## Papers

# Advances in Integrating Cosmology: The Case of Cometesimals

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### ABSTRACT

*A review of Louis A. Frank's discovery of the evidence for cometesimals, small comets, is completed. The primary evidence for them is data collected by a polar orbiting satellite designed to study ultraviolet light. The first data were collected in 1981 which indicates that as many as twenty 100-ton comets enter the Earth's atmosphere every minute, adding an estimated 100 million tons of water annually. That these little comets may historically have been a major source of the Earth's water has implications for abiogenesis, as well as for theories which indicate that a great amount of interconnectedness exists between the Earth and the solar system, if not our galaxy and our galaxy cluster. The interrelationship of these structures is compared to that between humans, plants and animals forming an ecosystem in which all of the major parts are necessary.*


### INTRODUCTION

Louis Frank discovered evidence in the early 1980s that approximately up to about twenty 100-ton comets consisting of frozen water slam into the Earth's atmosphere each minute.' These mini-comets or cometesimals are often about the size of a small house, and the ten million per year average rate of cometesimals adds an estimated 100 million tons of water to the Earth annually.[25] Frank estimates that they have been dumping water on the Earth for eons. If this is true, they would be the major source of the water for our oceans, lakes and rivers.[6] Increases in the cometary shower rate could have caused the ice ages, and may even be responsible for the extinction of certain animal species such as the dinosaurs.[78] The volume of water on Earth is either slowly increasing, or the water lost from the outer atmosphere into outer space may currently equal the level gained.

An enormous amount of water is necessary for life to exist on the Earth. Fully 75 per cent of the Earth's surface is water, the most common liquid on the planet. Water is critical for life for numerous uses, including as a biological carrier molecule, for thermal regulation, plant growth, as the universal solvent, and many other uses.[9,10] If the cometesimals theory is correct, life could not exist on the Earth without it being watered from space.

A major importance of this discovery is that it is one more piece of evidence which shows that the solar system and the entire universe are interconnected in ways that we have never before imagined possible. Related to the **anthropic principle,** research has found that many complex interrelationships *must* exist for life to live on Earth. An obvious example is that humans could not exist without plants, an ecological relationship recognised very early in history. Discovery of the complexity of the many ecological connections that exist has changed the way that we view the universe. The research as a whole is developing a picture of the universe as a giant watch, each part dependent upon each other part, all functioning as a unified whole.[11]

The comets that Frank found are much smaller, darker,

and far more numerous than the large comets such as Halley's that have received most of the publicity about comets. Frank claims that

*'less than a thousand different large comets have been recorded in all of human history'*[12]

and that a literature search reveals *next to nothing* in the astronomy literature about small comets.[13-25] A problem is that until very recently, researchers did not possess the technology to observe small objects, thus it was all but impossible to verify their existence. Almost all large comets are often visible *only* through telescopes, yet have been 'exhaustively' studied.[26] Only in 1988 was the existence of small comets supported by telescope observations that located *'small dark objects in near-earth space'}*[1]

In spite of valid reasons for the past lack of evidence, many astronomers dogmatically concluded that comets smaller than a football field must be incredibly rare. This is the opposite of Frank's research findings, and since large comets exist, why can we not also assume that many small ones also exist? Although very little past speculation exists in the literature about smaller comets, in view of the fact that both very small and very large meteors are known to enter the Earth's atmosphere, it is reasonable to expect that both large and small comets also exist.[28] Interest in this subject has been high: Frank's studies have received much publicity — even articles in **USA Today** and **The Economist.**

Speculation on the source of comets includes the theory that they are remnants of interstellar gas and dust that originally condensed to form our solar system.[2930] Much debate still exists about this view, but most other cometary origins theories suffer from even more major problems.[31,32] The large comets have nuclei that often measure about a mile across, and their surface area is close to that of a small city. Warmed by the Sun's heat as they veer near the Earth, their surface is vaporised, releasing long tresses of gas and dust which form the comet's distinctive **comas** (the word *koine* is Greek for *hair).*

From elementary school on, we read definitive statements in textbooks about many things that scientists do *not* in fact know with much certainty, but are only impressions or extrapolations from confirmed data. Frank stresses that dogmatic statements in the area of origins in general are common, and usually impede advancements in the field. He concludes that we know comparatively little about either our solar system or the interplanetary space that the Earth travels through. Closer to home, our knowledge about the origins of the heavy elements and just about everything else in the Earth's history is still debated.[33] Even the origin of the oceans has not been firmly established, and many other sources for the oceans, such as from inside the Earth itself, have been suggested. All of this has great implications for origin of life theories and the Earth's chronology.

According to current theory, the most probable source of the ocean water is from condensation of steam produced during primordial volcanic eruptions, which slowly built up the world's ocean level. Aside from stating that the water was simply here and the free liquid water was produced by the volcanoes, little is known for sure about this intriguing question — an important one because water is critical for life, and most planets have far less water than the Earth. Ocean water is a major source of the water for the water cycle, and a water source must first exist for precipitation to occur in the first place.

The *'greatest conflict that the cometesimal's discovery has with established thinking comes, not from geology, but fields such as biology'*.[34]

*A* major significance of the cometesimal finding is that if Frank's hypothesis is true, probably comparatively little water would have been present in the early Earth, and that Earth's rivers and oceans were not formed early in its history as once thought.[35] Since the major abiogenesis theories require large amounts of water, at least in its later stages, Frank hypothesizes that the origin of life *must* be due to some type of panspermia from outer space, or that the substances necessary for the origin of life came from an extraterrestrial source. Because of the implications of the cometesimal findings for other theories such as abiogenesis, Frank concludes that he has incurred the *'wrath of orthodox science'* in spite of his impressive empirical data.[36] The reason is because it forces a *'radical departure'* in our existing view of the universe and the origin of life, requiring a major modification in all existing abiogenesis theories.[37-39] As Kerr notes:

*'When Louis Frank of the University of Iowa, a prominent member of the space physics community, proposed 2 years ago that tiny, unseen comets are pummeling earth 20 times a minute, the groans from the earth and planetary science community were all too audible. Hardly a specialty could escape the implications of the mini-comet hypothesis, and the implications were outrageous to all but Frank'*[40]

A major fallout of Frank's research was that it vividly revealed to him

*'how science works today, and in particular how controversial ideas are handled by the scientific community,'*

and that this can impede the progress of science. A major reason for the tremendous opposition in his case was the implications of cometesimals for abiogenesis. The enormous amount of incompetence and unethical behaviour in science also impedes progress.[41] The case of one researcher who found clear empirical support for the cometesimals was noted by Murphy:

*'Although two of Olivero's graduate students wrote theses based on this research, Olivero himself still hasn't published an article* [until he runs] . . . *additional tests to rule out possible sources of noise, and. . . "This is not a subject that's easy to get funding for. " Olivero claims a friend at the National Science Foundation told him "not to even think of submitting*

*a proposal" because "reviewers would cut you to shreds. " He's hoping someone else will try to replicate the work. '*[42]

## THE SOURCE OF THE DATA

The primary data for Frank's team's conclusion was an evaluation of pictures relayed from an orbiting satellite in 1981. His first evidence for cometesimals were scores of 'dark spots' in normal ultraviolet images on satellite pictures of the Earth.[4344] The satellite used for collecting the data was a high altitude, polar-orbiting unit named **Dynamics Explorer. It** carried an ultraviolet camera which photographed the Earth in the electromagnetic frequency that lies just beyond the violet end of the visible light range.

The ultraviolet camera placed on Explorer was developed primarily to research a bright atmospheric feature known as **day-glow** that is produced by the interaction of sunlight with the atomic oxygen existing in the Earth's upper atmosphere. The ultraviolet light emitted by the day-glow is not visible to the naked eye, consequently a specially designed ultraviolet camera was needed. A major end goal of the space probe was to find evidence for *gravity waves*, small scale ripples in the upper atmosphere that sometimes follow the aurora brightenings.[45] The images obtained in late 1981 produced a blanket of day-glow speckled with small dark spots.[46] The researchers counted more than 30,000 such spots in the images during some 2,000 hours of observing time.[47-51] It was first assumed that these holes in the day-glow were random fluctuations in the data due to chance, an event called 'noise'.

The problem was that these areas in which the brightness was greatly reduced prevented accurate computer analysis of the data. Thus, the first concern was to find out what the dark holes were so as to get rid of them — otherwise the team's major goal of analysing the data for evidence of gravity waves could not be achieved. The small dark spots could have been computer removed, but a researcher cannot alter the data merely on the assumption that certain spots are noise. Thus, the team needed to find out *exactly what they were* so they could appropriately deal with them.[52, 53]

The entire radio transmission system was checked to ensure that the small dark spots were not due to radio transmission or other errors.[54] Subsequent analysis also found that the black spots were moving, indicating the presence of physical events instead of noise.[55] Further, most of them moved in the *same* direction across the face of the Earth, a conclusion based on the use of two light counters, *both* of which observed the spots in the same sequence and at the same rate.[56-58] Because it was nearly impossible for two uniform counters to malfunction in *exactly* the same way for so much data, the researchers concluded that the spots had to be real physical entities.[59]

After analysing the data and equipment for possible computer glitches, random flaws, radio transmission noise or interference, and faulty sensors, Frank's team concluded by February 1983 that some sort of object between the satellite camera and the Earth was absorbing the ultraviolet radiation, producing the apparent holes. The images that were obtained, Frank concluded, were snapshots of the object's movements. The suspicion at this time was that they were some unusual meteor shower. Meteoric dust tends to orbit the Sun more rapidly than the Earth, thus it approaches the atmosphere such that from our vantage point it appears to collide with the Earth (actually it is chasing the Earth, but moving faster). This prograde motion was evaluated, and the team found that the black spots *also* indicated prograde motion that is characteristic of meteoric material.[60]

The researchers then soon effectively eliminated virtually all possibilities except the mini-comet thesis. The conclusion was that the ultraviolet radiation in these 'black dot' regions was being *absorbed* by something physical, creating an ultraviolet hole. Not many chemical elements or compounds can produce this effect — and water is one of the few. It is possible that the dark spots were caused by some other compound, but so far the water hypothesis is the most reasonable. They can be caused only by an element or compound that responds to ultraviolet light in a way that is similar to water such as ammonia, but a rain of ammonia or similar compounds has far more horrendous implications.[61] Dynamics Explorer also picked up human-made material sent up by a rocket to the upper atmosphere, further confirming their hypothesis.[62]

A chief concern was that many of the dark spots were comparatively enormous — as much as 50 km (30 miles) in diameter. An object this large must have been caused by a water vapour cloud which could not have been produced by evaporation from the Earth's surface, and consequently the water source had to be extraterrestrial. The researchers also concluded that only the vaporisation of a comet originally about the size of a house in its solid form could explain what they observed.[63] Frank estimates that the water lost from the top of our atmosphere may just keep up with the rainfall from small comets. Given the supposed 4.6 billion year age, if no water was lost, this comet source could add enough water in the history of our Earth *'to fill the ocean basins four or five times over'.*[64]

The water is vaporised from the heat caused by the friction produced during its plunge to within about 480 km (300 miles) of the Earth. The up to 100 tons of water and ice travel at about 20 times the speed of sound. When they hit the atmosphere, they expand into a thin ball of gas about 48 km (30 miles) across. This relatively little amount of water would form a cloud thinner than a London fog but is enough to produce the black spots found in the satellite images.

The vapour would rapidly slow to subsonic speeds, plummeting until it reached a height of about 55 km (35 miles), at which point it would rapidly mix in with the air in the upper atmosphere. The stratosphere wind would convert the water vapour into ice crystals, which then rapidly mixes

in with the water vapour present in the atmosphere at low altitudes. By this means most of the water would eventually become part of the normal atmospheric precipitation load, and eventually the ground and ocean water load.[65]

## PRESENTING THE CONCLUSIONS OF THIS RESEARCH

The first paper on Frank's findings presented at a professional meeting was by one of Frank's students in May of 1983. His conclusion was that the black spots could *not* be caused by rock meteorites, but had to be a common molecule which absorbs light at a certain wavelength only, and that the only common molecule that absorbs light at the wavelength observed was water.[66]

Frank proceeded to work continuously on the comet project for *2Vi* years. When he finally presented the cometesimal theory at the American Geophysical Union Annual Meeting in 1986, he faced major antagonism. The problem was that much of the opposition *'had nothing to do with the science at all, but with belief'.*[61] Any observation that contradicted the small comet theory, or possible problems with it, was unethically touted as clear proof of its demise.[68 71] As Murphy notes, *'almost no other space scientist agrees with this theory',* even though four research teams have uncovered unambiguous empirical evidence in its favour, and no one has been able to empirically disprove it.[72]

Frank's decision to publish against the recommendation of his colleagues was prompted partially by the fact that his mentor was James Van Allen (b. 1914), the scientist who discovered the radiation belts that bear his name which gird the Earth, and who also experienced harsh criticism for his ideas. The interest stirred up by the small comet hypothesis in Geophysical Letters was *'unprecedented'.*[13] A common method to attack ideas in science is to attack the ideas' advocates, a ploy which has so far failed in this case:

> *'What really annoys some critics is the sense that Frank is so competent and experienced that he "should know better" than to print such hard-to-swallow ideas . . . Many of Frank's peers just wish the subject would go away. Olivero thinks some people view it as "not science " at all but a kind of theological debate. A few of Frank's colleagues say they are more disappointed by the* [scientific] *community's harsh response than by Frank's argumentation. Olivero feels this way. So does John Murphree, a physicist at the University of Calgary, and principal investigator on a Swedish satellite similar to Dynamics Explorer. Murphree disagrees with Frank's thesis, but says Frank has "been dealt a disservice by the community at large", because it has responded so "negatively". Frank "has been very imaginative" in responding to comments, says Murphree, following all the rules of scientific discourse, while the critics have been "very aggressive" in attacking him.* [1A]

## THE COMETESIMALS' PATH TO EARTH

One concern is that the comets may vaporise *before* they reach the general wind pattern in the *lower* atmosphere layer, losing much of their water to outer space. The wind atmosphere is composed of two main layers, the first consisting of winds that circulate near the surface of the Earth. These winds travel at a range of up to about 70 miles high in a region called thehomopause which separates the lower zone of the atmosphere from the upper zone. The upper zone winds are part of a large circulating cell which are not locked closely into the winds in the lower atmosphere.

According to Hun ten and Donahue,[75] much water leaves the Earth by water molecules evaporating from the ocean and rising into the atmosphere where ultraviolet rays split them into hydrogen and oxygen atoms. Since hydrogen is the lightest element, it is readily lost to interplanetary space. On the other hand, the highly reactive oxygen atoms sooner or later oxidise a local compound. Part of the opposition to Frank's theory was because it would force a total re-evaluation of the calculations of theorists such as Hunten who spent a lifetime developing his ideas. All current theories about the early Earth are problematic because

> *'there is a lot of conjecture about what went on in the* [early] *earth, but very little data'.*[16]

The author notes that our beliefs about early Earth history are based almost entirely upon data in the geological record, and much confusion exists about what this record means.

An additional confirmation of the theory was achieved by Bonadonna.[77] He studied the short-term variability of upper atmospheric water specifically so as to evaluate the extraterrestrial water vapour source proposed by Frank *et al.*[ls] Bonadonna used a ground-based microwave (22.235 GHz) radiometer located at Pennsylvania State University to measure the thermal emission of upper atmospheric water vapour. From November 1984 to December 1988, over 22,000 twenty-minute bright picture spectra were analysed for statistically significant transient increases in the amount of water vapour. Individual 20 minute spectra were compared to the local 12 hour mean and variant spectra using over 100 significant events which could have been caused by the cometary water vapour. The detection rate, the author concludes,

> *'compares favourably with what can be expected from the small comet theory (1.8 days/event). This result is also comparable to the 4.1 days/event obtained by Adams (1988) using a small subset of this database.* [7J]

In addition:

> *'John Olivero, a meteorologist at Pennsylvania Slate University. . . says he set out to disprove Frank's thesis in 1986 by searching through his own microwave data on the upper atmosphere for evidence of large water bursts. Expecting to find at most three —an amount within the random noise level —he instead found 113. The results, Olivero says, were "too darn close" in scale and frequency to Frank's prediction to be*

*dismissed.* '[80]

Olivero's student, Bonadonna, concluded,

*'After exploring alternative explanations for the observed phenomenon it is concluded that these results support the existence of the small comet hypothesis.'* [81]

Another study in support of the theory is by Jet Propulsion Laboratory's Clayne Yeates, who,

*'. . . using a special steroid-hunting telescope. . . found traces of light that. . . fit Frank's description of small comets'.*[82]

An insightful comment by a critic of the theory is the admission that

*'no geophysical alternative to the small-comet hypothesis has been proposed to account for the dark spots'.**[3]

## PROBLEMS WITH THE THEORY

Questions that need to be answered to accept the theory include, 'is the Earth the only planet watered this way?' If other planets are watered by cometesimals, they must lack a means of retaining the water and thus lose most of it as fast as it is gained. So far, only very indirect evidence exists to support the conclusion that other planets are watered by this method. Cometesimals may strike many other planets and even our Moon, but practically all of the water gained from the small comets must have been lost from these planets, although some could accumulate in the planet's crevices or around their poles. Some argue that the Moon and the other planets have rather distinct 'ice cap' appearing poles which actually consist of water vapour. The lack of water on all other planets is striking:

*'Most places near the Sun are strikingly dry. Closest to home, earth's upper atmosphere is generally thought to be too dry for such a steady influx of water. The surface of the moon and the atmosphere of Venus are bone-dry, as is Mars despite its ancient history of surface running water.'* [84]

Although the data are not conclusive, Kerr speculates that these objects may be causing the mysterious flashes that are at times seen on the Moon, and may have produced the water vapour in Venus' atmosphere and the periods of flowing water on Mars, as well as the icy composition of some of the moons orbiting certain planets. The question of Venus was a concern because a common theory is that the Earth and Venus were at one time more similar. The standard theory also concludes that Venus also once had Earth-like oceans, but that they were lost to evaporation caused by a runaway greenhouse effect that boiled away most of its water. But if a supply is continually coming from comets, how could it have all been lost?

One line of evidence for the comet water theory comes from the study of Halley's Comet — the only comet that scientists have been able to study up close. The research has found that the comet's chemical fingerprint has many similarities to the Earth's oceans.[85] A comet's composition requires something other than frozen water, namely a protective cover or mantle to help it survive the heat as it moves in its orbit toward the vicinity of the Sun.[86] Frank hypothesizes that many comets may have a protective crust constructed out of organics such as methane. He estimates about half an inch thick black crust may exist on most comets due to the Sun's cooking. Although not very thick, he concluded that the coal-black material is sufficient to protect comets from the Sun.[87] Halley's Comet was ironically determined to have an extremely black surface which was laden with holes — and an irregularly shaped nucleus which resembles a potato.[88] This coal-black carbon cover would also greatly hinder telescopic detection.

If the cover of cometesimals consists of carbon, this carbon will also be added to the Earth's supply when the comet strikes its atmosphere. It will most likely react with atomic oxygen, turning it into carbon monoxide or carbon dioxide. Research by Holland estimates that the large amounts of carbon monoxide and carbon dioxide lost through the Earth's atmosphere into outer space must be replaced — and about one-quarter of the replacement cannot now be accounted for.[89] Three-quarters is recycled from the weathering of sedimentary rocks and the source of the other one-quarter could be from comets.

A comet's illumination results from gas jets and dust that have blown out from its nucleus. The cloud of dust and gas located in the plane of the solar system planets that extends from about Venus to just past the orbit of Mars called the **Zodiacal dust cloud** could be supplied with several tons of dust per second from disintegrating comets. Some comets are destroyed by the Sun's heat, leaving the dust behind, much of which could be added to the Zodiacal dust cloud. The supply rate is calculated to be several tons per second, a level necessary to maintain equilibrium in the dust cloud. Both the origins as well as the stability of this dust cloud have been much debated.

## THE ORIGIN OF THE COMETESIMALS

The problem, where do the little comets come from, is a concern which is likewise a major unknown for larger comets. Many observers conclude that it is reasonable to assume that both have a similar origin.[90] One hypothesis is that all comets come from a hypothetical comet belt named the **Oort cloud** after the Dutch astronomer Jan Oort (1900-1992) who first proposed its existence in 1950.[91] The existence of the Oort cloud is inferred mostly by tracing the paths of known comets backward from their planet encounters. The Oort cloud itself is believed to be the home of over a trillion large comets.[92] This vast comet home is hypothesized to be located well beyond Pluto, about 100,000 times the distance from the Earth to the Sun, and yet they are still loosely bound by the Sun's gravity. It is hypothesized that the Oort cloud is supplied by an **Oort disc,** which has an estimated 24 times the number of comets as the cloud itself. For a comet to come hurtling in from the

distant Oort cloud requires a tug supplied by passing stars or gravity tides. The Oort cloud is still only conjecture, and other researchers have proposed other sources for comets.[93-97]

Frank concludes that some cometesimals can be accounted for by the *'random splitting and flaring of large comets.'* [98] The author also speculates that these small comets may have their origin in a disc of cometary material located far beyond the orbit of Neptune. These objects could be sent streaming into the solar system by the movement of a yet undiscovered dark planet which travels through the outer regions of this immense disc. The cometesimal source, Frank hypothesizes, may also exist near the orbital planet of the Sun's planets, less than one-thousandth of the distance to the outer edge of the spherical Oort cloud. This, though, is also speculation — the proof that they arrive on Earth is immensely greater than any proof of their source.[99,100]

Secondly, an adequate mechanism is required which will cause them to reach the Earth in the pattern which Frank's data indicates. Frank hypothesizes that stars with planet systems, both discovered and undiscovered, exist to water the Earth. A large storage disc of comets and a new large inert planet which is correctly positioned to annually scatter about 10 million small comets into the Earth's atmosphere is needed. The planet must plough through the rotating disc of comets, scattering them at just the right angle so as to guide them into the inner solar system toward the Earth. Those that do not strike the Earth and Sun or other planets are theorised to return to the disc, and eventually travel back to the planets again.

Next, the presence of giant planets like Jupiter and Saturn is needed to draw the comets into shorter period orbits so as to obtain the right number of small comets to produce the water supply needed to fill our oceans, ground water and atmospheric clouds. The giant planets are hypothesized to play a role in this process somewhat like an amplifier. Frank concludes that *'it bothers me that this is such a unique system',* but adds that *'this set of special conditions makes life'* on the Earth possible, and life on other

> *'planets around other stars much less likely than previously thought. So perhaps our lack of radio contact with extraterrestrial civilizations is due not to a quarantine for our barbaric social behavior or to the weakness of our radio telescopes, but because we are simply alone.* ' [101]

A major concern is that the emotions around the origins debate make it difficult to evaluate the evidence on cometesimals:

> ' *"Everybody wants to prove me wrong, " says Frank, and that makes the discussion "a lot more emotional" than it ought to be. Does he think the pressure has made it hard for him to read the evidence objectively? No, Frank says, all it takes to disprove the thesis is some solid physical evidence. "If somebody comes up with a real definitive experiment, like a good imager with real good time resolution, that shows* [the comets] *are not there . . . I've got no problem* [dropping the theory] *. . ." Besides, he adds, "my life is not small comets."'*
>
> *'Indeed, even one of Frank's severest critics, Thomas Donahue of the University of Michigan, Ann Arbor, says: Frank's "achievements are enormous . . . I'm a member of the* [National Academy of Sciences], *and I don't mind saying I think Louis should be a member. " . . . The story of Louis Frank suggests that whether an investigator is wrong or right, the investments that he —and his critics —develops* [sic] *can make it very hard to weigh the evidence coolly and calmly. '* [102]

As of this writing, by far the most common alternative explanation for the data is the instrument-artifact hypothesis, which Dessler claims is *'able, neatly and economically, to accommodate all the known facts.'* [103] Frank's response to this conclusion is that the instrument-artifact hypothesis is one that he has carefully considered from the beginning and for numerous reasons was rejected.[104]

Frank's essential reason for rejecting the instrumentation-artifact interpretation is that it cannot account for the prominently east-to-west motion of the atmospheric holes, nor the

> *'correlation of the diurnal variations of occurrence rate of atmospheric holes with those of radar meteors, (3) the correlation of the temporal variations of the atmospheric hole rates with the nonshower meteor rates detected with forward scatter radar, and (4) the sightings of atmospheric holes with large apparent angular sizes at low altitudes. Atmospheric holes with similar dimensions and occurrence frequencies are found in the limited number of ultraviolet day glow images available from the Viking spacecraft. Two entirely different observational techniques confirm the existence of the small comets and yield fluxes and masses that are in coarse agreement with the inferred values from the observations of atmospheric holes with Dynamics Explorer I, i.e., sightings of small comets with a ground-based telescope and detection of water bursts in the upper atmosphere with a microwave radiometer.* '[105]

## IMPLICATIONS OF THIS RESEARCH

This controversial research, although still in the early stages, has major implications for all systems of cosmology. The biblical account relates that water was created on Earth in the Creation Week as mentioned in Genesis 1, but does not mention how much, and we know that large amounts of water were needed for the Noachian Flood. The volume of sea water alone is now estimated to be 1.35 billion cubic kilometres.[106] Cometesimal research could have important implications, especially relative to the age of the Earth, if the current influx can be determined and the amount of original water on the Earth can be estimated. The more free water that originally existed, given the assumption that

the water addition rate has been constant since the Earth's creation (which, like all extrapolations, cannot be proved beyond a doubt), the younger the Earth.

Cometesimals also have clear implications for the conditions that existed on the early Earth, and thus for both abiogenesis theories and naturalistic explanations of the evolution of life on Earth. The original environment, which was the primary one in which most evolutionists hypothesize abiogenesis and evolution occurred, required huge amounts of free chemically unbound water. This discovery argues that far less water was available then, and that the Earth was far different than that painted by current speculations. If the rate of influx can be calculated, and, given that the Earth originally had a fair amount of water on it (a conclusion which can be argued from previous geological research), this data may require a major re-evaluation of our understanding of the Earth's chronology and history. Little evidence of a viable naturalistic explanation exists for the origin of water on the Earth:

> *'water has probably been present almost as long as the planet has existed as a solid body. Where did the water come from ? We can be sure that the ocean was created . . . when the earth formed . . . but we cannot be sure* ***how*** *it formed. Most probably, water condensed from steam produced during primordial volcanic eruptions.'* [107]

This process, of course, does not explain the original *source* of the water, only how it could have been removed from its bound state in rocks and converted into a liquid state, and spread to what is now the oceans and elsewhere on the Earth's surface. Also, far more water appears to still exist chemically bound-up in rocks than previously suspected:

> *'Where is most of the water on earth? The answer seems obvious, spelled out by the areas of vivid blue in a Rand McNally atlas: surely the oceans that cover two-thirds of the planet's surface constitute the bulk of terrestrial $H_2O$. Indeed, that eminently reasonable assumption was endorsed for many years by the geological community. But nature is not so conveniently self-evident. In the past decade more than a few doubts have been raised about the magnitude, distribution and location of the earth's water supply. Before long, such questions may play a role in geology. Just as many astronomers think most of the mass in the universe is made up of invisible dark matter, a growing number of geologists, and I am among them, are becoming convinced that most of the water on the earth may lie unseen, deep below the surface, dissolved into the rocks of the mantle and the core.'*[108]

Jegnloz estimates that the water he concludes exists in the lower mantle and also in the Earth's iron-alloy core, even if it exists in a concentration level of only 2 per cent, would equal over ten times the total water present in all the oceans and the atmosphere combined. Although it was once assumed that the source of the Earth's hydrosphere was from volcanic eruptions, hot springs, and geysers, and that the vast majority of water in the Earth's interior has been released, his research shows that the high level of pressure in the Earth's core keeps the hydroxide ions locked inside the crystal structures, and that the water is more easily released under the *lower* pressure nearer to the Earth's surface. Consequently, under the high interior pressures, the hydrogen and oxygen components of water are present in significant amounts:

> *'The inescapable conclusion seems to be that water may well be present as hydroxide molecules dissolved into crystalline structures throughout the deep mantle. Whereas it was once thought the entire mantle would have been degassed to form the oceans and atmosphere, it is now evident that only part of the planet nearest the surface, at depths less than 120 miles, exists at pressures low enough to release its water.'*[109]

Evolutionary theory has no model to explain why so much water evidently exists on Earth, especially in contrast to other planets. Nor does this chemically bound water help the current theory of abiogenesis, which requires huge amounts of available chemically unbound water.

## COMETESIMALS AS PART OF A COMPLEX CYCLE ILLUSTRATES THE EARTH'S DEPENDENCY ON THE UNIVERSE

It was once assumed that the universe consisted of several thousand stars which were relatively closely spaced and somewhat randomly placed. A century of intense astronomical research has now demonstrated that an incredible amount of unexplainable order, interdependence and complexity exists in the universe. An estimated over one-half of all stars are part of rotating binary or trinary star systems, and all known stars are parts of galaxy systems. Many of the galaxies in turn are grouped together in orbiting pairs. These pairs are organised in clusters which tend to be consistently about 400 million light years apart. Our solar system is part of the Milky Way Galaxy, an orbiting family of stars about 100,000 light years across. Our galaxy is in turn part of a galaxy collection called the **local group** that is part of the Virgo Supercluster.[110] The recent discovery of the **Great-Wall galaxy cluster,** the largest object in the universe — an estimated 200 million light years across and 500 million light years long, larger than the entire Virgo Supercluster— has forced a reassessment of the major evolutionary cosmological theories.

This new picture indicates a recycling universe similar to the systems found on the Earth. A terrestrial example includes the carbon, nitrogen and oxygen cycles. A non-terrestrial example is the mass/energy given off by stars may eventually collect again and form new stars. If a body collects enough mass, the pressure from gravity pulling the mass inward will eventually cause it to undergo nuclear fusion, and consequently it will once again give off high

levels of its energy into space as a star.

Some theorise that most of the universe's mass may consist of neutrinos, and this is one explanation of the composition of the theoretical 'dark' matter. The current speculation that as much as 90 per cent of the mass of the universe may be dark matter, undetectable by telescopes, is related to the research which indicates that a continuous interchange of mass must consistently occur within the universe in order for an island of life such as the Earth to exist.[111] Cometesimals may also be part of the universe recycling system, carrying water to the Earth possibly to help balance that lost by the splitting of water from photolysis in the upper atmosphere.

## SUMMARY

This review only attempts to summarise the existing research and attempts to harmonise current research findings on the cometesimal hypothesis with both existing geological as well as theological data. It is clear from recent geological research that many current scientific assumptions in several areas about the Earth need to be drastically revised.

A crucial implication of recent findings, as indicated by the research on neutrinos, is that the Earth is far more intimately connected to the rest of the universe than scientists have ever imagined. We are heavily dependent for our existence on, not only the Sun, but according to several lines of evidence, also upon the universe, or at least major parts of it.

The possible existence of cometesimals has clear implications for origins because it would mean, especially if the evolutionary time-scale is assumed, that the major hypothesized conditions on the Earth were radically different from those currently assumed to have existed then. Life is hypothesized to have evolved in the oceans, and to have been aquatic for much of its existence. This theory argues that oceans of the scale existing today did not exist in the early Earth's history, and that the Earth's surface was at this time relatively dry. The cometesimal findings also have major implications for the age of the Earth. If the rate of water addition could be determined, and assuming that the rate was consistent in the past, a maximum age could be calculated. A mechanism for extraterrestrial watering is also of potential interest in relation to the Flood of Noah.

Other important ramifications of Frank's work include the observation that even highly tenuous experimental evidence and data tends to be exploited and accepted as valid if it supports the existing naturalistic explanation of the origin of life. Conversely, research evidence which lends support to an alternate hypothesis, even if based upon a large amount of empirical data, tends at best to be ignored, and at worst the authors are unjustly criticised. In this case, the observations they produced were in conjunction with other research, and were made not to prove or disprove any preconceived hypothesis. Frank's observations were at first considered only a problem that must be dealt with in order to achieve the task at hand, in this case analysing the data for hypothetical gravity waves. His observations led into an empirical investigation which brought the author to conclusions he admits were not welcome at first, but was forced to accept based on the empirical data and the fact that other conclusions were far less supported or invalid.

## REFERENCES


1. Murphy, E. E., 1992. Small comets/Big flap. **Science,** 257:622-623,
2. Emsley, J., 1990 Are 'minicomets' peppering the Earth's atmosphere? **New Scientist,** 126(1720):36.
3. Monastersky, R., 1988. Comet controversy caught on film (swarms of tiny comets hurtling through the solar system and bombarding Earth). **Science News,** 133(22):340.
4. Monastersky, R., 1990. Small comet controversy flares again (cornels striking the atmosphere). **Science** News, 137(23):365.
5. Powell, C. S., 1990. Lost in the clouds; astronomers hunt for 100 trillion missing comets. **Scientific American,** 263(l):30-32.
6. Hecht, J., 1988. Snowballs from space 'filled Earth's oceans'. **New Scientist,** 118(1612):38.
7. Gibilisco, S., 1985. **Comets, Meteors and Asteroids: How They Affect Earth.** TAB Books, Inc., Blue Ridge Summit, Pennsylvania.
8. Asimov, I., 1988. **Did Comets Kill the Dinosaurs?,** Gareth Stevens Publishing, Milwaukee, Wisconsin.
9. DeYoung, D., 1985. The water of life. **Creation Research Society Quarterly,** 22(3): 107-114.
10. Klotz, J. W., 1986. Water for plants. **Creation Research Society Quarterly,** 23(l):7-8.
11. Tipler.F. J., 1994. **The Physics of Immortality,** Doubleday, New York.
12. Frank, L. A. (with Patrick Huyghe), 1990. **The Big Splash: A Scientific Discovery that Revolutionizes the Way We View the Origin of Life, the Water We Drink, the Death of the Dinosaurs, the Creation of the Oceans, the Nature of the Cosmos, and the Very Future of the Earth Itself,** Birch Lane Press, New York, p. 17.
13. Asimov, I., 1985. **Asimov's Guide to Halley's Comet,** Walker and Company, New York.
14. Baron/Scott Enterprises, Inc., 1984. **Mr Halley's Comet,** Sky Publishing Corporation, Cambridge, Massachusetts.
15. Brandt, J. C, 1981. **Comets; Readings from Scientific American,** W.H. Freeman and Company, San Francisco, California.
16. Calder,N., 1980. **The Comet is Coming!,** The Viking Press, **New** York.
17. Flaste, R., *el a!.,* 1985. **The New York Times Guide to the Return of Halley's Comet,** Times Books, New York.
18. Gropman, D. (with Mirvis, K.), 1985. **Comet Fever,** Simon and Schuster, Inc., New York.
19. Henbest, N., 1985. **Comets, Stars, Planets,** Exeter Books, New York.
20. Lancaster-Brown, P., 1985. **Halley and His Comet,** Blandford Press, New York.
21. Mallei, P. (translated by Mirella and Riccardo Giacconi), 1980. **Monsters in the Sky,** MIT Press, Cambridge, Massachusetts.
22. Moore, P. and Mason, J., 1984. **The Return of Halley's Comet; What it is, Why it returns, Where and when to see it best,** Warner Books, New York.
23. Richardson, R. S, 1967. **Getting Acquainted with Comets,** McGraw-Hill Book Company, New York.
24. Ritchie, D, 1985. **Comets; The Swords of Heaven,** New American Library, New York.
25. Seargent, D.A., 1982. **Comets: Vagabonds of Space, What they are, Where they come from, How to find and track them,** Doubleday and Company, Inc., Garden City, New York.
26. Frank, Ref. 12, p. 6.
27. Frank, Ref. 12, p. 226.
28. Wilkening, L, L. (ed.), 1983. **Comets,** University of Arizona Press, Tucson, Arizona.
29. Ruthen, R., 1989. Halley's birth place: the comet may be a drifter from the fringes of the galaxy. **Scientific American, 260(6):31.**

30. Chapman, C. R,, 1990. From dust to dust. Nature, 348(6301):486-487.
31. Benningfield, D., 1990. Where do comets come from? When we understand the origin of comets, we'll understand the origin of the solar system. Astronomy, 18(9):28-36.
32. Delsemme, A. H., 1989. Whence come comets? Sky and Telescope, 77(3):260-264.
33. Holland, H, 1984. The Chemical Evolution of the Atmosphere and Oceans, Princeton University Press, Princeton.
34. Kerr, R. A., 1988. In search of elusive little comets. Science, 240(4858): 1403.
35. Washburn, M, 1988. The waters above, the storm below (Louis Frank's theory of icy comets which bombard the Earth constantly). Sky and Telescope, 76(6):628-630.
36. Frank, Ref. 12, p. 5.
37. Powell, Ref. 5.
38. Monastersky, Ref. 3.
39. Monastersky, Ref. 4.
40. Kerr, Ref. 34, p. 1403.
41. Kohn,A., 1986. False Prophets, Basil Blackwell, Inc., New York.
42. Murphy, Ref. 1, p. 623.
43. Frank, L. A., 1989. Atmospheric holes and the small comet hypothesis. Australian Physicist, 26(1,2): 19-34.
44. Frank, Ref. 12, p. 10.
45. Frank, Ref. 12, p. 16.
46. Frank, L. A., Sigwarlh, J. B. and Craven, J. D., 1986. On the influx of small comets into the Earth's upper atmosphere; I. Observations. Geophysical Research Letters, 13(4):303-306.
47. Frank *et a!.*, Ref. 46.
48. Frank, L. A., Sigwarth, J. B. and Craven, J. D., 1986. On the influx of small comets into the Earth's upper atmosphere; II. Interpretation. Geophysical Research Letters, 13(4):307-310.
49. Frank, L. A. and Craven, J. D., 1988. Imaging results from Dynamics Explorer I. Reviews of Geophysics, 2:249-283.
50. Frank, L. A.., Sigwarth, J. B. and Craven, J. D,, 1989. Search for atmospheric holes with the Viking cameras. Geophysical Research Letters, 16(12): 1457-1460.
51. Frank, L. A., Sigwarth, J. B. and Yeates, C M., 1990. A search for small solar-system bodies near the Earth using a ground-based telescope: technique and observations. Astronomy and Astrophysics, 228:522-530.
52. Frank *et al*, Ref. 50.
53. Piel, J., 1986. Holes in the atmosphere. Scientific American, 255(1):64-65.
54. Frank and Craven, Ref. 49.
55. Franker *et al*., Ref. 50.
56. Frank, Ref. 12, p. 17.
57. Kerr, R. A., 1989. Double exposures reveal mini-comets? Science, 243 (4888): 170-171.
58. Piel, Ref. 5.3.
59. Beardsley, T. M., 1988. Ice storm; new observations are held to support a controversial theory. Scientific American, 258(6):24-25.
60. Frank, Ref. 12, p. 19.
61. Bonadonna, M. F, 1990. A Search for Episodic Increases in Upper Atmospheric Water Vapour as Evidence of an Extraterrestrial Source: A Thesis in Meteorology. Master's Thesis submitted to Pennsylvania State University.
62. Frank, Ref. 12, p. 226.
63. Ehmann, J., 1986. Cosmic comets of the sea. Omni, 8(10):69-72, 108-109.
64. Frank, Ref. 12, p. 41.
65. Anderson, I., 1987. Did comets create the oceans? New Scientist, 112:7.
66. Frank, Ref. 12, p. 20.
67. Frank, Ref. 12, p. 13.
68. Hall, D. T. and Shemansky, D. E., 1988. No cometesimals in the inner solar system. Nature, 335(6189):417-419.
69. Horgan. J., 1989. A snowball's chance; support is evaporating for a theory on tiny comets. Scientific American, 260(3):21-22.
70. Horgan, J., 1990. Death watch: updates on four dubious but enduring theories. Scientific American, 262(6):22-25.
71. Kerr, R. A., 1988. Comets were a clerical error. (Research by Donahue found that mini-comets were not proved; his proof was due to error in scientific notation). Science: 241(4865):532.
72. Murphy, Ref. 1, p. 622.
73. Frank, Ref. 12, p. 34.
74. Murphy, Ref. 1, p. 623.
75. Hunten, D. M. and Donahue, T. M., 1976. Hydrogen loss from the terrestrial planets. Annual Review of Earth and Planetary Sciences, 4:265.
76. Frank, Ref. 12, p. 44.
77. Bonadonna, Ref. 61.
78. Frank *et al.*, Ref. 46.
79. Bonadonna, Ref. 61, p. iii.
80. Murphy, Ref. 1, pp. 622-623.
81. Bonadonna, Ref. 61, p. iii.
82. Murphy, Ref. 1, p. 622.
83. Dessler, A. J., 1991. The small-comet hypothesis. Reviews of Geophysics, 29(3):355-382 (p. 358).
84. Kerr, Ref. 34, p. 1403.
85. Frank, Ref. 12, p. 48.
86. Frank, Ref. 12, p. 50.
87. Kerr, Ref. 34.
88. Waters, T., 1989. Halley is an alien. Discover, 10(8):26-27.
89. Holland, Ref. 33, p. 82.
90. Benningfield, Ref. 31.
91. Weissman, P. R., 1990. The Oort cloud. Nature, 344(6269):825-830.
92. Delsemme, Ref. 32.
93. Waters, Ref. 88.
94. Robinson, L., 1988. A comet reservoir just beyond Neptune. Sky and Telescope, 76(2): 123.
95. Chown, M., 1990. Old stars may shine a light on hidden comets. New Scientist, 126:34.
96. Chartrand, M. R., 1978. Comet chasing. Omni, 2(l):24-25.
97. Cowen, R., 1990. Frozen relics of the early solar system: astronomers search for distant comets. Science News, 137(16):248-250.
98. Frank, Ref. 12, p. 53.
99. Frank, Ref. 12, p. 227.
100. Zimmer, C, 1990. Death by cosmoid (tiny comets theorized as a threat to Galileo probe). Discover, 11(6):18.
101. Frank, Ref. 12, p. 167.
102. Murphy, Ref. l,p. 623.
103. Dessler, Ref. 83, p. 379.
104. Frank, L. A. and Sigworth, J. B., 1993. Atmospheric holes and small comets. Reviews of Geophysics, 31(1):1—28.
105. Frank and Sigworth, Ref. 104, p. 25.
106. Skinner, B. J. and Porter, S., 1987. Physical Geography, John Wiley and Sons, New York, p. 370.
107. Skinnerand Porter, Ref. 106, p. 371.
108. Jeanloz, R., 1993. The hidden shore. The Sciences, 33(1), p. 26.
109. Jeanloz, Ref. 108, p. 30.
110. Baily. M. E,, 1990. Comet orbits and chaos. Nature, 345(6270):21-22.
111. Maddox, J., 1992. Unrequited search for heavy neutrino. Nature, 355:173.

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