

# Human Consciousness: A Quantal Property of Matter?

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## Abstract

When talking about *evolution*, it is best to distinguish between natural history and natural science, the later being concerned with the genesis of *Natural Systems*. Their genesis is the result of a functional sequence of *processes of energy transformation (PETs)* which begin with the Hot Bang and end with the emergence of a natural system in a local context characterized by a reduced energy density or ambient temperature.

Because the science of matter is *functional*<sup>(1)</sup>, there are two main stages in the *scientific* approach to evolution: first, the identification of the *elementary*, i.e. non reducible, processes of energy transformation (*ePETs* for short), second, their *complexification* in local contexts (*cPETs*). The language used to represent them is *Quantum Mechanics (QM)*, generally held to map all known *PETs* involved in the genesis of *Natural Systems (NS)*<sup>1</sup>.

The belief that the *genesis of NS is quantal in nature* is based on the fact that all of these systems are *material* and therefore products of cosmic evolution. The energy path of *Cosmic Evolution* is fairly well understood, although the details of the structural elaboration of the various types of natural systems, which is affected by local conditions, become more difficult to ascertain experimentally as we proceed to systems of greater complexity, as is the case with biological organisms.

In the study of consciousness, and especially in that of human mentation, experimental psychologists often betray a temptation to *jump directly* from the micro-level of the substrate to the macro-level of emergence, without bothering to ascertain the dynamical nature of the intermediary stages. Ignorance of the fact that the evolutionary process, which is quantal, is syncopated from the Hot Bang on, results in the failure to ascertain the dynamical characteristics of the energy context wherein the last step before the emergence of cognition takes place, thereby getting an erroneous map of the evolutionary path leading to human consciousness<sup>(2)</sup>.

**Keywords:** Transmodal Causality, Unitary Action, Modal Cut, Internal Régime, Decoherence.

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<sup>1</sup> The sciences of matter have been developed on the Cartesian model, which requires the *functional analysis* of complexes to determine the characteristics of their elementary constituents, followed by their *functional synthesis* from these simple elements. In the quantal sciences of matter, these elements (and therefore the complex systems synthesized from them) are not material particles but *PETs*. (Cf. E.g. F. Wilczek in the references).

<sup>2</sup> To cite one example, a case has been made by Karl Pribram, based on empirical results, that the energy context for the emergence of mentation is to be found in the dendritic system rather than in the synaptic gaps.

## Introduction

The *language* of the science of matter, i.e. *quantum mechanics*, which as previously noted is about processes of energy transformation, is *causal* in nature. In the *context of evolution*, this form of *quantal causality* binds together the *internal régime* of the natural system, which enables it, to its *emergent domain*, where it acts as a *unitary quantum system*<sup>2</sup>. There is an observable *difference in kind* between these two domains made manifest by many symptoms: (a) the different *modalities* of the causal and emergent transactional processes<sup>3</sup>, (b) the *energy density* available for these processes in each of the two domains, (c) the *energy boundary*<sup>4</sup> which separates the *causes* of emergence, which are internal, from their effects, which are *external*, (d) the *transactional opacity*<sup>5</sup> of this boundary, and (e) the resulting *unitary action* of the quantum system.

The *unitary* character of a natural system is apparent in its *mode* of interaction, which is determined by its dynamical characteristics and represented by its de Broglie wave function  $\psi$ <sup>6</sup>. The *energizing* of the natural system is effected by the internal *synergetic enslavement* of the *material* constituents (e.g. the molecules), which extracts that energy from them<sup>7</sup>. This *causal process*, a unique characteristic of quantum mechanics, is radically different from the transactional processes in that it is *transmodal*, the modality of the emergent side of the boundary, which sports its de Broglie wave function  $\psi$ , being energized by the synergetic processes that created it<sup>(3)</sup>.

The processes of the local *complexification* of NS, which are temporally irreversible and energetically gauged, could only be discovered *ex post facto*, a pseudo Baconian effect. There is still no known mathematical instrument for *predicting a priori*, by derivation from first principles *on the basis of* the dynamical characteristics of the pre-emergent system, either the nature or the modal behavior of the evolved system that succeeds it, and none is expected in the future because of the opacity of the transmodal boundary. Even though the non-local character of the energy environment of the emergent system contributes to its local energy profile through the superposition of their energy fields it remains largely independent of it. However, once the *pre-emergent* cause and the *post-emergent* effects have been identified by independent observations, the *formal representation* of the causal endowment process becomes possible. Its *mathematical structure*, hence its *physical architecture*, are given by the *mathematical* theory of representation, and more specifically by the *coadjoint orbit method* developed by A.A. Kirillov<sup>8</sup>. It was applied by W.E. Schempp<sup>9</sup> to the quantum contexts where classical physics is not applicable, as well as to classical phenomena that were discovered earlier<sup>(4)</sup>. In particular, Kirillov's theory is applicable to the closure of the internal synergies which creates the bimodal energy boundary characteristic of *Quantum Macro Systems* (QMS)<sup>2</sup>, thereby endowing the emergent system with its endogenous properties<sup>10</sup>. It also constructs a sketch of the energy

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<sup>3</sup> This energy boundary, first identified by Heisenberg in the late twenties of the last century, is known as the *Heisenberg Cut*. More on this below

<sup>4</sup> This period encompasses the works of Kepler on planetary orbits, the work of Huygens on the propagation of wave fronts, and more generally the works on field theory.

context wherein the question raised in the title of the paper is to be understood.

These developments are recent though the question of the place of human cognition in cosmic evolution is not. Indeed, from time to time arguments have been put forward by distinguished physicists, among whom we find the Nobelists Niels Bohr, Erwin Schrödinger, Brian Josephson<sup>11</sup>, pondering the role of QM in the study of living organisms and of cognitive systems. In the rest of the paper, I should like to examine briefly some of the grounds underlying those of the arguments that are still to be found in the research literature.

## Text

I shall only mention two groups of arguments which appear to me to be the most important. The first group clusters around the effects of the *complexity* of natural systems, and raises the question of the possibility of experimental probes, on the grounds that biosystems are too fragile for them, thereby ruling out their examination in the laboratory. The central issue is that of the *decoherence* of their internal régime by the experimental probing of their dynamical structure. The second group is foundational in character and is focused on the absence of an *epistemic domain* external to the Cartesian Cut of the observer<sup>12</sup>, a fact which rules out the very possibility of an empirically grounded *science of human cognition*. I shall address each in turn, albeit briefly.

## ON DECOHERENCE

Because of the *non local* character of energy fields, the issue of decoherence must be examined in its natural context rather than in a contrived one in which a system, bereft of any shielding, is perturbed by an external field, as some experimentalists and theorists have occasionally been inclined to do (e.g. Zurek<sup>13</sup>, Tegmark<sup>14</sup>, etc.). If the issue is that of the evolution of life or of consciousness, and if the relevance of QM to the evolution of the Cosmos is granted, then it is desirable to divide all systems into two distinct categories, those that are natural (NS) and those that are engineered (ES). Only the first type is relevant to the issue.

That the evolutionary processes are quantal will be assumed without further ado, on the grounds of the mass of evidence collected in the past half century in the domains of observation whose emergence preceded those of life and mind<sup>1</sup>. The more so as there has been no hint of any change in the general profile of the evolution of matter. In point of fact, the realisation of the reported threat to the internal coherence of natural systems would rule out the very possibility of existence for all complex systems from organic chemistry on. Despite the claims made for it on the basis of experiments carried out on engineered systems, decoherence in natural systems remains in need of empirical support, given that these systems are known to be remarkably resilient within relatively wide limits in perturbed energetic environments<sup>(5)</sup>.

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<sup>5</sup> Nature is remarkably hospitable to the dynamical systems it creates. One may reflect for example on the

A quantum system is naturally associated with its own endogeneous energy field, and is usually immersed in other fields as well. Some of these, like the electromagnetic field, are long range, while others, such as the nuclear fields, are of shorter range. Though *Energy Fields*<sup>(6)</sup> are modally orthogonal in observation contexts, they are thought to be intimately related to each other in a sufficiently high energy environment, where they are expected to merge into the so-called Higgs field<sup>1</sup>. At any rate, the fields set the tone for the behavior of all natural systems, which may be thought of (metaphorically) as partially condensed forms of energy<sup>15</sup>, the symptoms of which are the *traces* left by their transactional behavior in domains of observation. Although energy fields are not directly observable, their effects are ubiquitous<sup>(7)</sup>. Their supreme importance is attributable to the dynamical nature of cosmic evolution, and ultimately, to the underlying Quantum Vacuum (zero-point field).

A natural system, to the extent that it is observable, is to be thought of as a *unit of action* in some energy field, i.e. it has an *transactional identity*, observations being interactions between observer and observed<sup>2</sup>. Its *Modal* transactions are effected by the superposition of the *energy profile* of its surrounds with the system's *emergent field*, the outward effect of its internal dynamical structure.

The *coherence* of a complex natural system, hence its dynamical stability, are due to the closure of the *cyclical synergies* of the internal régime which creates an *energy boundary*<sup>7</sup>. The synergetic hypercycles responsible for it in complex organic systems, chemical and biological<sup>(8)</sup>, which are part of the evolutionary mechanism of self organization, are the means by which the *internal dynamical régime* of a natural biosystem is effectively shielded from the perturbations of the external fields. However, it should be pointed out that, given the stages of its evolutionary history, a natural biosystem may also be affected by other fields of various modalities, e.g. electrical and gravitational fields<sup>(9)</sup>.

Several experimental contexts illustrate these processes of closure. I shall mention two briefly, one conducted in an engineered system, the other in a natural one.

(a) The first case is that of an engineered decoherence-free quantum memory of one qubit<sup>16</sup>. The qubit, stored in a single ion, is encoded into a *decoherence free subspace* (DFS) created by a pair of trapped <sup>9</sup>Be<sup>+</sup> ions. The qubit is thus found to be effectively shielded from the dephasing influence induced by applied external fields. The key points for us here are: (i) the boundaries of the space created by the trapped ions insulate *the subspace* inhabited by the qubit from the external environment; (ii) the engineered

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considerable power that binds large numbers of protons together within a nucleus of  $\sim 10^{-14}$  cm, given that the Coulombian energy of repulsion obeys an inverse square law.

<sup>6</sup> The experimental basis for their unification in the Higgs field is now expected within the next five to six years, either when the new CERN collider comes on line, and possibly earlier with the upgrades at the Fermi Lab or at Stanford. Cf e.g. *Nature* 409/6822 (2001), 754

<sup>7</sup> Cell phones, television and radio reception in different places at the same time, falling objects, the light from stars, etc. are the observed manifestations of these invisible energy fields.

<sup>8</sup> In the case of complex of particle systems, the closure of the system is governed by other processes based on the properties of short range modal fields.

<sup>9</sup> Electricity can stop the human heart even though the electric field is not itself an emergent mode of interaction for humans.

perturbations of the external fields actually increase the effectiveness of the shield protecting the qubit by up to an order of magnitude; (iii) the effect of encoding an arbitrary qubit stored in a single ion is to transfer it reversibly to the DFS created by the energy boundary formed by the two ions.

(b) The second case is that of NMRI (Nuclear Magnetic Resonance Imaging), which is a non-invasive engineered system set in a biological environment. It is achieved by creating in organic tissues closed energy cycles by exciting the magnetic moments of the protons from the water molecules by magnetic fields suitably modulated by radio frequency. These are then projected onto a symplectic space, i.e. onto a flat Euclidean space where the topology of organ slices is recreated in a different modal domain, where it can then be observed on a computer screen. The key points are: (i) the creation of forced cyclical processes in an organic milieu, (ii) their continued coherence in that same milieu, which is at high temperature, i.e.  $K^\circ$ , after the fields and the radio modulation have been turned off.

## THE MODAL CUTS

The opacity of the *energy boundary* to the transactional processes on either side of it sets the observable limits of what is in fact a *Quantum Macro System* (QMS), with its dynamical identity in its environment. This fact was first noted by Heisenberg in the late 1920's, and he referred to this modal boundary as a Cut (Schnitt), now called the *Heisenberg Cut* (HH). The modal boundary between objective transactional processes external to the observer and those internal to him, which he experiences, is called the *Cartesian Cut*, (CC) for short<sup>17</sup>.

The grounds of this objection are the most serious, because a *sine qua non conditio* for objective observation is that the observer be *external to* what is being observed. In the case of conceptual systems -and science is a conceptual enterprise- the difficulty is compounded by the fact that the *Cartesian Cut* of the observer lies astride his *Heisenberg Cut*, both of which are quantal consequences of the energy gap inherent in the energetic stratification of NS. The consequence is that any statement that depends on *introspection*, which is *inherently private*, for its logical value, fails the criteria for objectivity in scientific discourse. The *Know Thyself* of the Pythic Oracle, construed as a research program, is an impossible dream.

This situation is clearly an accident of natural history, though it rules out *de facto* a genuine science of human consciousness, i.e. the extension of an evolutionary science beyond the threshold of human mentation. However, this does not imply that QM no longer governs the patterns of evolution for systems of which Man is an integral part, e.g. social systems. A *more evolved* observer could conceivably be endowed with modally different endogeneous means of interaction, e.g. of observation, that would put him on a different and higher level from those of human consciousness and cognition, perhaps in ways somewhat analogous to those that separate us from animals. In such a situation, it is conceivable that these beings would be in a position to study Man objectively, and thus create a science of human mentation. However, on the assumption of the unity of Nature,

we may infer that this hypothetical being would end up with similar kinds of limitations at his level of observation if he were to undertake a study of his own cognitive processes, and if QM in its present state were to remain the only analytical instrument at his disposal.

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