

Review of: "The Conservation Laws in Quantum Mechanics"

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Potential competing interests: No potential competing interests to declare.

Review of: The conservation laws in quantum mechanics

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This manuscript by Richard Oldani [1] is identical by content and to a large extent by text with a recently published paper by the same author [2]. Since this paper is not cited in the present manuscript, the submission counts as self-plagiarism, which represents a violation of current ethical academic standards. The published version has already been reviewed, but I nevertheless have a number of comments.

1) I do not really agree that absorption cannot be observed, although for single photons detection may be more difficult for absorption than for emission. All sound work will consider both processes. It is therefore not really justified to construct a violation of energy and of momentum conservation.

2) Basically, conservation laws in quantum mechanics are nevertheless an interesting subject. For example, there is a paper by Aharonov et. al., with almost the same title ("On conservation laws in quantum mechanics") [3] but a very different content. It certainly deserves at least a citation.

The energy-lifetime duration uncertainty relation,

$$\Delta E \cdot \tau \geq \frac{1}{2} \hbar$$

is normally applied to the natural lifetime τ of excited states in the absence of a stimulating radiation field. The spectral width of the emitted photon translates to an energy uncertainty. Essentially, the limited length of observation due to the decay of the excited state leads to this uncertainty.

However, there is another application of this uncertainty relation that has so far received little attention. While eigenstates are stationary (i.e. they have a constant population), quantum mechanical non-eigenstates oscillate between two or more eigenstates of different energies, restricted by selection rules. This implies oscillating populations and therefore oscillating energies, while the average energy remains conserved. The larger the energy violation, the higher the oscillation frequency and thus the shorter the duration of the violation, which is compatible with the uncertainty relation (Fig. 14 in ref. [4]).

3) Today, most scientists regard the atomic models by Bohr and by Sommerfeld which propose Keplerian orbits for the electrons as historic and inappropriate. However, the fact is that the time-dependent Schrödinger equation is deterministic, and its solutions are in fact circular or more generally elliptic orbits which have the same energy as the common probabilistic orbitals which are the solutions of the time-independent Schrödinger equation. After all, the Hamiltonian of the hydrogen atom, with the $1/r$ dependence of the Coulomb potential, has the same structure as the Earth-Moon system with the $1/r$ dependence of gravitation. Thus, for purely mathematical reasons the solutions must also have the same structural dependence, apart from a much different scale due to the grossly different masses. This means that under collision-free conditions, H atoms are planar. The well-known spherical orbitals are collision-induced superpositions (ensembles) of all possible orbits and represent the well-known probabilistic density distribution of the electron [5]. The equivalence of the two views has been demonstrated by Feynman path integral calculations [6].

It is a clear merit of the present manuscript that it breaks the taboo and reactivates this forgotten or even suppressed picture of trajectory-like electron motion in atoms that results from the time-dependent Schrödinger equation. Its equivalence also with Bohmian mechanics has been discussed previously [7].

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