What are the *physical processes* behind a 50% beam combiner behave as a 0 to 100% reflector/transmitter inside an MZ or a Fabry-Perot interferometer?

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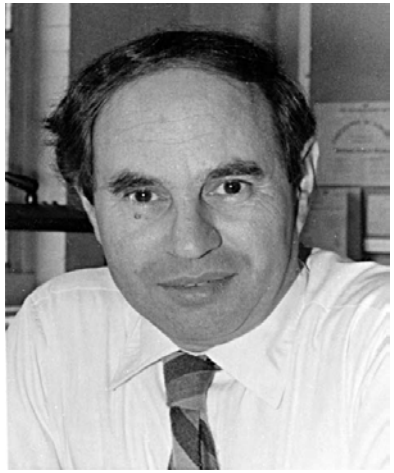
Reverences

1. Except the MZ experiments & videos, rest of the concepts can be found elaborated in my book, "Causal Physics: Photon Model by Non-Interaction of Waves"; Taylor & Francis, 2014: https://www.amazon.com/Causal-Physics-Photons-Non-Interactions-Waves/dp/1466515317/ref=sr_1_1?s=books&ie=UTF8&qid=1501859995&sr=1-1&keywords=causal+physics
2. My publication download site: http://www.natureoflight.org/CP/
3. To participate in the advanced web discussion, go to the site: https://www.natureoflight.org/

A very brief history on how I ended up doing my PhD at the Institute of Optics, U of R, where I am giving this colloquium today!

A very useful carrier change: a transfer from Physics to Institute of Optics



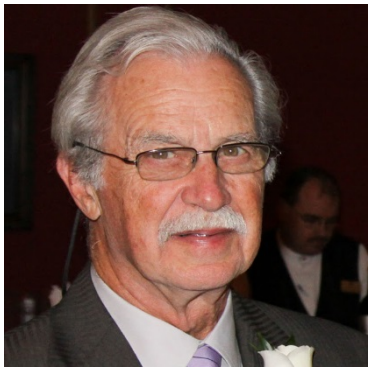
Leonard Mandel

I had written in my application to the Physics Department that I would like to study ***what photons are***! So Mandel interviewed me and transferred me to Brian Thompson! His suggestion was that I must first learn the filed of optics as deeply as I can!

My research advisers

2010; Brian Thompson

In 1969, I started working under Brian Thompson on measuring coherence properties of pulsed Ruby & Nd-Glass lasers.



Michael Hercher

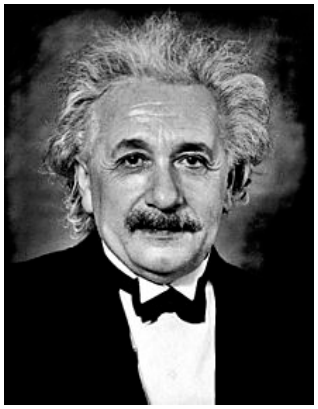
As ARPA contract finished up, I was transferred under Hercher. He had come up with a novel design concept for a supper-stable, super-resolution multi-pass ***Fabry-Perot*** Spectrometer to directly resolve Brillouin spectra of materials.

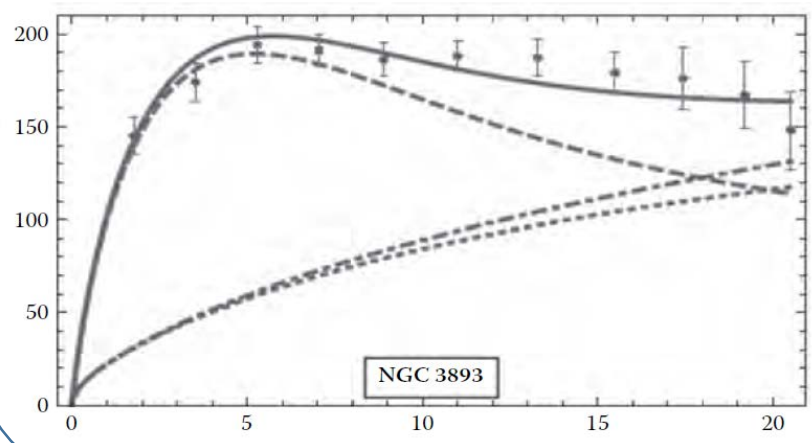
Laser cavity design, Coherence and Spectroscopy became my "expertise".

Now, back to the planned colloquium!

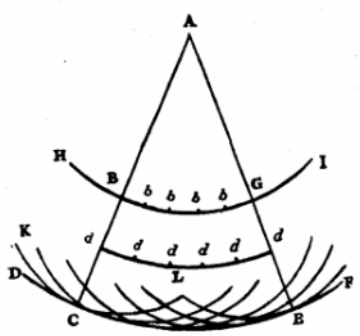
Why do physicists neglect Huygens Principle?

Neither of the Gravity theories can correctly predict the velocity distribution of the stars in galaxies





Optical science and engineering cannot survive without Huygens-Fresnel Diffraction integral based on "Secondary Wavelets"



References (Semi-classical approach)

[1] E.T. Jaynes and F. W. Cummings, “Comparison of Quantum and Semi-Classical Theories of Radiation with Application to the Beam Masers.”, Proc. IEEE Vol. 51, 89(1963).

[2] W. E. Lamb, Jr., *Interpretation of Quantum Mechanics*, (Rinton Press, Inc., 2001).

[3] G. Grynberg, A. Aspect and C. Fabre *Introduction to Quantum Optics: From the Semi-Classical Approach to Quantized Light.* (Cambridge U. Press, 2010). Free download: file:///F:/3_Ref._E-Books_160315/Quantum%20Optics/2012_Semiclas.QM-Grynberg.pdf

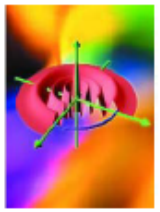
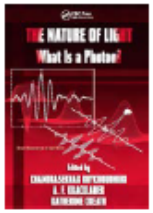
[4] Cray, M.; Shih, M.-L. & Milonni, P. W, “Stimulated emission, absorption, and interference”, Am. J. Phys., Vol. **50** (11), pp.1016-2021 (1982).

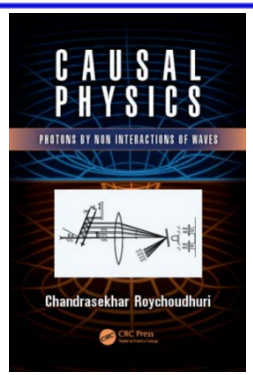
[5] C. Roychoudhuri & R. Roy, *What is a photon?* A special issue of OPN, October, 1993.

[6] C. Roychoudhuri, *Causal Physics: Photon Model by Non-Interaction of Waves* (Taylor & Francis, 2014; paperback 2017).

[7] C. Roychoudhuri, “Response of Fabry-Perot interferometers to light pulses of very short duration”, JOSA Vol.65 (12), p.1418, 1975.

A short history behind this colloquium

2003	2005	2007	2008	2008	2009	2011	2010,11,12…
							
Optics and Photonics News Special Issue; October 2003 Guest Editors: C. Roychoudhuri and R. Roy	**SPIE Proc. Vol.5866** Conference Editors: C. Roychoudhuri, K. Creath & A. Kracklauer	**SPIE Proc. Vol.6664** Conference Editors: C. Roychoudhuri, K. Creath & A. Kracklauer	**W-EPR Workshop** Organizer Roychoudhuri	**CRC: What is a Photon?** Editors: C. Roychoudhuri, K. Creath & A. Kracklauer	**SPIE Conf.** Chairs: Roychoudhuri Kracklauer Khrennikov	**SPIE Conf.** Chairs: Roychoudhuri Kracklauer Khrennikov	**SPIE Conf.** Speaker: Roychoudhuri

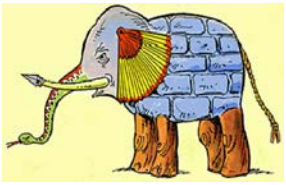


“Evidence based science” does not represent our FINAL knowledge about nature!

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

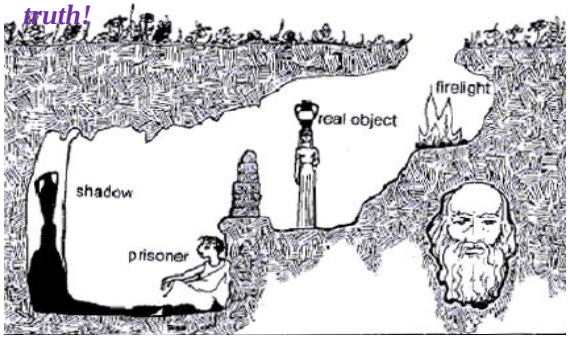
Some 6-thousand years old Indian allegorical story: We are all “blind”. The model of the Cosmic Elephant derived out of our individual sensorial input is quite limited. But ***collaborative synthesis brings out somewhat better reality***.

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!

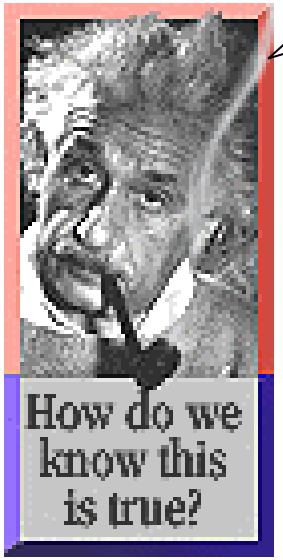
There is no “Measurement Problem”! It is a perpetual Information Retrieving Problem

- **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!"

The key enquiring “take-away” concepts from this colloquium

❖ ***Non-Interaction of Waves (NIW) ……..***

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- **EM waves do not require quantization for an electron to be released or to be excited to a higher energy level.** However, electron emission IS a quantum mechanical process as they are always bound in materials (bulk or isolated atom) quantum mechanically. EM wave frequency must be resonant to induce dipolar stimulations and a **quantum cupful** of energy, $E = h\nu$, is collected from all the wave groups present.

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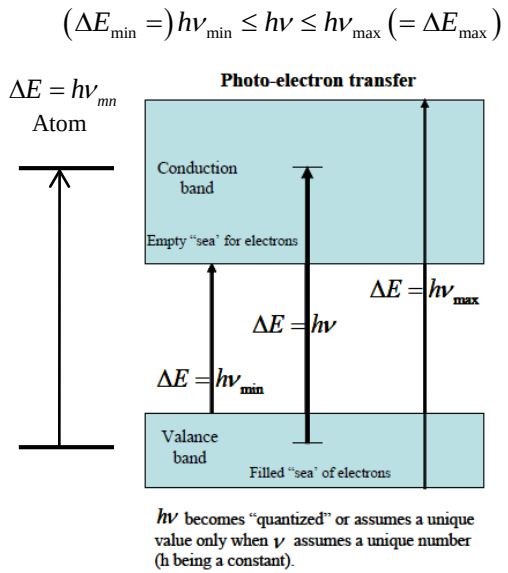
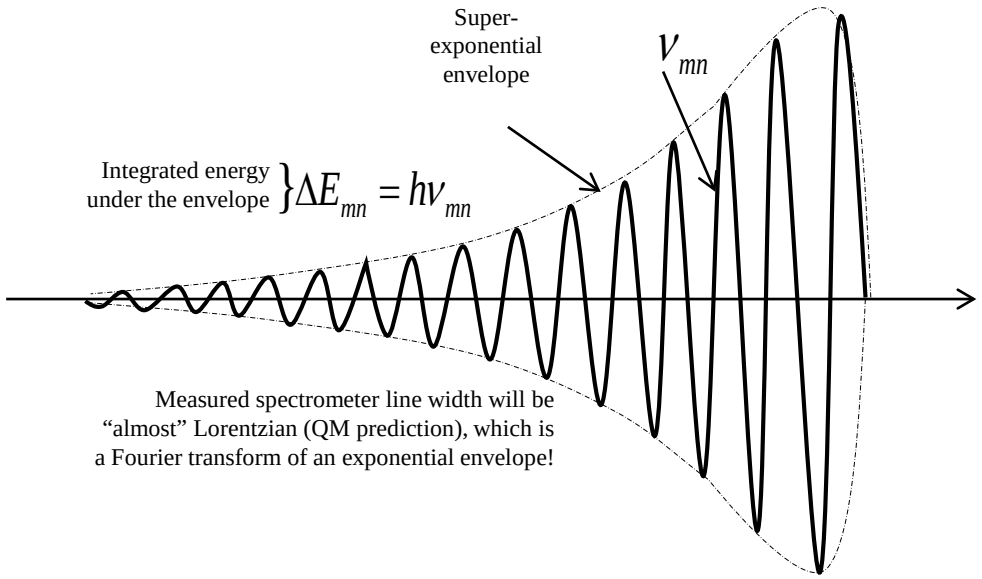
- ***Humans are not OBSERVERS*** in the broad sense. We are separate from the data gathering apparatus. **We are INFORMATION generators (**interpreters of data registered by our bodily and other engineered sensors). We are neural network driven thinking species, hard-wired for survival, rather than to be objective scientists. Observer and observed are separate.

So what would a photon be?
The map of a photon congruent with most observations – a classical pulse!





- 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 $h\nu$

Back to appreciating
Non-Interaction of Waves (NIW)

Why have we kept on missing the NIW-property?

"A photon is what a photodetector detects."

Glauber,

- **In spite of Glauber's articulation of the importance and active role of detectors, our basic superposition equation does not explicitly incorporate detector's dipolar polarizability factor that initiates the superposition effects.**

Learning to distinguish between SP & SE and discovering NIW

Learning to distinguish between SP & SE

Observable Superposition Effect is a Quadratic Energy Exchange Process.

Mathematical rules can fool us!

Generalized SE:

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

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

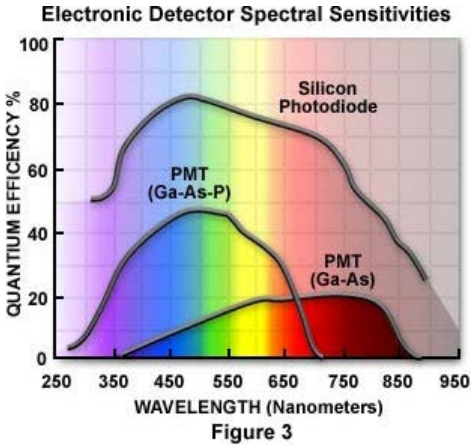


Figure 3

From the web

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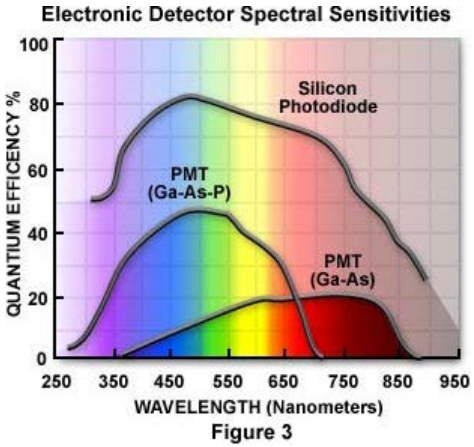

Figure 3

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

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

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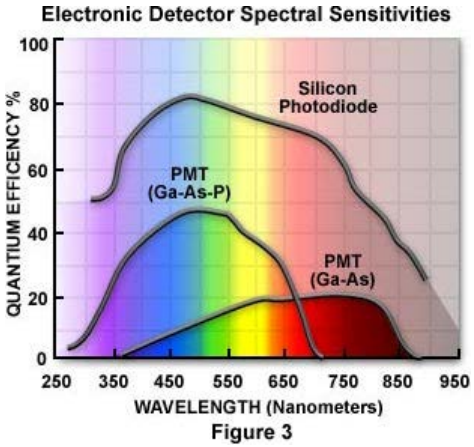

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Does this imply ***waves can sum themselves***, or operate on each other and re-organize their spatial and temporal energies? Can human mathematical rule dictate nature how she ought to behave?, ***Or, her causal rules dictate how humans should learn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

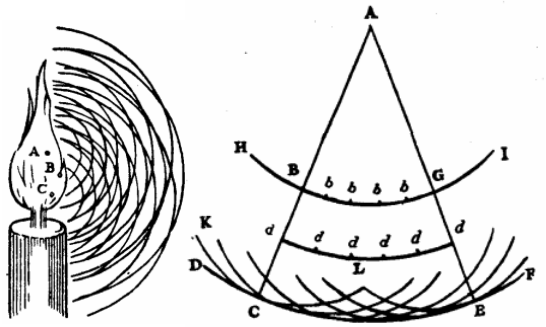
Even Huygens-Fresnel diffraction integral faithfully obeys Huygens' principle of non-interaction of secondary wavelets!

But, of course, we have succeeded in remaining oblivious to the physical implications.

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

Originator of the Interaction Process Mapping Epistemology **(IPM-E)**

1629–1695



The geometry is based on the assumption of the NIW-property.

Huygens explicitly articulated Non-Interaction of Waves (NIW)

- "For I do not find that any one has yet given a probable explanation of the first and most notable phenomena of light, namely why it is not propagated except in straight lines, and how visible rays, coming from an infinitude of diverse places**, cross one another without hindering one another in any way."** From p.2 in "Treatise on Light" by Huygens (1690). In p4. he clearly anticipated the existence of a universal tension field like pressure tension of air, but without material particles.

Learning to distinguish between SP & SE

Standard mathematical Superposition Principle (SP) does not represent any physical interaction process.

Generalized SP: $$E_{total} = \sum_n E_n(\nu) \equiv \sum_n a_n(t) \exp(i 2\pi \nu_n t)$$

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

Learning to distinguish between SP & SE

Standard mathematical Superposition Principle (SP) ***does not represent any physical interaction process*****.**

Maxwell's SP: $$E_{total} = \sum_n E_n(\nu) \equiv \sum_n a_n(t)\exp(i2\pi\nu_n t)$$

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

Re-write SP as a ***physical process*****; which would lead to measurable Superposition Effect (SE).**

Generalized SP: $$\Psi_{total} = \sum_n E_n(\nu) \equiv \sum_n \chi_n(\nu_n)a_n(t)\exp(i2\pi\nu_n t)$$

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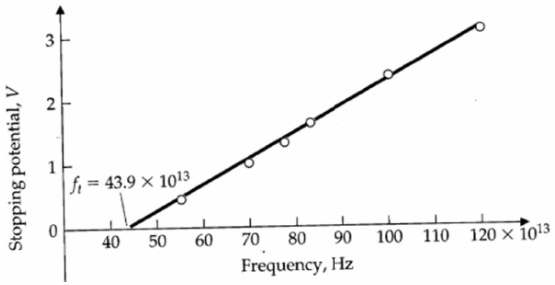
In general, the polarizability parameter cannot be taken out of the integral as a detector constant.

SP vs. SE & the photo-electric equation & the interaction process



Millikan's plot of photoelectric effect

Einstein's heuristic eq. wrongly assigns the "quantumness", he discovered, to the EM waves, rather than to bound electrons:

$$h\nu = \phi_{work\ fn.} + (1/2)m\mathrm{v}^2_{el.}$$

Elementary stimulation of the electron holding dipole complex:

$$\psi = \chi(\nu_q)E(\nu_q)$$

There are always multiple wave packets:

$$\psi_{res.} = \sum_q \chi(\nu_q)E(\nu_q)$$

Release of each bound electron requires a quadratic energy absorption process (filling the "Quantum Cup":

$$\left|\psi_{res.}\right|^2 = \left|\sum_q \chi(\nu_q)E(\nu_q)\right|^2 \Leftarrow \left[h\nu_q\right]_{QM\ Cup}$$

Recovering Einstein's Eq.

See slide #20 in, "Urgency of evolution process congruent thinking in physics"; Proc. SPIE Vol. 9570, paper #7 (2015).

Only ensemble average can generate a data-curve:

$$\left\langle\left|\psi_{res.}\right|^2\right\rangle = \left\langle\left|\sum_q \chi(\nu_q)E(\nu_q)\right|^2\right\rangle = \left\langle h\nu_q\right\rangle_{Many\ QM\ Cups}$$

$$= \left\langle\phi_{work\ fn.} + (1/2)m\mathrm{v}^2_{el.}\right\rangle$$

If we use a very narrow frequency radiation, the polarizability factor will be a constant & we can get the mistaken concept that wave amplitudes sum themselves even in the absence of interacting materials::

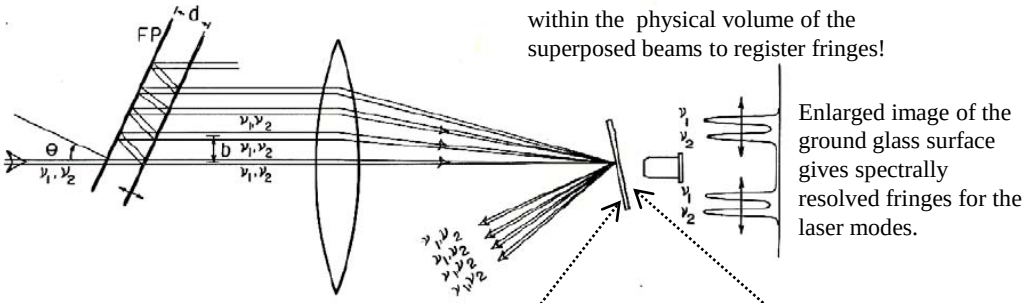
$$\left|\psi_{res.}\right|^2 = \left|\sum_q \chi(\nu_q)E(\nu_q)\right|^2 = \chi^2\left|\sum_q E(\nu_q)\right|^2$$

However, discovering NIW was an arduous path with decades of self-doubt!

I recognized the formality of un-perturbed propagation of crossing light beams only in 1975; and even that through an expensive and complex experiment! But, with some new enlightenment: Scattering particles can generate Superposition Effect!

It is not Quantum Mechanical!

Multiple parallel beams, produced by a tilted Fabry-Perot, made to converge on an one-sided ground glass. The laser beam contains two frequencies.



"Locality"
Note that the "detector" must be within the physical volume of the superposed beams to register fringes!

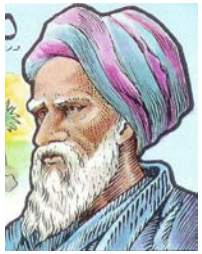
Enlarged image of the ground glass surface gives spectrally resolved fringes for the laser modes.

Flat front surface sends out the convergent beams as a divergent set as if reflection from a flat surface does not allow them to experience each other!

The silica clusters of **ground glass surface** becomes detectors & facilitates spectral energy separation leveraging superposition. Light beams do not re-distribute their energy!

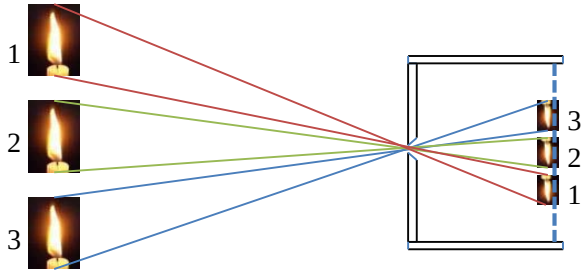
• C. Roychoudhuri; Am. J. Phys. 43 (12), 1054 **(1975)**; "Demonstration Using a Fabry-Perot. I. Multiple-Slit Interference".
• C, Roychoudhuri; Bol. Inst. Tonantzintla 2 (2), 101 (**1976**); "Is Fourier Decomposition Interpretation Applicable to Interference Spectroscopy?"

Alhazen experimentally noted in his book that light beams pass through each other unperturbed. It was around 1080, or earlier! A brilliantly simple experiment!



~965-1040

Alhazen's experiment



Light beams freely pass through each other!

Unperturbed, inverted images are formed, even though different candle light are crossing through each other at the pinhole.

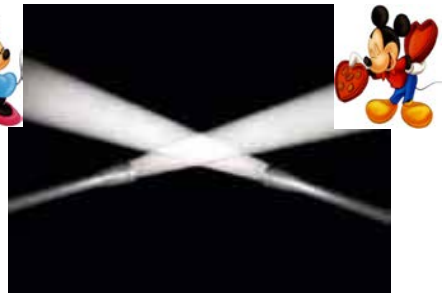
Generalizing
Non-Interaction of Waves

More common sense observations!

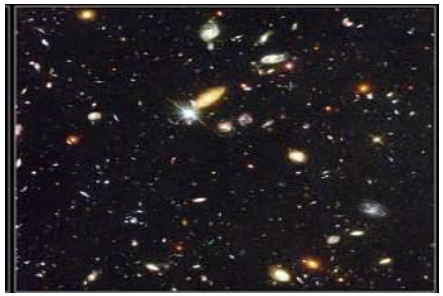
In the linear domain, all waves pass through each other unperturbed. Different harmonic undulations of the same tension field cannot exert any force of interaction on each other.

Otherwise these observations would not have been possible?

The visual world would have been full of spatial and temporal scintillations (speckles).



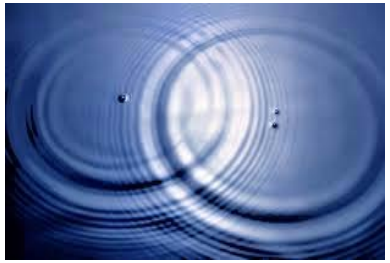
Light waves



"Hubble deep field galaxies". Expanding universe, indicated by Doppler shift, would not have been measurable.

We can here each piece of an orchestra team, because sound waves of different frequencies co-propagate while remaining unperturbed.

Sound waves



Water waves

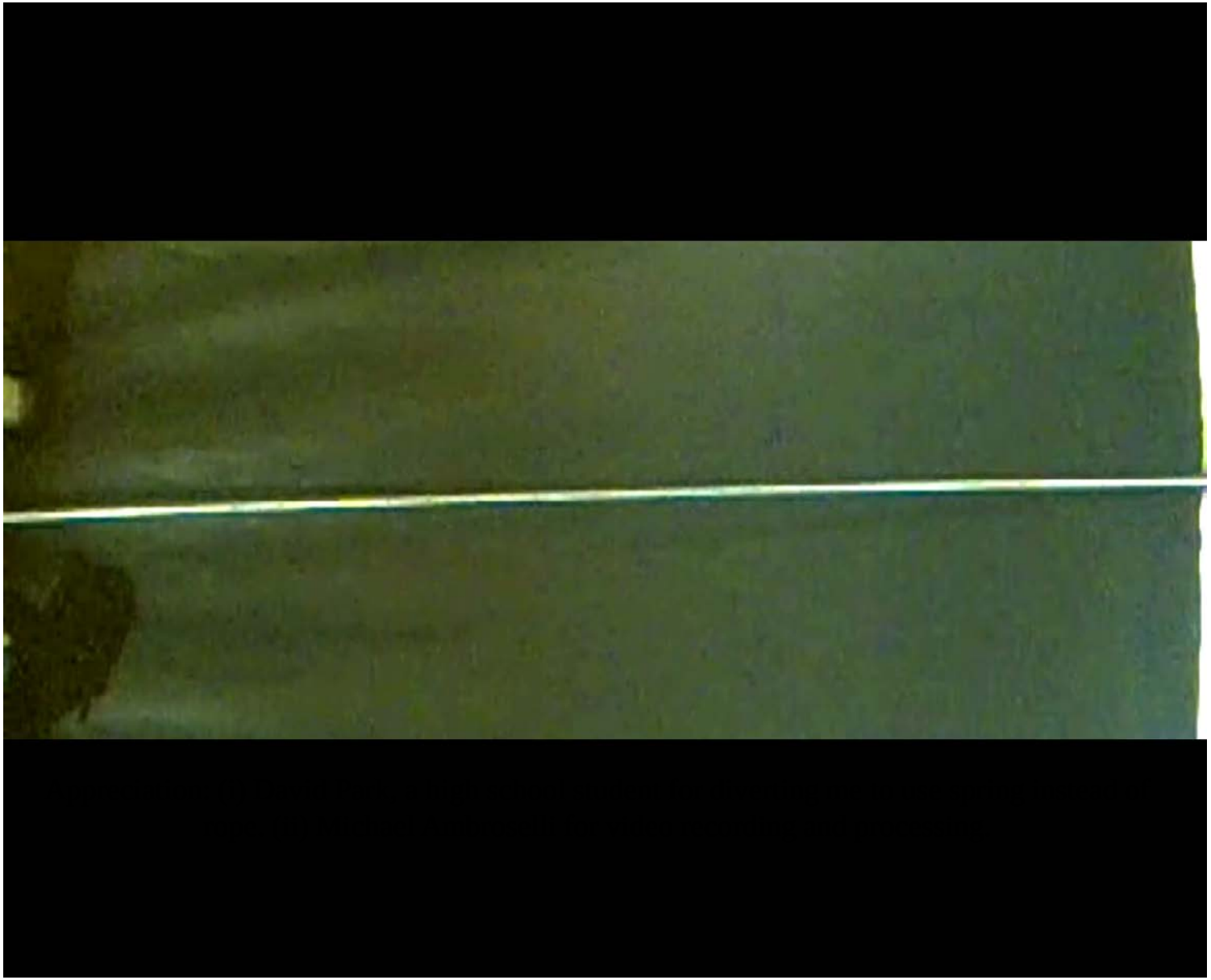
Water waves pass through each other unperturbed.

We have been ignoring the absence of any physical interaction process (force) between waves!

Waves (excitation) of water surface-tension field pass through each other without interacting.

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

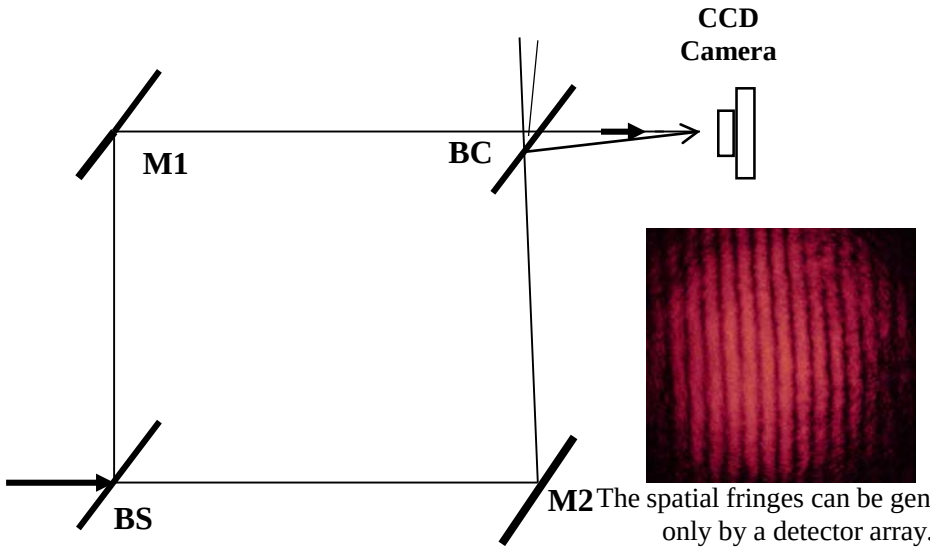
Waves (excitation) of spring-tension field pass through each other without interacting



Let us look at the Superposition Effect as a pure classical light-matter interaction process

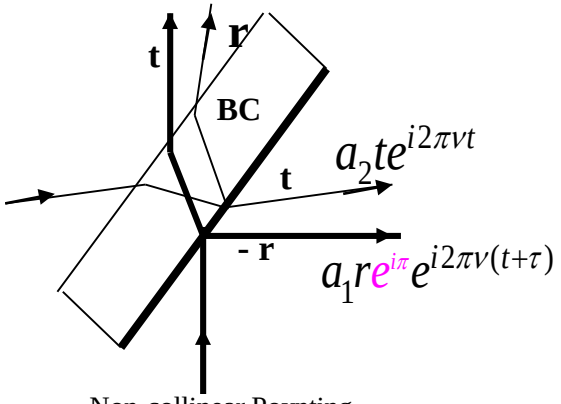
Traditionally we use interferometer in the *"fringe mode"*

If the Poynting vectors are non-collinear, the BC remains constant at 50% for both the directions.



The spatial fringes can be generated only by a detector array.

The detector pixels determine the recorded energy variation as spatial fringes



Non-collinear Poynting vectors

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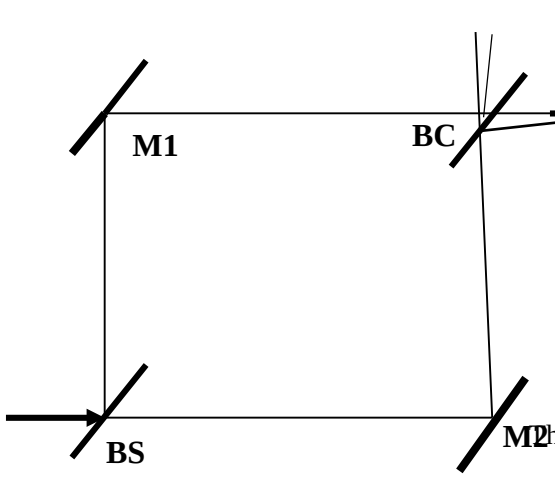

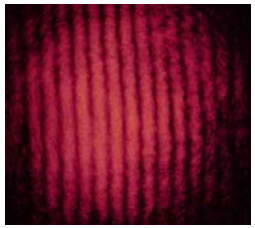

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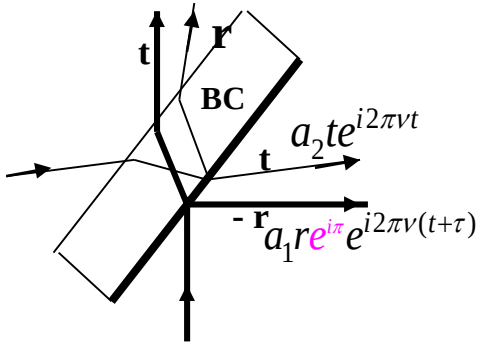


Non-collinear
Poynting vectors

$$D(\tau) = \left|\chi a_1 r e^{i\pi} e^{i2\pi\nu(t+\tau)} + \chi a_2 t e^{i2\pi\nu t}\right|^2 = \chi^2 \left|a_1 r e^{i\pi} e^{i2\pi\nu(t+\tau)} + a_2 t e^{i2\pi\nu t}\right|^2$$

$$= \chi^2[(a_1^2 r^2 + a_2^2 t^2) - 2a_1 a_2 tr\cos 2\pi\nu\tau]$$

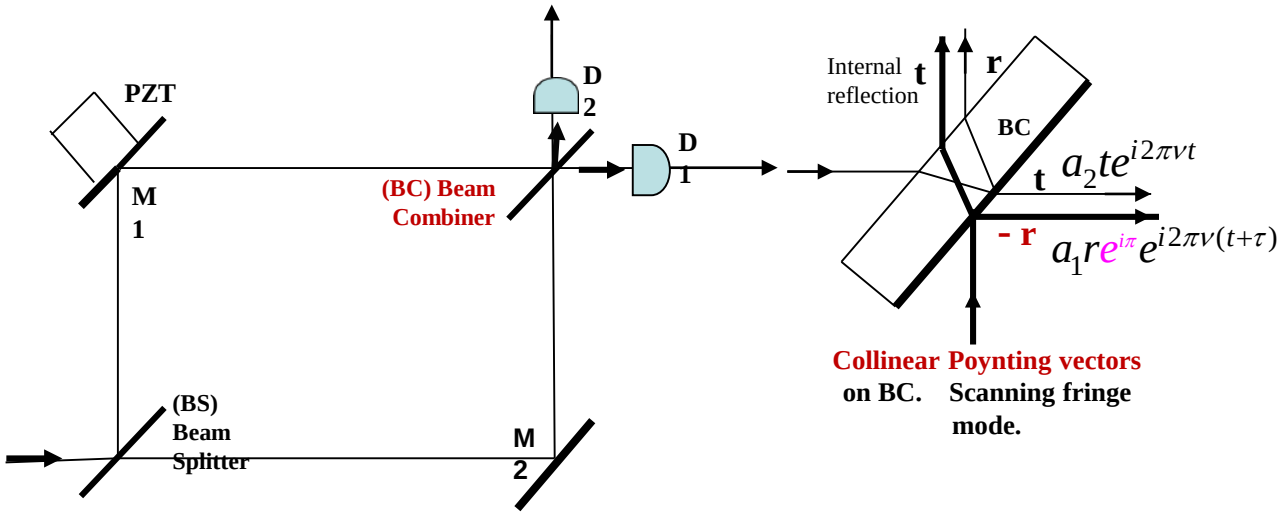
$$= 2\chi^2 a^2[1 - \cos 2\pi\nu\tau];\ when\ r^2 = t^2 = 0.5 \text{ and } a_1 = a_2 = a$$

$\Uparrow$ Linear dipolar polarizability of the detector molecules.

But deeper enquiry becomes very interesting when the interferometer is in the *"scanning mode"!*

If the *Poynting vectors are collinear*, the effective reflectance or transmittance of the BC oscillates from 0 to 100%, when the beams are of equal intensity.

This is a different phenomenon under beam "collinearity" condition; the output intensity oscillates between the two ports when one of the mirror is scanned.



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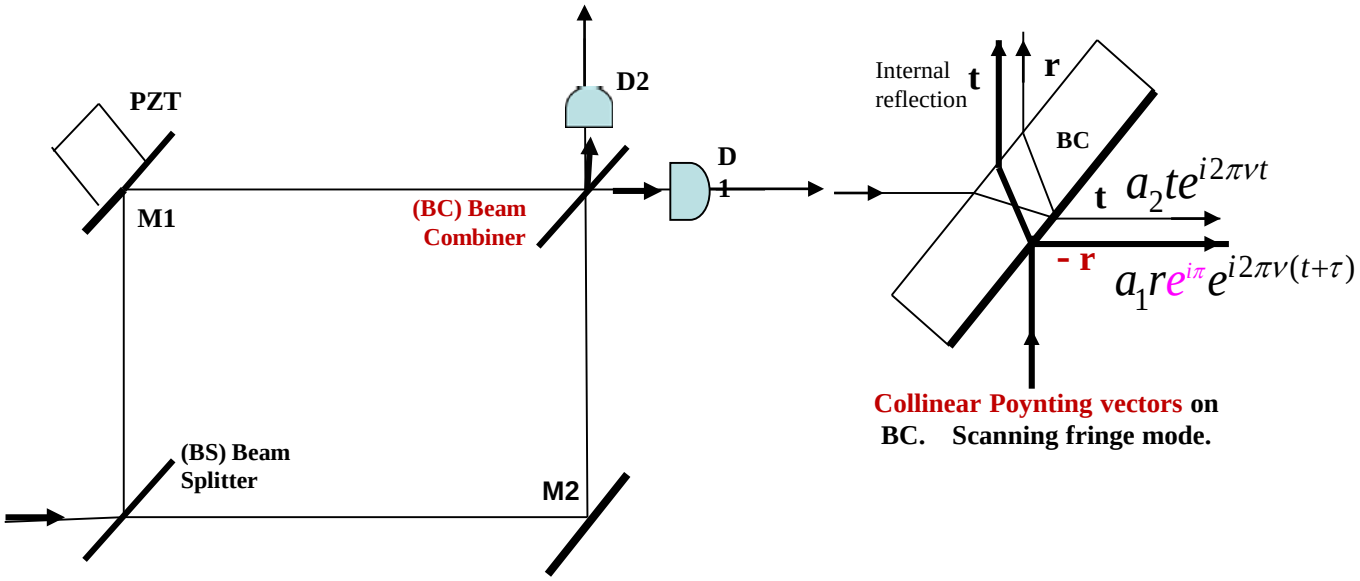


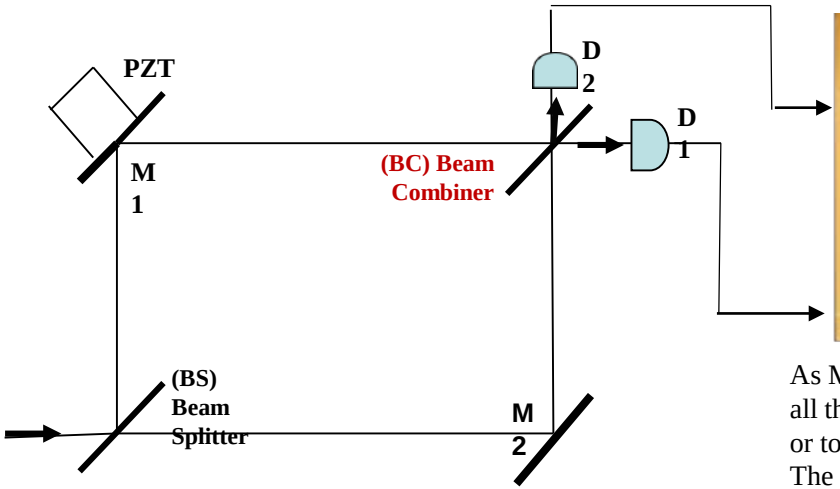
$$D(\tau)=\left|\chi a_1 r e^{i\pi} e^{i2\pi\nu(t+\tau)}+\chi a_2 t e^{i2\pi\nu t}\right|^2=\chi^2\left|a_1 r e^{i\pi} e^{i2\pi\nu(t+\tau)}+a_2 t e^{i2\pi\nu t}\right|^2$$

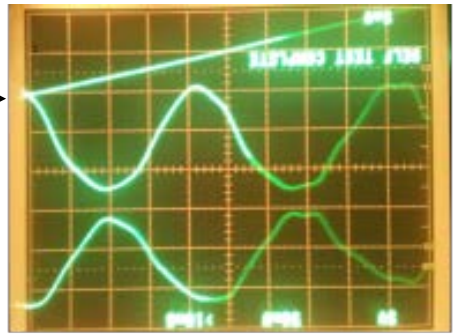
$$=\chi^2[(a_1^2r^2+a_2^2t^2)-2a_1a_2tr\cos 2\pi\nu\tau]$$

$$=2\chi^2a^2[1-\cos 2\pi\nu\tau];\ \textit{when}\ r^2=t^2=0.5 \text{ and } a_1=a_2=a$$

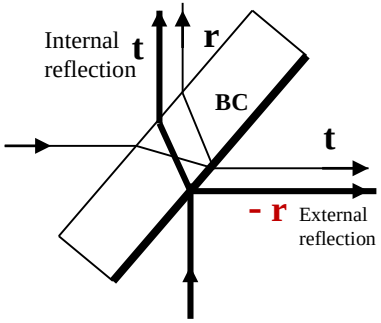
$\Uparrow$ The dielctric boundary plays the role of re-directing energy.

What are the physical processes behind a 50% beam combiner becoming a100% transmitter, or a reflector?

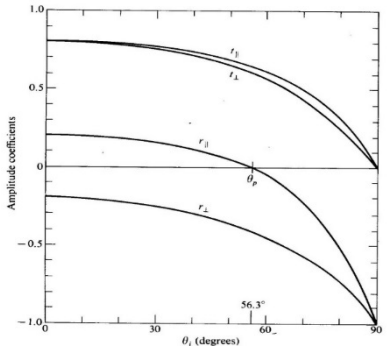




As M1 is scanned (straight inclined line on top) all the energy of both the beams could go to D1 or to D2, depending upon the phase conditions. The 50% BC effectively oscillates between being a 100% reflector or a 100% transmitter.



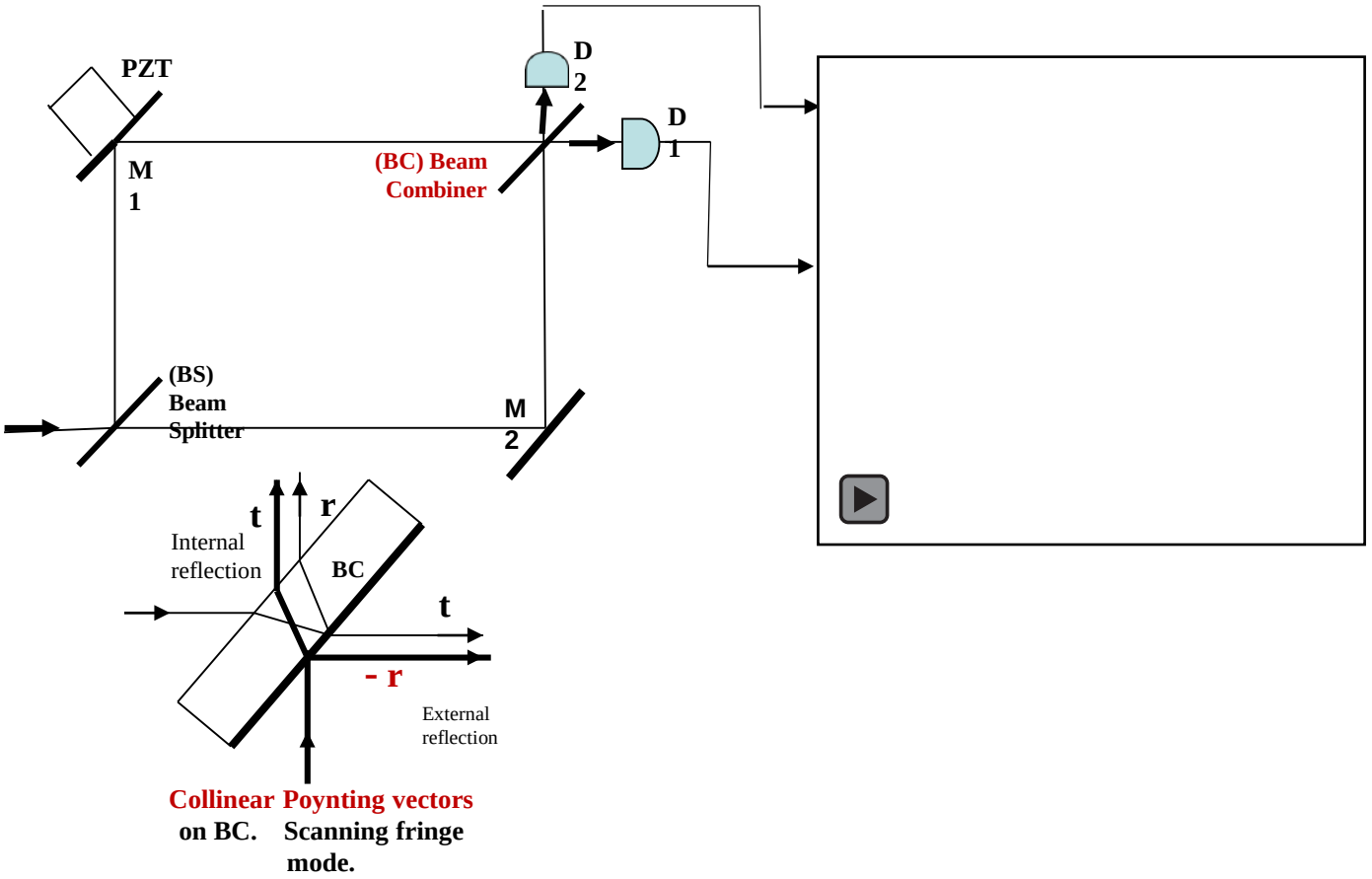
Collinear Poynting vectors on BC. Scanning fringe mode.



Note "pi" phase shift between external and internal reflection.

From Hecht

Video: Oscilloscope voltage display
How does a 50% beam combiner becomes 100% transmitter, or a reflector?
The interferometer is in the "scanning mode"!



Collinear Poynting vectors on BC. Scanning fringe mode.

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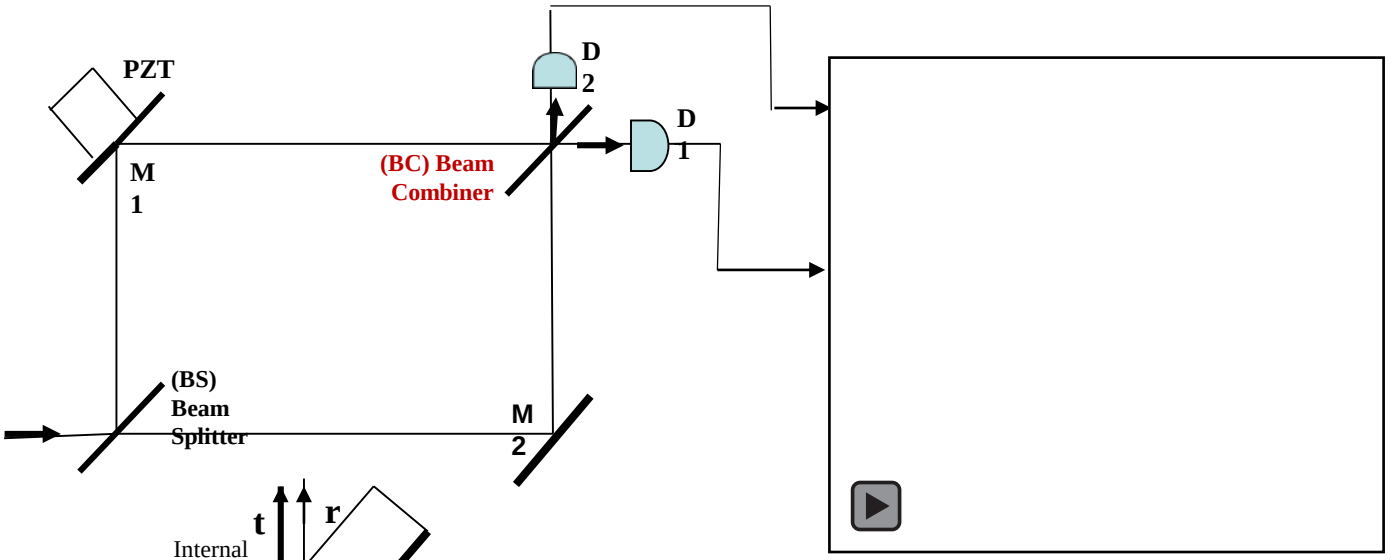
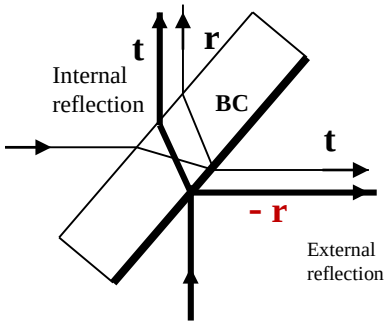


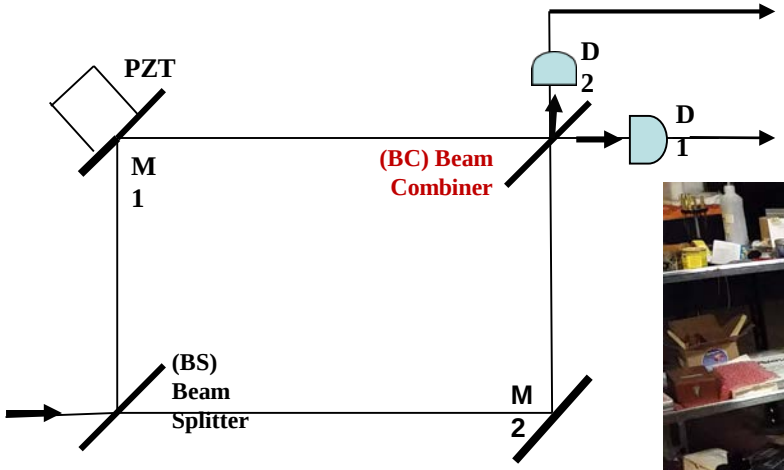


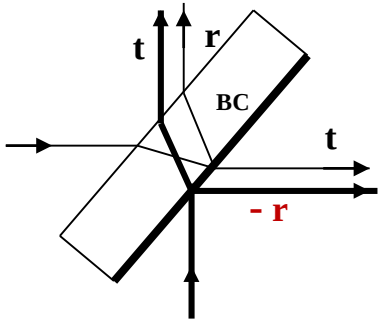
Collinear Poynting vectors on BC. Scanning fringe mode.

The dipolar behavior of classical molecular clusters, under the influence of oscillating electric vectors from the opposite sides of a boundary layer, DETERMINES which way the wave energy can propagate and in in what quantity!

Video: Visual display of oscillating intensity
How does a 50% beam combiner becomes 100% transmitter, or a reflector?

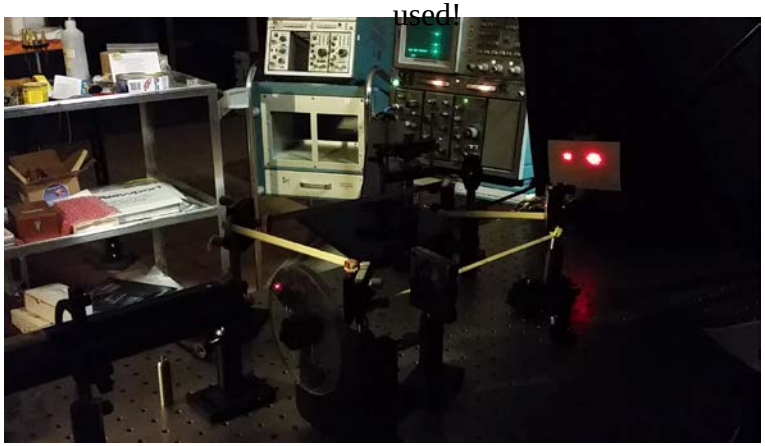
The interferometer is in the "scanning mode"!





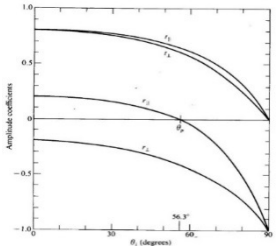
Collinear Poynting vectors on BC. Scanning fringe mode.

Visually observable pure classical superposition effect generated by a beam combiner. No quantum detector used!



The two light signals must stimulate the boundary-layer molecules simultaneously from the two opposite sides for the energy re-direction (Supreposition Effect) to take place. Even if "indivisible single photon" existed; we would need two of them to incident simultaneously from the opposite sides of the beam combiner.

The phenomenon of the capability of re-directing energy of both the beams into one or the other direction is built into classical electromagnetism. The postulate of "single photon interference" effectively denies this easily observable classical property!!



Summation of the amplitudes

$$d_{right}(\tau) = a_1 r e^{i2\pi\nu(t+\tau)} + a_2 t e^{i2\pi\nu t}$$

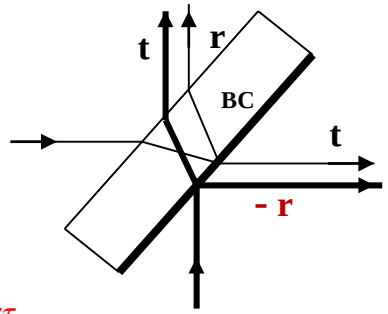
$$d_{up}(\tau) = a_1 t e^{i2\pi\nu(t+\tau)} + a_2 r e^{i2\pi\nu t}$$

Apparent energy

$$D_{\text{right}}(\tau) = \left|d_{\text{right}}\right|^2 = a_1^2 r^2 + a_2^2 t^2 + 2a_1 a_2 tr\cos 2\pi\nu\tau$$

$$D_{\text{up}}(\tau) = \left|d_{up}\right|^2 = a_1^2 t^2 + a_2^2 r^2 + 2a_1 a_2 tr\cos 2\pi\nu\tau$$

$$D_{total}(\tau) = D_{\text{right}}(\tau) + D_{\text{up}}(\tau) = a_1^2 + a_2^2 + 4a_1 a_2 rt\cos 2\pi\nu\tau$$



Collinear Poynting vectors on BC. Scanning fringe mode.

Real energy

$$D_{total}^{real}(\tau) = D_{\text{right}}(\tau) + D_{\text{up}}(\tau) = a_1^2 + a_2^2 = 2a^2 \quad (\text{for } a_1 = a_2 = a)$$

$$d_{right}(\tau) = a_1 (re^{i\pi}) e^{i2\pi\nu(t+\tau)} + a_2 t e^{i2\pi\nu t}$$

$$D_{\text{right}}(\tau) = \left|d_{\text{right}}\right|^2 = a_1^2 r^2 + a_2^2 t^2 - 2a_1 a_2 tr\cos 2\pi\nu\tau$$

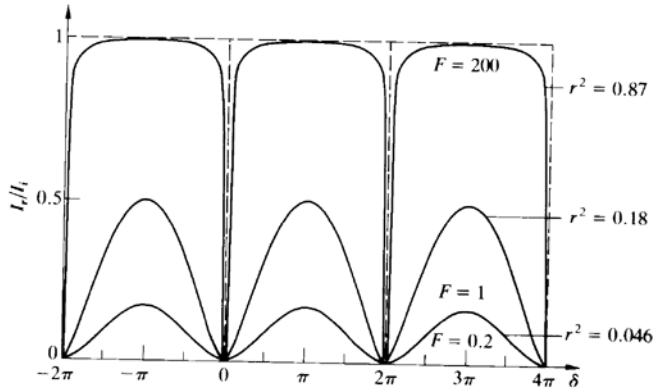
A 50% beam combiner re-directs all energy of both the beams in the "up" direction, zero in the right. The physical properties of the boundary layer is critically important!

$$D_{\text{right}}(\tau = 0) = \left(a_1 r - a_2 t\right)^2 = 0, \text{ when } a_1 / a_2 = t / r.$$

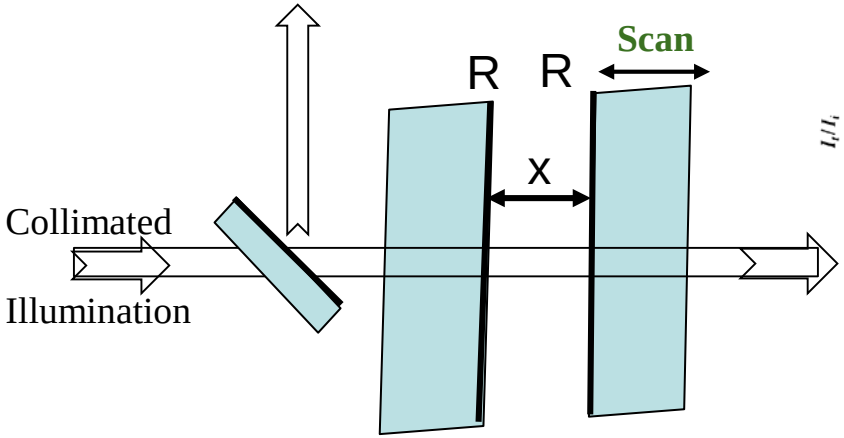
$$D_{up}(\tau = 0) = 2a^2; \text{ when } R{=}T{=}0.5 \text{ and } a_1 = a_2 = a.$$

A pair of parallel beam-splitters of any reflectance R, also known as a Fabry-Perot interferometer, can become (i) a 100% transmitter (as if the pair does not exist!), or (ii) a 100% reflector, irrespective of the value of R.

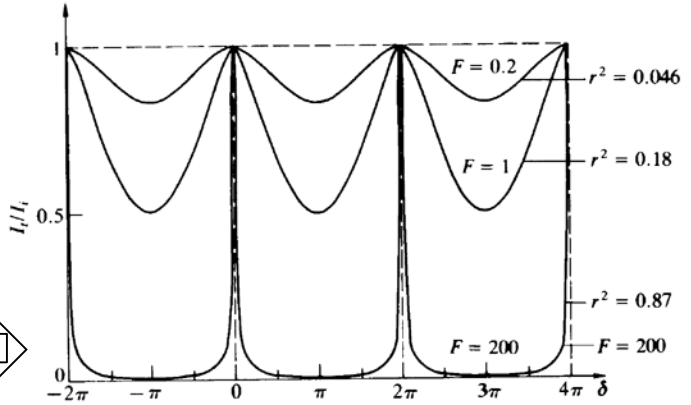
The Poynting vectors must be collinearly superposed on the beam splitter boundaries!



Reflected Intensity



Parallel-plate beam-splitters (Fabry-Perot)



Transmitted Intensity

The curves have been copied from Hecht.

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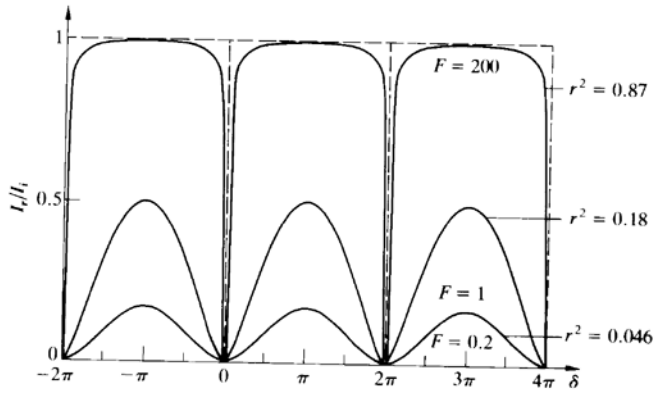
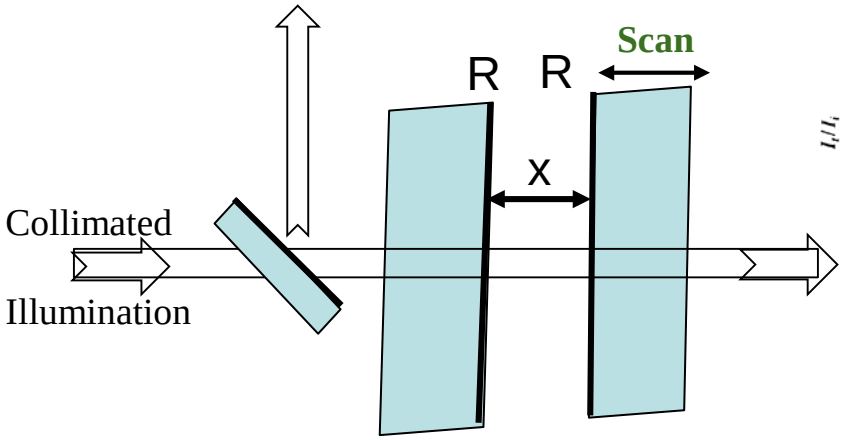
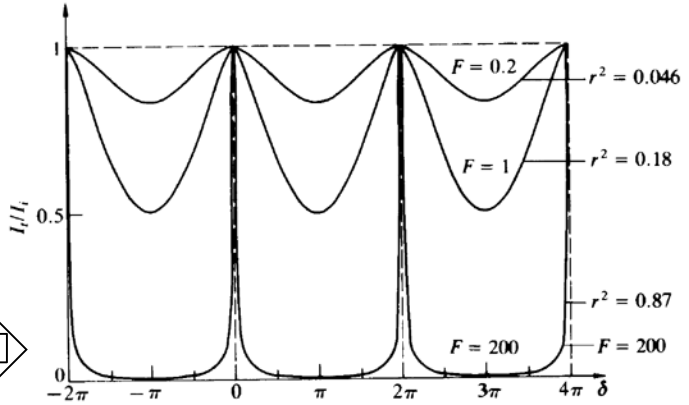


Reflected Intensity



Parallel-plate beam-splitters (Fabry-Perot)

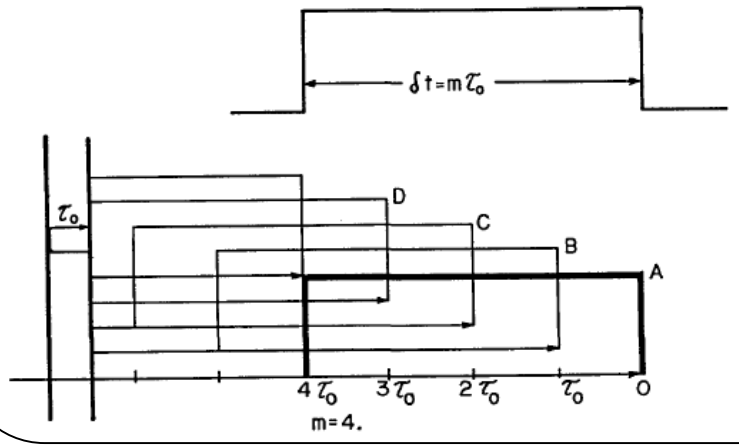
Light duration must be longer than Spectrometer Time Constant = (Finesse. Round trip) = N.Dt = N.2x/c
Ref; JOSA 65(12).p1418 (1975)



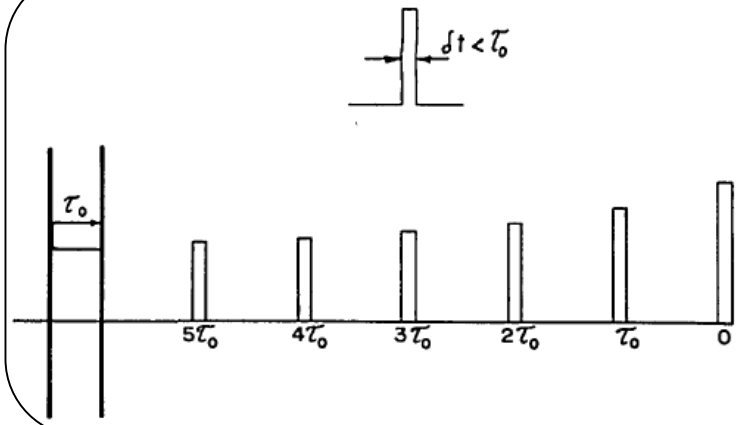
Transmitted Intensity

The curves have been copied from Hecht.

Without simultaneous (real physical) superposition of all the beams with proper phase on both the beam-splitters, the steady-state fringes will not be generated.



For light duration < N.dt=N.2x/c, partial superposition generates broader (lower finesse) fringes.



For light duration << N.dt=N.2x/c, No superposition effect can be observed. broader (lower finesse) fringes.

Ref. JOSA 65(12).p1418 (1975); by CR

The 1975 Fabry-Perot experiment helped me realized that:

- **Huygens-Fresnel "principle" is founded on the NIW-property. Huygens explicitly postulated that his *secondary wavelets* expand and evolve through each other without interacting.**

- ***It also resolved my enquiring question:*** Why does the Fourier theorem work for the cases of Space-Space Fourier Transform (SS-FT)?

Answer: Under the far-field conditions and ***5-degree approximation***, the HF wavelets become a series of tilted plane waves, emulating the Fourier harmonics, or exponential function.

- ***Then, I was forced to consider the follow-on enquiring question:*** What is the Huygens'-equivalent physics postulate that can assure Time-Frequency Fourier Theorem (TF-FT) also represents nature's reality?

Answer: There is no physics postulate that directly corroborates TF-FT in physics. In many places it works because we have been fortunate. In other cases; we have introduced ad hoc, but wrong, postulates to accommodate our mistakes.

The NIW-property has very broad impact in most optical phenomena and extends into most of the other branches of physics (Quantum Mechanics, Relativity and Astrophysics).

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.

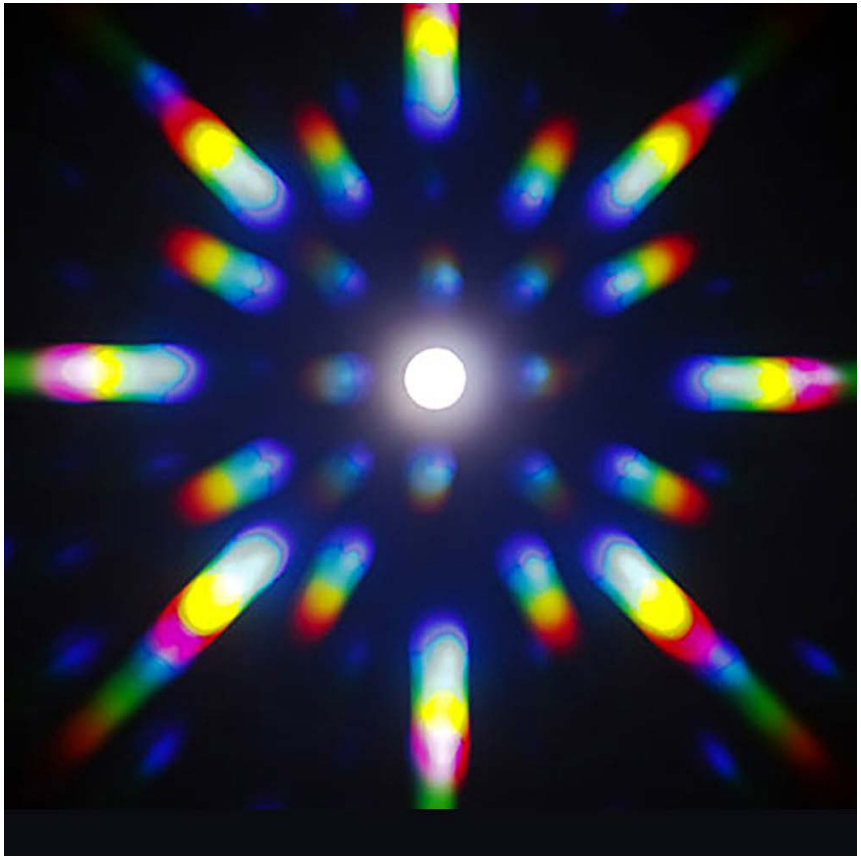
5. Polarization: Drop the concept of elliptical polarization. E-Vectors do not sum to spin helically. Jones' matrix correctly propagates orthogonal E-vectors.

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**" $\lambda = h / p \ \ [\rightarrow \infty \text{ for } v = 0]$, 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!



From OPN

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/