

# **2025: Quantum Physics' Centenary & 150 Years of Arya Samaj**

## **The Vedic Epistemological Perspective : A Comparative Study**

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### **Introduction**

2025 marks twin milestones in humanity's intellectual journey: the 100<sup>th</sup> anniversary of quantum physics' formal establishment through Werner Heisenberg's matrix mechanics, and the 150<sup>th</sup> year of the Arya Samaj movement founded by Swami Dayanand Saraswati. This convergence is profoundly significant - while quantum physics revolutionised our understanding of the material universe, the Arya Samaj revived the rational, scientific foundations of Vedic knowledge systems.

At their core, both revolutions shared a common epistemological approach - what Dayanand termed *Yukti-vicār* (rational inquiry). The quantum pioneers - Einstein, Bohr, Heisenberg, Schrödinger, and Bose - employed methods strikingly similar to the *pramāṇa* (means of knowledge) systematised in Nyāya philosophy. *This article explores these parallels, revealing how Vedic epistemology not only anticipated but conceptually framed the scientific methods that gave birth to quantum theory.*

### **Keywords**

Quantum Physics Epistemology; Vedic Epistemology; Pramāṇa; History of Quantum Mechanics; *Yukti-vicār*; Science and Religion; Comparative Philosophy; Nyāya Philosophy; Philosophy of Science; Matrix Mechanics; Bose-Einstein Statistics; Albert Einstein; Niels Bohr; Satyendra Nath Bose

### **2025: 100 Years of Quantum Physics & 150 Year Anniversary of the Arya Samaj Movement**

The year 1925 witnessed Werner Heisenberg's formulation of matrix mechanics, the first complete mathematical framework of quantum theory. This breakthrough, complemented by Schrödinger's wave mechanics the following year, marked the culmination of a quarter-century of quantum discoveries beginning with Planck's quantum hypothesis (1900) and Einstein's photon theory (1905).

Remarkably, this scientific revolution coincided with the global spread of the Arya Samaj, founded in 1875. Dayanand's mission to restore the Vedic tradition's scientific temper through Yukti-vicār (evidence-based reasoning) mirrored the quantum physicists' rejection of classical dogma. Both movements represented a return to first principles - for physicists, this meant re-examining fundamental concepts of space, time and causality; for the Arya Samaj, it meant rediscovering the Vedic worldview through rational inquiry rather than blind tradition.

### Matrix Mechanics - Simple Definition & Overview

Matrix mechanics, developed by Werner Heisenberg in 1925, was the first formal theory of quantum physics. Breaking radically from classical physics' continuous variables, Heisenberg represented physical quantities as matrices (grids of numbers), whose non-commutative algebra, encoded quantum jumps between discrete states.

This abstract approach, while mathematically rigorous, departed from visualisable models. Significantly, it aligned with Nyāya's emphasis on parokṣa (indirect knowledge) - recognising that quantum reality could only be known through its observable effects, not direct perception. Heisenberg's focus on measurable quantities (inspired by Einstein) echoed Nyāya's pramāṇa epistemology, where valid knowledge requires systematic verification.

### Definitive Parallels: Einstein & Bohr vs. Vedic Darśanas

The Einstein-Bohr debates encapsulated quantum theory's philosophical core, mirroring ancient discourses between Vedic darśanas:

#### 1. Einstein ↔ Nyāya-Vaiśeṣika Realism

Einstein's insistence on an objective, observer-independent reality reflected Nyāya's pramāṇavāda (theory of valid knowledge). His rejection of quantum randomness ("God does not play dice") paralleled Vaiśeṣika's atomic determinism (paramāṇuvāda).

#### 2. Bohr ↔ Advaitic Non-Dualism

Bohr's complementarity principle - that quantum entities exhibit wave-particle duality depending on measurement - recalled Advaita's māyāvāda, where reality's nature depends on the observer's state.

### Einstein: The Unshakable Bedrock of Quantum Physics

Though famous for relativity, Einstein's contributions to quantum theory were foundational:

1. **Photoelectric Effect (1905):** Proved light's quantum nature, earning the 1921 Nobel Prize
2. **Wave-Particle Duality:** His photon theory forced physics to accept paradoxical dualities
3. **Stimulated Emission:** Theoretical basis for lasers (quantum technology's backbone)
4. **Bose-Einstein Statistics:** Enabled understanding of fundamental particles

Einstein's epistemological approach mirrored Nyāya's emphasis on pratyakṣa (direct

observation) and anumāna (systematic inference). His famous thought experiments were modern equivalents of Nyāya's tarka (dialectical reasoning).

### **Satyendra Nath Bose: The Quantum Pioneer Who Rewrote Physics**

S.N. Bose's 1924 paper deriving Planck's law through quantum statistics revolutionised physics:

- **Bose-Einstein Statistics:** Governed fundamental particles later called "bosons"
- **Bose-Einstein Condensate:** Predicted a new state of matter (confirmed in 1995)
- **Legacy:** Foundation for quantum field theory, Higgs mechanism, and modern particle physics

Bose's breakthrough exemplified Yukti-vicār - applying rigorous logic to empirical data. His derivation, initially rejected by journals, gained recognition only after Einstein's endorsement, showing how Vedic epistemology's emphasis on āpta-vākya (expert testimony) remains relevant in modern science.

### **Einstein's Epistemology & Nyāya's Pramāṇa: A Parallel in Rational Inquiry**

The development of modern physics, particularly through Albert Einstein's revolutionary work, reveals a fascinating parallel with the ancient Indian system of logic and epistemology known as Nyāya. At the heart of both approaches lies a rigorous commitment to rational inquiry—Einstein through his scientific methodology, and Nyāya through its system of pramāṇa (valid means of knowledge). This alignment is not merely coincidental but points to a universal framework for discovering truth, whether in ancient philosophy or cutting-edge physics.

#### **1. Pratyakṣa (Perception): The Role of Empirical Observation**

Einstein's work was deeply rooted in empirical evidence. His fascination with anomalies—phenomena that defied classical explanations—drove his theoretical breakthroughs. A prime example is the Michelson-Morley experiment (1887), which failed to detect the "luminiferous ether," a hypothetical medium thought necessary for light waves to propagate. While most physicists tried to salvage the ether theory with increasingly convoluted explanations, Einstein took the experimental result at face value. Instead of forcing reality to fit existing theories, he built a new framework—special relativity—that aligned with what was actually observed.

This approach mirrors Nyāya's emphasis on pratyakṣa, or direct perception, as the foundation of knowledge. Just as Nyāya philosophers insisted that valid knowledge must be grounded in observable reality, Einstein's physics always returned to measurable phenomena. His famous dictum—"Theories should be as simple as possible, but not simpler"—reflects this empirical rigor.

#### **2. Anumāna (Inference): From Principles to Predictions**

Einstein did not rely solely on observation; he also employed powerful deductive reasoning. His 1905 paper on special relativity began not with experimental data but with two postulates:

1. The laws of physics are the same in all inertial frames (no "privileged" reference frame).
2. The speed of light is constant, regardless of the observer's motion.

From these principles, he inferred revolutionary consequences—time dilation, length contraction, and the equivalence of mass and energy ( $E=mc^2$ ). This method of working from axioms to logical conclusions is strikingly similar to Nyāya's anumāna, where knowledge is derived through systematic inference.

### 3. Upamāna (Analogy): Thought Experiments as Tools

Einstein was a master of the "thought experiment"—a hypothetical scenario used to explore theoretical implications. His most famous example involved imagining himself chasing a beam of light. Classical physics suggested he should see a stationary wave, but Maxwell's equations forbade it. This contradiction led him to special relativity.

Similarly, Nyāya philosophers used analogies (upamāna) to clarify complex ideas. Just as Einstein's light-beam scenario made relativity more intuitive, Nyāya thinkers employed relatable comparisons to explain abstract concepts. Both methods reveal how analogical reasoning bridges the gap between theory and understanding.

### 4. Arthāpatti (Postulation): Bold Conceptual Leaps

Perhaps Einstein's greatest strength was his willingness to introduce radical new concepts when existing theories failed. His general theory of relativity (1915) redefined gravity not as a force but as the curvature of spacetime—a geometric property of the universe itself. This was not incremental progress but a complete reimagining of physics.

Nyāya's arthāpatti—the method of postulating necessary explanations—operates similarly. When observed facts cannot be reconciled with current knowledge, new principles must be introduced. Einstein's spacetime curvature was precisely such a postulation, one that resolved anomalies (like Mercury's orbit) while making new, testable predictions (e.g., light bending around the sun).

### 5. Anupalabdhi (Non-Apprehension): The Limits of Knowledge

Einstein's critique of quantum mechanics—the EPR paradox (1935)—highlighted what he saw as the theory's incompleteness. He argued that quantum entanglement implied either "spooky action at a distance" (which he rejected) or hidden variables not yet discovered. His insistence on identifying the boundaries of knowledge aligns with Nyāya's anupalabdhi, which recognises absence as a form of valid knowledge.

### Schrödinger & Heisenberg: Quantum Mechanics Through the Lens of Pramāṇa

The two founders of quantum mechanics, Erwin Schrödinger and Werner Heisenberg adopted complementary approaches that further reflect Nyāya epistemology.

#### Schrödinger's Wave Mechanics: Pratyakṣa and Upamāna

Schrödinger's wave equation (1926) described electrons as standing waves, a visualisable

model rooted in mathematical elegance. This emphasis on direct conceptualisation aligns with *pratyakṣa*—knowledge through perceptual models. His famous "Schrödinger's cat" thought experiment, meanwhile, used analogy (*upamāna*) to expose the paradoxes of quantum superposition, making abstract theory tangible.

### **Heisenberg's Matrix Mechanics: Anumāna and Arthāpatti**

Heisenberg, in contrast, focused strictly on measurable quantities (like spectral lines) rather than visual models. His matrix mechanics treated observable data as primary, inferring underlying rules (*anumāna*). His Uncertainty Principle (1927) then postulated a fundamental limit to knowledge (*arthāpatti*)—a bold acknowledgment that some quantum properties cannot be simultaneously known with precision.

### **Conclusion: A Universal Epistemology**

As we commemorate these twin anniversaries in 2025, we recognise a profound truth: the quantum revolution's epistemological foundations were prefigured in Vedic thought. From Einstein's realism echoing *Nyāya* to Bohr's non-duality reflecting *Advaita*, modern physics has unconsciously mirrored ancient Indian wisdom.

The Arya Samaj's 150-year mission to revive Vedic science through *Yukti-vicār* finds unexpected validation in quantum theory's development. This convergence suggests that the Vedic epistemological framework - with its balanced emphasis on observation, logic and authoritative testimony - remains remarkably relevant for scientific inquiry.

In honouring these milestones, we celebrate not just particular discoveries, but the enduring human quest for knowledge through rational means - a quest that transcends cultures and centuries, uniting the ancient *ṛiṣi*s and seers, and modern physicists in a shared journey toward truth.