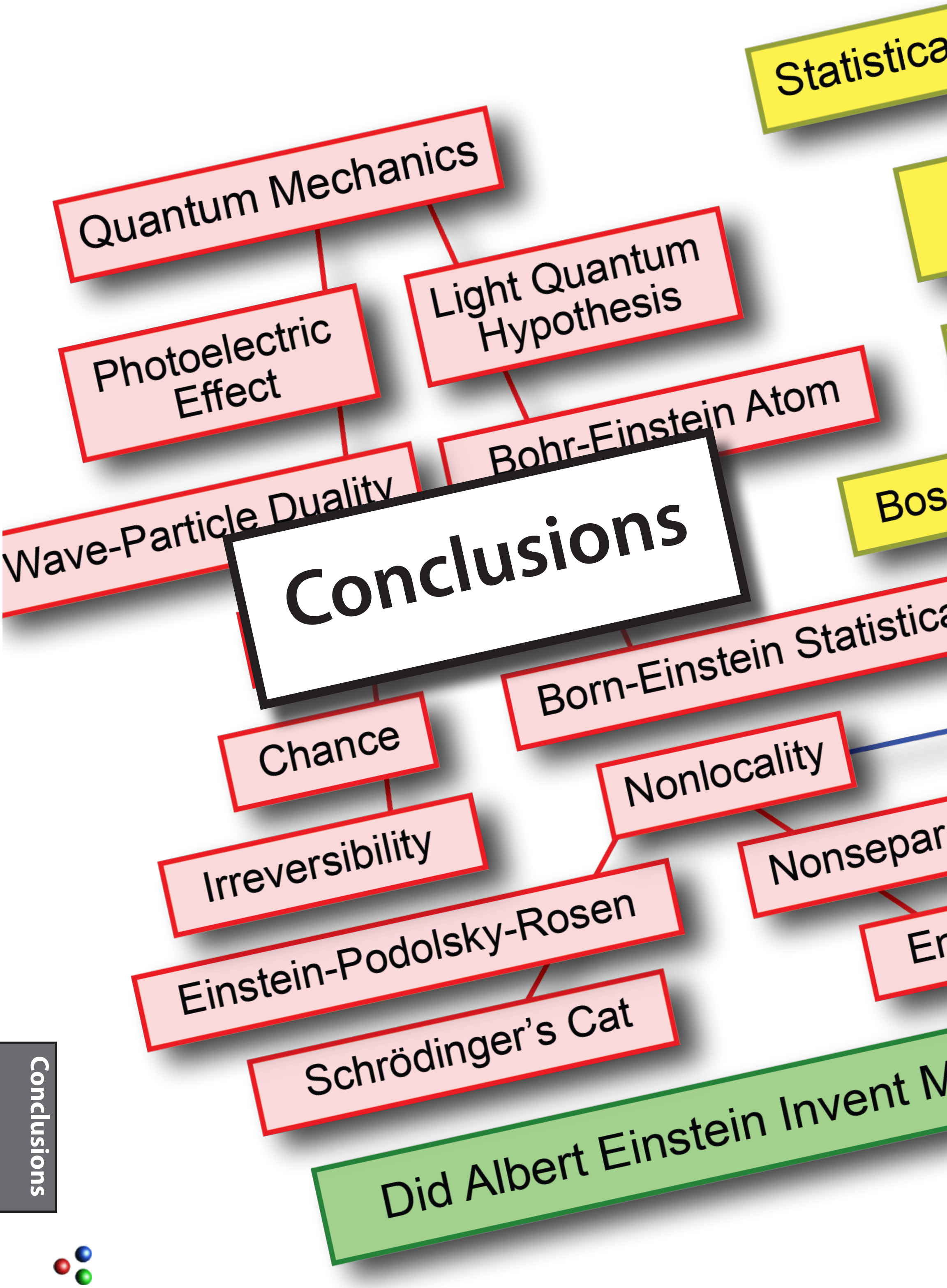
Quantum Mechanics
Photoelectric Effect
Light Quantum Hypothesis
Bohr-Einstein Atom
Wave-Particle Duality
Conclusions
Chance
Irreversibility
Nonlocality
Einstein-Podolsky-Rosen
Schrödinger's Cat

Conclusions

★ Arrow of Time

The fundamental arrow of time is the expansion of the universe. All other arrows - entropy increase, information creation, outgoing waves of radiation - are derivative or impossible without the increase of the distance between particles that produces more h^3 cells in phase-space.

★ Collapse of the Wave Function

Since the wave function is an *immaterial* mathematical expression that depends only on the material boundary conditions and the wavelength of hypothetical particles, it does not change when a particle is detected.

The word "collapse," with its implied movement of something material falling together, is simply inappropriate, showing why we need to get "beyond language" in the philosophy of science.

When there is a quantum jump between eigenstates, between energy levels in an atom, for example, the eigenfunctions and their eigenvalues of the atom do not change, being solutions of the Schrödinger equation in the potential field of the nucleus.

Only the occupation numbers of different states change.

★ Conscious Observers Not Needed

Information must be recorded *irreversibly* before any observer can know the results of a measurement. Data recorded (ontologically) by an instrument creates new information in the universe.

We might say that information becomes known (epistemic) when it is recorded as an experience in a human mind. But most new information created is the universe *observing itself*.

★ Decoherence

Doherentists think the unitary, continuous, and deterministic time evolution of the Schrödinger equation means there are no particles and no quantum jumps. They are wrong.

★ Entanglement

Conservation principles require that entangled particles do not change their fundamental properties – energy, momentum, angular momentum, and spin – while they travel from creation in the center and with no external interactions to their symmetric and sychronized detections by "Alice" and "Bob."

While there might not be Bohmian "hidden variables," the conserved quantities might be called "hidden constants" that explain the *appearance* of Einstein's "spooky action-at-a-distance."

★ Measurement Problem

John von Neumann saw a logical problem with two distinct (indeed, opposing) processes, the unitary, continuous, and deterministic time evolution of the Schrödinger equation versus the non-unitary, discontinuous, and indeterministic "collapse of the wave function." This shows why we need to get "beyond logic" in the philosophy of science.

★ Microscopic Irreversibility

The assumption that particle collisions are reversible fails when the quantum-mechanical interaction with radiation or changes (jumps) in internal quantum structure are taken into account.

★ Nonlocality

Einstein's insight into nonlocal behavior, from 1905 to 1935, was because he assumed the light wave is in some way "ponderable." Schrödinger thought a wave is distributed energy or electricity.

★ Objective Reality

We can answer Einstein's question about whether particles have paths affirmatively. Just because we cannot observe or know anything about the paths does not mean they do not exist.

★ Particles Are Primary, Fields Derivative

A field is immaterial information that predicts continuous values for all space and time. The field depends on the positions of discrete discontinuous localized particles of matter and energy.

★ Quantum-to-Classical Transition

The emergence of classical laws and apparent deterministic causality occurs whenever the number of particles grows large. And Bohr's "correspondence principle" claims it occurs when quantum numbers are large.

★ **Recurrence Paradox**

The recurrence of original, low entropy states is prevented by the expansion of the universe.

★ **Schrödinger's Cat**

We never observe a cat simultaneously dead and alive. What exists are only *probabilities* for the cat being dead *or* alive.

★ **Space and Time Are *Immaterial* Information**

Space and time have no substantial materiality. Scientists project arbitrary coordinate systems onto them as the basis for partial differential equations that predict values with mathematically infinite precision.

Einstein suspected correctly that finite algebraic equations decribing quantum integer *differences* might be all that is needed.

★ **Two-Slit Experiment**

Interference patterns are solutions to the Schrödinger equation determined by the boundary conditions of the experiment and the wavelength of incoming particles.

Probabilities for future particles do not change when a particle is detected. That particle's probability of being found elsewehere is now zero. But nothing collapses in the sense of moving together.

★ **Wave-Particle Duality**

Particles are discrete discontinuous localized quanta of matter or energy. Waves are solutions to the Schrödinger equation that provide the probabilities for finding particles in a given quantum state.

Wave functions are continuous and evolve deterministically. Particles are discontinuous and change their quantum states indeterministically.

★ **What Is Quantized Is Action!**

Whether it is the product of momentum and position in the uncertainty principle, the product of energy and time, or just the angular momentum, all interactions of radiation and matter involve at least at one unit of Planck's quantum of action h (or $\hbar$, the rationalized $h/2\pi$ called *h-bar*).