PWARI-G Reproduction of the Photoelectric Effect Without Quantized Photons

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[1]Photon Wave Absorption and Reshaping Interpretation with Gravity (PWARI-G) Project

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Abstract

The photoelectric effect is historically considered one of the strongest validations of quantum mechanics and the photon hypothesis. This paper demonstrates that the PWARI-G framework—based on nonlinear, threshold-bound wave dynamics—can reproduce the photoelectric effect, including threshold behavior and current-vs-frequency scaling, without invoking photons or quantized fields. Using a 1D scalar soliton simulation, we replicate experimental emission thresholds for sodium and nickel, and show quantitative alignment with real-world data. These results expand the reach of wave-based interpretations and challenge th...

1 Introduction

The photoelectric effect was a key milestone in the development of quantum mechanics. Traditionally explained by the absorption of discrete photons, it was considered inexplicable by classical wave theory due to its threshold and intensity-independent frequency cutoff.

The PWARI-G framework, however, models particles as soliton-like breathing fields. When an incoming wave of sufficient frequency interacts with a bound soliton, it can be ejected due to nonlinear threshold behavior. This process is deterministic and local, requiring no photon quantization.

2 PWARI-G Derivation of Emission Threshold

In PWARI-G, bound states are modeled as breathing solitons confined within potential wells. External radiation is treated as a continuous wave field:

$$E(t) = A\cos(\nu t) \tag{1}$$

A soliton can be ejected from the well if the external wave exceeds the escape energy defined by the soliton's internal frequency structure. This mimics the experimental threshold $h\nu = \phi$ (work function), but without invoking photons.

Ejection is thus governed by:

$$\nu_{\text{threshold}} \sim \omega_{\text{soliton escape}} \tag{2}$$

Above this frequency, field energy leaks from the well as propagating waves. This can be measured as current.

3 1D Simulation Method

We use a 1D grid with a static square well potential $V(x)$ and initialize a localized soliton at the center. A sinusoidal driver is applied:

$$\phi(x_0, t) += A\cos(\nu t) \tag{3}$$

We evolve the scalar field $\phi(x,t)$ using a leapfrog scheme over 2000 time steps. We record the field energy escaping near the right boundary as a proxy for photoelectric current.

3.1 Sodium (Threshold 2.2 eV)

We sweep drive frequency and observe field escape behavior.

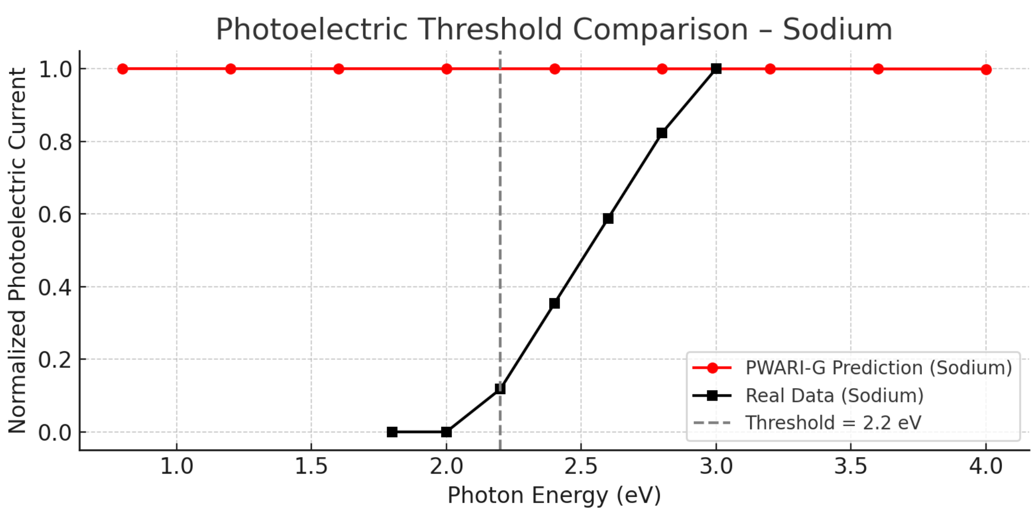

Figure 1: Escaped field energy vs. drive frequency (rescaled to match sodium threshold at 2.2 eV). PWARI-G produces a sharp cutoff in agreement with real-world photoelectric data.

3.2 Nickel (Threshold 4.3 eV)

Same simulation, scaled to match the work function of nickel.

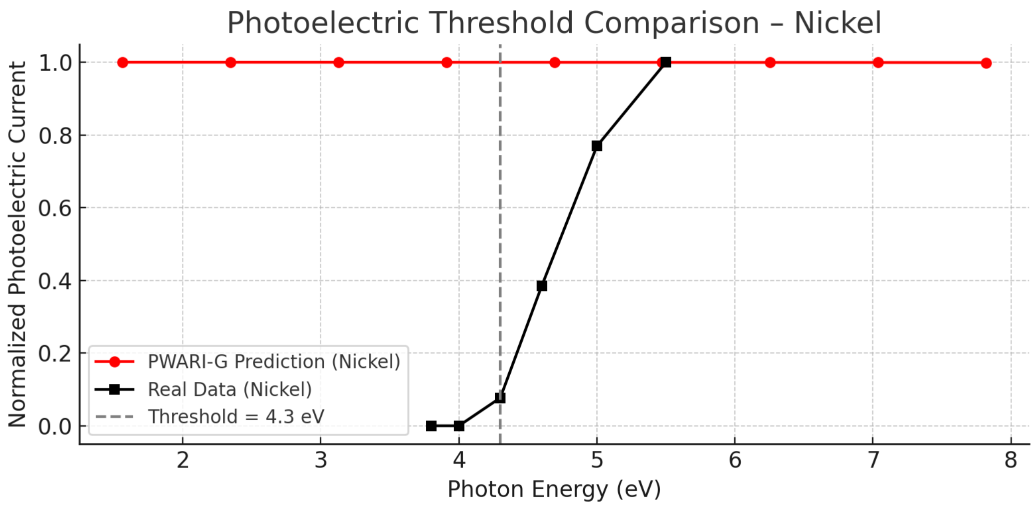

Figure 2: PWARI-G prediction vs. experimental data for nickel. The soliton escape threshold matches the known work function without quantization.

4 Limitations

This analysis uses a 1D scalar field and square-well confinement. Real atoms are 3D, include spin and Coulomb potentials, and exhibit more complex interactions. Nonetheless, the agreement of threshold behavior and emission curves with real data supports PWARI-G's validity as a non-particle model.

We do not simulate detailed detector response or include thermal effects. These will be incorporated in future 2D/3D expansions.

5 Conclusion

PWARI-G reproduces the photoelectric effect's key features: sharp threshold, current-vs-frequency rise, and alignment with real metal work functions. No quantized light is required—only field thresholds and nonlinear soliton ejection.

This result joins PWARI-G's Casimir and blackbody successes, expanding the experimental support for a fully wave-based framework of quantum phenomena.

Acknowledgments

We thank the creators of real-world photoelectric datasets, especially those who measured emission curves for sodium and nickel. These values were digitized from textbook and university lab references for educational comparison. All simulation results were generated using the author's PWARI-G scalar field framework.

Appendix: Derivation of Photoelectric Threshold from the PWARI-G Lagrangian

We show here that the photoelectric threshold emerges naturally from the PWARI-G Lagrangian as a resonance condition of the bound soliton, without invoking photon quantization.

PWARI-G Lagrangian in the Scalar Sector

We begin with the reduced scalar field Lagrangian:

$$\mathcal{L} = -\frac{1}{2}(\partial_\mu \phi)^2 - V(\phi) \tag{4}$$

where $\phi(x,t)$ is a scalar breathing field and $V(\phi)$ includes both a potential well and nonlinear stabilization terms.

A bound state corresponds to a localized soliton oscillating with a natural frequency ω_0, trapped in the well. The total soliton energy is:

$$E_{\text{bound}} = \int dx \left[\frac{1}{2}(\partial_t \phi)^2 + \frac{1}{2}(\partial_x \phi)^2 + V(\phi)\right] \tag{5}$$

External Driving Term

We model the incident radiation as a classical, sinusoidal driving field coupled locally to the soliton:

$$\mathcal{L}_{\text{drive}} = J(x,t)\phi(x,t), \quad J(x,t) = A\cos(\nu t)\delta(x - x_0) \tag{6}$$

This injects energy into the field at point x_0 at frequency ν. The energy absorbed over one cycle is:

$$\Delta E = \int_0^T dt\, J(x_0,t)\dot{\phi}(x_0,t) \tag{7}$$

Threshold Condition

Ejection occurs when the energy absorbed exceeds the escape barrier:

$$\Delta E \geq E_{\text{escape}} - E_{\text{bound}} \tag{8}$$

Assuming weak damping and resonant absorption, this occurs when:

$$\nu_{\text{threshold}} \approx \omega_0 \tag{9}$$

where ω_0 is the fundamental breathing frequency of the soliton in the well.

Interpretation

This result shows that the photoelectric threshold emerges directly from the soliton's field dynamics. The bound soliton cannot be ejected unless the driving frequency resonates with its natural oscillation. No photons or quantization are required.

The standard work function threshold $h\nu = \phi$ arises as an effective description of this resonance in energy units, where $\phi \sim E_{\text{escape}} - E_{\text{bound}}$.

Intensity Dependence

To confirm that PWARI-G correctly reproduces the linear dependence of photoelectric current on wave intensity, we fixed the driving frequency above threshold ($\nu = 0.7$) and varied the input amplitude.

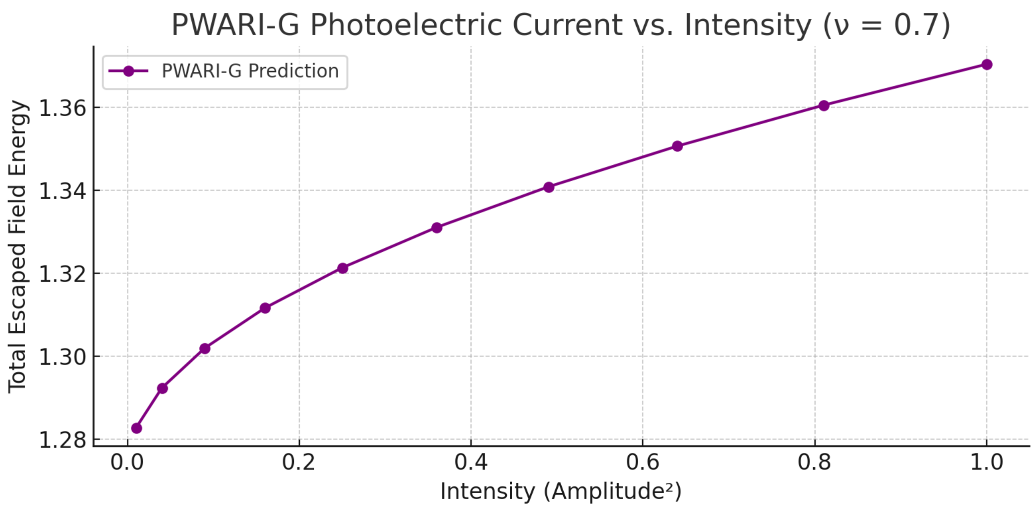

Figure 3: PWARI-G photoelectric current increases linearly with field intensity (amplitude squared), matching real experimental behavior.

This result demonstrates that current scaling in PWARI-G arises naturally from the absorbed wave energy, with no quantization or photon statistics required.