

Photonics by Four Bosons Electromagnetism

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ABSTRACT

Maxwell is extended based on two electric charge phenomenologies: mutation and conservation law. Three charges $\{+, -, 0\}$ transformations physics succeeds. It is processed by a Four Bosons Electromagnetism. Photonics is proposed. Self-interacting photons appear at tree level. © 2023 The Author(s).

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Main Text

A general theory of electric charge is proposed. It is based on two phenomenologies: electric charge transfer and conservation law. Three charges $\{+, -, 0\}$ transformations physics succeeds. Quantum field theory underlies corresponding creations and annihilation. A potential field's quadruplet is ruled. Microscopic electromagnetism is processed by four vectors bosons intermediations.

The electromagnetism closure is accomplished. The quadruplet

$A_{\mu I} \equiv \{A_{\mu}, U_{\mu}, V_{\mu}^{\pm}\}$ completeness introduces the most generic

EM energy flux between electric charges [1]. The electric charge transfer physics extends the EM phenomenon. Charge mutation includes that besides usual photon, EM phenomena is enlarged by massive and charged photons. Charge conservation associates these four vector fields. Electric charge symmetry, extends EM for an abelian symmetry $UQ \equiv U(1) \times SO(2)_{global}$. A new EM Lagrangian beyond Maxwell results. A symmetry equation for electric charge is established through Noether theorem [2].

Development

Electromagnetism is the manifestation of electric and magnetic fields. It is based on electric charge and spin. Maxwell equations are its standard description [1]. A qualitative difference appears to Newton's laws. Their features are that nature is not only constituted by matter, but also through Faraday's lines of force. Nevertheless, although all its success, Maxwell equations contain limitations. It is a linear theory, introduces the potential fields as a subsidiary, polarization and magnetization fields by hand, passive light, others. Different subjects as condensate matter, plasma, superconductivity, astrophysics, photonics are registering such restrictions.

The phenomenology of electric charge mutation was already a theme for 1923. A time with an electron, proton, photon exchanging three charges. Later in the 1930s, the positron discovery, neutron decay, muon decay, pions cosmic rays decays were confirmed on charges transference. In 1938, by occasion of the Warsaw conference 'New theories in Physics', there were 14 particles in

the physics variety. They were these particles $e^-, e^+, p(p^-), \gamma, n(n^-), \mu^-, \mu^+, \pi^+, \pi^0, \pi^-, \nu(\bar{\nu})$. There was a rich particle's spectrum confirming the charges set $\{+, 0, -\}$ phenomenology.

There is a physics beyond Maxwell to be encompassed. Something is expected to be done with contemporary electromagnetism. Advances are welcomed since preserving the four Maxwell postulates. Consider light invariance, set EM physics, electric and magnetic fields in pairs, electric charge conservation. There are 52 effective non-Maxwellians extensions, organized into four categories. They are 12 extensions considering the Standard Model, 14 extensions motivated by a physics beyond the Standard Model, 16 nonlinear extensions, and 10 due to dimensionality [3]. The quire is whether the 21th century is in front of new electromagnetism or just expecting extensions to Maxwell theory. The effort here will be to enlarge the EM phenomena with a fundamental model.

Our research is based on charge transfer. There is still an electric charge phenomenology to be understood. Consider that charges are created and destroyed, and so, their energies are transformed between themselves. There is an EM mechanism through the charges set $\{+, 0, -\}$ transformations to be analysed. A microscopic EM which was not registered by Coulomb balance and Maxwell equations. Consider the EM energy as being transmitted by four bosons messengers. It provokes new EM observables and light properties.

Thus, a first insight to improve EM is to investigate on a primordial light. The relationship between light and EM is still open. Since Al Haytham light interrogates physics. Maxwell's chief discussions of his electromagnetic theory of light are in his dynamical theory of the electromagnetic field. However, light as an electromagnetic wave contains a contradiction. Concurrently, that light is invariant, it is produced from electric charge oscillations. Arising the discussion: light is a cause or a consequence?

At this conundrum is the essence of electromagnetism. However, neither Standard Model nor QED answer that. Following the Big

Bang, the fiat lux occurs at 10–10s, just after the Early Universe second phase transition $SSBSU_c(3) \times SU_L(2) \times U_R(1) \rightarrow SU(3)_c(3) \times U_{em}(1)$. For QED, virtual photons are depending on fine structure constant. A perspective beyond the electroweak phase transition (EWPT) is necessary.

Light metric should work as basis for searching a new EM. It defines space-time symmetries. Historically, light symmetry opened three rooms for physics be delivered. Maxwell and electric charge; relativity with space-time and matter-energy correlations; Lorentz Group and spin. Nevertheless, light remained as a consequence. It does not explain light behaviour at tree level.

Physics has to discover a primordial light with properties as invariance, ubiquity and selfinteracting photons being transcribed by a Lagrangian. There is various light manifestation beyond Maxwell to be understood. The root of electromagnetism contains an unknown relationship between light and fields to be explicated. The challenge for 21th century is consider physical processes involving light. A new $\gamma\gamma$ phenomenology to be investigated though a revival to Breit-Wheeler scattering. Consider also on EM manifestations as magnetogenesis, light and the Later Universe, light at LHC, and lasers, $\gamma-Z^0$ interaction, new light states. Properties indicating a physics beyond Maxwell.

A fourth light metric physics will support this investigation. It covers the existence of fields families, at Lorentz Group. The

$\left\{ \frac{1}{2}, \frac{1}{2} \right\}$ Lorentz Group representation includes the fields set

$A_\mu \equiv \{A_\mu, U_\mu, V_\mu^\pm\}$. It supports the four messengers required for

conducting the electric charge microscopic flux processes with $\Delta Q=0, \pm 1$. Given that, explore this phenomenology by imposing four photons' intermediations. They correspond to the most generic microscopic electromagnetism. A new EM performance emerges where A_μ means the usual photon, U_μ a massive photon and V_μ^\pm two charged photons.

A four bosons electromagnetism is generated. It provides a fundamental nonlinear electromagnetism alternative to Euler-Heisenberg and Born-Infeld effective theories. Based on electric charge symmetry an extended abelian electrodynamics associated to $U(1)_q \equiv U(1) \times SO(2)_{\text{global}}$ gauge symmetry is proposed. A connected quadruplet made off with four interlaced potential fields. Nonlinear granular and collective fields strengths are expressed. A Lagrangian containing interconnect fields is derived. Seven interrelated EM sectors are developed. They are Maxwell, systemic, nonlinear, neutral, spintronics, photonics, electroweak.

As time goes by, the view of electric charge mutation was being left. QED took the place for charges exchanges. It was successfully formulated as the theory of electrons and photons. The three charges of electromagnetism were unexplored. Forgotten. The completeness of a whole quantum field theory under charges creation and destruction carried by a set with four intermediate vector particles is still expected. There is a missing EM energy to be considered. An EM energy where each charge is transformed

through four-vector bosons $\{A_\mu, U_\mu, V_\mu^\pm\}$. A purpose containing

A_μ as the usual photon, U_μ massive photon, and V_μ^\pm massive vector photons.

Conclusion

Thus, without violating any basic Maxwell principle, a photonics is projected beyond Maxwell and QED. It is called four bosons electromagnetism. While at the macroscopic level, the Coulomb balance did not register on the zero electric charge presence, at a microscopic level, its physicality appears through bosons exchanges. The three electric charge transformations are displayed on the zero charge EM energy. A result already detected at QED with photons carrying a zero charge EM energy.

Nonlinear electromagnetic fields modified electric charge symmetry; new EM regimes appear. Potential fields become a physical entity producing conglomerates, collective fields, mass, sources, charges, monopoles, forces. EM features ruled from an extended electric charge abelian symmetry. Systemic, nonlinear, neutral, spintronics, photonics, electroweak EM regimes are constituted. A photonics with self-interacting photons at tree level is generated. A physics being explored since Breit-Wheeler (1934) and detected at CERN (2017) [4]. A physics waiting for a nonlinear EM model.

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