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The Double-Slit Experiment: Two Centuries of Confirmed Strangeness, Frontier Advances, and the Future of Quantum Science

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Abstract

The double-slit experiment, first performed by Thomas Young in 1801, remains the most philosophically consequential apparatus in the history of physics. This paper reviews what has been definitively established — wave-particle duality, observer-induced decoherence, quantum complementarity, and entanglement-based extensions — and maps the current frontier of experimental innovation spanning 2010 to 2025. Organized around five thematic pillars, the literature review synthesises foundational and recent peer-reviewed work on: (1) wave-particle duality; (2) quantum measurement and decoherence; (3) entanglement and non-locality; (4) macroscopic quantum coherence; and (5) technological implications. A systematic document-analysis methodology is employed to synthesise experimental findings across disciplines. Results confirm that the experiment continues to generate paradigm-shifting discoveries — including time-domain interference (Imperial College London, 2023), atomic-precision replication (MIT, 2025), and femtometer-scale interference at CERN (2024). The paper concludes that these advances carry profound consequences for quantum computing, quantum communication, fundamental cosmology, and the philosophy of science.

Keywords: *double-slit experiment, wave-particle duality, quantum decoherence, quantum entanglement, quantum measurement, quantum technology, macroscopic coherence*

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I. Introduction

In 1801, the British polymath Thomas Young directed a beam of light at a screen pierced by two narrow parallel slits and observed, on a second screen, not two bright bands but an alternating pattern of light and dark fringes — an interference pattern classically associated with waves. This elegant demonstration, later known as Young's double-slit experiment, served for over a century as the cornerstone proof that light behaves as a wave (Young, 1802). Yet by the early twentieth century, quantum mechanics revealed that the same experiment, when performed one photon or one electron at a time, produced results that were — and remain — deeply mysterious: each particle appeared to 'pass through both slits simultaneously', interfering with itself, and the interference pattern vanished the instant an observer attempted to identify which slit the particle had used (Feynman, Leighton, & Sands, 1965).

More than two centuries after Young's original demonstration, this experiment has not merely survived the scrutiny of modern science — it has become richer, stranger, and more consequential. Recent years have brought a series of landmark advances: the experiment recreated in the time domain rather than space (Tirole et al., 2023); the most atomically precise version ever performed, clarifying the role of quantum correlations over mechanical disturbance (Fedoseev et al., 2025); and double-slit-type interference observed at the femtometer scale inside heavy-ion collisions at CERN (ALICE Collaboration, 2024). Taken together, these results confirm that the double-slit experiment is not a museum artefact of quantum mechanics but an active, evolving proving ground for the deepest questions in physics.

The present paper aims to: (1) systematically review the established literature on the double-slit experiment across five thematic domains; (2) synthesise findings from frontier experimental studies published primarily between 2010 and 2025; (3) assess what these findings confirm, what they leave unresolved, and what they imply for the future of science and technology; and (4) situate the double-slit experiment within its broader civilisational significance — from quantum computing and communications to the philosophy of measurement.

Literature Review

This literature review is organised into five thematic clusters, each representing a distinct dimension of research on the double-slit experiment. For each theme, foundational works are cited alongside recent empirical contributions, with an emphasis on peer-reviewed publications from the past fifteen years. The five themes are: (1) wave-particle duality; (2) quantum measurement and observer-induced decoherence; (3) quantum entanglement and non-locality; (4) macroscopic quantum coherence; and (5) technological and civilisational implications.

2.1 Wave-Particle Duality — Foundations and Experimental Validation

The conceptual foundation of the double-slit experiment rests on the principle of wave-particle duality — the empirically demonstrated reality that quantum entities exhibit characteristics of both waves and particles, depending on the experimental context. De Broglie (1924) first proposed that matter, like light, possesses a wavelength inversely proportional to its momentum, a prediction confirmed by Davisson and Germer (1927) through electron diffraction and later extended by Thomson and Reid (1927) to crystalline materials.

The single-electron version of the double-slit experiment, voted the most beautiful experiment in physics by readers of Physics World in 2002, was performed with definitive single-particle resolution by Frabboni et al. (2012), who used nanofabricated slits approximately 100 nanometres wide and a single-electron detector to demonstrate the gradual statistical build-up of the interference pattern — confirming the inherently probabilistic and wave-like character of electron propagation. This landmark result showed beyond doubt that the interference arises from the wave nature of individual electrons, not from interaction between multiple particles.

Wave-particle duality was extended dramatically to mesoscopic molecules by Arndt et al. (1999), who demonstrated interference for buckminsterfullerene (C_{60}), and subsequently by Gerlich et al. (2011), who confirmed quantum interference for molecules comprising 430 atoms — a result stretching the boundary of the quantum-classical divide. Most recently, Fein et al. (2019) demonstrated matter-wave interference for molecules of up to 2,000 atoms, establishing new upper limits on the mass scale at which quantum superposition can be maintained.

The theoretical underpinning of wave-particle duality in the double-slit context has been rigorously formalised through the complementarity principle, first articulated by Bohr (1928) and subsequently developed in quantitative form by Englert (1996), whose duality relation $D^2 + V^2 \leq 1$ (where D is which-path distinguishability and V is interference visibility) provided a mathematically precise statement of the trade-off between particle and wave behaviour. A subsequent experimental confirmation by Schwindt et al. (1999) validated Englert's inequality in optical systems, and the relationship was further probed by Fedoseev et al. (2025), whose MIT experiment demonstrated it with atom-scale slit precision, confirming that it is the acquisition of quantum information — not mechanical disturbance — that governs the duality trade-off.

Taken together, these works establish wave-particle duality not as an interpretational posture but as an experimentally robust, mathematically constrained, and universally applicable fact of quantum physics — one that holds from single photons up to molecular assemblies of thousands of atoms.

2.2 Quantum Measurement and Observer-Induced Decoherence

The measurement problem — what happens when a quantum system interacts with an observing apparatus — is arguably the central unsolved conceptual problem of quantum mechanics, and the double-slit experiment is its paradigmatic illustration. The key question is not merely whether the interference pattern disappears when measurement occurs, but why, and through what physical mechanism.

The modern answer centres on decoherence: the entanglement of the quantum particle with its environment (including the measuring apparatus) destroys the phase coherence between the two path amplitudes, eliminating interference. Zurek (1991, 2003) developed the decoherence programme into a systematic framework, demonstrating that classicality emerges from quantum systems through their interaction with environmental degrees of freedom — a process that explains the quantum-to-classical transition without invoking consciousness or any special collapse postulate.

Kincaid, McLelland, and Zwolak (2016), in a study published in the American Journal of Physics and validated by the National Institute of Standards and Technology (NIST), presented a precisely solvable model of measurement-induced decoherence in a one-dimensional double-slit experiment. Their model demonstrated that the loss of interference is quantitatively correlated with the mutual information gained by the measuring apparatus — formalising the information-theoretic nature of the measurement problem in a form accessible to senior undergraduates.

Wang, Zhang, and Zou (2024), in a study published in AIP Advances, designed a revised double-slit experiment using metal nanoparticles as passive observing elements, aiming to probe wavefunction collapse while minimising direct instrumental involvement. Their results raised new questions about whether collapse is triggered by interaction with quantum-scale objects, not only macroscopic ones, opening a new line of enquiry into the boundary conditions of the observer effect.

Lemos et al. (2021), in Nature Scientific Reports, proposed and partially implemented a microscopic quantum model of dephasing and decoherence derived entirely from Schrodinger's equation, without supplementary collapse postulates. Their model showed that decoherence and collapse are recoverable from standard unitary evolution when the measuring apparatus is treated as a quantum system — lending formal support to the many-worlds and relational interpretations of quantum mechanics.

Samuel (2017), in a paper connecting gravity and decoherence, proposed double-slit variants in which gravitational effects (modelled via Unruh radiation in Rindler spacetime) generate decoherence — suggesting that the measurement problem may ultimately have a gravitational solution. This connects the double-slit experiment to the broader programme of quantum gravity research.

2.3 Quantum Entanglement and Non-Locality in Double-Slit Variants

Entanglement — the non-local quantum correlation between particles that Einstein famously dismissed as 'spooky action at a distance' — has been incorporated into double-slit variants in increasingly sophisticated ways, generating insights about the relationship between quantum information, spatial coherence, and measurement.

Gatti, Brambilla, and Lugiato (2003) demonstrated ghost imaging using entangled photon pairs, a phenomenon closely related to the double-slit in that interference arises from coincidence measurements on spatially separated photons. Their work connected the double-slit to the broader field of quantum imaging and showed that entanglement can produce non-local interference patterns.

Mandel (1999), in a landmark review published in Reviews of Modern Physics, systematically examined quantum effects in one-photon and two-photon interference, establishing the theoretical framework for understanding how entanglement modifies the standard double-slit results. His analysis remains a foundational reference for subsequent experimental work on multi-photon interference.

Devrari and Singh (2022), in a study published in Nature Scientific Reports, presented an experimental realisation of a quantum double-double-slit thought experiment with momentum-entangled photons. Their configuration was arranged so that each photon could, in principle, reveal the which-path information of its entangled partner, suppressing single-photon interference while allowing two-photon interference patterns to emerge only when detection locations were correlated without revealing path information — providing a definitive experimental test of complementarity in an entangled system.

In a further extension published in Scientific Reports (2024), Devrari and Singh demonstrated double-slit interference with reversible detection of entangled photons, where one photon was detected at a screen before its entangled partner had passed through the slits — probing the temporal and causal structure of quantum measurement and raising deep questions about the arrow of time in quantum information acquisition.

Aspect, Grangier, and Roger (1982) demonstrated violations of Bell's inequalities using entangled photon pairs — results which, though not performed in a double-slit configuration, directly constrain any hidden-variable account of the which-path problem and confirm the fundamentally non-local character of quantum correlations that underlie double-slit physics. Subsequent loophole-free tests by Hensen et al. (2015) closed the remaining experimental ambiguities, cementing non-locality as a confirmed feature of physical reality.

2.4 Macroscopic Quantum Coherence — Scaling Up Interference

One of the most actively contested questions in quantum physics concerns the scale at which quantum coherence — and therefore double-slit-type interference — gives way to classical behaviour. The boundary between quantum and classical is not merely a philosophical puzzle; it has direct experimental and technological consequences.

Gerlich et al. (2011) demonstrated quantum interference for molecules of 430 atoms using a Kapitza-Dirac-Talbot-Lau interferometer, a sophisticated extension of the double-slit principle to large, complex molecules. Their results pushed the confirmed mass frontier of quantum superposition dramatically upward and motivated theoretical reconsideration of decoherence models for large objects.

Fein et al. (2019), in a study published in Nature Physics, demonstrated quantum wave interference for molecules containing up to 2,000 atoms and masses of approximately 25,000 daltons — the largest objects for which de Broglie interference has been confirmed. Their experiment required cooling, precise collimation, and isolation from environmental decoherence to an extraordinary degree, demonstrating that macromolecular quantum coherence is physically achievable under controlled conditions.

At the opposite extreme of scale, the ALICE Collaboration at CERN (2024) reported an interference pattern analogous to the double-slit at the femtometer scale, arising from ultra-peripheral heavy-ion collisions at 5.02 teraelectronvolts. The two colliding nuclei acted as coherent sources, producing quantum-mechanically entangled decay products that generated an interference pattern across 57,000 recorded events — extending confirmed double-slit physics to the domain of nuclear structure and quark-gluon dynamics.

Tirole et al. (2023), in a landmark paper published in Nature Physics (Imperial College London and Monash University), recreated the double-slit experiment in the time domain rather than space, using a material whose optical properties could be switched within femtoseconds to create 'time slits'. Their results showed that light passing through these temporal apertures produced frequency-domain interference patterns entirely analogous to the spatial fringes of Young's experiment — opening a new dimension for quantum optics, photonic engineering, and potential applications in ultrafast signal processing.

Couder and Fort (2006) demonstrated a hydrodynamic analogue of single-particle double-slit interference using oil droplets bouncing on a vibrated fluid surface, generating an interference-like pattern in single-particle statistics. While subsequent analysis (Andersen et al., 2015) established that the droplet statistics differ fundamentally from quantum interference, the experiment catalysed renewed interest in pilot-wave accounts of quantum mechanics and in the boundary between wave-guided determinism and genuine quantum indeterminacy.

2.5 Technological and Civilisational Implications

The double-slit experiment is not merely a conceptual tool — its physical principles underpin a growing portfolio of transformative technologies. The superposition and interference phenomena it demonstrates are directly exploited in quantum computing, quantum communication, precision measurement, and materials science.

Nielsen and Chuang (2000), in Quantum Computation and Quantum Information — the canonical reference in the field — establish explicitly that the qubit's superposition behaviour, which enables quantum parallelism, is the same wave-like property demonstrated in the double-slit experiment. Every quantum algorithm, from Shor's factoring algorithm to Grover's search algorithm, exploits the constructive and destructive interference of quantum amplitudes that the double-slit first made observable.

Gisin et al. (2002) provided a comprehensive review of quantum cryptography, centred on quantum key distribution (QKD), which exploits the same measurement-induced collapse demonstrated in double-slit which-path experiments: any eavesdropper who intercepts a quantum-coded message disturbs the quantum state irreversibly, revealing their presence. This principle has been extended to satellite-based quantum communication by Liao et al. (2017), who demonstrated entanglement-based QKD between ground stations 1,200 kilometres apart using China's Micius satellite.

In metrology and sensing, LIGO — the Laser Interferometer Gravitational-Wave Observatory — employs a Michelson interferometer operating at the quantum limit of light, exploiting precisely the same wave interference principles as the double-slit to detect gravitational wave strains of order 10^-21, a sensitivity so extraordinary it requires active quantum noise management (Abbott et al., 2016). The detection of gravitational waves — one of the most significant scientific achievements of the twenty-first century — is, at its physical core, a double-slit-class interference measurement.

The time-domain double-slit results of Tirole et al. (2023) have direct implications for photonic computing and ultrafast signal processing. By demonstrating controllable interference in the frequency spectrum of light, their work opens the possibility of materials that can simultaneously manipulate electromagnetic signals in both space and time — a capability with transformative potential for telecommunications, optical computing, and the design of novel metamaterials.

Finally, Zeilinger (2010) and collaborators have argued that the double-slit experiment's demonstration of the physical reality of quantum information — its capacity to destroy or restore interference depending on what is known, not merely what physically happens — has profound implications for foundational physics, for the theory of consciousness, and for the relationship between information and physical reality. These arguments, developed through decades of increasingly precise quantum optics experiments, suggest that the double-slit experiment is not merely a probe of matter's behaviour, but of the nature of knowledge itself.

3. Methodology

This study employs a systematic qualitative document analysis methodology, situating itself within the tradition of integrative literature reviews as defined by Torraco (2005) and refined by Whittemore and Knafl (2005). The objective is not to generate new empirical data from a laboratory setting, but to synthesise, interpret, and critically evaluate the existing body of experimental and theoretical literature on the double-slit experiment with a view to mapping confirmed knowledge, identifying frontier developments, and projecting future implications.

3.1 Source Selection Criteria

Primary sources were selected from peer-reviewed journals including Physical Review Letters, Nature Physics, Nature Scientific Reports, AIP Advances, Reviews of Modern Physics, and the American Journal of Physics. Secondary sources include published experimental announcements from the Massachusetts Institute of Technology (MIT), Imperial College London, CERN ALICE Collaboration, and the National Institute of Standards and Technology (NIST). The search period prioritised publications from 2010 to 2025, with foundational references drawn from the historical literature (1800–2009) where essential for theoretical context.

Inclusion criteria required that each source: (a) addressed the double-slit experiment or a directly derivative experimental variant; (b) was published in a peer-reviewed venue or issued by a reputable research institution; and (c) contributed substantively to at least one of the five thematic clusters defined in the literature review. Sources were organised thematically rather than chronologically, allowing the synthesis to illuminate conceptual relationships across the literature.

3.2 Analytical Framework

The five themes — wave-particle duality, quantum measurement and decoherence, entanglement and non-locality, macroscopic coherence, and technological implications — were identified through an initial broad reading of the literature and subsequently validated against the principal research objectives of the paper. For each theme, sources were analysed for: (1) the experimental claims made and evidence presented; (2) the theoretical framework invoked; (3) points of consensus and ongoing dispute; and (4) the implications for future research and application.

Content from each source was coded according to these analytical dimensions, and thematic patterns were identified through a process of iterative comparison. Where multiple sources addressed the same experimental phenomenon, their findings were compared and any discrepancies noted. This process followed the interpretive synthesis method described by Dixon-Woods et al. (2005), which is particularly suited to bodies of literature that are diverse in method but convergent in subject matter.

4. Results and Discussion

The following section presents findings from the literature review organised by theme. For each theme, established results are distinguished from frontier findings, and implications for each research objective are addressed.

4.1 Wave-Particle Duality: Confirmed and Expanding

The literature confirms, without meaningful scientific dissent, that wave-particle duality is a universal property of quantum matter. Frabboni et al.'s (2012) single-electron interference results represent the definitive experimental closure of the foundational question — individual quantum particles produce interference patterns through their own wave nature. The subsequent extension to molecules of 2,000 atoms by Fein et al. (2019) establishes that quantum superposition is not confined to the subatomic domain but operates at scales approaching the nanometre range.

The frontier finding here is Fedoseev et al.'s (2025) MIT experiment, which clarified a century-old debate about Einstein's recoiling-slit thought experiment. Their results demonstrate that it is the quantum correlation between the particle and the slit — the information-theoretic entanglement — that destroys interference, not the mechanical recoil of the slit. This finding is conceptually significant: it confirms that wave-particle duality is an information phenomenon, not merely a mechanical one, with direct implications for how quantum measurement is understood across all experimental contexts.

For this journal's readership, the implication is that wave-particle duality is now understood not as a philosophical paradox but as a precisely constrained, mathematically formalised, and universally confirmed physical law — one that applies from the scale of individual photons to molecules approaching the boundary of biological chemistry.

4.2 Quantum Measurement and Decoherence: The Information-Collapse Connection

The literature on quantum measurement presents a coherent and increasingly precise picture: interference is destroyed not by the physical disturbance of a particle but by the entanglement of that particle with an information-gathering apparatus. Kincaid, McLelland, and Zwolak (2016) formalised this as a quantitative relationship between mutual information and interference visibility. Wang et al. (2024) extended it into a regime where the 'observer' is itself quantum-scale, probing the boundary of what constitutes a measurement.

These results together support a decoherence-based account of the quantum-to-classical transition (Zurek, 1991, 2003): classicality is not a fundamental feature of large objects but an emergent property of quantum systems that have become entangled with their environments to the point where their superpositions are effectively unobservable. This finding is of direct relevance to quantum computing, where maintaining coherence — preventing unwanted entanglement with the environment — is the principal engineering challenge.

The unresolved question is whether decoherence fully explains the measurement problem or whether a deeper account — including gravitational decoherence (Samuel, 2017) or spontaneous collapse models — is ultimately required. The double-slit experiment remains the central empirical arena in which these accounts will be tested.

4.3 Entanglement and Non-Locality: The Which-Path Problem Deepened

The entanglement-based extensions of the double-slit experiment reviewed in Theme 3 confirm that quantum non-locality — the capacity of entangled particles to exhibit correlated behaviour regardless of their spatial separation — is a confirmed, loophole-free feature of physical reality (Hensen et al., 2015). The double-double-slit results of Devrari and Singh (2022, 2024) operationalise this non-locality within the double-slit framework, demonstrating that which-path information about one photon can be carried by its entangled partner, suppressing interference — and that this suppression can be reversed by erasing the which-path information through coincidence measurements.

These results have direct implications for the design of quantum communication networks, where entanglement is the physical resource that enables quantum key distribution and quantum teleportation. They also deepen the conceptual puzzle of the double-slit experiment: in an entangled system, 'which path' information is not localised in any single region of space but distributed across a non-local quantum state — a fact that resists any intuitive classical account.

4.4 Macroscopic Quantum Coherence: A Frontier Without a Clear Boundary

The results reviewed under Theme 4 establish that the boundary between quantum and classical behaviour — if such a boundary exists — is much further toward the macroscopic than previously assumed. Fein et al.'s (2019) 2,000-atom molecules represent the current confirmed upper limit, but theoretical models suggest that with sufficient isolation from environmental decoherence, interference could in principle be demonstrated for even larger systems.

The CERN ALICE result (2024) is equally significant in the opposite direction: it confirms that double-slit-type coherence operates at the femtometer scale within the nuclear interior — a domain governed by quantum chromodynamics — suggesting that the interference phenomenon is not merely a low-energy curiosity but a fundamental feature of quantum field theory at all energy scales.

The time-domain double-slit (Tirole et al., 2023) represents perhaps the most conceptually novel extension: it demonstrates that the wave-interference principle is not inherently spatial but can operate in the time dimension, with the 'slits' being brief windows of optical transparency rather than apertures in a barrier. This finding expands the conceptual scope of the double-slit experiment and opens new avenues for research in temporal quantum optics and space-time metamaterials.

4.5 Technological Implications: From Thought Experiment to Civilisational Infrastructure

The review of Theme 5 confirms that the double-slit experiment is not merely of historical or conceptual interest but is the physical foundation of a growing portfolio of transformative technologies. Quantum computing, as systematically presented by Nielsen and Chuang (2000), exploits interference of quantum amplitudes as its fundamental computational mechanism. Current quantum processors, including those developed by IBM, Google, and D-Wave, are physical implementations of this principle.

Quantum communication, as reviewed by Gisin et al. (2002) and experimentally demonstrated at satellite scale by Liao et al. (2017), exploits the measurement-collapse principle of the double-slit experiment — the irreversible disturbance of quantum states upon observation — to achieve provably secure communication. The gravitational wave detections reported by Abbott et al. (2016) demonstrate that interferometric precision at the quantum limit has already yielded a major scientific discovery, opening a new observational window on the universe.

Looking further ahead, the time-domain results of Tirole et al. (2023) suggest that double-slit physics will inform the design of next-generation optical materials capable of manipulating electromagnetic signals in both space and time simultaneously — materials of potential importance for 6G telecommunications, photonic AI hardware, and ultrafast sensing systems.

4.6 Discussion

Taken in aggregate, the literature reviewed across five themes presents a consistent and convergent picture: the double-slit experiment has, over two centuries, transformed from a demonstration of light's wave nature into the empirical ground zero of quantum mechanics, and it continues to generate paradigm-level discoveries in the third decade of the twenty-first century.

Three overarching tensions in the literature merit explicit discussion. First, the tension between the completeness of quantum mechanics and the incompleteness of its interpretation: while every experimental prediction of quantum theory has been confirmed to extraordinary precision, there is no consensus on what quantum mechanics means — what the wave function describes, what 'measurement' fundamentally is, and whether the universe branches, collapses, guides, or merely correlates. The most recent experiments (Fedoseev et al., 2025; Tirole et al., 2023; Devrari & Singh, 2024) constrain but do not resolve these interpretational disputes.

Second, the tension between the quantum and classical domains — where exactly does the interference disappear, and why? The progressive extension of confirmed quantum interference from electrons to 2,000-atom molecules, and the simultaneous probe of nuclear-scale coherence at CERN, suggests that the quantum-classical boundary is not a sharp line but a gradient determined by the degree of environmental entanglement. Decoherence theory provides the leading account, but gravity-induced collapse models and spontaneous localisation theories remain viable alternatives awaiting more decisive experimental discrimination.

Third, the tension between the fundamental and the applied: as quantum technologies mature, the conceptual puzzles of the double-slit experiment increasingly have engineering consequences. The fidelity of a quantum computer depends on maintaining the interference of quantum amplitudes against decoherence — precisely the challenge formalised in the double-slit measurement problem. The security of quantum communication rests on the same collapse principle that mystified Einstein. The civilisational stakes of resolving these tensions are therefore not merely philosophical.

5. Conclusion

This paper has reviewed two centuries of research on the double-slit experiment, with emphasis on frontier developments from 2010 to 2025, organised into five thematic pillars. The following conclusions are drawn in response to the paper's research objectives:

First, wave-particle duality has been confirmed as a universal, precisely quantified, and information-theoretic principle of quantum physics, holding from single photons to molecular assemblies of 2,000 atoms. Second, observer-induced decoherence has been established as the physical mechanism through which measurement destroys interference, with the mutual information acquired by the observing apparatus serving as the controlling parameter. Third, quantum entanglement and non-locality extend the double-slit's conceptual reach to non-local quantum correlations that defy any classical, local account of physical reality. Fourth, macroscopic quantum coherence has been confirmed across an extraordinary range of scales — from 2,000-atom molecules to femtometer nuclear structure — and in a new experimental dimension: time. Fifth, the technologies built on double-slit physics — quantum computing, quantum cryptography, gravitational-wave interferometry, and temporal metamaterials — represent some of the most consequential scientific infrastructure of the twenty-first century.

The double-slit experiment is not a solved problem. It is an open question that has progressively revealed deeper layers of physical reality with each new experimental iteration. As 2025 marks the centenary of quantum mechanics, the most honest assessment available is also the most exciting: the strangeness observed by Young in 1801 has not been explained away — it has been confirmed, extended, and weaponised into technology, while the deepest question it poses — what does the universe do when no one is looking? — remains, exhilaratingly, open.

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