Review of: "Foundations of Quantum Mechanics Revealed by the Conservation Laws"

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The author approaches a delicate and extremely important part of quantum physics related to the comprehension of the nature of light in quantum theory. Within this framework, he claims that "Einstein's theories are found to be superior."

Caution has to be taken when advancing similar arguments at the scientific level, and I would wish to add some remarks.

We recall that the photoelectric effect has been interpreted remarkably well by many authors since a century ago, using the wave nature of the electromagnetic field and without invoking the photon concept at all [1,2,3]. This is also true for the Compton effect [4].

We also recall that Einstein's model for the specific heat in solids, based on the vibrational energy quantization, was wrong, while Debye's model was indeed correct.

In his first paper on light quanta [5], Einstein advances his point of view on photons ".*the energy of a light ray consists of a finite number of energy quanta which are localised at points in space, which move without dividing and which can only be produced and absorbed as complete units*". Compton demonstrated that photons scattered by electrons can concede a part of their energy by changing frequency, and consequently, they do not behave only as complete units. Furthermore, the statement that photons are localised points in space does not hold either. A photon cannot be conceived within a length shorter than its wavelength [6], and the experiments have demonstrated that its radial extension is a fraction of its wavelength [7-10]. Hence, since Mandel's experiments [11,12], we can only localise a photon within a volume proportional to the cube of its wavelength [13]. This yields the theoretical difficulty in quantum electrodynamics (QED) for defining a photon position operator. Consequently, photons are not localised as points in space, and the experimental evidence has demonstrated that they are much more complex physical entities than we have imagined.

On the other hand, it is well known that Einstein's demonstration of Planck's energy density from statistical concepts [14] is not really direct, since imposing the ratio A/B to be equal to Wien's law (equation 8) is rather arbitrary. In addition, this conflicts with the hypothesis that A and B are constants, thus frequency independent.

What can be drawn is that Einstein has contributed, without any doubt, to the introduction of the light quanta concept, but one has to be more careful before affirming that his theories are superior to the QED achievements.

Finally, regarding the developments presented in the paper, the approach is quite interesting and has the merit to be investigated further.

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