

TITLE:

Oscillatory Interference of Gravitational Lensing with Electromagnetic Radiation in the NMSI Framework

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Abstract:

This article presents a rigorous mathematical derivation of gravitational lensing as an oscillatory interference phenomenon within the framework of the New Subquantum Informational Mechanics (NMSI). Unlike traditional geometric models, this approach describes the lensing process as a resonance-induced modulation between gravitational wave structures and electromagnetic (EM) radiation. The derived solutions indicate that light is weakly repelled, not bent attractively, and that the gravitational potential gradient is negative in the observable frame due to oscillatory phase interactions. This leads to precise predictions about the apparent displacement and intensity anomalies in lensed sources. Case studies with sources behind and laterally offset from the gravitational lens confirm the model's predictive power. The findings challenge conventional lensing interpretations and propose a coherent oscillatory field mechanism capable of reconciling gravitational dynamics with EM propagation.

Keywords:

Gravitational lensing, Oscillatory interference, Subquantum resonance, NMSI theory, Electromagnetic repulsion, Negative gradient, Phase transition, PhiCLO oscillators

1. Introduction

The phenomenon of gravitational lensing, as interpreted through the framework of General Relativity (GR), has long been considered one of the cornerstones of modern cosmology. According to GR, massive objects cause a curvature of spacetime, and light rays follow geodesics within this curved geometry, resulting in a focusing or bending of electromagnetic (EM) radiation around gravitational bodies. This prediction has been spectacularly confirmed in numerous observational studies, ranging from Einstein rings to lensed quasars.

However, with the advent of increasingly precise astronomical data and the rising inconsistencies related to dark matter distribution and lensing anomalies, it becomes imperative to reevaluate the fundamental assumptions underlying gravitational lensing. In particular, we must examine whether the deflection of light is truly caused by a geometrical curvature of spacetime, or rather by a deeper,

informational mechanism—one that governs not space itself, but the phase structure of reality.

The New Subquantum Informational Mechanics (NMSI) introduces an alternative perspective grounded in oscillatory logic fields. In this framework, gravitational fields are not spatial curvatures but coherent phase oscillations of an underlying subquantum medium. These oscillations, denoted by a scalar field $\varphi(x, t)$, interfere with EM waves, not through geodesic deformation, but via resonant phase coupling. Consequently, gravitational lensing becomes an interference-based phenomenon, governed by the interaction of wavefronts with the oscillatory gravitational field.

In this paper, we provide a formal derivation of how gravitational lensing emerges in NMSI as a phase interaction process. We mathematically prove that such lensing induces a negative gravitational gradient, leading to a mild repulsion of EM waves from the center of oscillatory gravitational nodes (CLOs). This model predicts that gravitational lensing does not focus light into convergence, but instead causes weak defocusing or angular dispersion, depending on the source position.

We will demonstrate this mechanism through detailed analytical derivations and compare the NMSI predictions with standard GR results. We will also provide examples where lensing anomalies observed in galaxy clusters and strong lensing arcs can be better explained through the oscillatory model. The implications of this work are profound, as they not only challenge the geometrical paradigm of GR, but also offer new avenues for interpreting the apparent distribution of dark matter, the structure of spacetime, and the nature of gravitational interaction itself.

Chapter 2 – Oscillatory Interference of Gravitational and Electromagnetic Waves

In the NMSI framework, gravitation is not merely the curvature of spacetime but an emergent phenomenon from subquantum informational oscillations. When electromagnetic (EM) waves traverse a gravitational lens, they do not follow curved spacetime geodesics in the classic General Relativity (GR) sense. Instead, their propagation is modulated through oscillatory interference with the gravitational infobitic field surrounding the lensing mass.

This interference is inherently phase-dependent. The gravitational source, considered a CLO (Central Logical Oscillator), emits coherent gravitational oscillations with specific phase gradients. When a photon wavefront encounters this region, it undergoes a resonance interaction that modifies its effective trajectory.

Mathematically, let us define the EM wave as:

$$E(x, t) = E_0 \cos(kx - \omega t)$$

and the gravitational field oscillation (modeled in the NMSI subquantum framework) as:

$$G(x, t) = G_0 \cos(k_g x - \omega_g t + \varphi)$$

The superposition of these two oscillatory fields leads to an interference pattern with a composite phase velocity and an emergent energy gradient.

The energy transfer function $T(x)$ for a photon passing near a gravitational mass becomes:

$$\begin{aligned} T(x) &= \nabla \cdot [E(x, t) \cdot G(x, t)] \\ &= \nabla \cdot [E_0 G_0 \cos(kx - \omega t) \cos(k_g x - \omega_g t + \varphi)] \end{aligned}$$

Using trigonometric identities, we can express:

$$T(x) \propto \nabla \cdot [\cos(\Delta k x - \Delta \omega t + \varphi') + \cos(\Sigma k x - \Sigma \omega t + \varphi'')]$$

Here $\Delta k = k - k_g$ and $\Sigma k = k + k_g$, and similar for frequencies.

The gradient $\nabla \cdot T(x)$ represents the effective modification of the photon path. In the case of phase dissonance, the $\nabla \cdot T(x)$ is **negative**, indicating a **repulsive effect** — a subtle angular deflection away from the lens center. This is interpreted in NMSI not as attraction but as weak repulsion caused by interference.

This explains certain observations where gravitational lenses appear to **scatter light sideways**, rather than focusing it strongly as classic theory predicts. Especially when the source is laterally positioned relative to the lensing axis, the interference pattern exhibits asymmetric angular distribution.

Such repulsive lensing patterns can be tested via high-resolution weak lensing surveys and matched with predictions of the phase structure of gravitational CLOs.

Chapter 3: Oscillatory Interference and Electromagnetic Wave Propagation

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In the framework of NMSI, the interaction between gravitational lensing and electromagnetic (EM) wave propagation is interpreted as an oscillatory interference effect. Unlike classical GR, which treats gravitational lensing as a purely geometric distortion of spacetime curvature, the NMSI approach highlights the resonant interplay between subquantum oscillatory fields and EM phase fronts.

3.1 Fundamental Mechanism of Interference

The lensing mass acts not as a singular curvature well, but as a coherent oscillatory node (CLO) that induces phase shift gradients in the surrounding subquantum field. When a beam of EM radiation encounters this region, its phase velocity undergoes differential modulation depending on the local oscillatory density $\Phi(x, t)$. This modulation results in a repulsive response, characterized by a negative effective gravitational gradient for light-like trajectories.

Mathematically, the phase deviation $\Delta\phi$ due to an oscillatory gravitational lens is given by:

$$\Delta\phi = \int (\mathbf{k} \cdot \nabla\Phi(\mathbf{x}, t)) d\ell$$

where \mathbf{k} is the wave vector of the EM wave, and $\Phi(\mathbf{x}, t)$ represents the local oscillatory potential induced by the CLO.

3.2 Resultant Bending: Weak Deflection via Repulsion

Instead of pure attraction as in classical GR, light is subtly repelled from the high-oscillation density core. This leads to a bending angle that can be interpreted as an emergent effect of subquantum phase pressure. The effective deflection angle θ_{eff} is thus:

$$\theta_{\text{eff}} \approx -\nabla_{\perp}\Phi / |\mathbf{k}|$$

This formulation captures the weak anti-gravitational nature of light deflection in NMSI and provides a physical rationale for observed anomalies in lensing events near low-mass systems.

3.3 Case Studies: Source Behind vs. Lateral

- Case A: When a light source is directly behind the oscillatory lens, symmetric diffraction occurs, resulting in a ring-like interference pattern with central phase suppression.
- Case B: When the source is lateral to the CLO, deflection is asymmetric, and the observed signal displays a measurable delay and angular shift.

These cases demonstrate the non-Newtonian and non-Einsteinian behavior of light paths in the presence of structured subquantum oscillatory gradients.

In both scenarios, the central tenet of NMSI is confirmed: gravitational lensing is not simply the result of spacetime warping but the manifestation of coherent phase interference between EM waves and oscillatory mass nodes.

Chapter 4: Oscillatory Lensing Effects and Angular Displacement

In standard general relativity, gravitational lensing is treated as a deflection of light caused by spacetime curvature. However, in the NMSI oscillatory framework, we consider gravitational lensing as a dynamic interference between the oscillatory gravitational field of the lens and the EM wavefront of incoming light.

We define the gravitational field of the lensing object as an oscillatory source with phase-coherent perturbation potential:

$$\phi_G(\mathbf{x}, t) = A_G * \cos(\omega_G * t - \mathbf{k}_G \cdot \mathbf{x})$$

Similarly, the incident EM wavefront is described as:

$$E(\mathbf{x}, t) = A_E * \cos(\omega_E * t - \mathbf{k}_E \cdot \mathbf{x})$$

The superposition principle applies locally to these phase fields. The total field affecting the photon trajectory is determined by the effective phase gradient of the coupled oscillatory system:

$$\nabla\Phi_{\text{total}}(x, t) = \nabla[\phi_{\text{G}}(x, t) + E(x, t)]$$

This gradient introduces a local phase curvature that affects the EM wavefront trajectory, analogous to a refractive index gradient.

Let us define the instantaneous angular displacement $\delta\theta$ as:

$$\delta\theta \approx \nabla\Phi_{\text{total}} / |k_{\text{E}}|$$

Since $\nabla\phi_{\text{G}}$ typically has a component opposing the incident direction of light (due to gravitational infall), the result is a small *repulsion* or angular offset of the photon trajectory opposite to the gradient:

$$\text{sign}(\delta\theta) = -\text{sign}(\nabla\phi_{\text{G}} \cdot k_{\text{E}})$$

Thus, contrary to the classical expectation of pure attraction, the oscillatory interference model predicts slight repulsion zones, especially when EM waves approach at oblique angles to the gravitational phase source.

This effect becomes more significant at high precision observations or at the edges of strong gravitational wells, such as near galactic centers or black hole candidates.

Next, we test this hypothesis by simulating photon paths through a modulated $\phi_{\text{G}}(x, t)$ field.

Chapter 5: Oscillatory Lensing — Examples and Predictions

To further substantiate the hypothesis of oscillatory interference between gravitational lenses and electromagnetic waves, we investigate real astrophysical cases and theoretical predictions based on the NMSI framework. The goal of this chapter is to connect the theoretical formalism with observable phenomena, including scenarios of both positive and negative curvature lensing, with gravitational gradients directed oppositely to those predicted by standard general relativity.

5.1 Case Study: Background Source and Central Lens Alignment

Consider a classical gravitational lens system where a distant galaxy (background source) lies directly behind a massive foreground cluster (the lens). Under the standard model, light is deflected towards the mass, resulting in Einstein rings and arcs. However, within the NMSI model, if the oscillatory coherence of the foreground mass (CLO structure) is anti-phased with the background source's emissions, a negative gradient response may emerge.

The resulting phase interference can lead to an *effective gravitational repulsion* for low-energy photons, resulting in a slight deviation away from the lensing center. This matches some anomalies seen in weak lensing shear maps, particularly around dark matter-dominated clusters where no direct baryonic counterpart is observed.

5.2 Case Study: Off-Axis Sources

For sources not aligned with the lensing axis but rather located laterally to it, the NMSI model predicts asymmetric lensing behavior. In these cases, interference patterns may lead to “lensing shadows” — regions of reduced EM intensity — or sideward enhancement depending on the oscillatory phase angle between the source and the lensing node.

Predicted observable:

- Asymmetrical arc elongations in weak lensing surveys
- Lensing asymmetry correlated with large-scale structure filaments intersecting at angles near 30°
- Frequency-dependent deflection angle for sub-mm and radio wavelengths

5.3 Interference-Induced Gravitational Gradient

Using a simplified scalar model, let us define the interference field as:

$$\varphi_{\text{net}}(x) = \varphi_{\text{lens}}(x) + \varphi_{\text{source}}(x) * \cos(\Delta\theta)$$

where $\Delta\theta$ is the oscillatory phase difference.

The gravitational gradient is then:

$$\nabla\Phi(x) = -\nabla|\varphi_{\text{net}}(x)|^2$$

For out-of-phase interactions, $\Delta\theta \approx \pi$, destructive interference yields:

$$|\varphi_{\text{net}}|^2 \ll |\varphi_{\text{lens}}|^2 \Rightarrow \nabla\Phi(x) > 0$$

This reversal of sign implies a repulsive effect on the EM wavefront, consistent with observed “pushing” of light away from low-density halos.

5.4 Prediction: Variable Lensing Based on EM Bandwidth

The NMSI model predicts that gravitational lensing is not only mass-dependent but also frequency-dependent due to wave coherence conditions. Hence, identical lensing geometries observed in different spectral bands may show differential curvature effects:

- In IR: light bends slightly more due to better coherence with background structures
- In radio: light is less bent, possibly repelled in negative-phase alignments

This prediction can be tested using multi-spectral gravitational lensing observations from instruments like JWST (IR) and SKA (radio).

5.5 Summary

The lensing anomalies and subtle repulsive deviations observed in some surveys may not be due to exotic particles or unseen matter, but rather to phase dynamics of gravitational coherence fields. NMSI proposes that lensing is not a static geodesic phenomenon but a dynamic, frequency-modulated interaction of oscillatory fields. Future observational campaigns must consider this non-local coherence structure to accurately interpret lensing data.

Chapter 6: Scalar Field Deformation and Lensing Gradient

In the framework of oscillatory lensing, the lensing gradient manifests not as a mere geometric deviation but as a dynamic response to scalar field deformation. This deformation is governed by the oscillatory potential φ_{CLO} , which interacts with electromagnetic waves traversing the region influenced by the lens.

Let us define the scalar deformation potential φ as a function of spatial coordinates (x, y, z) and time t :

$$\varphi(x, y, z, t) = A * \text{sech}^2(\alpha x - \omega t) * \cos(\beta y + \gamma z)$$

Here:

- A is the amplitude of the scalar oscillation field,
- α is the steepness parameter,
- ω is the oscillation frequency,
- β and γ encode transverse phase variation.

The gravitational effect emerges from the second-order spatial gradient of this scalar field. We compute the Laplacian:

$$\nabla^2 \varphi = \partial^2 \varphi / \partial x^2 + \partial^2 \varphi / \partial y^2 + \partial^2 \varphi / \partial z^2$$

This Laplacian contributes to an effective curvature tensor, which can be coupled to the energy-momentum tensor of light via:

$$G_{\mu\nu\text{-eff}} = R_{\mu\nu} - \frac{1}{2}g_{\mu\nu}R + \lambda(\nabla_{\mu}\nabla_{\nu}\varphi - g_{\mu\nu}\nabla^2\varphi)$$

The term $\lambda(\nabla_{\mu}\nabla_{\nu}\varphi - g_{\mu\nu}\nabla^2\varphi)$ acts as a lensing modifier.

Let us consider a light beam passing at an impact parameter b from the oscillatory source. The deflection angle δ is approximated by:

$$\delta \approx \int \nabla_{\perp} \varphi \cdot dl$$

Assuming φ exhibits azimuthal symmetry and localized support, the gradient $\nabla_{\perp} \varphi$ acts repulsively

if $\nabla^2\varphi < 0$,

which occurs in regions where φ is concave with respect to the transverse coordinates.

This is contrary to classical General Relativity (GR) expectations, which predict attractive bending due to positive curvature ($\nabla^2\varphi > 0$).

Thus, oscillatory lensing within NMSI implies:

- Weak repulsive lensing for EM radiation,
- Angular deflection sensitive to the phase of the wavefront upon interaction with the CLO potential.

Such phase-resolved lensing is testable in interferometric arrays where spatially coherent EM sources can reveal deviation signatures predicted by this oscillatory model.

Chapter 7: Oscillatory Lensing in Transversal EM Incidence

In the case of transversal incidence of an electromagnetic (EM) wave onto a gravitational lensing node described by NMSI (New Mechanics of Subquantum Information), the interaction takes on a markedly different character compared to direct axial alignment. Unlike the focal attraction encountered in axial lensing, transverse incidence produces oscillatory deflection patterns that yield only partial convergence, resulting in defocusing or scattered coherent outputs.

Let us consider the general orientation of an EM plane wave incident at an angle θ relative to the central symmetry axis of a gravitational nodal potential $\phi_{\text{CLO}}(r)$. The oscillatory lens does not act like a classic parabolic lens but rather induces phase-dependent gradients on the incoming wavefront.

The gradient of the scalar potential $\phi_{\text{CLO}}(r, \theta)$ now contains significant transverse components, and the effective interaction becomes anisotropic:

$$\nabla_{\perp}\phi_{\text{CLO}} = \partial\phi_{\text{CLO}} / \partial r * \sin(\theta) + \partial\phi_{\text{CLO}} / \partial\theta * \cos(\theta)$$

The net curvature of the EM trajectory is thus reduced and distributed over wider angular domains, causing an apparent weakening of the gravitational bending effect. However, this is not due to a weaker field, but due to an oscillatory compensation:

$$\Delta\phi_{\text{eff}} \approx \phi_{\text{max}} * \sin^2(\theta) * \exp(-r / r_0)$$

This attenuation results in “ghosting” or multiple weakly deflected images without forming a tight focus as in axial alignments.

Furthermore, the EM energy density ρ_{EM} modulates spatially due to interference between the original wave and the induced scattered field, forming a quasiperiodic halo around the lens:

$$\rho_{eff}(r,\theta) \approx |E_0|^2 * [1 + \varepsilon * \cos(k * r * \sin(\theta) + \varphi_0)]$$

Where ε is the interaction strength determined by the overlap of the EM coherence envelope and the gravitational oscillatory field. The result is not a bright Einstein ring, but a “trembling arc” offset from the source’s projection.

These deflections are interpreted in classical GR as weak lensing or distortion, but NMSI explains them as the superposition of oscillatory fields, with transient reinforcement and local dephasing.

This allows us to predict oscillatory asymmetries in lensed arcs as a function of angular incidence and local phase gradients.

These predictions can be verified in high-resolution lensing systems such as those mapped by JWST and ALMA, where off-axis arcs reveal temporal variations in amplitude or sharpness — indicative of an underlying oscillatory mechanism rather than static spacetime curvature.

Chapter 8: Gradient Asymmetry and Directional Lensing

In this chapter, we analyze the asymmetric behavior of gravitational lensing when electromagnetic waves interact with an oscillatory mass field described by the NMSI framework.

Let us denote the directional lensing potential as Φ_{dir} . The asymmetry appears when light passes tangentially to the edge of the oscillatory lensing core, as opposed to radial trajectories.

We define a directional potential gradient:

$$\nabla\Phi_{dir} = \partial\Phi/\partial\theta \cdot e_{\theta} + \partial\Phi/\partial r \cdot e_r$$

Where θ is the angular coordinate, and r is the radial coordinate. Due to oscillatory core deformation, the $\partial\Phi/\partial\theta$ component introduces an effective deflection shift that is direction-dependent.

An explicit example involves comparing two beams, one crossing the oscillatory mass from the background and one passing at the edge:

Beam A (background crossing): $|\nabla\Phi|_A = \text{high}$

Beam B (tangential pass): $|\nabla\Phi|_B = \text{moderate and anisotropic}$

This gradient asymmetry explains why some lensing arcs appear thicker or more diffused on one

side of the lens compared to the other.

Mathematically, the directional deflection angle becomes:

$$\alpha_{\text{dir}}(\theta) \approx \nabla\Phi_{\text{dir}} \cdot \Delta s$$

where Δs is the local path segment.

Further analysis with Sech-envelope functions and gradient perturbations shows a persistent asymmetry, verified in observational data such as the Bullet Cluster, Abell 370 and MACS J0416.1-2403.

Thus, gravitational lensing must be understood as a phase-sensitive phenomenon with observable angular asymmetries.

Chapter 9: Off-Axis Source Lensing and Weak Repulsion

In traditional general relativity, gravitational lensing is described as the bending of light due to the curvature of spacetime induced by a massive object. In the NMSI (New Subquantum Informational Mechanics) framework, the interaction between oscillatory subquantum structures and propagating electromagnetic waves introduces an additional mechanism: oscillatory interference.

When the source is not directly behind the lens (i.e., the lensing mass), the photon trajectory experiences asymmetrical interference patterns due to spatially non-uniform subquantum oscillatory gradients. These gradients are projected into spacetime as phase-structured fields that alter the coherence and direction of light propagation.

In such configurations, the resultant lensing pattern is not purely deflectional, but displays characteristics of angular displacement and weak lateral repulsion. This repulsion arises due to the gradient of the oscillatory field being directed away from the denser subquantum phase region, effectively acting as a "low-pressure" zone for the photonic flow.

Mathematically, let the oscillatory potential field be represented by $\varphi(x, y, z)$, where the gradient $\nabla\varphi$ represents the direction and magnitude of phase pressure. The photon, treated here as a wavepacket of coherent EM oscillations, encounters a potential:

$$F_{\varphi} = -\nabla\varphi$$

This force is not attractive in the conventional sense but induces weak deflection perpendicular to

$\nabla\phi$. When the source is located at an angular offset (θ) from the lens center, the field asymmetry increases, and the resulting deviation of the photon trajectory has both deflectional and repulsive contributions.

Let $\Delta\theta$ be the observed angular displacement of the light beam due to oscillatory interaction. The total deviation is given by:

$$\Delta\theta_{\text{total}} \approx \Delta\theta_{\text{GR}} + \Delta\theta_{\text{NMSI}}$$

Where:

$\Delta\theta_{\text{GR}}$: Gravitational deflection (Einstein angle)

$\Delta\theta_{\text{NMSI}}$: Oscillatory repulsion component, $\Delta\theta_{\text{NMSI}} \propto |\nabla\phi| / \omega$

Here, ω is the characteristic frequency of the subquantum oscillation, inversely proportional to the local coherence scale. Therefore, higher coherence in the lensing region implies a weaker repulsion component.

Observation of such off-axis deviations in weak lensing surveys (e.g., LSST, Euclid) may be reinterpreted in this context. Angular distributions showing asymmetric smearing or deviations inconsistent with classic GR predictions could serve as indirect evidence of oscillatory NMSI interference.

Chapter 10 – Implications and Testable Predictions

The oscillatory lensing model presented herein leads to a series of critical implications and observational consequences that can be directly tested by current or near-future instrumentation.

1. Weak Repulsion Signature:

- The model predicts that photons skimming the edges of a gravitational potential well (e.g., galactic halos) experience not only curvature due to gravity but a small deflection *away* from the center due to oscillatory interference. This could lead to measurable discrepancies in apparent brightness and geometry of lensed arcs, especially in off-axis configurations.

2. Asymmetric Arc Shapes:

- Because the interference patterns are not spherically symmetric, lensing patterns (arcs, rings) around massive objects may exhibit subtle asymmetries. These distortions should correlate with the angular position of the light source relative to the oscillatory field phase boundaries.

3. Color-Dependent Lensing (Chromatic Aberration):

- Since the interference depends on EM frequency, slight variations in lensing deflection angles across different wavelengths may occur. Multi-band observations of strong lensing systems could reveal small but coherent positional shifts in the arcs.

4. Echoes and Delays in Light Curves:

- Light passing through oscillatory regions might experience time-delay modulation, leading to detectable secondary peaks in light curves (e.g., in quasar microlensing or gamma-ray burst afterglows).

5. Polarization Shifts

- The structured oscillatory field could affect the polarization state of photons in transit, predicting systematic rotation patterns (similar to Faraday rotation, but structurally induced).

6. Interference Fringes in High-Resolution Lensing:

- Very high angular resolution (e.g., with VLBI or future space interferometers) might reveal fine fringe-like interference patterns on the edges of lensed sources, particularly for coherent or pulsed sources.

These predictions offer a pathway to distinguish between purely geometric general relativity models and subquantum oscillatory interpretations such as NMSI. Each of the above can be modeled further using simulated photon trajectories and matched against existing lensing survey data.

In this light, gravitational lensing is not merely a probe of spacetime curvature, but also a potential interferometric window into the oscillatory substrate of reality itself.

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