Mass, Density, and the Limits of Newtonian Inertia

An Absolute-Space Investigation

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Status of This Document

This document reports a complete investigation into the origin of Newtonian inertia within the absolute-space foundation, including a working hypothesis that was tested rigorously, found circular at two distinct levels, and closed. Every claim below is reported as derived, adopted, or open, consistent with the standard applied throughout this project's companion documents. Where a claim remains unresolved, that is stated directly rather than implied by omission.

What Has Been Verified

Mass and Density

Using the energy-balance method independently validated in this foundation's neutron star radius derivation [1], the equilibrium size of a hydrogen atom is derived by balancing quantum kinetic energy against electrostatic attraction. This yields the standard Bohr radius formula, matching the real, measured value to six significant figures [2, 3]. Combining this with the real, dominant nuclear mass yields a first-principles atomic density of approximately 2,696 kg/m³, within the real range of ordinary solid matter. This establishes $m = \rho L^3$ (mass proportional to volume, at fixed density) as a physically grounded relationship. A simpler $m \sim L$ hypothesis was tested against real nuclear radius data across seven elements, from hydrogen to uranium, and found to fail decisively [4].

Mass-Energy Equivalence for Signal-Carried Energy

Working from Postulate 1 (absolute space is homogeneous, giving momentum conservation via Noether's theorem [5]) and Postulate 4 (every particle's internal signal propagates at the fixed rate c), the momentum carried by that signal follows directly: anything propagating at the same invariant speed in every frame has a null energy-momentum relation, giving $p = E/c$ with no assumption about mass. Tracking a single, one-time transfer of this signal's energy between two points, the self-consistent accounting of total energy and total momentum across the transfer requires that the transferred energy contribute exactly E/c^2 of inertial mass to the system. This independently reconstructs the mass-energy relation from this foundation's own postulates [6], rather than adopting it.

This result is genuine and load-bearing, but its scope should be stated precisely: it establishes that energy carried by Postulate 4's internal signal must contribute inertial mass in the amount E/c^2. It does not, by itself, explain why inertial mass — once present, from any source — produces resistance to acceleration in the specific $F = ma$ form. That question is addressed, and found unresolved, in the sections below.

What Was Tested and Closed

The Bounce-Reflection Derivation of F = ma

An internal signal bouncing between two endpoints treated as effectively infinite in mass, with the resulting reaction force found to equal ma, was tested as a candidate derivation of Newton's second law. On rigorous re-examination, the circularity in this derivation was found to operate at two distinct levels, not one.

The first, surface-level circularity: the derivation begins from the premise that the particle is already undergoing acceleration a, then computes the internal reaction force required to sustain that motion. Showing that sustaining a given acceleration requires a force of ma is not equivalent to independently showing that an applied force F produces acceleration F/m.

The second, deeper circularity, identified on closer inspection of Section 3.1's own construction: the calculation relies on elastic-collision mechanics, which is itself built on conservation of momentum (Σmv = constant) and kinetic energy ($\frac{1}{2}mv^2$) — both of which already treat mass as the coefficient linking velocity to inertia, the exact quantity under investigation. Separately, describing the endpoints as "effectively infinite in mass" is mathematically equivalent to stating that their acceleration under any finite force is zero ($a = F/M \to 0$ as $M \to \infty$) — that is, asserting the endpoints already possess ordinary inertial resistance as a starting condition. Because the endpoints constitute essentially the entire mass of the particle ($m = \rho L^3$, from Section 2), this amounts to assuming the property under investigation before the calculation of that property begins. The internal signal, idealized as comparatively massless, contributes a small, self-consistent correction that trivially rides along without ever exerting real inertial resistance on anything.

This flaw cannot be repaired by adjusting the collision model or the endpoint mass assignment. Any model that computes a reflection via momentum conservation between a signal and an object assigned a mass M will, by construction, report F = Ma for that object — not because the model discovered this relationship, but because momentum conservation combined with an assigned mass M is definitionally equivalent to F = Ma. This holds regardless of how the endpoint mass is specified (infinite or finite), and regardless of whether the signal bounces once or repeatedly; a repeating-bounce structure was found to reintroduce the same circularity at every individual reflection event. This is a general, structural fact about classical mechanics, not a flaw specific to this derivation: mass has no operational definition independent of its role in F = ma or p = mv, so any calculation that assigns an object a mass and conserves momentum has already encoded Newton's second law, whether or not that law is explicitly written down.

Historical Parallel: The Electromagnetic Mass Program

This pattern has a direct, real precedent in the history of physics. Around 1900–1905, Abraham and Lorentz attempted to derive an electron's entire inertia from the self-interaction of its own electromagnetic field — structurally the same ambition as the bounce-reflection derivation tested here: explain mass and inertia as the byproduct of a sub-mechanical process, rather than assuming them. That program's self-energy calculation returned a coefficient of 4/3 (¾ the expected value) rather than exactly 1, and could only be reconciled with observation by introducing additional, non-electromagnetic "Poincaré stresses" [7, 8] — an ad hoc patch, not a resolution. The pattern of an initial, wrong small-rational-number coefficient preceding an eventual match to the physically expected value is the same signature produced in this session's own derivation process (2ma, then 3ma, before ma). This is logged not as an accusation, but as a documented, historically recurring warning sign in exactly this class of problem — attempting to derive inertia from a sub-mechanical model — worth treating with real caution in any future attempt along similar lines.

This mechanism is recorded in the Mechanisms Tested and Closed appendix below, alongside two mechanisms tested earlier in this same investigation: a signal-delay mechanism, found to produce resistance scaling as $1/m^2$ (the wrong direction), and a radiation-reaction mechanism, found to produce resistance independent of mass entirely.

What Remains Open

The origin of inertial resistance itself — why matter's resistance to acceleration is proportional to its mass, not merely how much resistance a given mass produces — remains unresolved. This was tested against a wide range of candidate physical origins, each found to be either a real but separate phenomenon or a reintroduction of the same circularity closed above.

Environment and Composition, Tested Separately

A dedicated test compared a proton's and an electron's inertial resistance within a single matched physical environment — same beam line, same fields, same surrounding conditions — specifically to isolate whether location or surroundings affect the resistance-to-mass relationship. The real, measured ratio of their resistance held constant at the real proton-electron mass ratio (≈ 1836) regardless of where the comparison was run, confirming that environment (gravity, surrounding fluid, contact, existing motion state) does not affect the ratio. Composition does: a proton's mass originates in strong-force binding energy; an electron's, in Higgs-field coupling; different physical origins, different resulting mass, and resistance tracks that mass precisely.

This confirms "what an object is built from" correctly predicts how much resistance it has, and rules out "where it is" as a factor. But this finding, even taken fully, only explains why the amount of resistance differs between two objects of different composition. It does not explain why possessing mass — of any origin — produces resistance to acceleration in the $F = ma$ form at all, rather than some other relationship entirely. Binding energy and Higgs coupling both explain how much mass a particle has; neither explains why mass, once present, resists acceleration in the first place.

The Point-Particle Limit

The electron, which retains full, real inertia while showing no measurable internal size in any real experiment to date, rules out any candidate mechanism that requires physical extent as a necessary ingredient.

Mach's Principle

The one candidate that survives without being directly testable is Mach's principle — the proposal that inertial resistance may be a relationship to the total mass-distribution of the rest of the universe, rather than a property residing in the object alone. This is a genuinely open, serious question in physics broadly, unresolved by Newton, unresolved by Einstein's attempts to build it into general relativity, and unresolved here. The Higgs mechanism gives a real, physical account of where a particle's rest mass-energy originates, but does not itself explain why possessing mass-energy entails resistance to acceleration in the specific $F = ma$ form — that link remains assumed, in this framework and in the Standard Model alike.

This is logged as a third open frontier of this research program, alongside the fifth-postulate/ħ gap and the $r = 0$ singularity identified in the companion documents [9, 10]. It is not unique to this foundation's postulates; it is an open question in physics as a field, and the electromagnetic mass program's own history (Section "Historical Parallel" above) suggests it may not be answerable from any sub-mechanical toy model at all — a structural, not merely practical, limitation.

Two Honest Paths Forward

- Reframe the bounce-reflection result as a self-consistency check — confirmation that the framework does not contradict itself if inertia is assumed — rather than a derivation. This is the status recorded for it in this document.
- Pursue mass's origin through the energy route (Section 2's Bohr-radius energy balance and the mass-energy equivalence result) rather than the collision route, since any momentum-conserving collision

model with an assigned mass has already presupposed the result by construction. This represents a genuinely different, larger undertaking, not a patch to the derivation closed above.

Mechanisms Tested and Closed

- Signal-delay mechanism: resistance found to scale as $1/m^2$ — the wrong direction, decisively closed by direct computation.
- Radiation-reaction mechanism: resistance found to be independent of mass entirely — closed by direct computation.
- Simple $m \sim L$ (length) hypothesis for mass: tested against real nuclear radius data across seven elements and found to fail decisively, in favor of the real, established $m \sim L^3$ (volume) relationship.
- Bounce-reflection derivation of $F = ma$: closed as circular at two levels — the acceleration-first framing, and the deeper structural fact that elastic-collision mechanics with an assigned mass already presupposes $F = ma$ by construction. Not repairable by adjusting the collision model.

Statement of Methodology

No numerical result in this document has been adjusted, tuned, or reverse-engineered to produce an intended outcome. All results — including closed mechanisms, corrected intermediate errors, and unresolved open questions — are reported in full, including the process log ($2ma \rightarrow 3ma \rightarrow ma$) that itself constitutes evidence against the derivation's independence, per the historical parallel discussed above.

References

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[9] Andreola, D. M., Jr. (2026). The Black Hole Center as Exposed Absolute Space: A Working Note.

[10] Andreola, D. M., Jr. (2026). Gravitational Radiation Investigation.