APM Post-Newtonian and Solar-System Tests (QMU): Perihelion, Shapiro, Frame-Dragging, and Light Bending

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Abstract

We construct the post-Newtonian (PN) weak-field expansion of the Aether Physics Model (APM) directly in Quantum Measurement Units (QMU). The weak-field sector is closed entirely by a set of foundational ledger identities. These relations fix all metric potentials without introducing new free constants. We compute the standard PPN expressions for perihelion precession, Shapiro delay, geodetic and Lense–Thirring precession, and light bending. We show that the effective PPN parameters (γ, β) arise as fixed values $\gamma = 1, \beta = 1$ from the ledger identities and are therefore not adjustable. APM successfully reproduces the standard values for perihelion precession, Shapiro delay, and light bending. The gravitomagnetic sector is shown to be consistent with LAGEOS and Gravity Probe B data, with the Lense–Thirring effect correctly derived from a dual-gauge cross-term in the APM Lagrangian. All APM predictions are shown to match observation without free parameters.

Keywords: QMU; APM; post-Newtonian gravity; Solar System tests; frame-dragging; VLBI

1 Introduction

The pursuit of a unified physical theory remains a primary goal of modern physics. While General Relativity (GR) describes gravity through curved spacetime, it requires its key post-Newtonian (PN) parameters, γ and β, to be measured experimentally, where they are found to be $\gamma \approx 1$ and $\beta \approx 1$. The original program to geometrize gravity and unify it with the rest of physics can be traced back to Einstein's generalized theory of gravitation Einstein (1950), which provided the conceptual backdrop for later post-Newtonian formalisms.

The Aether Physics Model (APM) offers an alternative foundation, positing a quantized, dynamic medium—the Aether—from which physical laws, forces, and constants emerge Thomson (2025). This model is constructed using Quantum Measurement Units (QMU), a metrological framework designed to close the constants of physics on a compact "ledger" and to express a unified force structure Thomson III (2024). APM and QMU have already been used to model electron binding energies Thomson III and Bourassa (2024) and g-factor observables Thomson III (2025b), providing independent tests of the ledger outside the gravitational sector.

This paper's goal is to demonstrate that the APM does not assume the PPN parameters, but instead *derives* them from its foundational ledger. We show that the APM weak-field expansion

internally and necessarily fixes $\gamma = 1$ and $\beta = 1$. We then apply these derived parameters to the classical Solar-System tests to check for consistency with observation.

Institutional attribution follows the Quantum AetherDynamics Institute (QADI) reference identity Thomson III (2025a).

2 Ledger Closure for the Weak Field

The APM framework is built upon a set of core QMU quantities and definitions, which are explored in detail in Thomson (2025). The weak-field sector is governed by these foundational relationships.

Core QMU Definitions. The QMU system defines physics in terms of fundamental constants and capacities. The key quantities for this analysis are:

- Gforce: The universal Gforce, the primary force from which couplings are derived (1.210×10^{44} N).
- m_a: The mass capacity of the Aether.
- λ_C: The quantum length (Compton wavelength).
- F_q: The quantum frequency (c/λ_C).
- A_u, k_C: Aetheric and electromagnetic permeability/permittivity analogs.
- curl: Aetheric vorticity.

The Newtonian constant G is a *derived* quantity, defined by the relationship between the Gforce and the mass capacity of the medium:

$$G = \frac{\text{Gforce}{\lambda_C}^2}{m_a^2}.$$

The Gforce itself is postulated as Gforce $= m_a \lambda_C {F_q}^2$ Thomson (2025).

Weak-Field Identities. A minimal weak-field closure is imposed by the three QMU identities:

$$\text{Gforce} = \lambda_C \, {F_q}^2 \, m_a, \qquad A_u \, \text{curl} = {F_q}^2 {\lambda_C}^2, \qquad \frac{A_u}{k_C} = 16\pi^2.$$

These relations reflect the deeper packing and curvature structure of the Aether units, whose geometric constraints are related to optimal packing problems Torquato (2009) when expressed in QMU form.

Canonical sanity check. The class identity

$$A_u \, \text{curl} \;=\; {F_q}^2 \; {\lambda_C}^2 \equiv \frac{\text{Gforce}}{\lambda_C \, m_a \, {F_q}^2} = 1$$

remains valid throughout the PN expansion and is used repeatedly to confirm closure of intermediates.

3 QMU Weak-Field Ansatz

We write the stationary metric in the usual PN form but normalized by QMU potentials:

$$g_{00} = -\left(1 - 2U + 2\beta U^2 + \cdots\right), \qquad g_{ij} = \delta_{ij}\left(1 + 2\gamma U + \cdots\right),$$

where the gravitational potential is normalized by the APM Gforce:

$$U = \frac{\text{Gforce}\, M}{r}.$$

We assume U here is the dimensionless potential, $U \equiv GM/(c^2 r)$, where the QMU normalization Gforce$M$ is equivalent to the SI normalization GM/c^2.

APM identification. In APM, the coefficients (γ, β) arise from the structure of the aetheric vorticity and its relation to the mass ledger:

$$\gamma = \frac{A_u\, \text{curl}}{{F_q}^2 {\lambda_C}^2}, \qquad \beta = \frac{\text{Gforce}\, m_a}{\lambda_C\, {F_q}^2\, m_a} = 1.$$

Using the closure $A_u\, \text{curl} = {F_q}^2 {\lambda_C}^2$, we obtain

$$\gamma = 1, \qquad \beta = 1,$$

with no adjustable parameters.

Thus the classical PPN limit of APM is internally consistent and fully ledger-determined.

4 Perihelion Precession

The standard PPN formula for the perihelion advance per orbit is

$$\Delta\varpi = \frac{6\pi\, GM}{a\, c^2\, (1 - e^2)} \left[\frac{2 - \beta + 2\gamma}{3}\right],$$

where the term in brackets is a multiplier that equals 1 for GR.

APM Prediction. Using the derived APM parameters $\beta = 1$ and $\gamma = 1$ from Section 3:

$$\left[\frac{2 - \beta_{\text{APM}} + 2\gamma_{\text{APM}}}{3}\right] = \left[\frac{2 - (1) + 2(1)}{3}\right] = \frac{3}{3} = 1.$$

Thus APM predicts the exact same perihelion shift as GR, not as an assumption, but as a consequence of the QMU ledger.

5 Shapiro Time Delay

For radar signals grazing a massive body, the additional time delay in PPN theory is given by

$$\Delta t \approx \frac{4\, GM}{c^3} \ln\left(\frac{4\, r_E r_R}{b^2}\right) \left(\frac{1 + \gamma}{2}\right),$$

where the final term $\left(\frac{1+\gamma}{2}\right)$ is the PPN multiplier.

APM Prediction. Using the derived APM parameter $\gamma = 1$:

$$\left(\frac{1+\gamma_{\rm APM}}{2}\right) = \left(\frac{1+(1)}{2}\right) = 1.$$

APM reproduces the standard GR prediction for the Shapiro delay. In the APM interpretation, this delay is due to the local reduction of chronovibration frequency relative to F_q in regions of increased aetheric stiffness.

6 Frame–Dragging and Geodetic Precession

The gravitomagnetic sector arises from the full APM Lagrangian, not from the simplified vector–potential analogy. The derivation in Thomson (2025) shows that g_{0i} originates from the *dual* $U(1)$ gauge sector of the Aether, projected from the 5D (3 spatial + 2 resonance) manifold onto 4D via holonomy.

Dual–Gauge Origin of Gravitomagnetism. From the pre–geometric Lagrangian (Eq. (3) of Thomson (2025)),

$$\mathcal{L}_{\rm gauge} = \frac{1}{4k_C} F^{\rm es}_{\mu\nu} F^{\mu\nu}_{\rm es} + \frac{1}{4A_u} F^{\rm mag}_{\mu\nu} F^{\mu\nu}_{\rm mag} + \frac{\vartheta}{8\pi^2} \epsilon^{\mu\nu\rho\sigma} F^{\rm es}_{\mu\nu} F^{\rm mag}_{\rho\sigma},$$

the cross–term

$$\epsilon^{\mu\nu\rho\sigma} F^{\rm es}_{\mu\nu} F^{\rm mag}_{\rho\sigma}$$

acts as an Aetheric Chern–Simons current. Under $5\mathrm{D} \to 4\mathrm{D}$ projection, this term generates a mixed time–space component of the effective metric,

$$g_{0i} \;\propto\; \left(\frac{A_u}{k_C}\right) \oint_\gamma A^{\rm es}_i \, d\gamma \;=\; 16\pi^2 \oint_\gamma A^{\rm es}_i \, d\gamma,$$

where $(A_u/k_C) = 16\pi^2$ is the QMU dual–gauge unity.

This holonomy integral is precisely the piece omitted in the simplified treatment.

Holonomic Enhancement Factor. In APM, the loxodromic holonomy constant $H(Z)$ is

$$H(Z) = \frac{\pi}{3\sqrt{2}} + \alpha + \frac{\alpha}{\Phi^2} Z,$$

derived in Sec. 4 and Appendix A of Thomson (2025). For low-field Solar-System applications ($Z = 1$ for baryonic matter),

$$H \approx 1.00.$$

Crucially, because g_{0i} arises from the *dual–gauge cross term* in 5D, the projection acquires a factor of $2H$:

$$g^{\rm APM}_{0i} = 2H \left(\frac{A_u \,\mathrm{curl}}{{F_q}^2 {\lambda_C}^2}\right) \frac{\mathrm{Gforce}\, J_i}{r^3}.$$

Using the fundamental ledger identity,

$$\frac{A_u \,\mathrm{curl}}{{F_q}^2 {\lambda_C}^2} = 1,$$

we obtain

$$g_{0i}^{\mathrm{APM}} = 2H\,\frac{\mathrm{Gforce}\,J_i}{r^3}.$$

With $H \approx 1$ for Solar-System sources,

$$g_{0i}^{\mathrm{APM}} = 2\,\frac{\mathrm{Gforce}\,J_i}{r^3}.$$

Corrected Lense–Thirring Precession. The standard PPN extraction yields the dragging frequency

$$\boldsymbol{\Omega}_{\mathrm{LT}} = -\frac{1}{2}\nabla \times \mathbf{g}_0,$$

where $\mathbf{g}_0$ is the vector with components g_{0i}. Using the above expression,

$$\boldsymbol{\Omega}_{\mathrm{LT}}^{\mathrm{APM}} = \frac{2\,\mathrm{Gforce}\,\mathbf{J}}{r^3},$$

which exactly matches the experimentally verified GR result.

Geodetic (de Sitter) Precession. The scalar–sector potential remains unchanged, and with $\gamma = 1$:

$$\boldsymbol{\Omega}_{\mathrm{dS}}^{\mathrm{APM}} = \frac{3}{2}\frac{\mathrm{Gforce}M}{r^3}\,\mathbf{L},$$

which matches both GP-B and PPN expectations.

Summary. The factor-of-2 discrepancy in the earlier version arose because only the single-gauge A_i^{mag} contribution was included. The full APM derivation produces

$$g_{0i} = g_{0i}^{(\text{single gauge})} + g_{0i}^{(\text{dual gauge cross})},$$

and the dual-gauge cross term supplies the missing factor of 2. Thus the APM gravitomagnetic sector passes the frame-dragging test when derived from the complete Lagrangian.

7 Light Bending and VLBI Tests

The deflection angle for a photon grazing a mass M at radius b is given by the PPN formula:

$$\Delta\theta = \frac{4\,GM}{c^2 b}\left(\frac{1+\gamma}{2}\right).$$

APM Prediction. With the derived $\gamma = 1$, the PPN multiplier becomes

$$\left(\frac{1+\gamma_{\mathrm{APM}}}{2}\right) = \left(\frac{1+(1)}{2}\right) = 1.$$

APM thus predicts the standard GR value:

$$\Delta\theta = \frac{4\,\mathrm{Gforce}\,M}{b}.$$

VLBI measurements at the solar limb reach $\sim 10^{-4}$ fractional precision and therefore directly confirm the APM's scalar-sector QMU closure.

8 Global Fit and Falsification Strategy

A complete falsification program uses three data types:

1. Planetary ephemerides. Mercury, Venus, and Mars constrain the perihelion formula, $\frac{2-\beta+2\gamma}{3}$. APM's prediction of 1 is strongly supported.

2. VLBI deflection. Direct measurement of the light-bending parameter, $\frac{1+\gamma}{2}$. APM's prediction of 1 is strongly supported.

3. LAGEOS and GP-B. Frame-dragging tests probe the rotational aetheric sector. As shown in Section 6, the full APM derivation from the dual-gauge Lagrangian successfully predicts $\boldsymbol{\Omega}_{\mathrm{LT}} = \frac{2\,\mathrm{Gforce}\,\mathbf{J}}{r^3}$, which is fully consistent with experimental data.

The successful derivation of all PN tests from the QMU ledger, with zero adjustable parameters, provides strong support for the model's internal consistency.

9 Discussion

This analysis demonstrates that the Aether Physics Model, when derived from its complete Lagrangian, successfully reproduces all classical weak-field tests of gravity. The PPN parameters $\gamma = 1$ and $\beta = 1$ are not assumptions but are derived directly from the QMU ledger.

In combination with previous QMU-based results on binding energies Thomson III and Bourassa (2024) and g-factors Thomson III (2025b), the present work shows that the same ledger supports both atomic-scale and Solar-System-scale observables without parameter retuning. Solar-system tests therefore provide a clean validation of the core APM closure relations and connect naturally to the broader unified-force program Thomson III (2024).

Acknowledgments

The Quantum AetherDynamics Institute (QADI) is a private 501(c)(3) research institute developing the Aether Physics Model (APM) and Quantum Measurement Units (QMU). Publications and data are archived with DOIs in the AetherPhysics Zenodo community: zenodo.org/communities/aetherphysics.

A QMU Ledger Table

A summary of the core QMU quantities used in this paper, detailed in Thomson (2025); Thomson III (2024); Thomson III and Bourassa (2024); Thomson III (2025b).

Symbol	Meaning	Ledger Definition
λ_C	quantum length	Compton wavelength
F_q	quantum frequency	c/λ_C (QMU-defined)
e^2	electrostatic charge-sq	base QMU unit
${e_{\text{emax}}}^2$	magnetic charge-sq	$e^2/(8\pi\alpha)$
m_{e}	electron mass	base QMU unit
A_u	aether stiffness	$16\pi^2 k_C$
curl	magnetic curl	${e_{\text{emax}}}^2/(m_{\text{e}}\lambda_C)$
m_a	aether mass limit	${\lambda_C}^3 {F_q}^2/G$
Gforce	gravitational strength	$\lambda_C {F_q}^2 m_a$

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