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In Quantum Physics, Free Will Leads to Nonconservation of Energy

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Abstract

Modern physical theories are deterministic in the sense that once we know the current state of the world, we can, in principle, predict all the future states. This was true for classical (pre-quantum) theories, this is true for modern quantum physics. On the other hand, we all know that we can make decision that change the state of the world – even if, for most of us, a little bit. This intuitive idea of free will permeates all our life, all our activities – and it seems to contradict the determinism of modern physics. It is therefore desirable to incorporate the idea of free will into physical theories. In this paper, we show that in quantum physics, free will leads to nonconservation of energy. This nonconservation is a microscopic purely quantum effect, but it needs to be taken into account in future free-will quantum theories.

Physics is mostly deterministic. Traditionally, in physics, the state of world changes with time in accordance with appropriate differential equations; see, e.g., [5]. For example:

- in Newton's mechanics, we can use Newton's equations;
- to describe the changes in the electromagnetic field, we can use Maxwell's equations;
- to describe the changes in the state ψ of a quantum system, we can use Schrödinger's equations

$$\mathrm{i}\cdot\hbar\cdot\frac{d\psi}{dt}=H\psi, \qquad (1)$$

  in which H is an operator describing the total energy of the system.

In all these situations, once we know the state of the world at some moment of time t_0, we can uniquely determine its future state.

It is important to take free will into account when describing the physical world. In physics, the future state of the world is pre-determined. This pre-determination contradicts our intuitive understanding that we humans have free will, that often, we can make decisions, and the outcomes of these decisions are not pre-determined: depending on what we decide, the state of the world will change.

Free will is not just an abstract philosophical viewpoint, it is a practical notion that guides our lives and our behavior. It is therefore desirable to modify physics to avoid this disturbing contradiction between physics and our everyday behavior; see, e.g., [1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16] and references therein.

In classical (pre-quantum) physics, it is relatively easy to come up with equations that allow free will. Let us start with the situation in classical (pre-quantum) physics. Let us start with simple physical systems, such as point particles, whose state $s(t)$ at any given moment of time t can be described by describing the values of finitely many quantities $s_1(t),\ldots,s_n(t)$. For example, in the original Newton's approximate description of celestial bodies as points, to describe the state of each body, it is sufficient to describe the current values x_1, x_2, and x_3 of its three spatial coordinates, three components v_1, v_2, and v_3 of the current velocity, and the body's mass m. In electrodynamics of point particles, we need to add electric change q to the list of these quantities. To describe a system of several interacting points, we need to describe the quantities describing each of these points.

Dynamical equations describe how each of these quantities change:

$$\frac{ds_i}{dt} = f_i(s_1, s_2, \ldots).$$

For example, in Newton's celestial mechanics, such equations describe how the corresponding parameters $x_i^{(j)}$, $v_i^{(j)}$, and $m^{(j)}$ of different bodies $j = 1, 2, \ldots$ change:

$$\frac{dx_i^{(j)}}{dt} = v_i^{(j)}; \quad \frac{dm^{(j)}}{dt} = 0;$$

$$\frac{dv_i^{(j)}}{dt} = G \cdot \sum_{k \neq j} \frac{m^{(k)} \cdot (x_i^{(k)} - x_i^{(j)})}{\sqrt{\left(x_1^{(k)} - x_1^{(j)}\right)^2 + \left(x_2^{(k)} - x_2^{(j)}\right)^2 + \left(x_3^{(k)} - x_3^{(j)}\right)^2}},$$

where G is the gravitation constant.

If we take freedom of will into account, then the change in the state $\frac{ds_i}{dt}$ is no longer uniquely determined by the current state $s(t)$. So, to determine the desired change, we also need to describe the values of some other quantities $f_1, \ldots$, which we can set arbitrarily because of our freedom of will:

$$\frac{ds_i}{dt} = f_i(s_1, s_2, \ldots, f_1, \ldots).$$

There is no differential equations for describing how the quantities f_k change, since we can change them at will.

When the effect of the new quantities is small, we get a small change in the original physical theory.

In quantum physics, the situation is drastically different. In quantum physics, the situation is different. In quantum physics, the state of the world at any given moment of time t is described by a wave function $\psi(t)$, and the change in this state is described by Schrödinger's equation (1). In this equation, the change is determined by the Hamilton operator H that describes the total energy of the system.

So, if we want to allow non-determinism, if we want the ability to change the derivative $\frac{d\psi}{dt}$, we have to be able to change the Hamilton operator.

How this leads to nonconservation of energy. In quantum case, as we have concluded, freedom of will means that we can modify the Hamilton operator, the operator that described the total energy of the system. What does it mean that the Hamilton operator changes? It means for the some states, the energy value changes. Thus, in effect, in quantum physics, freedom of will means that, by exercising our will, we can change the total energy of the system. In other words, *in quantum physics, free will leads to non-conservation of energy.*

How big is expected energy nonconservation? As we have mentioned earlier, in classical (pre-quantum) effect freedom of will does not necessarily lead to energy nonconservation. Thus, energy nonconservation caused by the freedom of will is a purely quantum effect, that disappears in the classical limit, when the Planck's constant $\hbar$ tends to 0. So, this purely quantum effect should be proportional to $\hbar$ and thus, it should be reasonably small. This smallness explains why this effect have not been observed: in our usual free-will decisions, we control macro-size objects, objects for which the quantum-size microscopic changes in energy are not easy to measure.

Conclusion. To make sure that physics is in better accordance with our intuition and our everyday experience, it is important to incorporate freedom of will into physical theories. Current physical theories are all based on quantum mechanics; it is therefore necessary to incorporate freedom of will into quantum physics. In this paper, we show that this incorporation leads to an unexpected observable effect: nonconservation of energy.

This nonconservation is a purely quantum effect, it is microscopically small for macro-objects, but it needs to be taken into account in future free-will quantum theories.

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