

**Opening up the enquiring minds to:
Discover, invent and innovate -
In the fields of Optical Science and Engineering**

**How to explore & utilize nature-allowed processes
for our long-term well-being!**

**Prof. ChandraSekhar Roychoudhuri
Physics Department, University of Connecticut, Storrs, CT**

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

June 14, 2017
University of Dayton, Ohio



Consequences of Repeated Discovery and Benign Neglect of Non-Interaction of Waves (NIW)

LECTURE -1

Prof. ChandraSekhar (Chandra) Roychoudhuri

Chandra.Roychoudhuri@UConn.edu

Femto Macro Continuum & Physics Department, University of Connecticut, Storrs, CT 06269

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Core conceptual take-away messages:

Re-energize your creative mind!

1. ***Non-Interaction of Waves (NIW)*** is the generic property of all propagating waves. Application of NIW significantly enhances our understanding of many optics & physics phenomena.
2. Superposition Principle (SP), a linear mathematical sum of amplitudes, *is not an observable phenomenon*. Measurable Superposition Effect (SE) *is the observable phenomenon*; which is reported by detectors as their physical transformations, after they execute the square modulus interaction process to extract the necessary energy out of *all the stimulating fields*.
3. We, humans, are neural network driven thinking animals. We are only *INTERPRETERS* of data (information) registered by our engineered instruments. Our instruments are the *OBSERVERS*.
4. We need to think like *reverse system engineers*, as children do, to stay anchored to explore realities of nature, instead of always imposing mathematical logics on her and tell her how to function!

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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!”

I don't have the audacity that I do. But, I will underscore that if we keep on framing and re-framing our enquiring questions; physics will progress as a science; rather than becoming a religion as to who said what!

Persistent humility is a key virtue to frame, and re-frame, and re-frame enquiring questions to understand nature!

“I do not know what I may appear to the world; but to myself I seem to have been only like a boy playing on the seashore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me.”



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

- ❖ Today we are both fortunate and confused. Our guiding giants, individually, have discovered many realities of nature, but they are not merging seamlessly into one harmonious “picture”.
- ❖ We need to initiate a collective approach to re-visit and re-construct the foundational hypotheses behind the most successful theories, for they hold more realities than the weaker theories.
- ❖ We need an iterative approach to enhance the theories by incorporating **Interaction Process Mapping Thinking (IPM-T)** over and above the currently successful approach of Measurable Data Modeling Thinking (MDM-T).



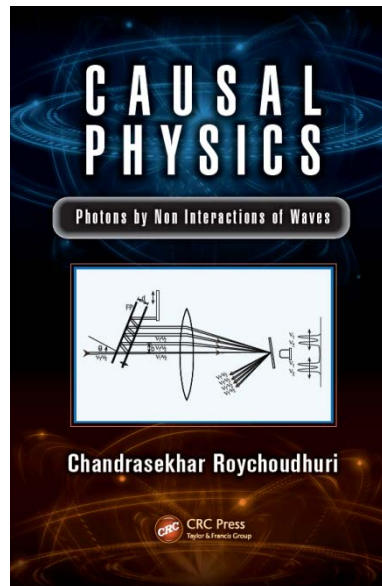
Now, to blow my own horn!

**Professional background of:
Prof. Chandrasekhar (Chandra) Roychoudhuri**

- ❖ I came to USA as a Fulbright Scholar from India and finished my PhD from the Institute of Optics, University of Rochester.
- ❖ I have diverse academic background as a professor in India, Mexico & USA. I am now with the U. of Connecticut at present.
- ❖ I have diverse industry background and worked for TRW, Perkin Elmer and United Technologies. My last industry position was the Chief Scientist, Optics & Advanced Technology Lab., Optical Systems Division, United Technologies.
- ❖ I have served as a Member of the Board of Directors for both SPIE and OSA. I am also an elected Fellow of both these societies.
- ❖ I have been giving lectures as a Traveling Fellow of OSA in many different countries around the world on the nature of light.

After fifty years' of brooding, by early 2014, I have succeeded in publishing this book;
which will transform physics-thinking significantly based upon clearly recognizing a
universal property of propagating waves:

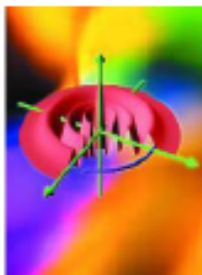
**In the linear domain, propagating waves do not interact to re-organize their energy in
the absence of resonant detectors.**



For human scientific endeavors to continue to evolve & to avoid stagnancy:
We must iteratively keep on applying **Interaction Process Mapping Thinking (IPM-T)**,
over and above the currently successful **Measurable Data Modeling Thinking (MDM-T)**.

I have initiated and organized 6 biennial conferences on “The Nature of Light: What are photons?” during SPIE annual conferences during 2005 to 2015 .

2003



**Optics and Photonics News
Special Issue;
October 2003**
Guest Editors:
C. Roychoudhuri
and R. Roy

2005



**SPIE Proc.
Vol.5866**
Conference
Editors: C.
Roychoudhuri,
K. Creath & A.
Kracklauer

2007



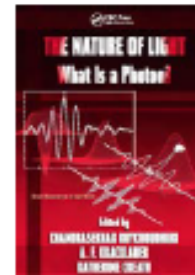
**SPIE Proc.
Vol.6664**
Conference
Editors: C.
Roychoudhuri,
K. Creath & A.
Kracklauer

2008



**W-EPR
Workshop**
Organizer
Roychoudhuri

2008



**CRC: What is
a Photon?**
Editors: C.
Roychoudhuri,
K. Creath & A.
Kracklauer

2009



SPIE Conf.
Chairs:
Roychoudhuri
Kracklauer
Khrennikov

2011



SPIE Conf.
Chairs:
Roychoudhuri
Kracklauer
Khrennikov

2010,11,12...



SPIE Conf.
Speaker:
Roychoudhuri

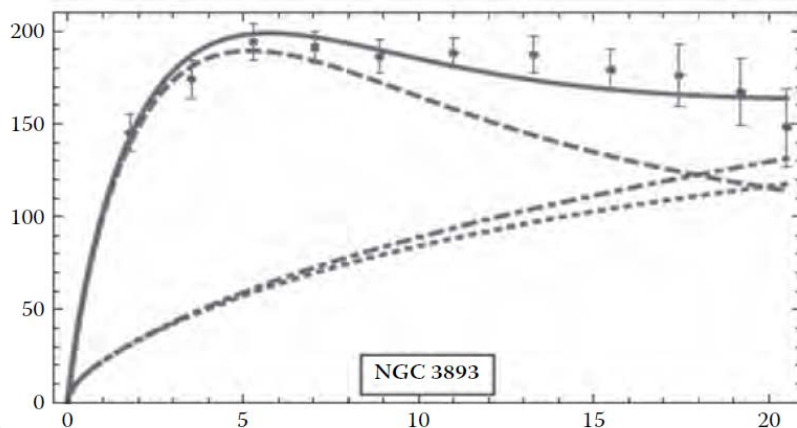
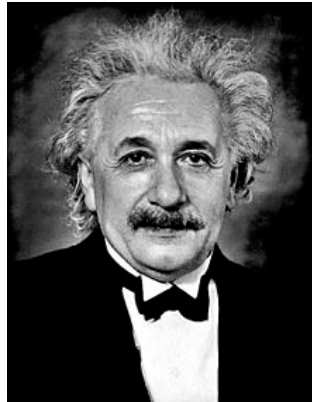
The first effort started in 2003. I have facilitated the publication of a special issue on the nature of light in Optics and Photonics News, OSA.



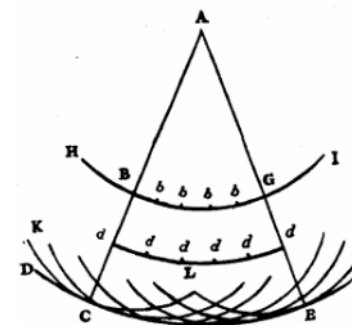
Why do physicists neglect the deep and enduring significances of the Huygens Principle?

Why do physicists neglect the significances of the 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”**





**My journey to appreciate the physical root
behind the staggering successes of Huygens
Physical Principle and Fourier Mathematical
Theorem!**

The driving force behind my (re-)discovery of the generalized Non-Interaction of Waves, or NIW!

Attempts to understand the physical processes behind:

SS-FT

vs.

TF-FT

The far-field (Fraunhofer) diffraction pattern is the Fourier transform of the “aperture function”

The spectral frequency content for a pulse is the Fourier transform of the temporal envelope function.

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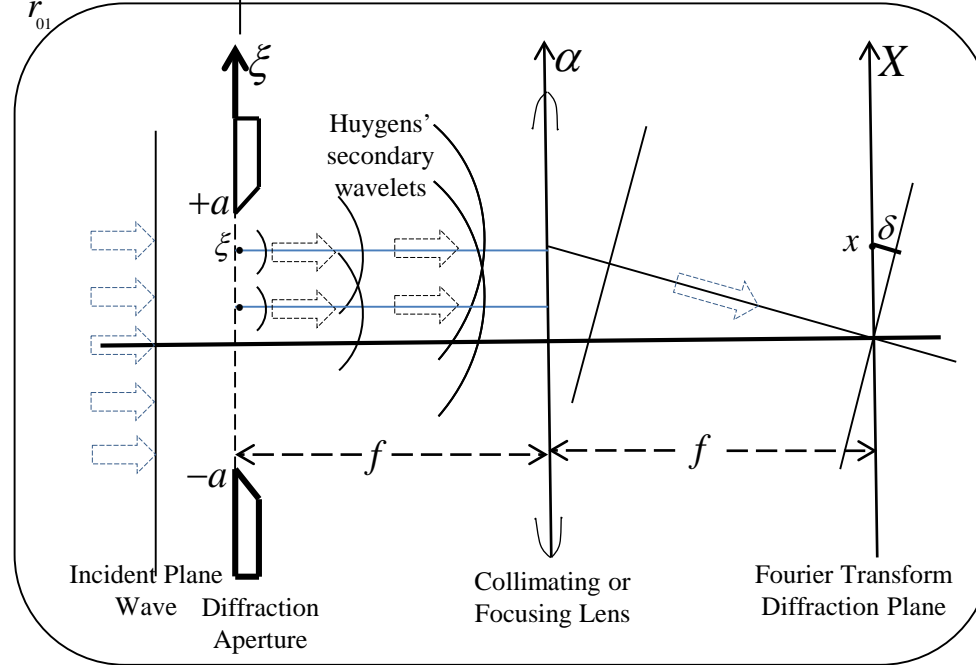
Why is the SS-FT theorem so successful in Physics/Optics?

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

Un-observable Superposition Principle (SP)

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

Observable Superposition Effect (SE)



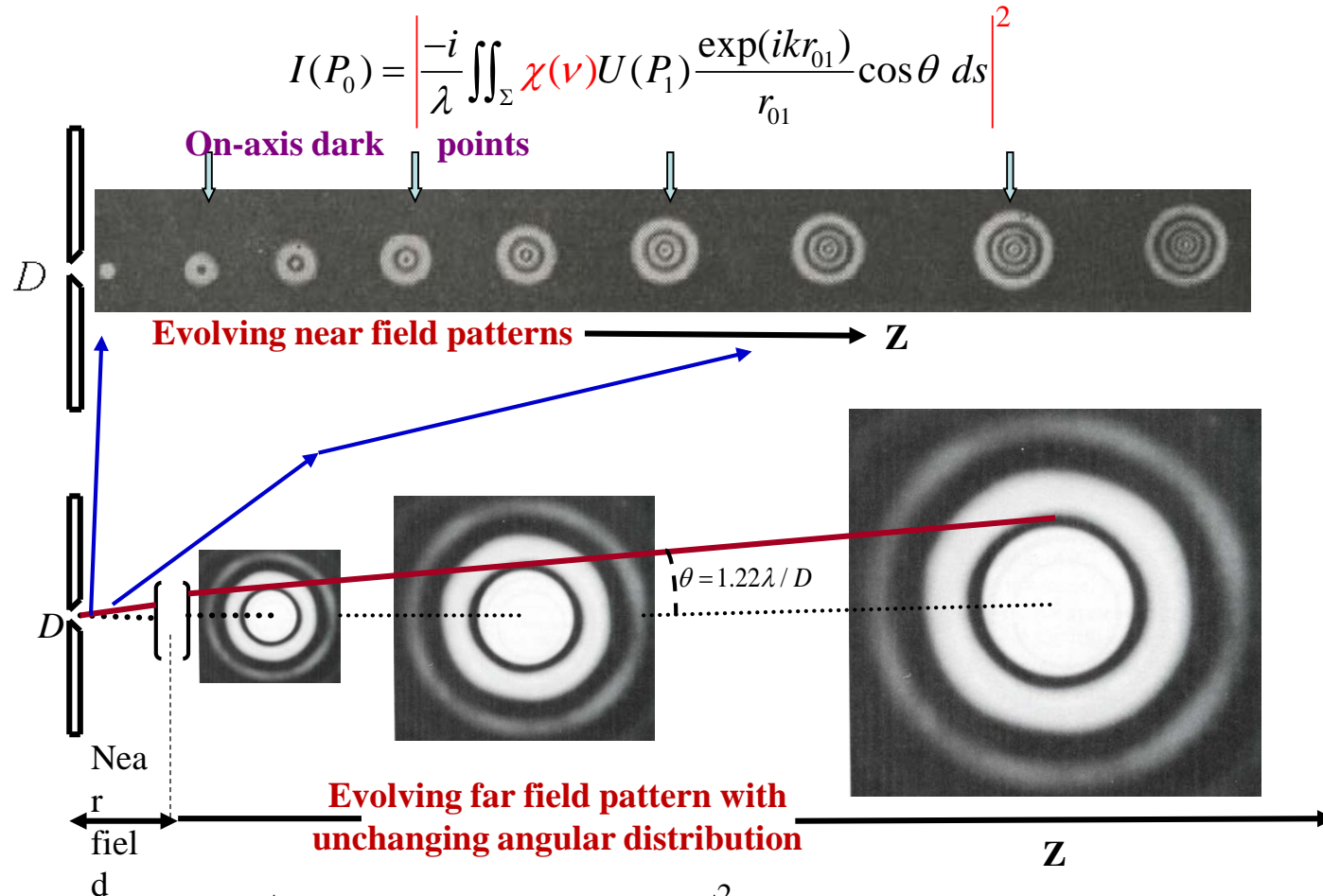
$$U(x) = \frac{e^{ikz}}{i\lambda z} e^{i\frac{kx^2}{2z}} \int_{-\infty}^{+\infty} U(\xi) e^{-i\frac{2\pi\xi x}{\lambda z}} d\xi = C \int_{-\infty}^{+\infty} U(\xi) e^{-i2\pi\xi f_x} d\xi; \quad f_x = (x / \lambda z)$$

Huygens Principle captures part of the ongoing physical process in nature!

In the far-field (or in the focal plane of a lens), due to plane wave superposition, the HF integral directly morphs into a space-to-space Fourier transform integral.

But, have we paid attention to *all* the causing processes? $\chi(\nu)$

Superposition effect generate local dark and bright spots. Energy flow does not alternate!



$$I(P_0) = \left| \frac{e^{ikz}}{i\lambda z} e^{i\frac{kx^2}{2z}} \int_{-\infty}^{+\infty} \chi(\nu) U(\xi) e^{-i\frac{2\pi\xi x}{\lambda z}} d\xi \right|^2 = C^2 \left| \int_{-\infty}^{+\infty} \chi(\nu) U(\xi) e^{-i2\pi\xi f_x} d\xi \right|^2 ; f_x = (x / \lambda z)$$

HF wavelets co-propagate and cross propagate without altering each other!

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Attempts to understand the physical processes behind:

SS-FT vs. **TF-FT**

The far-field (Fraunhofer) diffraction pattern is the Fourier transform of the “aperture function”

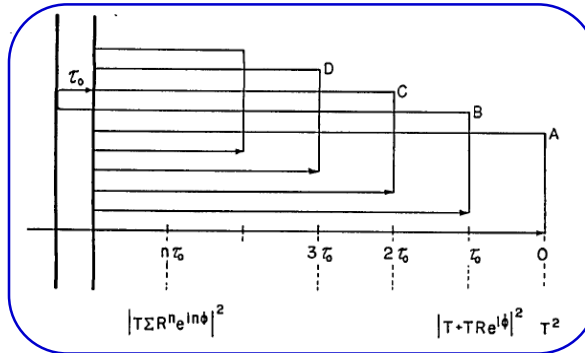
The spectral frequency content for a pulse is the Fourier transform of the temporal envelope function.

**Can a spectrometer really execute the
Fourier transform algorithm on an
incident pulsed light?**

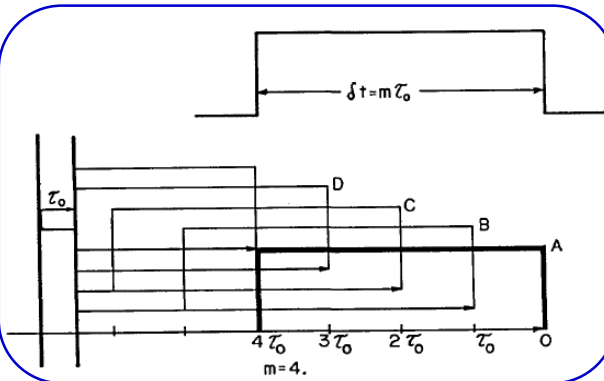
Output wave fronts from a high resolution Fabry-Perot spectrometer

A train of delayed transmitted wave fronts for a CW input.

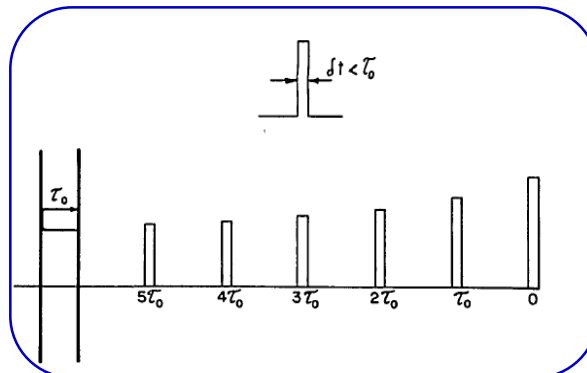
Time evolving partial superposition at “turn-on”.



A train of delayed transmitted wave fronts for a long input pulse. *Time evolving superposition starts and dies.*



A train of delayed transmitted wave fronts for a very short input pulse. *No superposition at all.*



$$a(t) = \int \tilde{a}(f) e^{+i2\pi ft} df$$

$$\tilde{a}(f) = \int a(t) e^{-i2\pi ft} dt$$

Powerful, self consistent mathematical logic representing mathematical Superposition Principle (SP)..

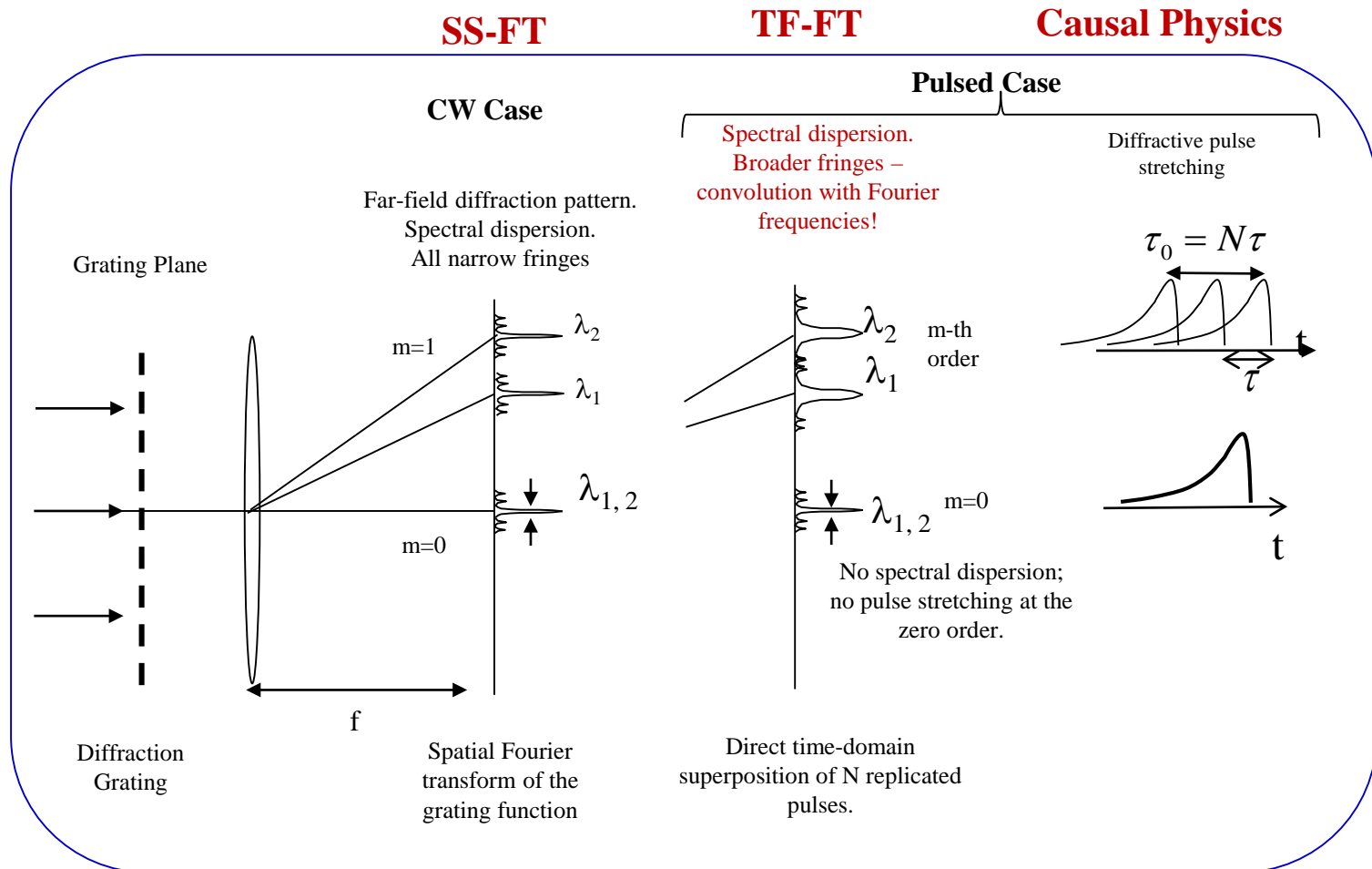
But they do not represent neither cosmic logic nor any real physical interaction PROCESSES.

They violate the NIW-property.

C. Roychoudhuri, “Response of Fabry-Perot interferometers to light pulses of very short duration”; JOSA 65 (12), pp. 1418-1426, **1975**.

The optical response characteristics of a grating spectrometer

Why do we mix up SS-FT and TF-FT?



The driving force behind my (re-)discovery of the generalized Non-Interaction of Waves, or NIW!

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SS-FT

vs.

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The far-field (Fraunhofer) diffraction pattern is the Fourier transform of the “aperture function”

The spectral frequency content for a pulse is the Fourier transform of the temporal envelope function.

Unlike SS-FT,
TF-FT *is not directly supported by any principle of physics.*
This, again, is related to NIW!



Omni-presence of NIW all around us

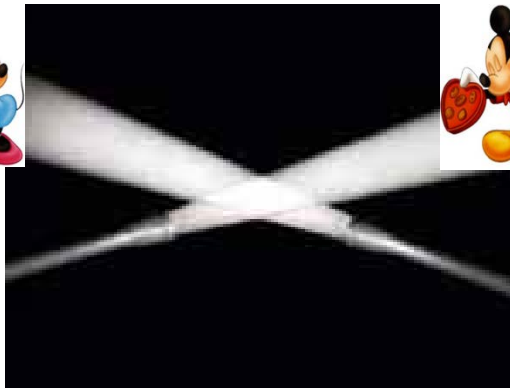
Common sense observation of NIW!

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).



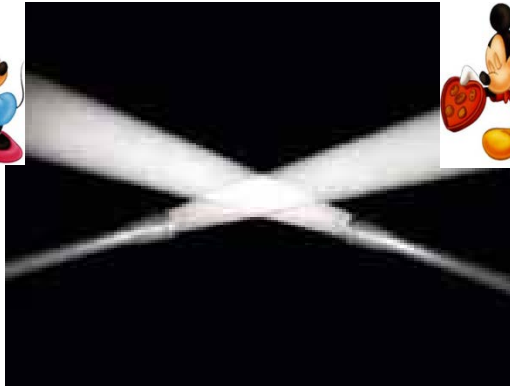
Light waves

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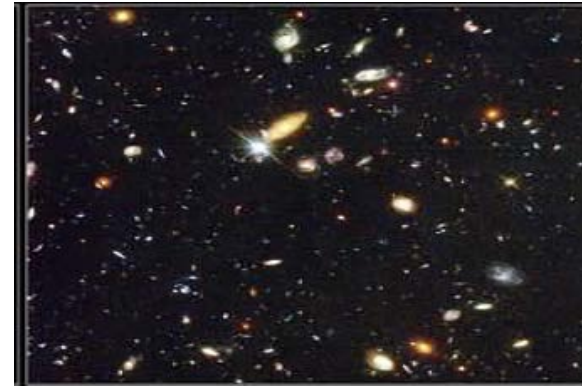
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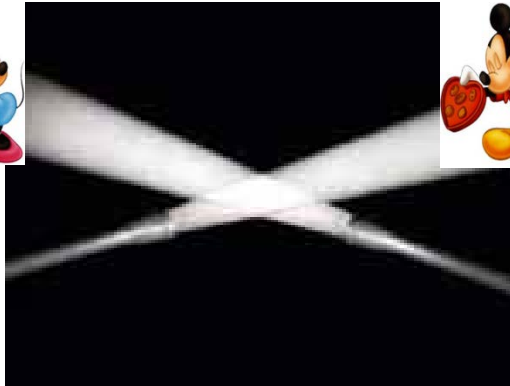
“Hubble deep field galaxies”. Expanding universe, indicated by Doppler shift, would not have been measurable.

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Light



waves



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



Water waves pass through each other unperturbed.

Water waves

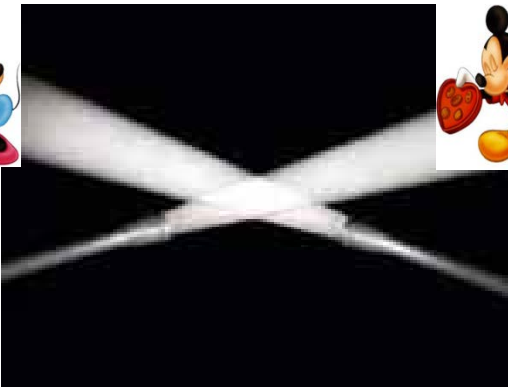
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Light



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 pass through each other unperturbed.

Water waves

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

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



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



Before
crossing

Propensity of water waves to perpetually expand as circular wave packet remains unperturbed even when two wave groups cross through each other.



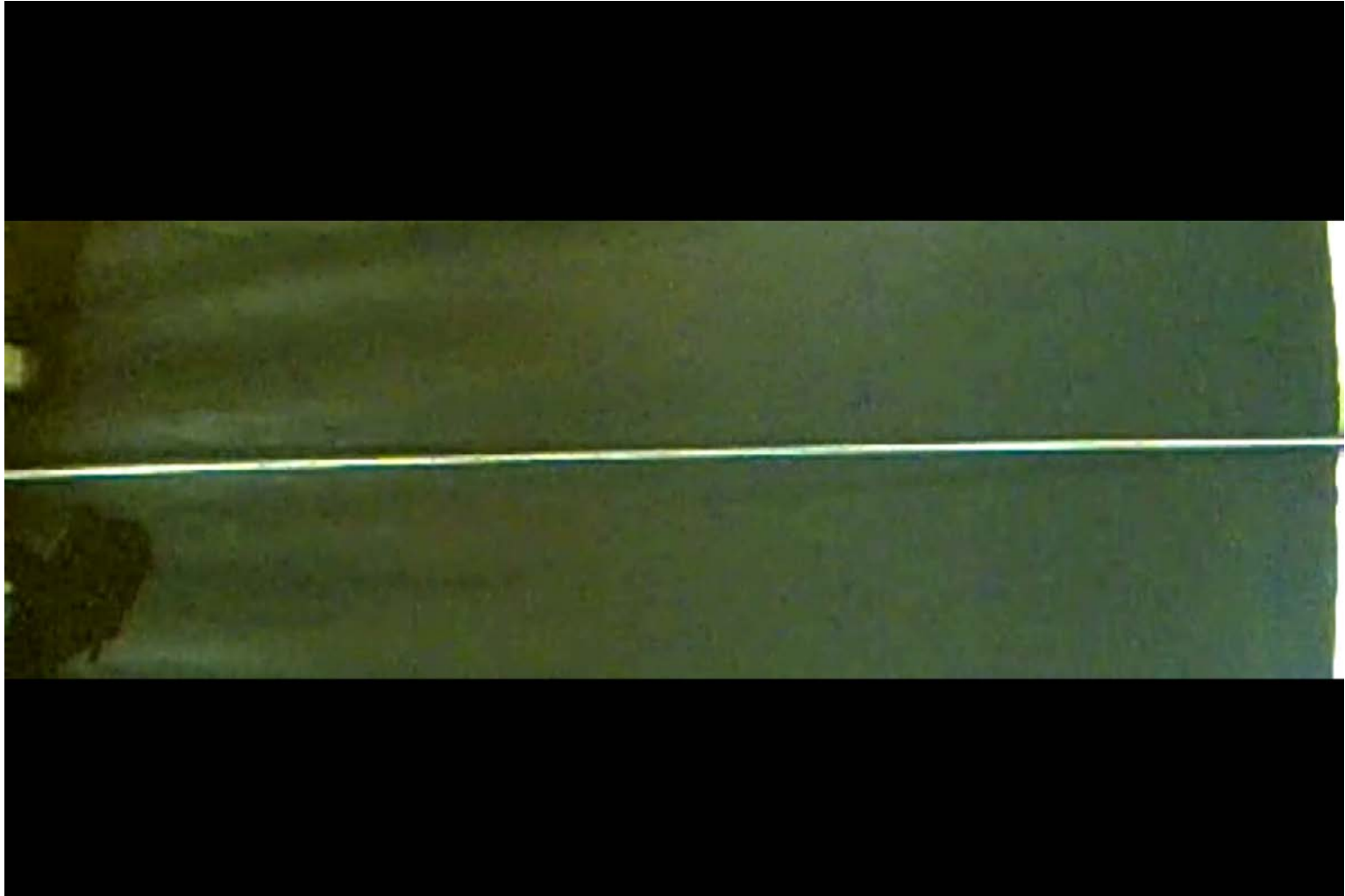
Just
crossing

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



Well into
crossing

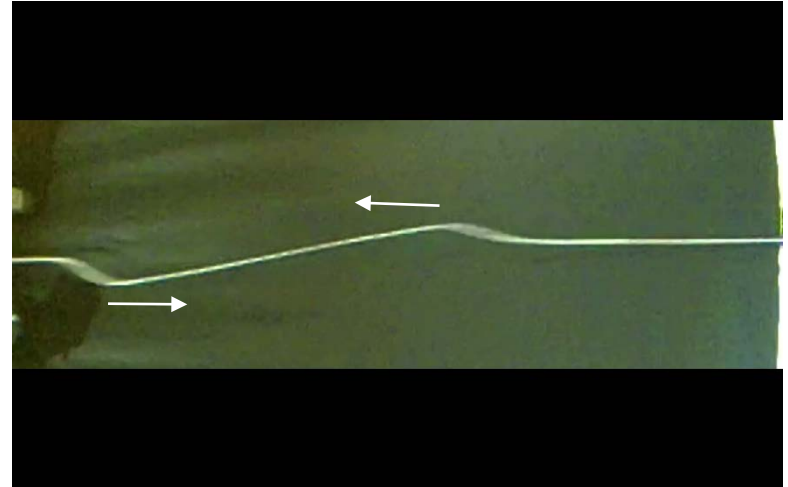
**The NIW-property is true for all linear waves:
Case for the mechanical tension wave in a spring (video).**



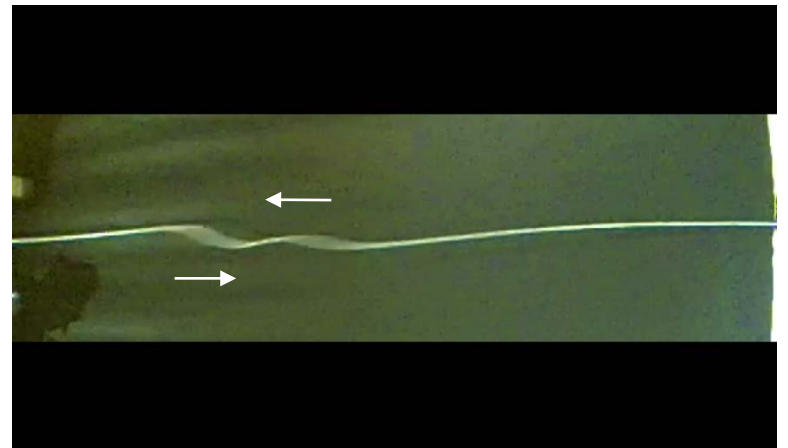
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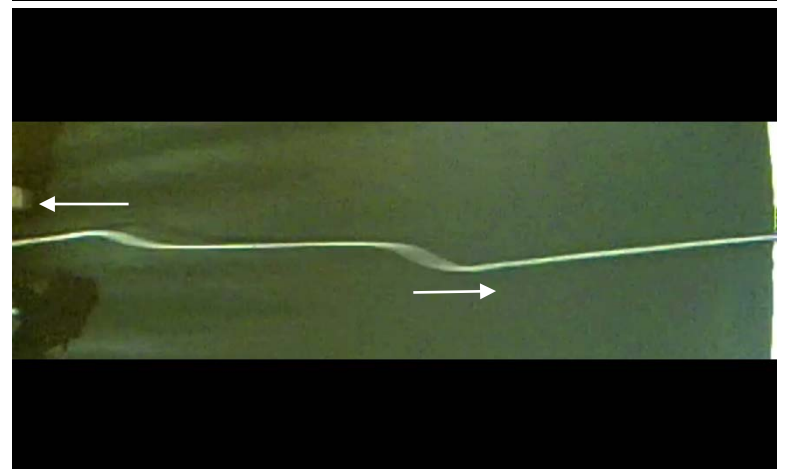
Wave pulses
approaching.



Wave pulses
about to cross.

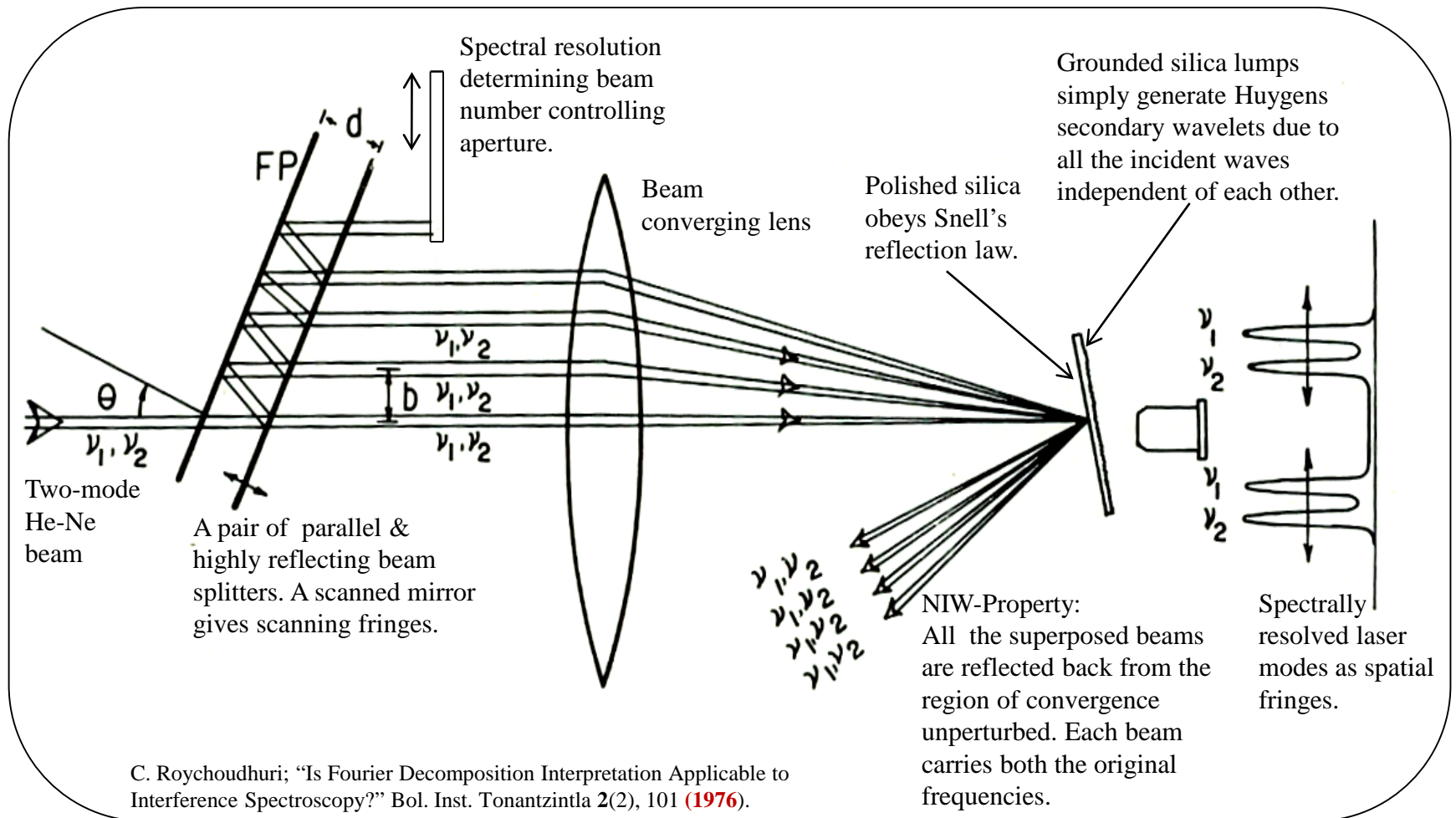


Wave pulses
have crossed
through.



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.

I have come to realize the NIW-property in a set of 1974-75 experiments, without knowing the historical background



A few decades of persistent experimental research and literature search demonstrated that I am right; but the basic concept was known as early as 1000 years earlier!

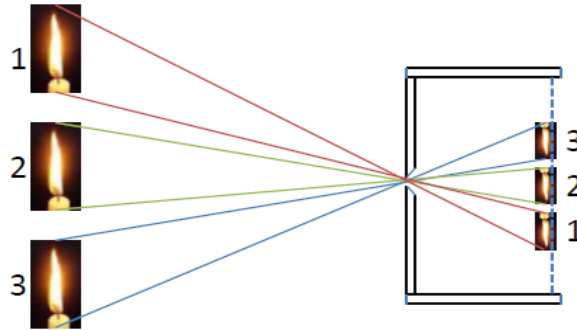
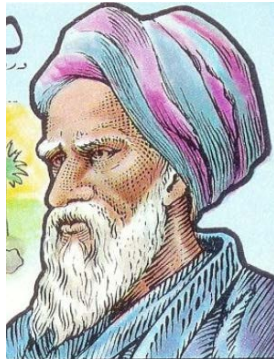
- ❖ **Some noted NIW; but were ignored.**
- ❖ **Most modern physicists understood that NIW is built into the linearity of the wave equation; but miss the deeper implications in all the branches of physics!**
- ❖ **I have become sensitized to the shortcomings of the prevailing thinking methodology behind modern science!**



Repeated Discovery and Benign Neglect of Non-Interaction of Waves (NIW)

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

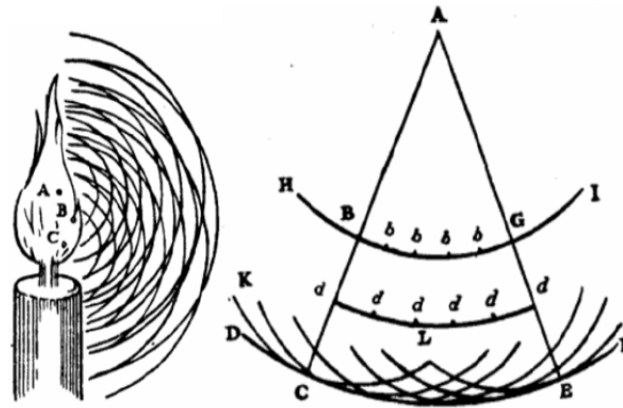
Haytham was first physicist to experimentally recognize NIW



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

Christian Huygens (1629 –1695)

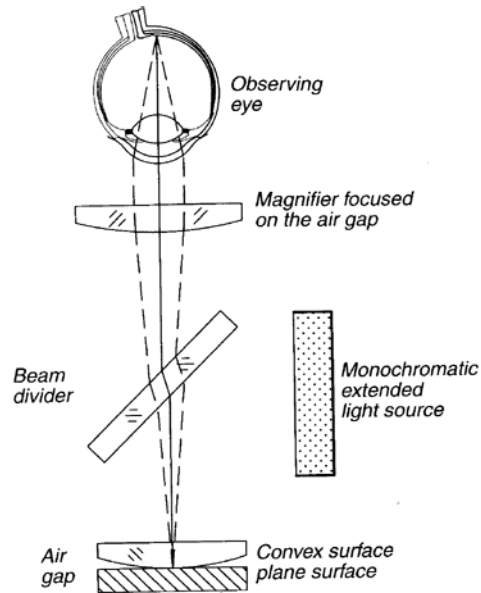
Huygens was the first one to postulate NIW as an integral part of his wave propagation principle.



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)

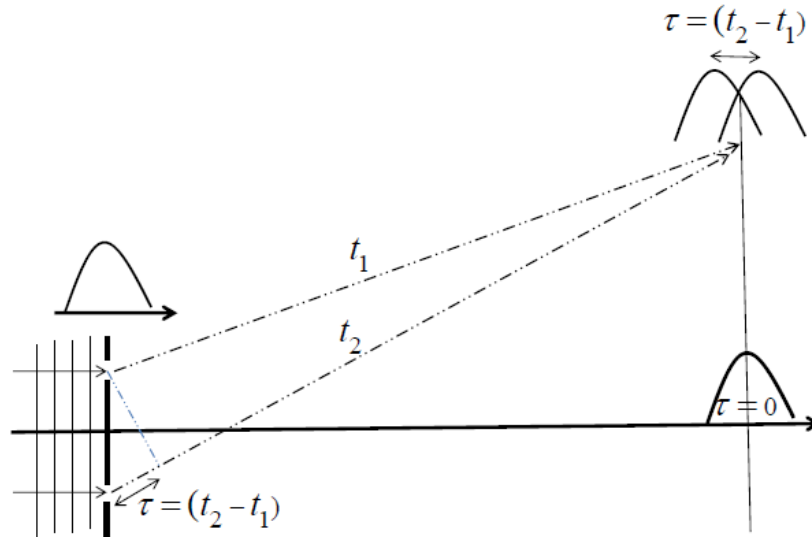
Newton missed NIW even though his beam splitter worked because of NIW.



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)

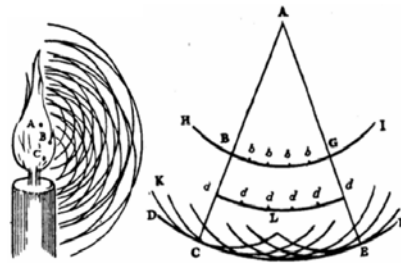
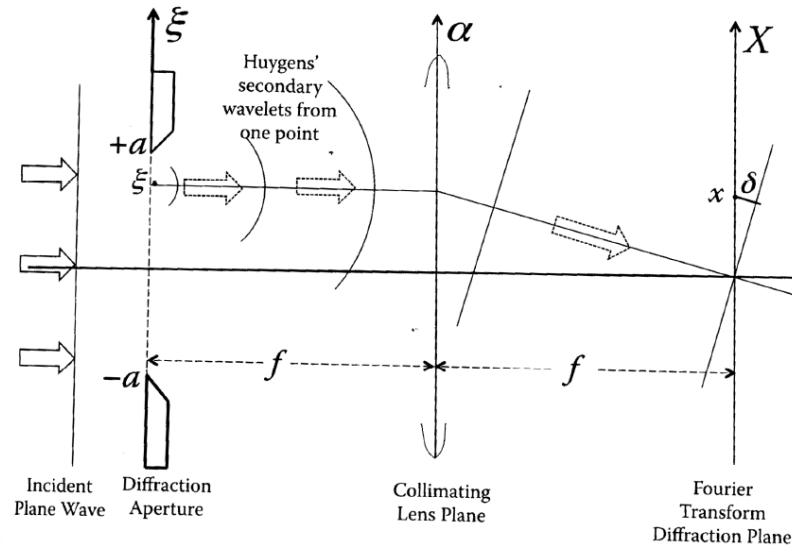
Young missed the fact that it is the retinal molecules that carries out the “square modulus” energy transfer out of the superposed beams.



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)

Fresnel also missed the fact that it is the retinal molecules that carries out the “square modulus” operation to carry out the energy transfer process out of the superposed beams.



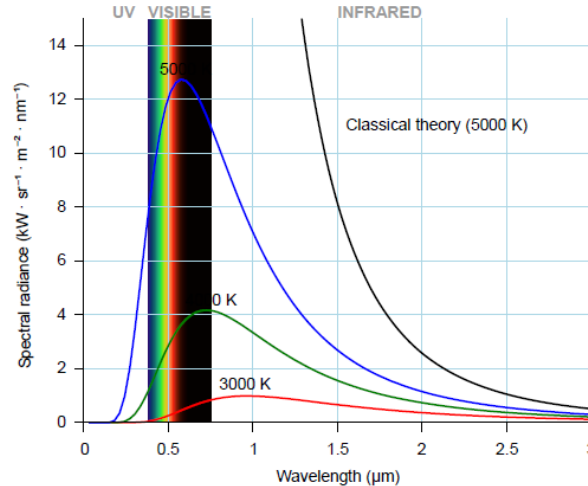
$$\Psi(P_0) = \frac{-i}{\lambda} \iint_{\Sigma} U(P_1) \frac{\exp(ikr_{01})}{r_{01}} \cos \theta \, ds$$

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

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)

Planck did explicitly recognize NIW in his book!



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.

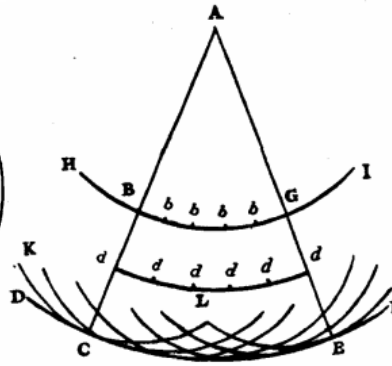
M. Planck, translated by M. Masius, [The Theory of Heat Radiation], now available from Dover and Gutenberg eBook; Blakistons Son & Co. (1914).

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.

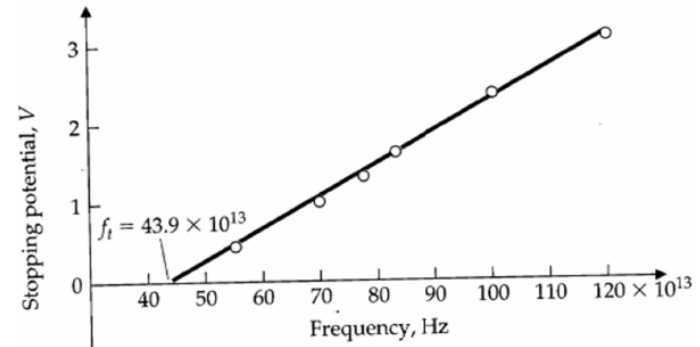
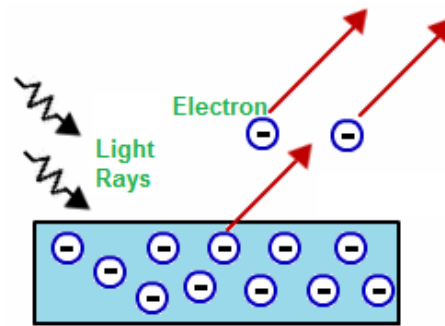
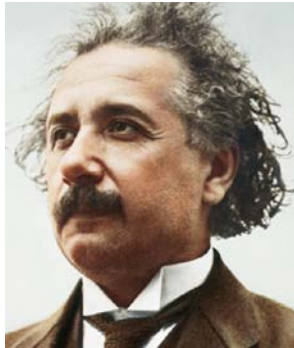
We should celebrate the continued and successful guidance provided by the Huygens-Fresnel diffraction integral from early 1800 till today. The integral does preserve NIW!



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

Albert Einstein (1879 –1955)

Einstein could have recognize NIW, had he focused on the detecting dipoles' physical stimulation process.



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

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

Ensemble average of multiple dipolar
amplitude stimulations of the same quantum
detector & quadratic energy transfer

Einstein's original eq. under
ensemble average, equating only
the energy transfer

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

Significance of NIW in Physics



Significance of NIW in Physics

Impact of Non-Interference (non-interaction) of Waves (NIW)

Impacts in Classical Physics

1. Spectrometry: The resolution limit $\delta\nu\delta t \geq 1$ is not a principle of nature.

2. Coherence: Waves are never incoherent. Visibility (correlation) is determined by the time constant of the detecting system.

3. Polarization: NIL implies superposition of orthogonally polarized beams cannot generate elliptically rotating E-vector.

4. Mode locking: A laser pulse is generated by “time gating” of saturable absorber, not locking of modes

5. Pulse broadening: Is due to time diffraction, not due to dispersion of Fourier frequencies.

6. Fourier transform & light beating spectroscopy determine real carrier frequencies, not Fourier frequencies.

Impact in mathematical framing of physics problems

Mathematical operating symbols should be carefully tied with transformational interactions

The time-frequency Fourier theorem cannot be a principle of nature!
No natural interactions create Fourier frequencies out of a pulse nor create a pulse out of Fourier frequencies.

Wiener-Khintchine theorem – Fourier spectral density and autocorrelation functions form a “Fourier transform pair” – is based on non-interference of Fourier sinusoids!

More to come!

Impact in Quantum Physics

1. Photons are divisible & summable in light-matter interactions.

2. Dirac’s “photons” do not conform to causality & energy conservation

3. Classical photon as an exponential wave packet conforms to quantum predictions: $\Delta E_{mn} = h\nu_{mn}$

4. A photon cannot interfere with itself. “Which way?” photon travels, is a meaningless question.

5. Bell’s Inequality theorem is inapplicable to superposition effects due to photons.

6. Indivisible entangled single photon interference does not exist

<http://www.natureoflight.org/CP/>

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 Field (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.

Significance of NIW in Optical Science and engineering.



**The NIW-property enhances the conceptual
foundation of physics**
(some issues will be discussed in the next session)

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Significance of NIW in Optical Science and engineering

(These will be discussed in details in the next session)

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

- 1. Superposition Basic:** Replace “Summing of wave amplitudes” by “Summing conjoint detecting dipole stimulations”. Distinguish between “Mathematical Superposition Principle” and “Physical Superposition Effects” we observe.
- 2. Diffraction:** Recognize that Huygens-Fresnel diffraction integral, summation of secondary sinusoids, obeys the NIW-property; so does Maxwell’s wave equation.
- 3. 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.
- 4. 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).
- 5. Laser Mode Lock:** Replace “Mode Lock” concept (modes sum to create energy pulses), by “Time Gating” behavior by intra-cavity phase locker.
- 6. Dispersion:** Drop the concept and the theory of “Group Velocity”. It is based upon non-causal mathematical assumptions. Ignores NIW-property.
- 7. Polarization:** Drop the concept of elliptical polarization. E-Vectors do not sum to spin helically. Jones’ matrix correctly propagates orthogonal E-vectors.
- 8. Photons:** Photons are diffractively expanding classical wave packets conforming to QM frequency and energy requirements.



What are the key shortcomings behind our historic neglect of NIW?

(Becoming self-introspective that objective modeling of nature using our subjective biological mind requires special attention!)

What is the lesson?

How have we succeeded in ignoring NIW that is obvious from our daily encounter with various wave phenomena?

With the enormous success of mathematics in framing theories, which can quantitatively validate measured data; we forgot that the (i) data are always generated through some interaction processes between interactants in our instruments and (ii) the validations (interpretations) are carried out by our mind. Each one of these steps has problem that we are not taught to pay attention to become truly objective interpreters.

- ❖ **1. Information Retrieval Problem:** We must learn to mentally visualizing the physical interaction processes between interactants that generate the measurable data in our instruments
- ❖ **2. Inherent Subjectivity Problem:** We must learn to introspect our undeclared logics behind our individual *thinking processes*.

**Little bit of history behind the
evolution of my mind!**

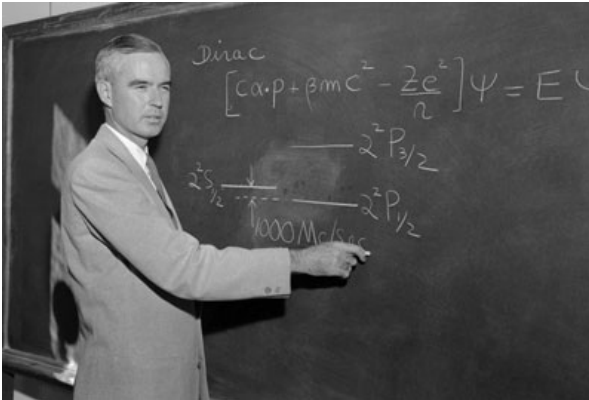


With my adviser (**1969-1974**),
Prof. Brian Thompson (in 2010)

I have learned Physical Optics from Prof. Brian Thompson of Institute of Optics, Rochester.

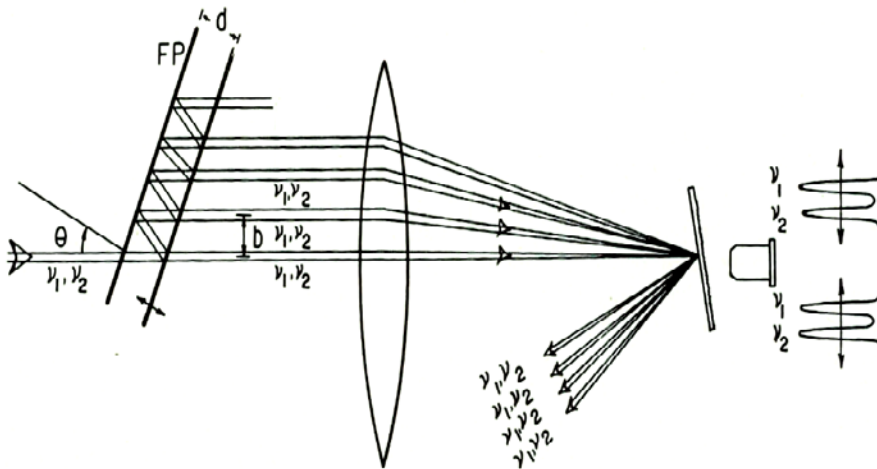
- Thompson was the first person to experimentally validate van-Cittert-Zernike theorem on spatial coherence.
- As far as I know, he believes that “photons” are classical wave packets.
- The “indivisible light quanta” postulate was initiated by Einstein in 1905; but he acknowledged its serious shortcomings in 1955..

Some encounters to assure reality of NIW



It was 1976 summer! I failed to convince Prof. Lamb, in spite repeated discussions over five days, as to why “photons” cannot be Fourier modes of the vacuum!

Nobel laureate, Willis E. Lamb,
the author of “Anti-photon”.



My 1975 experiment that convinced me of NIW and that mathematical Fourier mode cannot represent “photons”.

Some encounters to assure reality of NIW

“A photon is what a photodetector detects.”

- ❖ The release of a bound photo-electron does require a *quantum cupful* of energy to be absorbed by a frequency-resonant dipole.
- ❖ But, the cupful of energy can be collected from an *assembly* of classical EM waves, through a kinetic collision, or from a resonant quantum-quantum “scattering”.
- ❖ **“Indivisible light quantum” is not at all a necessary requirement for QM formalism.**



Glauber,

❖ It has been easy for me to
convince the existence of NIW
to scientists who are naturally
process driven
system engineering thinkers.



A personal encounter with Satyen Bose of “Bose-Einstein Statistics” in 1963!

- The story of re-packing books with a large plastic sheet inside a metal box for shipping as an un-accompanied luggage.
- My mode of thinking has been driven by understanding the physical processes involved in the event under consideration.

In a 1963 encounter, Bose praised my “process driven thinking**”; but I was not able to appreciate that until much, much later!**

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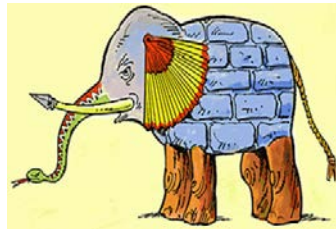
“Evidence based science” does not represent our FINAL knowledge about nature!

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.

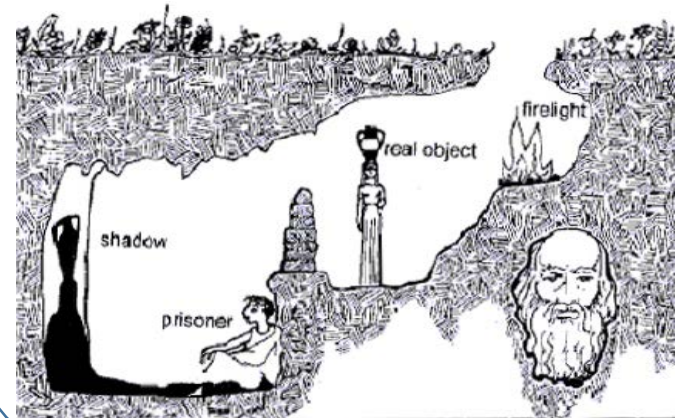


Detailed reality
invisible to blinds.



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!





Dissecting the generic measurement process is of profound significance; but rather straight to appreciate.

“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!

What is the lesson?

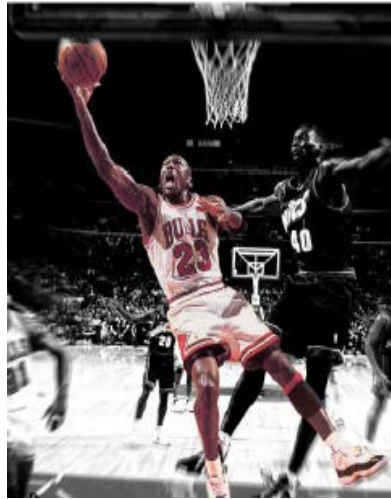
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We still do not understand what constitutes biological intelligence!

There are “problems” behind the assumption of our superior intelligence by abandoning conscious evolution-process-congruent thinking!



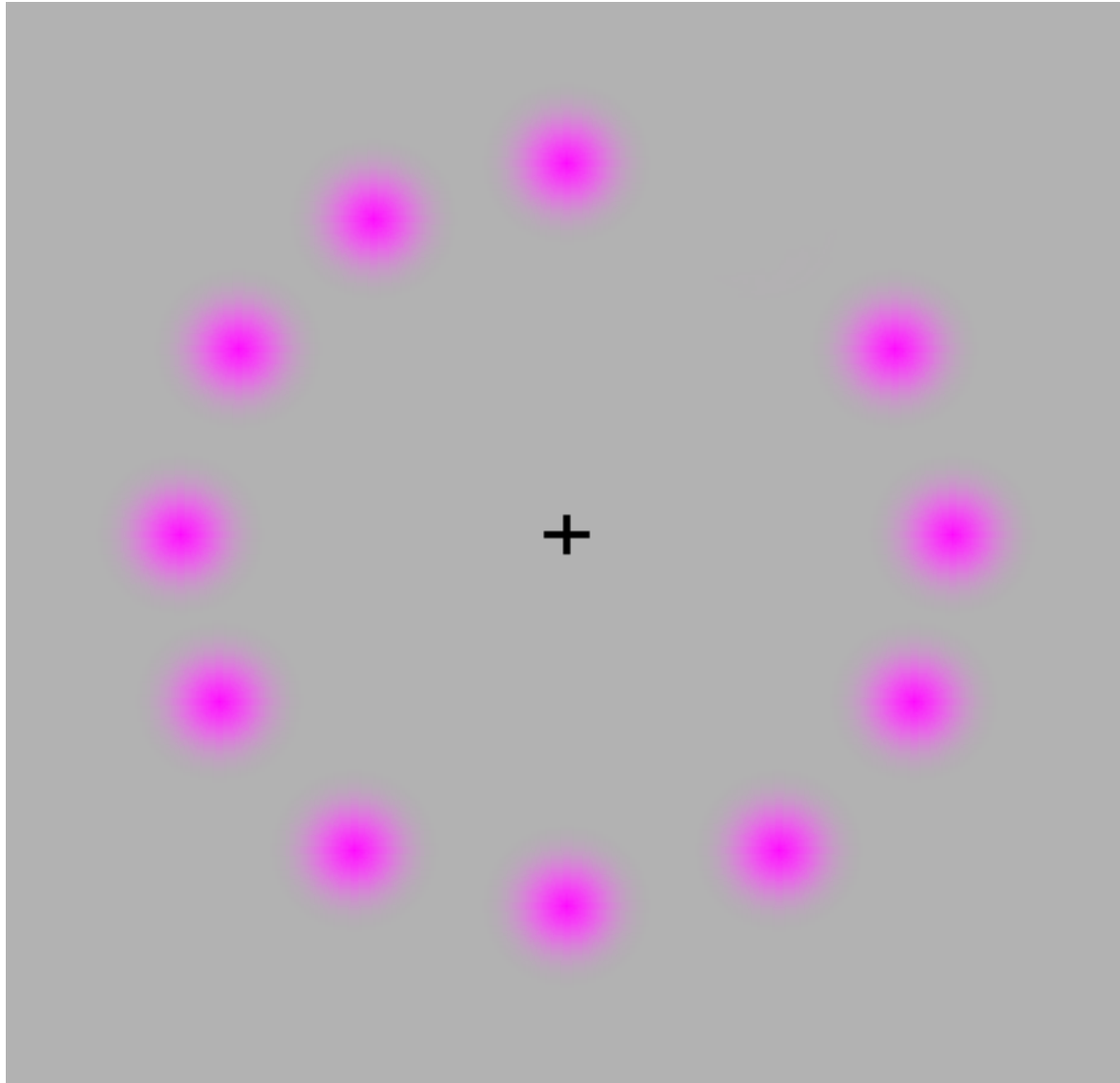
Pictures borrowed from web



Does human invented current mathematics represent the ultimate tool for science?

Emergent conscious human intelligence is only small component of the total biological intelligence.

We see, hear and interpret that which are necessary for our biological sustainability. Exploring the objective reality is a new evolutionary dimension!



Step-1: Focus on one purple spot to see a rotating green spot!

Step-2: Intensely concentrate on the central cross to make all the purple spot disappear!

Are there any questions?

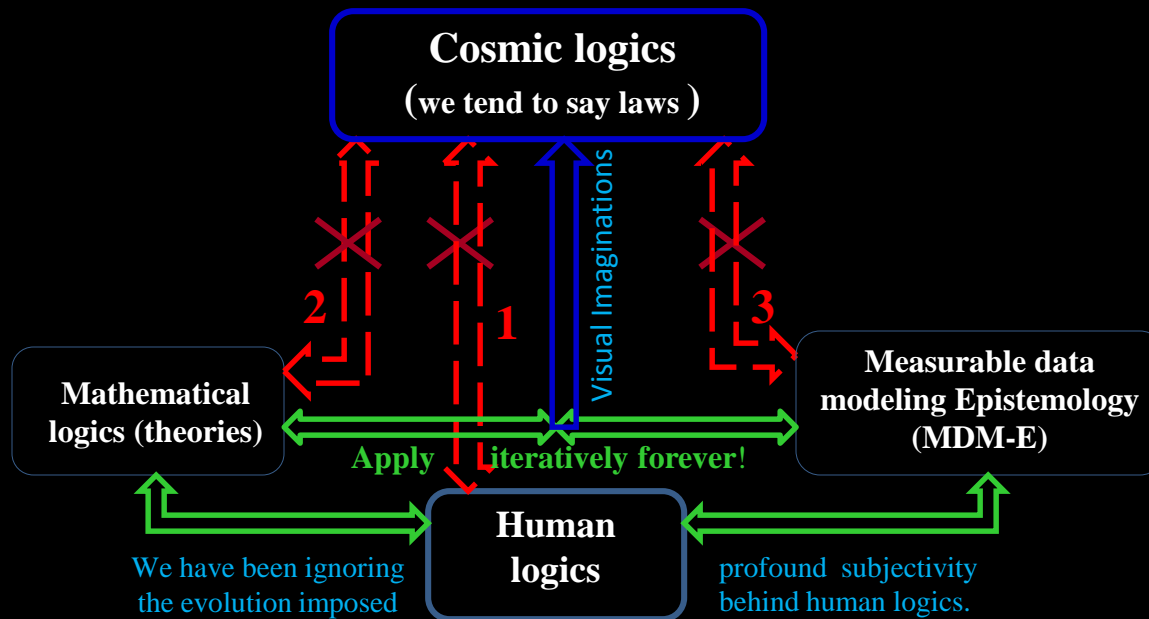


- ❖ We never know **what is absolutely true!**
- ❖ Physics must try to map the **interaction processes.**
- ❖ Technology innovation is simply emulation of **interaction processes** allowed in nature
- ❖ Demand on process visualization will automatically force us to **keep on iterating our theories for 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/>

Why do we have so many conceptual contradictions between successful theories and repeatedly validated experimental data?

- ❖ **1.** Human logics do not have direct access to the Creator's mind, or logics, or laws.
- ❖ **2.** Human invented mathematical logics have been very successful; but we are failing to access the perfect cosmic logics.
- ❖ **3.** Our Measurable Data Modeling Epistemology (MDM-E) also are failing to access ultimate cosmic logics.
- ❖ **So, we need to introduce a more complex iterative theorizing process using Interaction Process Mapping Epistemology (IPM-E), by visualizing the diverse invisible interaction processes in nature.**



Interaction Process Mapping Epistemology (IPM-E)