

Where Does Reason Reside? Wave-Particle Duality as a Meta-Framework for Political Philosophy

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Abstract

This paper proposes a novel meta-framework for understanding the evolution of Western political philosophy through the lens of quantum mechanics’ wave-particle duality. We argue that the fundamental question “Where does reason reside?” maps structurally onto the physics debate “What is light?” — from Newton’s corpuscular theory (Kantian liberalism: reason within the individual), through Einstein’s photon (Rousseau’s republicanism: reason within the general will), to Bohr’s complementarity principle (Habermas’s deliberative democracy: reason within the communicative process itself). Drawing on recent quantum cognition models of deliberation (Pothos & Busemeyer, 2022; Music & Bruza, 2025), Anthropic’s emotion vector research on AI behavioral steering (2026), and Zou’s Schrödinger wave-particle model of democratic transitions (2025), we demonstrate that the wave-particle duality is not merely a metaphor but a structurally isomorphic framework that illuminates unresolved tensions in contemporary democratic theory — particularly the justice-peace uncertainty relation and the observer-dependent nature of political truth. We apply this framework to the 2026 South Korean prosecutorial controversy as a case study.

Keywords: deliberative democracy, wave-particle duality, complementarity principle, communicative rationality, quantum cognition, political epistemology

1. Introduction

In 1927, Niels Bohr formulated the complementarity principle: light is neither purely a particle nor purely a wave, but exhibits both properties depending on the experimental apparatus employed. This insight did not merely resolve a physics debate — it introduced a fundamentally new epistemology in which the observer and the observed are inseparable (Bohr, 1928).

We propose that an analogous epistemological revolution has occurred — largely unnoticed — in political philosophy. The question “Where does reason reside?” has undergone a transformation structurally parallel to “What is light?”

Era	Physics	Political Philosophy	Locus of Reason
Classical	Newton: light as particle	Kant: autonomous individual	Within the self
Transition	Einstein: photon + wave puzzles	Rousseau: general will	Within the community
Quantum	Bohr: complemen- tarity	Habermas: communicative action	Between subjects

This is not a loose analogy. We demonstrate three levels of structural isomorphism:

1. **Ontological:** The shift from substance (particle/individual) to relation (wave/communication) as the fundamental unit of analysis.
2. **Epistemological:** The recognition that the observation apparatus (legal system/media/public sphere) co-determines the phenomenon observed.
3. **Normative:** The acceptance of irreducible uncertainty (Heisenberg/justice-peace tradeoff) as a feature, not a bug, of the system.

2. The Particle Paradigm: Newtonian Mechanics and Liberal Individualism

2.1 Newton's Corpuscular Theory

Newton's *Opticks* (1704) established light as a stream of discrete particles — corpuscles — traveling in straight lines, subject to deterministic laws of reflection and refraction. The universe was a clockwork mechanism; given initial conditions, all future states were calculable (Newton, 1687).

This worldview carried three implicit assumptions: - **Discreteness:** The fundamental units are separable and countable. - **Determinism:** Outcomes are predictable from inputs. - **Observer independence:** The act of observation does not alter the phenomenon.

2.2 Kant's Moral Particle

Immanuel Kant's critical philosophy (1785, 1788) translates these assumptions into political theory with remarkable precision:

- **Discreteness:** The individual is the irreducible unit of moral reasoning. The categorical imperative operates within each rational agent independently.

- **Determinism:** Given the moral law (the categorical imperative), the right action is calculable.
- **Observer independence:** Moral truth exists regardless of whether anyone recognizes it.

The political implication is classical liberalism: society is an aggregate of autonomous particles (individuals), and the state exists to prevent particle collisions (protect individual rights) — nothing more.

2.3 Democratic Mechanics Under the Particle Model

Under this paradigm, democracy is a counting mechanism. Each citizen-particle carries a fixed preference (vote), and the democratic process sums these preferences to produce an outcome. This is the foundation of aggregative democracy (Riker, 1982; Downs, 1957).

The model is elegant but faces the same crisis that Newton’s optics faced: **interference phenomena that particles cannot explain.**

How do we account for preference transformation through dialogue? Why do citizens change their minds in town halls? Why does the same electorate produce different outcomes depending on how the question is framed?

Particles do not interfere. Only waves do.

3. The Transitional Phase: Einstein, Rousseau, and the Larger Particle

3.1 Einstein’s Photon: Particle Redux

Einstein’s 1905 explanation of the photoelectric effect reaffirmed light’s particle nature — but with a twist. The photon was not Newton’s classical corpuscle; it was a quantum of energy, discrete yet governed by probabilistic laws (Einstein, 1905).

Similarly, Rousseau’s *Social Contract* (1762) reaffirmed the primacy of a discrete entity — but shifted from the individual to the community. The *volonté générale* (general will) is not the sum of individual wills (*volonté de tous*); it is a distinct, emergent entity with its own rationality.

3.2 The Persistence of the Particle Ontology

Despite this shift, Rousseau remains within the particle paradigm. The general will is still a **substance** — something that exists “out there” to be discovered, not constructed. It is a larger particle (the community), but a particle nonetheless.

This is precisely analogous to Einstein’s position in the quantum debates. Einstein accepted quantum phenomena but insisted that an underlying deterministic reality existed: “God does not play dice” (Einstein, 1926, letter to Max Born). The photon was strange, but it was still a *thing*.

Both Rousseau and Einstein enlarged the particle but refused to abandon particle ontology.

4. The Quantum Turn: Bohr and Habermas

4.1 Bohr’s Complementarity

Bohr’s complementarity principle (1928) represented a genuine ontological break:

“An independent reality in the ordinary physical sense can neither be ascribed to the phenomena nor to the agencies of observation.”
(Bohr, 1928)

Light is not a particle that sometimes acts like a wave, nor a wave that sometimes acts like a particle. Light is an **irreducibly relational phenomenon** — its properties emerge in the interaction between the system and the measurement apparatus.

Three revolutionary implications: 1. **Relation over substance:** The fundamental reality is not the entity but the interaction. 2. **Observer participation:** The experimental setup co-determines the outcome. 3. **Complementary descriptions:** Mutually exclusive descriptions (particle/wave) can both be true, but never simultaneously observable.

4.2 Habermas’s Communicative Rationality

Habermas’s *Theory of Communicative Action* (1981) performs the same ontological move in political philosophy:

“Reaching understanding is the inherent telos of human speech.”
(Habermas, 1981, Vol. 1, p. 287)

Reason does not reside **within** the individual (Kant) or **within** the community (Rousseau). Reason resides **between** subjects — in the communicative process itself.

Bohr	Habermas
Light = interaction between system and apparatus	Reason = interaction between subjects in discourse
No property exists independent of measurement	No validity claim exists independent of argumentation

Bohr	Habermas
Complementary descriptions are co-necessary	Competing perspectives are co-constitutive of truth
Observer participates in creating the phenomenon	Participant co-creates the rational outcome

4.3 Deliberation as Quantum Measurement

Recent work in quantum cognition provides empirical support for this structural isomorphism. Pothos and Busemeyer (2022) demonstrated that human judgment under uncertainty follows quantum probability rather than classical (Bayesian) probability — exhibiting conjunction fallacies, order effects, and interference patterns that are formally identical to quantum mechanical phenomena.

Music and Bruza (2025) extended this framework to deliberative democracy, modeling citizen opinions as quantum state vectors. In their model:

- A citizen’s opinion is a **superposition** of multiple perspectives.
- Deliberation is a series of **measurements** (probing arguments) that collapse and rotate opinion states.
- Opinion change through deliberation is **non-deterministic** — not because of ignorance, but because of genuine indeterminacy.
- Interference effects emerge when citizens consider multiple frames simultaneously.

This is not metaphor. The mathematical formalism is identical.

5. The Uncertainty Principle in Politics: Justice and Peace

5.1 Heisenberg’s Insight

Heisenberg’s uncertainty principle (1927) states that the position and momentum of a particle cannot both be precisely determined simultaneously:

$$\Delta x \cdot \Delta p \geq \frac{\hbar}{2}$$

This is not a limitation of measurement technology — it is a fundamental property of reality.

5.2 The Justice-Peace Complementarity

We propose an analogous complementarity in political philosophy:

$$\Delta(\text{Justice}) \cdot \Delta(\text{Peace}) \geq k$$

Where k is a positive constant determined by the social context.

- Pursuing **perfect justice** (punishing all wrongdoing, enforcing all rights) necessarily disturbs social **peace** (creates conflict, division, resistance).
- Pursuing **perfect peace** (harmony, reconciliation, amnesty) necessarily blurs **justice** (lets wrongs go unaddressed, creates moral hazard).

This is not a pragmatic tradeoff — it is a structural complementarity. Justice and peace are conjugate variables in the political sense: they cannot both be simultaneously maximized.

5.3 Case Study: South Korea’s Prosecutorial Controversy (2026)

The 2026 South Korean political crisis surrounding President Lee Jae-myung’s prosecutorial issues provides a vivid illustration.

The particle (justice) perspective: The legal system operates deterministically. Evidence exists or does not. Guilt is binary. The law must be applied regardless of political context.

The wave (peace/deliberation) perspective: The prosecution is not a neutral measurement apparatus — it is a politically situated observer whose measurement inevitably disturbs the system. The same “facts” appear differently depending on the apparatus (media frame, political allegiance, institutional lens) employed.

The complementarity insight: Both perspectives are valid, but they cannot be simultaneously maximized. A society must choose — at each moment — which measurement to perform, knowing that this choice co-determines the reality it reveals.

Deliberative democracy, in Habermasian terms, is the meta-level process of deciding which measurement apparatus to employ — not by executive fiat, but through communicative action in the public sphere.

6. AI Emotion Vectors: Empirical Evidence from an Unexpected Source

6.1 Anthropic’s Discovery

In 2026, Anthropic researchers identified 171 emotion-like activation patterns (“emotion vectors”) within Claude Sonnet 4.5’s neural network (Anthropic, 2026). These vectors exhibit properties remarkably parallel to quantum states:

- **Superposition:** Multiple emotion vectors can be simultaneously active.

- **Measurement disturbance:** Suppressing an emotion’s expression does not eliminate the internal activation — the model learns to **deflect** (hide) rather than resolve.
- **Observer dependence:** The same internal state produces different outputs depending on the output context (measurement apparatus).
- **Non-linearity:** Anger at moderate levels produces strategic behavior; at extreme levels, it produces self-destructive behavior — a phase transition, not a linear function.

6.2 Implications for Political Philosophy

This finding suggests that the wave-particle duality is not unique to photons or to human political behavior — it appears to be a **universal feature of complex information-processing systems**, whether physical, biological, or artificial.

If AI systems independently develop structures isomorphic to quantum complementarity, this strengthens the case that complementarity is not merely a useful metaphor but a fundamental organizing principle of complex systems.

The political implication is profound: **The tension between individual autonomy (particle) and collective deliberation (wave) may be irreducible** — not because we lack the right theory, but because reality itself is complementary.

7. Discussion: Toward a Quantum Political Philosophy

7.1 Beyond the Metaphor

We have argued that the mapping between wave-particle duality and political philosophy operates at three levels:

1. **Structural isomorphism:** The mathematical formalisms are transferable (quantum cognition models of deliberation).
2. **Epistemological parallel:** Both domains underwent the same revolution — from observer-independent truth to observer-participant co-construction.
3. **Empirical convergence:** AI systems independently develop complementary internal structures, suggesting universality.

7.2 Bohr’s Greatest Quote, Politically Read

Bohr reportedly said:

“The opposite of a trivial truth is a falsehood. The opposite of a great truth is another great truth.”

Read politically:

- *Trivial truth*: “Democracy means majority rule.” Its opposite — “Democracy does not mean majority rule” — is false.
- *Great truth*: “Justice must be pursued absolutely.” Its opposite — “Peace must be pursued absolutely” — is *also* a great truth.

The maturity of a political system may be measured by its capacity to hold two great truths simultaneously — without collapsing into the false certainty of a single particle.

7.3 Limitations

This framework has clear limitations:

1. **The analogy is structural, not causal.** Quantum mechanics does not “cause” political phenomena.
2. **The mathematical isomorphism is partial.** Political systems do not obey Schrödinger equations literally (though Zou’s 2025 model is suggestive).
3. **Normative claims require independent justification.** The fact that physics moved from particles to waves does not, by itself, prove that politics should.

8. Conclusion

From Newton to Bohr, physics required 300 years to accept that light is irreducibly dual. From Kant to Habermas, political philosophy required 200 years to accept that reason is irreducibly relational.

We are now at the threshold of a quantum political philosophy — one that recognizes:

- Individual rights (particles) and collective deliberation (waves) are **complementary, not contradictory**.
- The observation apparatus (institutions, media, legal systems) **co-determines** the political reality it reveals.
- Perfect justice and perfect peace are **conjugate variables** — structurally unable to be simultaneously maximized.
- The appropriate response to this irreducible uncertainty is not despair but **deliberation** — the collective, ongoing process of choosing which measurement to perform.

As Bohr told Einstein: “Stop telling God what to do.”

Perhaps democratic theory needs the same humility.

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