

Visual Perception Using Advanced Wave Solutions of Maxwell's Equations

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Abstract : The process of visual perception is re-analyzed in view of recent developments in Physics and it is proposed that the age-old belief of some “light” coming out from the eyes and alighting on the object thereby making visual perception possible may really have a grain of truth. We discuss the Vedantic theory of perception, propose the incorporation of scientific theory into its framework and show how it can be applied to understand some of the inexplicable phenomena like blind-sight.

1. Introduction

The earliest explanation of visual perception is found in the *Vedas* [1] wherein it is stated that the eyes don't see, and that the true seer is different from the eyes which are but instruments of perception. The same thing is stated in respect of all other sense organs like ears etc. Further it is also mentioned [2] that there are subtle centres or areas in the brain (subtle senses) where perceptual images are stored, synthesized and analyzed before coming to a definite conclusion regarding the perceived object, which does point to the existence of consciousness or a self doing these internal activities[3].

In later era, Empedocles (~5th century BC) postulated and then Plato (~4th century BC) supported the extramission theory (also called emission theory) which was later supported by Ptolemy and also Galen (both 2nd century AD) according to which visual perception results from rays emanating from the eyes which fall on the object, thereby resulting in perception, though Euclid (~3rd century BC) and Lucretius (~55 BC) had questioned the theory on the basis of some valid arguments. Still, it continued to be accepted as the theory of vision for about a thousand years more in Europe till Kepler [4] and Newton [5] came upon the scene.

Interestingly, Aristotle, Plato's best student, had rejected the extramission theory, while Leonardo da Vinci as late as in the late 15th century had supported it. Even before Kepler, it was the famous 11th century Islamic scientist Alhazen who in his *Book of Optics* advocated the intromission theory with good deal of reason and experimentation. The persistence of the extramission theory has been discussed by Gross [6], and an even more recent study by Winer *et al* [7] found that about 50% of American college students still hold extramission theory to be the true theory of vision!

The currently accepted theory of visual perception following Newton is that the light from an object gets into the eye, forms an inverted image in the retina and that is conveyed to the visual centre in the brain whereby the perception occurs. The biggest challenges to such a simplistic explanation are:

- 1) The perceived object is seen to be outside rather than inside the brain where the perception seems to occur.
- 2) What the brain registers are only firings of neurons making up a certain live neural correlate or a functioning neural network. How are those neuronal firings translated to the characteristics of the perceived object?
- 3) How do we perceive wholeness by integrating neuronal firings in different locations in the brain, which is impossible unless some sort of non-locality is assumed, at least of the dimensions of the physical brain, thereby implying a role for quantum mechanics in a thermodynamic neural system of classical dimensions at room temperature?
- 4) What is the exact mechanism of re-inversion of the totally inverted retinal image during the interpretation process in the brain?

Many more such questions have been left unanswered by the currently accepted classical Newtonian theory of visual perception, which have drawn the attention not only of the physics community, but also from workers in the fields of neurobiology and neuro-psychology. In this work, we try to find out possible solutions to some of such difficult queries in view of the latest developments in physical theories concerning the nature of light since the time of Newton.

2. Advanced Waves in Physics

In classical electrodynamics of Maxwell, the wave equation for propagating electromagnetic field or potential components in vacuum is second order in space and time derivatives:

$$\frac{\partial^2 \psi}{c^2 \partial t^2} - \nabla^2 \psi = 0 \quad (1)$$

One can separate the variables and find that the solutions for waves travelling with finite speed c will be having the four possibilities :

$$\psi(\mathbf{r}, t) = A e^{\pm i\mathbf{k}\cdot\mathbf{r}} e^{\pm i\omega t} \quad (2)$$

For the inhomogeneous case involving charge-current sources also, one can use Green functions to find the retarded and advanced wave solutions. Fig. 1 below depicts these retarded as well as advanced waves emanating in future and past time directions respectively waves from the source at $x=0$ and $t=0$ for the one dimensional propagation. Usually, we discard the advanced wave solutions as unphysical as they are never observed and the retarded waves are taken to suffice for all purposes to explain all phenomena involving electromagnetic waves.

In stark contrast to this well accepted classical scientific thought, Feynman and Wheeler [8] proposed the Absorber theory of electrodynamics, where presence of future absorbers is essential for an emitter to emit radiation. This requires half amplitude backward-in-time advanced waves to be included alongside half amplitude retarded waves for the emission-absorption process to be completed by constructive interference of the retarded components and destructive interference of the advanced components between the emitter and the absorber. The emission of radiation is no longer the well-accepted one-way emitter-to-absorber full amplitude retarded wave solutions, but is a combination of half-amplitude absorber-to-emitter advanced waves with half-amplitude emitter-to-absorber retarded waves. Both the emitter and the absorber play symmetrical roles in such a way that we get to see only retarded waves propagating from emitter to absorber, as the advanced waves from the emitter and the absorber cancel out exactly while the retarded wave components get reinforced yielding the full amplitude emitter-to-absorber retarded wave.

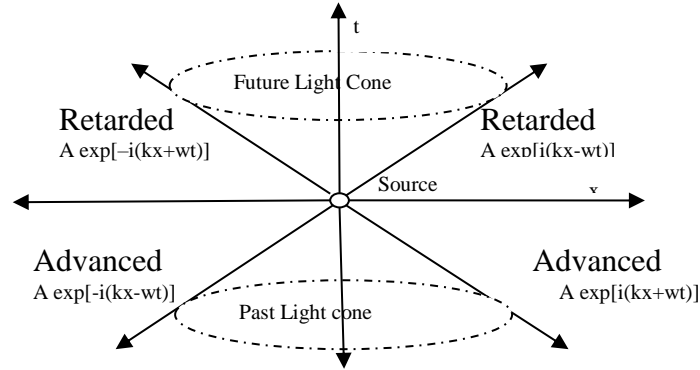


Fig. 1: Minkowski diagram of Advanced and retarded waves emanating from source at (x=0, t=0)

This was utilized by Cramer[9] in his transactional interpretation to address vexing issues in Quantum theory in which a transaction between the emitter and the absorber as an offer-confirmation handshake is what leads to the so called collapse processes. All interactions manifest through such transactions and therefore it grants further validity to the Feynman-Wheeler proposal of the reality of advanced waves.

Pradhan[10] has recently proposed a psychophysical interpretation of quantum theory by augmenting the transactional interpretation to incorporate conscious observers as essential to the process of measurement. In this interpretation, the conjugate quantities are taken to represent psychic counterparts to the physical quantities and consciousness is shown to be inherent in the framework of quantum theory through psychophysical parallelism[11]. Further, the advanced waves are interpreted to be carriers of psychic information or knowledge while the retarded waves carry mere physical information. Therefore, in any emission or absorption process, there is propagation of physical information in forward time direction as well as of knowledge in backward time direction. The justification for this comes from the fact that our knowledge always moves backwards further and further into the past (down memory lane, so to say) as we proceed further and further into the future in physical time which always moves in forward direction, or rather, which defines forward direction.

In explaining CPK using advanced waves, Pradhan assumes these advanced waves to be selectively made to be issuing out from the desired future state to achieve an actual transition to that state [12]. In fact, it requires the LASER-like phase-coherent advanced waves from large number of atoms making up the object in such a future state which has indeed an enhancement of probability by the infinitude of its neighboring states (such as a bent key) which are all macroscopically identical from the point of view of the PK practitioner.

The interpretation of advanced waves as carriers of knowledge backwards in time effectively provides for the merger of the scientific theory of perception with the vedantic theory of perception.

3. Vedantic Theory of Perception

Vedanta speaks of two kinds of pervasions or *vyāpti* : (1) *vritti-vyāpti* - pervasion of the object by *antahkarana* or a “ray of mind” which leads to a thought-form or a psychoses creating a concept or *vritti* or a modification of the mind, and (2) *phala-vyāpti* - Pervasion or *vyapti* of the concept by the individual consciousness leading to cognition which is the end result or *phala* [13-14]. The second pervasion is done by the individual consciousness which is the knower (also called *Chidābhāsa*) in each of us and which J. von Neumann [15] termed the *abstract ego* in his interpretation of measurement in Quantum theory. The object externally perceived is a physical one while the *vritti*, the psychoses or percept is a psychic one while the ultimate perceiver is the cognizing consciousness or ego. In this sense, the mind by itself like the object, is not really conscious and is an instrument of the consciousness.

The connection of Feynman-Wheeler absorber theory to Vedantic theory is straightforward if we associate the advanced waves as the waves or psychoses emanating through the observer's eyes, which traveling backwards in time from the future envelope the object (*Vritti-vyāpti*) at present and result in the perception by *Phala-vyāpti*. Vedantic theory of perception is thus completely based on advanced waves while the currently accepted scientific theory is completely based on retarded waves. The latter consists of purely retarded waves traveling from the object to the eyes, translated to neural signals carried forward along the nervous channels, finally forming the neural correlate in the brain. This neural correlate is somehow illumined by the individual knower resulting in perception. The wheeler-Feynman proposal and the transactional interpretation are thus taking a middle ground by combining both retarded and advanced waves in their formulations. The psychophysical interpretation, by associating advanced

waves with knowledge carriers, paves the way for effectively unifying the scientific perspective with the vedantic perspective.

We can take this neural correlate along with the object as a new composite object enveloped in a single psychoses or *vritti*, which is a thought-form or concept. This is *Vritti-vyāpti*. The only problem is that we tend to presume the mind or the *vritti* to be housed within the physical brain, while as per Vedanta the mind or the *antahkarana* is not housed inside the brain nor even in the body, but is a pervasive entity existing everywhere, though functioning through the individual body or brain sometimes. The knowledge of this thought-form arises via a non-local pervasion of the whole neural correlate by the perceiving consciousness (*chaitanya*). This is the *phala-vyāpti*. The non-local element or agent is the perceiving consciousness which pervades the whole nervous system as well as the object and hence knows all the three: the psychic thought-form or *vritti*, the neural correlate and the physical object or *vastu*.

Having realised the utility of advanced waves in describing emission, absorption and transmission of electromagnetic waves, we can venture to have a quantum theory of visual perception. The outline of such a theory has been very briefly delineated by Pradhan [10], but a lot more remains to be done in regard to the details of the psycho-neuro-physiological processes involved even if the physical propagation of signals from the emitter to the eyes is dealt with perfectly by absorber theory.

We reiterate that we may not utilize the advanced waves for purely matter-matter interactions where retarded waves suffice to give a satisfactory description. But, when it comes to mind-matter interaction, such as in perception and cognition, we have to bank upon the advanced waves with the psychophysical interpretation(fig.2). This opens up the possibility of explaining hitherto unexplained observed phenomena such as direct brain to brain communication[16-17].

Plato's Emission theory, perhaps derived from vedantic theory, was one-sided as it held that only the eyes emitted light which led to perception, while Newtonian theory or the scientific theory is also one-sided as it held that only light from the object was needed for perception. But Vedanta subsumes within itself elements from other five philosophical systems (*Nyāya*, *Vaisesika*, *Sāṅkhya*, *Yoga* and *Mimāṃsā*) which admit *pratyaksha* (sensory perception) as a valid means of perception. In this sense, Vedanta has both advanced and retarded waves-Advanced waves as per Vedanta proper and retarded waves as per the rest

five systems, Vedanta being the culmination of them all. In modern physics, it is only Wheeler-Feynman absorber theory which has both kinds of waves and it provides a complete theory of perception when augmented by the Psychophysical interpretation.

Interestingly, the scientifically accepted retarded wave theory of perception can be put in very similar terms by defining *vritti prāpti* (attainment of psychoses) and *phala prāpti* (attainment of perception). *Vritti prāpti* happens when the concept is formed from processing of the neural correlate excited by the input sensory signals in the form of purely retarded waves from the object. *Phala prāpti* happens when the concept is cognized by the individual consciousness and one gets the result (*phala*) as the perception of the object. The major defects of adhering to only this retarded wave theory have been briefly outlined in the introduction.

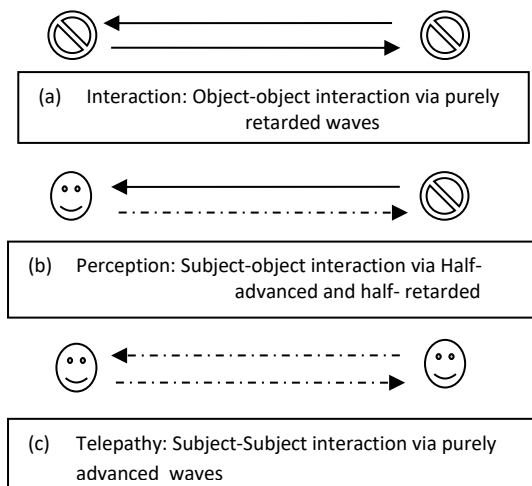


Fig. 2: The three kinds of interaction in psychophysical interpretation : dotted rays represent advanced waves

Blind sight- An application

Other observed phenomena such as blind-sight [18-20] too can be explained on the basis of this formulation with suitable modifications. Our traditional explanation of visual perception in terms of retarded wave signal from external luminous source illuminating the object and getting scattered (reflected, refracted, diffracted, dispersed or transmitted) to form a retinal image that excites a neural correlate in the visual cortex which is somehow decoded by the

ego/consciousness for perception [21] is not the only way in which perception occurs. Perception can also occur through advanced waves emerging from the observer and completing transactions [10] with the retarded waves from the object. As the eyelids or material media are no obstruction to advanced waves, and the brain can directly generate advanced waves and send them towards the object forcing it to assume the final changed state, it can explain such eyes-closed perceptual effects. This is because all our conclusions about reflection, refraction and other phenomena with electromagnetic waves are based on only retarded waves. We have never consciously produced, detected and transmitted advanced waves as such as part of scientific experiments. The individual perceiving consciousness working through the neural system in the brain can directly generate, send, receive and detect advanced waves without any obstruction by the physical objects. Thus, with attention on the surrounding, one can have perception of the objects around oneself even with eyes closed, if one can tap the advanced waves impinging on one's psychic apparatus.

The psychophysical parallelism employed in the psychophysical interpretation [10] can thus be elevated to interactionism, where mind and matter mutually interact thereby leading to possible changes in the states of both. This idea has been recently used by Pradhan [22] by a modified Born rule to explain psychic effects on a double slit interference pattern observed by Radin *et al* [23]. This incredible quantum mechanical PK effect needs to be observed by other researchers in other laboratories so as to ascertain the feeble impact on physical systems that the trained and focused psyche can have. Basing on a proposal of retrocausality by breaking Time reversal symmetry[24], a Hamiltonian formulation for PK effects by a modification of Fermi's Golden rule has also been proposed which may explain even classical PK effects[12]. The possibility of a subject-centric vision where objectivation is a reality is thus evident if we take the advanced waves as playing their part in perception[25].

4. Conclusion

A hybrid psychophysical theory of perception is outlined which has the essential ingredients to explain many unanswered questions. How qualia arise from the neural correlate remains a mystery as also the rise of concept from percept, though they may be closely related. The binding problem and the mind-brain connection can to some extent be tackled using the subject-object duality and non-locality as advocated in the psychophysical interpretation.

Thus, we may be closer now than ever before to the possible resolution of the mind-over-matter issue i.e. mind is more fundamental than matter, which in turn can set the stage for a truly unified theory of everything since the so called final theory now will have to include the observer for its true finality.

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