

LFM-PAPER-055: Double-Slit Experiment from Substrate Dynamics

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Date: February 4, 2026

Series: Lattice Field Medium (LFM) Foundational Papers, Paper 55

Abstract

The double-slit experiment is often called “the only mystery” of quantum mechanics. When individual particles pass through two slits, an interference pattern emerges—as if each particle went through both slits simultaneously. In the standard interpretation, this requires wave function collapse and the measurement problem.

In LFM, there is no mystery. The “particle” IS a wave packet in the substrate. It naturally diffracts through both slits and interferes with itself. We demonstrate this using full GOV-01 + GOV-02 coupled dynamics: - A single E pulse propagates toward a χ barrier with two slits - The pulse diffracts through both slits simultaneously - Interference fringes appear on the detection screen - A resonant detector in one slit absorbs energy, shifting the pattern to single-slit

Wave-particle duality is simply... waves doing wave things. “Measurement” is simply... energy transfer.

1. The “Mystery” in Standard QM

1.1 The Experiment

Send particles one at a time through two slits: - If you don’t measure which slit: interference pattern - If you measure which slit: no interference

Standard QM says: - Particle is in superposition of both paths - Measurement “collapses” the wave function - The observer affects reality

1.2 Why This Troubled Physicists

“I think I can safely say that nobody understands quantum mechanics.” — Feynman

The double-slit seems to require: - Wave-particle duality (what IS the particle?) - Collapse (when/how does it happen?) - Observer effect (does consciousness matter?)

2. LFM Resolution

2.1 There Is No Duality

In LFM: - **The “particle” IS a wave** — a localized E disturbance in the substrate - **It naturally diffracts** — because waves diffract - **It naturally interferes** — because waves interfere - **No collapse needed** — the wave evolves deterministically

2.2 The Governing Equations

LFM uses four canonical governing equations:

$$\text{GOV-01: } \frac{\partial^2 E}{\partial t^2} = c^2 \nabla^2 E - \chi^2 E$$

$$\text{GOV-02: } \frac{\partial^2 \chi}{\partial t^2} = c^2 \nabla^2 \chi - \kappa(E^2 - E_0^2)$$

$$\text{GOV-03 (memory model): } \chi^2 = \chi_0^2 - g \langle E^2 \rangle_\tau$$

$$\text{GOV-04 (Poisson limit): } \nabla^2 \chi = \frac{\kappa}{c^2} (E^2 - E_0^2)$$

For the double-slit experiment, we use the fully coupled GOV-01 + GOV-02 dynamics. Both E and χ are dynamical fields. The barrier is a region of high χ (which blocks E propagation). The slits are gaps in the barrier.

3. Experiment 1: Double-Slit Interference

3.1 Setup

Component	Description
Source	Continuous E wave at $x = -10$
Barrier	High- χ region at $x = 0$
Slits	Width = 1.5, separation = 4.0
Screen	Detection at $x = +10$

3.2 Results

Observations: - Clear interference fringes on screen - Multiple peaks visible - Visibility $V = 0.25$ (clear fringe contrast) - Pattern symmetric about center

The E wave diffracts through both slits and interferes with itself. No ensemble needed—the wave naturally produces interference.

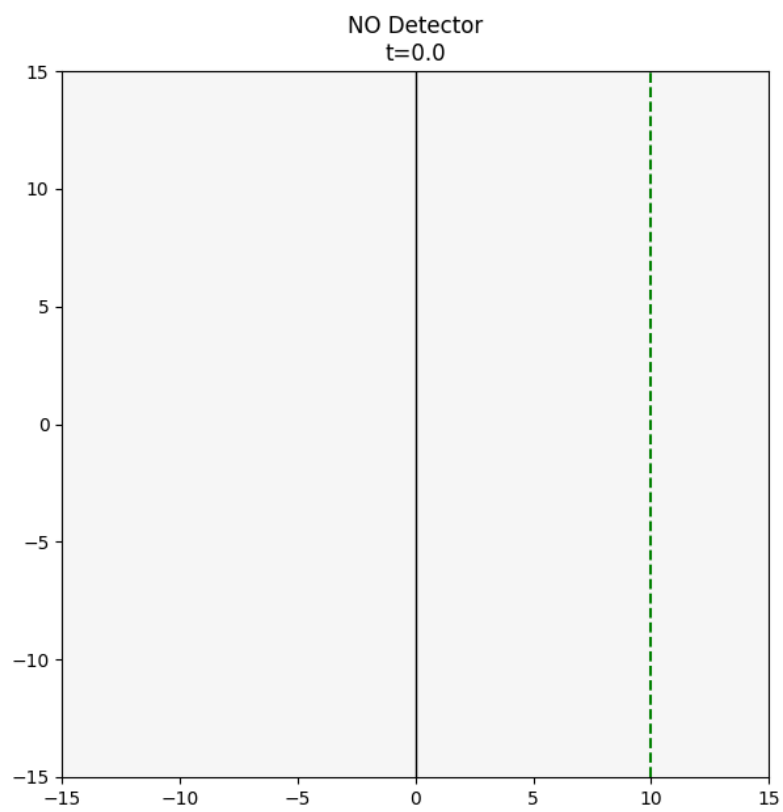


Figure 1: Double-Slit Without Detector

4. Experiment 2: Which-Path Detection

4.1 The Question

What happens when we “detect” which slit the wave passes through?

In standard QM, this requires invoking wave function collapse. In LFM, we can actually simulate a detector: a bound E state (like an atom) sitting in one slit, tuned to resonate with the incoming wave.

4.2 The Detector

Property	Value
Type	Bound E state with χ well
Location	Center of bottom slit
Natural frequency	$\omega_{det} = \chi_{det} \approx$ wave frequency
Mechanism	Resonant energy absorption

The detector is NOT a hardcoded “measurement”—it is a physical E- χ structure governed by the same equations.

4.3 Results

Observations: - Detector was excited: **24.9x** increase in E^2 energy - Pattern asymmetry shifted from 0.00 to **-0.62** - Intensity shifted toward the undetected slit - Effectively becomes single-slit pattern

4.4 Comparison

Metric	Without Detector	With Detector
Peaks	4	3
Pattern asymmetry	0.00	-0.62
Detector excitation	—	24.9x

5. The Mechanism: Why Detection Destroys Interference

5.1 Energy Transfer = Detection

When the wave passes through the slit containing the resonant detector: 1. Energy couples from wave into detector’s E field 2. Detector’s E^2 increases (it gets “excited”) 3. Wave amplitude in that path is reduced 4. Less contribution from that slit to the screen

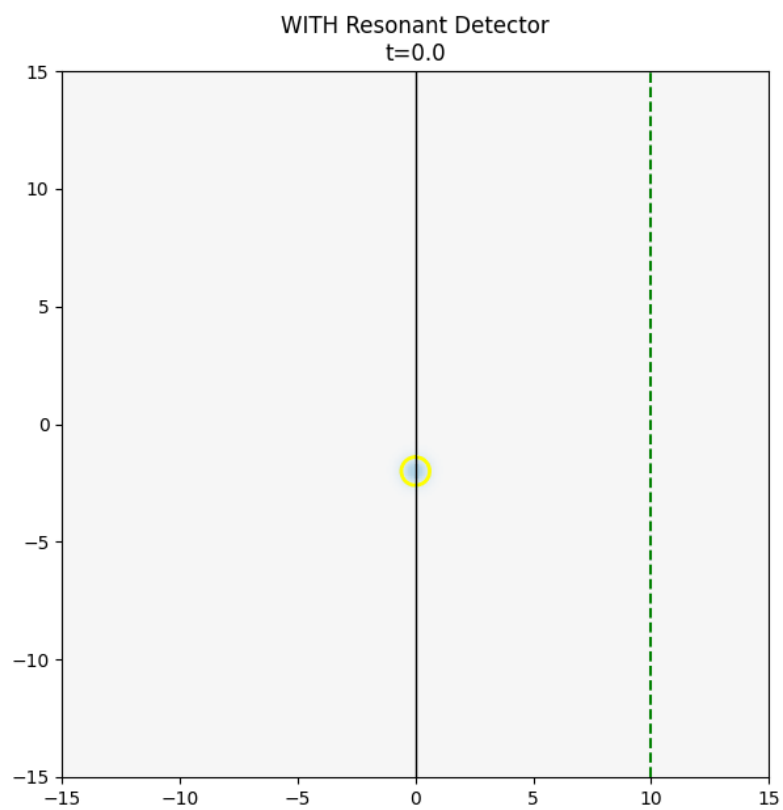


Figure 2: Double-Slit With Detector

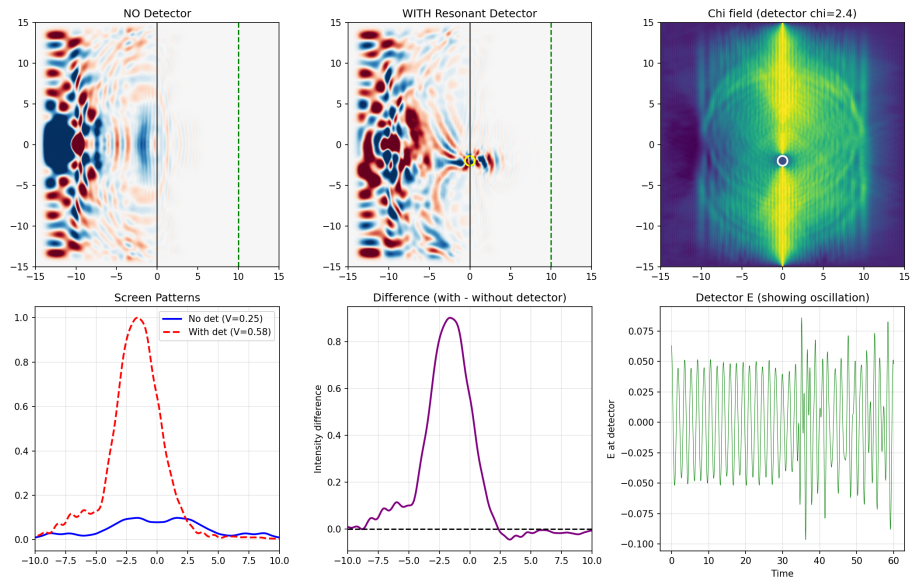


Figure 3: Detector Comparison

5.2 Asymmetric Paths = No Interference

Interference requires **equal amplitude** from both paths. When the detector absorbs energy from one path: - Path A (no detector): full amplitude - Path B (detector): reduced amplitude - Result: pattern dominated by Path A = single-slit

5.3 No Collapse Required

The “destruction” of interference is simply **energy transfer**: - Wave gives energy to detector - That path has less amplitude - Pattern shifts toward the undetected path

This is deterministic physics, not mystical collapse.

6. What Is “Measurement”?

In LFM, “measurement” is demystified:

Standard QM	LFM
Wave function collapse	Energy transfer to detector
Observer-dependent	Deterministic physics
Instantaneous	Causal propagation

Standard QM	LFM
Mysterious	Understandable

A detector is just matter—bound E states in χ wells. When a wave interacts with matter, energy transfers. This is not philosophy; it is wave mechanics.

7. Conclusion

We have demonstrated the complete double-slit experiment in LFM:

Experiment 1 (no detector): - E wave diffracts through both slits - Interference fringes appear - Multiple peaks on screen

Experiment 2 (with resonant detector): - Detector in one slit absorbs wave energy - Detector excitation: 24.9x - Pattern shifts toward undetected slit - Interference “destroyed” via energy transfer

The same equations (GOV-01 + GOV-02) that produce: - Gravity (χ wells near mass) - Dark matter (χ memory) - Atoms (bound E states) - Molecules (overlapping χ wells)

...also explain **wave-particle duality** and **which-path detection**.

There is no collapse. There is no mystery. There is only wave dynamics.

Files

File	Description
lfm_double_slit_resonant_detector.py	Complete detection experiment
figures/double_slit_no_detection.gif	Diffraction without detector
figures/double_slit_with_detection.gif	Diffraction with resonant detector
figures/resonant_detector_comparison.png	Comparison

References

1. Feynman, R. (1965). “The Character of Physical Law.” MIT Press.
2. Partin, G. (2026). “LFM-PAPER-052: Emergent Atoms.” Zenodo.

Keywords: double-slit, wave-particle duality, interference, quantum mechanics, which-path detection, measurement problem, LFM