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Einstein's revolutionary ideas

Richard Oldani

Abstract

Einstein published four papers in 1905 that revolutionized our understanding of the fundamental concepts of space, time, mass, and energy. We draw attention here to an idea in one of the 1905 papers that revolutionizes our understanding of quantum mechanics, but its significance was never understood. We use it to derive classical interpretations of matrix and wave mechanics, resolve the "collapse" problem, and demonstrate that the standard model is deficient in its physical interpretation of Nature.

1. Introduction

A brief search on the internet reveals that public opinion is solidly opposed to Einstein's views on quantum mechanics. Although Einstein could not say why he rejected the final form that quantum mechanics took, no one was able to convince him that he was wrong either. The disagreement remains at an impasse to this day. To resolve the dispute we compare Einstein's unfinished quantum theory developed during the 12 year period 1905 – 1917 to non-relativistic theories developed from 1926 to the present. The passages that most clearly illustrate his ideas are highlighted.

2. A review of Einstein's unfinished quantum theory

2.1 "On a heuristic point of view concerning the production and transformation of light" *Ann Phys* 17 (1905) 132- 148.

"For the time being, we disregard the radiation emitted and absorbed by the resonators and look for the condition for dynamic equilibrium corresponding to the interaction (collisions) of molecules and electrons. For such an equilibrium, the kinetic theory of gases provides the condition that **the mean kinetic energy of a resonator electron must be equal to the mean kinetic energy of the progressive motion of a gas molecule**.

Einstein equates the kinetic energy of an electron in atomic space with the kinetic energy of the atom in ordinary space. This is a revolutionary idea for it distinguishes between the internal space of a molecule or atom and the space which it resides in *as a first principle*. The electron resides in atomic space and the atom resides in ordinary space. The standard model describes the space of an atom or molecule as first principle and derives the space they reside in as secondary. Loop quantum gravity is a manifestation of that idea. The foundations

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of Einstein's theory are straight-forward and easy to understand, but theories are judged by where they arrive, not where they begin.

In a discussion about the photoelectric effect Einstein comments, "The simplest possibility is that a light quantum transfers its entire energy to a single electron; we will assume that this can occur. However, **we will not exclude the possibility that the electrons absorb only a part of the energy of the light quanta.** "

The idea that a portion of a light quantum's energy may be absorbed contrasts with the standard model which states that the energy quantum is absorbed as a whole.

2.2 "On the present status of the radiation problem" *Phys. Z.* 10 (1909) p. 185 – 193.

In a discussion about the use of retarded potentials to describe electromagnetic radiation Einstein argues as follows: "Putting $f(x,y,z,t) = f_1$, amounts to calculating the electromagnetic effect at the point x,y,z from those motions and configurations of the electric quantities that took place prior to the instant t. Putting $f(x,y,z,t) = f_2$, we are determining the above electromagnetic effects from the motions and configurations that take place after the instant t. **In the first case the electric field is calculated from the totality of the processes producing it, and in the second case from the totality of the processes absorbing it.**"

Here Einstein treats the time evolution of radiation processes as a progression in continuous time from absorption to emission. This contrasts with the standard model where time evolution may refer to the state, to observables, or to operators; and it may be discrete or continuous depending upon the physical system. Einstein's model of time is consistent with the principles of relativity and a relativistic model of time. Time in the standard model is consistent with the absolute time of Newtonian mechanics.

2.4 "Statistical investigation of a resonator's motion in a radiation field" A. Einstein and L. Hopf *Ann Phys* 33 (1910) 1105-1115.

"**We consider a mobile electromagnetic oscillator that is, on the one hand, subjected to the effects of a radiation field and, on the other hand, possesses a mass m and enters into interaction with the molecules present in the radiation-filled space**. If the above interaction were the only one present, then the mean square value of the momentum associated with the oscillator's translatory motion would be completely determined by statistical mechanics. In our case there also exists the interaction of the oscillator with the radiation field."

Einstein again notes that oscillators interact in two ways: in ordinary space due to a molecule's mass and in the internal space of the molecule. He postulates that the interactions are to be described by two different laws, the classically derived laws of statistical mechanics and the laws of quantum mechanics.

"For what follows, it is expedient to distinguish two kinds of dynamical effects through which the radiation field influences the oscillator, namely
1. The resistive force K, with which the radiation pressure opposes the rectilinear motion of the oscillator.
2. The fluctuations A of the electromagnetic momentum that arise in the disordered radiation field owing to the motion of the electric masses [electrons]. These can be positive just as well as negative, and are independent - in first approximation - of the circumstance that the oscillator is in motion."

Einstein notes that the electron motion is independent of the oscillator motion. Because energy follows two paths, one in ordinary space and one in oscillator space, he treats radiation processes as the result of non-conservative forces. The standard model treats radiation as a conservative force following a single path described by the wave function.
2.5 "Emission and absorption of radiation in quantum theory" *Deutsche Phys Gesellschaft* Verhandlungen 18 (1916).

"**Two kinds of change can be distinguished**. First the change A_1E = -AEτ effected by emission; and second, the change A_2E caused by the work done by the electric field on the resonator. This second change increases with the radiation density and has a "chance"-dependent value and a "chance"-dependent sign. An electromagnetic, statistical consideration yields the mean-value relation A_2E = Bpr. The constants A and B can be calculated in known manner. We call A_1E the energy change due to emitted radiation, A_2E the energy change due to incident radiation."

Einstein confirms the non-conservative nature of radiation by distinguishing between the energy of emission and the energy due to 'work done by the electric field on the resonator'. By specifying the two paths that energy takes, 'energy change due to emitted radiation' and 'energy change due to incident radiation' he anticipates the A and B coefficients he will derive the following year. The standard model adopts the coefficients, but without noting their distinct physical origins and that therefore they must represent a non-conservative force.
2.6 "On the quantum theory of radiation" *Phys Z* **18**, 121 1917, p. 63.
https://www.informationphilosopher.com/solutions/scientists/einstein/1917_Radiation.pdf

In Einstein's last contribution to a quantum theory of radiation he expresses his ideas formally by deriving coordinate systems to describe both classical and quantum systems.

"**Let a molecule of given kind be in uniform motion with speed v along the X-axis of the coordinate system K**. We inquire about the momentum transferred on the average from the radiation to the molecule per unit time. **To calculate this we must consider the radiation from a coordinate system K′ that is at rest with respect to the given molecule**."

He uses classical coordinates K to describe a molecule's motion in ordinary space and quantum coordinates K′ to describe electron motion during emission. Two distinct laws of motion will be required to describe a complete radiation process. His quantum theory is defined in continuous time so it is not affected by differences in gravitational potential. It is relativistically correct from first principles. The standard model derives quantum mechanics in K′ with matrix mechanics and wave mechanics, and it transfers the results to K by introducing the concept of "wave function collapse". Einstein introduced K and K′ as first principles so he has no need for collapse phenomena.

3.0 Non-relativistic quantum mechanics

All of the mathematical models of quantum mechanics attempt to describe what happens to a quantum oscillator during radiation processes. Einstein's methods differ from the non-relativistic methods, which is especially noticeable for matrix mechanics.

3.1 Matrix mechanics

The emission properties of an atomic oscillator, its frequencies and transition probabilities, are described in coordinates relative to K′ by matrices. The matrices include all transition possibilities, where **p** and **q** represent the conjugate variables of quantum systems and are based on the assumption that the Hamiltonian can be expressed as the sum of the momentum and position as in classical theory.

$\mathbf{pq} - \mathbf{qp} = i\hbar\,\mathbf{I}$ or equivalently $\sum_k (p_{nk} q_{km} - q_{nk} p_{km}) = \begin{matrix} i\hbar \text{ for } n=m \\ 0 \text{ for } n \neq m \end{matrix}$

The emission properties, or observables of black body radiation are given by the diagonal elements of matrices, $m=n$. Einstein describes these same observables in the coordinate system K′ as "energy change due to emitted radiation" and in an earlier work, as the "mean kinetic energy of a resonator electron". Off-diagonal elements $m \neq n$ represent emissions or absorptions that are unobservable in K′ so they are assigned a value of zero. Although they are zero in the coordinate system K′ they are non-zero in K. Einstein referred to energy in K as "mean kinetic energy of the progressive motion of a gas molecule", so that off-diagonal elements represent thermal energy. Thus an oscillator with off-diagonal matrix elements equal to zero is in fact immersed in a "thermal bath" equal to absolute zero. *It is impossible for an oscillator to emit radiation if the non-diagonal elements of its energy matrix are equal to zero.* Matrix mechanics cannot be used to describe the energy of an atom because it only tells half the story; the observables.

Heisenberg created the classical quantum divide by insisting that quantum mechanics should be "founded exclusively upon relationships between quantities which in principle are observable". He ignored the fact that in order for an atom to radiate it must first absorb thermal energy from the environment which is observed as temperature. As a result the only matrices that are actually used in radiation processes describe spin, a quantum mechanical variable with no thermal input.

3.2 Wave mechanics

The wave function is believed to have properties that are rather fantastic, such as using entanglement to describe a distant event instantaneously. However, as Einstein demonstrates in his quantum theory the equations of motion of an atom require eight degrees of freedom, four to describe absorption and four to describe emission, and the wave function has only four degrees of freedom available. It is inevitable that unexplained motions will occur. Imagine trying to describe a pea inside of a hollow sphere. We may have very good equations to describe the pea's motion; however they will abruptly change for unexplained reasons when the ball moves. Therefore we need another set of equations to describe the sphere. Einstein envisioned the atom in exactly the same way; an electron following quantum mechanical laws contained within an atom or molecule following classical laws. The mathematics do not change, only our interpretation changes.

Wave function behavior is not strange, the way we choose to describe nature is strange. We try to describe how energy is emitted without first describing how it is absorbed, a clear violation of energy conservation. When using Einstein's methods "wave function collapse" is the sudden recuperation of the four dimensions that were originally suppressed.

4.0 Discussion

Einstein is incomparable in his ability to derive the foundations of a theory. He achieved his most notable success, the special and general theories of relativity, due to his ability to specify suitable systems of coordinates. Other theoreticians tried to explain the observables of relativity theory; such as the dilation of space and time, by using scalar equations in absolute space and time. He recognized that a more fundamental meaning is obtained by generalizing the coordinates to include all motions, also accelerated motions. It is understandable therefore that he would make coordinate systems the centerpiece of an attempt to formulate quantum theory. Indeed his concept of the coordinate system is his single most important contribution to quantum mechanics because it demonstrates that classical and quantum mechanical laws, though distinct in their origins, *are inseparably linked*. His theory is revolutionary because it demonstrates a fatal flaw in the foundations of the standard model, a flaw so old that Socrates spoke of it, a flaw so simple that it can be taught in middle school. It is also revolutionary because it removes questions about how we perceive nature from control by an elite few with access to complex resources and mathematical methods, and it restores them to the common man.

Further reading

Einstein's complete papers are found at https://einsteinpapers.press.princeton.edu/vol2-trans/ and https://einsteinpapers.press.princeton.edu/vol6-trans/

The philosophical origins of Einstein's concept of the coordinate system are described in Oldani, R. "Exercises in Natural Philosophy" (Scholar's Press, 2015).

Proposed completion of Einstein's quantum theory is found at Oldani, R. "Time evolution of energy states" Preprints.org DOI:10.20944/preprints202305.0952.v7

Experimental test of the standard model is proposed at Oldani, R. "Galactic symmetry" preprints.org DOI:10.20944/preprints202009.0215.v8