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THE CASE FOR A RADICAL NEW MODEL OF GRAVITY AND THE CRUCIAL EXPERIMENT BY WHICH IT CAN BE TESTED

Back to Sections 1 - 4

5. INTERLUDE; REALITY CHECK

What is gravity?... What is inertia?... Is our much-exalted axiom of the constancy of mass an illusion based on the limited experience of our immediate surroundings?... How are we to prove that what we call matter is not an endless stream, constantly renewing itself and pushing forward the boundaries of our universe?

[Arthur Schuster, 'Potential Matter—A Holiday Dream,' *Nature* (1898) vol. 58, p. 367.]

5.1. Arrow of Time; Cosmological Preview 2. Having discussed what the Rotonians' conception of (4+1)-dimensional spacetime is *not*, we will momentarily pick up the thread of their exploration with a more constructive approach. Ultimately our purpose is to supplement the arguments for doing Galileo's experiment by connecting a range of physical ideas and observations to the cosmological implications presented at the outset. Let us now reset our bearings to this purpose by stepping back once again to widen the scope and foreshadow what is to follow.

In §2 we encountered the idea of "unification" of the forces as envisaged by Earthian physicists. Aitchison suggested that connecting Newton's G to the other physical constants would be instrumental in achieving this. Then our Rotonian/TwoWorldian exploration of higher dimensions highlighted the mutual interdependence between the physical and spatial dimensions, especially as implied by the readings of accelerometers attached to massive bodies. It will be argued that both of these thought trajectories—unification via cosmic/atomic G-connections and via dimensional reasoning—converge to indicate a simple solution to another deep physical problem: The famously enigmatic *arrow of time*. Revealed by the fact that time always increases (things only get older, never younger) the SGM explains the asymmetry as it is co-existent with and manifest by virtue of the *arrows of matter and space*. Conceiving gravity as a process of stationary outward motion and the source of space implies that the three basic dimensional elements of the physical world increase together in the same proportion forever.**[22, 23]**

If this is true, it further implies that the large scale state of the Universe depends on the atomic behavior of matter—not exclusively at some "early" high-energy era near its alleged birth, but inclusively, at all energies, all the time. Assuming this to be true logically leads us to *expect* connections between numerical relationships arising in electromgnetism, Quantum Theory (QT) and those arising in the large-scale cosmic realm of gravity. It is thus not too surprising that we should have found some of them—with a degree of exactitude not previously realized. Suspicions that such relationships are of profound physical significance have often been discussed in the literature.**[24-28]** But none of the prior proposals have survived, as the Rotonians see it, for three primary reasons:

1. The *assumption of material staticness*.

2. The *assumption of a cosmic beginning*, which entails a discontinuity as between matter and space (one expands, the other does not). And

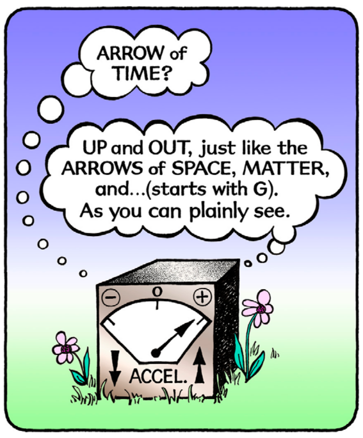
3. The *assumption that gravity is an attraction* (whose magnitude—for no known reason—is exactly proportional to inertial mass). This contradicts the truthfulness of accelerometer readings because an accelerometer that falls gives a *zero* reading, yet the assumption requires regarding falling bodies as *accelerating downward*.

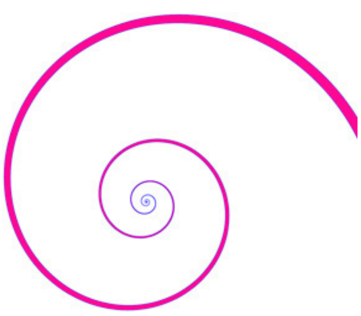
Note that the opening quote of this section, written in 1898, does not suffer from these objections. The ideas expressed therein are based on researches by its author and a colleague, Karl Pearson, who proposed that "ether" (i.e., space) is produced by matter; that this conception may help to explain gravity, inertia, and their collective effect on the whole Universe. Being a well-respected physicist, Schuster saw fit to protect his reputation by presenting such wild speculations as a "Holiday Dream." Though many physicists in later years suspected a connection between atomic and cosmological constants, none of them made the connection to the ideas contained in Schuster's obscure Letter to *Nature*. Instead, they and their followers continue to regard gravity as a force of attraction between essentially static bodies of matter.

Notice that Schuster put the kernel of his speculations as a question: "How are we to prove that matter is not..?" We see now that the answer is to probe the insides of material bodies by conducting Galileo's experiment. If the Rotonians' prediction were supported, i.e., if the test object does not pass the center (because accelerometers always tell the truth) then strong evidence will have been obtained that "matter ***is*** an endless stream, constantly renewing itself and pushing forward the boundaries of our Universe."

SIDE NOTES and REFERENCES, CONTINUED

[22] Unhidden thoughts of a basic Anthropomorphized Accelerometer:





[23] Exponential Growth; Constant Cosmic Density.

[24-28] — Curious Cosmic Numbers discussed in the literature:

[24] Herman Bondi, *Cosmology* (Cambridge, 1952) pp. 59, 61.

[25] P. A. M. Dirac, 'Cosmological Models and the Large Numbers Hypothesis,' *Proceedings of the Royal Society of London A*, vol. 338 (1974) pp. 439-446.

[26] Robert H. Dicke, 'The Many Faces of Mach,' in *Gravitation and Relativity*. Eds. Hong-Yee Chiu and William F. Hoffmann (W. A. Benjamin, Inc. 1964) pp. 121-141.

[27] E. J. Zimmerman, 'Numerical Coincidences in Microphysics and Cosmology,' *Am. J. Phys*, vol. 23 (1955) pp 136-141.

[28] John D. Barrow, 'The Mysterious Lore of Large Numbers,' in *Modern Cosmology in Retrospect*. Eds., B. Bertotti, et al (Cambridge, 1990) pp. 67-93. This paper is replete with other references on the subject.

A detailed account of how the SGM conception of gravity leads to the expression for G (§2, Eq. 1 and 2) by way of connections between atomic constants and cosmological parameters is given in **SGM, Cosmic Numbers and Dark Energy**. We will return to some of these connections later. For now, let's acknowledge an aspect of the unfolding presentation that has less to do with *content* than with how (or from whom) it is being delivered.

5.2. Rotonian Marketing Strategy. Our frequent deferrals to a fictional civilization of Rotonians serves partly as a device for cushioning myself (Richard Benish) from knee-jerk criticism that might otherwise flow freely against any Earthian who would harbor such a slew of seemingly crackpot ideas: "*Believe accelerometers? Acceleration of volume per mass? Constant cosmic density? Arrows of matter and space?* Well, that's just crazy talk!" To the average Earthian physicist it may well seem crazy, but to intelligent beings who have evolved in a world whose *rotation* keeps its inhabitants grounded, where accelerometers always tell the truth about their state of motion, *nothing could be more sane*.

What's crazy is to interpret non-zero accelerometer readings as indicating staticness or a state of rest. Having trust in accelerometers engrained in their psyches, Rotonians have no choice but to bring this perspective to their first encounter with an astronomical body of matter, to adhere to it in trying to figure out what is really going on, and to test their working hypothesis by experiment. Even if skeptical of its scientific import, the reader is, I hope, at least having some *fun* imagining this point of view. Whether skeptical or swayed, we should all be eager to reach the story's climax, which has been tragically postponed by the physics community because of their neglect to perform Galileo's Small Low-Energy Non-Collider experiment. The story's climax (or anti-climax?) is the long-awaited result of this experiment.

Our Rotonian shift in perspective does not contradict any known facts, but only looks at them from a new angle—a perspective based on an unexpected, though *possible* set of primal experiences. Respected proponents of fundamental physics (such as E. Okon **[10]**) admit to "profound confusion...over basic concepts like time, space, matter and causality, resulting in the absence of a general coherent picture of the physical world." Stanford physicist Savas Dimopoulos laments: "There is something big that we don't understand about gravity."**[29]** Lee Smolin echoes: "We are horribly stuck...We are missing something big...Every physicist I know will agree that probably at least one big idea is missing."[§**3.1]** Such comments are evidence that incrementally tippy-toeing on the doorstep of the little Einstein-chained box of the status quo is not taking physics where it needs to go. The Rotonian perspective light-heartedly launches us way beyond these fog-filled confines to a starkly clear, previously unimagined vantage point.

[29] Savas Dimopoulos, as quoted in 'Free Fall,' Dana Mackenzie, *New Scientist* (10 February, 2007) p. 26.

5.3. Big Things Don't Hide in Small Places. Soon after landing on Planet Earth, Rotonians formulated their gravitational hypothesis, which emanates directly from their instinct to believe accelerometer readings. Ever since, they have continued trying every angle allowed by their modest resources to point out to Earthians that the big thing they are looking for may well come to light by asking a new set of questions. The clues are probably hiding in plain view, like on the nearest accelerometer readouts and inside the nearest body of ordinary matter; a fundamental, yet potent clue may come forth by innocently contemplating the flatness of our undersides and explaining this phenomenon in the simplest possible way.

Being acutely aware of the decades of rigorous training undergone by Earthian physicists (and the prejudice this experience is likely to have induced) Rotonians' *Plan A* has been to initially omit the shocking notion that Galileo's experiment might yield a surprising result. Instead they would first appeal to the uncontroversial Galilean connection: "The *Father of Modern Science* proposed the experiment 384 years ago; nobody has ever done it. Shall we?" Unfortunately, even this appeal to the veritable icon of science and basic human curiosity has proven ineffective. Though several brief dialogs on the matter have taken place, the hopefully optimistic collaboration between Earthians and Rotonians—as suggested at the end of §3—remains unobtained. The responses from Earthian physicists to many hundreds of attempts to communicate the situation has left Galileo's proposal waiting on the drawing board. Earthian physicists *pretend to know* the outcome of the experiment prior to doing it, so the empirical spirit of Galileo has been kicked to the curb.

The comment by Dimopoulos quoted above arose in a discussion about trying to improve measurements of free-falling objects to an accuracy of $0.000\,000\,000\,000\,001$ (10^{-15}). Dimopoulos laments missing something big, but he proposes to find it in an extremely small place. The instructions for growing a blue whale reside in microscopic DNA molecules. So in some sense at least a *map* of a big thing can be found in a small place. It is also true that important (large) truths about the micro-world are to be found (guess where?) in the microworld, i.e., small places. But the domain of gravity is the *macro*-world. If our understanding about gravity is missing something big, should we look in small or big places to find it? The current situation may be mapped as in **Figure 3** (§1), whose incompleteness is plainly visible. The map (graph) exhibits a large unexplored territory reminiscent of medieval maps depicting scary monsters surrounding that which is known. Ironically, our present monster dominates the *center* of the map.

The discipline of physics may be imagined as a large botanical garden. Most of the established grounds have been inspected and re-inspected many times over with extremely fine-toothed combs, microscopes, colliders and other fancy devices. The resulting data is proudly displayed alongside every specimen and every apparatus for all to see. Smack dab in the middle of the garden is a large boulder under which, by contrast, nobody has yet looked. The lack of an inspection record is conspicuous by its absence. Curious children, good detectives and Rotonians see—attached to the stone—no data (because there is none) but a large flashing neon question mark. They hear loud alarm bells, whose annoying blare will cease only after someone finally performs the long-awaited inspection under the stone.

Meanwhile, the selectively deaf, blind and numb grounds-keepers, who feel not the flattening of their undersides, assure the curious ones: "There's no need to look under this stone because our theories tell us what we would find if we did. (So get over it.)" Sadly, the opinions of these authorities weigh heavily on those with the resources needed to lift the big rock. The big rock that sits in the big place where the big thing that the authorities say they are looking for might reside, must not be moved because the authorities have maintained their consistent faithful regard for it for so long that, if they were to change their minds, they would suffer the embarrassment of not having changed their minds sooner. "Ha ha, made you look!" The authorities seemingly dread having to face this comically humbling outcome. It is decidedly not a picture of the open-minded empiricism and thorough objectivity by which physicists often represent themselves.

How does the intransigence of these academicians compare with that exhibited by fundamentalist religion? Religion at least admits that its precepts are a matter of faith. Followers are *supposed* to believe. In fundamental theoretical physics, by contrast, the physical Universe is supposed to get the final say. This lofty empirical ideal of science is routinely saluted; faith is alleged to play a minimal or non-existent role, being overruled at every turn by the supreme authority of Nature, as revealed by experiment. Instead of living up to this ideal, esteem for it sadly often amounts to only lip service. Huge egos or similarly important personal concerns evidently take priority. In practice, a myopic sense of self-preservation (as in herd animals) drowns out, tramples, or otherwise prevents Nature's gentle testimony. The familiar stomping grounds of established theories provide comfort and protection from the unknown. Blind faith mixed with denial of its tacit, though clearly prominent role, is thus more pernicious than blind faith alone. **[Sociology of Physics PostCard]**

Another simpler, more common metaphor is that of the drunk fellow looking for his keys on the illuminated pavement under a nearby street light. When asked, he admits that he knows he lost the keys some distance away in the dark: "But there's no light over there to see." Out of fear, ignorance, habit, arrogance, and plain foolishness, we keep looking where we've already looked and ignore the unexplored, yet accessible places where we substitute knowledge with belief. The self-imposed limits of human curiosity—in the name of science—are indeed curious!

Understandably, the Rotonians are not impressed. Dimopoulos' extra-dimensional scheme of gravitational attraction predicts that different particles should fall with different accelerations —which is in violation of GR. Nobody has ever given a *physical reason* why GR's prediction for the equal falling of all material bodies must be true. In the eyes of standard physics it is therefore *debatable* and *maybe* possible—if only we can look in a small enough place—to find a deviation from Einstein's prediction.

Ironically, the missing physical reason is often to be found—though never taken seriously—in plain view of the standard literature. For example, L. C. Epstein has written, "Einstein's view of gravity is that things don't fall; the floor comes up! That easily explains why [all material bodies fall at the same rate]." [*Relativity Visualized* (Insight, 1988) p. 152.] Due to various overriding preconceptions, this patently Rotonian view must be rejected by Einstein and all status quo physicists. For to take it seriously would mean (tentatively) believing accelerometers, and conducting an experiment to *test* this belief.

If the Rotonians' prediction for Galileo's experiment were confirmed, it would unequivocally *prove* why all material bodies fall at the same rate. (Because it would prove that *falling has nothing to do with accelerating downward*.) This proof, this big missing thing, would then have been found (as we should expect) in a physically big place—in the *zeroth* decimal place, with the opposite of the expected sign [(+), not (-)]—right under our noses.

Dimopoulos' idea that physics suffers from a "big" misunderstanding about gravity echoes Eric Adelberger's guess that "We are missing something huge in physics."**[8]** Sadly, Adelberger's experimental researches also involve looking for tiny deviations in tiny places. It should be mentioned that some of the looking is astronomical or cosmological. Even in this domain of large far away objects, however, the hoped for evidence would only show up as some tiny deviation from predictions of standard theory. More commonly, the searches involve miniscule discrepancies hoped to be found in particle physics or other high-tech big-budget gravity experiments. This empirical territory keeps getting explored over and over again. Meanwhile, the huge domain of physical reality inside common bodies of matter has not yet been probed even once (Galileo's experiment).

The theoretical underpinning of the standard approach (talk of finding big things coupled with inspection of only small places) is the *deep-rooted conviction that standard physics satisfactorily explains virtually all common phenomena*. Contrary to the idea that finding big things requires looking in the big forgotten places in our immediate experience, and as a way of denying that such places even exist, Sean Carroll has metaphorically claimed that "When it comes to understanding the architecture of reality, the low-hanging fruit has been picked." [*The Particle at the End of the Universe* (Dutton, 2012) p. 282.] The same sentiment is echoed (among many other places) in Stephen Hawking's, popular book, *The Brief History of Time* [(Bantam, 1988) p. 168.]: "We already know the laws that govern the behavior of matter under all but the most extreme [i.e., high-energy] conditions."

Blindly presumed to be known about the "architecture" of all these laws and all this fruit is that if an apple, for example, had a hole through its center and a test object were dropped into it, its matter would prove to be statically conserved and gravity would pull the test object downward, yanking it back and forth forever. Other presumptions in the same vein include that accelerometers contradict themselves, and that physicists can be trusted to abide by the empirical ideals of science.

5.4. The Meaning of "Unification." Because of their appeal to absurdly extreme and imaginary states of existence, Earthian notions of *unification* utterly fail to convince the Rotonians. Earthian archives reveal that the "standard model" is the basis for conceiving unification not as something manifest in the Universe as it normally, observationally *is*, but as it supposedly *used to be* near the time of the hypothetical Big Bang's $t = 0$. That is when the Universe is predicted to have been so hot and dense that all the forces had the "same strength" so they effectively merged into one. Subsequently, as the story goes, the Universe cooled and, by doing so, caused the "freezing out" of the separate forces and bodies of discontinuous matter that we see today.

Rotonians think this scenario is a nightmarishly fragmented, most unlikely, and frankly ugly account of things. It is of course too early to make a definitive judgment. But the Rotonians have a strong hunch that the result of Galileo's experiment will bear heavily in swaying opinions on the matter. Meanwhile, the best we can do is to continue presenting the Rotonian perspective, whereby their novel prediction for the result of Galileo's experiment appears more plausible than the Earthian prediction.

5.5. Evidence of Spacetime Curvature; The Problem of Gravitation. Before returning to the Rotonian interpretation of extra dimensions, it is pertinent to briefly present a list of evidence of spacetime curvature, as gathered by Earthian physicists and astronomers. Earthians' seemingly (3+1)-dimensional world exhibits non-Euclidean features that have been duly explained in terms of Einstein's theory of gravity.

Cogent evidence in support of this GR-based conception of warped spacetime includes the three historically "classic" tests:

1. Shift of Mercury's perihelion in its orbit around the Sun;

2. Bending of light around the Sun; and

3. Slowing of clocks depending on height in a gravitational field.

To these may be added the Shapiro time-delay test, astrophysical gravitational lenses, Gravity-Probe B's measurements of "frame-dragging," and decays of the orbits of binary pulsars. Together *these observations convincingly establish that spacetime is curved*. The reader is encouraged to consult the abundance of literature on these observations.

Much is said about how Einstein's geometric conception of gravity and the Universe has superceded the Newtonian world view. Newton famously and humbly admitted to not knowing the mechanism of gravity: "*hypothesis non fingo.*" Einstein, by contrast, grandiosely wrote of his "Solution of the Problem of Gravitation" and claimed—with incomplete evidence—that "the theory is correct."**[30]** As historian Jagdish Mehra has written, "Einstein was very content with general relativity."**[31]** He scarcely expressed any interest in the deep mysteriousness of the physical mechanism by which gravity really works; i.e., what matter must be *DOING* to make spacetime curve. Arguably influenced by Einstein's example, Earthian archives are essentially void, to my knowldege, of any discussion about this obviously pertinent question. GR's Schwarzschild solution (as the mathematical expression pertaining to the gravitational field of the Earth or Sun) doesn't concern any *active physical process*. It represents a static geometrical object that just sits there, magically "telling" spacetime how to curve. Being wholly unsatisfied with this slippery talk, Rotonians rephrase *the problem of gravitation* thus:

> **How exactly is it that our motion-sensing devices tell us loud and clear that we are moving, even as our visual impressions—while fixed in a stationary state with respect to a large material body—make it *appear* that we are not?**

[30] Ilse Rosenthal-Schneider, 'Reminiscenses of Einstein,' in *Some Strangeness in the Proportion*, Ed. H. Woolf (Addison-Wesley, 1980) p. 523.

[31] Jagdish Mehra, *Einstein, Hilbert, and The Theory of Gravitation, Historical Origins of General Relativity Theory* (D. Reidel, 1974) p. 38.

The problem of gravitation thus becomes that of reconciling ancient, everyday *visual* impressions with ubiquitous *tactile* evidence of perpetual outward motion.

Both Einstein's Equivalence Principle and his rotation analogy contain clues that suggest either *denial* of self motion (Einstein) or *acceptance of the ubiquity* of self-motion (Rotonians). Upon learning of them, every Rotonian immediately supposes that Einstein's conclusions based on these heuristic devices are backwards. Both sets of ideas are way more logically combined into the following proposition: Just as a rotating body actually moves, as indicated by motion-sensing devices, so too do seemingly static material bodies. Motion-sensing devices keep telling us this is so. Simply believing them leads to the conclusion that spacetime is curved because *everything MOVES*. Space is being actively generated by matter. As revealed by accelerometers and clocks, the patently inhomogeneous distribution of matter means the local, linear rates of motion of space are correspondingly non-uniform. Most importantly, this view leads to mathematical consequences that are consistent with the observations listed above. Where the opposing hypotheses disagree is in the huge accessible place *where we have not yet looked*, inside matter (Galileo's experiment). Not only does the Rotonian hypothesis go a long way toward answering the above question—that is, toward resolving the "problem of gravitation"—it is quite feasibly *testable*.

NOTE: Printable pdf of Section 5:

GravLab Sec 5. PDF.

Legal size paper (8.5" x 14") works best.

6. SPACETIME CURVATURE; SPATIAL and PHYSICAL DIMENSIONS: Phase 2

> *The structures, whose possible congruences are to be described by Euclidean geometry, cannot therefore be represented apart from physical concepts. But since physics after all must make use of geometry in the establishment of its concepts, the empirical content of geometry can be stated and tested only in the framework of the whole of physics.*
>
> [Albert Einstein, 'Relativity and the Problem of Space,' in *Relativity, the Special and General Theory* (Crown, 1961) p. 143.]

6.1. Introduction; Space Itself and Block Time. Due to huge differences in physical experience and cultural conditioning, Einstein's and the Rotonians' approaches to physics vary greatly. Yet, just as the Rotonians often see fit to justify their current thinking by tracing it back to their primal roots, Einstein also saw the value of appealing to the heritage of Earthian philosophy, mathematics, and physics in framing the context of his frontier research. In our opening quote we see that Einstein was deeply aware of the *interdependence* between geometry and physics.

An underlying goal that Einstein held—and sometimes thought he had achieved (via GR) was to show that the existence of space and time *depend* on the existence of matter. Being entirely mathematical in nature, and exhibiting no connection between this goal and an understanding of *gravity's mechanism*, these attempts all failed. This goal was initially couched in terms of satisfying the nebulous thing that Einstein referred to as "Mach's Principle."

[Remainder Under Construction...]

email: rjbenish@GravitationLab.com