Immaterial Goals: Nature's Whys - from the Wise.

How can mindless mathematical laws give rise to aims and intentions?

Mindless? Hardly. Mathematics exists as an immaterial abstraction of reality or as the creative act of 'pure' mathematicians, in both cases only within the human mind, an immaterial domain itself. The rules of the latter merely need internal axiomatic consistency to produce imaginative math systems which have no intended benefit to the other sciences…but often do, as in the case of Boolean algebra. Goals are set by the human, not nature. So interest will focus here on the former case of math as a tool used to measure, test and interpret scientific methodology in support of natural laws. Math extracts from data such properties as quantity, direction, shapes and forms. Its foundation is in the real physical world but it only exists in an immaterial context – the human mind.

Many scientists have marveled at how mathematics aids in ordering reality via laws of science that predict how the real world will behave and operate. *It will be the focus of this essay to carefully examine the role of immaterial entities – like math -in shaping our sense of an end game. The scope will be limited to math as applied in science to data interpretation, a unification of math with the physical sciences.*

Ground rules: To communicate on common ground it is necessary to agree on approaches to truth in science via a certain world view – realism - and the scientific method. Painful experience has shown these two belief systems avoid disconnected dialectics.

Scientific method: method of research in which a problem is identified, relevant data are gathered, a hypothesis is formulated, and the hypothesis is empirically tested. A validated hypothesis then becomes a scientific theory. To this we add the realistic epistemology/interpretation of results. Two key failures historically in implementing this method are undisciplined data interpretation and the lack of adequate testing - or of any at all.

Philosophy: Much rejection of philosophy by scientists is understandable; their knowledge of pre-modern systems is misdirected along narrow paths like Rousseau's pure Rationalism and the Idealism of Kant. Most scientists hold a low opinion of philosophy, probably due to having no formal training; appreciation cannot spring from ignorance. Or else any knowledge is likely to be of modern philosophy, which embraces a diverse and often conflicting set of –isms, such as:

- Determinist: every event has only one cause; Skeptic: one can't find truth, so why try…
- Creationist: life was created from nothing; Darwinist; Life evolved from inanimate substances.
- Materialist: everything is made of matter; Spiritualist: immaterial spirits exist.
- Realist: sense perception is truly real; Idealist: reality is a mental creation
- Rationalist: reason is sufficient to know reality; Nihilism: nothing is important/there's no truth.

Scientism is a belief in the universal applicability of the scientific method and approach. Science holds all truth - the epitome' of human knowledge.

A blend of materialism, scientism, and atheism is usually found among the leading promoters of modern science. However, materialism is logically refuted by all those who acknowledge mathematics – an immaterial system - as part of science!

Many modern philosophies lead to a dead-end in scientific discovery – a result of being overly specialized, pessimistic and exclusive, especially if only the scientific method is their epistemology.

Realism is our time-tested choice of scientific world-view, rooted in the Age of Pericles and enhanced by the Mid Ages Scholastics. Realism asserts that an actual world exists independent of human perception by the senses. Patterns in nature are codified eventually into laws of nature as scientific knowledge. Many familiar axioms are embraced by realism through introspection of common experience:
Causality: every effect has at least one cause, but not every cause need have a cause!
Sufficient Cause: There's nothing in the effect which is not potentially in the cause.
Non-Sequitur: A logical statement cannot be true and false at the same time, in the same context.

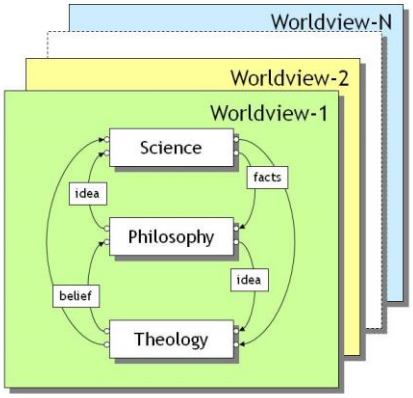
Realism has solved deep thorny questions posed by science, as with, "Is time infinite?" Since infinite time would contain all possible instants, there would be no potential (null possibility) for change to a new instant. Yet time does change, so time is finite…not infinite.
Math does have a uniqueness theorem which says that when/if a problem solution is found, it's the only solution – there's no more. But realism says the theorem must be proven – each time - not assumed! For example, it's true for linear equations but not for higher order.
The Athenian academy used two useful concepts. Aether was the fifth component of matter beyond earth, air, fire and water. This invisible quintessence – fifth nature – filled all of the universe to mediate remote causes and effects. Aristotle's phrase was, "From nothing, comes nothing." This logic recognizes that a separation of source and receiver can't communicate without a medium between them. Starlight would violate causality if Action At A Distance (AAAD) were possible through medium-free space. Even Newton would not hazard a guess as to the connective substance that transmitted gravity across space.
Modern science has taken the lead of relativity and removed the aether concept from contemporary thinking. But the 'vacuum' is now interpreted by scientists in ambiguous terms like quantum vacuum, zero-point energy, dark matter/energy, which seem to return empty space to the status of a physically detectable substance, albeit indirectly. Aether is everywhere, but its name still can't be spoken.

The second contribution of the Greek philosophers was the universal model for any change in a physical process, hylomorphism. Aristotle held a teleological worldview – a purposeful universe. Change involves potentiality reducing to actuality, possibilities becoming realities. Matter exists to receive a specific form or set of attributes/ characteristics essential to its nature; form exists to in-form or instantiate matter. The more a thing achieves its full set of potentials, the more it succeeds in achieving its purpose. Knowing the full potential of a substance means knowing its goals. But how does a substance know its own goals? Isn't that extrinsic, imposed from an external source?
That which exists is called being. If substantial form represents the possible properties or characteristics of a specific type of substance, and prime matter is completely undifferentiated matter, having no substantial form of its own…then when prime matter is informed or activated by a particular form, then the substance changes to a new actual state of being with (possibly) new substantial forms. Prime matter has no properties to reveal its existence by testing, so technically it cannot be observed empirically.
If we generalize matter and form to include in form all the potential states of a substance, given its current state, then we have a philosophical model that can cover all types of physical change.
Prime matter can be thought of as a slab of clay before being placed in the hands of a sculptor or potter, whose mind contains the possible forms that can be used to produce change.
Aether would seem to be the closest to prime matter, having the minimum properties of being.

In physics the rules for changing matter to form are the laws of physics governing motion, the laws expressed by the axioms and equations of Maxwell and Newton. But science only discovered these laws, not initiated them.

Knowledge Domain Architecture: The weaknesses of science are in scope and a false sense of the importance of subject matter depth. In the sequence of knowledge domains physics is a specific branch of science - which is part of philosophy – which is part of theology. Physics is the most detailed in the list while theology is the widest in scope. As a hardware store sign states: "We are deep but not wide."

When scientism ignores the scope limits of science by ignoring wider sources of knowledge, the pyramid of broad understanding is turned upside down! (see left.)



False knowledge domain hierarchy

Physics is limited to natural events focused on energy and motion, requires proof by repetition (experiments) and eschews human testimony in favor of self-testing. This narrow but deep view sacrifices full understanding of the human condition. Non-repeatable events are ignored. The need for self-testing to confirm laws is impossible in modern times. Scientific tests are funded and executed by governments or large corporations, with staffing of hundreds. What non-billionaire could compete with NASA in validating space discoveries?

Human testing by witnessing events is limited in time to about 5000 BC and in space to the solar system. Use of relics of ancient times as evidence assumes a false philosophical position - that nothing has changed since the remnants were formed - uniformitarianism. With no witnesses for corroboration the speculation about scientific pre-history vitiates the scientific method. This really differs little from a court of law, where credible witness are required. All the sciences based on pre- human history abrogate the scientific methodology established by the ancient Greeks and updated by Francis Bacon.

Celestial evidence of radiation – both light and Cosmic Microwave Background - is assumed unaffected in transit from sources assumed similar to our own Sun. Galactic distances and recession speeds are based on speculation about wavelength shifts toward the infrared - Doppler shifting. But photon energy doesn't change in empty space, so E = hf implies that the light speed is changing, not frequency. This can only be due to changes in the luminiferous aether, arising in galactic sources or on the path to Earth.

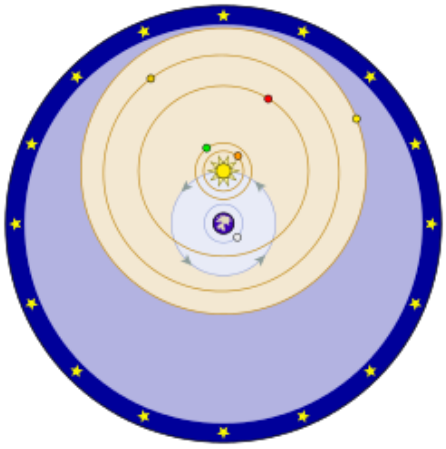
A valid application of science would limit our theories to those based on verifiable evidence less than seven millennia old and within the solar system. Demanding this does eliminate access to huge spans of space and time but eliminates wishful speculation. This would counter the freewheeling projections promoted in the popular scientific press and hailed as exciting but unfounded discoveries. By forcing progress to be slow but valid in scope the knowledge gained would be based on substantiation and not imagination.

Ignoring the discordant modern versions of philosophy is certainly reasonable, but versions like realism, tested over 24 centuries, provide extensions to physical knowledge that would be foolish to overlook. Consider the multiple universe hypothesis. Physical multiverses beyond our own have never been

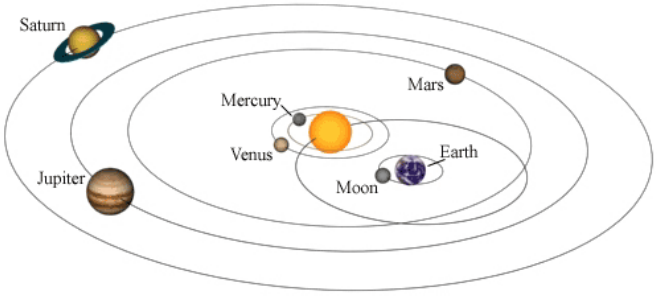
observed, and universe means all of physical reality (in science), so the multiverse concept seems ill-conceived.

Historical errors: Bringing our common understanding of physics up to date will require a historical review of some wrong theoretical paths where interpretations stumbled – and are still uncorrected.

GC vs. HC: The break between science as subordinate to philosophy and theology occurred with the adoption of the Copernican heliocentric world model. The prior single-focused geocentric model of Ptolemy was correctly proven to contradict such observations as the phases of Venus and the retrograde motions of Mars… a methodology rejection..
But within a few decades Tycho Brahe had eliminated the Ptolemaic faults by using a hierarchical geocentric diagram with the Sun and Moon as primary satellites, the planets as secondary satellites of the Sun and the moons, tertiary.



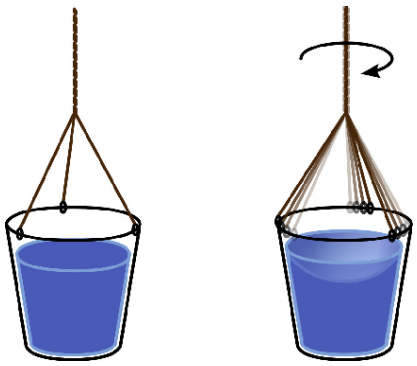
Tychonian Geocentric System



Copernican Heliocentric System

Imagine the Copernican model with the Earth pinned at the center instead of the Sun. All solar system motions seen from Earth would be identical with either kinematic model.
The model of Copernicus was favored for its simplicity, a subjective epistemic, and adopted as the standard of science …but no observations could eliminate the Tychonian model by using the objective standard – the scientific method.

Newton's bucket



Before rotation and after co-rotating

In the Principia of 1687 Newton introduced a key example that motivated his mechanics and hasn't been interpreted correctly…. until now.

A bucket is spun until the water co-rotates with it and a surface vortex is formed. An observer on the bucket will PREDICT that no vortex will form - for no centrifugal force is created by Newton's 2nd law of motion. When v = 0 in F = mv*v/r, F = 0. Yet a vortex is observed by Newton in the lab frame and by the bucket observer. Newton had no problem predicting

the vortex, for the centrifugal force law was perfectly valid…IN THE LAB FRAME.

Why does water obey this law of rotating dynamics in the Earth's frame, but not in any rotating frame? Newton said the water was rotating relative to absolute space, an undefined location in the universe. Ernst Mach believed the water was influenced by forces generated by the rest of the universe (and not by the distant stars, as most physics texts promote). The rest of the universe is everything that's not the bucket, thus including the Earth itself.
The mainstream consensus of physics academics now is that there are 'fictitious forces' in the rotating frame that must be added to the 2nd law to 'correctly' predict the dynamic result. This appeal to 'fake physics' may be accepted by students intimidated to pass their tests. But this chestnut cannot pass tests of realism or logical self-consistency. In the bucket frame we see Newton, the lab, and the rest of the universe (as Mach said) rotating around the bucket. Either the Earth or the bucket can be thought as spinning…relative rotation. No preferred reference frame existsin kinematics – if I see you moving 5 ft/s north, you see me moving 5 ft/s south…ditto in ft/s*s for accelerations and all higher states of motion. This is a self-evident truth, an unassailable axiom in kinematics. And there's no preferred frame in dynamics…or is there?
Einstein believed in general covariance, that all reference frames are valid in predicting motion from the laws of dynamics (Newton and Maxwell). But the bucket result blows this principle away.
Yet thinking out of the box, we have a single frame, the lab or Earth Centered Earth Fixed (ECEF) frame, that predicts physical laws of motion correctly, which no non-lab frame can do. The absolute space Newton sought was right under his feet!
This geo-focused worldview of dynamics– call it geovariance – is derived from testing and eviscerates much theory of 20th century dynamics - and it has yet to be refuted.

Bennett's hiker: Is the lab frame uniquely valid for rotational motion? Well, consider this linear analog of Newton's Bucket.
A car heading north accelerates past a hiker. From measurements of the car's acceleration *a*, and the driver's mass *m*, the hiker predicts that the driver will feel an inertial force of f = ma. And so the driver does, as we know from our own experience.
Now the driver in the car frame measures the hiker's acceleration south, (-a by kinematic relativity) and the hiker's mass M, and predicts a force on him of F= -Ma south (dynamic relativity) … But NO… the hiker feels no inertial force as the car races by! Again, evident from experience.
The situation is symmetric; why the difference? The hiker is in the ground frame, the absolute dynamic reference frame of Newton's bucket. Should we add some 'fake forces' to pretend the laws of physics are also true for the car frame? Please, no!
Motion is relative in kinematics but absolute in dynamics. And the absolute reference frame for the universe is nothing but *terra firma*…Mother Earth.

MMX: The Michelson-Morley eXperiment was intended to detect Earth's motion through the aether proposed by 19th century theorists. In the heliocentric model the estimated speed was a constant 30 km/s but a variable speed was found after six weeks of testing, not exceeding 7 km/s. Attributing the variation to random errors, the consensus was that the orbit speed was null/zero.

Michelson offered four options to explain the unexpected result, none of which was the obvious one – an immobile Earth, the realistic interpretation of Newton's Bucket! More precise repeats of the MMX by Dayton Miller and others (see Cahill) later found two overlapping waves having periods of a day and a year….stellar in origin, not solar! The heavens were modifying light speed from a source identified as in

Leo, which is also the CMB dipole location, known only since this century's turn! Ring laser testing in NZ found the same periodic motion, plus another for the lunar day (tides). What is going on here??

Celestial rhythms are being detected on a stationary Earth as changes in light speed - or is it in aether?

Failure of SR and GR. Einstein offered the two postulates of Special Relativity to force a kinetic Earth understanding of the MMX. But the first is refuted by Ruyong Wang's optical glider, which detects its speed only in the lab frame via SoI = c + v. Placed in the hold of Galileo's ship, the glider would measure the ship's speed relative to the dock/lab frame! There's only one inertial/absolute frame – the Earth.

All tests for light speed with gas interferometers detect anisotropy, SoL = c + v (Cahill). All vacuum tests always find SoI = c. By removing gas from the light path, thought to be contamination, the researchers have thrown the baby out with the bath water. Aether motion is undetectable without a substance to manifest its interaction. Would a test of water waves in a tub first drain the tub to remove the side effects of water? So Postulate 2 is empirically voided.

CMB implications: CMB multipole anomalies imply a geocentric universe; several analyses of the microwave sky scans (Planck the latest) confirm an unexplained local pattern. Conventional physics identifies the CMB as the remnant radiation of the Big Bang, allowing a vision of the random radiation emitted when matter first formed 13 billion years ago, a pattern identical to all observers.
BUT - the CMB dipole strangely aligns with the Earth's ecliptic plane, as do the next 3 n-poles. They also line up with the equinoxes, both sentinels in the sky unique to Earth's location in the solar system, formed 5 billion years ago, not 13 billion, when the CMB was formed – that's in theory! On an Andromedan planet (and throughout the universe) would be seen the same microwave architecture of the Earth's sky! An analogy - everyone in the world looks outside their back window and sees the same thing…your own backyard!

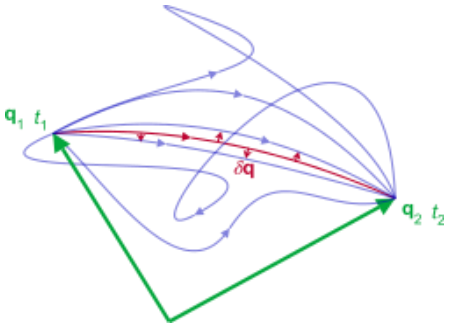
The hints at immaterial goals are now examined, some of which already were noted.

The origin of dynamics: Maupertuis felt that "Nature is thrifty in all its actions" so he sought the laws of motion selected by nature from an infinite set of options**.** The principle of least action he proposed determines the path followed by an object in a physical system, a metaphysical principle that underlies all the laws of mechanics. In this context "least" means finding the path that has the minimal change from nearby paths.
Something called 'action' is minimized, three factors that describe and determine motion: the product of travel distance, velocity and mass (resistance to motion). Alternate expressions for 'action' are angular momentum or kinetic energy times time, the latter Lagrange's choice for determining future motion.
Applied to light the refracted light followed a path through two optical media which minimized the action. Applied to hard and elastic bodies in collision their trajectory in space was as predicted. The laws of movement deduced from this principle are precisely the same as those observed empirically in nature. It truly seemed universal, almost magical, though the root cause for the success was unknown. For why should minimal action produce the laws of dynamics formulated by Newton and Maxwell?

Lagrangian analysis: Lagrange used the calculus of variations to derive the Euler–Lagrange equations as extrema of functionals. The trajectory of a particle system was derived by using the dynamic system information L = T - V, the difference between kinetic and potential energy. It was later found applicable to much of fundamental theoretical physics, particularly quantum mechanics and particle physics.

Generalized coordinates simplify solving for the system's motion. However, assuming all reference frames are valid (covariance) makes the method fail as a complete dynamical solution. As demonstrated

by Newton's Bucket and the hitchhiker model, only the lab frame makes valid predictions of motion. A strategy for success is to only apply the Euler-Lagrange equations in the Earth-focused frame of reference.



Curve **q**(*t*), parameterized by time

The Lagrange principle considers all possible energy paths (blue) from a start to end time(green). Each possible path represents the summation/integral of all the energy values at each instant of time. The max/min path computed is the dynamic equation for the true motion.

The action principle has been applied physically, not mathematically, to the real world:
- Surveyors once stretched corded ropes to measure the distance between two points.

- Hero of Alexandria discovered that the path of reflected light was the shortest length and least time.

Feynman wondered at the process of energy conservation which applies to closed and symmetric Lagrangian systems. An increase in speed caused KE to rise here and PE to drop over there. Did a Master Accountant balance every motion to keep the total system energy constant? As a result of immaterial processing of potential paths in search of the one true and actual path?

Quantum Mechanics: introduced a world of potentialities rather than one of things or facts – matching the hylomorphic model for change! A quantitative version of Aristotle's *potentia*, the probability wave - between the image/form and the actual event - describes a tendency for different states to occur, a blurred condition somewhere amidst possibility and reality.

When the classical variational principle is applied to the quantum interference of probability amplitudes, goal-seeking seems to vanish. The classical case is the quantum technique's limit of path integration where extremal paths are obtained as interference of amplitudes along all possible paths. But how does the minimum of all classical energy paths of the Lagrangian relate to the corresponding sum of all quantum possibilities expressed as probability amplitudes? The reality of the energetic Lagrangian has now become a purely mathematical process of summing possibilities of complex amplitudes. Reality is reduced to a computer algorithm …with an unknown programmer….unknown, that is, to scientism.

Double slit: Bohm's pilot wave theory fancies that when a photon or electron approaches two slits, waves are emitted which detect the environmental configuration via interference and return to the particle with this information, including a memory of what particles have already passed the slits! A fantastic notion, imbuing quantum objects with knowledge and memory beyond human unaided capability. Fantastic, yes, but not logically impossible in an immaterial world.

Entanglement: Two correlated quanta can share their quantum state instantly, over large distances, implying a speed defying material limits … and so implying immaterial communication.

QED: Feynman substituted the energy of the classical approach with a path integral of the wave functions of all possible electron-positron pairs in an electro-magnetic field. This again implied an

intelligence in the process of computing that somehow led to the observed electrodynamics. But Richard emphasized that the path integral technique was an 'algorithm', not a real process!

Biology: Living systems efficiently organize with the intricate aims of survival, reproduction, and other biologic ends; this organization is not imposed by the human mind, but the (immaterial) mind of nature.
Without immaterial support evolution is not explicable, but devolution, degradation of perfection, is.
Immateriality is most transparent in biology: what material substance leaves (or enters) a life form upon death? What are the physical parts of the human mind –<u>not the brain</u>?

Possible teleology: All these variational principles need at least two responses:

- How does math – like a bloodhound - sniff out the actual single event or motion using only an abstract model of reality?
- How did the mind of man discover these mathematical – and immaterial - principles?

Since the initial and final states of the system are fixed, the choice of final location and time are said by some to endow the action principles with a teleological content. The final choice sets the goal.
This is a deflection from the true issue, the intelligence that underlies the determination of the true path from L= T-V.
Others claim the physical content of the system creates an apparent teleology by specifying the positions but not the velocities. This initialization about the initial conditions from the final conditions is said to impose a reverse inference, implying teleology.
Does the tail wag the dog? Neither does the final determine the initial state, independently of L.
Contrarily, it's contended that the variational principles have properties reflecting immaterial intelligence which explain their success in predicting the future.

SUMMARY

Progress toward a human goal is imposed by the immaterial mind, so goal-oriented systems can't arise from material systems, but from intelligent ones that proscribe a future set of events and the cause-effect relationship between them.
Natural laws hint at the true underpinning of reality, a merger of possibilities (potency) and raw material (prime matter/aether) that are implemented/instantiated whenever any change takes place.
What is the purpose of a motionless Earth, the only place in the universe where laws of motion are obeyed? Theology has the answer, an immaterial One, that scientism is blind to.
Reject the fictitious forces of fake physics and adopt real forces from the right perspective (laboratory reference) and aethereal motion.
Recognize kinematics as relative but dynamics as absolute – only from the Earth's perspective.
Mathematical laws aren't self-revealing; the subliminal goals established in nature can only have an immaterial and intelligent origin that designed the world – including ourselves - to accomplish its goals.

Until scientists break the shackles of materialism, scientism, naturalism and egotism by adopting the truths of philo-realism and the supernatural knowledge shared with us by a superior intellect in theology, then they will live in a self-imposed darkness, which ends in agnosticism and nihilism.

The essay message:

- Subscribe to an epistemology of realism and the scientific method, without exception
- Correct the errant paths taken in scientific history
- Identify true goals by removal of false laws/assumptions/principles
- Admit that immaterial intelligence governs our physical world

The lost wonder at what causes nature's goals as they wander in an intellectual desert.
Others know that 'what' is really 'Who'.
Employing all the tools of a realistic scientific methodology to find the answer to their 'whys' has made them wise.

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Technical endnotes:
Thinking that is outside the box ... but inside the bucket!

Newton's bucket was designed to demonstrate that true rotational motion cannot be defined as the relative rotation of the body with respect to the immediately surrounding bodies. His contention was that, in general, true motion and rest cannot be defined as special instances of motion or rest relative to other bodies, but instead can be defined only by reference to absolute space.
A contrasting position was taken by Ernst Mach, who contended that a body's motion was relative to everything else.

> *When, accordingly, we say that a body preserves unchanged its direction and velocity in space, our assertion is nothing more or less than an abbreviated reference to the entire universe*.
>
> Ernst Mach; as quoted by Ciufolini and Wheeler: Gravitation and Inertia, p. 387

The argument from Newton:

> *...the surface of the water assumes a concave shape as it acquires the motion of the bucket spinning relative to the experimenter. This concave shape shows that the water is rotating, despite the fact that the water is at rest relative to the pail. In other words, it is not the relative motion of the pail and water that causes concavity of the water, contrary to the idea that motions can only be relative, and that there is no absolute motion. ...the concavity of the water shows rotation relative to something else: absolute space.*
>
> *If a vessel, hung by a long cord, is so often turned about that the cord is strongly twisted, then filled with water, and held at rest together with the water; after, by the sudden action of another force, it is whirled about in the contrary way, and while the cord is untwisting itself, the vessel continues for some time this motion; the surface of the water will at first be plain, as before the vessel began to move; but the vessel by gradually communicating its motion to the water, will make it begin sensibly to revolve, and recede by little and little, and ascend to the sides of the vessel, forming itself into a concave figure...This ascent of the water shows its endeavour to recede from the axis of its motion; and the true and absolute circular motion of the water, which is here directly contrary to the relative, discovers itself, and may be measured by this endeavour. ... And therefore, this endeavour does not depend upon any translation of the water in respect to ambient bodies, nor can true circular motion be defined by such translation. ...; but relative motions...are altogether destitute of any real effect. ...It is indeed a matter of great difficulty to discover, and effectually to distinguish, the true motions of particular bodies from the apparent; because the parts of that immovable space in which these motions are performed, do by no means come under the observations of our senses.*
>
> Isaac Newton; *Principia*, Book 1: Scholium

The argument that the motion is absolute, not relative, is incomplete, as it limits the cause and effects to only the pail and the water, and the location of the absolute space is undefined. Does absolute space move with the Earth? …with the Sun? The concavity of the water involves gravity, so the Earth also is a participant.
Mach argued contrarily that only relative motion is established: Newton's experiment with the rotating vessel of water simply informs us that the relative rotation of the water with respect to the sides of the vessel produces no noticeable centrifugal forces, but that such forces are produced by its relative rotations with respect to the mass of the Earth and other celestial bodies.

All observers agree that the surface of rotating water is curved. However, the explanation of this curvature involves an additional 'fictitious' centrifugal force for all observers - with the exception of a truly stationary observer, who finds the curvature is consistent with the rate of rotation of the water as he observes it, with no need for an additional 'fictitious' centrifugal force. Thus, a stationary frame can be identified - it is the lab frame.
The law of general covariance assumes that the laws of dynamics are valid in all frames of reference.
In reality the laws of motion must be correlated with their reference frame(s). The physics laws, developed and tested on Earth, can be said to apply only relative to the Earth frame... unless and until other frames retain the same laws. This law of formal invariance –tested by Newton's Bucket and other modern experiments – is best termed geovariance.
The rotating bucket experiment suggests one can detect the reference frame for absolute rotation by observation of the shape of the surface of the water.

Parable of the Bucket People - a conceptual *gedanken* experiment ….but testable!
We know how the water appears to Newton. As the bucket spins up, the water vortex forms, its speed lagging behind the bucket rotation until the bucket and water co-rotate. We focus ONLY on the state of water and bucket co-rotating in the lab frame, as seen by Newton.
All the phenomena in the lab frame can be explained with Newton's laws.
Imagine the perspective of the Bucket Frame People (BFP), who live inside the bucket, near the flat water surface. Are their laws of physics the same as ours?
Our life on the Earth's surface makes the ground our natural reference frame... so also with the BP. Their view is that the bucket is always at rest - the basis for their observations and measurements.
But they are plagued by strange events... The water surface unpredictably starts to rotate and rise up and swamp their homes while they themselves are mysteriously attracted to the walls during the tides, as if by gravity. Then a window is built in the sidewall to view the lab world outside - for the first time.
Their physicists note that when Newton and the outside lab starts to spin, the water rotation and tides will soon start, but when the water stops rotating the tides remain, even though the lab still is seen spinning. Only when the lab has stopped spinning does the tide recede and the flat surface returns.
They have derived from many observations a complex set of rules that all depend on the lab spin outside, with a time delay for water level effects. One scientist says that the 'wall force' only appears when the lab is spinning, so this centrifugal force must be universal.
Yet a look through the window shows Newton standing next to the bucket, nowhere near the lab walls. Nor do his pencil and paper on the lab table show any sign of moving away from the bucket center.
The BFP find that when the outside world is stationary, Newton's laws are valid, but not when the lab moves. Then Newton's laws no longer hold and complexity sets in.
If we are tempted to give up covariance and allow each non-Earth lab frame have its own laws, then we will have a nightmare of effects without causes... unless reference is made to the lab frame for sanity.

Inventing 'fictitious forces' for the non-lab frame forces is substituting 'fake physics' for the truth.

Bottom line: to make sense of the world of dynamics requires that we use *terra firma* – Mother Earth.