Cosmogony of the Solar System

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Abstract

The original solar system comprised only the giant planets. They accreted in 400 million years as solid, cold, methane gas hydrate bodies, from ice crystals encapsulating dust nuclei. Gas not captured as ice was lost. All features of the giant planets, including temperature excesses, are the result of 'recent' high energy impacts. The proto-terrestrial planets rebounded from similar impacts. Repeated heating (>10^4 K) by tidal and electromagnetic braking at perihelion rapidly reduced their orbits, increased densities by out-gassing of lighter elements, and concentrated iron in their cores. Light elements originally out-gassed, were later recaptured to form oceans and atmospheres.

Background

The Giant Planets

At Gottingen in the 1930's, Rupert Wildt observed the visible reflection spectra of Jupiter and suggested that its atmosphere exhibited 'combination bands,' which indicated large quantities of methane and ammonia were present in its atmosphere. Since these molecules are easily destroyed by ultraviolet solar radiation, he reasoned that the only feasible way they could be sustained was if they were in equilibrium with a deep, convective, hydrogen atmosphere. He further suggested that bulk planetary compositions very rich in hydrogen would also explain the low average densities of the Jovian planets, and even posited the possibility that they may have the same elemental composition as the Sun. In spite of the multitude of data from space probes and thousands of papers on the giant planets planets in the last fifty years, this hypothesis has not changed appreciably since Wildt's time.

Jupiter and Saturn are still thought to be gaseous hydrogen down to the pressure levels of a few megabars, below which the hydrogen molecules are so compressed that the electrons can move freely from one to another, forming an electrically conductive hydrogen 'mantle.' This layer is hypothesized to extend upward from the surface of a denser rocky-iron core, of some 20 or 30 earth-masses, extending to 76 (Jupiter) and 50 (Saturn) percent of their radii, respectively.

The currently accepted accretion process for the 'gas giant' is riddled with problems. Observations of a number of young sun-like stars indicate that the hydrogen gas in their solar nebulae is lost in a few million years, while the dust disks last hundreds of millions of years. But in order to capture the large amounts of gas that supposedly make up these giants, a large rocky-iron core must first accrete, which would require much longer than ten million years. Some models have been constructed which incorporate non-physical initial conditions in order to force

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the proto-planets to form very quickly, in a desperate attempt to solve the dilemma.(1) These are just the last ditch efforts to save a failed hypothesis.

Jupiter

Assuming a solar elemental concentration, the solid rocky-iron core of Jupiter would represent only > 0.5 percent of Jupiter's mass and even if all the ices are included, only 3 percent. However, the latter assumption is not consistent with the large amount of ammonia and methane detected at the cloud tops, the measurements by the Galileo atmospheric probe or the effects produced by the Shoemaker-Levy 9 impacts. The equation of state of conductive hydrogen is not known, because it has not been reproduced in a laboratory in the steady-state, indeed there is no proof that it even exists. In spite of the large rocky-iron core hypothesized in the current model, the Jovian magnetic field is attributed to a dynamo in the conductive hydrogen layer.

In the currently popular paradigm the temperature excesses of Jupiter, Saturn and Neptune are attributed to the tail end of their formation process, i.e. to primordial energy still escaping from their interiors. The exception is Uranus, which exhibits no temperature excess, essentially refutes primordial energy as the source of the temperature excesses. The assumption of hydrostatic equilibrium and an adiabatic lapse rate, implies that the electrically conductive hydrogen layer within Jupiter, as well as the molecular layer, be liquid, in order to convect sufficient thermal energy from the center, calculated to be at 25,000 K. Unfortunately, the current paradigm does not uniquely identify the mechanism by which the energy of formation is being released. In the case of Jupiter, this could be manifested by the growth of the metallic hydrogen 'mantle' and/or the shrinking of the entire planet Because of the great size of Jupiter, the emitted energy would correspond with a shrinkage of the planet by only one millimeter per year - much too small a change to be measured.

Assuming the hydrogen model, including the calculated adiabatic lapse rate and solar abundances, discussed above, a detailed analysis of the chemistry in the convective troposphere was conducted.(2) This resulted in the prediction of the 'famous' three cloud layers of Jupiter. Each of these is due to the condensation of a different molecular species. Their depths in the atmosphere are measured relative to the 1 bar reference level (approximately at the visible cloud tops). In descending order these are; ammonia at 5 km, ammonium hydrosulfide at 40 km, and a dense water ice cloud layer at 65 km. These well defined cloud layers, the 'signature' of the gaseous hydrogen model of Jupiter, were not observed by the Galileo atmospheric probe.

Saturn

Saturn also exhibits a temperature excess. Its lower mass and lower internal pressure make the presence of a conductive hydrogen layer questionable, implying that it may have a different mechanism for releasing its primordial energy and generating its magnetic field. Also, its dipole magnetic field is so axi-symmetric that it appears to violate Cowling's theorem (3), which states that fluid motions cannot maintain an axi-symmetric field. Saturn's core, estimated to be 10 to 30 earth masses, comprises a much larger fraction of its total mass. If it had a solar composition the core could only be about one earth mass. Assuming it is a hot gaseous planet, its central temperature is calculated to be 10,000 to 15,000 K.

Uranus and Neptune

A problem has been recognized in the current literature, concerning Uranus and Neptune. Simply stated, it asks: What happened to the large gas envelopes of these two giant planets? That is, they seem to have the large rocky-iron cores similar to Jupiter and Saturn, but are thought to be mostly ice with much less gas. It has even been suggested that they originally had large gas envelopes, which were 'blown away' early in the history of the solar system by a nearby star in a stellar 'nursery.' Unfortunately no such nursery or star is anywhere to be found. Moreover, it is difficult to understand how this could have so thoroughly removed their gases while not affecting Jupiter and Saturn.

Uranus and Neptune are not sufficiently massive for the existence of a conductive hydrogen 'mantle.' Their lack of massive hydrogen envelopes, assumed for Jupiter and Saturn, precludes a solar composition. These planets are currently considered to comprise rocky-iron cores, surrounded by ice which makes up the bulk of their masses, enveloped in relatively deep molecular hydrogen layers, which are estimated at 30 % of Uranus' and 15 % of Neptune's radius. Neptune is the more massive, 17.26 compared to Uranus' 14.51 earth masses. Measurements of their tidal influence on satellites or rings imply that Neptune is less differentiated than Uranus, which would make sense because it is 30 versus 20 AU from the Sun. This is similar to the Jovian satellites, in which Callisto, the farthest of the Jovian moons from Jupiter, comprises a more undifferentiated mixture of rock and ice than do the interior moons. However, infrared observations indicate that Neptune has an intrinsic energy source 3.61 times the incident solar energy, while Uranus has none, making Neptune warmer than Uranus. The fact that Uranus has no intrinsic energy source raises serious questions about the argument that the heating of the other three giant planets is primordial.

The Terrestrial Planets

The accretion of the terrestrial planets is currently believed to have taken place in the inner solar system close to their present orbits. There are three major problems with this hypothesis. There is no known mechanism whereby dust and gravel sized particles could 'stick together' in order to begin the accretion process. Collisions would be elastic, merely changing the direction and velocities of the two particles. Assuming that there was a mechanism by which larger bodies could form, and they crash into the growing proto-planet one at a time, how did the iron and nickel within each one get into the core of the proto-planet? Assuming ten million years for this process, the large impacts could have been one hundred thousand years apart, during which time the proto-planet would have cooled and hardened, and the lesser bodies would hardly be able to penetrate sufficiently for their iron to reach the center of the planet. Thirdly, how did planets like the Earth later become covered with vast oceans of water and atmospheric gases? The current theory claims that millions of comets carried the water to the Earth from the cold outer solar system. These naive ideas are the best that planetary science has come up with in the last fifty years.

The Proposed Cosmogony

Giant Planets Comprised the Original Solar System

The original solar system accreted from ice crystals, which encapsulated all the refractory compounds now present in the solar system. Since ice was required to enable the accretion of the smallest particles, this process only occurred in the zone from the radius of Jupiter outward. Outbursts from the young Sun quickly expelled gases and dust from the inner solar system. At the radius of Jupiter the dust grains catalyzed the formation of ice particles of H_2O, NH_3, and CH_4, thereby capturing much of the gas in solid form. The gases, primarily hydrogen and helium, that were not incorporated in these solid ices was swept completely from the system in a few million years. This view is corroborated by studies of a number of young, sun-like stars, which show that hydrogen is expelled from their stellar nebulas in only a few million years, before the formation of proto-planets could hardly have begun (4). Conversely, infrared studies of similar nearby stars with ages of 300 to 400 million years have discs of ice and dust, whereas those older than 400 million years do not (5). This is also consistent with NASA's Submillimeter Astronomy Satellite (SWAS) observations, showing large quantities of water in stellar nurseries.

In the proposed cosmogony, the solar system began with the accretion of four giant ice planets, Jupiter, Saturn, Uranus and Neptune in their current orbits. No terrestrial planets were present. The most abundant of these ices was water, because, next to hydrogen and helium, oxygen was the most abundant element in the solar system and because water freezes at the highest temperature. There is no reason to assume, as the current paradigm does, that some ten or twenty million years later, when the 10 to 30 earth-mass proto-giant planets formed, that the accumulation of ice suddenly ceased in favor of the accretion of the long-lost hydrogen gas.

I therefore maintain that the original solar system comprised four giant ice planets, Jupiter, Saturn, Uranus and Neptune, all of which are solid, low density, ice bodies and there are no 'gas giants.' Their initial accretion, perhaps from localized concentrations, was rapid enough, therefore hot enough, to form rocky iron cores from the refractory elements trapped in the ice. However, their great orbital radii dictated that the collection of ice bodies from their entire orbital path required a long time. Most of these bodies melted upon entering the proto-planet's atmosphere and fell as snow. Fred Hoyle analyzed the accretion of Jupiter from first principles and concluded that it took approximately 50 million years and, assuming the accretion of solid matter, this process produced a prograde rotational period of one hour (6). Because of the great time involved, the bulk of their accretion was cold, and the other giant planets accreted more slowly due to their greater orbital radii. Thus the accretion of Neptune is consistent with the observation of sun-like stars, the disks of which are gone after 400 million years. The sizes of the giant planets were dictated by the amount of material available at their orbital radii. The degree of differentiation of iron, rock and ice was also a function of the temperature and the orbital period, and therefore their distance from the Sun. Thus the rock and ices in Neptune are more intermixed.

The current disinclination to recognize the solid nature of the giant planets stem from: 1. Rupert Wildt's hypotheses; 2. The obscuration of the 'gas giant' planet's surfaces; 3. The misinterpretation of the temperature excesses; 4. The current lack of understanding of the natural high pressure states of matter, particularly water in the form of gas hydrates; and 5. The failure to correctly interpret the atmospheric features, the data returned by the Galileo atmospheric probe, and the phenomena produced by the impacts of the Shoemaker-Levy 9 comet fragments. These provide more than sufficient evidence that Jupiter is a solid planet. I have no doubt that Cassini will do the same for Saturn.

Recently planetary/earth scientists have come closer to recognizing the true nature of water at high pressures, primarily as a result of the discovery and study of methane gas hydrates, also known as clathrates, in the Earth. In fact, methane hydrates, found in the high pressure environment beneath the ocean beds in many places on Earth, are considered to be the natural source of energy most likely to succeed petroleum. These gas hydrates are structures of water molecules which form naturally at *low temperature and high pressure* - exactly the conditions in the large bodies of the outer solar system. Based on their gas hydrate research, some scientists have already proposed that these represent the most common form of matter in the bodies of the outer solar system, such as the Galilean moons, Pluto and Charon and the KBOs (6) However, no one has, until now, suggested that the giant planets be included in this list and furthermore that these alone comprised the original solar system.

Solid Evidence

Temperature Excesses

Astronomy textbooks invariably point out that the powerful gravitational fields of the giant planets in the outer reaches of the solar system act to shield the terrestrial planets from marauding comets and asteroids, which could potentially destroy the latter. However, planetary scientists fail to recognize the considerable evidence of just such impacts, probably because the longevity of the resulting features is not consistent with their assumed gaseous composition. The temperature excesses of Jupiter, Saturn and Neptune are one result of such impacts, which bored deeply into their low density gas hydrate surfaces and released large volumes of methane, hydrogen and oxygen which ignited, producing flaming jets which shoot into space from the planet for millennia.

The Great Red Spot and Multiple Zonal Winds

An impact which released more than $>10^{42}$ ergs occurred on Jupiter some 6,000 years BP, and although continuously decreasing for six millennia, it is still responsible for its temperature excess and every other observable Jovian feature. Its great longevity is depicted by a drawing in an arabic document dated around 900 AD shown in Figure 1. The Great Red Spot represents the tail end of that great jet, which is still injecting hot gases into the upper atmosphere above the cloud tops. The gases, being vaporized in the crater, comprise all the elements originally accreted, but they crystallize as they rise through the atmosphere and cool, inflating and coloring the atmosphere and obscuring the surface. This twisting, rising vortex of hot gases drives the multiple zonal jets, which in turn spread the heat from the crater like a thick blanket over the entire planet, disguising its true source.

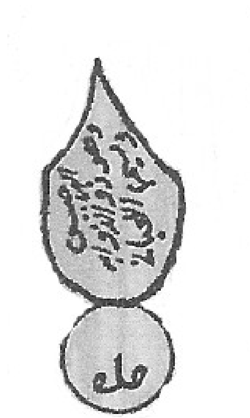

Fig.1 Drawing of Jupiter circa 900 AD with jet still extending more than two Jovian diameters.

The spots, such as the Great Red Spot (GRS) on Jupiter, the recent White Spot on Saturn and those also found on Uranus and Neptune, are the direct result of the energy still being ejected from ancient impact craters. The GRS has persisted at the same latitude (23 degrees S) for as long as it has been observed - some 350 years, an impossibility for a 'storm' on a planet with such a strong Coriolis acceleration. The hot gases emanating from the Jovian impact crater rise above the cloud tops, forming an atmospheric high and therefore appearing colder than the surroundings, further disguising its hot origin. As the hot gases rise, the Coriolis acceleration on the rapidly rotating planet induces a strong vorticity in the column, which has a horizontal as well as a vertical component. This imparts opposite velocities and vorticities to the atmosphere to its north and south, giving rise to the primary wind belts. These in turn impart opposite velocities and vorticities to the distal zones to their north and south, creating the entire system of zones and belts. Observations of the winds and vorticity within Jupiter's atmosphere and the GRS verify this scenario (7). Current models, based on the 'gas giant' paradigm fail to produce *multiple zonal jets* (the belts and zones) because they assume the atmosphere is not bounded below by a shallow solid surface. As soon as such a surface is introduced, multiple zonal jets appear. The notion that the boundary of the conductive hydrogen 'mantle' could serve this purpose contradicts the requirement that it be a convective liquid at a depth of 37,000 km (8).

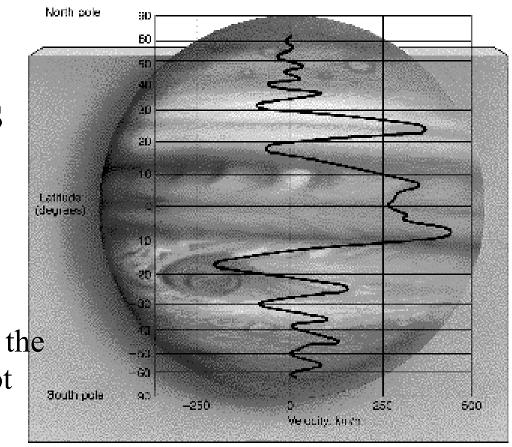

Fig.2 Strongest westerly zonal wind coincides with north side of counter-clockwise rotating GRS.

The latitudinal asymmetry of the zonal winds, with the strongest westerly at the latitude of the northern edge of the counter-clockwise rotating GRS is further evidence that the entire system is being driven by the hot gases still being emitted from the impact crater. If the energy source were primordial there would be no such asymmetry.

The 'drift' of the GRS relative to an *assumed constant rotation period* of Jupiter, is usually cited as evidence that it is merely a large storm on a gaseous planet. In Figure 3 it exhibits a gradually declining monotonic westerly 'drift' which ended in 1932. I maintain that this represents the tail end of a six millennia deceleration of Jupiter's rotation due to the mass, i.e. angular momentum ejected by the jet, centered in the GRS. If Hoyle's initial calculation of a primordial rotational period of one hour is correct, the ejection of mass at the time of the impact and during the subsequent six millennia has reduced the period to approximately ten hours.

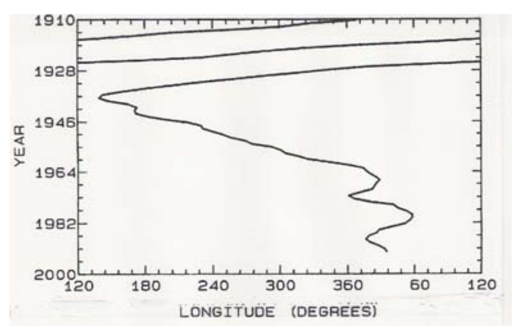

Fig 3 'Drift' of the GRS since 1910 is a plot of the deceleration of Jupiters up until 1932. (from *Jupiter*, by Reta Beebe)

Rings

Many scientists apparently believe that planetary rings are primordial but this notion is in conflict with theorists who claim they would dissipate in a few hundred million years. The question naturally arises why, if the rings are primordial, do they still exist around all the giant planets, particularly the vast collection surrounding Saturn, shown in Figure 4. The currently accepted explanation is that as particles are lost, they are replaced by new ones spalled off small satellites interspersed within the ring systems.

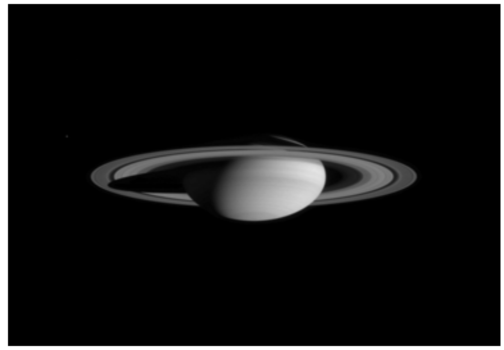

Fig.. 4 A 'recent' impact on Saturn blasted the water from its surface to form its rings. (NASA Cassini photo)

In the proposed paradigm a 'recent' high energy impact on Saturn sent water from the surface into space. This is consistent with a gas hydrate makeup, since they are formed primarily of water molecules. The material which did not have sufficient velocity to get outside the Roche limit formed its beautiful ring system shown in Figure 4. An ancient long-lived jet may have also contributed water to the ring system for millennia after the the impact, as they have on the other giant planets.

Galileo Atmospheric Probe

This probe's primary purpose was to confirm the existence of the famous three cloud layers predicted by the equilibrium condensation model (2) in a hot convecting atmosphere. The fact that no such cloud layers were found counters the gas giant hypothesis. Initially, the failure to find the cloud layers was attributed to the notion that the probe entered a non-typical zone in which the atmosphere was descending instead of rising. However, the reprieve was quickly denied when the Cassini probe took 'motion pictures' of Jupiter, showing that the entry zone was one of rising air, in which the cloud layers should have been present.

The probe sensed an unexpectedy high upper atmosphere density and temperature. It also detected winds at depths greater than can be explained by differential solar influx. Moreover, the latitudinal asymmetry of the zonal jets mitigates against both solar and primordial explanations. In the proposed paradigm these are driven by the column of hot gases emanating from the 6,000 year old impact crater, manifested by the GRS at the cloud tops. The probe's mass spectrometer found less-than-expected quantities of helium, neon, water, carbon, oxygen and sulfur. The latter four are in direct conflict with the large amounts observed in the main events from the larger Shoemaker-Levy 9 impacts. This is because these elements are frozen in the body of the planet. The primordial noble gases were depleted when they became entrained in the jet.

Shoemaker-Levy 9 Impacts

Observations of the individual S-L 9 impacts made it clear that the more massive fragments produced different phenomena than the rest. I maintain that these fragments penetrated the atmosphere of Jupiter and impacted its solid gas hydrate surface. The impact site of the G fragment is shown in Figure 5 with a radiating shockwave. The six to ten minute delay in the 'main events' were the times required for the great mushroom clouds to rise from the surface impacts. They appeared above the cloud tops as earth-sized plumes, which saturated infrared detectors for hours and remained visible for weeks. The argument that these plumes were due to the ballistic reentry of the expended fireball molecules is weakened by the unexpectedly high density of the clear 'air ' measured above the cloud tops by the atmospheric probe, which would have 'thermalized' the fireball atoms/molecules, precluding their proposed ballistic free fall. The high density of the atmosphere above the cloud tops was reinforced by the 'bolide' precursor flashes that marked the entry of each fragment. The shock waves seen emanating from the impact sites of the larger fragments were due to surface impacts, which also released large amounts of oxygen, sulfur, carbon, water and methane along with a number of heavy elements observed in the earth-sized plumes.

Fig. 5 The shock wave produced by the impact of the G fragment on the surface of Jupiter.

The large quantities of methane in the atmospheres of the giant planets is consistent with a clathrate composition, since methane is the most common molecule found within gas hydrate structures. The atmosphere of Jupiter is not primordial. It comprises a mix of primordial gases and all the molecular species currently being ejected from the 6000 year old impact crater. The noble gases are depleted because some of primordial atmospheric complement was entrained in the jet and carried into space. The less-than-expected concentration of water measured by the Galileo atmospheric probe is due to the fact that much of the water emanating from the crater freezes and falls as snow back on to the cold surface of the planet. The seemingly contradictory measurements of large amounts of oxygen resulting from the impacts of the more massive S-L 9 fragments were released from the surface impacts and carried to the cloud tops by the resulting mushroom clouds. The greater than expected D/H ratio is consistent with the proposed paradigm, since ice from which the hot gases are being expelled should be enriched in deuterium relative to hydrogen in the primordial atmosphere. Thus many Jovian features can be explained by impacts on their solid clathrate bodies.

Origin of the Terrestrial Planets

The gas hydrate composition of the great planets is a necessary aspect of the creation of the terrestrial planets. The giant planets are natural 'bombs,' waiting to go off. They explode locally in response to high energy impacts, causing the rebound of a massive amount of material from the crater into interplanetary space. Fortunately, the entire process was recorded in ancient chants, primarily the Rig Veda, a time-ordered hymn of a thousand stanzas, which begins with the impact on Jupiter 6,000 years BP resulting in the birth of *Aditi*. This event marked the birth of a new terrestrial planet, proto-Venus. The impact, perhaps of a galactic traveler, on Jupiter has released a total of ~10^{43} ergs in the last six millennia, but the energy released upon impact was somewhat less. A vast amount of the total energy resulted from the reaction of the methane gas hydrates in the impact crater. A glowing cloud of plasma many times the mass of Venus and thousands of times the volume of Jupiter, rebounded into space interplanetary space. The immediate effect of the impact caused notable disturbances of the Earth, which were recorded by many ancient cultures. These were due to either to gravitational radiation or the passage of the impacting body close to the Earth on its approach to Jupiter. Most of the rebounded plasma cloud escaped Jupiter and entered an eccentric orbit around the Sun. It quickly contracted, giving up its gravitational potential energy and forming a star-like proto-Venus, with a temperature well above 10,000 Kelvins. The remainder formed the proto-Galilean moons, the many smaller satellites of Jupiter, and some probably became the first main belt asteroids.

The perihelion of proto-Venus was probably closer to the Sun than the ancient orbit of what I call priori-Mars, which was in an orbit similar to that of Venus today. Its initial aphelion was near Jupiter's orbit, giving an orbital period of some five years. But the great energy of its eccentric orbit was rapidly converted to heat, due to its first fifty or so interactions with the Sun, at perihelion. The tidal force of the Sun greatly distorted its fluid body and induced chaotic motions of its interior. At the same time, *electromagnetic forces*, due to the interaction of its ionized body with the magnetic field of the Sun converted even more of its orbital energy into internal heat. Each of these interactions reheated it to over 10,000 K, reduced its orbital velocity. The resulting reduction of its aphelion and period increased the frequency of these interactions, until after only a few decades its eccentric orbit was brought inside that of the Earth. This rapid reduction was accomplished with the aid of innumerable close interactions with priori-Mars which was originally in an interior orbit. The net effect of these interactions was not only the reduction of proto-Venus' orbit but also the increasing of the orbit of priori-Mars to the point that it began crossing the orbit of the Earth.

The repeated elevation of proto-Venus' temperature caused massive volumes of the more volatile, lighter elements, hydrogen, oxygen, carbon and sulfur, which dominated the cloud ejected from Jupiter by the impact, to be out-gassed and lost to space, by Jeans, or thermal, escape. Thus the same heat generation which rapidly reduced its aphelion resulted in the increasing of its average density to over 5 g/cm^3, characteristic of a terrestrial planet. Although the volatile light atoms, were initially lost to space, they remain in the inner solar system and are being captured by Venus as it cools and by extant planets such as the Earth, perhaps in the form of tenuous house-sized snowballs (10). This process of obtaining oceans and atmosphere is more physically appealing than the current hypothesis, that billions of primordial comets delivered all the volatile compounds found on the mature terrestrial planets, over the life of the solar system.

This process also explains how iron and nickel are immediately concentrated in the core, and the how the hot radioactive elements thorium, uranium and potassium fractionate to the surface, along with the less dense elements which form surface rocks. It also explains the great amount of heat in the interior of the terrestrial planets. *This is how all terrestrial planets were formed.*

An interesting corollary of this paradigm is that each terrestrial planet has a unique age, and all are younger than the giant planets. Based on the oldest Martian meteorite ages compared with the oldest rocks found on Earth, Mars is some 800 million years older than the Earth, and Venus is only 6,000 years old (11).

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