Essay Written for the Gravity Research Foundation 2020 Awards for Essays on Gravitation.

Galileo's Experiment is Still Undone

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Abstract. —
Galileo's classic *thought* experiment, in which he envisions a cannonball falling through the Earth, has been doable as a scaled-down *real* experiment for decades. This fact was the subject of an essay submitted to this Foundation five years ago. [1, 2] The apparatus needed for the experiment—a very simple thing, in principle—may be called a Small Low-Energy Non-Collider. Sadly, the experiment remains undone. Presently, I will more emphatically argue that the standard prediction for the experiment could be wrong. The reasons for not filling this gap in our empirical knowledge of gravity have little to do with physics and a lot to do with sociology. The most operative influence is our primitive concept of an unmoving Earth, whose modern incarnation is embodied by Einstein's relativistic principles. Inspiration to question prevailing dogma is found in the perspective of an imaginary alien civilization.

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1. – Introduction: Clash of Perspectives

A 5.97×10^{24} kg ball of matter is the only home humans have ever known. It may be impossible to overestimate the influence of this experience on our conceptions of motion. A starkly contrasting perspective springs from an alien civilization that evolved in an enormous rotating space station, so far removed from astronomical bodies that they have no conscious experience of gravity. These *Rotonians*, as we will call them, have a highly developed understanding of physics, mathematics and technology—superior to Earth's 21st century.

Rotonians are acutely aware of their rotational motion, both acceleration and velocity, which they regard as *stationary and absolute*. They trust accelerometers and clocks as reliable gauges of acceleration and speed. Roton's diameter is about twice that of our Moon; its rotation period is $P = 2\pi/\omega =$ one hour. The acceleration of Roton's rim is equal to Earth's surface acceleration $R\omega^2 = g_\oplus$, and the corresponding tangential velocity $v = R\omega$ is about $\frac{1}{2}$ that of escape velocity at Earth's surface: $R\omega \approx \frac{1}{2}\sqrt{2GM_\oplus/R_\oplus}$.

Rotonians' understanding of electrodynamics and quantum theory have long been sufficient for them to have engineered a light path around Roton's circumference, L whose transit times are accurately measured with atomic clocks. Assuming a base speed of light c, they discover a difference of $2Lv/c^2 \approx 1/400,000$ sec between signals sent in opposite directions around Roton's rim. The speed of light with respect to themselves is $c + R\omega$ (*against* rotation direction) and $c - R\omega$ (*with* rotation direction). Rotonians have no reason to think of space as isotropic. Effects of motion

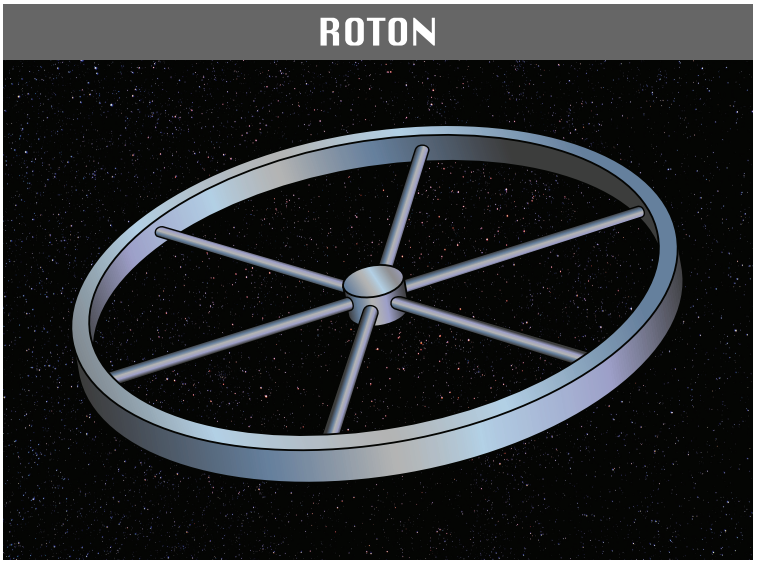

Fig. 1. – Rotonians reside primarily on the inside wall of the outer circumference of the gigantic rotating world of Roton. We do not concern ourselves with the origins of Roton, nor its means of sustenance. We are satisfied that it is an at least *possible* living space, and that the world view conceived by its inhabitants over many thousands of years would likely be—in certain key respects—much different from that of humans, who evolved on planet Earth.

are in no way symmetrical or reciprocal. Rotonians would never think to invent something so bizarre as a *theory* of "relativity."

2. – Einstein's Rotation Analogy

Echoing some of Einstein's early reflections on the need for non-Euclidean geometry, however, Rotonians encounter the same idea as follows: Rotonians' circumferential light circuit is a large *Sagnac interferometer*. Instead of phase shifts, they measure the effect of rotation on light as real-world speed and time differences. When Rotonians invent a Michelson-type interferometer, they expect this device to be another way of using light to measure their rotation speed. To their surprise, the result is null. Why?

Rotonians had also learned that the rates of their atomic clocks vary with distance from the rotation axis, such that

$$f = f_\circ \sqrt{1 - \frac{(r\omega)^2}{c^2}}\,, \tag{1}$$

where $f_\circ$ is the rate of a clock on the axis. From such explorations Rotonians had deduced that the elapsed time of a moving clock serves as an *odometer*. Time and distance are thus intimately linked by the properties of light.

Having also developed an understanding of non-Euclidean geometry—as a purely abstract line of thought—Rotonians were astonished to realize a possible *physical* application. Considering that

clocks on Roton are slowed according to Eq 1, they could explain the null result of their Michelson interferometer experiments if the interferometer and in general all stretches of circumferential distance in their world were contracted by the same factor. It was only after making similar realizations—in the years leading up to General Relativity—that Einstein adapted them to launch his theory of gravity. [3]

3. – Voyage to Planet Earth

Meanwhile, the Rotonian space program—more advanced than Earth's 21st century NASA—was planning an expedition to the distant points of light. They had invented a means of putting the crew in stasis for centuries with no ill-effects upon reawakening. As planned, this event would be triggered by proximity to a large ball of matter.

The time eventually comes, as the groggy crew beholds the reflected light from such an orb in the distance. Rotonians' staggering awe and wonderment turns to alarm as the sphere—fast-approaching straight toward them—begins to fill their field of view. Engines on the ship are off, so their measurement of the orb's approach indicates a definite pattern of increasing acceleration and speed. To propel the huge sphere with such rapidity surely requires an enormous rocket on the body's far side.

After they manage a harrowing, nick-of-time soft landing, communicate with the natives and complete their own exploration, Rotonians confirm that *there is no far-side rocket*. Rotonians have the utmost trust in accelerometer readings. Accelerometers all around the planet give the same reading. Rotonians thus reason as follows: *Matter must be an inexhaustible source of perpetual propulsion*. Rotonians had failed to notice this before because they had not previously encountered such a huge and concentrated chunk of it.

4. – Hyper-Dimensional Motion *OF* Space

Rotonian mathematicians had long ago developed not only non-Euclidean geometries, but also *hyper-dimensional* geometries. Just as physical discoveries in electrodynamics inspired application of non-Euclidean geometry to their measurements of Roton, their new experience with this thing Earthians call *gravity* inspired a combined application of both kinds of geometry to explain their observations.

Rotonians conclude that the *stationary outward motion* of gravitating matter is the *cause of space-time curvature*. This conception is made coherent by adding the idea that gravitational motion is unfolding into or outfrom a fourth spatial dimension. (See Figure 2.)

Rotonians add rigor to these conclusions by invoking the equation they had long ago derived to explain the limiting speed of light in relation to constant linear acceleration,

$$v = \frac{at}{\sqrt{1 + (at)^2/c^2}} \ . \tag{2}$$

Rotonians expect the form of Eq 2 to be reflected in the stationary motion of gravitating matter:

$$V_s = \frac{\sqrt{2GM/r}}{\sqrt{1 + 2GM/rc^2}} \ . \tag{3}$$

The square of the denominator in Eq 3 serves as a replacement for $(1 - 2GM/rc^2)^{-1}$ in Earthians' Schwarzschild solution, which treats gravity and matter as static things. [4]

Earthians regard the square of the velocity $\sqrt{2GM/r}$ as twice the *negative* "potential," representing a speed that *could* apply to falling bodies. Whereas, from empirical observations of clocks attached to Earth at a range of heights, Rotonians regard such velocities as *positive* and as happening all the time. Eq 3 represents the range of stationary outward speeds attributable to the source mass itself, and its surrounding space, as they move in $(4 + 1)$-dimensional spacetime.

Rotonians regard the *center* of a uniformly dense massive sphere as analogous to an axis of

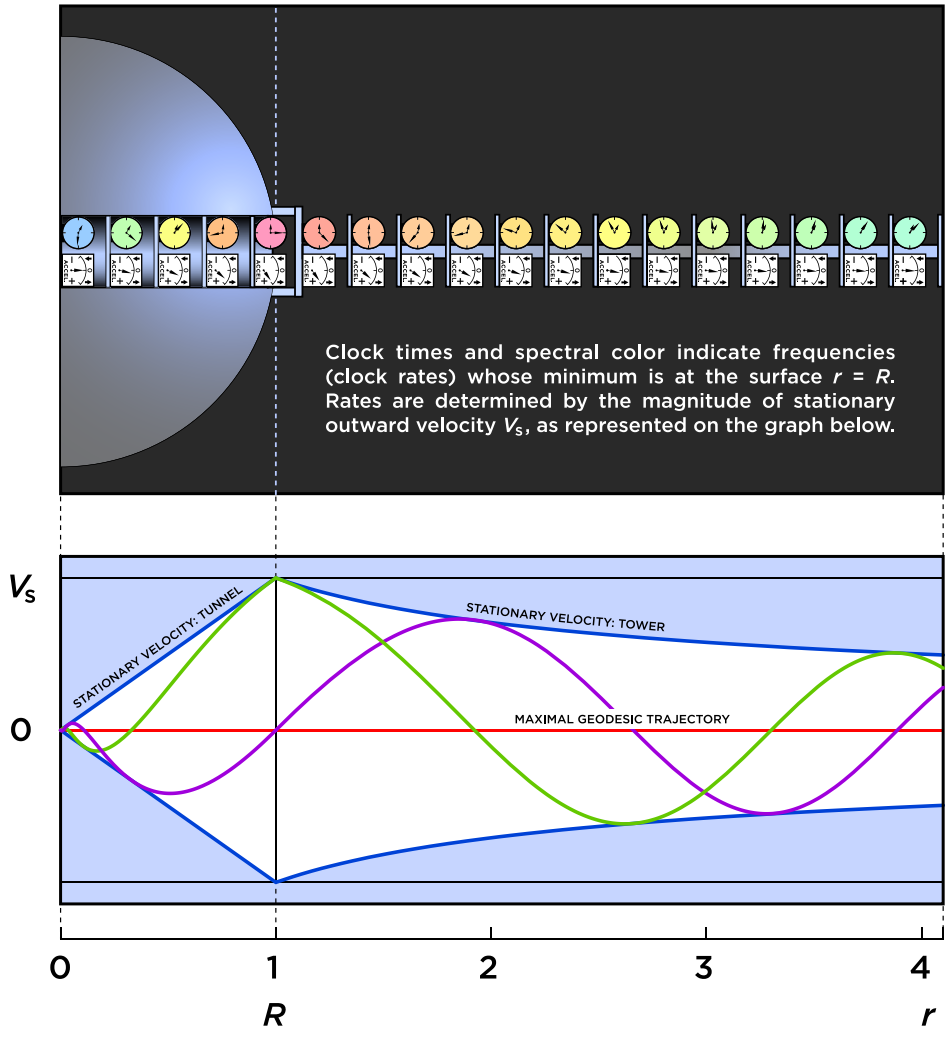

Fig. 2. – Tubular model of $(4 + 1)$-dimensional radial stationary motion. **Top:** Physical circumstance represented in the graph below; i.e., a gravitating body with a tunnel to its center and a tower attached to its surface. **Bottom:** V_S-axis represents stationary outward velocity; i.e., the stationary motion of space—into or outfrom a fourth spatial dimension. Think of the cross-sectional graph as rotating around the r-axis. Helices drawn on the tube at 45° to the axis facilitate visualizing the falling motion of maximal geodesics.

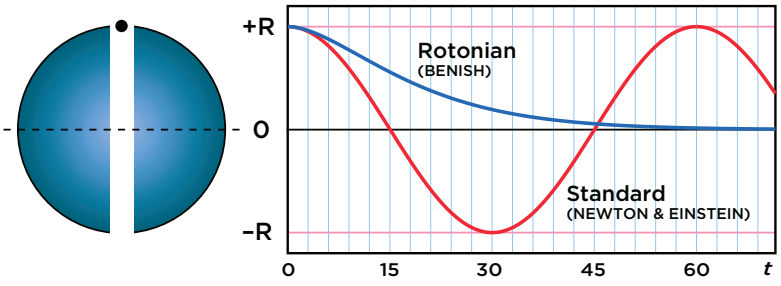

Fig. 3. – Comparison of Predictions. Newton's and Einstein's theories of gravity predict that the test object oscillates in the hole. For a sphere having the uniform density of lead, the period of oscillation would be about one hour. Based on their belief in accelerometer readings, Rotonians predict that nothing ever pulls the test object downward, so it never passes the center.

rotation. Being a place of minimum motion, it is a place of maximum clock rate. The prediction of maximum clock rate at the center, in fact, corresponds to the Rotonians' prediction for Galileo's experiment. (See Figure 3.)

Since falling objects are never pulled downward, Rotonians predict the result of Galileo's experiment to be that the test object does not pass the center. Rotonians are dismayed to discover that Earthians have not yet got around to fulfilling this 388 year old proposal. (See Figure 4.)

As they await plans to at last get the experiment done, Rotonians further develop their gravity hypothesis (Space Generation Model) and explore its cosmic consequences. They deduce that, if the experiment confirms their prediction, then the following predictions would also prove to be essentially correct.

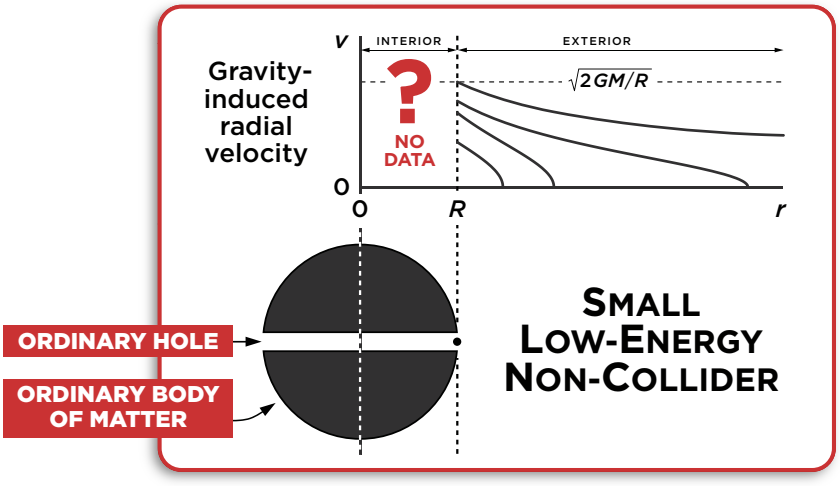

Fig. 4. – Humans have never seen what happens when a small body is allowed to fall to the center of a larger body. The big red question mark indicates where neither Newton's nor Einstein's theories of gravity have been tested. Representing the insides of all familiar bodies of matter, under our noses, it corresponds to the most ponderous half of the gravitational Universe. Earthian physicists only just *pretend* to know what they'd see if they looked there.

5. – Predictions

1. Energy is not conserved.
2. Time only increases because space and matter also only increase.
3. Gravity is not an attraction between bodies.
4. The *cause* of spacetime curvature is the generation of space by matter.
5. The *curvature* of spacetime caused by the gravitational motion of matter and space indicates the existence of a *fourth spatial dimension*, as required for the seemingly three dimensions of space to have a *new direction to curve into*.
6. Inertia is the same thing as gravity because that which causes *resistance* to acceleration in *one* direction is the accelerated generation of space and regeneration of matter in *every* direction.
7. Positive results reported by the LIGO collaboration will turn out to have been caused by something other than gravitational waves. What are commonly regarded as "black holes" are not really black. Dividing by zero yields only unphysical nonsense.
8. The Universe is infinitely old because its density remains constant as the whole of it, the whole saturated continuum, exponentially expands.
9. Matter is an inexhaustible source of perpetual propulsion.
10. Newton's constant may be expressed as follows (showing connections between micro-physics and the Universe):

$$G = 8\left(\frac{\rho_\mu}{\rho_N}\cdot\frac{c^2 a_\circ}{m_e}\right) = \frac{4}{\pi\alpha}\left(\frac{\rho_\mu}{\rho_N}\cdot\frac{hc}{m_e^2}\right) = \frac{4}{\alpha}\left(\frac{\rho_C}{\rho_N}\cdot\frac{\hbar c}{m_p m_e}\right), \tag{4}$$

where ρ_μ is the mass-equivalent of the background temperature, ρ_N is nuclear saturation density, $a_\circ$ is the Bohr radius, m_e and m_p are the electron and proton masses, respectively, α is the fine structure constant, h is Planck's constant, $\hbar$ is $h/2\pi$, and ρ_C is the average cosmic matter density. Though the far right side includes the cosmic matter density, which has not been reliably measured, it brings out the importance of both α and the echoed proton/electron mass ratio.

These predictions all stem from the Rotonian perspective outlined above. Further support is to be found in the all-encompassing *Cosmic Everything Chart* (Figure 5) and other work. [4-9] The ultimate goal—in the spirit of Galileo—is to secure a plan to build and operate humanity's very first Small Low-Energy Non-Collider.

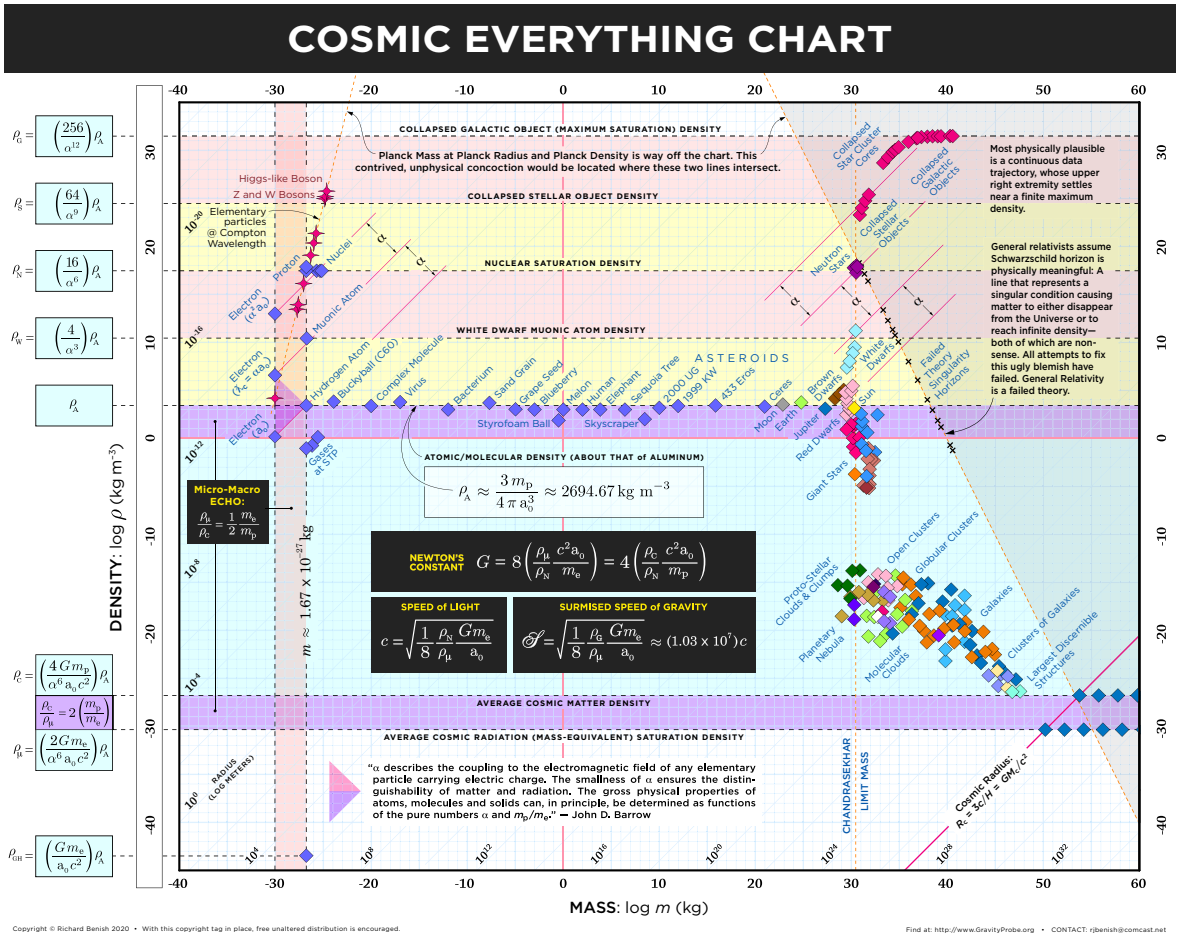

Fig. 5. – **Cosmic Everything Chart**: Log Mass vs. Log Density (vs. Log Radius at 45°). With data points gotten from the physics and astronomy literature, the wide horizontal stretch of more or less familiar bodies (atomic/molecular density) is readily apparent. As masses approach those of stars, gravity's role begins to dominate, as seen on the vertical stretch near the Chandrasekhar mass limit. The absurdity of black hole singularities is strongly implied by the abrupt and wholly unnatural discontinuity at the Schwarzschild line. Data points above this line represent a logical, continuous alternative. The roles of the fine structure constant α, the proton/electron mass ratio, Newton's constant G, and the significance of key saturation densities are duly accentuated. Rotonians think of the Chart as a treasure map.

REFERENCES

[1] Benish, Richard: *Galileo's Belated Gravity Experiment – The Small Low-Energy Non-Collider*. (February 11, 2015) <https://vixra.org/abs/1503.0139>. Accessed March 10, 2020.

[2] Benish, Richard: *Correspondence With Professors*, July 26, 2019 <http://vixra.org/abs/1907.0522>. Accessed December 11, 2019.

[3] Stachel, John: 'The Rigidly Rotating Disk as the "Missing Link" in the History of General Relativity,' in *Einstein and the History of General Relativity*. Eds: Don Howard, and John Stachel (Birkhäuser, Boston, 1991) p. 48.

[4] BENISH, RICHARD: *Maximum Force from Space Generation Model—with Annotation*. <vixra.org/abs/1908.0616> Accessed February 26, 2020.

[5] BENISH, RICHARD: *Cosmic Everything Chart*. <https://vixra.org/abs/1507.0155> Accessed February 26, 2020.

[6] BENISH, RICHARD: *Rethinking the Universe*. FQXi Essay Contest entry, 2017. <https://fqxi.org/community/forum/topic/2838>. Accessed February 26, 2020.

[7] BENISH, RICHARD: *The Space Generation Model, Cosmic Numbers, and Dark Energy*. <https://vixra.org/abs/1503.0138>. Accessed February 26, 2020.

[8] BENISH, RICHARD: *Speed of Light and Rates of Clocks in the Space Generation Model of Gravitation, Part 1*. <http://vixra.org/abs/1406.0090>. (Accessed February 26 2020).

[9] BENISH, RICHARD: *Gravitational Clock: Near Space Proof-of-Concept Prior to Deep Space Measurement of G – Part I*. <https://vixra.org/abs/1612.0341> Accessed February 26, 2020.