

Neutron Gravity and the Anti-universe

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This paper explores the implications of the proposition that only neutrons and unbound hydrogen atoms and molecules experience the force of gravity. If true, the reason would be because the electromagnetic and gravitational forces are mutually exclusive. Protons and electrons would have zero gravitational mass. If this is true, then $G'M'_1 = (\lambda_2/\lambda_1)GM_1$, where $\lambda = (A - Z)/A$ is the ratio of inertial neutron mass to atomic or molecular mass, $G'M'$ indicates the new neutron-gravity-theory value for the legacy constant GM , and the indices 1 and 2 refer to the primary and secondary orbital bodies, respectively. This suggests that the Earth may have a value for λ that is similar to that of aluminum because artificial satellites made of aluminum orbit the Earth as expected. If this proposition is true, it means that if an aluminum spacecraft orbits the Earth in a circular orbit having a period of 90 minutes at an altitude of 282 km, then a pure ice body that is released from the spacecraft would have a perigee altitude of 282 km, an apogee altitude of 2912 km, and a period of 127.33 minutes. Likewise, a pure lead body that is released by the spacecraft would have a perigee altitude of -1378 km, an apogee altitude of 282 km, and a period of 68.25 minutes.

The evidence in support of this proposition is that ice particles ejected downward by the Space Shuttle in a water dump curve forward as they move relative to the Shuttle. Legacy gravity theory predicts a straight-line trajectory, not a curved one. This proposition can be confirmed or refuted by releasing a tethered lead ball from the inverted Space Shuttle's open cargo bay. If it remains motionless relative to the Shuttle, then this proposition would be refuted. If it exerts a downward pull on the tether corresponding to an acceleration of 1.5 m/s^2 , then this proposition would be confirmed. No such pull would occur inside the cabin where the gravity field is zero.

This proposition cannot be confirmed or refuted by repeating the Cavendish torsion balance gravity experiment with the lead balls replaced with ice balls having equivalent inertial masses because we must assume that both theories must yield the same acceleration of gravity. Orbits of lead and ice will be different because the centrifugal force is based on inertial mass, which is unchanged, while the centripetal force is based on gravitational mass, which is different.

Gravity is caused by space flowing into or out of space bodies. Space flows from this universe through pinholes inside neutrons into the anti-universe, and space flows out of the anti-universe through pinholes inside antineutrons (dark matter) into this universe. The ordinary universe expands because antineutrons are about six times more numerous than neutrons so that space expulsion exceeds space absorption. Time runs backwards in the anti-universe, and there is no such thing as universal time. Every space body has its own historical time line that is local to itself and gets reset at each nexus when its space flow reverses direction from inward to outward or vice-versa. Cepheid variable stars apparently expand and contract in cycles of a few days because they are reversing their space flow directions at that rate. Every comet, moon, planet, star, and galaxy has a concentric antimatter version of itself that experiences time backward, growing younger while its ordinary companion grows older. Space flow directions reverse in a space body from outward to inward or vice-versa when the relative abundance between neutrons and antineutrons reverses, and the majority becomes the minority and vice-versa. The toggling of matter into antimatter and vice versa occurs to conserve angular momentum when a space flow direction reversal occurs. One implication of bi-directional local time is that time travel is at least conceivable. All a time traveler needs to do is toggle his neutrons.

1. Flowing Space Gravity

The neutron gravity hypothesis arises out of flowing space gravity considerations. I first learned of flowing space gravity theory from Henry Lindner in 1997 [1]. In this context, the word "space" refers to the underlying physical substratum. In Newtonian mechanics this substratum is called absolute space. In electromagnetic terminology it is called the ether. Modern physicists tend to call it the quantum vacuum or quantum foam.

The idea is that space flows into or out of a star or planet at the escape velocity and each one is either an ether sink or an ether source, depending on whether its antineutrons outnumber

its neutrons or vice-versa. The neutron gravity hypothesis claims that matter is an ether sink, and antimatter is an ether source.

See Tom Martin [2] for a rigorous review of flowing space gravity theory. At the end of his Section 1 Martin says, "For our purposes, the flow of physical space is completely characterized by a 3-space vector field $\mathbf{w} \equiv \mathbf{w}(\mathbf{r}, t)$ in a global Galilean coordinate frame $\{\mathbf{r}, t\}$ on the space-time manifold." If space is quantized, the quanta of space are static but compressible in General Relativity Theory and they are dynamic and incompressible in flowing space theory.

In an email, Martin described his paper this way: [3]

I'm glad you have enjoyed my paper and have understood some of my essential motivations for writing it. It was written, just as you have surmised, to provide a bridge between the Einsteinian and Lorentzian views of relativistic physics. ... The question I posed about whether Nature (physical reality) prefers flowing space to stretched or warped space may be of critical importance to the future of physics. The answer to this question can only be provided by experiment. That's why the two satellite experiments I have proposed are so crucial. In my opinion, they are the only experiments available to us which are actually capable of detecting the magnitude and direction of the translational flows of the substratum into or out of the Sun and the Earth. If the flow is established by experiment to be the hidden and likely cause of gravity, it will lead to a tremendous revolution in physics and cosmology. Rational physicists and astronomers will rejoice.

Martin taught that space can just as easily flow outward as inward from a star or planet at the escape velocity and the acceleration of gravity is inward in both cases. That is, space bodies can be either space absorbers or expellers. Flowing space theory does not explain where the space goes after it is absorbed or where it comes from when it is expelled. Neutron gravity theory proposes that the anti-universe is the source of expelled space via antineutrons, and the ordinary universe is the sink of absorbed space via neutrons.

2. The Anti-universe

I suggest that every galaxy, globular cluster, star, planet, and comet has two versions of itself that are space-concentric time-conjugates of each other that age in opposite directions. The ordinary version grows older while the antimatter version grows younger. This is because time runs backwards in antimatter. Positrons are electrons moving backward in time. Likewise, antiprotons are protons moving backward in time, and antineutrons are neutrons moving backward in time.

Neutrons absorb space, and antineutrons expel space in positive time. Every space body has both matter and antimatter components, and space absorption and space expulsion are continually occurring simultaneously. Most of the space flow is exchanged between the conjugate components of the same space body with each other, since they are concentric and they occupy the same Euclidean volume without interference, although one component is generally slightly larger than the other one. There is no interference between conjugate components because the ever-increasing time displacement between them prevents any significant electromagnetic interactions of one upon the other. On the other hand, space flow from an antineutron to an adjacent neutron occurs without delay because there is only one underlying physical substratum.

In the case where neutrons outnumber antineutrons in a given space body, the space that is expelled by all the antineutrons is absorbed by an equal number of neutrons in the same body, and the excess neutrons absorb space from the surrounding interplanetary or interstellar environment.

In the case where antineutrons outnumber neutrons in a given space body, the space that is absorbed by all of the neutrons is expelled by an equal number of antineutrons in the same

body, and the excess antineutrons expel space into the surrounding environment.

The conjugate of a spiral galaxy is an elliptical galaxy. The conjugate of a globular cluster is a void.

A void is an apparently empty region of space that gives the illusion of being at a great distance because the background galaxies behind it are minified by looking through the void's gravitational lens. The ordinary matter in void stars has been cooled down to 2.7K by inverse beta decay, and so these stars are only visible at micro wavelengths. In my cosmology the Sun is inside a void, near its center, and its cold dark stars are the source of the cosmic background radiation (CBR). Eventually, CBR telescopes may achieve sufficient resolution to resolve the CBR into point sources, proving the existence of cold dark stars.

The conjugate of a Population I star is a Population II star. The conjugate of a planet like the Earth may be a planet like Venus if Venus proves to have an inward space flow. If so, Venus would be cooling down. The conjugate of an active comet with a coma and tail is a dormant comet.

There is only one universe, and time is not universal. Time is local to each individual space body, and it is both cyclical and bidirectional. A space body's time frame is delimited by nexus points that mark the opposing time flow cross-over points where one cycle begins and the corresponding cycle ends and vice-versa. Every space body has its own clock, so to speak, that gets reset at every nexus. Nexus points for a given space body occur when its space flow direction reverses from inward to outward or vice-versa.

Such space-flow reversals within a space body occur when space absorption overcomes space expulsion or vice-versa. Space absorption overcomes space expulsion in positive time when a space body's neutrons, which had been in the minority, become the majority, and its antineutrons, which had been in the majority, become the minority. Space expulsion overcomes space absorption in positive time when a space body's antineutrons, which had been in the minority, become the majority, and its neutrons, which had been in the majority, become the minority.

In positive time, space is expelled by spiral galaxies, voids, Population I stars like the Sun, and active comets. In positive time, space is absorbed by elliptical galaxies, globular clusters, Population II stars and dormant comets.

Most solar system bodies expel space, but Venus alone may absorb space. This remains to be proved. If Venus is cooling down, it is absorbing space. Otherwise it is expelling space like the Sun and the other planets.

In positive time, all space expellers are warming up and expanding due to neutron beta decay. All space absorbers are cooling down and contracting due to inverse beta decay in positive time.

In positive time, neutron beta decay is the one and only source of thermal energy for all space-expelling Population I stars. There is no thermonuclear fusion going on inside these stars because their cores all have temperatures of absolute zero.

In positive time, inverse beta decay is the sink of thermal energy for all space-absorbing Population II stars. Legacy astrophysics theory teaches that white dwarf stars can only cool down by radiation. Neutron gravity theory claims that white dwarf stars are cooled in positive time much more efficiently by inverse

beta decay than by radiation. This theory claims that the dark matter that is so ubiquitous in the universe is comprised almost entirely of cold, dark white-dwarf stars with temperatures stabilized at 2.7K.

Cepheid variable stars pulsate with periods of a few days because their oscillations are periodic reversals in their space flow direction. When they absorb space, they cool down and contract. When they expel space, they warm up and expand. All stars and planets naturally oscillate as Cepheid variable stars do, but normally over much, much longer periods of time.

Earth's past space flow reversals have been the causes of its mass extinctions because the consequences of such reversals are geologically catastrophic. These periodic space flow reversals were caused by internal processes within the Earth; not by any comet or asteroid impact.

A space outflow reverses to an inflow when neutrons become exhausted in the innermost core, and the exposed unprotected residual antineutrons in the innermost core suddenly experience inverse beta decay all at once. This intense spike of negative thermal energy will suddenly freeze much of the liquid hydrogen in the outer core and condense any hydrogen gas that may be trapped inside the mantle. Consequently the Earth will suddenly contract with catastrophic violence.

A space inflow reverses to an outflow when antineutrons become exhausted in the innermost core, and the exposed unprotected residual neutrons suddenly experience beta decay all at once. This intense spike of positive thermal energy will suddenly melt much of the solid hydrogen in the inner core and boil some of the liquid hydrogen in the outer core, trapping the gas inside the mantle, and the Earth will suddenly expand with catastrophic violence.

The end of the last Ice Age (Pleistocene epoch) was caused by the reversal of a space inflow to an outflow. If Earth has been expanding over geologic time, it has been in steps at the nexus points where each expansion event was greater in magnitude than the previous contraction event.

There is no way to separate matter objects from their antimatter conjugate companions, since they are concentric with each other, and neither one can exist without the other one. Also each conjugate pair determines for itself which way its own time flows, and that direction reverses on a schedule that is unique to that pair's individual circumstances.

There are two ways to view physical reality: (a) the space-coherent view and (b) the time-coherent view.

2a. Space-Coherent View of Reality. In the space coherent view of the universe, the two versions of each space body are concentric with each other and share the same 3-space coordinates, but they are separated from each other by a continuously widening time displacement that is unique to each object. This is because ordinary matter grows older while antimatter grows younger in positive time, and every object has its own history since its most recent space-time flow reversal.

In a universe where time is bi-directional, it is difficult to imagine how any space body actually begins its existence, because as we examine the body's career, all we find are repeated cycles of time with reversals at each end. The beginning of each cycle is the ending of the previous one.

As we shall see in Section 3 the neutron gravity hypothesis states that hydrogen has no gravitational mass because it has no neutrons. If so, then star formation from the gravitational collapse of hydrogen gas clouds is impossible. Instead we can speak of evolution and transformations of space bodies. It is reasonable to speculate that comets evolve into moons, moons evolve into rocky planets, rocky planets evolve into gas giant planets, gas giants evolve into stars, and stars evolve into galaxies. The question as to where comets come from may have to be deferred until we know more about physical reality.

The two time lines for a given pair of concentric time-conjugate objects necessarily diverge from a common nexus that defines one object's beginning and the other's ending. Such a beginning would not be the creation of the object, *per se*, but the beginning of a new cycle of time in its history. Such an ending would not be the cessation of an object's existence, *per se*, but the end of a cycle of time in its history. At a nexus the ordinary object is transformed into an anti-object, and vice-versa. This seemingly amazing feat is accomplished when neutrons are transformed into antineutrons and vice-versa. Neutron-antineutron oscillations have been discussed in the literature. [4]

I suggest that neutron-antineutron toggling is accomplished by the reversal of the ether wind direction from outward to inward or vice-versa, and this ether wind direction reversal is caused by a tipping of the balance between the total number of neutrons and the total number of antineutrons in the time-conjugate object pair. This balance ebbs and flows in cycles. Neutron chirality (handedness) toggling is the particle's response to an ether wind direction reversal in order to conserve its angular momentum. Neutron-antineutron chirality toggling is analogous to the reversal in a propeller's pitch that allows a slipstream reversal without reversing the propeller's direction of rotation.

One implication of bi-directional local time is that time travel is at least conceivable. All a time traveler needs to do to experience the anti-universe is toggle his neutrons at a safe altitude in nearby interplanetary space. The best place to toggle his neutrons would be at the equilibrium point between a space-absorbing body and a space expelling body.

We might say that time in the antiuniverse is inverted or reversed in the space-coherent view. Inhabitants of each world regard the movie of the other world as if it were running backwards. Both versions of a space body necessarily share the same orbit since they are continuously concentric in 3-space, but they move in opposite directions, according to their own native cosmic time flow directions. There is an anti-Earth which has similarly sized and shaped anticontinents that are phase locked with our continents. Phase locking is caused by a gravity force between neutrons in the continents and antineutrons in the anticontinents. Gravity is the only force that has an infinite propagation velocity [5] so that a large time displacement is no barrier to the action of one body upon another. Both worlds rotate about their common axis with a 24-hour period, and both worlds orbit the same Sun/anti-Sun with a period of one year. Our Earth orbits the Sun in the counter-clockwise direction, and the anti-Earth orbits the anti-Sun in the clockwise direction, as they see it. Our Sun rises in the east and sets in the west. Inhabitants in the anti-Earth would say the Sun rises in the west and sets in the east.

The stars that our astronomers identify as being Population I stars, including the Sun, would be identified by anti-Earth astronomers as being Population II stars, and vice-versa. Population I stars are rich in heavy elements because their atomic nuclei absorb neutrons that flow up from their cores that expel them. Population II stars are poor in heavy elements because their heavy nuclei expel neutrons that fall downward and are absorbed by their cores in positive time. The conjugate version of every Population I star is a Population II star, and vice-versa.

Whenever we observe a star directly (not through gravitational lenses) we see its ordinary matter component only, and this is true for both Population I and Population II stars. The antimatter component is invisible to us. What distinguishes them from each other is that Population I stars have an ether wind outflow while Population II stars have an ether wind inflow. This is because Population I stars have an excess of antineutrons, and Population II stars have an excess of neutrons. Neutrons absorb space, and antineutrons expel space.

Outflowing space from stars carries with it a stellar wind of hydrogen plasma that results from free neutron decay. The Sun's corona has a temperature of about a megakelvin because of the thermal energy released by the beta decay of free neutrons carried upward into the Sun's coronosphere with the solar wind. Most of the Sun's free neutrons decay inside the photosphere, and that is the source of the Sun's thermal energy, not thermonuclear fusion in its core. The Sun's core has a temperature of absolute zero, and the anti-Sun has a negative absolute temperature in positive time.

Our astronomers observe redshifts in galactic spectra that are proportional to the distance from us and conclude that space is expanding. Their astronomers would observe galactic blueshifts and conclude that space is contracting. Both conclusions are correct. The universe is expanding in positive time and contracting in negative time.

The galaxies that we identify as being spiral galaxies would be recognized by them as being elliptical galaxies, and vice-versa. Our astronomers say that spiral galaxies are imbedded within a halo of dark matter. This antimatter halo is the invisible elliptical galaxy that is the spiral's conjugate companion. The time-conjugate version of every spiral galaxy is an elliptical galaxy, and vice-versa.

2b. Time-Coherent View of Reality. In the time coherent view of the universe, space is inverted or reversed, so to speak, in the other universe. It would be as if all neutrons and antineutrons were like pinholes peeping into the other universe, and the entire anti-universe were inside every neutron. There may be some sort of real or virtual spherical membrane inside each neutron and antineutron that separates the universes. There would be a mathematical mapping of outer space to the inside of the membrane in which the center of the membrane would correspond to an infinite radial distance in the other universe.

Photons cannot pass through this membrane, and that is why antimatter, AKA dark matter, is dark. Only space granules (quanta) can pass through the membrane. If gravity is caused by flowing space, then gravity may be the only force of nature that can be exchanged between neutrons and antineutrons. The other possibility might be the weak nuclear force.

If this hypothesis is true, then the Hubble space expansion is real and not an illusion. Antineutrons are pumping space granules or quanta from the antiuniverse and expelling them into our universe. As well, neutrons are absorbing space granules or quanta from our universe and pumping them into the antiuniverse where they are expelled in positive time. Our space is expanding because antineutrons (dark matter) greatly outnumber ordinary neutrons by a ratio of about six to one.

2c. Matter-antimatter Annihilation. In any antimatter theory the issue of annihilation is bound to arise. If matter and antimatter occupy the same 3-space as they do in the space-coherent view, then why don't they annihilate each other? Electrons and positrons annihilate each other upon contact, and protons and antiprotons do so as well in particle accelerators. I suggest that annihilation does not occur outside a particle accelerator. Electron-positron annihilation has been observed in the cores of active galaxies, but I suggest that such objects are natural particle accelerators. The criterion for annihilation is the time displacement between the colliding particles. If they were both recently created in the accelerator, such a time displacement would be small. In stars and planets, there is a very large time displacement between the matter and antimatter components in the space-coherent view. So the distance $s = ct$ between them is quite large and growing larger since they age in opposite directions. A pool of free neutrons and antineutrons in the innermost cores of space bodies may be thousands of light-years apart because of their time displacement. In the time-coherent view, the time displacement between matter and antimatter is small, but photons cannot pass through the membrane, so annihilation, which is an electromagnetic phenomenon, cannot occur. Time displacement also prevents electron-positron and proton-antiproton annihilations.

3. The Neutron Gravity Hypothesis

I suggest that the electromagnetic force and the gravitational force are mutually exclusive. This means that only neutral particles such as neutrons can generate a gravitational field. Ordinary neutrons do so by absorbing space, and antineutrons do so by expelling space in positive time (they absorb it in negative time). All subatomic particles have the same inertial masses that are conventionally assigned to them. Charged particles such as protons and electrons are accelerated in a gravitational field because they have inertial mass, but they cannot generate one because they have no gravitational mass.

One can imagine space flowing at the escape velocity past the subatomic particles in a star or planet that are stationary in the radial direction with respect to the center of the body. One can imagine that a charged particle may be a tiny helix like a slinky that is formed into a toroid that has either left-handed or right-handed helicity that determines the sign of the electric charge. The toroid axes are aligned with the space flow direction. Flowing space would pass through the central holes in those toroids and also around their outer edges without effect.

One can imagine that a neutron is a composite object that contains a positron and an electron that are stacked like donuts, one above the other on their common axis. Their contra-rotating helices would exert an inward pull on the surrounding space like

rollers on a washing-machine wringer. Conversely an antineutron would exert an outward pull on the space from the anti-universe inside the antineutron (in the time-coherent view) and push it into the universe.

Toggleing neutrons into antineutrons is automatic with the time flow reversal. It's the same with protons and electrons. They automatically become antiprotons and positrons in negative time.

According to this hypothesis all subatomic particles have positive inertial mass, but charged particles have no gravitational mass. Neutrons have positive gravitational mass because they are space absorbers, and antineutrons have negative gravitational mass because they are space expellers in positive time.

If true, this hypothesis means that Einstein's General Relativity Theory is not general because gravitational mass is generally not equivalent to inertial mass.

We must account for the fact the gravitational mass of matter is always less than its inertial mass, which has the usual value. We use the definitions specified by (1) and (2).

$$m' = \lambda m, \tag{1}$$

where m' is the gravitational mass, m is the usual inertial mass, and λ is the ratio of neutron mass to atomic or molecular mass.

$$\lambda = \frac{N}{A} = \frac{A - Z}{A}, \tag{2}$$

where N is the neutron mass, A is the atomic mass, and Z is the proton mass or atomic number. As an example, consider the calculation in Table I for the bulk λ of Earth's crust.

	A	B	C	D	E	F	G
1	The 10 Most Abundant Elements in the Earth's Crust						
2	Source: CRC Handbook of Chemistry and Physics, 77th Edition						
3							
4		A atomic	Z	N			
5		mass	number of	number of		w	weighted
6	Crust	amu	of	neutrons		Abundance	average
7	Element	per atom	protons	$N = A - Z$	$\lambda = N/A$	% by mass	$w\lambda$
8	Oxygen	15.99940	8	7.99940	0.499981	46.10%	0.230491
9	Silicon	28.08600	14	14.08600	0.501531	28.20%	0.141432
10	Aluminum	26.98154	13	13.98154	0.518189	8.23%	0.042647
11	Iron	55.84700	26	29.84700	0.534442	5.63%	0.030089
12	Calcium	40.08000	20	20.08000	0.500998	4.15%	0.020791
13	Sodium	22.98987	11	11.98987	0.521528	2.36%	0.012308
14	Magnesium	24.30500	12	12.30500	0.506274	2.33%	0.011796
15	Potassium	39.09830	19	20.09830	0.514045	2.09%	0.010744
16	Titanium	47.88000	22	25.88000	0.540518	0.57%	0.003081
17	Hydrogen	1.00867	1	0.00866	0.008591	0.14%	0.000012
18	Other	24.50000	12	12.50000	0.510204	0.20%	0.001020
19					Totals	100.00%	0.504412

Table I. Earth's Crust $\lambda = 0.504412$

The atomic mass number in column B includes all isotopes weighted by their relative abundances. Hydrogen has a small non-zero value for λ because the Earth's hydrogen includes some deuterium, found in heavy water, which has one neutron. The hydrogen in Table I is that which is bound into compounds. Unbound hydrogen atoms and molecules in the ground state are assumed to behave like neutrons gravitationally.

4. The Space Shuttle Water Dump

On December 2, 1985 I had just arrived soon after sundown at my dark-sky observing site near Kaufman, Texas, preparing to

photograph Comet Halley again, and I noticed the Space Shuttle flying overhead from the southwest to the northeast. My telescope was still in the car, but I observed the Shuttle in my 11x80 binoculars. What I saw was an amazing sight. The Shuttle was a bright white dot, but there was a white comet-tail-like cloud streaming down from it that flared out and bent forward like an alpine horn. I found out later that this was STS-61B on the day before it landed in California, and that cloud was a water dump. I learned this on January 23, 1998 when STS-61B Commander Brewster H. Shaw, Jr. made a presentation at the Texas Astronomical Society meeting in Dallas. I asked him what that was from the audience, and he said they were making a water dump over Houston. Here is a photograph of another water dump taken by Paul Maley. [6]

In the rare image below, the Shuttle is conducting such a dump as seen from Houston and the particulates are directed downward toward the earth. Because the particles are small and are forced into lower orbits, the comet-like tail curves forward as the particles below the Shuttle speed up. The object immediately to the lower right of the Shuttle and trailing it is the Hubble Space Telescope. This image was taken during the STS-103 mission. Other objects in the frame are stars.

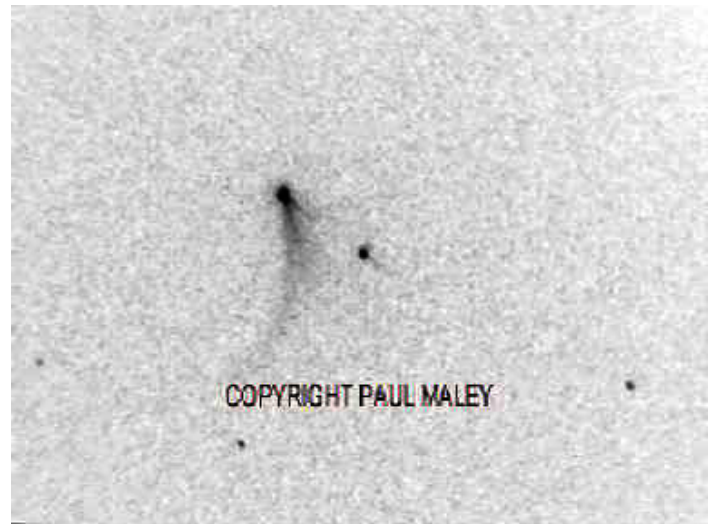


Fig. 1. Space Shuttle Water Dump

The Hubble Space Telescope is trailing behind the Shuttle, so they are both moving towards the upper-left corner of the picture. (This is opposite to Fig. 2 and 3, where the forward direction is towards the right.) The ice cloud is clearly curving forward as it moves downward relative to the Shuttle, and this forward displacement is more pronounced at the bottom of the cloud. Fig. 1 shows a 55° deflection. In 1985 I observed a 90° deflection at the bottom.

Here is a typical qualitative interpretation of the phenomenon of the forward drift of the downward spray. [7]

But the students were puzzled that the "tail" was preceding the presumed source of the dump, the shuttle itself. The swarm of ice particles that results when water is dumped from a shuttle follows a strange path through space, and this has confused many ground and space observers for years. To prevent the expelled

water from recontacting the shuttle, Mission Control usually instructs the crew to direct the stream downward, or even backward against the shuttle's motion through space. Objects moving backward from the shuttle are then going too slowly to maintain their original altitude, so they slip into lower orbits. By momentum conservation laws, they pick up speed along those new paths and quickly pull ahead of the shuttle, staying slightly below it. The stream often appears to move "out the back" of the shuttle, then curves downward and turns back forward.

Fig. 2 shows a quantitative interpretation of the phenomenon assuming a downward ejection velocity of 200 feet per second, relative to the Shuttle. The 200 fps value is only an estimate.

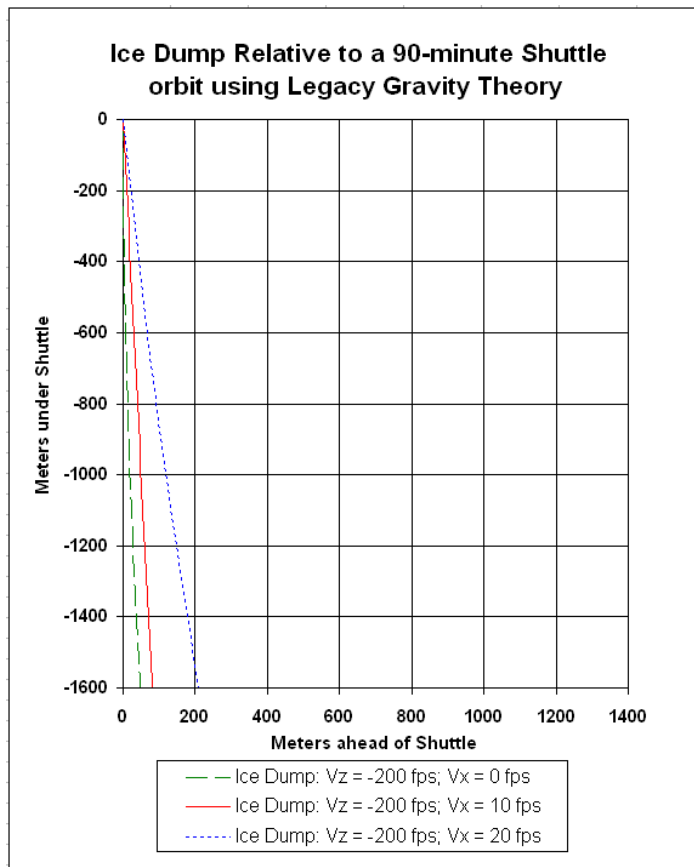


Fig. 2. Ice Dump Trajectories per Legacy Theory

Three trajectories are plotted in Fig. 2 with forward velocities of 0, 10, and 20 feet per second, respectively, relative to the Shuttle. At this scale these trajectories are all essentially straight lines.

The reason why the legacy theory predicts a forward drift in the ice dump, even when $V_x = 0$, is that the new orbit for the ice particles (due to their downward ejection velocity of 200 feet per second relative to the Shuttle) has a perigee that is 51.98 km beneath the Shuttle and an apogee that is 52.81 km above the Shuttle. At release, the ice particles are moving downward towards their new perigee, so their angular and tangential velocities increase relative to the Shuttle.

But there is no hint of the curvature in the ice trajectory in Fig. 2 that we see in the photograph of Fig. 1. In my visual observation of the STS-61B water dump on December 2, 1985 I saw a much more pronounced flaring curvature at the bottom of the ice cloud. At the time, I described it as looking like a cornucopia.

Compare Fig. 2 to Fig. 3. Fig. 3 shows how the same ice dump would look according to neutron gravity theory. All three curves have the same initial velocities relative to the Shuttle in both charts. Fig. 3 exhibits an upward acceleration that overcomes the initial downward velocity and produces a minimum displacement at -1458 meters beneath the Shuttle. This minimum occurs at 48 seconds after release for all three curves. Evidently the ice sublimates completely by the time it reaches the bottom of its travel, because I didn't see any upswing in 1985, and Maley's picture doesn't show one either. The trajectories take 32 seconds to reach 1300 meters beneath the Shuttle, and they remain beneath 1300 meters for another 32 seconds, so sublimation near the bottom of the curves seems plausible. The shape of the trajectories in Fig. 3 down to the bottom of the curves resembles the shape of the ice cloud in these two observations by Mr. Maley and me of water dumps by the Space Shuttle, but the straight-line trajectories in Fig. 2 do not.

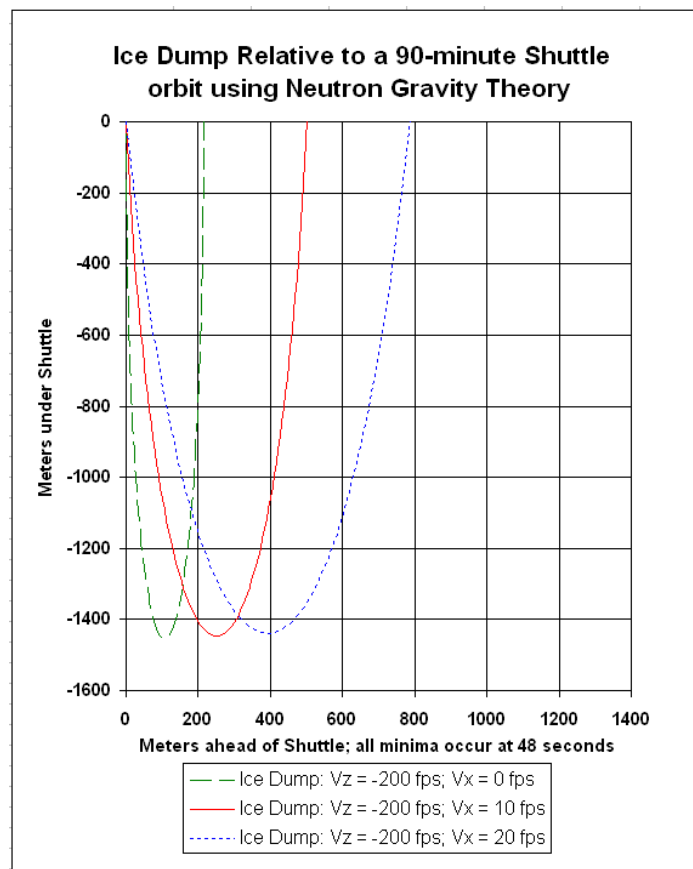


Fig. 3. Ice Dump Trajectories per Neutron Gravity Theory

Table II shows the calculation, using the neutron gravity theory, of orbit sizes and periods for artificial satellites made of lead, aluminum, and ice, respectively, that are released (not ejected with a relative velocity) from a Space Shuttle orbiting the Earth in a circular orbit at the altitude that produces a 90-minute period. The altitude of the Shuttle's circular orbit in cell C2 was varied (or "tuned") to 281.6 km to get a 90-minute period.

D17		=2*PI()*SQRT(D\$15^3/D\$14)/60				
	A	B	C	D	E	F
1	Geocentric gravity constant per IAG1999	GMe =	3.98600E+14	m^3/s^2 assumes equivalence principle		
2	Earth altitude for 90 minute circular orbit	h =	281.5557013	km Shuttle altitude; tune for a 90-min. alum. orbit		
3	Equivalent spherical Earth radius in km	Re =	6371	km		
4	Orbit radius for 90 minute orbit in km	Ro = Re + h =	6652.555701	km		
5	Orbit radius for 90 minute orbit in meters	Ro = (Re + h)*1000 =	6652555.701	m = aluminum a = ice perigee & lead apogee		
6	Space Shuttle matter dump orbits — assume circular orbit for aluminum; assume Earth's λ is that of aluminum.					
7			Lead	Aluminum	Ice	
9	Atomic or molecular weight	A =	207.21688	26.98154	18.010565	amu
10	Atomic number or number of protons	Z =	82	13	10	amu
11	Number of neutrons	N = A - Z =	125.21688	13.981540	8.010565	amu
12	Neutrons/(neutrons + protons)	λ = N/A =	0.604279347	0.518189103	0.444770333	
13		ψ = λ/learth =	1.166136733	1	0.858316648	
14		G'M'e = ψGMe =	4.64823E+14	3.98600E+14	3.42125E+14	m^3/s^2
15	semimajor axis	a = Ro/(2 - 1/ψ) =	5822970.863	6652555.701	7967811.913	m
16	Elliptical orbit periods	T = 2π sqrt(a^3/G'M'e) =	4094.993042	5400	7640.043353	sec
17		T = 2π sqrt(a^3/G'M'e)/60 =	68.24988403	90	127.3340559	min
18	Ro = Shuttle's orbit radius = Lead apogee	Ra_lead = Ro = a_alum =	6652555.701			m
19	Ro = Shuttle's orbit radius = Ice perigee	Rp_ice = Ro = a_alum =			6652555.701	m
20	Lead eccentricity	e = Ra/a - 1 =	0.142467627			
21	Ice eccentricity	e = 1 - Rp/a =			0.165071192	
22	Lead perigee	Rp = a(1 - e) =	4993386.024			m
23	Ice apogee	Ra = a(1 + e) =			9283068.126	m
24	Perigee altitude, km	hp = Rp/1000 - Re =	-1377.61	281.56	281.56	km
25	Apogee altitude, km	ha = Ra/1000 - Re =	281.56	281.56	2912.07	km

Table II. Orbit Sizes and Periods for Lead, Aluminum, and Ice Satellites Released from 90-minute Shuttle Orbit

Ro in cell B5 is the semi-major axis for the circular aluminum Shuttle orbit, the perigee E19 for the ice orbit, and the apogee C18 for the lead orbit. We assume that Earth's bulk λ_{earth} is the same as $\lambda_{\text{aluminum}}$, which is 0.5181891 (D12). Table I gives the bulk $\lambda_{\text{crust}} = 0.504412$, so if Earth has an abundance of 45.9% iron and 54.1% crust, that would give an overall weighted value of 0.51819 for λ_{earth} , and this seems to be reasonable. The main reason for postulating that Earth has the same λ as that of aluminum is that aluminum artificial satellites orbit the Earth with orbit sizes and periods that are expected. However, we need to remember how the legacy value of GM was computed in the first place.

$$GM = \omega^2 a^3 = \left(\frac{2\pi}{T}\right)^2 a^3, \quad (3)$$

where GM is the legacy geocentric gravitational constant, ω is the angular velocity, a is the semi-major axis, and T is the orbit period. If an aluminum satellite was used to calibrate GM in the first place, then we should not be surprised that aluminum satellites have expected orbits. Because the legacy gravity theory works so well for NASA, λ_{earth} may be a universal constant for the Sun and all planets and moons.

	A	B	C	D	E	F	G	H	I
1	Constants:	Ro =	6652.555640	km	Vc =	7.7406000	km/s		
2									
3	Matter	ψ	Vx ft/s	Vz ft/s	q	e	i	Node	arg peri
4	Shuttle	1	0	0	1.0430244	0.0000000	90	180	180
5	Ice	0.858317	0	-200	1.0427963	0.1653260	90	180	93.18147
6	Ice	0.858317	10	-200	1.0427976	0.1662425	90	180	93.16516
7	Ice	0.858317	20	-200	1.0427988	0.1671594	90	180	93.14902

Table III. Shuttle Ice Dump Orbital Elements for Fig. 3

Table III shows the orbital elements for the Shuttle and the ice dumps illustrated in Fig. 3. The parameter Ro (cell C1) was obtained from cell C4 in Table II. The circular orbit velocity (cell F1) was obtained from:

$$v_c = \sqrt{\frac{GM}{R_o}}, \quad (4)$$

where GM is given in cell C1 of Table II. The values for ψ in column B are taken from row 13 in Table II.

A polar orbit is used (inclination $i = 90^\circ$ in column G) for convenience in aligning the z axis with the Shuttle's radius vector. The values for the perigee (q) in column E are expressed in Earth radii.

5. Neutron Gravity Formula $G'M' = \psi GM$

The calculations in Table II depend on the neutron gravity formula in line 14 of that table. The idea is to get a new geocentric gravitational constant $G'M'$, expressed as some function $f(GM, \lambda_1, \lambda_2)$, that is appropriate for the neutron gravity hypothesis to replace the usual GM that is appropriate for the legacy gravity theory.

In the following equations, unprimed masses are inertial masses, and primed masses are gravitational masses. We will use lower-case m for the secondary inertial mass, m' for the secondary gravitational mass, upper-case M for the primary inertial mass, and M' for the primary gravitational mass. But we will use subscripts 1 and 2 on λ to indicate primary and secondary, respectively. We propose the following definitions.

$$M' = \lambda_1 M \quad (5)$$

$$m' = \lambda_2 m \quad (6)$$

I suggest that Newton's force of gravity between two gravitational masses should be re-written as follows.

$$F = \frac{G'M'm'}{r^2}, \quad (7)$$

where F is the force of gravity between the two gravitational masses, M' and m' , G' is the new gravity constant for neutron gravity theory, and r is the distance between the masses.

Neutron gravity affects orbits because the centripetal force on an orbiting body is proportional to its gravitational mass, but the centrifugal force is proportional to its inertial mass. Consider the legacy formula for a circular orbit in which the centrifugal force is equated to the centripetal force.

$$F = mr\omega^2 = \frac{GMm}{r^2}, \quad (8)$$

where ω is the satellite angular velocity, and GM is the legacy geocentric gravitational constant for the primary mass. In the legacy theory the satellite masses cancel out in equation (8). But in neutron gravity theory, the m on the left side is the satellite's inertial mass, while the m on the right side is the satellite's gravitational mass.

It might be tempting to develop a formula for the new gravitational constant $G'M'$ by setting the legacy force in (8) equal to the neutron gravity force in (7). But (8) only applies to circular orbits, and the circular orbit is a special case. These two forces are not equal in the general case.

Instead, I postulate that for the special case where $\lambda_1 = \lambda_2$, the neutron-gravity theory will get the same results as the legacy theory. By same results, I mean that given the same state vector

(position and velocity) for an orbiting body, the neutron-gravity theory will give the same orbital elements that are obtained by using the legacy theory. This can be expressed as follows.

$$G'M' \Big|_{\lambda_1=\lambda_2} = GM \Big|_{\lambda_1=\lambda_2} \quad (9)$$

Since $\lambda_1 = \lambda_2$ in this special case, we can multiply the right-hand side of equation (9) by either $\psi = (\lambda_1/\lambda_2)$ or $\psi = (\lambda_2/\lambda_1)$. Without choosing which definition of ψ is appropriate, we can nevertheless write:

$$G'M' \equiv \psi GM \quad (10)$$

To decide which definition of ψ is appropriate, we will derive the formula for the semi-major axis, a , as a function $f(\psi, r_c)$, where r_c is the radius for a circular orbit.

Consider the *vis-viva* equation [8].

$$v^2 = GM \left(\frac{2}{r} - \frac{1}{a} \right), \quad (11)$$

where v is the magnitude of the velocity of the satellite orbiting at a radius r from the primary having a central gravitational constant GM . Now consider the Space Shuttle water dump problem. For the circular Shuttle orbit, $a = r_c$. We assume that $\lambda_{\text{Shuttle}} = \lambda_{\text{Earth}}$ so that the legacy version of (11) for the Shuttle can be written:

$$v^2 = GM \left(\frac{2}{r_c} - \frac{1}{r_c} \right) = \frac{GM}{r_c} \quad (12)$$

The ice satellite that is released from the Shuttle will have a non-circular orbit with the same initial velocity but with $a > r_c$.

$$v^2 = G'M' \left(\frac{2}{r_c} - \frac{1}{a} \right) \quad (13)$$

Divide (12) by (13).

$$\frac{GM}{G'M'} = r_c \left(\frac{2}{r_c} - \frac{1}{a} \right) = 2 - \frac{r_c}{a} \quad (14)$$

Solve (10) for ψ and substitute (14) for the right-hand side.

$$\psi = \frac{G'M'}{GM} = \frac{1}{2 - \frac{r_c}{a}} = \frac{a}{2a - r_c} \quad (15)$$

Now solve (15) for a .

$$a = \frac{r_c}{2 - \frac{1}{\psi}} \quad (16)$$

Equation (16) is applied at line 15 of Table II. This equation says that if $\psi < 1$, the denominator $(2 - 1/\psi)$ will be < 1 , and so $a > r_c$. This is what must happen for the ice orbit because the circular launch radius will become the released ice's new perigee and

$$\frac{a}{r_c} = \frac{a}{r_p} = \frac{1}{1-e} > 1, \quad (17)$$

where r_p is the perigee, and $0 < e < 1$ is the eccentricity. Therefore, we can now choose this definition

$$\psi \equiv \frac{\lambda_2}{\lambda_1}, \quad (18)$$

because $\lambda_2 = \lambda_{\text{ice}} < \lambda_1 = \lambda_{\text{Earth}}$. The ratio ψ apparently ranges between about 0.8 and 1.2, depending on the relative abundances of chemical elements in the primary and the secondary.

In celestial mechanics whenever the mass of the orbiting body is significant (such as a moon instead of a spacecraft), the mass ratio parameter is usually defined as $\mu \equiv 1 + m/M$. With neutron gravity theory, that μ should be redefined as:

$$\mu \equiv \psi(1 + m/M) \quad (19)$$

6. The Cavendish Experiment

This proposition cannot be confirmed or refuted by repeating the Cavendish torsion balance gravity experiment [9] with the lead balls replaced with ice balls having equivalent inertial masses because we must assume that both theories must yield the same acceleration of gravity, g . Let m_1 be the inertial mass of the large ball, m_2 be the mass of the small ball and M_1 be the inertial mass of the Earth. If we assume the weight of the small ball is equal to the force of gravity between that ball and the Earth using either theory, we can write the following equation.

$$F_{w2} = m_2 g = \frac{GM_1 m_2}{r^2} = \frac{G' M_1' m_2'}{r^2} = \frac{G' \lambda_1 M_1 \lambda_2 m_2}{r^2} \quad (20)$$

$$G' = \frac{G}{\lambda_1 \lambda_2} \quad (21)$$

When we write the force equations between the large and small balls, we see that the force between them is the same for either theory if we substitute (21) for G' .

$$F_{12} = \frac{G m_1 m_2}{r^2} \quad (22)$$

$$F'_{12} = \frac{G' m_1' m_2'}{r^2} = \left(\frac{G}{\lambda_1 \lambda_2} \right) \frac{\lambda_1 m_1 \lambda_2 m_2}{r^2} = F_{12} \quad (23)$$

The forces for both theories are equal because the λ ratios cancel in (23). Therefore, the chemical element abundances in these balls do not matter. All that matters is their inertial masses. The Cavendish experiment estimates the inertial mass of the Earth based on the following ratios.

$$\frac{M_1}{m_1} = \left(\frac{F_{w2}}{F_{12}} \right) \left(\frac{r^2}{d^2} \right) \quad (24)$$

where $d = 9$ inches is the distance between $m_1 = 348$ pounds and $m_2 = 1.61$ pounds [9]. The force between the masses is obtained from the torsion spring constant and the deflection of the balance (0.16 inch), and the spring constant is obtained from the period of oscillation (7 minutes) of the torsion balance and its moment of inertia (balance diameter is 6 feet). This experiment does not depend on any knowledge of G to estimate the inertial mass of the Earth. Cavendish did not measure the force between ice balls. I used G to figure out what it should have been according to my theory. I concluded that you get the same value for M_1 from (24) using ice balls or lead balls.

7. Conclusion

The neutron gravity hypothesis can be confirmed or refuted by releasing a tethered lead ball from the inverted Space Shuttle's open cargo bay. If it remains motionless relative to the Shuttle, then this hypothesis would be refuted. If it exerts a downward pull on the tether corresponding to an acceleration of 1.5 m/s^2 , then this hypothesis would be confirmed. No such pull would occur inside the cabin where the gravity field is zero.

Future research should look to see if neutron gravity theory can shed any light on the flyby anomaly [10] or the Greenland ice cap borehole anomaly [11].

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