field
[j] Wikipedia; Coriolis effect
[k] Wikipedia; Comets
[l] Wikipedia; Nice Model
[m] Wikipedia; Lagrangian point
[n] http://lunarorigin.com by Tom Powell
[o] http://history.nasa.gov/SP-345/ch24.htm; NASA's journal SP-345 Evolution of the Solar System; Chapter 24 – Origin and Evolution of the Earth-Moon System
[p] Hyde, Christy; "Gas Drag Simulations of Particles in Protoplanetary Disks"
[q] Wikipedia; Age of the Earth
[r] Wikipedia; Earth, Mars, Jupiter, Pluto, Moon, Sun
[s] Wikipedia; Ceres (asteroid), Vesta (asteroid)
[t] Wikipedia; Io (moon), Ganymede (moon), Enceladus (moon)
[u] Wikipedia; Impact crater
[v] Wikipedia; Comet Shoemaker-Levy 9
[w] The Scientific Companion by Cesare Emiliani, 1988, p. 11
[x] Wikipedia; Asteroid
[y] Wikipedia; Escape velocity
[z] Wikipedia; Craton
[aa] Clark, F.W.; Evolution and the Spectroscope (1873), and Data on Geochemistry: Constitution of silicates (1895)
[bb] Brown, Geoff C.; Mussett, Alan E. (1981), The Inaccessible Earth (2nd ed.) Taylor & Francis p. 166; and Morgan, J.W.; Anders, E. (1980) "Chemical composition of Earth, Venus, and Mercury; Proceedings of the National Academy of Science, 77(12): 6973-6977.
[cc] The Teaching Company's Lecture Series, Course 1333, Chaos, Lecture 19, The Chaos of Space Travel.
[dd] Wikipedia; Titius-Bode law
[ee] Wikipedia; Gravity wave
[ff] Wikipedia; Protostar, Proto-planetary disk, Nebular hypothesis
[gg] Wikipedia; Solar system
[hh] Wikipedia; Kuiper Belt, Oort Cloud
[ii] Wikipedia; Nice theory, Later Heavy Bombardment

[jj] Wikipedia; Nebular hypothesis, Problems, and Dormand, John R.; Woolfson, Michael M.; (1989); The Origin of the Solar System – the Capture Theory; and Taylor, Stuart Ross; (1992); Solar System Evolution, a New Perspective