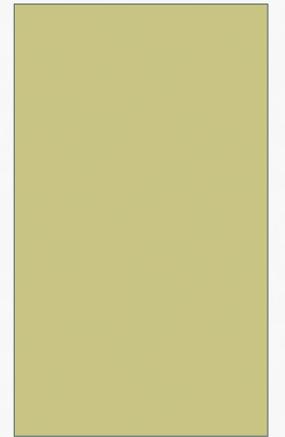# THE QUANTUM PHYSICS OF NONDUAL PERCEPTION

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Why Develop a Quantum Physics of Nonduality?

MOTIVATION

- Can there really be a physics of nonduality? Yes & No!
  - Math is only a symbolic representation of experience
  - So far, experiments embraced by science have been primarily of the dual type that assumes a separation of observer from observed. This assumption finds its limitations primarily at atomic and subatomic scales, hence quantum theory…

- Our intuition is that quantum physics embraces or points to a place from which observer and observed are not separate—a place of nonduality
  - Within the formalism of quantum physics there are many deep mysteries that speak to the mysteries of what is real and what is not real
    - Nonlocality, superposition, irreducible multidimensionality, complementarity

OBJECTIVES

- Nondual perception =

  entanglement of observer with observed (from outside)

  dissolution of self (from inside)

- What is the relationship of dual with nondual perception?

  - Metaphorically, nondual perception can be represented as a singular or non-perturbative solution to a set of equations that describe conventional (dual) perception

    - That is, dual and nondual are related, but you cannot arrive at the nondual from the machinations of the dual (echoes of Gödel)

SINGULAR/NON-PERTURBATIVE SOLUTIONS

- A singular solution is non-perturbative when it is not derivable from a general solution

- When two systems interact, a fundamental assumption is that the two systems are separate—we must 'add in' the interaction.

- A non-perturbative or singular solution avoids the assumption of separability: subsystems are fundamentally nonseparable.

- Collective motions of many-particle systems admit (nonlinear) solutions that are not derivable from our common linear coupled oscillator models or small perturbations of these.
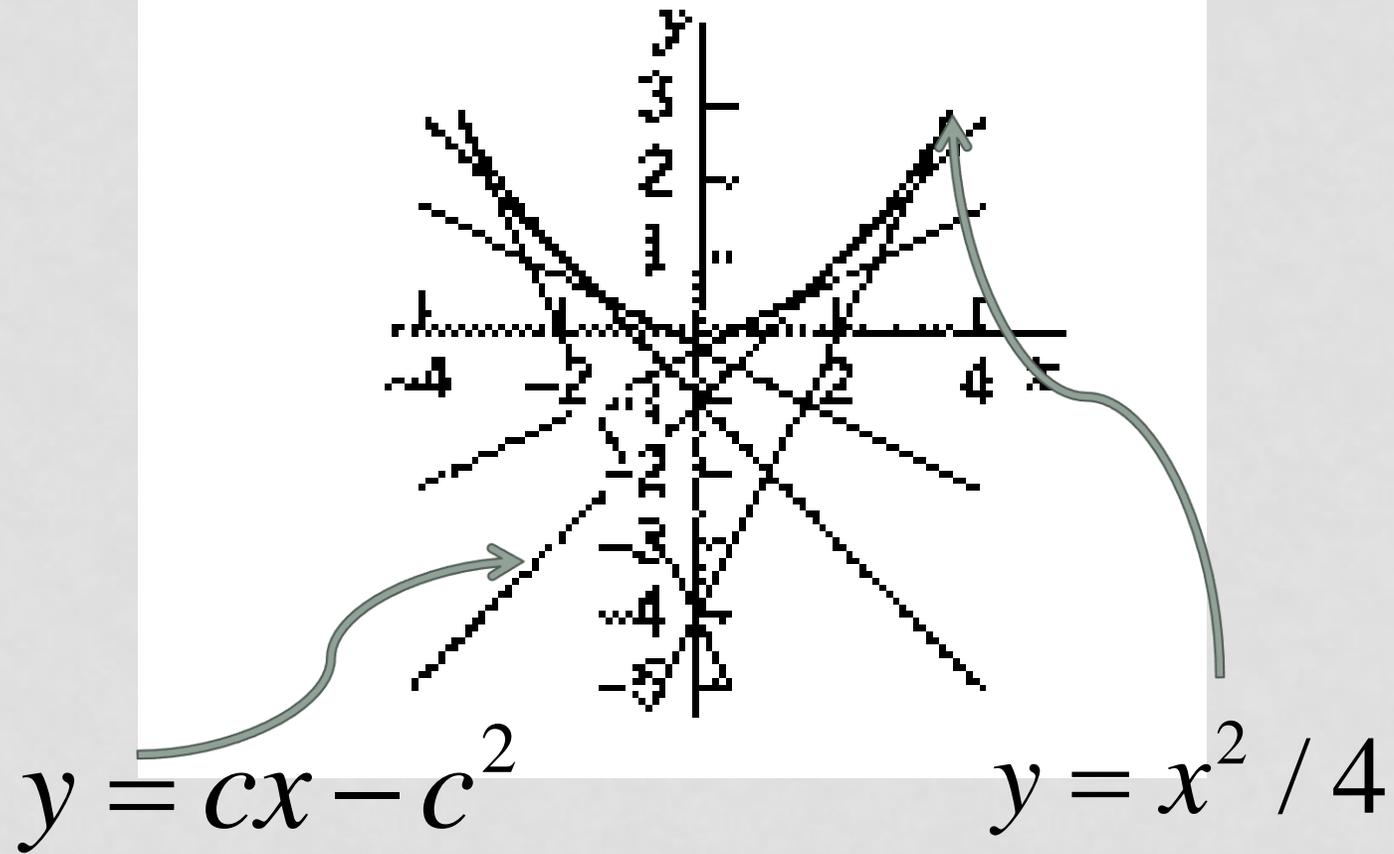
SINGULAR SOLUTIONS

- Consider the equation

$$\left(\frac{dy}{dx}\right)^2 - x\frac{dy}{dx} + y = 0$$

- This equation has two kinds of solutions: a general solution (straight lines), and a singular solution (curved line, parabola).

$$y = cx - c^2 \qquad\qquad y = x^2 / 4$$

SINGULAR SOLUTION IS BOUNDARY OF GENERAL SOLUTION

$y = cx - c^2$

$y = x^2 / 4$

PHENOMENOLOGY

- Perception of a single photon
  - By single atom
  - By large molecule
  - By extended condensed matter (structured, unstructured)
- Staring experiments: Rupert Sheldrake

PERCEPTION OF A SINGLE PHOTON

- A photon can be *absorbed* or *scattered* and therefore *perceived* by:

- a single atom

- An entire molecule

- An entire cell

- An entire organism

PHOTON SCATTERING

- Rayleigh scattering –
  - elastic scattering of photon from atom or molecule

- Raman scattering –
  - Inelastic scattering of photon from atom or molecule
  - Photon gains energy from atom or molecule → Stokes process
  - Photon gives up energy to atom or molecule → anti-Stokes process

- Brillouin scattering –
  - Scattering of photons from collective modes (phonons)
  - Phonons may be generated acoustically, thermally or nonlinearly generated by the light itself.
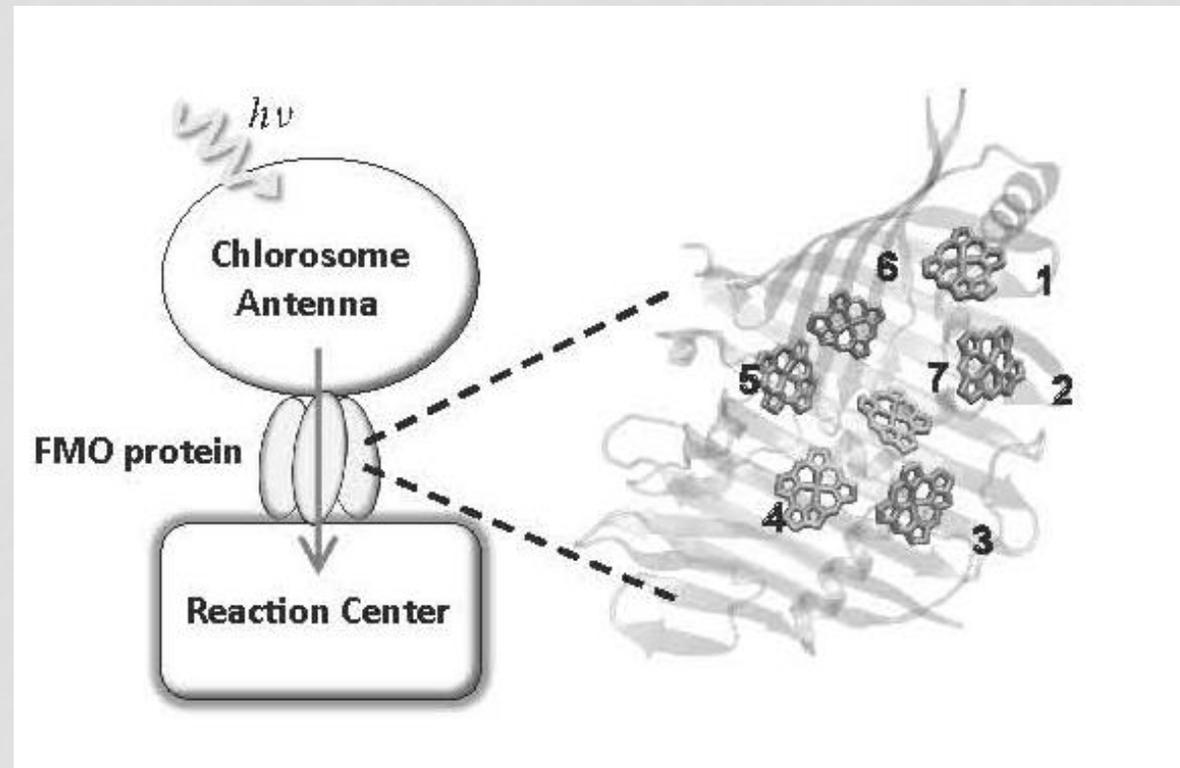
TYPES OF PHOTON SCATTERING
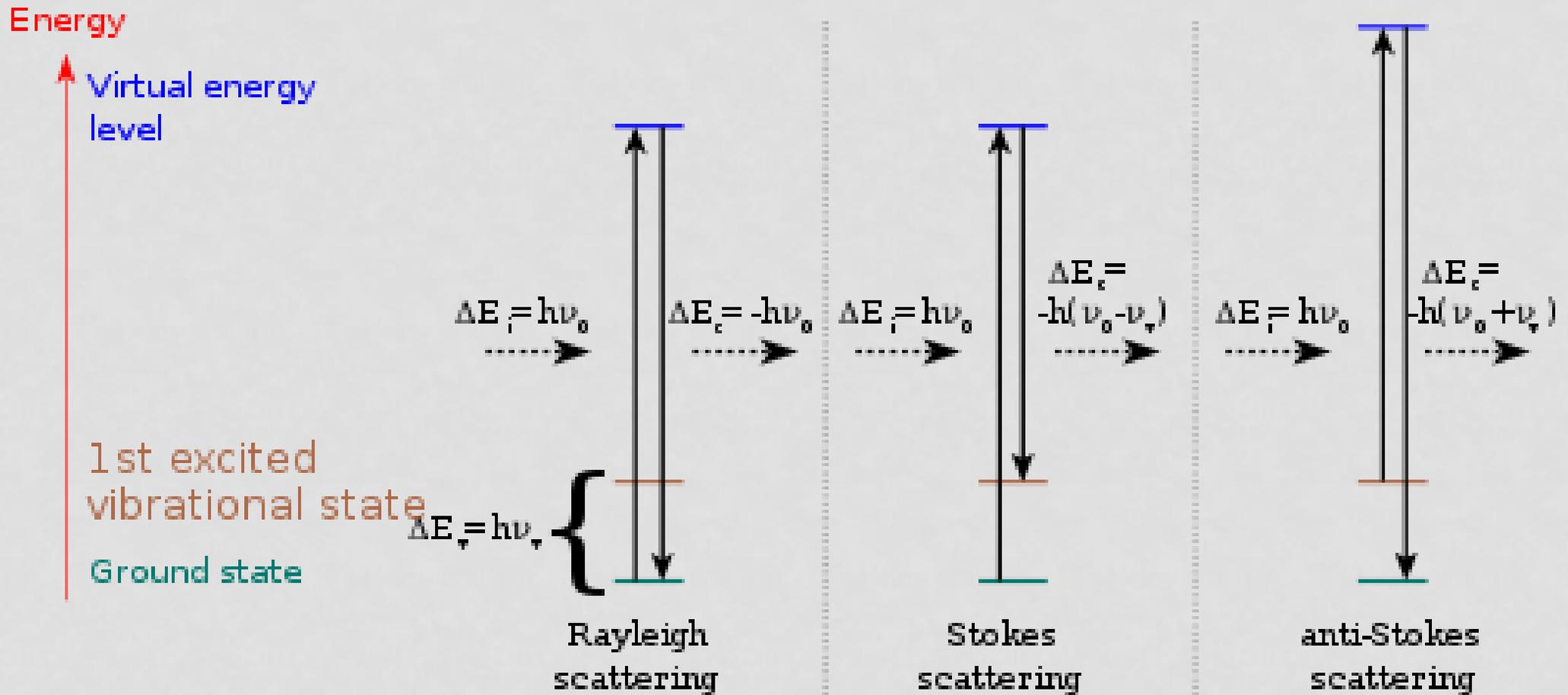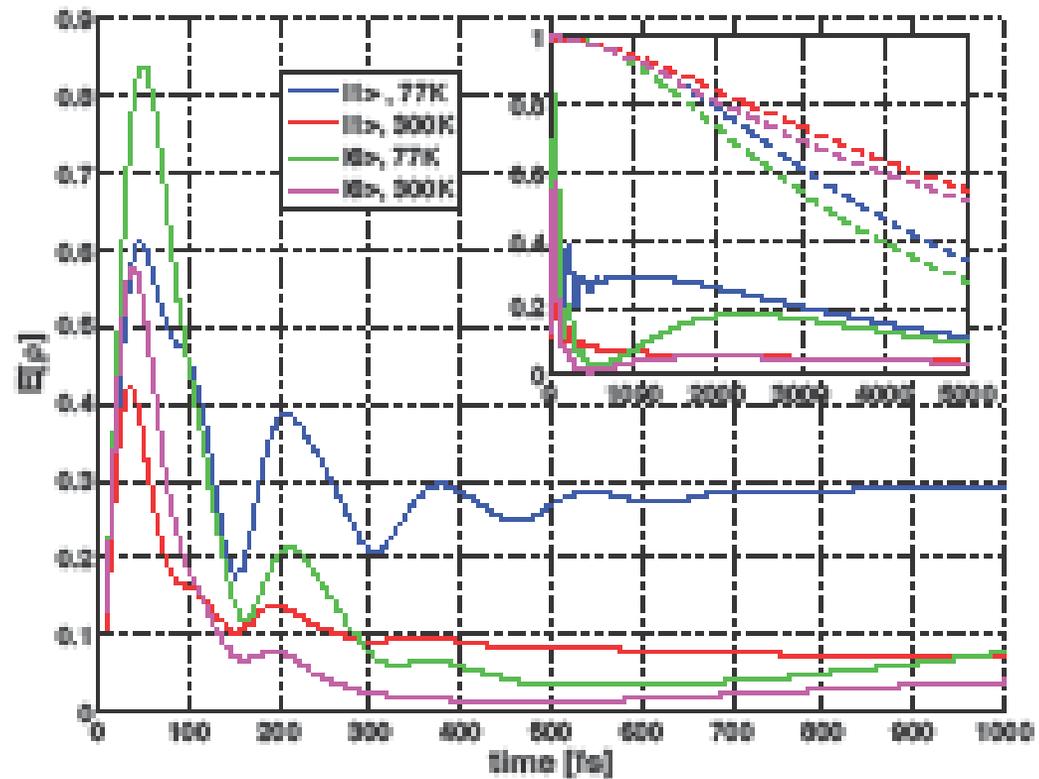
BRILLOUIN SCATTERING
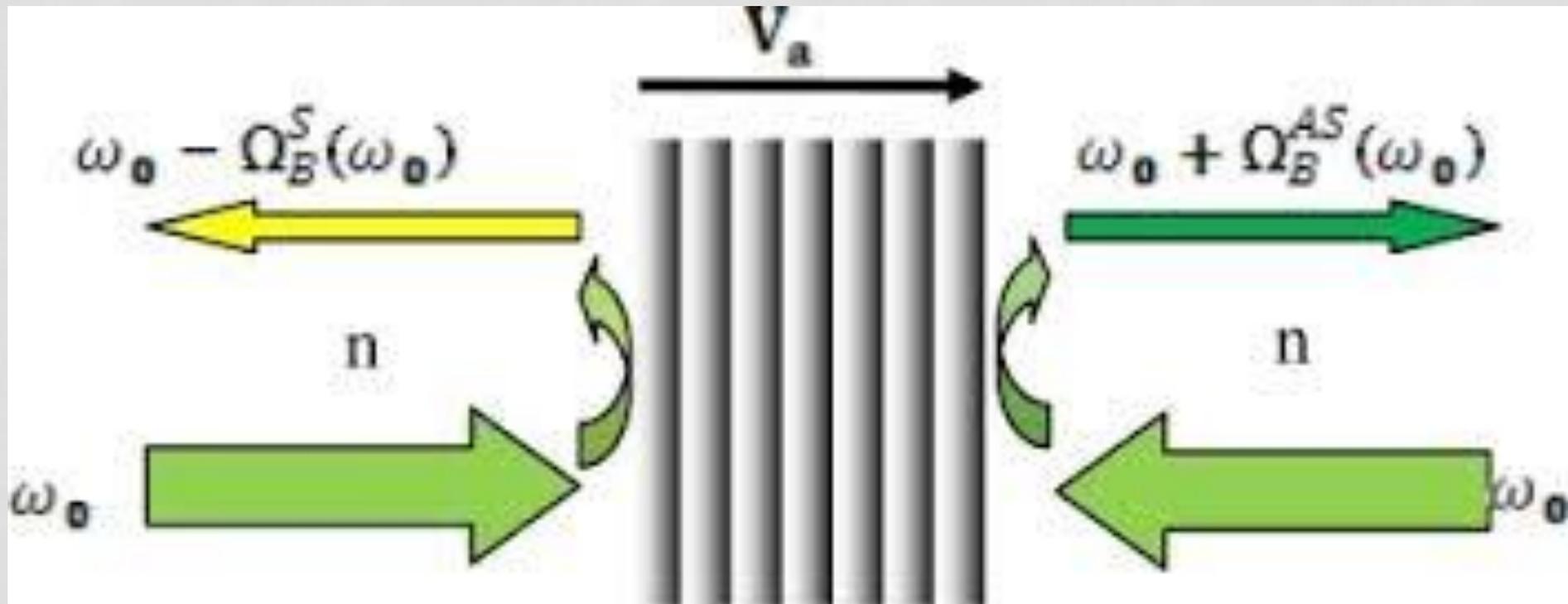
TRANSFER OF ELECTRONIC EXCITATION

- Fenna-Matthews-Olson complex in photosynthesis: persistence of quantum coherence in biological molecules – similar in vision? (Work of Graham Fleming et. al., UC Berkeley and Lawrence Berkeley Labs.)

TIME EVOLUTION OF GLOBAL ENTANGLEMENT

Quantum Entanglement in Large Molecules

"This is the first study to show that entanglement, perhaps the most distinctive property of quantum mechanical systems, is present across an entire light harvesting complex,"

Mohan Sarovar, UC Berkeley Center for Quantum Information and Computation.

SUPERPOSITION OF WAVEFRONTS
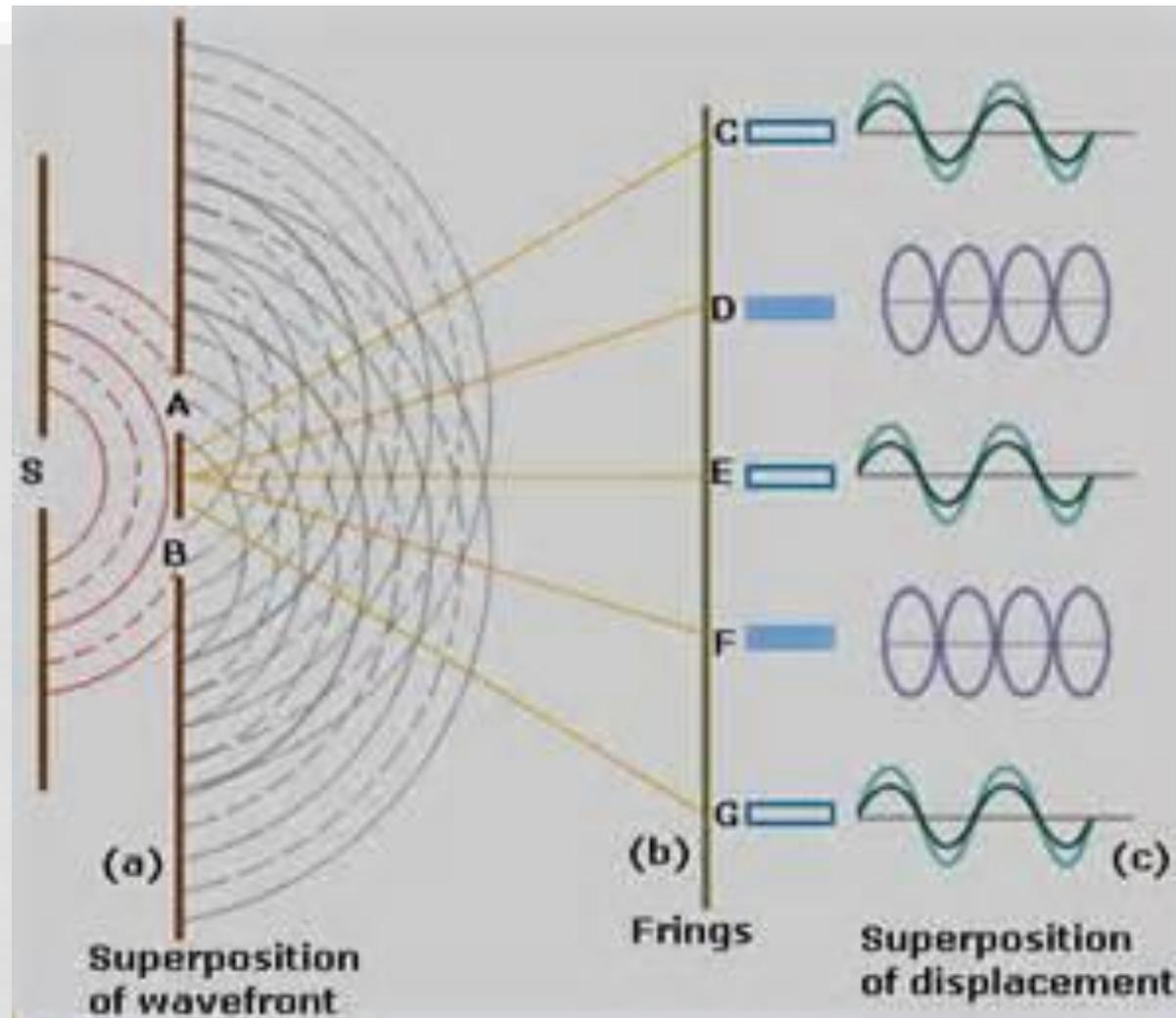
QUANTUM ENTANGLEMENT IN FMO COMPLEX

- $E[\rho]$ is a measure of global quantum entanglement between N chromophores where, in the site basis, $|i\rangle$ represents the state where only the ith chromophore is excited, all other chromophores are in their ground states.

- $S(\rho)$ is the von Neumann entropy of the state ρ .

$$\rho(t) = \sum_{i=1}^{N} \rho_{ii}(t)|i\rangle\langle i| + \sum_{i=1}^{N}\sum_{j>i}^{N} \rho_{ij}(t)|i\rangle\langle j| + \rho_{ij}^{*}|j\rangle\langle i|$$

$$E[\rho] = -\sum_{i=1}^{N} \rho_{ii} \ln \rho_{ii}$$

$$S(\rho) = -\operatorname{tr} \rho \ln \rho$$

ABSORPTION OF PHOTON ALTERS RADIATION FIELD

- The source of the photon is the object being observed

- Observation (absorption of photon) alters radiation field which, in turn, changes the object being observed

- Absorption of photon links (entangles) observer and observed

STARING EXPERIMENTS

- Person A stares at person B without person B's knowledge.
- Person B 'senses' or feels they are being stared at and turn around.
- What is happening?
- Variables:
  - Attention of observer
  - Attention of observed
  - Ambient radiation field
- Person B senses A staring at them if:
  - Person B pays attention to and therefore absorbs and perceives just those photons from the ambient radiation field that couple to person A at the level at which person A's attention is embodied.

THE RELEVANCE OF QUANTUM PHYSICS

- Quantum physics is a language for describing what is unseen and what is assumed to be separate from us (classical also assumes separability, but is seen by the unaided senses)
  - The moment we contemplate making an observation, we establish a point of reference (ourselves) and a spacetime (3+1) from which we make that observation.
  - The measurement problem arises in the change in the fundamental symmetries that are put in place by the implicit subject/object duality of having a reference point
- As a language, quantum physics (i.e. a Hilbert space that carries the symmetries and uncertainty inherent in assuming an observer/observed split)
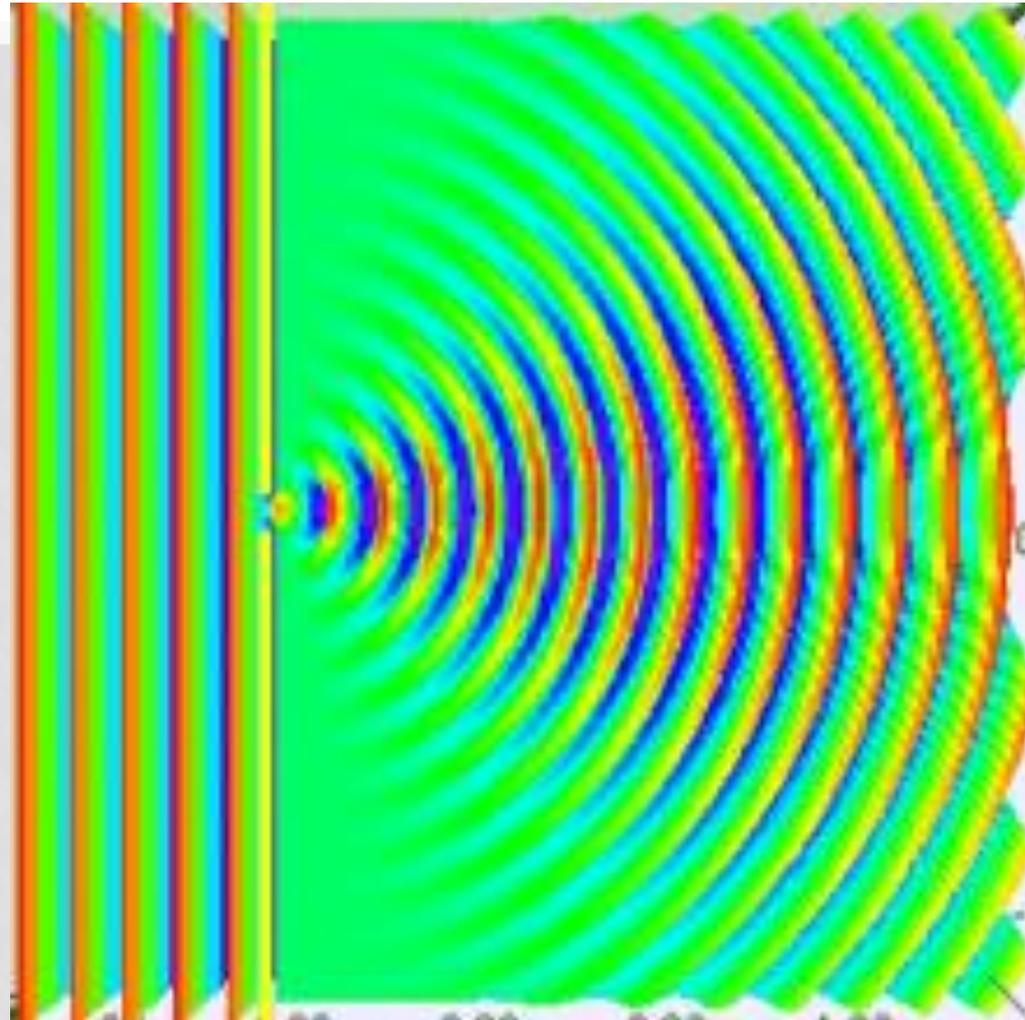
THE WAVEFUNCTION IS ALREADY ENTANGLED

- The wavefunction entangles its real and imaginary parts

- This implies we cannot observe one property of Ψ without affecting a complementary property

PHOTONS AS WAVES

LINK BETWEEN DUAL AND NONDUAL PERCEPTION

- Nondual perception is the singular solution (wavefunction) to generalized equation whose classical version is the equation for the reduced wavefunction.
  - Classical equations are singular limit as $\hbar \to 0$ of Schrödinger equation
  - Classical equations for any system but the simplest are highly nonlinear…
- That is nondual perception is coming into entanglement with the object of observation—observing without collapsing the wavefunction.
- Classical equations are related to Schrödinger's equation as general solution to an equation is related to its singular solution.

A WAVEFUNCTION LIVES IN TWO WORLDS – SEEN AND UNSEEN

- Hilbert Space is the space where wavefunctions live, and may therefore seem to be outside of the 3+1-dimensional world of sense-based observation.

$$\left|\Psi\right\rangle = \left|\Psi\right\rangle_R + i\left|\Psi\right\rangle_I \qquad \Psi(x) = \Psi_R(x) + i\Psi_I(x)$$

- Observation/measurement is an integrative/additive action, which consists in taking the modulus of wavefunction and adding up its conjunction throughout all of space with the operator that represents the observable we are interested in.

$$\left\langle O\right\rangle = \int d^3x\, d^3x'\, \Psi*(x')O(x',x)\Psi(x)$$

DUALITY IN WAVEFUNCTION

- The wavefunction embodies wave-fronts as well as rays: wave-fronts embody the extensive and nonlocal wavelike nature of the wavefunction, whereas rays embody the particle nature of wavefunctions.

- In the following expression, r is the distance from the origin of a spherical wavefunction, k is the wavenumber, which is related to the momentum of the particle represented by the wavefunction.

$$\Psi(r) = A\frac{\exp(ikr)}{r}$$

PRIMARY MANIFESTATION OF SYMMETRY: NONDUAL VIEW OF QM

- Aage Bohr (Niels Bohr's son) developed a reinterpretation of symmetry where the group of symmetry transformations that characterizes an experimental set-up is the quantum.

- "Hence quantum mechanics, as the physics of these elementary variables, is liberated from the concept of quantization and the need for interpreting a formalism. It is, therefore, but an implication of spacetime invariance, with complementarity originating in the non-Abelian spacetime symmetry. " (Bohr and Ulfbeck, 1995)

- Hence quantum indeterminacy originates in our 'point of view', in the limited dimensionality of normal (dual) perception.

NONDUAL PERCEPTION

- Nondual perception is the quale present when the wavefunction that couples observer and observed is not integrated, when its real and imaginary components are not mixed.
  - When the non-Abelian multidimensional group elements that embody the symmetries of a point of view are apprehended simultaneously.
- The subjective experience of nondual perception is that inside and outside are both 'inside', and that events that span inside and outside take place simultaneously.

REVERSING CONFLATION OF TRUE SELF AND FALSE SELF

- Conflation (confusion) of Self with self (by self) is the origin of suffering:
  - The root cause of afflictions (avidya)
  - The origin of conditioned experience
  - Second-order and higher order mapping in the brain, autobiographical (conceptual) self
- Conflation happens *in time*, as a repeating transient event, and is avoidable
- Being present to the dissolution of percepts (including core self) prepares the attention to be present to the formation of the next percept, to the event of conflation

→ *being present to the ending allows us to see the 'matrix': how a neural image conjoins itself with a mental image (the hard problem of consciousness), how a localized self arises from a nonlocal Self (how duality arises from nonduality)* ←

ORIGIN AND END OF SUFFERING (DUAL PERCEPTION) IN THE YOGA SUTRAS

- II.17 *drastr-drsyayoh samyogo heya-hetuh*
  - The correlation (*samyoga*) between the seer (*drastr*) [i.e. the Self] and the seen [i.e. Nature] is the cause (*hetu*) [of that which is] to be overcome (*heya*):
- II.25 *tad-abhavat samyoga-abhavo hanam tad-drseh kaivalyam*
  - With the disappearance (*abhava*) of this (*tad*) [nescience] the correlation (*samyoga*) [also] disappears (*abhava*); this is [total] cessation (*hana*), the aloneness (*kaivalya*) of the [sheer power of] seeing (*drsi*).
- II.26 *viveka-khyatir-aviplava hana-upayah*
  - The means (*upaya*) of [attaining] cessation (*hana*) is the unceasing (*aviplava*) vision (*khyati*) of discernment (*viveka*)

THE UNCONDITIONED - NIBBANA NONDUALITY IN BUDDHISM

- *Nibbana* (*Nirvana* in Sanskrit) = nir 'absence of' + vana 'suffering', 'defilement' → 'absence of suffering', 'state of no suffering', can be temporary as we can all experience, or permanent as in the case of the Buddha
- *Nibbana* is the nature of the original unconditioned transcendental Mind, which is luminous, void (of defilements), and is the middle mind beyond duality
- *Sunnyata (Shunya* in Sanskrit, the void: the realm of changeable forms is empty and *nirvana* must not be sought outside *samsara*
- *Unconditioned* = undivided (real and imaginary axes remain separate), uncollapsed

DOES AN ELECTRON KNOW IT'S AN ELECTRON?

- An electron is always in a nondual state, so its identity and form of consciousness is one of 'being whatever it is entangled with.' Entanglement is a unique form or knowing that is independent of space and time (it is nonlocal and atemporal).

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