

ETOP 2017.
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**Consequences of repeated discovery and
benign neglect of non-interaction of waves
(NIW)**

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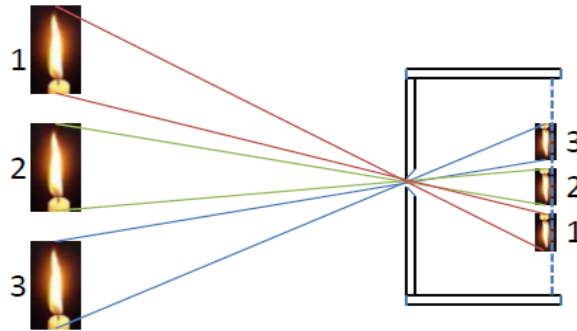
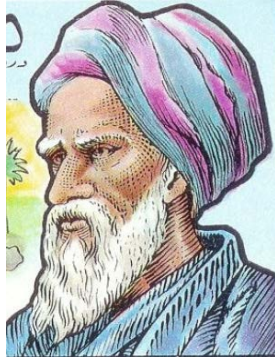
The Key Objectives

- ❖ We present a brief history of repeated discovery and benign neglect of Non-Interaction of Waves (NIW) along with some of the deep implications behind the modern explanations of major optical phenomena.
- 1. Had we recognized and appreciated NIW property of waves from the time of Alhazen, the evolutionary history of physics would have been dramatically different from what we have today.
- 2. The prevailing dominance of the postulate of wave-particle duality is keeping us confused from seeking out actual reality; and hence, we should abandon it and search out better models.
- 3. NIW it is not just semantics. Explicit recognition of NIW can guide us to explore new physics and invent better engineering tools and technologies.

Reference: “Causal Physics: Photon by Non-Interaction of Waves”, by C. Roychoudhuri, Taylor & Francis, 2014; Paperback, 2017.

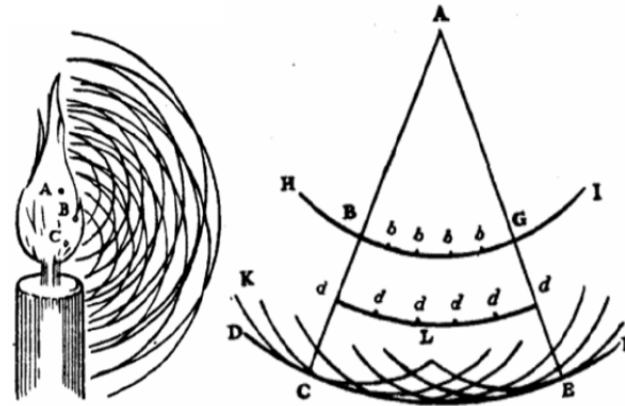
(A major part of the contents of this paper is being used as a “hand out” to promote the yearly workshop, “The nature of light: What are photons?”, at the SPIE Photonics West conference series.)

Ibn al-Haytham (Alhazhen), a major physicist (965 – 1040) of the Arab world



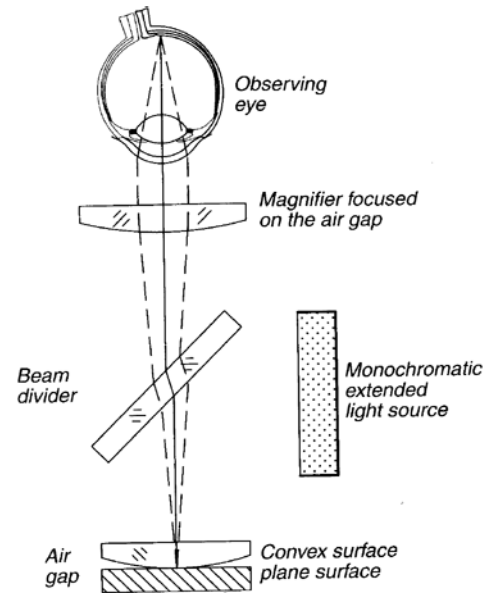
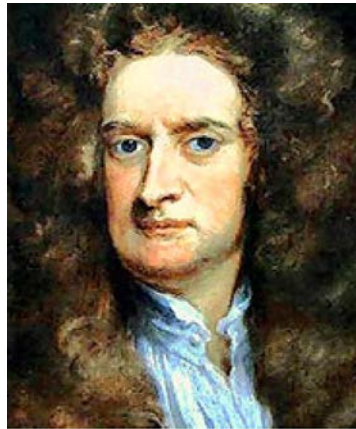
Alhazen, using an array of candles and a pin-hole camera, experimentally demonstrated that light beams cross through each other without destroying any information they are carrying.

Christian Huygens (1629 –1695)



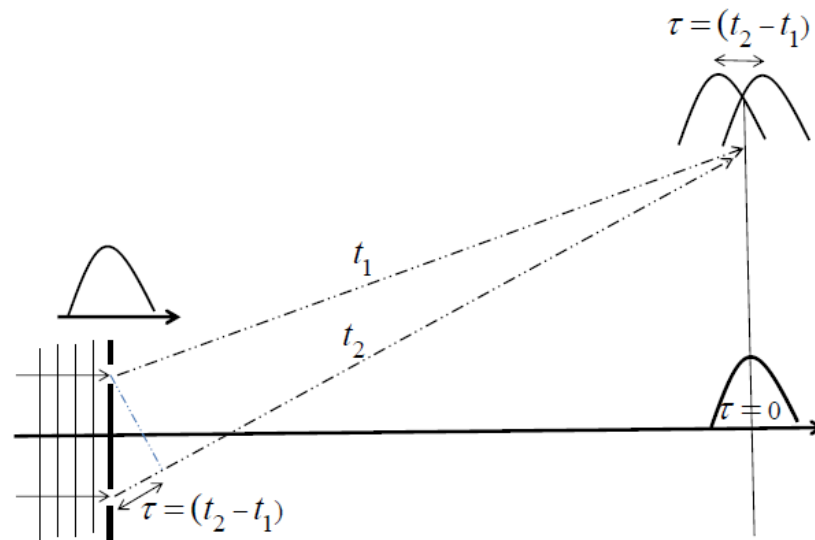
Huygens clearly wrote in his 1690 book that waves evolve by spreading diffractively through each other without altering each other physical properties.

Newton (1642 –1726).



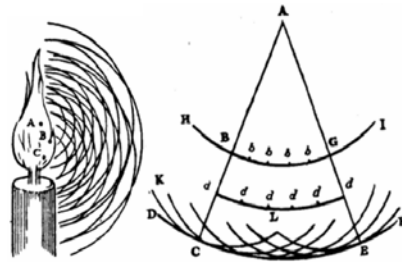
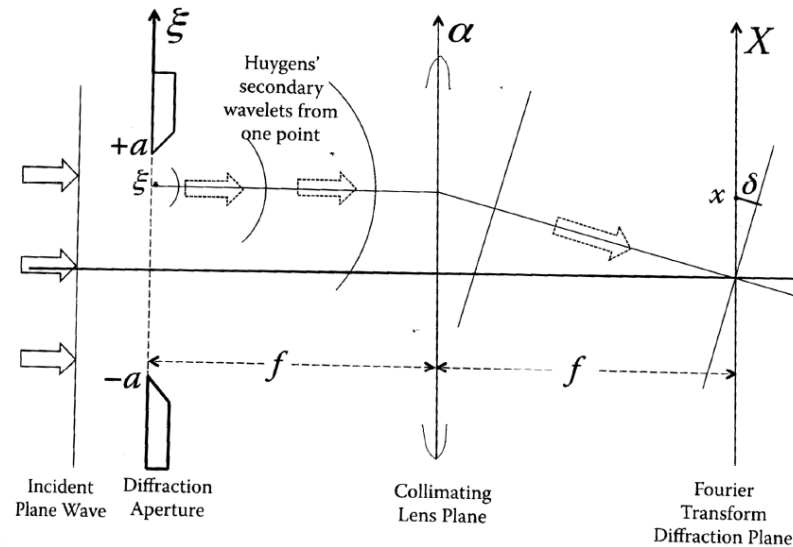
Newton was the first optical engineer to use an optical interferometer to measure the radius of curvature of his hand-polished plano-convex lens (for his telescope). But he missed recognizing that light is simultaneously getting transmitted and reflected by the same region of the beam splitter of the “Newton Interferometer” without altering each others’ intrinsic properties.

Thomas Young (1773 –1829)



Original proponent of the Superposition Principle (SP). In his time, it was almost impossible for him to imagine that the energy re-distribution due to the superposition of wave groups from the two different slits are not directly reorganizing their intensities by themselves. It was the molecules of the retinal “pixels” that were absorbing energy proportional to the square modulus of the sum of the joint stimulations induced by the fields coming from the two separate slits.

Augustin-Jean Fresnel (1788 - 1827).

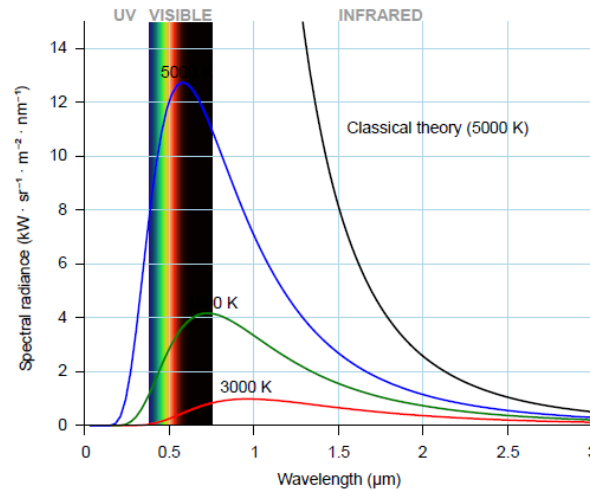


$$\Psi(P_0) = \frac{-i}{\lambda} \iint_{\Sigma} U(P_1) \frac{\exp(ikr_{01})}{r_{01}} \cos \theta \, ds$$

$$|\Psi(P_0)|_{Detector}^2 = \left| \frac{-i}{\lambda} \iint_{\Sigma} \chi(\lambda) U(P_1) \frac{\exp(ikr_{01})}{r_{01}} \cos \theta \, ds \right|^2$$

Fresnel gave us the famous Huygens-Fresnel diffraction integral, literally mathematically mapping Huygens non-interacting wavelets. But, he used Young's mathematically correct "Superposition Principle" without explicitly recognizing that his integral does not represent an observable, only a state of superposed propagation. Observable energy transfer happens to a detector after it takes the square modulus of his "amplitude" integral.

Max Planck (1858 –1947)



It is surprising that Planck, like Huygens, explicitly recognized in his 1914 book on the derivation of his Blackbody formula, that the “quantum packets” of light evolve diffractively spreading within the blackbody chamber without interacting with each other. That is why the thermal equilibrium can take place within the cavity without the need for introducing light-light integration process term. However, somehow people ran with his formula, without listening to his explanation for basic physics.

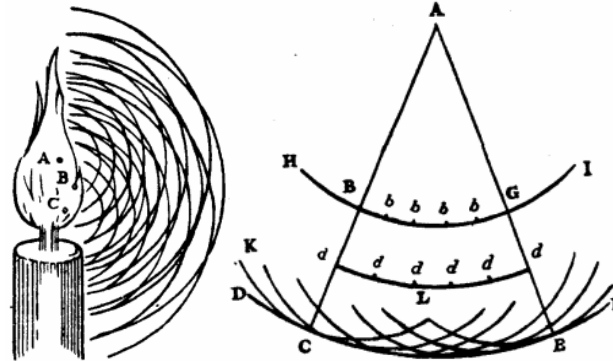
M. Planck, translated by M. Masius, [The Theory of Heat Radiation], now available from Dover and Gutenberg eBook; Blakistons Son & Co. (1914).

We should not underestimate the deeper physics behind Huygens Principle

Originator of the
Interaction Process
Mapping
Epistemology



1629–1695



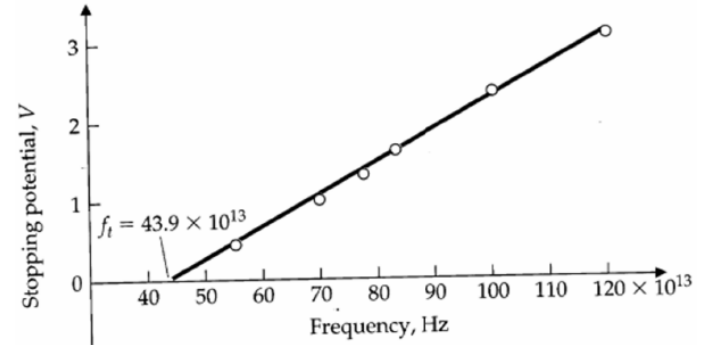
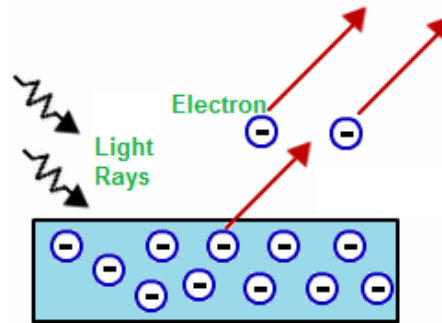
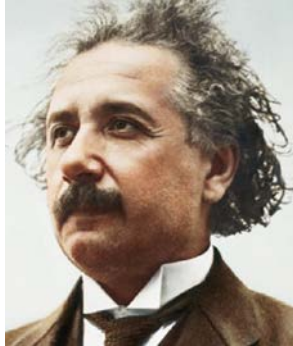
1. The Non-Interaction of Waves (NIW). “Treatise on Light” (1690).
2. Space is a Complex Tension Field (ether) to support the perpetual propagation of light waves.

We should celebrate the continued and successful guidance provided by the Huygens-Fresnel diffraction integral from early 1800 till today



$$\Psi(P_0) = \frac{-i}{\lambda} \iint_{\Sigma} U(P_1) \frac{\exp(ikr_{01})}{r_{01}} \cos \theta \, ds$$

Albert Einstein (1879 –1955)

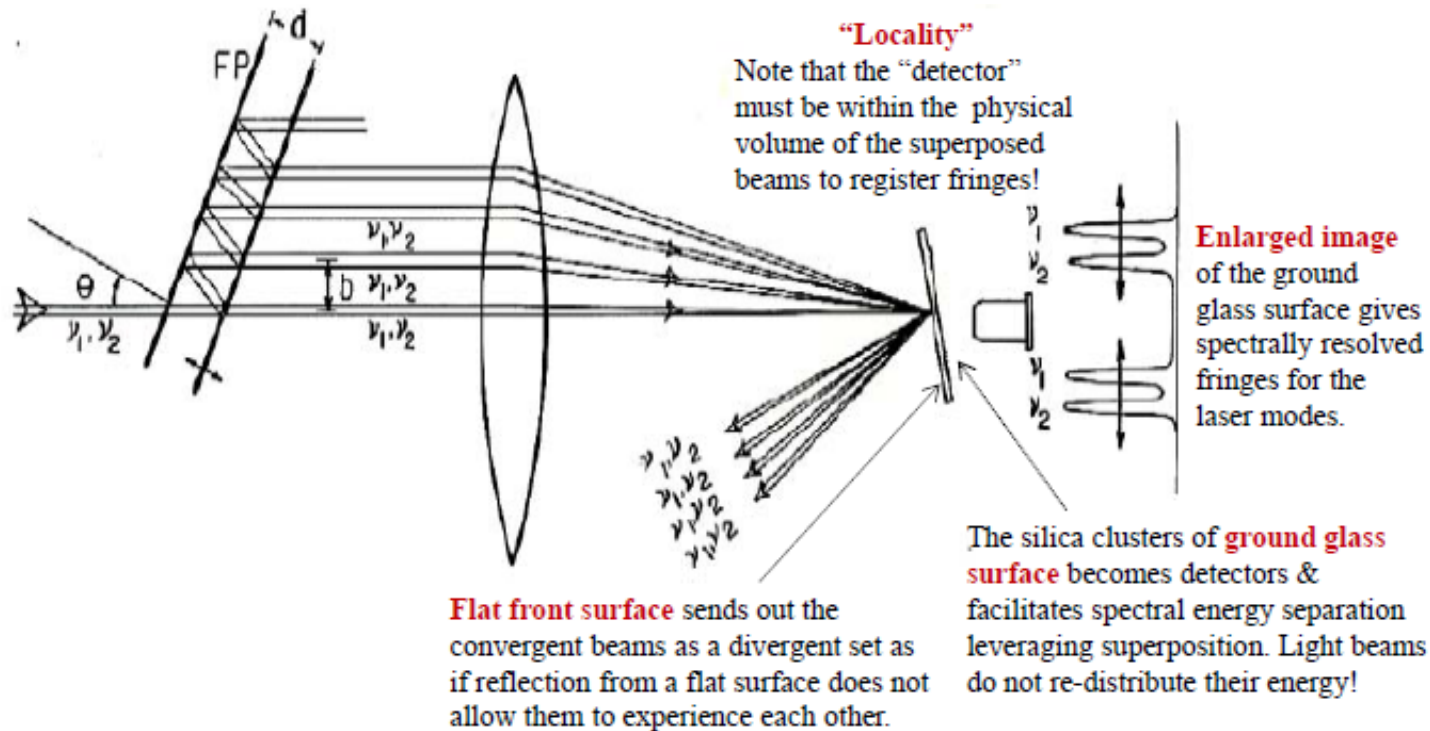


Einstein broke all the barriers of earlier views and concepts, including the hybrid photon model of Planck. He used the measurable data-modeling epistemology and assigned the observed quantumness in the photoelectric data as due to EM waves. This was 20 years before the formulation of quantum mechanics. So, it was not known that all electrons are always bound in materials with discrete quantum mechanical energies. Had he assigned the quantumness to electrons, he could have formulated quantum mechanics with his own logic. Besides, reformulation of his photoelectric equation due to simultaneous stimulation by many wave packets would have yielded Non-Interaction of waves

$$\langle |\psi_{res.}|^2 \rangle = \langle \left| \sum_q \chi(\nu_q) E(\nu_q) \right|^2 \rangle \propto \langle h\nu_q \rangle = \langle \phi_{work\ fn.} + (1/2)m v_{el.}^2 \rangle$$

Einstein did say that in spite of 50 years' of brooding, he was still confused about what "indivisible light quanta" are.

Author came to realize the NIW-property in a 1975 experiment, without knowing the historical background

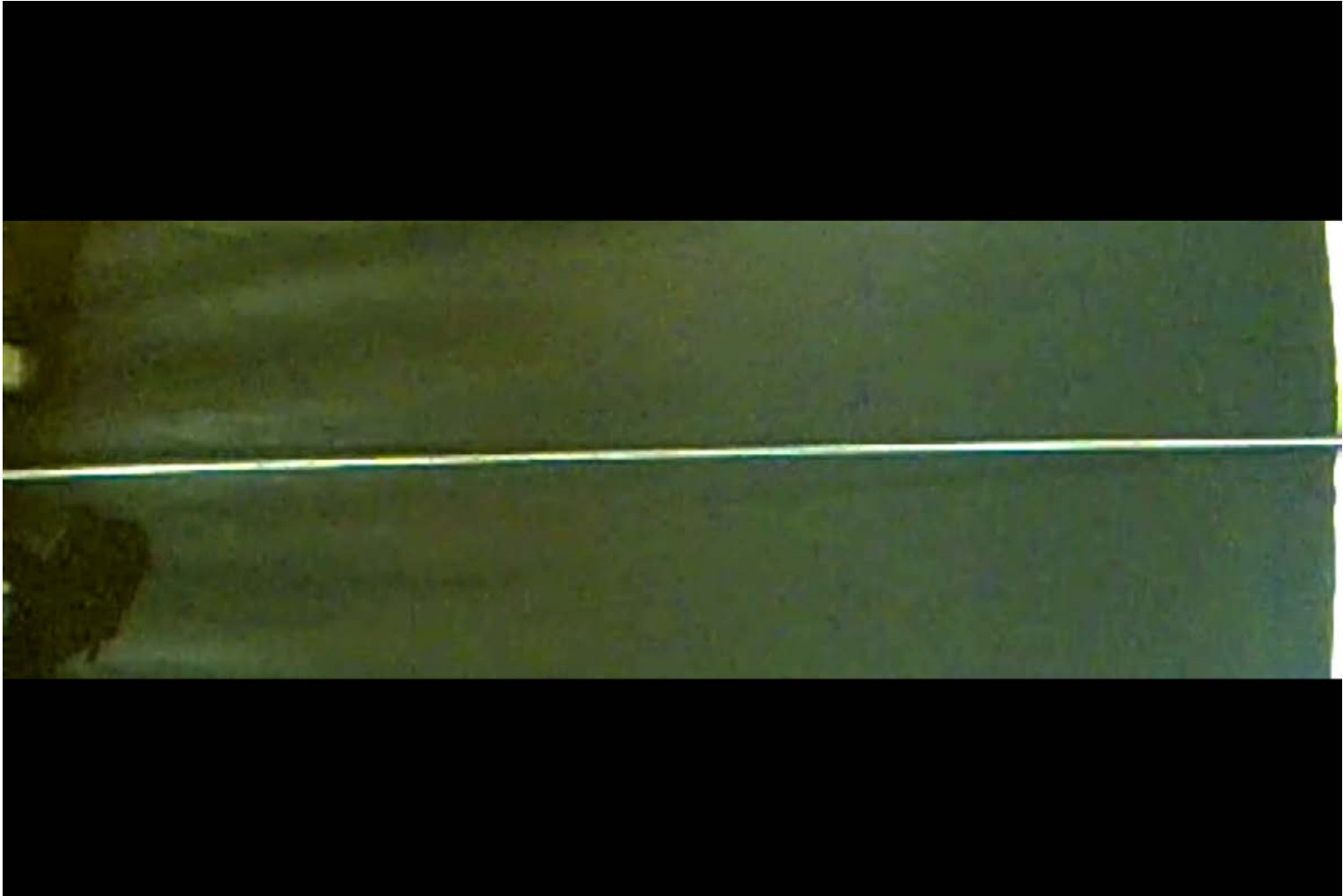


**The NIW-property is true for all linear waves:
Case for water surface tension waves.**



Appreciation: (i) Michael Ambroselli, my PhD student, for video recording and processing

**The NIW-property is true for all linear waves:
Case for the mechanical tension wave in a spring.**



Appreciation: (i) David Park, a high school student for diverting me to use spring instead of rope. (ii) Michael Ambroselli for video recording and processing.

**The NIW-property enhances the conceptual foundation
of Classical Optics by facilitating the following changes:**

- 1. Spectrometry:** Recognize spectrometers' characteristic time constants and their temporal evolutionary behavior by propagating carrier frequency of time finite pulse, instead of non-causal Fourier monochromatic mode, which does not exist. Resolving power is never limited by the Fourier bandwidth.

- 2. Coherence:** Replace “coherence property of waves” by “correlation property of detectors” and recognize their (i) intrinsic “Time Averaging” property and (ii) “Time integration” property detecting system (process).

- 3. Laser Mode Lock:** Replace “Mode Lock” concept (modes sum to create energy pulses), by “Time Gating” behavior by intra-cavity phase locker.

- 4. Dispersion:** Drop the concept and the theory of “Group Velocity”. It is based upon non-causal mathematical assumptions. Ignores NIW-property.

- 5. Polarization:** Drop the concept of elliptical polarization. E-Vectors do not sum to spin helically. Jones' matrix correctly propagates orthogonal E-vectors.

- 6. Photons:** Photons are diffractively expanding classical wave packets conforming to QM frequency and energy requirements. “Indivisible light quanta” is not a causal postulate.

The NIW-property enhances the conceptual foundation of physics

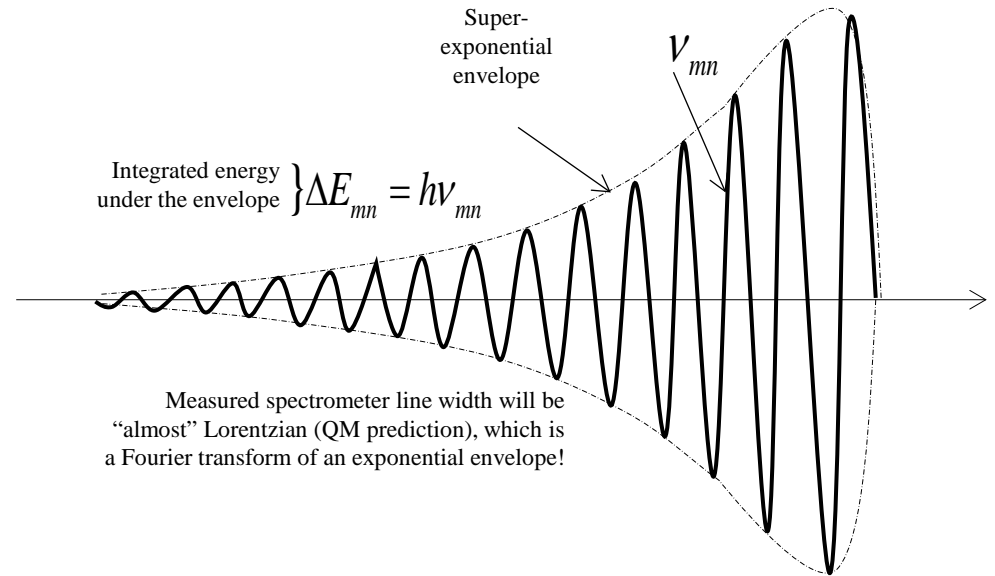
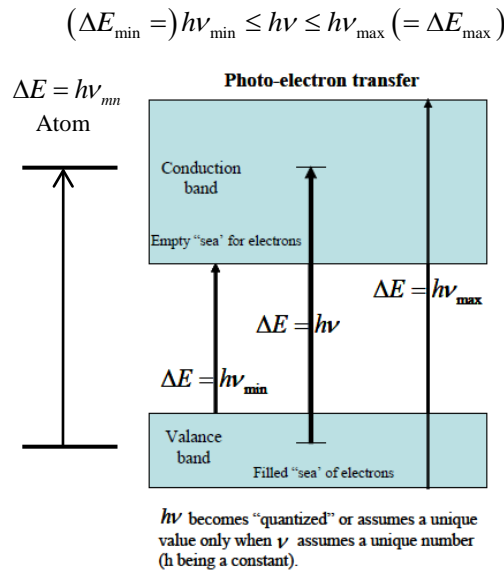
1. Replace Einstein's "**indivisible quanta**" by Planck's divisible classical wave packet, while energies of photo electrons are quantized.
2. Replace Dirac's "**A photon interferes only with itself**", by "A detector's simultaneous stimulations due to multiple excitations, create superposition effect".
 3. Replace Dirac's photon as a "**Fourier mode of the vacuum**" by "Classical wave packet of the "Complex Tension Filed (CTF)".
 4. Replace "**Space as Vacuum**" by "Space as Complex Tension Field (CTF)". Re-instate improved "ether" by "CTF".
5. Replace Born's interpretation of ψ as "**mathematical probability amplitude**" by physical stimulation of internal structure of particles.
 6. Drop "**Bell's In-equality theorem**" as it does not map Superposition Effect and re-instate "EPR Reality & Locality".
7. Replace "**Uncertainty Principle**" by "information retrieval problem"
8. Replace "**Relativistic Doppler Effect**" by "Classical Doppler Effect". Actual and measured Doppler shifts are different for source movement and detector movement. Drop "**Expanding Universe**" by "Stationary Universe".
 9. Replace de Broglie's "**pilot wave**" $\lambda = h / p$ [$\rightarrow \infty$ for $v = 0$], by internal harmonic frequency proportional to its kinetic energy.
10. Replace "**wave-particle duality**" by separate realities for waves and for particles.
11. Replace "**4-D Space**" by "3-D Space" since running time is not measurable physical attribute of anything in this universe; frequency is.

Thank you for your attention !



So what would a photon be?

A hybrid photon model: a quantum at emission that evolves as a wave packet.
The quantum-cup postulate bridges classical and quantum optics.



- ❖ 1. All photon energy packets emitted through spontaneous and stimulated emission processes evolve into super-exponential classical pulses, which can co-propagate or cross propagate without interacting with each other.
- ❖ 2. Super-exponential pulses evolve through diffractive spreading following Maxwell's wave equation (and hence, follow Huygens-Fresnel's diffraction integral).
- ❖ 3. Under the condition of frequency-resonant stimulated absorption, atoms and molecules behave as *Quantum Cups*, to accept the necessary quantity of energy *hν*

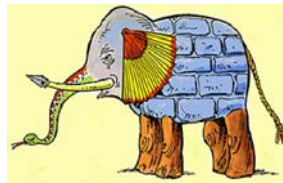
“Evidence based science” does not represent our FINAL knowledge about nature!

It is not the “Measurement Problem”; it is the “Information Retrieval Problem”!
Take cues from the ancient philosophers:

Some 6-thousand years old Indian allegorical story: We are all “blind”. The model of the Cosmic Elephant derived out of our individual sensorial input is quite limited. But *collaborative synthesis brings out somewhat better reality.*

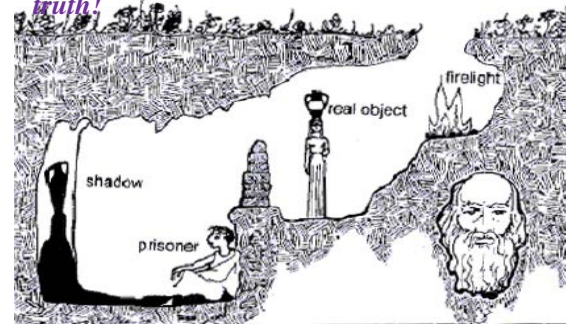


Detailed reality invisible to blinds.



Model from synthesis of multitudes of observed data.

Plato’s (~428-348 BC) allegorical story of interpreting reality behind the shadows cast by external light by cave-dwelling people.
Experimental evidence does not contain all the truth!



“Evidence based science” does not represent our FINAL knowledge about nature!

There is no “Measurement Problem”! It is a perpetual Information Retrieving Problem

- **1. Measurables Are Transformations:** We can measure only physical transformations.
- **2. Preceded by Energy Exchange:** There are no transformations without energy exchange.
- **3. Guided by Forces of Interaction:** Energy exchange, and consequent transformations, must be guided by an allowed force of interaction.
- **4. Must Experience Physical Superposition:** Interactants must be within each other’s sphere of influence to be able to interact under the guidance of an allowed force to exchange energy and undergo transformations. Thus, all **interactions producing transformations must be “local”!**
- **5. Through Some Physical Interaction Process:** The understanding & visualizing the invisible interaction process anchors us to inch towards understanding cosmic logics (reality).

We can never gather all the information about anything through any set of experiment since the details of none of the interaction processes and those of the interactants are completely known to us, as yet. But the rules (cosmic logics) behind **interaction processes are invariant**, which we are after!

Let us take cues from the founders of physics



“If I have seen further than other men, it is by standing on the shoulders of giants.”



“.....After 50 years’ of brooding over the question of what are light quanta; I still do not understand it!”

How do we know this is true?

Learning to distinguish between SP & SE

Observable Superposition Effect is a Quadratic Energy Exchange Process.

Mathematical rule can fool us!

Generalized SE:

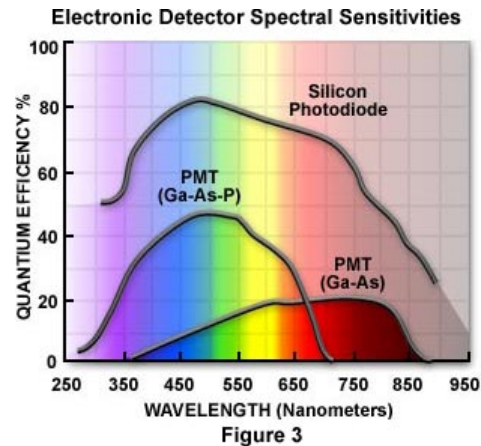
$$D_{Det.} \equiv |\Psi_{total}|^2 = \left| \sum_n \chi_n(\nu_n) E_n(\nu) \right|^2$$

$$= \left| \sum_n \chi_n(\nu_n) a_n(t) \exp(i2\pi\nu_n t) \right|^2$$

Only for an extremely narrow band of frequency, can one assume the constancy of the linear dipolar stimulation factor, and re-write:

$$D_{Det.} \equiv |\Psi_{total}|^2 = \chi^2 \left| \sum_n E_n(\nu) \right|^2 = \chi^2 \left| \sum_n a_n(t) \exp(i2\pi\nu_n t) \right|^2$$

Does this imply **waves can sum themselves**, or operate on each other and re-organize their spatial and temporal energies? Can human mathematical rule dictate nature how she ought to behave?, **Or, her causal rules dictate how humans should learn to re-organize their logical thinking and mathematics?**



From the web



Are there any questions?

- ❖ We never know **what is absolutely true!**
- ❖ Physics must try to map the **interaction processes.**
- ❖ Technology innovation is simply emulation of **interaction processes** allowed in nature
- ❖ Demand on process visualization will automatically force us to **keep on iterating our theories for continuous evolution.**
- ❖ Working theories should be used to explore our **further ignorance** about nature.

My paper download site through UConn Physics: <http://www.natureoflight.org/CP/>