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The Nature of Light: What are Photons? IV

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Introduction

This is the fourth biannual conference on this series exploring the nature of light. We are pleased to say that we have experienced a dramatic increase in our growth compared to the 3rd biannual conference held in 2009. Compared to 30 papers published for the 2009 conference proceedings, we have 56 papers published for this year out of 63 accepted (due to various attritions). This is a very positive sign for this conference series. So, all of you, the contributors and all other readers, are very welcomed to join us, while actively soliciting papers from other colleagues, for our 5th biannual conference. It will be held during 25–29 August 2013 in San Diego. It will have a new parallel program: a workshop on how to logically analyze and map nature by studying interaction processes behind various natural phenomena. The workshop will be further strengthened by a good number of hour-long review presentations on relevant phenomena by various invited experts. We are in the process of raising funds from various sources to provide travel grants to senior graduate students who will be pre-selected based on their submitted papers. Readers, you are very welcomed to contact us with potential sources for raising private funds to expand the long-term productivities of this conference series.

History and Background: This conference was launched in 2005, the year of Einstein centennial, with Nobel Laureate Nicholas Bloembergen as the opening Keynote speaker. Our key objective is to provide a platform to all those serious scientists who appreciate that it is time to revitalize physics from the bottom-up starting from the time of Galileo. We are aware that the field of physics has been stagnant for decades due to the prevailing belief system that the foundation of the *Physics Edifice* has been laid quite firmly! So we need serious forums for those whose enquiring minds fully appreciate that all of our theories are necessarily incomplete as they have been constructed based upon insufficient knowledge of the cosmic system.

While we have stayed on course with the ontological question "What are photons," the prevailing concept of *wave-particle-duality* has given us the reason to solicit all possible papers that can guide us to broaden and deepen our understanding of the nature of both photons and particles. We have remained conscious that the nature of light and the nature of elementary particles are inseparable, as demonstrated by the decay processes of elementary particles and their association with photons. That this connection is inseparable is also obvious from the fact that the limiting velocities of light and particles are given by: (i) $c^2 = \varepsilon_0^{-1}\mu_0^{-1}$; (ii) $m_{\rm v} = m_0(1-{\rm v}^2/c^2)^{-1/2} = m_0(1-{\rm v}^2\varepsilon_0\mu_0)^{-1/2}$. Even the mass of a particle is recognized as some inertial resistance of the relevant energy packet, $m = \Delta E/c^2 = \Delta E\varepsilon_0\mu_0$. Thus the *free space* that helps manifest both photons and

particles, clearly possess the physical properties ε_0 & μ_0 which dictate the motions of photons without inertia and the motions of particles with inertia, besides making them deeply interconnected. However, almost 90 years of *wave-particle-duality* has not brought us any closer to a clear understanding of the physical (ontological) structure of either photons or particles. This conference explicitly solicits papers that help us bring out self-consistent logical congruence between our hypotheses, mathematical theories, and observed data in such a way that they facilitate the visualization (imagination) of the invisible interaction processes, which is one of the paths towards the ontological reality! The prevailing epistemology of our Quantum Theory explicitly directs us to stay away from asking such questions. The instruction is: *just compute*!

For several centuries we have basically remained focused on successfully modeling the measurable data, without paying deeper attention to the invisible interaction processes that give rise to the data through our instruments. Thus, our mainline epistemology of modeling only data has kept us away from getting closer to the ontological realities of the cosmic system. We need to appreciate that a set of rules discovered while successfully modeling data, gathered from the study of a tiny segment of a vastly complex cosmic system, may not exactly coincide with the actual cosmic rules behind interactions. So, we must revitalize our efforts to discover and employ new logical tools, including interaction process mapping epistemology, to iteratively improve/correct the foundational hypotheses behind all of our working theories. It has definitely been productive to study particle-particle interactions at very high energies, albeit at very high costs, to unravel some of the unknown mysteries of our cosmic system! Yet, in spite of staggering successes of quantum hypotheses and their various theoretical derivatives over some 80 years, they do not really explain the root physical process behind its foundational discovery, the quantumness of the material universe!

In semi classical theory, the quantumness of the radiation field can be fully accommodated in terms of quantumness of the material emitters and detectors. Can the quantumness of the material world be fully understood in terms of classical stochastic field, or do we need to hypothesize elementary particles as quantized resonant undulations of the *vacuum field*? Are not the mainstream research efforts neglecting the fact that a deeper focus on the light-matter *interactions processes*, in contrast to just data modeling, is significantly more cost effective approach to probe the ontological structures of light and matter?

We need a rational balance. It is time for private and public funding organizations to support new scientific approaches based on a combination of old and new hypotheses, supported by logically self-consistent new theories, anchored by reproduction of the existing observations, while leading us into the future by predicting new observables, hitherto unknown!

Appreciating the Energy Behind the 4th Biannual Conference: The excitement and the energy that was pervading this 4th biannual conference was not just due to the large number of papers, but also due to the diversity of session topics. Distinctly different models for photons were presented, which should pave the way for much more refined debates during the future biannual conferences. We also had a very productive session on *Superposition and Interaction Process Models* driven by experiments and experimental modeling. We must keep on soliciting these kinds of papers since they help us anchor our models and theories closer to reality. The sessions on the *Being Aware of Our Diverse Epistemologies*, followed by the Panel Discussion on the same topic, clearly energized the minds of most of the participants. Participants recognized that we all suffer from our deep evolutionary propensity to individual subjective interpretations of the same mathematical model. This is why we need to develop our logic-refining tools like interaction process mapping epistemology in the absence of direct access to the cosmic ontology. This was obvious from participants' comments like: (i) The Solvay Convention on Quantum Mechanics will be superseded by the San Diego Convention. (ii) The sessions and the panel discussions on *Being Aware of Our Diverse Epistemologies* is a very foresighted step towards bringing new growth impetus to physics, etc…

Translating the Energy to Future Growth: Our European colleagues are already working towards expanding this San Diego conference series to Europe, by raising the necessary funds from European organizations. This is very inspiring for the organizing chairs and committee members. We would like to utilize this moment of our *conference-energy* to solicit new committee members. Please, feel free (i) to volunteer to join the committee and feel empowered to solicit new contributors, and (ii) to submit new session concepts with names of potential participants.

The Sessions of the 4th Biannual Conference: Below we present the names of the sessions for this year's conference. Please feel free to comment on which ones you would consider important and productive for the future growth of this conference series. Of course, the final session names are usually dictated by the content of the actual papers submitted.

Session 1:	Photon Counting Stat and QM-CM Dichotomy
Session 2:	Gravity, Relativity, and EM Waves
Session 3-4:	Revisiting Derivations and QM Concepts
Session 5:	Waves, Photons, and Computing Logics
Session 6:	Space as a Medium and its Properties
Session 7-9:	Diverse Photon Models
Session 10-11:	Superposition and Interaction Process Models
Session 12:	Being Aware of Our Diverse Epistemologies
Panel Discussion:	Being Aware of Our Diverse Epistemologies

We would like to take this opportunity to thank all the participants for taking time, bearing expenses for the attendance, and presenting thoughtful ideas to give this 4th biannual conference such inspiring and dramatic growth. Technological innovations come through successful emulation of physical processes behind natural phenomena. We are promoting the development of deeper understandings of physical processes behind all light-matter interaction phenomena.

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Announcement for the 5th biannual conference

For our 5th biannual conference in 2013, we want our current and future participants to appreciate that our conference platform will remain as broad as the frequency range of EM waves, from radio waves to gamma-rays! The key platform is to broaden our understanding of light and matter through all possible light-matter interactions. We strongly encourage authors to submit papers that attempt to imagine, visualize and explain the real physical processes behind the generation, propagation, and detection of EM waves, thereby energizing the debate on whether EM waves consist of indivisible quanta, divisible wave packets, or something new. All submitted theoretical and experimental papers should deal with actual or feasible experiments to prove their points in deference to pure mathematically formalistic papers primarily on quantum philosophy, pure quantum logics. To trigger the creative minds of the potential contributors to develop specific ideas for their papers, we are presenting a set of guiding concepts below.

Generic Physics Questions

Principle of Non-Interference of Waves (NIW)
Can a single photon create "interference" effects all by itself, when photon-photon interaction is essentially negligible in the absence of material dipoles? Are photons indivisible quanta, or divisible classical wave packets?

Causality of Time-Frequency Fourier Theorem
Should we continue to use Fourier's mathematical time-frequency theorem as a de-facto principle of physics, as if superposed light beams interfere with each other, even though they constitute non-interacting Bosons, or non-interfering classical wave packets?

Relativity and Reality of Cosmic Medium as Sustainer of Light
Why do we continue to ignore the field properties of space as unreal when Maxwell's wave equation and quantum field theory of light are based upon such fields? How can light travel through real empty space with the same possible highest velocity irrespective of the velocity of the emitters?

Quantum Optics Questions (Both Atoms and Light are Quantized)

Electrons are Discrete but "Photons" May Not Be
If electrons are stable and quantized elementary particles and their binding energies are quantized in detectors, how can we be so decisive that discrete number of photoelectron emission proves that light is also discrete? Does QM bar

all quantum devices from absorbing the necessary quantum of energy from multiple stimulators?

Single Photon Generation, Detection
Since emitting and detecting molecules are nanometer in size and the wavelengths of visible light are three orders of magnitude larger, can we trust the hypothesis of single photon generation or detection unless the emitter/detector is an isolated single atom?

"Photon Interferes Only with Itself"
Can we accept this proposal by Dirac as final when we know that heterodyne spectrometry can be carried out by superimposing beams of light on a fast detector from a star some 13-billion light-years far and an Earth-based laser?

Photons do not Arrive at Dark Fringe Locations
Should we accept the explanation that superposition fringes (whether spatial or temporal) are produced due to preferential arrival of photons as the final resolution of Dirac's proposal? All transformations happen in nature through interactions and energy exchange. How can a single photon make itself appear or disappear without any physical interaction?

Photon as a Fourier Monochromatic Mode of the Vacuum
Is it logically congruent for us to accept the definition for a photon as a Fourier monochromatic mode of the "vacuum?" A Fourier monochromatic mode is a non-causal proposition since it mathematically exists over all space and time!

Non-locality
If the fringes of superposition due to light beams become manifest only in the presence of nanometer size detecting molecules, present within the physical volume of superposition of the beams, how can interference phenomenon be non-local?

Validity of Bell's Theorem
If the fringes of superposition due to light beams become manifest only in the presence of detecting molecules, should not the Bell's theorem be re-derived in terms of summation of the simultaneous dipole stimulations by the light beams?

a & $a^{\dagger}$ as Repackaged A&B Coefficients
Since "creation" and "annihilation" of photons in reality are always carried out by material dipoles, do a & $a^{\dagger}$ really represent Einstein's "AB" coefficients for atoms?

Quantum Computation by Single Photons
Is it possible to track the same single photon through the stages of generation, propagation, manipulation, and detection processes for quantum computation,

encryption, and communication when the light-matter interaction is always statistical?

Nanophotonics and Plasmonic Photonics
If quantum, in contrast to bulk, material properties start dominating in nanophotonic materials, why do we not need propagating quantized EM fields in such devices? Why classical diffractive propagation using Maxwell's wave equation yields perfectly valid results?

Optical Trapping and Vortex Optics
Can the experimental advancements in these fields help us discern between "indivisible photon vs. classical wave packet?"

Bose-Einstein Condensates
Since photons are Bosons, can we leverage the advancements in BEC physics to understand the nature of light, photons vs. wave packets, any better?

Particle Physics
Since photons and elementary particles can give birth to each other, can the study of the structure of light lead to better understanding of the structure of particles?

Semi-Classical Optics Questions (Quantized Atoms and Classical Wave Packets)

Diffraction vs. Interference
Classical mathematical formulation for both these phenomena is fundamentally the same. We sum the component EM waves, whether they are secondary wavelets produced due to perturbation by apertures or they are superposed well-formed beams. But, if light beams constitute photons and photons are non-interacting Bosons, then classical physics has been wrong for centuries to assume "interference" of light. Is classical physics correct?

Fourier Transform Spectroscopy
Why does Michelson's Fourier transform spectroscopy work, even though different frequencies produce heterodyne signals, while Michelson derived his relation by assuming that different frequencies do not interfere?

Mode-lock Laser Pulse
If light beams of different frequencies do not interfere, why do we claim that mode-locked laser pulses are produced by superposition of periodic longitudinal modes? Why do the multi-mode CW He-Ne gas lasers produce steady CW intensity instead of random pulses even though the "temporal coherence" of each mode in over millisecond?

Elliptically Polarized Beam
If orthogonally polarized light cannot interfere to produce fringes, how can they interfere to produce elliptically polarized beam? If the amplitude of the electric vector in an elliptically polarized light oscillates in its value, would not the energy of the beam (square of the amplitude) oscillate?

Dispersion: Fourier Frequencies of a Pulse and Pulse Broadening
If the response time of atoms and molecules to incident light beam is in the domain of femto seconds or shorter, then how do material media figure out how to respond to the Fourier frequencies of pico or nano second pulses that barely touched the material facet? What are the physical processes by which the molecules of a "dispersive" medium figures out the presence of Fourier frequencies due to short pulses?

Slow and Fast Light
Is "superluminal" velocity of light a physical reality or limitations of our mathematical model that use Fourier frequencies?

Coherence Theory
If light beams constitute non-interacting Bosons, then why do we present coherence of light beams as field-field correlation instead of as correlation of simultaneous dipole stimulations of the detecting molecules simultaneously induced by multiple superposed fields?

Coherence and Decoherence
If diffractive propagation of all classical beams show enhancement in coherence (van Cittert-Zernike theorem), how can we reconcile decoherence of light beams as they evolve through propagation?

Classical Spectroscopy
The principle of conservation of energy in the real world dictates that all light signals constitutes finite pulses. Then, why do we not derive classical spectroscopic formula by directly propagating the carrier frequency of pulses, while taking care of their time-finite durations? Can a passive grating really decompose a pulse into its component Fourier frequencies and then separate them out? Then why do we need nonlinear optical media to generate new frequencies?

Resolution Limit of Classical Spectroscopy
Classical physics accepts the fundamental limit of spectrometric resolving power limit as $\delta\nu\delta t \geq 1$ for pulse of width δt. This is only a corollary of the time-frequency Fourier theorem. Can this mathematical corollary of the time-frequency Fourier theorem be a principle of nature when the parent theorem is not?