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Resolution of the wave-particle paradox of light using a new approach

Part II: Computer modeling for the double-slit interference pattern

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The men...



Planck

1858 - 1947



Einstein

1879 - 1955



Born

1882 - 1970



Dirac

1902 - 1984



Feynman

1918 - 1988

Outline

- Our view of what photon is
- Emission and absorption of photons as probabilistic but linear
- All features (i.e. findings) of the double-slit experiment explained
- Computer simulation for photons (“faked”, i.e. in 2D—not 3D)
- A new class of quantum-theoretical predictions we propose
 - Possible only with our approach
- Concluding remarks

What Is Photon?

In our view...

- A photon is a localized condition in the luminiferous (EM) aether
 - Not something apart from it
 - *Essentially*, not spread out... But may have finite size (?)
- Like waves in materials, photons are patterns. They...
 - Involve transport of momentum and energy across space and time
 - Do not involve transport of material
- Like material particles, photons are spatially definite—not spread out or fuzzy
 - A photon is at a definite point at a given instant and nowhere else
- Photons do not spread with time as waves do
 - An expanding envelop or locus is an inapplicable idea
- Photons do not follow the laws of motion of the straight-line trajectory particles
 - The difference from material particles

Emission of Photons

- Our assumption: Source emits monochromatic, coherent radiation
 - Not group waves (unlike all previous theories)
 - Not confined waves (Cavity radiation analysis is not the starting point)
 - Sinusoidal variation of amplitude in time ← Wave Equation
- Planck's energy-quantization hypothesis is not necessary
- The number of photons emitted at an instant is statistically proportional to the instantaneous source intensity
 - Probabilistic, but linear
 - Not time-averaged intensity (unlike all previous theories)
- The emitted photons can be physically distinguished as separate entities
 - Departure from the physics implied by the Bose-Einstein theory

Absorption of Photons

- Absorption is symmetrical to emission
 - Probabilistic
 - Proportional to the energy at the absorption point
 - Therefore, ψ denotes the electric field at the absorption point, even in quantum mechanical description
- Einstein's explanation of the photo-electric effect
 - An explanation that did not have to be modified
 - A rarity, in our approach / theory!
- Note: No special collapsing mechanism

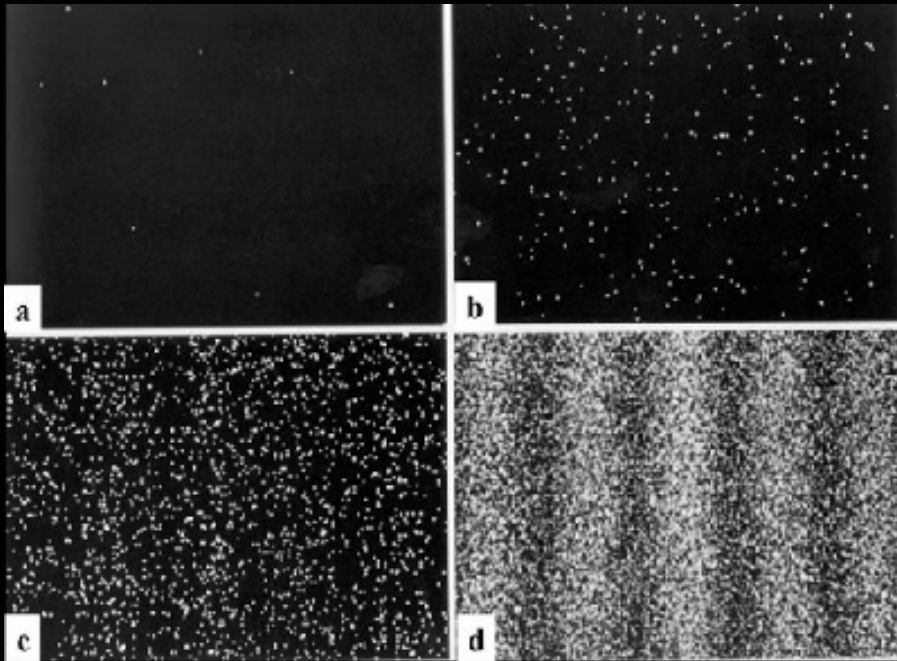
About the Traveling Photon

- A photon, even while traveling, occupies only definite points
 - Not spread everywhere
- Therefore, its motion traces a continuous path
 - The path is not fuzzy, spread out, vague, disconnected, or with sudden jumps, etc.
- The path in space has the characteristics of random walks
 - In part. (Phases!)
- The path traced is deterministic (i.e. the process is causal)
 - Else, a build up to a predictably wave-like pattern would not be possible
 - Has isotropy at a point in space for all the photons passing by it
 - Has isotropy for a single photon over its path
- Note: No hidden variables

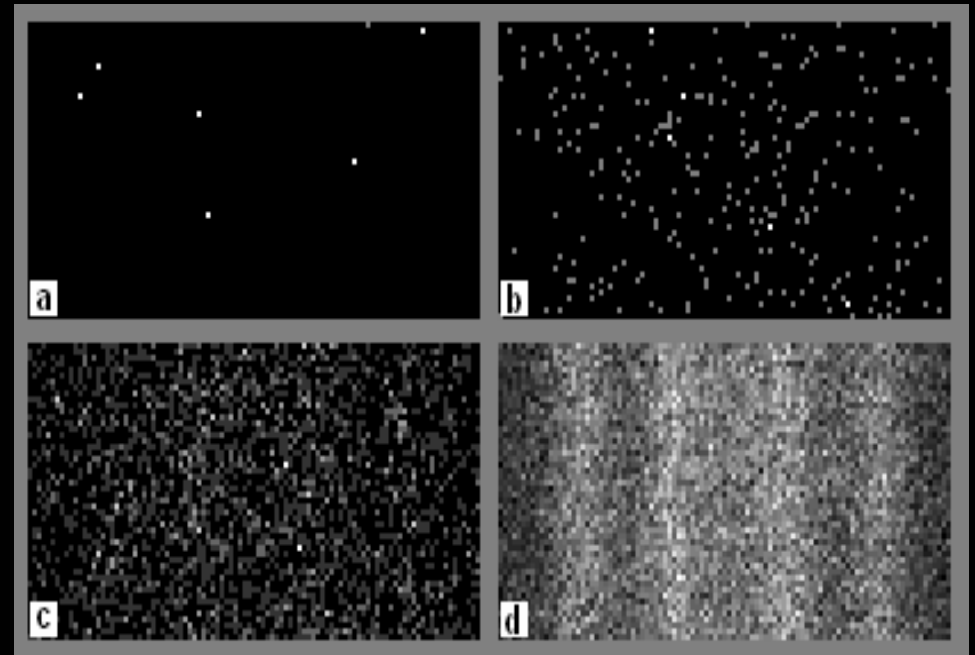
The Double-Slit Experiment

- A single photon goes through only one slit at a time
- For a shower of photons, the diffraction or interference patterns necessarily builds up at the screen
- An extra detector near the slit collapses the interference pattern because detectors are active, not passive devices
 - Detectors exert receptive influence and thus modify the field
 - Less than 100% detection efficiency causes a partial collapse of the interference pattern

Experimental Results and Simulation



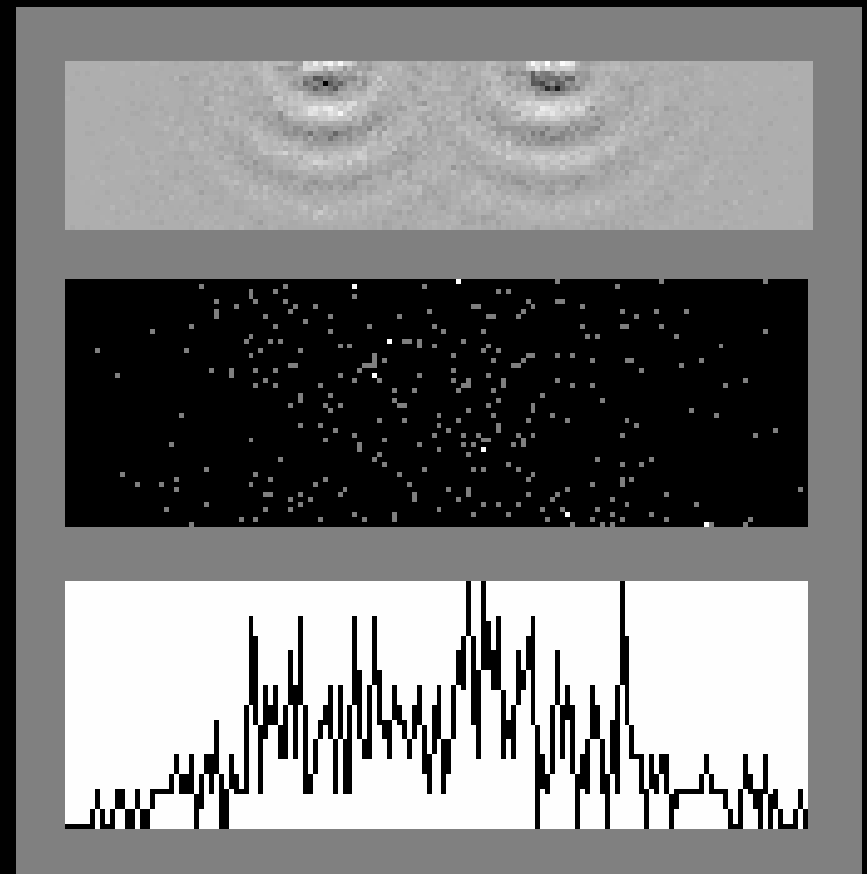
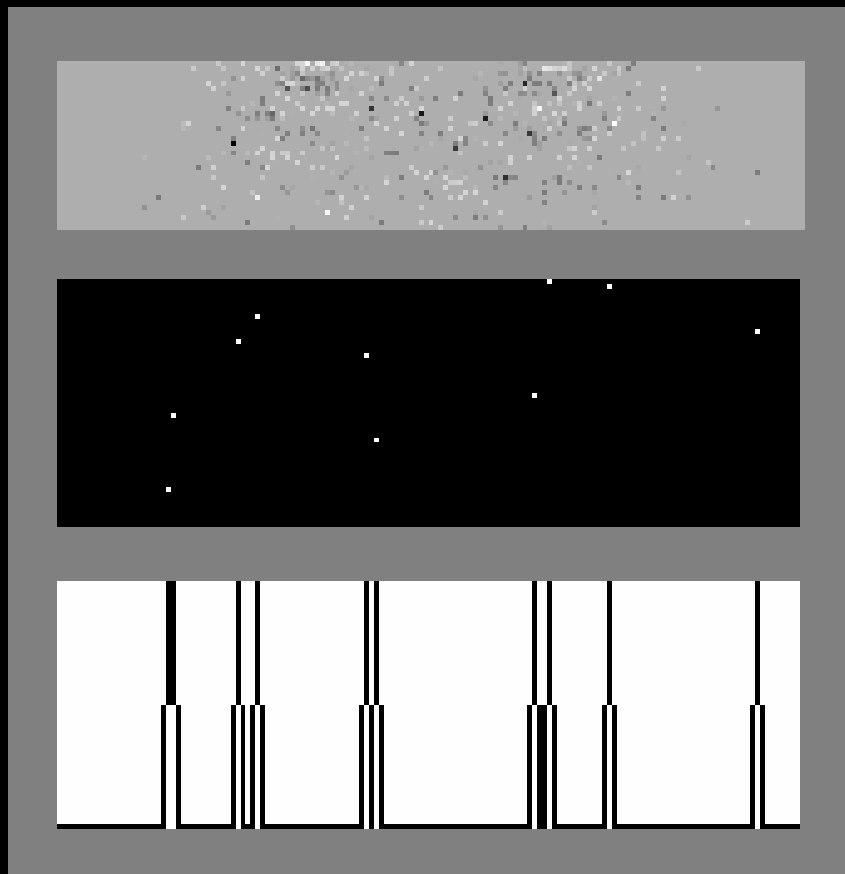
- Tonomura et al (1989)
- 3D
- Biprism-like
- Electron (Fermions)
- Far-field (Plane waves)



- Our simulation
- 2D (Planar)
- Double-Slit
- Photons (Bosons)
- Near-field (cylindrical, microwaves)

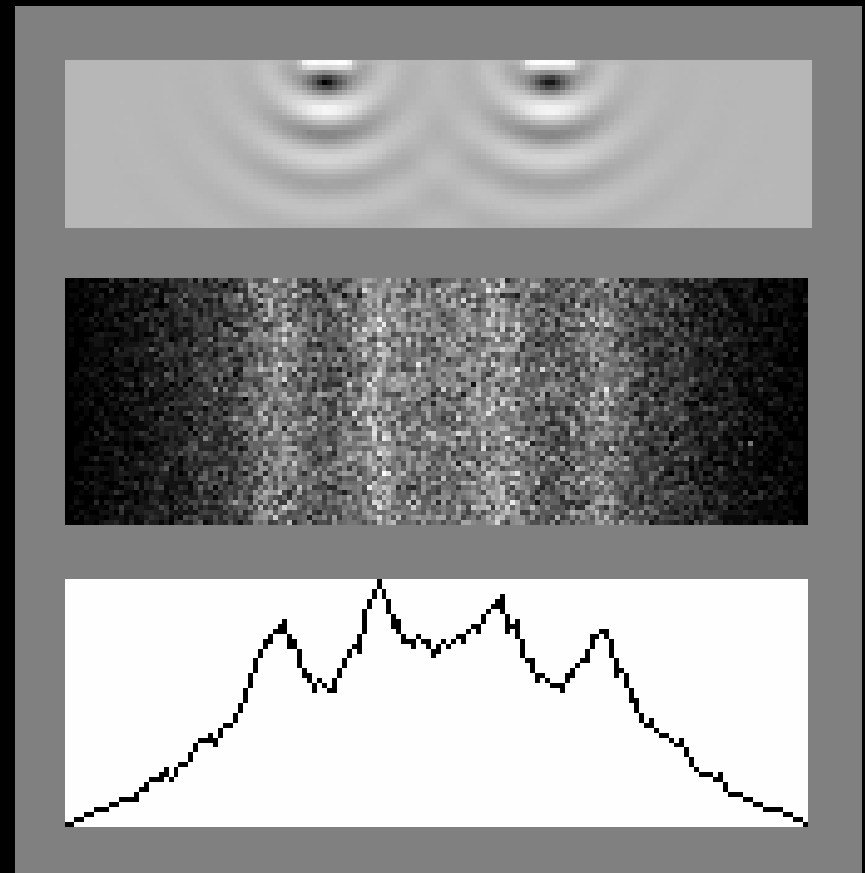
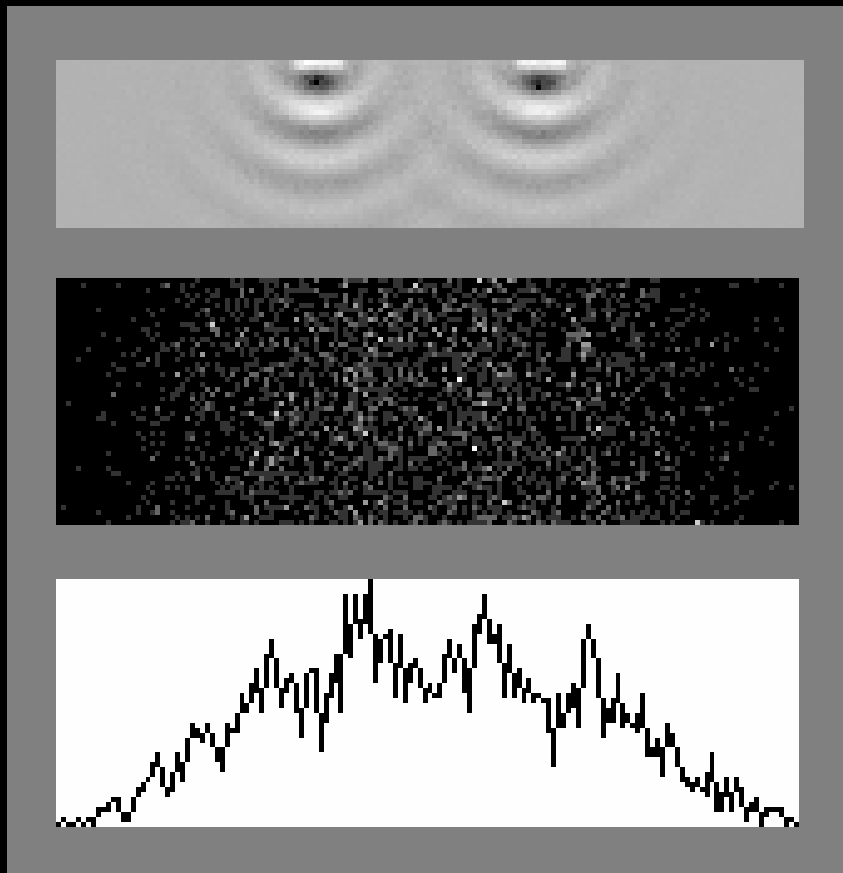
Progress in Simulation

10 and 300 photons



Progress in Simulation

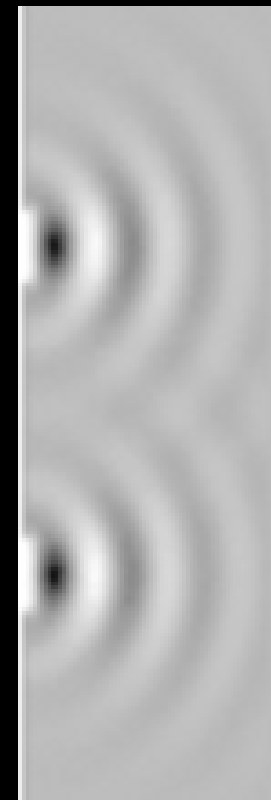
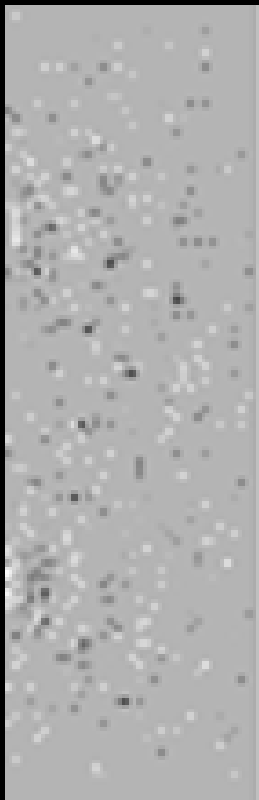
3,000 and 60,000 photons



Progress in Simulation:

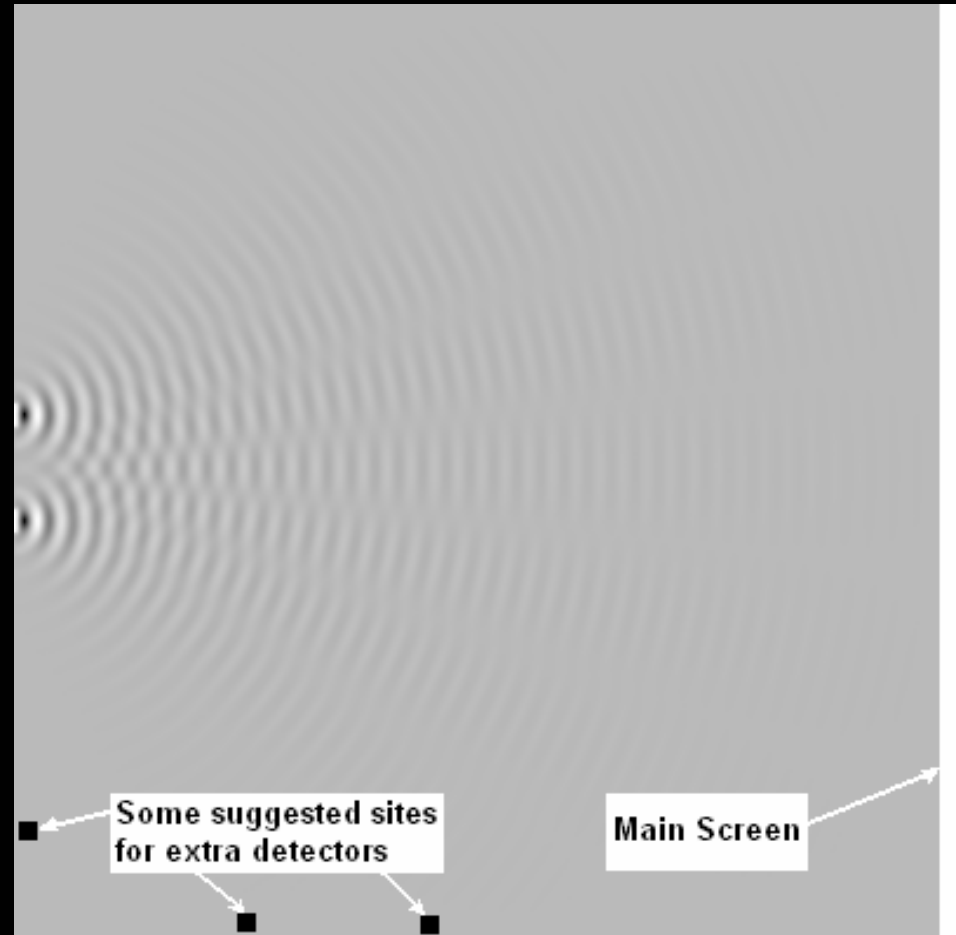
Top view of the (planar) interference chamber

- 4 Stages: 10, 300, 3000 and 60000 photons



A New Class of Predictions

- Place an extra detector
- The screen is farther than the extra detector
- Note the time of each photon arrival
 - E.g. time of first hit
- Over a sufficient number of experiments, some photons will hit the screen before the closer extra detector



About the New Class of Predictions

- Our view shows temporal order in photon propagation
 - Does not need the notion of anti-particles
- Others remove temporal order, in principle, out of theory
 - Path Integral-based formulations that make everything fuzzy
 - Photon coming into present from a future!
- Therefore, we can make predictions involving the time element
- Other suggestions for experiments will follow in due course of time

What Was Left Out of Discussion...

- A detailed account of the phases
 - Involves vector addition
 - Explaining physics implied by it
- Present our theory using mathematical notation...
 - Relevant to notation are:
 - Green's Functions and propagator formalism of QED
 - But new notation must keep intact quantum propagation with the following attributes
 - Finite sampling of the Huygens process
 - Spatially definite
 - Time-ordered
- Discuss quanta other than photons
 - Fermions and Bosons

Our Theory, Contrasted from Other Quantum Theories - 1

- What we did not do or undertake, in our theory/approach...
 - Offer a non-probabilistic theory
 - Agree with uncertainty as a fundamental principle
 - Use Planck's energy quantization as a starting point or as a rationale for justifying the quantum nature
 - Agree with the “welcher-weg” principle (and many others!)
 - Theorize about pilot waves or hidden variables
 - Multiply the world into hypothetical infinite realities
 - Describe particles arriving in the here and now from future
 - Accept the duality as a necessary dichotomy
 - Reject causality
 - Theorize about a cat being simultaneously alive and dead

Our Theory, Contrasted from Other Quantum Theories - 2

- What we have shown...
 - Pointed out that Fresnel (and all, subsequent to him) misapplied the original Huygens' principle—i.e. wavelets vs. waves
 - Corrected the misconception, propagating since 1818, concerning the necessity of the obliquity factor
 - Reinterpreted and then further modified Huygens' Principle to arrive at a process-based, temporally ordered description of radiation
 - Showed the necessity of aether in quantum theory
 - On a new basis—the exchange of forces / momenta and isotropy
 - Gave an exact description of the relation between the classical (continuum) and quantum views

Our Theory, Contrasted from Other Quantum Theories - 3

- What we have shown...
 - Provided an entirely new view of the term “quantum”. Thus, photon is:
 - Definite in space, and having continuous path
 - Order-preserving in time
 - Indicated an indirect but physical meaning to ψ (not just ψ^2)
 - Explained all the features of the double-slit experiment
 - Juxtaposed results of “the most beautiful” physical experiment and computer simulation
 - Formulated a new class of predictions

Before Closing...

- The Wave-Particle duality is now resolved....
- But, this is just a beginning. The ideas are still evolving...
- ...though, already there is sufficient clarity regarding:
 - Application to continuum fields of engineering interest
 - Lorentz and Galilean invariance
 - Special Relativity and QED
 - Application to (modeling of) Beam-Splitter experiments
- For work in the indefinite future...
 - QED of electrons (Fermions)
 - More complex problems

Thank You!

- This is Schrödinger's Cat.
- He is alive.
- He always was!
(...since his birth)

