OPINION AND PERSPECTIVES

Quantum Physics Relevance to Psychiatry

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Abstract

Since the early 1900's, physics has gone a silent revolution, the heart of which lies the idea of quantum mechanics. We now understand the predictions based on classical or Newtonian physics to be incomplete. Given the complexity and minute scale of neuronal and mental phenomena, it is suggestive to reconsider these issues in the light of newer insights from quantum physics. We present an overview of similar philosophical questions in this paper. A systematic literature search for ideas pertaining to quantum physics was carried out on the electronic search resources using various subject headings. Relevant articles were selected for review. A wide selection of original literature from quantum physics was reviewed as well a search for ideas relevant to psychiatry. The quantum paradigm can be very helpful in developing an understanding of psychic and mental processes. It might potentially explain some empirical neuro- psychiatric findings. There is a need for psychiatric profession to incorporate non-classical ideas from other fields of science in their thinking and research.

Key Words: Quantum physics, psychiatry, mental disorders, interdisciplinary approach

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Introduction

Psychiatry as a discipline has relied traditionally on many other fields of enquiry for insights and methods of investigation. They range from purely philosophical ideas such as phenomenology (a technique developed by the philosophers such as Edmund Husserl (1859-1938) for introspective examination of self and later adopted and modified by Karl Jaspers and others (Sims, 1995) to purely mathematical ideas such as inferential statistics. Initially the relevance of an important discovery in another field may not be clear to mental health as was the case of the discovery of classical mechanics by Kepler, Galileo and Newton, or the discovery of evolutionary processes by Darwin. But as the knowledge seeps through successive generations of neuroscientists and society as a whole, it invariably produces new insights and ways of thinking and treating of patients. Thus Freud based his theories of Instinct on a hydraulic model essentially drawn from Newtonian physics. The operative definitions (basis of DSM system) and the algorithmic approach incorporated in various treatment and psychotherapy models are best explained by Boolean logic. Therefore it is not unreasonable to suggest that psychiatrists should look outside the traditional scope of their field and should search for new ways of comprehending the basic reality of mental phenomena

The inferential process for psychiatry is traditionally based on classical Newtonian mechanics. This is a deterministic model, which presupposes the prediction of a later state if all

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the parameters describing a previous state in the system are known. There is an implicit expectation to predict complex human behavior. This becomes even more difficult as we try to fit complicated phenomena such as psychotic states to the simplistic cause and effect models. But as any self-respecting psychiatrist knows, this is not necessarily true. The main flaw with such reasoning is that the foundations in the parent sciences, physics, and chemistry and to a certain degree in biology have moved away from classical mechanics to a far more subtle and encompassing model, which is based on quantum physics.

A brief history of quantum physical thought

Although some Ideas reminiscent of quantum physics go back to the original discussion of nature of light between Isaac Newton (1642-1727) and Christiaan Huygens (1629-1695) (Greene, 1990), modern interest in quantum phenomena began after Max Plank constructed a mathematical model to explain Black Body Radiation. Planck worked on the total energy calculation in an enclosed cavity, the so-called "black" body; because it is assumed to perfectly absorb light. The thermodynamics of classical mechanics produces infinite results contrary to what was observed. In a shift of his paradigm, he conceptualized energy as coming in lumps or discrete transitions, and was thus able to calculate finite answers that agreed with experimental observations (Kuhn, 1978). This was a novel idea, since the smoothness of the physical world as conceptualized for centuries was suddenly lost. Niels Bohr (1885-1962) further developed this idea by constructing a quantum model of the atom. Einstein introduced the concept of the quantum to explain the photoelectric effect. The truly innovative implication is that the nature is detected in only distinct states, and we can only observe it in when it has transitioned from one state to the other. However, we are unable to observe it in between the states of transition. This subtlety was further formalized by the development of the principle of uncertainty by Werner Heisenberg. It postulated that in any given measurement we could only determine the position or the momentum of a particle, but not both. Subsequently, a general probability wave theory was developed by Erwin Schrödinger, implying that at best physics can only estimate, the probability of something happening, not the particular path that will be followed. This paradigm shift was quite unsettling to the physics community at the time. The discomfort of many physicists led to the Copenhagen interpretation of quantum dynamics (named for the location of a gathering of leading developers of quantum mechanics). It was espoused by Bohr and others and interprets quantum phenomena by presuming that in the presence of an observer, the probabilistic wave functions break down and a definite state emerges. However, prior to the observation, the system exist in a superposition of the possible states called eigenstates, each having a unique measured value called its eigenvalue (Bohr, 1961). The idea was philosophically intriguing. Schrödinger exposed an apparent paradox of this position in his famous thought experiment with a cat, in which the hidden cat's life is dependent upon an occurrence or otherwise of a quantum phenomenon such as the decay of a radioactive particle. Schrödinger argued that according to the Copenhagen interpretation, until an observer directly viewed the situation, the quantum phenomenon existed in either of two eigenstates (decayed and not decayed), and hence the cat would be dead and alive at the same time. Different interpretations could be developed to avoid this paradox, such as existence of different time-space sections (alternative universe) in which the cat could be dead but it is not accessible from our point of view.

Quantum physics is a well established model of fundamental physical nature, whose foundations are continuing to be confirmed by empirical data. There are a great many practical examples of the usefulness of quantum physics. For example, LASER (light amplification by stimulated emission of radiation) and electronic semiconductors work on quantum principles. Quantum principles are even used for data encryption by the military.

However an important point to keep in mind through this discussion is that quantum effects are most often discernable only at the level of the very small. On the macroscopic scale we are most accustomed to, classical mechanics still produces extremely accurate results. However a closer look reveals many intriguing

philosophical and practical applications of the insights of quantum physics.

Implications for psychiatry

It should be emphasized from the outset that quantum mechanics is a physical model developed and modified to explain empirical data. Perhaps it is not the last word in physics; but no inconsistency has yet been found. The use of insights developed from quantum physics in psychology, psychiatry or social sciences, like the use of insights from classical mechanics, is often a matter of analogy. However the use of analogies is well-established in philosophical and scientific reasoning. So far it has been difficult to determine empirically whether quantum physics is really needed to understand mental phenomena, but there are tantalizing theoretical and practical cues that point in that direction.

One of the basic questions in psychiatry is that of consciousness. An essential feature of this "occasion of experience" is non-computability which distinguishes our minds from computers. The reductionist Helmholtzian model of mind implicates that thought process and consciousness is a function of the chemical machinery of the brain. This reductionism forces the paradox of circularity of self-observation. If we take mind as a reduction of electro-chemical processes, then the mind is made of the conglomerization of the very process it describes. Quantum logic can avoid this paradox by producing a level of indeterminacy. Philosophically this can allow the possibility of freedom of will. Indeed, it is very hard to preserve free will in the classical model of mind, because classical physics presumes that once all the initial coordinates of a system are known, final coordinates can be determined.

The intriguing question is how consciousness emerges from a physical structure. It appears that mysteries of consciousness lie deeper than the molecular and atomic structures of the brain and in the quantum realm. Many eminent scientists have postulated that the nerve junction warrants a description in quantum rather than classical terms because of its delicacy and sensitivity (Bohm, 1986).

There have been intriguing suggestions by Roger Penrose that the brain quantum functions taking place in microtubule subunit proteins (tubulins), could be the basis of consciousness (Penrose 1994). Hemeroff and Penrose have suggested that consciousness occurs if an appropriately organized system is able to develop and maintain quantum coherent superposition state until threshold criteria (related to quantum gravity) is reached. At that point the system, self reduces giving rise to a conscious experience. This theory has been called Orchestrated Objective Reductionism (Orch OR) (Hameroff, 2001).

So called "mind body duality" has plagued the field of neuroscience for generations. The idea of Phase Transition derived from quantum physics can be important to avoid this Cartesian dualism. Just like water can exist in the form of ice, liquid and steam, similar phase transition ideas have been invoked to understand the emergence of elementary forces on a quantum level. Likewise brain and mind can be seen as the two phases of same reality. It is because of the methods of observation used that we detect one phase or the other (mind or body).

Curiously quantum logic can, at least in theory, explain some experimental data in neuroscience. For example it has been shown that there is a delay between the stimulus and the time the brain takes to evoke a conscious event (Libet, 1992). In this delay of about half a second it seems that brain can affect the past in a sort of "Backward Causality". This apparently bizarre idea makes some sense intuitively with the psychiatrists working with the patients, where the whole concept of psychogenic causality is very complex. Meaning could be assigned to internal experiences long after such experiences took place (for example delusional memories in a psychotic state). Long range coherent phenomena in biological systems (for example in psychoskletal microtubules and in nerve conduction) can be difficult to explain on classical grounds but they can be explained using laser like quantum coherent effects (Penrose, 1994).

The nature of doctor patient relationship in deep psychotherapy is often elusive. The heavy handed application of rules and regulation often breaks down the fine therapeutic balance. Often it is hard to pinpoint the psychic events that lead to clinical improvement. It may be that the difficulty is in part due to methodological

issues. Nevertheless, it may also be true that something in this paradigm is inherently incalculable. The analogy that comes to mind is indeed the Heisenberg's principle of uncertainty.

A therapeutic paradigm based on quantum mechanics can go a long away in relieving the feelings of anxiety, helplessness and dependence on part of the patient. This "existential anxiety" as described by Yalom reflects the stoical mortalism and deterministic consensus of early 20th century (Yalom, 2005). Keeping a view that acknowledges the empirical limitations of our treatments and makes patients the primary agent of their treatment prevents us from forming the pseudo-insights into the psychiatric "disorders" and viewing patients in a deterministic, preconceived way.

Lastly, a word about the dogmatic reliance of inferential statistics in psychiatry. The critics have argued that the statistical inference now aims to replace judgment in the name of objectivity (Gigerenzer, 1989). Quantum physics reminds us that we can only predict the nature of the course based on statistical inference but never quite determine it. The overly reliant use of statistics should be thought over again.

It may be impossible for now to test most of the quantum hypotheses in biological systems directly. However, the usefulness of these ideas can indirectly be studied. Lee and Wexler found that the use of quantum insights is associated with better clinical practices among more experienced psychiatrists, who intuitively used them in their practice (Lee, 1999).

Many interesting examples of application of quantum principles to the field of biophysics are being studied currently. Additionally the area of nano-technology is rapidly developing. Technological tools based on quantum principles are being developed such as Tunneling Electron Microscopes and Quantum Computers. The twenty-first century has been hailed as a century of neurosciences. It is likely that in years to come, we will witness an increasingly sophisticated approach to neurosciences based, no doubt, on the principles of quantum physics.

This approach will necessitate a greater interdisciplinary collaboration. It appears that apparently diverse fields such as quantum physics and psychiatry have much in common. There is great need for these two fields to collaborate for synergy of ideas and future growth from mutual insights. The relevance of quantum physics to neurosciences is explored fully in an upcoming book by one of the authors (Lindesey, 2007).

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