‘Zero-spin-photon hypothesis’ finds another important application: Could possibly solve the ‘infinity-problem’ of QED without the need of renormalization

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Abstract

‘Zero-spin-photon hypothesis’ as proposed in an earlier paper [1] states that: ‘due to inevitable consequence of the second-law of thermodynamics and spin-conservation, the ‘zero-spin-photon’ is generated in pair-production process (of elementary particles), which decays into neutrino and antineutrino’. The zero-spin photon hypothesis explains several riddles of physics and universe. In the present paper, it is shown that ‘the zero-spin photon hypothesis’ when incorporated into the higher-order Feynman diagram (with a closed-loop) could possibly solve the half-a-century-old and famous ‘infinity-problem’ of QED, and thus could avoid the need of the so called ‘re-normalization’ procedure.

Key words: Feynman diagrams, Zero-spin-photon, Infinity problem, Re-normalization
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1 Introduction

Laws of thermodynamics are universally valid. The first-law is about the ‘conservation of energy’ whereas the second-law is about ‘conversion of energy’. Engineers give equal weightage to both these laws, but unfortunately the second-law has largely been ignored by physicists. The second-law of thermodynamics which basically tells about the ‘irreversibility’ of the energy (heat and work) conversion process, has far-reaching consequences [1-3]. When examined from thermodynamics perspectives, it is found [1-3] that: all forms of energies including mass energy (\(E = mc^2\)) are ‘work’, except the radiation energy (\(E = h\nu\)) which is ‘heat’. It is also concluded therein [1-3] that in fact energy carried by particles-with-mass are ‘work’ whereas energy carried by massless particle ‘photon’ is ‘heat’. The important consequence is that it necessitates generation of a residual photon in the pair-production process (of the elementary particles); the spin-conservation requires the residual-photon to be of spin zero; the ‘zero-spin photon’ being unstable further decays into a pair of neutrino and antineutrino. It has been stressed therein [1] that any ‘proposal’ even at the level of hypothesis, which solves some of the riddles, should be welcomed. The ‘zero-spin photon hypothesis’ [1] seems to be correct as it indeed explains reasonably well several riddles of physics and universe including that of the neutrino-handedness and parity-violation.

Quantum Electro-dynamics (QED) has been one of the most successful theories of twentieth century physics. However, the problem of ‘infinity’ had plagued the theory for couple of decades until a stop-gap arrangement or the so called ‘re-normalization’ procedure was developed to get rid of the infinity-disaster. Though successful, the ‘re-normalization’ has been considered disturbing since beginning (as mentioned in section-2). In the present paper; an alternative way (suggested in section-4), to solve the infinity-problem of QED without the need of re-normalization, is being suggested with the help of the ‘zero-spin photon hypothesis’-proposed [1] in an earlier paper (briefly revisited in section-3 of this paper).

2 Infinity-problem, Re-normalization and its Criticism

2.1 Infinity-Problem

Evaluation of the Feynman-diagrams to determine the ‘amplitude’ \(M\) for the process in question is necessary for calculation of decay rates (\(\Gamma\)) and scattering cross-section (\(\sigma\)), as the case may be. When the higher-order Feynman diagrams with closed-loops are evaluated for amplitude \(M\), the ‘integral’ diverges to infinite-value causing the infinity-problem. Infinity-problem in Feynman-calculus seem to be the characteristic of the closed-loops in the Feynman-diagrams. One such closed-loop under-consideration in the present-paper is
the one that arises when a (virtual) photon emits electron and positron (pair-
production) which are soon reabsorbed (annihilation) therein.

2.2 Re-normalization

‘Re-normalization’ is a set of ad-hoc strategy and procedure to ‘regularize’ the
integral and to absorb (cancel) the infinities with the ‘re-normalized’ masses
and coupling-constants as effective and running respectively. Detailed strategy,
procedure and formulae can be found in particle-physics or quantum-mechanics
books [4, 5].

2.3 Criticism of Re-normalization

Griffith [4] mentions about the problem of infinities in QED/QFD while applying
the Feynman-rules to the Feynman-diagrams with closed-loops (for calculating
amplitude $M$) as follows: “The ‘integral’ is logarithmically divergent at large ‘q’.
The disaster in one form or the other, held up the development of quantum
electrodynamics for nearly two decades, until, through the combined efforts of many
great-physicists (critics and supporters)–Dirac, Pauli, Kramers, Weisskopf and
Bethe through Tomonaga, Schwinger and Feynman–systematic methods were
developed, for sweeping the infinities under the rug”, as ‘re-normalization’.

Dirac is reported [4, 6] to have critically remarked about re-normalization as
follows: “it (re-normalization) is just a stop-gap procedure. There must be
some fundamental change in our ideas, probably a change just as fundamental
as passage from Bohr’s orbit theory to quantum-mechanics. When you get a
number turning out to be infinite which ought to be finite, you should admit
that there is something wrong with our equations, and not hope that you can
get a good theory just by doctoring up (manipulating) that number..., with a
good theory the ‘infinity’ would never arise in the first place”.

Kaku and Thomson [7] reiterate as satire that “can ‘infinity minus infinity’
yield a meaningful results (or in the language of physics can $\infty - \infty = 0$? Math-
ematically, it is known to be indeterminate). To the critics, using one set of
infinities (arising from loops in the Feynman diagrams) to cancel another set
of infinities (arising from electric charge and mass) looked like a parlor-trick”.
They [7] further quote Dirac to have said on it that “ This ($\infty - \infty = 0$) is not
a sensible mathematics. Sensible mathematics involves neglecting a quantity
when it turns out to be small, not neglecting it (or getting rid of it ) because
you do not want it”.

3
3 ‘Zero-spin photon hypothesis’ Re-visited and using it into single-vertex Feynman-Diagrams for (single) pair-production to yield multi-vertices Feynman-diagram for (double) pairs-Production:

3.1 ‘Zero-spin photon hypothesis’- Revisited

The second-law of thermodynamics, which spells of ‘irreversibility’, prohibits the full-conversion of heat (radiation energy $\gamma$) into work-energy (or generation of pair-particles of energy $2mc^2$) and thus necessitates some residual energy ($\gamma_0$) to come-out. As described in the earlier paper: the inevitable consequence of second law of thermodynamics and spin-conservation necessitates the generation of a zero-spin photon ($\gamma_0$) in pair-production (of electron and positron), which ($\gamma_0$) being unstable subsequently decays into a pair of neutrino and antineutrino. The generation of zero-spin photon ($\gamma_0$) in electron-positron pair-production and its subsequent decay into neutrino-antineutrino pair-production makes together (combined) pairs-production process, as shown in Fig.1. The strong photon $\gamma$ is shown as wave with continuous wavy-line, whereas the weak zero-spin-photon $\gamma_0$, being unstable, is shown as dotted-wave. The proposed hypothesis seems okay as it is able to explain many riddles of physics and universe, including the famous parity-violation.

Figure 1: Schematic-diagram for ‘zero-spin-photon hypothesis’: generation of ‘zero-spin-photon $\gamma_0$’ during electron positron pair production and its subsequent-decay into neutrino and antineutrino, leading to pairs-production

Note: $\rightarrow$ Time-axis is horizontal from left-to-right.
3.2 Introducing the zero-spin photon hypothesis concept towards the Feynman-Diagrams

3.2.1 Simple Feynman-diagram(tree) of electron-positron pair-production and that also for neutrino-antineutrino pair-production

The single-vertex Feynman trees/diagrams (wherein only 3 lines are permissible) for electron-positron pair-production (from the energetic gamma-ray photon $\gamma$) and that also for neutrino-antineutrino pair production (from the residual zero-spin photon $\gamma_0$) are ‘separately’ shown in Figs.2.a and 2.b, note that the time-axis is horizontal from left-to-right; thus the particles traveling from right to left towards vertex are the corresponding anti-particles.

![Figure 2](image)

Figure 2: (a) Feynman diagram for electron-positron pair-production from $\gamma$
(b) Feynman diagram for neutrino-antineutrino pair-production from $\gamma_0$

3.2.2 ‘Single-vertex Feynman diagrams (trees) for the two pair-production process’ together to yield Feynman-diagrams for pairs-production with three or five vertices

The two pair-production process (as mentioned in Section 3.2.1 and shown in Figs.2.a and 2.b) when combined-together is named (plural) as the pairs-production, and is mentioned earlier (in section 3.1) and is shown schematically in Fig.1 (The Fig.1, at the first vertex, contains ‘4’ line(s), which is not permissible in such Feynman-diagram). However, it can also be shown compatible (permissible) as Feynman-diagrams as in Figs.3 (with three vertices) and in Fig.4 (with five vertices). Pairs-production can possibly occur in either way; Fig.4 is more likely, being symmetrical. Herein it is assumed that the uncertainty-principle $\Delta E\Delta t = \frac{\hbar}{2}$ (which permits violation of ‘energy-conservation or the first law of thermodynamics’ for a moment) also permits violation of second-law of
Figure 3: Suggested Feynman-diagram for pairs-production with one $\gamma_0$ and three-vertices
Figure 4: Suggested Feynman-diagram for pairs-production with two $\gamma_0$ and five-vertices

Note: Time axis is horizontal from left to right. Particles coming right to left towards vertex are in fact the corresponding antiparticles coming out.
thermodynamics as well, thus the $\gamma_0$ can come-out after a moment from next-vertex to be in accordance with Feynman-diagram, with only 3-lines on each vertex.

4 Introducing the ‘zero-spin photon hypothesis’ onto the closed-loop of Feynman-diagram (for Moller-scattering) as possible solution to the infinity-problem of QED

4.1 Closed-loop in Feynman-diagrams as source of the infinity-problem

Infinity-problem (divergence of the ‘integral’ for amplitude $M$) normally arises due the closed-loops in the higher-order Feynman-diagrams, such a closed-loop situation for the electron-electron Moller-scattering is shown in a conventional-way in Fig.5. The closed-loop comes due to ‘pair-production’ and its subsequent ‘annihilation’ therein.

To get rid of this infinity-problem, a set of procedure called ‘re-normalization’ is adopted. The ‘re-normalization’ though successful, seems dubious and has been criticized enough. The half-a-century-old problem of infinity has not been solved as yet, but rather it has only been ‘managed’ through ‘re-normalization’. The present paper is an honest attempt which could possibly solve the infinity-problem without re-normalization, if the ‘zero-spin photon hypothesis’ is incorporated into the closed loop of higher-order Feynman-diagram, described as follows.

4.2 Introducing the ‘zero-spin photon and its subsequent decay’ onto the closed-loop of the Feynman-diagram – modifications in the Feynman-diagram – could possibly solve the infinity-problem

As discussed in the ‘zero-spin photon hypothesis’ [1], revisited here in section-3.1; electron-positron pair-production from a photon ($\gamma$) also necessitates generation of zero-spin photon ($\gamma_0$) which subsequently decays as pair-production of neutrino and antineutrino, making the whole process as ‘two’ pair production(s) referred simply as ‘pairs-production’. The Feynman diagrams(Figs.3 and 4) of pairs-production with additional vertices could now be ‘superimposed’ onto the closed-loop of the Moller-scattering (Fig.5).

Thus two possible (modified) Feynman-diagrams are produced with six or eight vertices as shown in Figs.6 and 7 respectively. It may be seen and noted (and idiomatically said) that the closed-loop (the problematic viscous-circle) is no
Figure 5: Higher-order Feynman-diagram for electron-electron Moller scattering (with four-vertices) with the smooth closed-loop in it, which leads to the ‘infinity-problem’
longer smooth-curve but broken-down (in pieces) and therefore the root-cause of
the infinity-problem is broken (the possible ‘technical’ explanation for why the
infinity-problem goes off is briefly mentioned in the next paragraph).

Due to more internal-line(s) (as in the Figs. 6 and 7) more contributions will
be there in the ‘integrand’ through ‘propagators’, thus having more terms (of
internal four-momentum ‘q’) in the denominator, it is therefore expected that
the ‘integral’ instead of being divergent would rather now be convergent (pos-
sibly inverse dependence). This could thus solve the infamous infinity-problem
altogether, making the need of ‘re-normalization’ unnecessary or redundant.

Figure 6: Modified higher-order Feynman-diagram for the Moller-scattering
(with six vertices) using one ‘zero-spin-photon’, super imposing figure 3 on 5

Notes: → Time-axis is horizontal from left-to-right
particles coming right-to-left towards vertex are in fact the
corresponding antiparticles coming-out.
Figure 7: Modified higher-order Feynman-diagram for the Moller-scattering (with eight vertices) using two ‘zero-spin-photon’, super imposing figure 4 on 5.

Note: → Time axis is horizontal from left to right. Particles coming right-to-left towards vertex are in fact the corresponding antiparticles coming-out.
Incorporating ‘zero-spin photon hypothesis’ onto the conventional Feynman diagram seems to make the diagram complex but solution cleaner. The zero-spin-photon, being unstable (thus shown as dotted-wavy-line) comes only for a short while to decay into the realistic neutrino and antineutrino; thus from the internal-line-propagator point-of-view the wavy-lines may possibly be considered absent/omitted.

The authors invite the physicists of the world to tackle the modified Feynman-diagrams (Fig.6 and 7) rigorously. The ‘zero-spin-photon’-path is laid down, directions for solution are indicated. It is to be seen who wins the race to be the first to ‘actually’ solve the ‘infinity-problem’, of say, Moller-scattering, without using the crutches of ‘re-normalization’? Also to be seen that how the two other types of loops in the Feynman-diagrams (those not discussed at all in the present-paper) are to be tackled and who does that? In addition; the ‘zero-spin photon’ - approach, for avoidance of infinity, may also be applied to other scattering-process and decay-process.

5 Discussions

‘Law(s) of thermodynamics’ are not simply meant for engineers only. Its greatness goes much beyond [8, 9]. It is said [9] ‘that the four laws of thermodynamics (Zeroth, First, Second and Third) drives the universe, and that not knowing (appreciating) the second-law of thermodynamics is like never having read a work of Shakespeare’! Interestingly, it has been shown [1-3] that though remotely distinct, ‘second-law of thermodynamics’ and ‘special-relativity’ are linked to each other. Physicists have great respect for special-relativity and other physical-laws, but in-general ignore the importance of the second-law of thermodynamics. Anyway, the ‘zero-spin photon $\gamma_0$’ is much smaller than $\gamma$; so should we bother about including $\gamma_0$? It is true that, ‘though most of small differences don’t make much of a difference, but even if the small difference pops up at crucial point then it can make all the difference’ [10]. Ignoring the second-law of thermodynamics is the basic etiology of the infinity-problem, which can be overcome if the zero-spin-photon (which is the outcome of the second-law of thermodynamics) is incorporated in the Feynman-diagram.

The root cause of the infinity-problem is known to be the closed-loops in the higher-order Feynman-diagrams. One such case considered in this paper is the Moller-scattering (Fig.5) wherein the exchange-photon ($\gamma$) creates the electron-positron (pair-production) and its subsequent recombination (annihilation) results in a closed-loop in the diagram. ‘Annihilation’ is thermodynamically okay; but the simple (single) pair-production is, in a way, thermodynamically wrong or incomplete, it should be rather be pairs-production as mentioned in section 3.1. Once the inclusion of ‘zero-spin photon’ is made (as in modified Feynman-diagrams, Figs.6 and 7) to incorporate the correct pair(s) - production, the problem of infinity should go away because the troublesome vicious-circle
(the smooth continuous closed-loop of the original Feynman-diagram Fig.5) is broken-down (in pieces, as shown in the modified Feynman-diagrams Figs.6 and 7) to first-order (slope) discontinuity. A few additional-vertices and internal-lines are thus introduced in the modified Feynman-diagram(s), which would contribute via ‘propagators’ possibly in such a way to have more powers of ‘q’ in the denominator of the amplitude’s ‘integrand’ ultimately making the ‘integral’ inversely convergent. The ill-behaved original integral should now become well behaved!

It is anticipated in the present paper, that the problem of infinity originating out of the smooth closed-loop (as in Fig.5) can most likely be solved with the incorporation of ‘zero-spin photon’ hypotheses. The authors ask the physicists and graduated-students to analyze the new suggested (modified) Feynman-diagrams with the broken-down loop (Figs.6 and 7); the authors have indicated in the previous paragraph(s)– how to possibly get the ‘integral’ convergent thus avoid the infinity-problem altogether. But this is not the end of story. There are other two more types of loops which too cause divergence problem but these have neither been tackled nor answered in the present-paper. But at least, a new light of ‘zero-spin-photon’ has been thrown-upon possibly in the right-direction which can illuminate the path.

6 Conclusions

Normally physicists bother much about momentum-conservation and energy-conservation (‘first-law’ of thermodynamics), and that is what the Feynman-calculus insures; but the ‘second-law’ of thermodynamics has completely been ignored. This non-consideration of second-law of thermodynamics is basically the origin and root-cause of the infinity-problem in QED; therefore to avoid this disastrous problem, the right perspective of second-law of thermodynamics should be incorporated via ‘zero-spin photon hypothesis’, and that is what is done in the present paper by modifying the Feynman-diagram accordingly. The herein proposed theory/approach seems to be in the right direction because it is in accordance with what Dirac has said that ‘with a good theory the infinity would never arise in the first place’. It appears that the half-a-century-old infinity problem, which so far has only deem managed with re-normalization, can possibly be solved without re-normalization. The authors anticipate a wide-scale repercussions of this paper, as the suggested approach is expected to make changes in the shape and fate of the Feynman-diagrams and the particle-physics.

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