3I/ATLAS: A Unified Framework and Live Test for Field-Mediated ISO Dynamics

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Abstract

The interstellar object 3I/ATLAS confronts standard cometary models with a fundamental contradiction: its surface chemistry indicates billion-year Galactic Cosmic Ray processing, while its global dynamics exhibit large-scale coherence. A CO_2/H_2O ratio of 7.6 ± 0.3 [1] points to a heavily irradiated, fragile crust, yet the object displays a spherical X-ray halo [2], persistent sunward jets [5,9], non-gravitational acceleration guiding it precisely toward Jupiter [3,4,24,37], and an intact nucleus [6]. This tension between long-term chemical processing and short-term dynamical integrity challenges models that treat irradiation solely as a source of structural weakness and passive degradation.

We introduce the **Torque-Entrained Interstellar Object (TEIO) model**, in which 3I/ATLAS couples to a **Solar Torque-Spin Field (STSF)**—a heliospheric field structure generated by the Sun's rotation. Within this framework, the object's coherent dynamics—including fixed jet orientation, entrained trajectory, and preservation of nucleus integrity—are interpreted as manifestations of torque-spin field entrainment rather than conventional volatile sublimation. The model further proposes that orbital inclination relative to the solar system's invariable plane governs the strength of torque-spin coupling, offering a unified explanation for the distinct behaviors of 1I/'Oumuamua, 2I/Borisov, and 3I/ATLAS.

This interpretation yields clear, falsifiable diagnostics. The model predicts a measurable kinematic perturbation as 3I/ATLAS traverses the Sun–Jupiter L_1 torque-spin interface in early 2026, representing a direct signature of field-transition dynamics. Ongoing observations already indicate evolving coma properties alongside sustained large-scale coherence, a combination difficult to reconcile with progressive surface degradation alone. A detectable, torque-induced

reorientation of the spin axis during L_1 passage will further distinguish field-mediated coupling from surface-driven outgassing. The persistence of global coherence without correlated mass loss or fragmentation through this encounter would strongly favor the TEIO framework, while rapid loss of halo coherence or the emergence of multiple nuclei would support conventional sublimation-driven scenarios. Thus, the object's dynamical outcome—whether torque-spin entrainment leads to extended Jovicentric confinement ("capture") or a deterministically modified hyperbolic escape—will serve as a decisive empirical test among competing interpretations. Observational confirmation of a new, Jupiter-directed jet following the L_1 passage would provide particularly strong support for the torque-spin-coupling hypothesis.

Keywords: 3I/ATLAS, interstellar objects, galactic cosmic ray processing, non-gravitational acceleration, field-mediated dynamics, Sun–Jupiter L_1, Jupiter encounter test.

Observational Data Sources

The observational foundation for these predictions is drawn from publicly reported, independent measurements of 3I/ATLAS across multiple facilities and wavelengths. Discovery data, early light curves, and long-baseline photometric behavior are provided by the ATLAS survey and complementary ground-based monitoring [11,31]. Imaging and spectroscopy from HST, JWST, Gemini, Keck, Palomar, Apache Point, and SPHEREx constrain nucleus integrity, coma morphology, and volatile and metal abundances [1,6,10,15–18,22,32,35]. ALMA observations resolve spatially extended molecular dissociation in the coma [16]. Polarimetric measurements indicate unusual dust and scattering properties [28,36], and XRISM has detected an extended, approximately spherical X-ray halo produced by solar-wind charge exchange [2]. Precision astrometry and trajectory solutions incorporating non-gravitational acceleration are taken from JPL Horizons and independent orbital analyses [3,4,23,24,37]. Because 3I/ATLAS is an actively evolving object, much of the relevant observational literature currently exists in the form of rapid communications and preprints; peer-reviewed consolidation has not yet occurred. All data sources cited are publicly accessible via their respective archives, enabling independent verification.

Introduction

The discovery of the interstellar object 3I/ATLAS presents a significant challenge for contemporary cometary science. Its trajectory, coma morphology, jet behavior, and non-gravitational acceleration together exhibit a combination of properties that are difficult to reconcile within the standard cometary framework. A systematic enumeration of these observational constraints is presented in Section 3. Rather than treating these features as unrelated anomalies, we examine whether they may instead reflect a coherent dynamical signature of an interaction not currently parameterized in conventional models.

The coordinated anomalies of 3I/ATLAS suggest an interaction not described by standard gravitational and sublimation-driven physics. This points to an interaction with a large-scale, structured environment. A fundamental source for such structure is the solar system's own dynamics. As the Sun moves, it traces a helicoidal trajectory defined by the Milky Way's gravitational field and the total angular momentum of its planetary system. This collective motion inherently carries rotational degrees of freedom. We propose that these degrees of freedom manifest as a coherent, heliospheric-scale structure—a Solar Torque-Spin Field (STSF). In this framework, these rotational degrees of freedom manifest as a coherent heliospheric structure—a Solar Torque-Spin Field (STSF)—and 3I/ATLAS is interpreted as an object being entrained by this field; its trajectory and activity are shaped by the same rotational dynamics that govern the solar system's own path through space.

General Relativity successfully describes gravitational interactions as spacetime curvature, but it has no conceptual framework for torque-spin—a dynamical property linked to rotational degrees of freedom. The system-scale coherence of 3I/ATLAS suggests that rotational degrees of freedom may play a role in large-scale solar-system dynamics that pure curvature-based models cannot capture. The STSF is introduced here as a phenomenological construct that encapsulates this collective rotational imprint, providing a single mechanism for 3I's trajectory guidance, jet alignment, and nucleus coherence without requiring ad-hoc compositional assumptions.

Recent analyses have only deepened this tension. The standard sublimation-driven interpretation has proven dynamically unstable: the JPL-Horizons orbital solution for 3I/ATLAS has undergone multiple, significant downward revisions of its non-gravitational parameters since November 2025 [39], shifting from a water-based Marsden model toward a generalized $1/r^2$ power law in an effort to fit the post-perihelion astrometry. Even under this revised model, coupling the non-gravitational acceleration to observed mass-loss rates yields a nucleus diameter of order 1 km [40]—a scale consistent with long-term structural integrity. Yet these conventional reconstructions remain highly sensitive to assumed outgassing geometry, velocity, and thermal lag [40], and they do not naturally account for the reported persistent sunward jetting both before and after perihelion [5,9], a directional anomaly difficult to reconcile with thermally driven sublimation. When combined with the recent detection of only trace hydroxyl (OH) emission amid a CO_2-dominated coma, the emerging picture is one of a body whose activity and trajectory are poorly described by standard volatile-driven models.

The Torque-Entrained Interstellar Object (TEIO) model addresses a kinematic phenomenon first identified in 1I/'Oumuamua—anomalous non-gravitational acceleration [8]. However, it proposes a fundamentally different physical mechanism: persistent torque-spin entrainment by a Solar Torque-Spin Field, rather than the impulsive recoil of volatile sublimation. Importantly, this interpretation does not rest on post-hoc explanations of individual observables. Instead, it yields a set of specific, near-term, falsifiable predictions associated with the object's imminent passage through the Sun–Jupiter L_1 region and subsequent interaction with Jupiter's sphere of influence.

3I/ATLAS offers an unusually rich observational record for assessing such a hypothesis. Early imaging revealed a persistent sunward antitail [5,9], followed by detections of strong non-gravitational acceleration [3,4,24], extreme and time-variable gas-phase Ni/Fe ratios [10], and rapid pre-perihelion brightening [11,31]. High-resolution imaging has consistently resolved a single, compact nucleus with no evidence of fragmentation [6], while multi-wavelength observations reveal a chemically complex, spatially extended coma [1,2,16,17].

Of particular interest is the detection of a high-latitude jet exhibiting periodic angular modulation while maintaining a near-constant mean orientation over multiple observing epochs [9]. Within conventional sublimation-driven interpretations, reproducing this behavior requires finely tuned assumptions about nucleus geometry, spin state, and localized activity. In contrast, the TEIO model interprets such behavior as a natural consequence of field-mediated entrainment, in which large-scale geometry rather than surface rotation governs the orientation of coherent outflows.

As the observational dataset expanded, these anomalies began to converge into a distinctive dynamical pattern. Updated trajectory solutions incorporating non-gravitational acceleration direct 3I/ATLAS toward a narrowly defined encounter with Jupiter's Hill sphere [3,4,24]. Statistical analyses indicate that such an alignment is highly unlikely under random-trajectory assumptions [37]. When considered together with rotation-invariant jet morphology and sustained structural coherence, the object's behavior suggests an organizing influence extending beyond surface chemistry alone.

A range of material-based explanations has been proposed, including CO_2-driven activity and metal-bearing volatile chemistry [10,14]. While these models can reproduce selected features, they do so by invoking increasingly specialized internal structures and activation sequences. Moreover, they do not naturally account for the coordinated relationship between activity, non-gravitational acceleration, and orbital evolution observed in 3I/ATLAS.

In the sections that follow, we synthesize the full observational record and outline the TEIO model as a minimal phenomenological description capable of unifying these behaviors. The focus is on identifying observational signatures that can be evaluated decisively by the object's imminent interaction with Jupiter, transforming 3I/ATLAS from a static anomaly into a dated, falsifiable live test of macroscopic field-mediated dynamics, with a definitive outcome expected by 2026.

2. The TEIO Model: A Framework of Field-Mediated Dynamics

The coordinated anomalies of 3I/ATLAS suggest it is not a passive body moving through static space, but an active participant in a dynamic, solar-mediated field environment. We propose these phenomena as manifestations of a Solar Torque-Spin Field (STSF), a large-scale structure whose dynamics are fundamentally rotational. This section establishes the STSF's empirical necessity and its phenomenological consequences, outlining the Torque-Entrained Interstellar Object (TEIO) model.

We emphasize that this work is intentionally restricted to the empirical and predictive level, providing a minimal phenomenological description capable of unifying the observed behaviors. A first-principles derivation of the STSF and its coupling dynamics from the helicoidal motion of the solar system will be presented in a separate theoretical treatment (J. Sarvon, in preparation). Here we focus exclusively on identifying the empirical signatures that any such theory must reproduce.

This model is constructed inductively from the object's own behavior. The anomalies are diagnostic, each revealing a necessary property of the interaction:

- The entrained trajectory implies a field that structures pathways.
- The fixed-orientation jets imply a field with stable local geometry.
- The structural coherence implies a field that can impart binding stress.
- The non-gravitational acceleration implies a field capable of sustained momentum transfer.

The TEIO model posits the Solar Torque-Spin Field (STSF) as the minimal physical entity capable of producing all these signatures simultaneously—a macroscopic field whose origin is traced to the solar system's helicoidal galactic trajectory and total angular momentum. The recurrence of coordinated kinematic anomalies in interstellar objects, including the entrained trajectory of 3I/ATLAS and the anomalous pre-perihelion activity of 2I/Borisov [38], provides direct empirical motivation for such a field-mediated framework.

2.1 The Torque-Spin Resolution of the Mass-Velocity Paradox

3I/ATLAS combines a substantial mass (~30 billion tons) with high interstellar velocity (~58 km/s). Conventional ejection models cannot easily reconcile both for kilometer-scale bodies. TEIO resolves this via torque-spin entrainment, built on four core principles:

1. **Torque-Spin Entrainment & Helical Pathways**: Its retrograde, ecliptic-aligned trajectory reflects stable torque-spin lanes within the solar STSF. This can be understood through a vortex analogy: a massive log entrained in a powerful river vortex is not disadvantaged by its mass; rather, its greater inertia locks it more firmly into the rotational flow. Similarly, 3I/ATLAS's mass enabled stable, sustained entrainment within a galactic-scale torque-spin field.
2. **Torque-Spin Recoil & Topological Stability**: Sunward and multi-directional jets are fixed along torque-spin field lines, not sublimation plumes. Recoil events impart directional force, explaining the non-gravitational acceleration [3,4].
3. **Torque-Spin Coherence**: Field-mediated binding preserves structural integrity near perihelion [6].
4. **The "Ghostly Push" of Entrainment**: Momentum transfer from the STSF produces the observed acceleration naturally [3,8,25].

This framework suggests a two-stage origin: primordial formation in a high-spin stellar system where the object naturally occupied a fast, entrained helical path, followed by torque-spin "slinging"—ejection via large-scale field reconfiguration that preserved its coherent state and velocity. The object's measured hyperbolic excess velocity (v_∞) is thus not an initial condition from a violent ejection, but a dynamical parameter of its entrained state within the STSF.

2.2 Resolution of Post-Perihelion Anomalies as Torque-Spin Signatures

Recent observations reveal features that further challenge conventional models while being natural consequences of torque-spin interaction:

- **X-Shaped Jet Pattern & Fixed Sunward Jet:** Interpreted as intersections of torque-spin stress lines within the local STSF geometry [5,30]. The jets are torque-spin recoil events locked to specific field axes, explaining their collimation and fixed orientation irrespective of nucleus rotation.

- **Forward-Plume Anomaly (~3,000 km):** A "torque-spin bow wave" created by the object's motion through the dynamic STSF medium [5].
- **Multi-component Ejecta (200–500 m/s):** Consistent with torque-spin shearing—mechanical release of material along STSF stress lines [5,30].
- **Color-Changing Coma (Red → Green → Gold):** Not random chemistry but a visible timeline of torque-spin adaptation. The pre-perihelion red glow corresponds to ablation of the ancient GCR-processed crust. The post-perihelion shift to a warm golden hue and coherent stillness signals a field-mediated transition as the object begins coupling to Jupiter's torque-spin field [35,36].

2.3 Torque-Spin Navigation and Solar System Architecture

The TEIO model interprets 3I/ATLAS's journey as navigation within a coherent torque-spin architecture spanning the solar system. Key elements include:

- **The Sun-Jupiter L_1 Lagrange Point as a Torque-Spin Interface**: This gravitational saddle point functions as the boundary where solar torque-spin guidance ends and Jovian dominance begins. An object on a torque-entrained trajectory to Jupiter's Hill sphere must transit this corridor—a falsifiable prediction. Furthermore, traversing this torque-spin boundary is an active dynamical process. The TEIO framework predicts that the transition between the Solar Torque-Spin Field (STSF) and the Jovian Torque-Spin Field (JTSF) will impart a measurable perturbation to the object's velocity. This should manifest as a detectable kinematic anomaly—such as a brief re-acceleration or a statistically significant departure from the gravitational deceleration ephemeris—in high-precision tracking data as 3I/ATLAS passes through the L_1 region in early 2026. This "velocity signature" serves as a direct, pre-encounter test of torque-spin gradient interaction.
- **Jupiter as a Torque-Spin Anchor**: Within the TEIO framework, Jupiter's rapid rotation generates an intense, localized torque-spin field. Its influence extends to approximately 3 AU,

which the model interprets as the cause of 2I/Borisov's anomalous coma activation at that heliocentric distance [38].

- **Structured Ingress**: The object's initial trajectory intersected a stable torque-spin ingress lane coincident with the Sun-Mars Lagrange region, guiding it into a retrograde, ecliptic-aligned path predetermining its subsequent Earth flyby and Jovian encounter.

This architectural perspective explains why 3I/ATLAS's trajectory appears highly structured—it is following pre-existing torque-spin pathways within the solar system's dynamic field geometry. The predicted L_1 velocity perturbation provides a critical, falsifiable signature of this navigation in action. Large-scale, long-lived structuring of the outer solar system has been independently suggested in gravitational contexts, including evidence for persistent Jovian-mass influences shaping cometary phase space [13], reinforcing the plausibility of non-random dynamical corridors.

2.4 The Live Test: Predictions for the 2026 Jovian Encounter

The TEIO model's most critical feature is that it makes unambiguous, near-term predictions that will conclusively validate or falsify it. The imminent gravitational interaction with Jupiter functions as a live, cosmic-scale experiment.

The latest orbit determination, incorporating the significant non-gravitational accelerations measured during perihelion [39], projects that 3I/ATLAS will pass within 0.357 AU (≈53.4 million km) of Jupiter on 16 March 2026—a distance that coincides almost exactly with Jupiter's Hill radius (~0.36 AU). JPL's trajectory analysis concludes that the measured non-gravitational acceleration "served as a precise course correction" that brought the object into this alignment [37]. Orbital geometry further constrains the path: following perihelion, 3I/ATLAS emerged on a far-side trajectory relative to the Sun, placing its outbound arc behind the Sun as viewed from Earth. This geometry requires the object to cross the Sun–Jupiter line at the L_1 Lagrange point—a precise, testable prediction of the TEIO model.

The TEIO framework provides a physical mechanism for this otherwise unexplained guidance: continuous torque-spin entrainment within the Solar Torque-Spin Field. For this entrainment to transfer the object from solar to Jovian torque-spin dominance—thereby producing the observed guidance toward Jupiter—its trajectory must pass through the equilibrium region where the two fields interact. In the Sun–Jupiter system, this equilibrium manifold coincides with the L_1 Lagrange region. Consequently, a confirmed transit of L_1 by the NGA-corrected trajectory is a necessary condition for the field-mediated navigation hypothesis.

This guidance arises naturally from the coupled torque-spin field topology. The Solar and Jovian Torque-Spin Fields function dynamically as two linked whirlpools. Their interaction creates an equilibrium interface at the Sun–Jupiter L_1 region—the natural transition zone where field dominance shifts from solar to Jovian. Thus, the object's trajectory is not merely geometrically constrained; it is actively channeled along this field topology toward the L_1 handoff point.

The field-transition at L_1 should also manifest in the object's activity. The model predicts that as solar torque-spin coupling weakens, sunward jet activity will cease. If the object then couples to Jupiter's dominant field, new jet activity—potentially a prominent feature oriented directly toward Jupiter—may emerge, providing a direct morphological signature of the torque-spin handoff [5,33,37].

2.4.1 The Fine-Tuning Debate

The remarkable precision of the predicted encounter—wherein the object's non-gravitational acceleration appears to have steered it to the very threshold of Jupiter's Hill sphere with a projected perijove of 0.357 AU, within 1% of Jupiter's Hill radius (~0.36 AU)—has been noted as a statistically improbable alignment, with an estimated likelihood of ~1 in 26,000 under uniform-distribution assumptions [37]. This "fine-tuning" has sparked debate over whether such a trajectory could arise from anisotropic sublimation alone or might instead reflect a hitherto unrecognized dynamical coupling [see, e.g., discussions in 39].

The TEIO model resolves this debate by identifying the coupling mechanism: torque-spin field entrainment. Within this framework, the object is not being stochastically "steered" by its own outgassing, but is instead following pre-existing torque-spin field lines that inherently converge at the Sun–Jupiter L_1 interface. Consequently, the predicted kinematic perturbation during L_1 transit (Section 2.3) and the subsequent dynamical outcome of the encounter serve as direct signatures that can distinguish field-mediated navigation from chance outgassing alignment.

2.4.2 Encounter Geometry: Ecliptic Latitude and Retrograde Path

The refined orbital solution [39] provides precise geometric context for the encounter. Ecliptic coordinates (J2000) derived from the JPL Horizons ephemeris for 3I/ATLAS, Solution #42 [41], show that 3I/ATLAS will pass at an ecliptic latitude of $\beta \approx -2.8°$ at closest approach, placing it slightly below Jupiter's orbital plane (which itself lies within ~0.1° of the ecliptic). This near-coplanar geometry is consistent with the object's high orbital inclination ($i \approx 175°$)—a retrograde trajectory that carries it through the ecliptic plane in a shallow, descending-node crossing near the time of the Jovian encounter.

Importantly, the inclusion of the non-gravitational acceleration with a time-lag ($\Delta T \approx -34$ days) in the Eubanks et al. model is what refined this latitude solution; without it, the predicted β would have been ~0.4° lower, altering the depth of the object's passage through Jupiter's gravitational well. This sensitivity underscores how the standard outgassing model must be finely tuned to match the observed astrometry, whereas in the TEIO framework the trajectory is inherently constrained by the torque-spin field geometry, which naturally favors low-latitude ingress/egress corridors aligned with the solar system's angular momentum plane.

The retrograde motion (decreasing ecliptic longitude) further distinguishes 3I/ATLAS from most solar-system comets. Within the TEIO interpretation, a retrograde path is not anomalous; it may reflect the handedness of the Solar Torque-Spin Field or the object's initial spin-field alignment upon entering the heliosphere. Consequently, the encounter will test not only the positional alignment with Jupiter's Hill sphere, but also the dynamical response of a retrograde, slightly out-of-plane object to Jupiter's torque-spin field—a more constrained and therefore more discriminating experiment than a purely planar flyby.

The forthcoming encounter between 3I/ATLAS and Jupiter thus provides a definitive test of the TEIO framework through two sequential stages.

Stage 1 – The L_1 Corridor Test (Falsifiable)

The TEIO model interprets the object's far-side trajectory as kinematic evidence of torque-spin navigation. For transfer from solar to Jovian torque-spin dominance to occur, the object must pass through the field-equilibrium region coincident with the Sun–Jupiter L_1 Lagrange point. Thus, the model predicts that the object's true trajectory will transit the L_1 corridor.

This provides a decisive falsifiable prediction: if future high-precision astrometry shows the trajectory does not pass through the L_1 region (within a defined margin), the torque-spin navigation hypothesis is falsified. Conversely, confirmation of L_1 transit supports field-mediated dynamics over anisotropic outgassing alone.

Stage 2 – The Coupling Measurement (Quantitative)

The TEIO framework interprets "capture" not as gravitational binding in the classical three-body sense, but as sustained torque-spin entrainment—a field-mediated coupling between the object's spin and Jupiter's rotational torque-spin field.

Torque-Spin Entrainment vs. Gravitational Three-Body Capture

- *Source:* Spin-induced torque-spin field vs. mass-induced curvature.
- *Binding:* Field-mediated coupling vs. potential-well trapping.
- *Trajectory:* Guided, possibly non-Keplerian vs. Keplerian ellipse/hyperbola.
- *Energy:* No Jacobi-constant threshold vs. requires Jacobi constant < 0.

- *Signature:* Persistent non-Keplerian residuals & spin-axis reorientation vs. gravity-only orbital elements.

This form of interaction does not require the Jacobi constant to drop below zero; instead, it may manifest through continuing non-gravitational trajectory modifications or spin-axis alignment that persist well after the gravitational flyby.

Quantitative detection thresholds
– **Extended Jovicentric coupling** is defined as sustained non-Keplerian motion relative to Jupiter for >3 orbital periods (in a rotating Jovicentric frame), with astrometric residuals >5σ above the pure-gravity ephemeris and without evidence of outgassing-driven acceleration.
– **Spin-axis reorientation** is defined as a sustained shift in orientation >15° (from photometry or jet-direction data) that aligns the spin vector to within 30° of Jupiter's rotation pole, persisting >30 days post-encounter.

Consequently, the post-encounter dynamical state should be assessed through two complementary observables:

1. **Kinematic signature** – Detection of persistent non-Keplerian residuals in high-precision astrometry for weeks to months after closest approach, indicating ongoing field-mediated acceleration unrelated to outgassing.
2. **Rotational signature** – A measurable reorientation of the object's spin axis (via periodic photometry or jet morphology) toward alignment with Jupiter's rotation pole.

If torque-spin coupling is established, one of the following outcomes is predicted:

- **Strong coupling (field "lock")** – The object's trajectory exhibits a continuous, guided deflection that mimics binding, potentially leading to an extended period of Jovicentric looping without formal gravitational capture.

- **Weak coupling (deflection with memory)** – The object exits on a modified hyperbolic path but with a total deflection angle α that exceeds the gravitationally predicted value, and with a spin axis that remains altered post-encounter.

Both outcomes would provide quantitative measures of torque-spin coupling strength, distinguishing field-mediated interaction from purely gravitational scattering.

Explicit Falsification Criteria

The TEIO framework will be considered falsified if:

1. The object's trajectory does not pass through the Sun–Jupiter L_1 region (within a 0.02 AU margin).
2. Post-encounter astrometry shows no significant non-Keplerian residuals ($<2\sigma$) for 60 days after closest approach.
3. The spin axis shows no sustained reorientation ($<5°$ shift) toward Jupiter's pole for more than 30 days.

Statistical Context

The closest approach is projected at 53.445 ± 0.06 million km, within Jupiter's Hill radius (53.502 million km). Under a uniform-distribution assumption, such a coincidence has an estimated likelihood of approximately 1 in 26,000 [37]. The measured non-gravitational acceleration incorporated into the trajectory solutions provides the precise ~0.1 million km course correction required for this exact alignment [24], as evaluated using JPL ephemerides [23]. Within the TEIO framework, this "correction" is not a stochastic result of outgassing but the expected kinematic signature of torque-spin entrainment guiding the object along a pre-existing field geometry.

2.4.3 Jupiter as a Torque-Spin Gatekeeper

The comparative behavior of the two previously observed interstellar objects suggests a structured pattern:

- 2I/Borisov exhibited statistically anomalous pre-perihelion coma activation at *r* ≈ 3 au [38], interpreted here as its ingress into Jupiter's extended torque-spin field domain.
- 3I/ATLAS displays precision trajectory guidance—with a shallow ecliptic latitude (β ≈ –2.8°) and a predicted Sun–Jupiter L_1 transit—consistent with egress through the same field architecture [41].

Within this interpretation, Jupiter functions not merely as a gravitational perturber but as an active torque-spin gatekeeper. The TEIO framework predicts that future interstellar objects will exhibit either premature activation (as with Borisov) or precision dynamical guidance (as with ATLAS) upon encountering this ~3 au torque-spin boundary.

Paradigm Contrast

Standard cometary models retrofit non-gravitational acceleration using empirical prescriptions whose functional form is based on volatile sublimation—most commonly an r^{-2} heliocentric dependence (e.g., JPL's standard model [23]). This form is physically inconsistent with the observed steep $r^{-7.5}$ perihelion brightening of 3I/ATLAS [11], which indicates an activation mechanism far more sensitive to solar proximity than canonical ice sublimation. Consequently, orbit solutions based on the r^{-2} assumption embed a fundamental physical mismatch, a tension reflected in the repeated downward revisions of the NGA parameters in JPL's solutions [39,41].

Within the TEIO framework, by contrast, both the trajectory shaping and the anomalous acceleration profile arise naturally from the same STSF interaction, rendering the precise Hill-radius encounter a predictable dynamical outcome of field-mediated entrainment rather than a statistical coincidence.

The apparent predictive success of this field-mediated framework highlights a corresponding limitation of material-based interpretations: their inability to account for the coordinated anomalies of 3I/ATLAS without invoking increasingly ad hoc constructions. The following section examines these limitations systematically.

3. Limitations of Standard Interpretations

3.1 The Material-Reductionist Impasse

Standard cometary models interpret activity and dynamics as consequences of nucleus composition, internal structure, and solar-driven sublimation. This framework has been highly successful for indigenous Solar System comets. When applied to 3I/ATLAS, however, it requires an increasingly elaborate set of special assumptions to accommodate the full observational record. These include exotic volatile chemistry, exceptional mechanical cohesion, finely tuned jet geometries, and spatially distributed source regions.

To clarify the scope of this challenge, we enumerate fifteen observational features (A1–A15) reported across independent datasets. Each feature has precedent in isolation, but their coexistence within a single object defines a constraint set that material-based interpretations must satisfy simultaneously.

Dynamical constraints. 3I/ATLAS follows an inbound trajectory closely aligned with the solar system's invariable plane (A1) and exhibits retrograde motion relative to the system's dominant angular momentum (A11), with a well-defined inbound asymptote lacking a clear Solar-system analogue (A9) [23]. Precision astrometry incorporating its non-gravitational acceleration reveals a narrowly targeted encounter with Jupiter's sphere of influence (A4), an alignment whose a priori improbability under random-trajectory assumptions has been quantified independently [3,4,24,37]. Furthermore, the object's inferred mass–size combination presents a challenge for conventional models. Its hyperbolic excess velocity relative to the local standard of rest is also anomalously low for a randomly ejected interstellar object, further complicating dynamical and sublimation-based scenarios (A3) [9,23].

Morphological constraints. Imaging reveals a persistent, collimated sunward jet (A2) [5,14] alongside multiple jets that retain fixed orientations despite a ~16-hour rotation period (A12) [5,29,30]. A high-latitude jet exhibits periodic angular modulation consistent with precessional motion while maintaining a near-constant mean position angle (A12) [9]. Additional large-scale structures include orthogonal, X-shaped jet geometry extending to ~10^6 km (A13) [5,33,36] and a forward-directed plume extending ~3,000 km along the velocity vector (A14) [5,33]. Multi-component ejecta with relative velocities of 200–500 m s^{-1} have also been reported (A15) [29]. Reproducing this combination of rotation-invariant geometry and multi-axis structure within a sublimation framework requires finely tuned assumptions about nucleus topography, spin state, and volatile distribution.

Chemical and physical constraints. The coma exhibits extreme and unusual properties: a very low H_2O contribution (~4%) to the volatile inventory (A7) [18], severe C_2 depletion with strong CN dominance (A6) [10,22], an anomalously high gaseous Ni/Fe ratio (A5) [10], and spectroscopic affinities more consistent with metal-rich chondritic material than with canonical cometary nuclei [15]. ALMA observations indicate spatially extended molecular dissociation, with species such as CH_3OH originating hundreds of kilometers from the nucleus rather than from localized surface sources [16]. Polarimetric measurements further indicate dust and scattering properties outside the range observed for typical comets (A8) [28,36].

Structural and coherence constraints. High-resolution imaging consistently resolves a single, compact nucleus with no evidence of fragmentation through perihelion (A10) [6], despite strong activity and sustained non-gravitational acceleration. XRISM observations detect an approximately spherical X-ray halo extending to ~4×10^5 km [2], indicative of large-scale charge-exchange interactions between an extended coma and the solar wind. Together, these observations imply a chemically processed yet dynamically coherent object—volatile-active yet structurally stable, and solar-responsive yet trajectory-constrained.

Individually, many of these features can be accommodated within specialized extensions of standard cometary models. Collectively, however, they undermine the premise that surface composition and localized sublimation provide a sufficient explanatory basis. The simultaneous requirements of nucleus integrity (A10), rotation-invariant jet geometry (A12–A13), sustained non-gravitational acceleration (A4), and a narrowly constrained Jovian encounter exceed the predictive envelope of material-reductionist interpretations.

3.2 The Cometary Sublimation Model

The cometary sublimation framework interprets observed activity and non-gravitational acceleration as consequences of volatile-driven mass loss modulated by nucleus rotation, morphology, and thermal history [14,21]. Within this framework, collimated jets arise from localized active regions whose orientation evolves systematically with the nucleus spin state, while non-gravitational acceleration emerges as a secondary effect of asymmetric outgassing.

When applied to 3I/ATLAS, this framework encounters several difficulties that exceed the known range of cometary diversity. Most notably, the persistent observation of a narrowly collimated jet maintaining a fixed, sunward orientation over extended timescales, together with multiple jets retaining stable orientations despite a ~16-hour rotation period, departs qualitatively from the rotation-modulated behavior observed in Solar System comets [5,29,30]. Reproducing such geometry requires finely tuned assumptions about nucleus topography, spin-axis orientation, and volatile distribution that lack independent observational support.

Temporal evolution presents a related challenge. The rapid pre-perihelion brightening [11] and the extreme, time-variable Ni/Fe gas ratio [10] have been interpreted as signatures of unusual or compositionally anomalous cometary behavior. However, reproducing both within a sublimation-driven model requires a stratified internal structure in which multiple volatile and metal-bearing phases activate in a precisely ordered sequence [10,14]. Such constructions are not ruled out, but they significantly reduce predictive power.

Orbital dynamics further strain the framework. While sublimation-driven mass loss can, in principle, generate non-gravitational acceleration, it does so as a byproduct of activity rather than as a coordinated dynamical driver. In 3I/ATLAS, non-gravitational acceleration, activity onset, and orbital evolution appear tightly correlated, culminating in a narrowly constrained Jovian encounter [3,4,24,37]. No extension of standard sublimation physics naturally links chemical activation profiles to such precise, large-scale trajectory shaping.

Thus, 3I/ATLAS does not simply represent an extreme member of the cometary population. Extreme comets amplify known behaviors; they do not typically invert core expectations such as rotation-modulated jet geometry or the loose coupling between activity and long-term orbital evolution. The full constraint set defined in Section 3.1 therefore lies outside the predictive envelope of the sublimation framework when applied without additional organizing principles.

3.3 Limitations of Random-Trajectory Assumptions

A common interpretive baseline for interstellar objects is that they arrive on dynamically random trajectories and evolve passively under gravitational forces, with any non-gravitational effects treated as local perturbations. For 3I/ATLAS, this assumption encounters both statistical and empirical tensions.

The object's inbound trajectory is closely aligned with the solar system's invariable plane and exhibits a well-defined asymptotic direction lacking a clear Solar-system analogue [23]. Incorporating measured non-gravitational acceleration into trajectory solutions produces a narrowly targeted encounter with Jupiter's Hill sphere, with a statistical likelihood of approximately 1 in 26,000 under random-trajectory assumptions [3,4,24,37]. While such alignment is not impossible, it is sufficiently improbable to motivate consideration of non-random structuring influences.

This difficulty echoes unresolved aspects of the trajectory of 1I/'Oumuamua, where non-gravitational acceleration was similarly detected in the absence of clear sublimation signatures [8]. In that case, the lack of an organizing physical mechanism led to a proliferation of mutually incompatible explanations [25–27]. The recurrence of coordinated dynamical anomalies in multiple interstellar objects suggests that the assumption of purely ballistic motion may be incomplete.

Importantly, the limitation here is not statistical rarity alone, but the absence of a physical degree of freedom within random-trajectory models capable of producing structured, repeatable dynamical pathways. The combined constraints of low inclination, retrograde motion, sustained non-gravitational acceleration, and precision guidance toward a specific planetary encounter define an organized dynamical pattern rather than an accumulation of independent perturbations.

Accordingly, treating 3I/ATLAS as a dynamically random visitor with incidental activity provides an incomplete description of its behavior. The observations instead motivate consideration of a framework in which large-scale rotational or field-mediated structures can influence interstellar-object trajectories in a systematic way. The TEIO framework introduced in the following section is presented as a minimal phenomenological response to this limitation, designed to accommodate the constraint set without presupposing randomness or invoking fine-tuned initial conditions.

3.3.1 The Risk of Ad-Hoc Parameter Retrofitting

A persistent methodological challenge in interpreting anomalous ISO trajectories—particularly in light of the statistically improbable guidance seen in 3I/ATLAS—is the flexibility of outgassing-based non-gravitational acceleration (NGA) models. By adjusting the parameters A_1, A_2, A_3 and the thermal lag ΔT, such models can be retrofitted to match a wide range of astrometric residuals—including those that might arise from non-sublimation forces. This flexibility means that any observed deflection or orbital modification could, in principle, be attributed to finely tuned outgassing even in the absence of corroborating coma activity. Consequently, statistical fits alone cannot distinguish between sublimation-driven motion and field-mediated dynamics unless accompanied by signatures unique to field interaction—such as spin-axis reorientation toward a planetary spin pole, or persistent residuals aligned with the rotational axis of the perturbing body. The TEIO framework explicitly predicts such distinctive signatures, thereby offering a path to break the degeneracy inherent in parameter-rich NGA models.

3.4 Chemical Indicators of Exogenous Origin

The chemical properties of 3I/ATLAS further distinguish it from typical solar system comets. Extreme Ni/Fe ratios, pronounced C_2 depletion, and low H_2O abundance are accompanied by evidence for a chemically dissociated coma, in which species such as CH_3OH and HCN originate from spatially and kinematically distinct regions rather than from a homogeneous nucleus [16]. Taken together, these characteristics are more consistent with a differentiated planetesimal formed in a non-solar environment than with a pristine icy comet.

A key constraint is provided by the object's irradiation history. The measured CO_2/H_2O ratio of 7.6 ± 0.3 is consistent with prolonged Galactic Cosmic Ray (GCR) exposure on billion-year timescales [1], implying the presence of a thick, chemically processed surface layer. Such an irradiated crust records an extended residence in interstellar space and does not, by itself, require ongoing volatile-driven mass loss at the level inferred from the observed non-gravitational acceleration.

Recent interpretations of SPHEREx data have emphasized strong CO_2 emission, drawing analogies to hyperactive comets such as 103P/Hartley 2 [17]. However, Hartley 2's hyperactivity is water-dominated, accompanied by substantial mass loss, nucleus erosion, and pronounced rotational variability [21]. In contrast, 3I/ATLAS exhibits photometric stability at the $\lesssim 15\%$ level, a single intact nucleus through perihelion [6], and spectral affinities more consistent with metal-rich chondritic material than with volatile-dominated cometary nuclei [15]. Reconciling these opposing behaviors within a single cometary classification requires increasingly specialized evolutionary pathways, reducing predictive specificity.

In summary, the chemical evidence indicates an object whose composition functions primarily as a record of long-term interstellar processing rather than as a direct driver of its present-day dynamics. The apparent decoupling between surface chemistry, activity morphology, and orbital evolution reinforces the broader conclusion of Section 3: material properties alone do not uniquely determine the observed behavior of 3I/ATLAS.

This separation between compositional origin and dynamical guidance points decisively toward the influence of factors external to the nucleus—specifically, a large-scale, structured field environment. The TEIO model provides just such a field-mediated framework. We now turn to its most critical feature: a set of specific, falsifiable predictions that transform the forthcoming Jupiter encounter into a definitive live test of field-mediated dynamics.

4. Discussion and Predictions

The current astronomical paradigm encounters a fundamental explanatory impasse with 3I/ATLAS. While standard models can parameterize the object's post-perihelion non-gravitational acceleration (NGA) as a “rocket effect,” they fail to explain its causal origin and specific outcome. Crucially, this acceleration occurred during a transient period of peak sublimation-driven activity; the object is now photometrically quiet yet follows the precise Jupiter-targeting trajectory imparted during that active phase. This timing contradicts a sustained outgassing thrust and instead points to an impulsive kinematic change.

More significantly, these models offer no physical mechanism to explain why this acceleration produced a trajectory that converges with high precision on Jupiter’s Hill sphere—an alignment with a quantified statistical improbability. The NGA thus remains an uninterpreted dynamical anomaly within a descriptive but causally underdetermined forecast.

The TEIO model addresses this core limitation by proposing a new physical parameter: torque-spin field strength. This parameter predicts the kinematic perturbation at the Sun–Jupiter L_1 interface and the resulting post-encounter trajectory modification. This reframes the encounter from an unpredictable curiosity into a calibrated experiment. Where conventional approaches allow only post-hoc interpretation, the TEIO framework provides a priori, testable predictions anchored in field-mediated dynamics.

4.1 Key Model Predictions for 3I/ATLAS: A Live Test Sequence

The TEIO framework's primary contribution is its transformation of the 2026 encounter from a passive observation into an active, staged experiment. Crucially, the predictions below do not depend on a fundamental derivation of the STSF; they follow directly from the hypothesis that 3I/ATLAS is coupled to a large-scale, rotating field structure. The March 2026 encounter therefore tests whether such a field-mediated interaction exists, regardless of its ultimate theoretical origin.

The following sequence of outcomes constitutes a direct, falsifiable test of field-mediated dynamics.

Jupiter Encounter as a Calibrated Experiment

1. **L_1 Corridor Transit (Geometric Necessity)**
   Given the far-side orbital geometry of 3I/ATLAS relative to the Sun, its path to Jupiter must cross the Sun–Jupiter line outside the Sun's position—a region that includes the L_1 Lagrange point. This geometric requirement is already reflected in JPL's non-gravitationally-corrected orbital solutions [23,24]. Confirmation of L_1 transit by independent high-precision astrometry will support the hypothesis of field-mediated navigation; a clear miss would falsify it.
2. **Field-Transition Signature at L_1**
   As the object traverses the L_1 region—the interface between solar and Jovian torque-spin dominance—the TEIO model predicts a measurable kinematic perturbation (velocity shift) and a potential change in activity: cessation of sunward jetting followed by the possible emergence of new activity oriented toward Jupiter.
3. **Post-Encounter Coupling Measurement**
   The object's dynamical outcome will calibrate the strength of Jovian torque-spin coupling:
   – Strong coupling may produce extended Jovicentric looping or guided deflection mimicking capture, accompanied by spin-axis alignment with Jupiter's rotation pole.
   – Weak coupling will yield a modified hyperbolic exit with a deflection angle α exceeding the gravitational prediction and a persistent change in spin orientation.

4. **Jet Reorientation and Resurgence**
   Sunward jet activity (A2) should cease as solar torque-spin coupling weakens. If the object couples to Jupiter's dominant torque-spin field, new jet activity may emerge, potentially manifesting as a prominent jet oriented directly toward Jupiter, aligned with Jovian field geometry [5,33,37].
5. **Field-Mediated Atmospheric Transition**
   The massive, spherical X-ray halo [2] is expected to decay as solar entrainment wanes. Engagement with the Jovian torque-spin field may reconfigure the coma structure, altering the spatial morphology of any residual X-ray emission.
6. **Chemical Shift Upon Crust Shedding**
   If the GCR-processed crust [1] is shed coherently through torque-spin shearing—potentially triggered by the field transition—a subsequent change in coma volatile ratios (e.g., a decrease in the extreme CO_2/H_2O ratio) may reveal less-processed interior material.
7. **Sustained Coherence**
   The nucleus is expected to remain a single, coherent body with minimal photometric variability ($\lesssim$15%) throughout departure [6]. No fragmentation consistent with volatile-driven disintegration should occur.

The a priori improbability of the precise Hill-radius alignment under random dynamics (~1 in 26,000 [37]) underscores the diagnostic power of this encounter: a match to the above sequence would provide compelling evidence for torque-spin entrainment, while a deviation would constrain or rule out field-mediated effects.

4.2 Implications and Resolving Power

Resolving the Anomaly Cascade. Observations of X-shaped jets, forward plumes, and multi-component ejecta—features difficult to reconcile with isotropic sublimation—are interpreted within the TEIO framework as natural signatures of torque-spin shear and recoil. This reframes the anomaly catalog from a collection of isolated curiosities into a diagnostic profile of field-mediated interaction.

Energetic and Conceptual Plausibility. The energy required for field-mediated momentum transfer and structural coherence is orders of magnitude below the incident solar power and is negligible compared to the energy demands of sublimation-driven acceleration for a ~3×10^{10}kg body. In standard thermodynamic models, the dominant energy cost is the latent heat of sublimation of water ice, approximately 2.84×10^{6}J per kilogram of mass loss [34]. The TEIO model is therefore energetically conservative while accounting for phenomena that conventional sublimation models struggle to reconcile without significant, sustained mass loss.

4.3 Population-Level Prediction: The Inclination Filter

Beyond 3I/ATLAS, the TEIO framework makes a population-level prediction: interstellar objects that exhibit strong, sustained non-gravitational acceleration or entrained dynamical signatures will preferentially occupy orbits closely aligned with the solar system's invariable plane (|*i* – 180°| ≲ 10° for retrograde objects, *i* ≲ 10° for prograde). This bias arises because torque-spin coupling is strongest when the object's trajectory lies near the plane that defines the dominant orientation of the Solar Torque-Spin Field.

Conversely, high-inclination objects (those significantly inclined to the invariable plane) are expected to behave ballistically (as with 2I/Borisov [38]) or to exhibit only transient, impulsive anomalies (as observed for 1I/'Oumuamua [7, 8]), because their trajectories pass rapidly through the torque-spin field with minimal integrated coupling.

This "inclination filter" provides a direct observational test of the geometric basis of torque-spin coupling. As the sample of detected interstellar objects grows, a statistically significant correlation between low inclination (i.e., proximity to the invariable plane) and anomalous non-gravitational behavior would support the TEIO interpretation, while the absence of such a correlation would challenge it.

5. A Unified Framework: Orbital Inclination as the Determinant of ISO Behavior

The three recognized interstellar objects (ISOs)—1I/‘Oumuamua, 2I/Borisov, and 3I/ATLAS—exhibit a striking spectrum of dynamical and physical behaviors. The TEIO framework posits that this diversity is not random but follows a predictable continuum governed by a single geometric parameter: orbital inclination relative to the solar system’s invariable plane (where alignment is measured by min(*i*, 180° – *i*) for retrograde objects). Inclination dictates the efficiency of coupling with the structured Solar Torque-Spin Field (STSF), producing three distinct phenomenological classes:

- **3I/ATLAS (The Entrained TEIO): Strong-Coupling Regime**
  Inclination: *i* ≈ 175° (retrograde, but ecliptic-aligned; β ≈ –2.8°).
  Interaction: Achieved resonant locking with the primary torque-spin plane, enabling stable helical entrainment.
  Manifestation: Precision navigation of the Sun–Jupiter torque-spin corridor, coherent large-scale structure, and field-mediated non-gravitational acceleration.
  Interpretation: Represents the strong-coupling, coherent limit of torque-spin interaction.
- **1I/‘Oumuamua (The Recoil TEIO): Impulsive Regime**
  Inclination: *i* ≈ 33° (moderate inclination, high hyperbolic excess).
  Interaction: Transient, off-axis STSF interaction; insufficient alignment for stable guidance.
  Manifestation: Post-perihelion non-gravitational acceleration interpreted as a torque-spin recoil impulse.
  Interpretation: Represents the impulsive, high-stress limit of torque-spin coupling.
- **2I/Borisov (The Passive ISO): Weak-Coupling Regime**
  Inclination: *i* ≈ 44° (high inclination, distant perihelion).
  Interaction: Weak, negligible torque-spin coupling.
  Manifestation: Activity dominated by native volatile sublimation, consistent with a classic comet [38].
  Interpretation: Represents the weak-coupling, ballistic limit.

This inclination dependence is not predicted by standard outgassing models, which tie non-gravitational acceleration solely to volatile composition and insolation, independent of orbital orientation.

The progression—from passive passage (Borisov) to chaotic recoil (‘Oumuamua) to precision guidance (ATLAS)—demonstrates that torque-spin entrainment is not a binary state but a continuous function of orbital alignment. The interaction strength scales inversely with the angle between the object’s trajectory and the STSF symmetry plane.

Thus, orbital inclination emerges as the master parameter controlling ISO behavior. This unified framework directly links the observed spectrum of structural, dynamical, and chemical anomalies to a quantifiable measure of field interaction, transforming three unique curiosities into a predictive sequence within a single physical theory. Future interstellar objects should be classifiable along this same continuum: low-inclination objects will show signs of torque-spin guidance; high-inclination objects will appear ballistic or exhibit only impulsive anomalies.

A statistically significant correlation between low inclination and anomalous non-gravitational behavior in future ISO detections would support the TEIO interpretation; absence of such a correlation would challenge it.

The 2026 Jupiter encounter will therefore serve a dual purpose: it will directly test the torque-spin-entrainment hypothesis for 3I/ATLAS, and—if confirmed—will calibrate the inclination-coupling relation that may govern the behavior of all future interstellar visitors.

6. Conclusion

The unified TEIO framework provides what has long eluded the standard cometary paradigm: a single, geometric principle that resolves the disparate anomalies of interstellar objects while making definitive, falsifiable predictions. 3I/ATLAS, as the clearest exemplar, exposes the internal tensions within that standard paradigm—tensions that remain unresolved when all observables are considered jointly. Incremental modifications to sublimation-based models are insufficient to reconcile the full constraint set. The Torque-Entrained Interstellar Object (TEIO) model addresses this limitation by introducing a new phenomenological interaction class: coupling to an effective Solar Torque-Spin Field (STSF).

Within this framework, the object's observed behavior emerges from a single organizing process. Its trajectory reflects entrained helical navigation; its jets arise as torque-spin recoil; its structural coherence is maintained by field-mediated binding; and its apparent guidance toward Jupiter follows pre-existing torque-spin pathways. This is not a composite explanation but a unified field-interaction description.

Critically, the TEIO framework unifies the entire known population of interstellar objects. The behavioral spectrum—from Borisov's ballistic passage, to 'Oumuamua's impulsive recoil, to ATLAS's precision guidance—is explained as a continuous function of orbital inclination relative to the solar system's invariable plane. Low-inclination objects couple strongly to the STSF and exhibit field-mediated dynamics; high-inclination objects remain weakly coupled and behave ballistically. This inclination filter turns what appeared to be three disconnected curiosities into a predictive sequence within a single physical theory.

The STSF finds its physical motivation in the solar system's own dynamics: the rotational degrees of freedom embedded in the Sun's helicoidal galactic trajectory, carrying the total angular momentum of the heliosphere. This motion provides the rotational substrate from which a large-scale torque-spin field naturally arises. In this context, 3I/ATLAS is a coherent interstellar body entrained within this structured environment, offering the first observational access to a field-mediated dynamical regime.

The forthcoming passage of 3I/ATLAS through the Sun–Jupiter torque-spin interface constitutes the critical test of the TEIO framework. The predictions are necessary consequences of field-mediated entrainment and will be evaluated using public data. Key is the predicted transition from solar- to Jovian-dominated coupling. The continuous momentum exchange this entails provides a physical mechanism to reduce hyperbolic excess velocity during approach, lowering the kinetic barrier to gravitational capture—a pathway with no analogue in purely gravitational or sublimation-driven models.

Validation of these predictions would not only support the TEIO interpretation of 3I/ATLAS but would also establish torque-spin entrainment as a candidate process governing a broader class of interstellar objects. Conversely, the failure of these signatures to materialize would place strong constraints on the model. In this sense, 3I/ATLAS represents a decisive observational experiment rather than a static anomaly.

A first-principles derivation of the STSF from the rotational dynamics of the solar system constitutes the necessary next theoretical step. In such a derivation, the anomalies catalogued here would emerge not as independent puzzles but as natural, interconnected consequences of a coherent field interaction. This approach—allowing empirical anomalies to guide theoretical development—prioritizes physical reality over formal abstraction.

The imminent 2026 encounter thus functions as a definitive, time-constrained live test. Its outcome will either validate a new class of field-mediated solar-system dynamics or confine 3I/ATLAS's remarkable behavior to the domain of conventional—yet inexplicably fine-tuned—celestial mechanics.

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