A Rheological Approach to the Viscous Fermionic Vacuum Condensate. IV. Relativistic Pericenter Precession of Mercury via ψ-Condensate Drag

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This paper demonstrates that the anomalous perihelion precession of Mercury ($\Delta\Phi \approx 43''$ per century) emerges naturally from the hydrodynamic interaction between a baryonic defect and the physical vacuum, modeled as a viscous fermionic condensate (VFC). By modifying the classical Binet equation to include the rheological momentum dispersion tensor of the medium, we derive the exact analytical expression for the secular shift without resorting to the geometric abstractions of general relativity. The calculated precession of $42.98''$ per century is in exceptional agreement with empirical observational data.

1 Introduction

The anomalous precession of Mercury's perihelion has historically been treated as the primary proof of spacetime curvature within the Einsteinian framework. However, within the Fermionic Universe Hypothesis (FUH) [1] [2] [3] , the physical vacuum is formalized not as a geometric void, but as an active macroscopic quantum medium—the ψ-condensate (the Ocean)—possessing a fundamental dynamic viscosity $\eta \approx 1.2\times10^{-15}$ Pa·s. Any material body or elementary particle acts as a localized topological soliton or defect moving through this substrate. In this work, we demonstrate that the non-zero viscosity and localized pressure density of the Ocean induce a subtle, non-linear velocity-dependent drag force on planets moving deep within a gravitational potential well. This rheological tax prevents planetary orbits from closing into perfect Newtonian ellipses, forcing a deterministic precession of the pericenter.

2 Modified Binet Equation in a Viscous Medium

In the Eulerian specification of the VFC flow field, the motion of a macroscopic baryonic defect in a central gravitational field is governed by the balance of the central Newtonian force and the non-linear rheological response of the sub-quantum medium. Let $u = 1/r$ be the reciprocal radius vector of the planet's orbit, and ϕ be the azimuthal angle. The classic Binet equation is modified by introducing a perturbative rheological term $\Delta_{visc}(u)$ [4] [5] that accounts for the relativistic momentum tax of the ψ-condensate:

$$\frac{d^2u}{d\phi^2} + u = \frac{GM_\odot}{h^2} + \Delta_{visc}(u) \tag{1}$$

where G is the gravitational constant, $M_\odot$ is the mass of the central body (the Sun), and $h = r^2\frac{d\phi}{dt}$ is the specific angular momentum of the planet. The rheological tax $Delta_{visc}(u)$ stems from the non-linear momentum dispersion tensor due to the elastic deformation of the surrounding ψ-condensate layers at high orbital velocities v. The coefficient 3 represents a superposition of lateral shear resistance (factor of 1) and radial medium compression (factor of 2). Since $v^2 \propto h^2u^2$ for paths with low eccentricity, this drag scales non-linearly with the interaction transmission limit c:

$$\Delta_{visc}(u) = \frac{3GM_\odot}{c^2}u^2 \tag{2}$$

Substituting Equation (2) into Equation (1) yields the fundamental differential equation for planetary motion within the viscous Ocean manifold:

$$\frac{d^2u}{d\phi^2} + u = \frac{GM_\odot}{h^2} + \frac{3GM_\odot}{c^2}u^2 \tag{3}$$

3 Analytical Derivation of the Secular Shift

To solve Equation (3), we utilize a perturbation method. Let the unperturbed Newtonian solution be a standard Keplerian ellipse:

$$u_0(\phi) = \frac{GM_\odot}{h^2}(1 + e\cos\phi) = \frac{1}{a(1-e^2)}(1 + e\cos\phi) \tag{4}$$

where a is the semi-major axis and e is the orbital eccentricity. We look for a first-order corrected solution of the form $u(\phi) = u_0(\phi) + \delta u(\phi)$. Substituting u_0^2 into the perturbative term of Equation (3) and isolating the resonant secular term proportional to $\cos\phi$, we obtain the driven harmonic oscillator equation:

$$\frac{d^2(\delta u)}{d\phi^2} + \delta u \approx \frac{6(GM_\odot)^2}{c^2h^4}e\cos\phi \tag{5}$$

The particular solution to Equation (5) that describes the non-periodic, cumulative structural shift of the orbital axis is:

$$\delta u(\phi) = \frac{3(GM_\odot)^2}{c^2h^4}e\phi\sin\phi \tag{6}$$

Combining $u_0(\phi)$ and $\delta u(\phi)$, the total solution becomes:

$$u(\phi) = \frac{GM_\odot}{h^2}\left[1 + e\cos\phi + \frac{3GM_\odot}{c^2h^2}e\phi\sin\phi\right] \tag{7}$$

Using the small-angle approximation $\cos(\phi - \delta\phi) \approx \cos\phi + \delta\phi \sin\phi$, Equation (7) can be rewritten as a precessing ellipse with a shifting pericenter argument:

$$u(\phi) \approx \frac{GM_\odot}{h^2}\left[1 + e\cos(\phi - \delta\phi)\right] \tag{8}$$

Thus, the secular pericenter advance $\delta\phi$ (in radians) during one complete orbital revolution ($\phi = 2\pi$) is explicitly derived as:

$$\delta\phi = \frac{6\pi GM_\odot}{a(1-e^2)c^2} \tag{9}$$

4 Precision Numerical Calculation for Mercury

To validate the model, we substitute the precise parameters of Mercury's orbit [6] and solar mass into Equation (9):

- $G = 6.674 \times 10^{-11}\ \mathrm{m}^3 \cdot \mathrm{kg}^{-1} \cdot \mathrm{s}^{-2}$
- $M_\odot = 1.9885 \times 10^{30}$ kg
- $a = 57.9091 \times 10^9$ m
- $e = 0.2056306$
- $c = 299\,792\,458$ m/s
- $\pi \approx 3.14159$

First, we calculate the geometric shape factor of the orbital ellipse:

$$1 - e^2 = 1 - (0.2056306)^2 = 0.957716 \tag{10}$$

Substituting these explicit parameters into Equation (9) yields the exact angular advance per single revolution:

$$\delta\phi = \frac{6 \cdot \pi \cdot (6.674 \times 10^{-11}) \cdot (1.9885 \times 10^{30})}{(57.9091 \times 10^9) \cdot 0.957716 \cdot (299\,792\,458)^2} \tag{11}$$

$$\delta\phi \approx 5.0186 \times 10^{-7}\ \text{rad/revolution} \tag{12}$$

To evaluate the cumulative effect over a standard cosmological observation window of one century ($t_{cy} = 3.15581 \times 10^9$ s), we determine the total number of orbital revolutions N performed by Mercury, given its precise period $T \approx 7.60052 \times 10^6$ s:

$$N = \frac{t_{cy}}{T} = \frac{3.15581 \times 10^9}{7.60052 \times 10^6} \approx 415.21\ \text{revolutions} \tag{13}$$

The total precession $\Delta\Phi$ is computed by converting radians into arcseconds (1 rad = $206\,265''$):

$$\Delta\Phi = (5.0186 \times 10^{-7}) \cdot 415.21 \cdot 206\,265 \tag{14}$$

Performing the direct product without intermediate truncation:

$$\Delta\Phi = 5.0186 \cdot 415.21 \cdot 206\,265 \cdot 10^{-7} \approx 42.98'' \tag{15}$$

The analytical result $\Delta\Phi \approx 42.98''$ per century offers a superb match to the historically observed anomaly ($\approx 43''$) [7] [8] [9] [10], proving that the localized momentum dispersion in the ψ-condensate substrate perfectly mimics geometric relativity effects at solar system scales.

5 Conclusion

The Fermionic Universe Hypothesis successfully resolves the anomalous precession of Mercury's perihelion via a purely material approach. By treating the physical vacuum as a viscous fluid medium, the secular advance of $42.98''$ per century is derived directly from the hydrodynamics of planetary motion within the ψ-condensate, rendering the abstract concept of empty curved spacetime obsolete.

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