

The Information Universe:

On the Missing Link in Concepts of the Architecture of Reality

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Abstract

There are many good reasons to ask basic questions on the construction of reality. These questions not only concern the structure of the world we live in and how we perceive it, but also the mysteries of how our Universe was born and how it will evolve in the far future. This article aims to highlight the prominent role of information in the manifestations of matter and discusses current materialistic paradigms, versus the concept that not matter but information is primary in the evolution of our Universe. Reconciliation of these opposing views is sought in hypothesizing that matter in its various modalities intrinsically contains proto-mental (informational) aspects and/or that matter and mind are complementary aspects of a total reality. Information is treated as a multi-layered phenomenon and is differentiated in intrinsic (elementary), observed (scientific), cultural (in the sense of meaning) and nouminous (mostly non-conscious) information. Reality is pictured as a four-dimensional domain (block universe), in which all time (past, present and future) is laid-out, along with space, housing a flow of information. It is postulated that basic information for creation of the Universe was provided, either through backward causation from the far future, or has originated from a preceding version of our Universe. Individual consciousness is considered as an expression of an underlying non-local quantum field, which exhibits holographic properties. It is postulated that the human brain is interfacing this universal information field, to our individual consciousness. This universal information domain is physically identified as the zero-point-energy field, also related to a time-reversed flow of anti-matter. Consciousness is hypothesized as arising from an inter-neuronal flow of information, perturbing local quantum gravity, that is seen as instrumental in the reduction of coherent quantum states to experience. The interfacing brain may also explain the phenomena of binding, qualia, intuition, serendipity, extra-sensory perception and some well established Psi-phenomena. It is stipulated that universal consciousness did contain the recipe for biological evolution and that it was instrumental in the evolutionary creation of conscious observers. Finally, a comprehensive scheme is presented, in which mind/matter is treated as a complementary unity and the abovementioned cosmological and evolutionary aspects are combined into a tentative picture for the construction of reality.

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1. Introduction: Information is a primary part of nature

This essay is aimed at the design of a tentative, integrated, model for the fabric of reality. The author made a semi-intuitive attempt to collect the necessary pieces of the puzzle in order to obtain a primary but, nevertheless, comprehensive picture of the information universe we all live in. This was done without the pretension to give a fair review of all of the relevant aspects and/or to discuss the chosen scientific concepts in detail, rather this material will be published elsewhere in the near future.

Our world, as we sense and experience it, can be viewed upon as consisting of three building blocks: matter (in all its modalities), energy (in all its forms) and information (in all its variants). It is postulated (see section 4) that, from the very beginning, intrinsic information has been present to initiate a creative process with an implicit encoding. The so-called "Big Bang" and the events that followed, appear to be, according to recent research in astrophysics a fine tuned expansion process (Fig. 1), in the framework of a very specific set of interrelated physical laws and constants, as it has been unveiled by humans 13.5 billion years later (see for excellent reviews: Davies, 2007, Greene, 2004, Linde, 2004, Vedral, 2010, and Penrose, 2004). This framework gave rise to the creation and processing of the abovementioned three building blocks, as currently described as waves/particles in quantum physics and the plethora of elementary particles in the so-called "standard model". The mutual interactions of these subatomic waves/particles subsequently created a dynamic network of quantum information, that finally also enabled the formation of highly complex macromolecular structures. The history of these particular wave/particle interactions, are supposed to be stored in an all pervading quantum field, as it was inherited from the initial information matrix (Zizzi, 2006). Each step in the unfolding evolution implied an inherent potential for change and, ultimately, the ability to generate biological life.

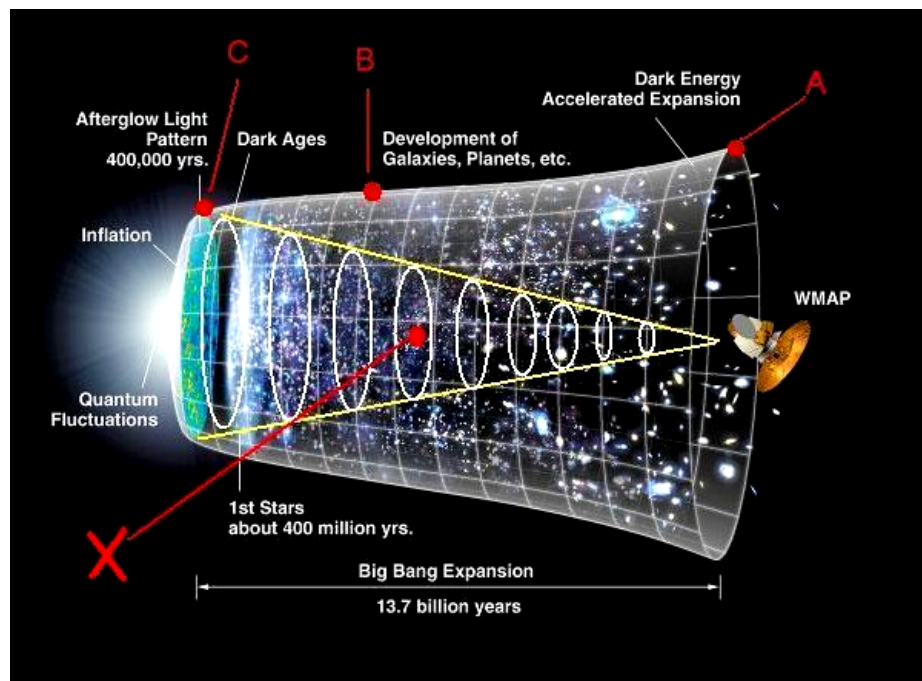


Fig. 1: Looking back to the very start of the Universe by the WMAP satellite, showing an afterglow pattern (left, green) (C), formation of planets (B), including planet Earth (red dot) and the state of current expansion (A).

Besides the above-mentioned intrinsic information that gradually was deployed in evolution, the creation of first life was facilitated by processes such as self-organization and autocatalysis as well as synergistic and symbiotic processes (see Kauffman, 1993, Margoulus, 1998), providing ever growing, novel, information. Further complexity and sophistication was partly realized by genetic mutation, and chromosomal reorganization, combined with the selection pressure of the environment. It should be realized here that classical Darwinism did not take into account a number of crucial factors in evolution: cooperation and symbioses (not only with regard to species but also being essential in cellular functions), horizontal gene transfer between species (for instance by viral elements), the role of quantum processes in evolutionary information processing, empathy as a crucial factor in individual and group survival and, last but not least, epigenetic influences on gene expression through interaction with the environment. Some epigenetic changes can even be inherited by next generations (Lamarck at last!). Most of the abovementioned evolutionary phenomena have in common that they are based on "copying of information".

Information patterns were gradually exhibited in various modalities (see section 2), and underwent an evolution in a spectrum of biological and cultural operations. In the ongoing process of higher complexification, the humanoid brain evolved, among others leading to social awareness and self-consciousness. The central element in these creative processes can be seen as the actualization of potentiality, according to quantum physical principles (see Shimony, 1997, Goswami, 1993).

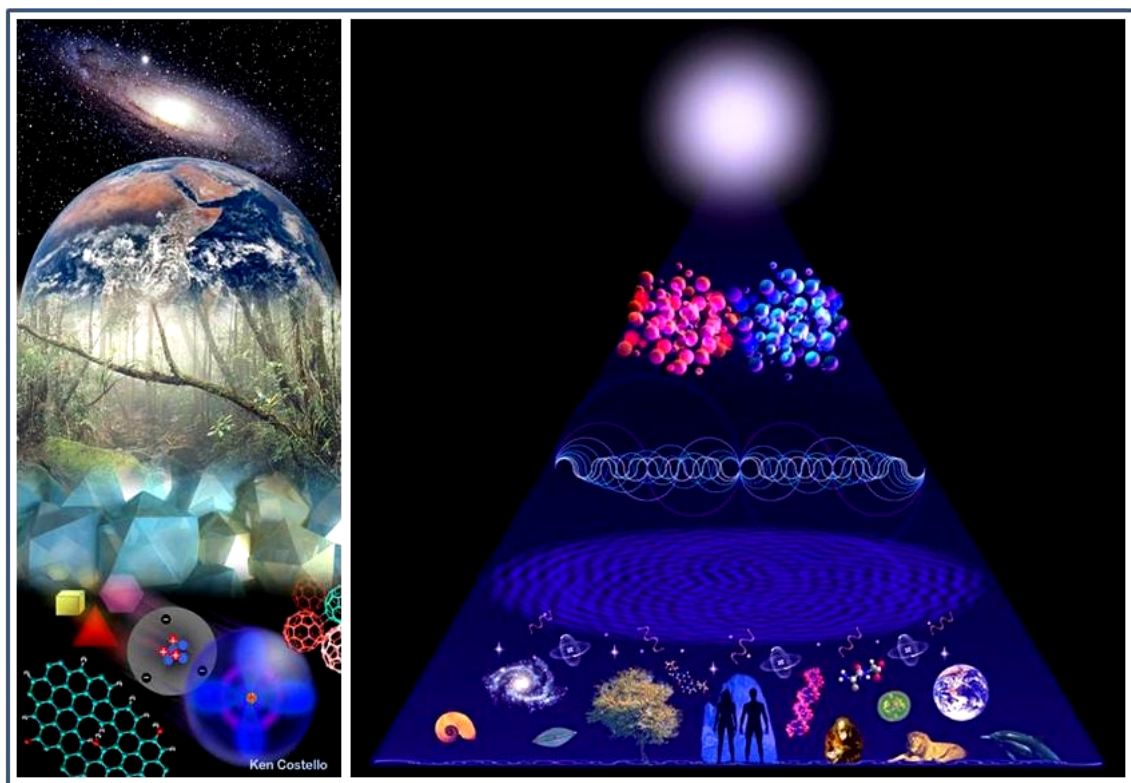


Fig. 2: Evolution as a progressive unfolding of information from micro-to macro level (left) and from the "Big Bang" to living organisms (right), both may be subject to backward causation (see part 6, 7 and 8).

A few hundred years ago, Descartes discussed scientific methods of inquiry and dramatically changed the way in which we search for answers. The scientific method stressed the individuality

and separateness of things. Processes could be understood by dissecting and analyzing the individual components. The inquirer was simply a passive observer of external phenomena. This paradigm went unchallenged for over three hundred years until the theory of relativity and quantum mechanics drastically changed the way in which we view our world (see for its various aspects Fig. 3).

Since the famous double slit experiment of Thomas Young in 1801, physicist have begun to realize that particles can also, depending on the experimental conditions, show wave-like behavior. Moreover, it is possible to interpret the results of the numerous (double slit) experiments that have been performed since Young's initial attempt in such a way, that the mere observation of the wave interference phenomenon, and implicit conscious interpretation of the experiment, results in the collapse of the wave pattern to a particle behavior. The experiment was first performed by Young in an effort to find out whether light is a wave or a collection of tiny particles. Young sent a beam of light through a plate with two parallel slits cut out of it. When the light hit a screen behind the plate, it produced a pattern of dark and bright bands that only makes sense if light is a wave, with crests (maxima, high points) and troughs (minima, low points). When the crests of two waves overlap, they create an especially bright patch, but when a crest and a trough overlap, they cancel each other, leaving a dark space (see upper right inset of Fig. 3 and bottom part of Fig. 4).

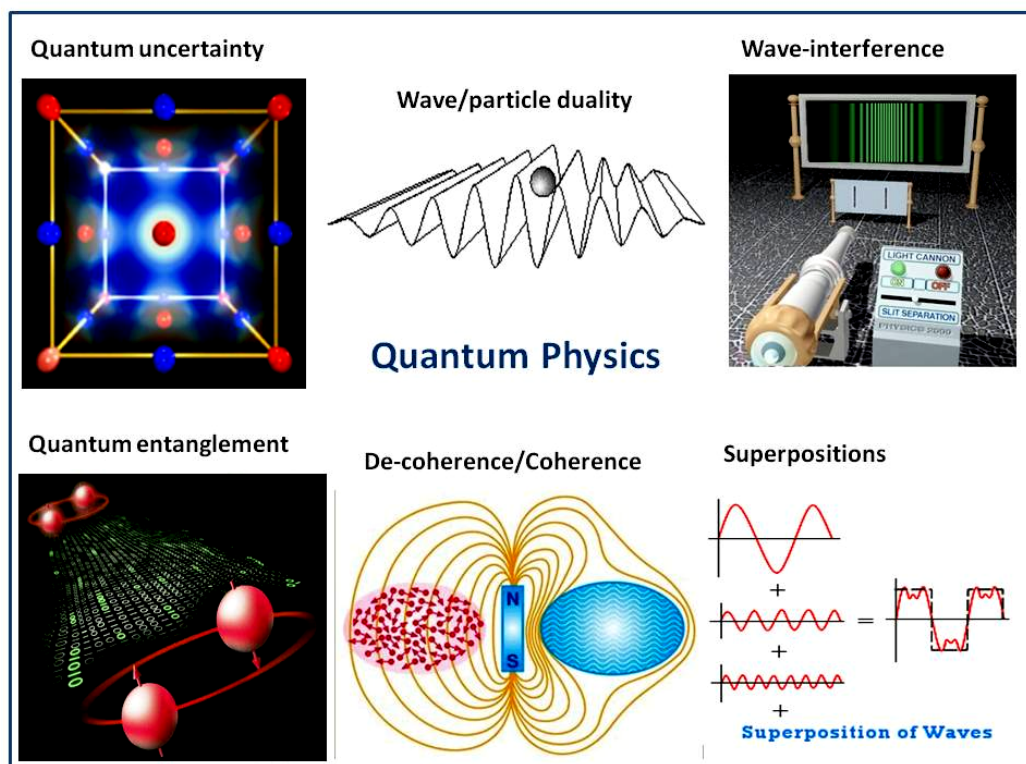


Fig. 3: Quantum Physics with its main characteristics: uncertainty of position (upper left), wave particle duality as demonstrated in double slit experiments (upper right figure), quantum, entanglement (below left), quantum (de)coherence (middle below) and superposition of wave information (see inset right below).

The results of the experiment showed that light behaves like a wave, and disproved the popular idea of the 17th and 18th centuries that light was composed of tiny discrete particles. However in 1905, Einstein's explanation of the photoelectric effect showed that the earlier interpretation of the nature of light has a ring of truth to it because, in addition to showing wave characteristics, light also has

particle properties, and can thus (after all) be pictured as a stream of particles, leading to the current notion of the "wave-particle duality" of light.

The double-slit experiment upturned physics again in 1961, when German physicist Jönsson showed that even when electrons pass through the two slits they produce an interference pattern. These results were quite striking, since electrons were regarded as individual particles, and therefore were not supposed to produce such a pattern at all — rather they were expected to produce two bright lines on the screen after passing through one or the other slit. In other words: about half would pass through one slit, and the rest through the other, thereby building up the two lines after a number of particles had passed through.

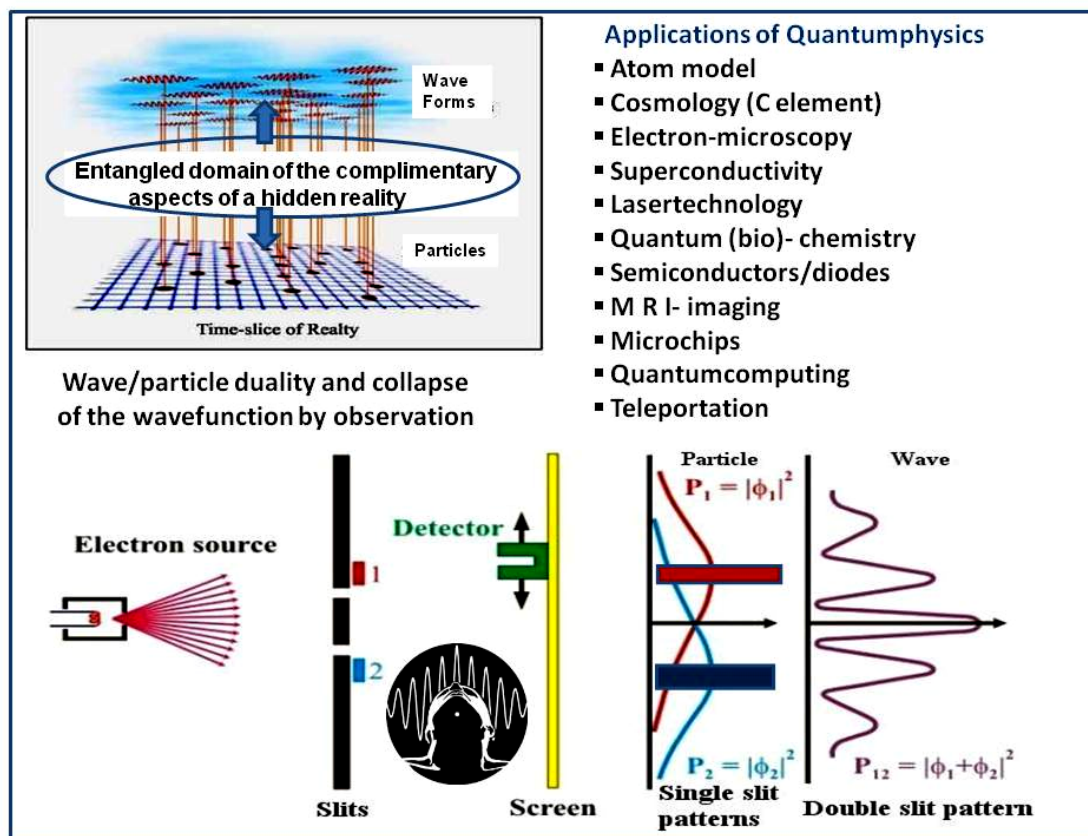


Fig. 4: Quantum physics uses the wave/particle duality concept (upper left) as demonstrated in double slit experiments (inset below), exhibiting wave collapse by active observation. Quantum physics is recently successfully applied in various crucial technologies (upper right inset).

Young's pioneering work was instrumental to the development of quantum mechanics that, because of its extremely high predictive value, became the most successful physics theory to date (see Fig. 4). Close examination of so called black body radiation (a black body is a surface that totally absorbs all radiation that falls on it) by Planck, in 1900, led to the concept of discrete (in the mathematical sense of ranging over the integers) packets of energy, called quanta. Quantum theory states that the energy levels that electrons can occupy in an atom are "quantized", so that the energy that is absorbed or emitted during transitions between these different energy levels can only take on (discrete) multiples of some minimal value. So energy is not absorbed or emitted on a continuous sliding scale, but can only change in discrete steps. Particles at the atomic level should therefore not be seen as refractory entities, but rather as elements that are able to exchange energy in a ongoing

process of quantum communication, albeit in discrete steps. In this communication process, light waves (photons) are crucially important. On the scale of the micro-universe, the resulting network of elementary particles has the ability to store information by perturbation of the wave function that belongs to the particles through modalities of position, spin, charge and polarization of a particle, both with an incredible number of possible combinations of these parameters. According to quantum theory, such interactions between particles (for example, between photons and electrons) can be described as wave interferences, producing novel vibrational patterns in the form of superpositions. In even greater detail: matter, at its most basic level, may exist as a system of vibration patterns in a web of mutual relations, as more recently hypothesized in the String/M theories (see further: Fig. 11).

In spite of such impressive insights of 20th century physics, the very nature of matter is presently not well understood and requires further investigation. Yet, one aspect of matter seems to be established more definitely: the intrinsic connectedness (or entanglement) between particles, as it has been proven experimentally in various studies in the past decades. For example, the communication between two "paired" particles (in terms of common properties) occurs over very long distances, without any loss of time (hence the concept of non-locality in quantum physics, see Bell, 1966). It was formerly (incorrectly) interpreted as being due to an inter-particle signal transduction exceeding the speed of light. However, contextual information on these correlated particles, should rather be viewed upon as being due to a non-local "hidden" variable that, at present, cannot be directly characterized. Entanglement is therefore supposed to represent a correlation of particle properties within a hidden (non-local) information field. The aspects of wave interference and non-locality in quantum physics were not only experimentally established but, later on, applied in a spectrum of technologies (see Fig. 4). The wave function is not a statistic probability function, only representing an experimenter's knowledge or information, as was often suggested, but a real, objective state of a quantum system, and the recently published theorem of Pusey et al. (2012), might corroborate such a point of view.

At the start of twentieth century science was also definitely marked by Einstein's theory of relativity. He postulated that the observer was no longer external to the phenomena being studied: all patterns can only be described relative to the observer. In addition, the earlier observations of Young have, as mentioned above, been followed by a spectrum of modern "double slit" studies, performed with photons, single electrons and more recently also with macromolecules, and these not only confirmed the wave/particle phenomenon, but clearly showed that, somehow, observation and interpretation (by some collected under the term human consciousness), and not measurement per se, is instrumental in the manifestation of the material aspect of wave/particle duality. Indeed the role of mental aspects in the construction of reality became an issue of concern, and in fact, for many scientists, it even grew to a central theme in the understanding of nature. Bohm, for example, argued that space itself was an illusion, and that it was meaningless to discuss the separateness of things at the quantum level. Physicists therefore began to describe the quantum potential in terms of nonlocal connections.

In fact, Bohm started to view "chaotic" nature as a misnomer. He believed that "randomness" contains a hidden order, and that we perceive disorder only because of our limited understanding of the complexity of the processes involved. In 1980, Bohm published his first book on the holographic nature of the universe entitled *Wholeness and the Implicate Order*. In it, he referred to our level of existence as the "explicate" (unfolded) order. He postulates that there is a deeper level of order in the universe which he calls the "implicate" order. The constant flow of energy between the explicate and implicate levels of reality offers an explanation of non-local phenomena. Bohm

refers to the universe as a dynamic "holo-movement". Bohmian mechanics provides an ontology of particles being steered from the implicate order, or non-local information field. Each individual physical system is contemporarily described by its wave function (which evolves according to the Schrödinger equation) and by the specification of the effective positions of the particles. The evolution of the latter is governed by a "guide" equation which enables that the movement of the particles is determined by the wave function. Bohmian mechanics seems to solve many of the paradoxes of quantum mechanics, by eliminating strangeness and explaining non-locality (see Fisaletti, 2007).

Bohm and Hiley (1987) concluded that the implications of nonlocal connections are that objective reality itself is entirely a construct of the human brain. The true nature of reality remains hidden from us. Our brains may operate as a holographic frequency analyzer, decoding projections from an underlying, more fundamental, dimension. Bohm concluded that even space and time represent constructs of the human brain, and probably may not exist as we perceive them. In this framework, chaos-theory (Poincaré, in the 1890's), and later extended with fractal geometry, see for instance Mandelbrot (1977), represent other branches of science with major impact on the study of brain function and consciousness (see the review of King, 1989).

Non-locality has, until recently, been regarded as a curious property of quantum physics at the micro-scale, but was thought as of little relevance to macro-scale reality. This view changed at the discovery of the quantum hologram. In 1982, Alain Aspect and a team of physicists were actually able to carry-out an experiment that Einstein, Podolsky and Rosen had proposed in 1935. Aspect created photon pairs by heating calcium atoms with a laser, and then the two photons were manipulated to travel in opposite directions. Aspect discovered that the polarization of one photon, at a marked distance, immediately polarized the other, just as quantum theory predicted. The photons were somehow communicating with each other or, as mentioned earlier, exhibiting a correlative state. Clearly, non-local connections seemed to exist between these elementary particles: somehow the separateness of the particles was more like an illusion. It is evidently of major importance to establish if non-locality is also a fundamental feature of nature at the macro-scale, for example in highly complex structures such as the central nervous system. This holds also for the question whether the brain interacts non-locally with an universal knowledge domain, or in Bohmian term, an implicate order.

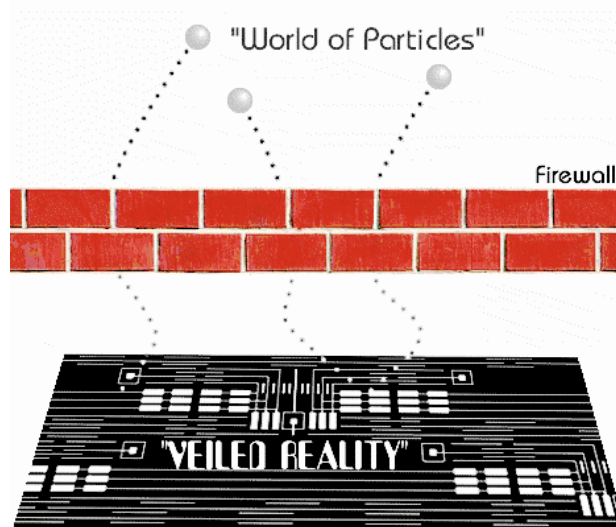


Fig. 5: The hidden reality of the wave world, as if screened from us by a "firewall".

Pribram (1991) believes that the brain can monitor many of the frequency patterns of the implicate order, leaving only a selective subset of information available to our conscious awareness. By perceiving only a fraction of the information, we usually think that we are observing chaos without recognizing any underlying pattern. Yet, such seemingly random phenomena may only appear chaotic because we cannot decode the information necessary to discern the supposed underlying pattern. Bohm hypothesized that there is no real disorder, rather a manifold of nested orders of deeper detail. Consequently, we may be an integral part of reality, composed of elements that we can only partly infer, but certainly cannot fully comprehend as a whole. We fail to picture this largely hidden world, being hindered by a “firewall” (see Fig. 5), that selectively passes information. Yet, we are equipped to translate this exposed knowledge, employing the cognitive instruments we have in science and also in art. In this respect, science requires the expression of knowledge in formats of language. It has been said, however, that “*the structure of whatever language cannot grasp the nature of non-locality and unity of consciousness any more than a fork could grasp the ocean...*”. It follows that we need to develop new modalities of communication and adequate language to deal with this challenge, and at least transform “the fork into a spoon” in order to expose deeper layers of reality.

2. The fundamental character of information

Generally speaking, the concept of information seems closely related to notions of news, constraint, communication, control of data, form, instruction, knowledge, meaning, mental stimulus, repeating patterns, perception of experience, as well as representation of observations and pattern recognition.

Since “Information”, is often no more than a container term, it seems important to differentiate information in its very nature into, at least, four interrelated layers:

- A. **intrinsic** information, such as the micro-physical properties of the constituent elementary particles and, for instance, the basic genetic information of organisms;
- B. **observed** (measured) information: the type of information that is produced in our brain and represents explicit information that was extracted from nature, and subsequently translated and stored as scientific representations, percepts, concepts and/or models;
- C. **cultural** information, that is, for example, processed in socio-cultural publications, internet and other media, by which it obtains the significance of societal meaning;
- D. **sub-nouminous** (mostly non-conscious) information that extends to feelings, qualia, intuition and subjective human experience, and that is only partially explicit in category B.

The verb “to inform”, as employed in the common daily language, can be originally related to the expression “to model according to a form”. In fact, “to inform” derives from the Latin term “informare”, that means “to give a form”. Aristotle wrote: “Information” (*translated in current terminology*) is a truly more primitive fundamental activity than energy and matter. So he seems to imply that information does not have an immediate meaning, such as the world “knowledge”, but rather it encompasses a modality that precedes every physical form.

Once there is a form, the potential information can become expressed through one of its possible manifestations. The totality of all forms can then be regarded as (the) space, and can be viewed upon as a “know-dimension”. A form is intrinsically capable of movement (and hence of re- and deformation as well as recombination), and a series of such events may have created first

manifestations of life and subsequently a spectrum of different life forms. The ability of a life form to control its own abilities can be defined as (proto) consciousness. This “awareness” enabled life forms to probe the environment and experience time (according to sequence and relative motion of forms), and also to interpret these data, for instance in the framework of maintenance, security and survival. The interpretation of a shape in the environment, or forms of sensed energy, can be envisioned as individual information that provided primitive entities with (proto)-consciousness. Perhaps the most important of all this is that consciousness, in more sophisticated forms, colored perceptions and directed manifestation of organisms by actively generating and selecting meaningful representations of the outer world. This in turn created self-awareness of the own life form, in relation to both the external and bodily environment.

According to Frieden, (2004), in information theory, a clear difference should be made between intrinsic (bound) information [B I] and observed information [O I]. Intrinsic information is defined as the most complete information that describes an object. In the process of observation, for instance by a human being, an incomplete picture is obtained due to the inherent limitation of the observer (for example, remember the uncertainty principle in quantum physics).

[B I] minus [O I] varies between infinite and zero, depending of the quality of the information (transmission) channel between object and observer as well as on that of the “measurement” with regard to sensory detection, perception and interpretation by the observer. This difference also indicates the ability to communicate the perceived observation, in a consistent form, to the external world (for example to the scientific community). Measurements are in principle imperfect” ([B I] – [O I] > 0). This difference can also be seen as a measure of complexity or, from the standpoint of the observer, as the relative inability to know perfectly. Thermodynamically bound information is a measure of disorder: [B I] has the intrinsic tendency to decrease (called entropy) and to spread across larger space (dissipation). [B I] is also a measure of value in the sense that it can be expressed in Bits or in Qbits (see Frieden, 2004)

As treated above, if the information is fully observed and transmitted, it may be compared with the result of teleporting a particle: by sending complete information on the particular particle over a long distance a real particle (in material form) is created at the given distance (Zeilinger, 1999, and 2000). This shows the *fundamental* property of information: it precedes matter or, in other words, information [B I] *produces* matter. This concept of intrinsic information [B I] has been earlier called “Fisher information” (see the review of Frieden, 2004).

[B I] may also be used to envision the phenomenon of entanglement of paired particles with opposite quantum mechanical spin over large distances as treated before: a measurement of the spin of one of the single particles immediately influences the spin of the other paired particle, irrespective of the distance between them (Bell, 1966). This is due to the fact that they share some form of intrinsic information that *for observers* represents a hidden variable, instead of being due to classical signal transduction between the particles. Thus, the observed particle contains, what Bohm calls, “active information” about the unobserved particle (Bohm, 1980, Bohm and Hiley, 1987).

In the process of observation, photons play a crucial role: they probe (illuminate) the object (the source of information) and act as a communication carrier in the chosen communication channel or information flowing route (for instance a telescope or a microscope). Observation of such information can subsequently lead to mathematical description and finally to the formulation of laws of nature. Important in this aspect is the role of the particular probe particle (for instance a photon). In the process of probing the object, the probe particle interacts with the object and

perturbs its intrinsic information. Nature therefore seems to play a “knowledge acquisition game” in which it adds a certain level of random noise to the data (this was called “the information demon”).

Although the truth at the micro-level may be directly hidden for us, it can, in principle, be inferred despite the “information demon”. We can penetrate to a certain extent in this intrinsic information level. In this sense the universe cooperates with intelligence. The goal in this cooperation is survival and consequently to reverse the destructive effect of the second law of thermodynamics. Potentially, all information that is ultimately available about the state of the universe could be collected and compressed in a recipe for the construction of a novel reality, suitable for transmission to a follow-up universe. In this sense, intelligent life may be inevitable for the future evolution of our type of universe (cf. the “Strong Anthropic Principle”, Linde, (2004) and for the final destiny of intelligence, Barrow and Tipler, 1986 and Tipler, 1995): *“all events in nature belong to a particular form of different codified energy transformations, so that the total energy cannot be created or destroyed”*.

The expanding Universe can, in this view, be considered as the outcome of an entropic force which in its turn gives rise to the accumulation of information that provided biological evolution with a life conferring potential. An intrinsic property of this system is that the universe, in spite of the ongoing entropic processes, at the same time, is increasing order in relation to creation and further development of intelligence. This aspect is not only inevitably connected to its ultimate destination on a cosmic scale (see Barrow and Tipler, 1986), but it is also fundamental for the organization of life on the micro-level.

Von Neumann (1963) introduced an "ontological" approach to this knowledge-based discipline, which brought the role of the observer and the measurement instrument in the operation of the system. Stapp described Von Neumann's view of quantum theory through a simple definition: *"the state of the universe is an objective compendium of subjective knowings"*. This statement implies that the state of the universe can be seen as represented by a wave function which is a superposition of all the wave functions that conscious beings can collapse through observations. In this sense it is a sum of subjective acts, although collectively an objective one. Thus the physical aspect of Nature (the Schrödinger equation) can be viewed upon as a compendium of subjective knowledge. Of note: the conscious act of asking questions on the very nature of reality may drive the actual transition from one state to another, i.e. the evolution of the universe.

Deutsch (1997) stated that:

“Information is that which is encoded in the structure of discernible patterns, where the discernor of the patterns is an experiential process. Hence information is a subjective measure that depends on the observer's capacity to receive and the fidelity of his/her interpretation. A field of discernible difference is an information medium that comprises an information space. Data exists encoded within an information space, i.e. data are not things in themselves, they are just discernible features of the information space. To the extent that it is capable, each system is resolving and refining an internal mirror of itself and its world, thereby gaining in knowledge. As self-knowledge leads to general knowledge of the nature of reality, this reality-model is a novel instance of the computational process within the virtual universe, which is a new level of creation and manifestation. This self-realization creates a resonance, where the veil of virtual appearances is subtly penetrated and the system apprehends the computational / virtual nature of reality and comes to know itself as reality in action.”

3. Information transfer in biological and cultural evolution

It should be stressed that using the term “transmission of information”, several aspects should be distinguished: the level at which information transfer takes place (in the atom, in the cell, in the brain), the actual content of the information, the type of information (vibration pattern, sequence of nucleotides, spatial forms of a protein, etc.), the density of information (the data content per unit of space), as well as the impact of the particular information, for instance in evolutionary processes or in a cultural setting. With regard to the latter aspect, it has been proposed earlier (see Shannon, 1959) that the impact of information is inversely proportional to the probability that the information arises. Nature preferentially detects anomalies and deviations from normal patterns of common reality! (see also Vedral, 2010).

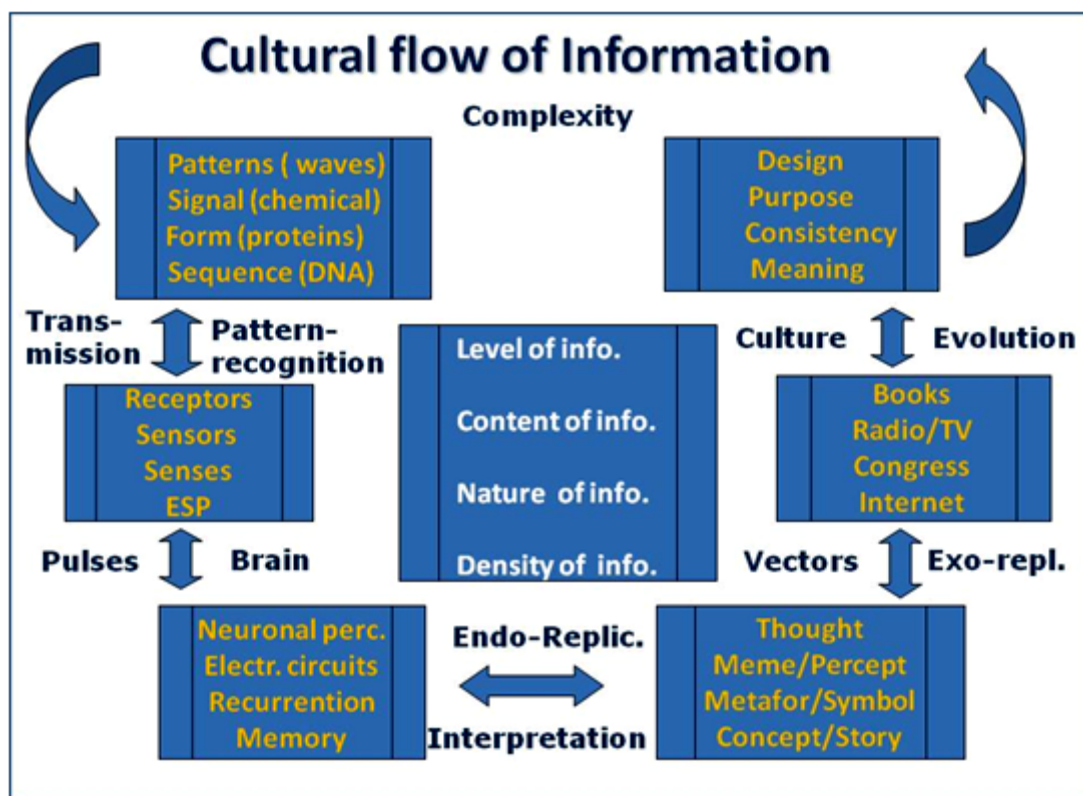


Fig. 6: The different forms of information and information processing in living organisms and human culture, represented as a circular process of pattern recognition and signal processing through detection by senses, leading to activation of neurons. Neuronal storage (short and long term memory) takes the form of neuronal firing patterns, leading to representations of thoughts, ideas, percepts and concepts. Metaphors and memes (Meijer, 2007) are forms of information (units of information, compiled from various information components). They are willingly or unwillingly combined with culture-specific features by the individual, so that the whole is suitable for transmission to other individuals, for example through the media. In this circular process of information processing, these information units obtain cultural significance. Information transfer is therefore based on sequential steps of information detection, perception (interpretation), representation and cultural transmission. Information is extracted from the environment by observation, and can also be derived through extra-sensory perception from knowledge fields that store quantum information (ESP).

In the biological and cultural evolution, with their ever-increasing complexity, information is a key aspect and in particular the mechanisms of information transfer deserve further attention. Information may be transmitted in very different ways and at very different levels (see Fig. 6). In the living cell this may constitute chemical and electrical signals, but also specific spatial perturbations, for instance, in the 3-dimensional structure of proteins as well as in specific sequences of nucleotide building blocks of DNA in the genes (belonging to the earlier mentioned category A, or intrinsic information).

At the level of human communication, vibration patterns can be expressed in electromagnetic waves in the form of light, sound, music, as well as in images and stories (transmitted by radio, telephone, internet and TV, for example). Such information is transferred into the brain through specifically tailored sensory organs that accommodate complex patterns of wave activity, that subsequently are converted to neural activities in the nervous system. Information types B. and C. get significance only after reception, perception and representation (see Fig. 6).

An important question here is how the diverse information that reaches our brains through our senses (sensory or potential extrasensory signals) is selected, stored, retrieved and then exported from the individual to, for example, the public domain. These processes are obviously crucial for the generation and processing of knowledge and also the transfer of cultural knowledge in society. Quantum information may be detected by our brain and interchanged with the so-called quantum vacuum field, scientifically identified as the non-local "zero-point energy field" (see section 6). This is a field with fluctuating energy, in which symmetric pairs of particle/anti-particles are continuously created and disappearing. Some consider it, by its nature, to represent a permanent storage medium for wave information and as such it can be seen as the physical basis for an assumed universal consciousness (see László, 2004, 2005, 2007). The latter domain may also incorporate information from the category D, as mentioned above).

From the birth of our universe to its supposed end, information will continuously flow, for example, in the process of biological and cultural/scientific evolution. This is not a time-linear event but should rather be seen as a chain of feed-back loops, in which existing information is processed and new information is generated and integrated. With regard to evolution, feed-back of information on the state of the whole, including that of the stable intermediates, of life forms is required to create and functionally integrate the particular building blocks of the entities that constitute the ongoing processes of higher complexification. This feed-back leads to perturbation of these basic processes that in turn can, but not always will, result in a to a higher level of functionality of the whole. This cyclic flow of information, for example can lead to efficient adaption of cells and organisms in evolutionary processes (see also section 8 and 9). A basic perception of the whole is only possible if a collective memory is available, which argues for some kind of universal knowledge domain. In principle, consciousness can be perceived as processing of information. Since the latter is observed in literally all the aspects of evolution, consciousness should have a universal character and must be present at each level of the cosmos.

Two aspects should be differentiated here: the gradual unfolding of the primary information that was present a priori, at the start of our universe, and along with that, new information that arises in the ongoing process of universal entropy. The interference of these two modalities of information can be viewed upon as a holographic process, in which these two types of information, projected in a two-dimensional space, are converted to a three-dimensional image (Fig.7), as earlier proposed by David Bohm, (1980) and later on worked out by Bekenstein, (2003), 't Hooft, (2001) and Hawking, (2010), among others. In a hologram, each sub-part contains the information of the total

holographic picture. It is the unfolding (a priori) information that is the basis of this holistic aspect and forms the fundamental binding element in the information matrix. This flow of information gives rise to evolution: the creation of form both in its material and mental modalities. In our brain the latter are thoughts, sensory and extra-sensory percepts, memes, metaphors, concepts, models etc.

It follows from this view that, if information monitoring is a fundamental and pervasive feature of the world at even the most basic levels, and that consciousness too indeed should appear at those levels. The central feature of quantum mechanics is the existence of informational but non-causal relations between elements of systems. These relations are non-causal insofar as they are modulated instantaneously over any distance and do not involve the transfer of energy between the parts of the system. In conclusion: the above mentioned information matrix pervades all non-living and living elements of the universe and can be called a knowledge domain or a universal information field that may be structured as a holographic system.

What is the basic entity to describe information? Entropy, if considered as information is measured in bits. The total quantity of bits is related to the total degrees of freedom of matter/energy. For a given energy in a given volume, there is an upper limit to the density of information (the so called Bekenstein bound), suggesting that matter itself cannot be subdivided infinitely many times and there must be an ultimate level of fundamental particles.

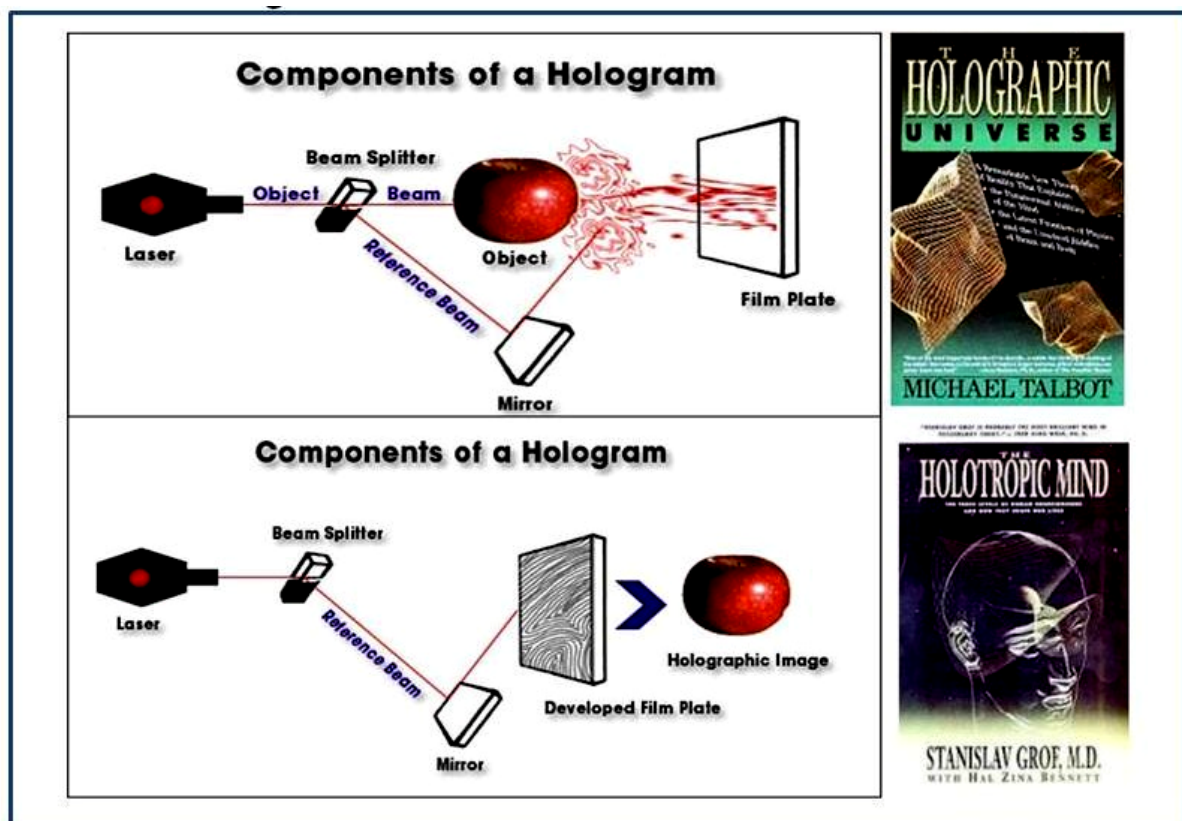


Fig. 7: The principle of holography, using a double laser technique. Holographic models are applied in describing the architecture of the Universe as well as brain memory function, as treated by Talbot and Grof, among others.

Bekenstein's overview "A Tale of Two Entropies" highlights a connection between the world of information theory and classical physics. This connection was first described by C. E. Shannon (1959), who introduced a measure of information content, known as Shannon entropy. As an objective measure of the quantity of information, Shannon entropy has obtained a central position, for example, the design of modern communication instruments and data storage devices, are based on Shannon entropy. As, mentioned above, Shannon entropy deals with an intuitive link between measures of uncertainty and information: the greater our uncertainty about the outcome of an experiment, the more one may gain from actually performing it. In fact, Shannon information represents a parameter indicating the expected information gain, even before we perform an experiment, and also an average gain following multiple repetitions. In this concept, the higher the deviation from uniform probabilities the more information is available. The central idea in this context is that information is a physical entity (it is encoded into configurations of energy and matter). Consequently physics, in fact, consists out of information, for instance by statistically indicating the amount of information imparted by prior conditions ("prior knowledge") at a given measurement. Of note, Shannon made clear that the notion of information, in principle, has nothing to do with meaning.

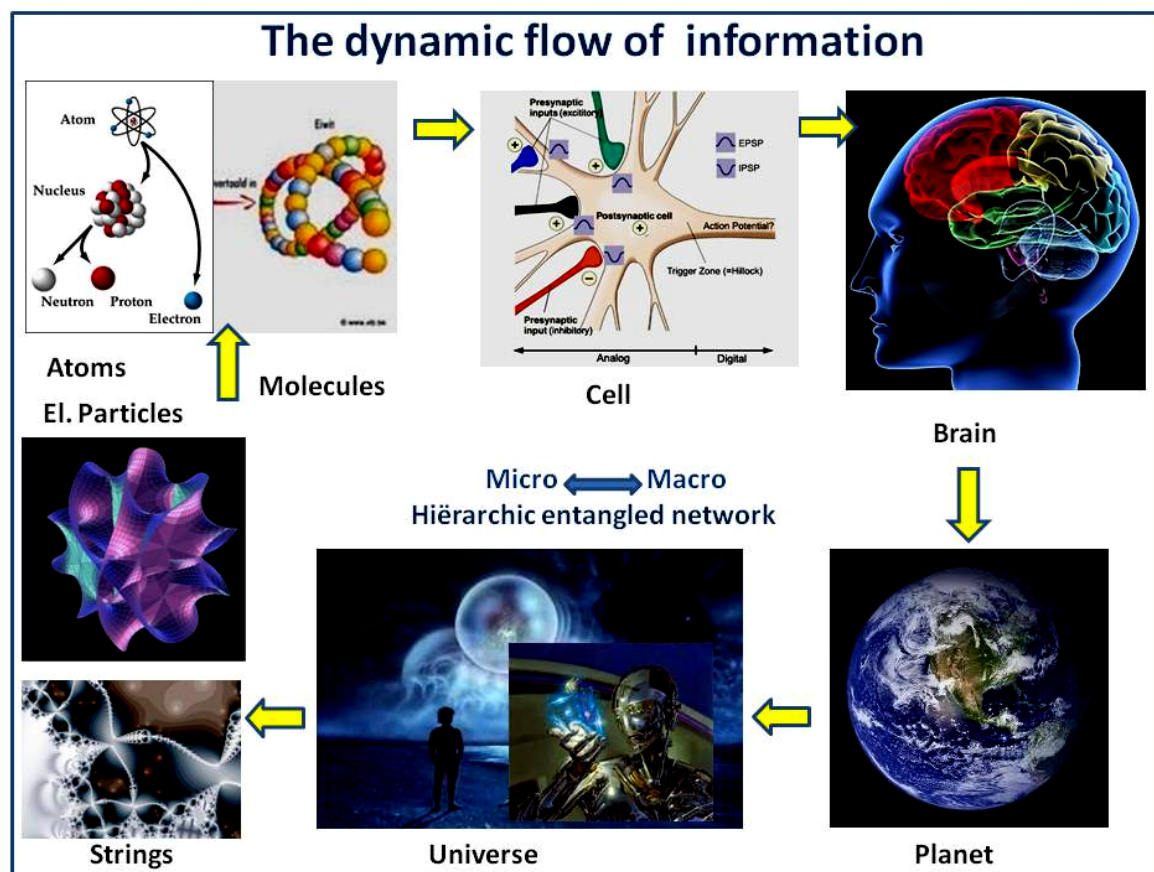


Fig. 8: The dynamic flow of information in our Universe is pictured as starting with vibration of strings (lower part, inset left) in a 10 dimensional space, leading to elementary particles and atoms that form molecules as a basis for living cells such as neurons that on their turn, with other cell types, form our brain as a part of the human organism. Humans inhabit planet Earth, as a part of our galaxy and the universe, in a process of participation by natural and artificial intelligence.

Science is concerned with the ability to make predictions that can be tested empirically. Observing an interaction of particles through studying interference patterns in quantum systems, yields relevant information. Particle interactions can be seen as a form of information propagation and in fact, each particle is basically a bundle of information fully describing its current state: the wave function of a particle contains various modalities of information about the particle. The spatial part of the wave function contains information about the probability of localizing the particle in a given spot.

The spin part has information about the probability of identifying it pointing one way or another, and a potential entanglement provides information of a paired particle, irrespective of their distance. Quantum information, however, is different from classical information since it cannot be established without its state becoming the measured value. Such states measured as a qubit are known as basis states or basis vectors.

Modern physics now considers the bit - the binary choice - as the ultimate fundamental entity. John Wheeler expressed this idea as “it-from-bit”, and implied that the basis of the physical universe -the “it” of an atom or subatomic particle - is not matter, nor energy, but a bit of information. Consequently, the entire universe should be seen as a cosmic processor of information. If elementary particles interact, they are exchanging bits or, in other words, they transmit quantum states. The universe can thereby also compute its own destiny. For instance, Lloyd (2006) postulated that there are content-holding structures in the universe, that posses "content" of whether they are "here or there". At the same time, there are other cosmic structures that can read that content and may identify it to be non-random. They then use this information to recognize patterns and quantify how much information is in a particular channel. It is important to note here that information does not exist by itself, because it depends on an intrinsic system that is able to decode the “message” and can register the "sender" and "receiver".



Fig. 9: The Universe seen as a symphony, on the basis of information and participation.

Shannon's efforts to find a way to quantify the information contained in transmitted messages, led to a formula with the same form as that of Boltzmann. In his article *Information in the Holographic Universe*, Bekenstein concluded that: "*Thermodynamic entropy and Shannon entropy are conceptually equivalent: the number of arrangements that are counted by Boltzmann entropy reflects the amount of Shannon information one would need to implement any particular arrangement of matter and energy.*" At first sight there seems to be a clear difference between the thermodynamic entropy and Shannon's entropy of information: the former is expressed in units of energy divided by temperature, the latter is essentially expressed in dimensionless "bits" of information, but this apparent difference is entirely a matter of convention.

As indicated above, information is, in general, expressed in bits which may have the value "0" or "1". In computers, bits are represented as the physical states of a certain physical system. It is obvious that a physical bit can only be either "0" or "1", that is, if it is represented by a classical system. Yet, with the possibility of characterizing individual quantum particles in much greater detail, the question arises which new phenomena may occur when we use such quantum systems to represent information, assuming that their propagation and processing is determined by the laws of quantum physics. One interesting aspect comes up when we consider the qubit or quantum bit. In contrast to a classical bit, a qubit is not restricted to the states "0" or "1", but it can also be in a superposition of "0" and "1". This means that the value of the bit is not exactly defined. If it is measured, one gets randomly the answer "0" or "1". Although in this way certainty is lost, a major advantage of a qubit is that the superposition can exist in many different forms, and consequently a qubit has the potential to represent much more information than the classical bit and renders extremely high calculation capacity.

But how is information organized and integrated in nature? Although a reductionist scheme on the dynamic flow of information in nature from the micro to the macro scale, as pictured in Fig. 8, seems intellectually satisfactory, such a scheme evidently lacks the aspect of integration and consistency that enables nature to act as a whole at the different levels indicated.

The unfolding and creation of information, as well as the processing of it, can be pictured as an act of composing of symphonic music: in addition to the interpretation by the maker and the musicians, it obtains significance through the subjective emotion of the listener (Fig. 9).

Unfolding can also be pictured as the growth of a huge tree from an extremely small seed (a priori information) that unfolds during maturing. During the growth of the tree, intrinsic (morphogenetic) information is used and new information is collected from the environment, resulting in steadily rising complexity as well as modulation of the basic recipe, resulting in the manifestation of life and survival.

The increasing complexity in nature was earlier defined as a neg-entropic (see Schrödinger, 1959) or as a syntropic process (see Vannini, 2005, 2008, 2009). This phenomenon is partly explained by, so called, "emergent" processes in which completely new properties are claimed to arise spontaneously from building blocks that themselves do not display that particular property. An often used example is the wetness of water that, according to this theory, cannot be derived from its building blocks: the very nature H_2O molecules. However, one could argue that the well known electrical dipole of the water molecule largely predicts its ordering within the water fluid as well as its behavior on surfaces. For this, and other reasons, the physical background and proof of emergent phenomena are presently debated. In general, supposed emergent processes are often an explanation in retrospect, and adequate models to predict emergent phenomena remain to be developed.

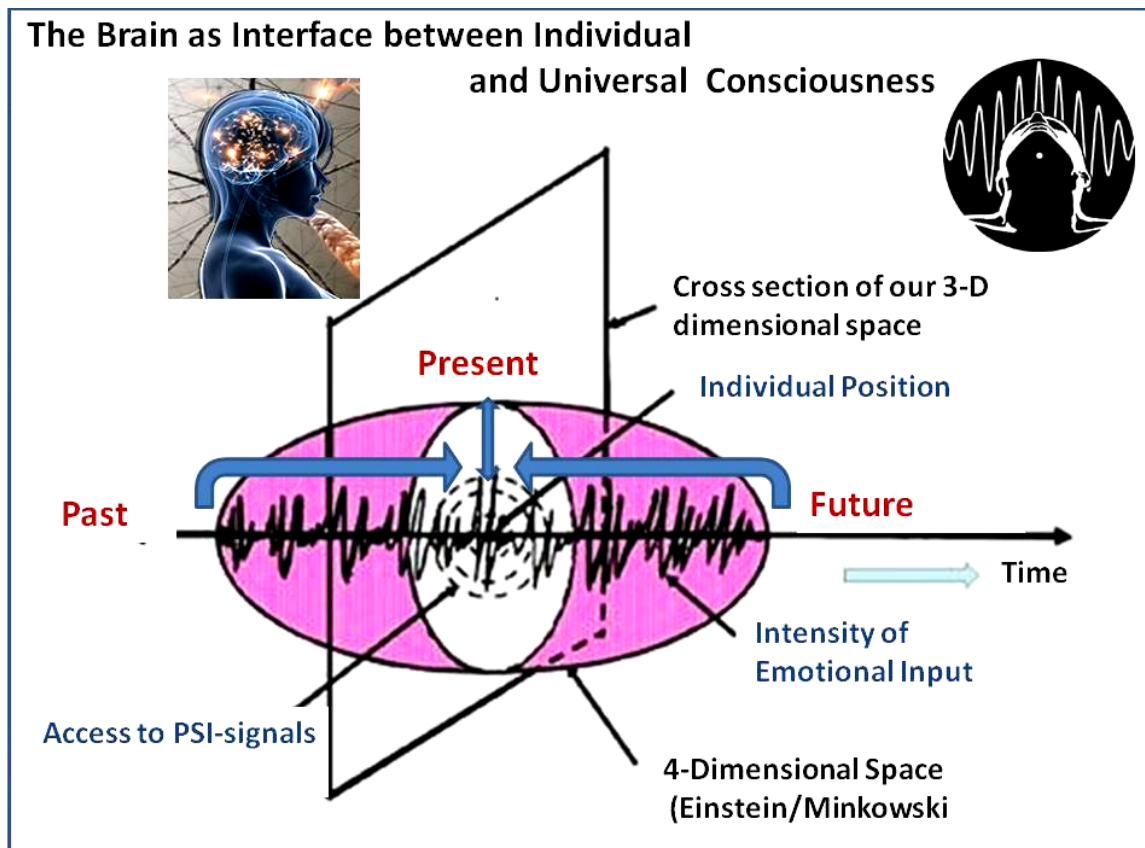


Fig. 10: The human brain acting as an interface between individual and universal consciousness. The working space of the brain is depicted as a 3-dimensional concept in a 4-dimensional space (pink ellipse), allowing input of information from both the past and future. This information includes ESP and PSI signals, the intensity of which is determined from emotional history and the emotional projections from anticipation the future.

Alternatively, the induction of novel complexity in time can be seen as a process of “backward causation”. Two different mechanisms may play a role here.

Firstly, such a time-reversed causation may entail a feed-back of information from a future condition of higher complexity (see also section 9). This can be related to the observer effect in quantum physics in which the wave information collapses to particle information by the act of conscious observation, but only after the observer chooses to read and interpret the interference pattern (see the delayed choice model of Wheeler, 1990). An observer effect can even be envisioned to occur in observing the boundaries of our Universe through a telescope and thereby looking back in time to the Universe in its starting conditions. The observer may, in this manner, even perturb events at the time of birth of our universe (see Wheeler, 1990). Thus the present observation may influence the past in a retro-causal manner. In information terminology, one could say that such backward causation is to make a time-reversed copy of a future event.

On the human level this may be a brain process that occurs in the unconscious domain that is proposed to represent 90% of the brain’s workspace and has also be related to aspects of clairvoyance and telepathy (see Radin, 1997, 2006, Grof, 1987 and Griffin, 1997).

Secondly, backward causation may be understood in relation to the so called transactional interpretation of quantum physics: collapse of the wave function and the experimentally observed time delays and “feeling the future aspects” may be due to the sending of an advanced wave (into the future) and simultaneously an offer wave (into the past) that then are accommodated by the best fitting future and past events (see Cramer, 1998, 2005: the handshake effect). The produced answer waves, subsequently, are returned to the present and mixed in order to create the state of the particular wave function. Each quantum event in the present time thereby entails specific but not directly observable information from the future (Fig. 10).

This highlights the notion that matter should be seen as a “frozen” (collapsed) aspect of wave information, each particle is in fact material point information in a quantum field and living organisms are complex compositions of billions if such wave/particle modalities. This idea is very much in line with the idea that, on the deepest micro-level, nature can be described as vibrational energy, in the sense that each specific type of elementary particle should be seen as one modality of vibration of strings. As mentioned earlier, strings might represent the most fundamental supposed building blocks of the universe according to the string and M-theories (Fig. 11)

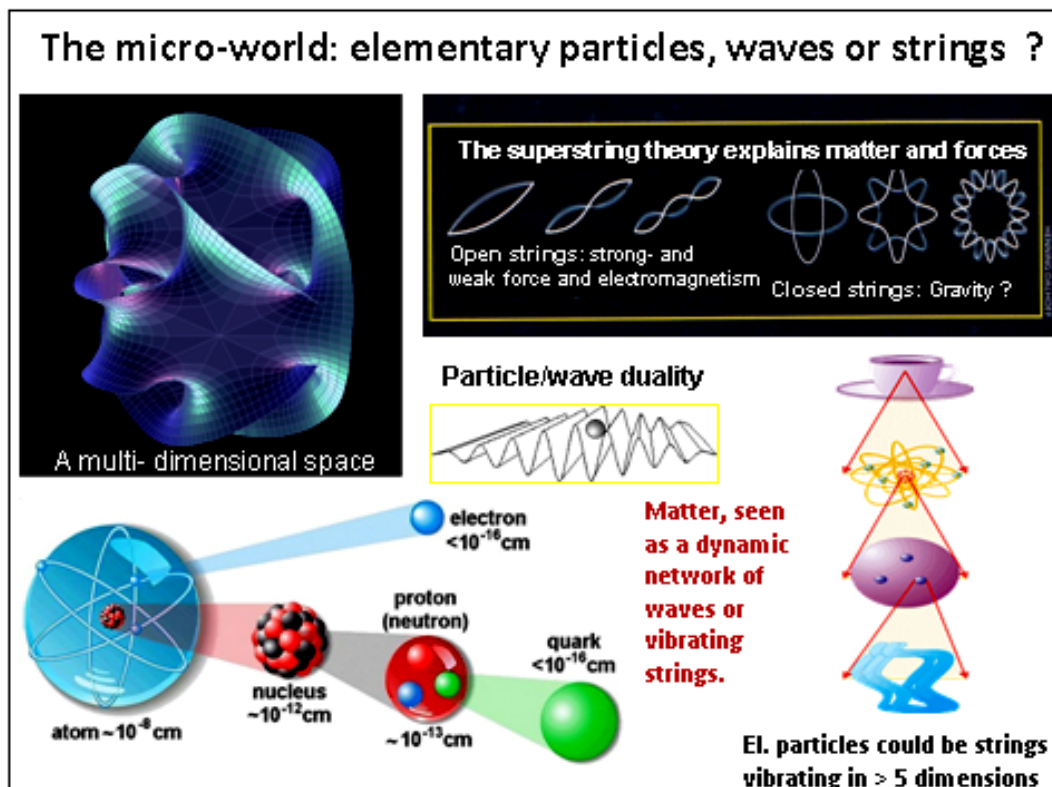


Fig. 11: Elementary particles (below left) may also behave as waves (middle) or, even smaller, string elements that take different forms (upper part right) and are supposed to vibrate in a > 5-dimensional space, (depicted in the cartoon up left), according to the M-theory.

Yet it should be realized that we cannot really detect what an electron or even an atom is really like: we will only see their shadows as representations on the background (see Plato’s cave). All of the above mentioned micro-events cannot be observed directly by humans since, as treated before, the measuring instruments and the act of observation intrinsically disturb the bound information (see section 2). Such events can only be indirectly inferred by postulating theories, designing models and

verification of these models by experimentation. In other words, humans with their evolutionary developed brain, can only see “reality” through a “firewall” that only permits selective filtration of information, see Jahn (1997 and 2004). Therefore it is of utmost importance to identify the nature of these inborn filters and create technology to deal with them. This may eventually be a feasible task: Spinoza (1677/1995) claimed that intelligence will ultimately learn to fully comprehend reality!

Ordered systems, such as our universe in the beginning, are supposed to expire in less ordered systems (increase of disorder or entropy increases, according to the principles of thermodynamics). A greater disorder implies that more information is needed to describe the system. An increase in entropy, consequently, means an implicit increase in information. In our part of the universe, contrary to the second law of thermodynamics, also a decrease in entropy is seen. This produces an increase of ordered complexity such as life forms (see Vannini, 2009). As mentioned earlier, this is also called neg-entropy and it is associated with a virtual reduction of information from the Category B. and partly C. since, in a systematic manner, information is compressed. For example, the compression of information in formulating the laws of nature can be seen as an example of such a neg-entropic process. Presently, more and more of such information is generated and shared in the non-local information store that we call the internet. In this global process, interestingly, information density is increasing, despite the much larger area over which it is distributed.

Information concepts have been examined by Wiener (1948), von Neumann (1963) and Shannon (1959), in well known contributions and, as mentioned earlier, by Frieden (2004), and generated useful theories to physics, to computation and to communications technologies. Information is hypothesized to be comprised of dual aspects, similar to the dual aspects of light: wave and particle. Wheeler stated that information is truly fundamental and exhibits two basic aspects: physical and phenomenal. Both are essential in the further understanding of consciousness.

The missing concepts that prevented the earliest investigators of consciousness from succeeding in their quest were: 1) a generalized theory of information; 2) a deeper understanding of quantum science itself, with its associated phenomena of non-locality, and quantum holography; 3) a theory on chaotic processes, that is necessary to understand the nonlinear evolutionary processes that caused consciousness to evolve toward the self-consciousness experienced by humans. As mentioned before, on the basis of these concepts, consciousness now seems an essential and integral modality in the manifestation of the material world. Scientific observations today may, through backward causation, even lead to adaptation of the fundamental laws of nature that were often assumed to be fixed from the beginning. Observations made throughout the entire duration of the universe, in this way, can contribute to fashioning the form of the laws in the first split second after the Big Bang, when they were still significantly malleable. Thus the potential for future life acted like an attractor, drawing the emerging laws towards a bio-friendly region in the parameter space (see Davies, 2003 and 2007).

What is the underlying basis for all of these processes in nature? There are now attempts to develop a “theory of everything” on the basis of string theories (see Green, 2004). Such a theory should be valid both on the micro (quantum) level and macro (cosmological) level (Fig. 11). Another candidate to describe the deep structure of reality is the so called loop quantum gravity theory (see Smolin, 2004), in which matter exists at the nodes of an extremely fine spin network. Interestingly attempts have been made by describing consciousness as being produced by the spin of elementary particles that make up our brain (see Hu and Wu, 2010).

Of note, it should be stressed that such theories can never fully describe reality without taking into account the phenomenon of consciousness and self-awareness, as essential parts of an information-generating and as well as information-processing system in our world. Anyway, a consistent “theory of everything” should also contain an explanation for itself (Vedral, 2010).

4. The possible origin of early information at the big bang.

It is assumed in this essay, that since the very beginning of our universe, basic information was present in the form of (what later was unveiled in) the laws of Nature. These include implicit natural constants that have been shown to exhibit a very precise value that can be regarded a prerequisite for the evolution of life. A slight deviation in even one of these twenty values would have been fatal for biological evolution! (see for this Anthropic Principle, Linde, 2004 and Barrow and Tipler, 1986). The latter theory also highlights the many entangled macro-conditions of the Earth-Moon-Sun system, indicating a fine-tuned constellation of our part of the cosmos. This may even imply that intelligent physical life, as manifested on our planet, may be rare in our Universe.

But where would such information come from?

- one argues that the universe had no real beginning: it simply existed in a timeless dimension. The term “beginning” is only valid within our unidirectional (compressed) concept of time (see Hawking, 2010). Alternatively, our reality may be part of a four-dimensional space/time domain with time as an uncompressed and fundamental aspect (named the “Block Universe”), as put forward by Minkowski, (1952) and later by Einstein (see Kumar, 2009), who called our linear perception of time an illusion. Indeed, time in all the laws of nature has a symmetrical (bidirectional) character. Although the evolutionary-developed human brain cannot perceive such a “Block Universe” that contains all time (information from past, present and future), according to modern physics such a model has to be taken into account seriously.
- It has been postulated, as mentioned above, that the initial information at the Big Bang may come from our own far future (Fig. 12), due to a process that the physicist Wheeler called backward causation. By asking scientific questions about nature, the science of physics developed and will also produce future observers that, with certainty, provide new information on the fabric of reality. Quantum physics predicts that this information must also influence events in the past, see also section 7 (see also Wheeler, 1990, and Aharonov, 2010).
- Alternatively, Barrow and Tipler (1986), Bostrom (2003) and Tipler (1995), have proposed that in the far future intelligent species will saturate the universe with information and that there are very good reasons to anticipate that, at that time, they will use the giant potential of computing to perform a perfect simulation of the entire history of the universe (also called emanation), including its initial conditions.
- Computer scientists working with extremely large data sets even now realized that for copying the universe with a 256 bit barcode, a unique identifier is available for each particle in the universe (see Loyd, 2006, in *Programming the Universe*). In general, the technology invented by humans became crucial in recent part of biological evolution and is expected to remain a dominant driving force when future modalities of intelligence will arise (see Fig. 13). Zizzi (2006) proposed that the early inflationary universe may be described in terms of quantum information. In this concept, the inflationary universe is viewed upon as a superposed state of quantum registers and during inflation, as a quantum superposition of universes. At the end of inflation, only one universe is selected, by a mechanism called self-reduction, which is

consistent with Penrose's objective reduction (OR) model. The quantum gravity threshold of (OR) is reached at the end of inflation, at which time the universe underwent a cosmic conscious event, which acted as an imprinting for the future minds to come, with future modes of computation, consciousness, and logic. The universe organized itself as a cellular automaton with two computational modes: quantum and classical.



Fig. 12: Processing of information occurs both as entropic and syntropic processes (see part 3 and 4), on the basis of initial compressed information, leading to the evolution of information networks, formed by entangled elementary particles at the big bang. Initial information may originate from another Universe in a multi-versum setting (see left below), or may originate from the future of our universe by backward causation or through simulation by advanced civilizations (see cartoon right below).

- Others have suggested that the origin of this information can be found in a multiverse background: our universe was born out of another, already developed, universe. In a special case of this, it has been proposed that the universe we know arose from a preceding version of that same universe: advanced forms of natural and artificial intelligence, in the distant future, would be able to collect all information from the universe and compress that information into a "law of everything" (see Barrow and Tipler, 1986, Bostrom, 2003, 2005). In this concept the condensed information could be used at the death of our present universe, for starting a new version of it. This mechanism of a "cyclic universe" may also explain how the initial information (laws of nature including natural constants as well as the seemingly programmed inflation) came into being: namely, from a previous version of our own Universe (for cyclic models of the Universe see, for instance, Gott, 1998, Penrose, 2010, and Steinhardt, 2007).

Thus, the new start of the universe can be envisioned as occurring at a zero-matter condition, because in the abovementioned concepts a recipe of the universe was present before any material form existed. This phenomenon finds a correlate in the current teleportation science: the sending of complete information on a elementary particle results in the material formation of the particular

particle at a distance (Zeilinger, 1999, 2000, and Pereira, 2003). These experiments clearly showed that information per se can create matter! It can be speculated that in this condition, information may have been present before it was exposed to the Higgs field, that is supposed to produce the mass aspect of elementary particles. It has been proposed that the current, rapidly growing, internet system may evolve into an advanced super-intelligence that, in the far future, could spread from planet to planet, eventually engulfing the entire universe. Hence, the universe may become some sort of "giant brain", a cosmic intelligence that will be able to simulate all previous civilizations in the utmost detail. In this manner the becoming of our universe can be conceptualized as a giant feed-back loop of information instead of a "Big Bang" out of nothing (see references of Tipler, 1995, Lloyd, 2006, and Bostrom, 2003). The latter author even provided arguments in favor of the possibility that we live in a computer simulation already!



Fig. 13: The evolution of mankind has been, and always will be, driven by technology.

According to some of these concepts, our universe may have started under a condition of omnipotency (total compressed information) that, as mentioned above, was somehow passed through at the start of our universe. This initial information, potentially, contained all future possibilities (quantum physical paths). However through the unique interaction of consciousness and physical laws, the universe underwent a single set of events. Free will is inherent in this process, since each decision made can be seen as a bifurcation of a path that is the resultant of information from the past and feeling of the future (see sections 3 and 5). In other words, there are many paths, but only a single is finally chosen by the individual, in the sense that the chosen change function becomes part of the future of the universe.

Paul Davies explains this possibility in his book "The Mind of God":

"What is remarkable is that human beings have the necessary intellectual equipment for us to unlock the secrets of nature. We could imagine another world in which either

there were no regularities, or the regularities were so well hidden, so subtle, that the cosmic code would require vastly more brainpower than humans possess. But instead we find a situation in which the difficulty of the cosmic code seems almost to be attuned to human capabilities. The mystery in all this is that human intellectual powers are presumably determined by biological evolution, and have absolutely no connection with doing science. Our brains have evolved in response to environmental pressures, such as the ability to hunt, avoid predators, etc. What has this got to do with discovering the laws of electromagnetism or the structure of the atom? Well, if our current universe actually created by an advanced human civilization then the answer to this puzzle becomes very clear: the universe is based on an advanced form of our current technology! No wonder we are capable of understanding it!"

5. Brain and consciousness belong to the quantum world.

One major observation: that measurement of wave interference collapses the quantum state to the material mode, but only through conscious observation and interpretation, is still hotly debated and raised the question whether a mental domain is instrumental in the fabric of reality.

In a publication in Nature, in 2005, the astrophysicist Henry wrote:

"The 1925 discovery of quantum mechanics solved the problem of the Universe's nature. Bright physicists were again led to believe the unbelievable — this time, that the Universe is mental. According to Sir James Jeans: the stream of knowledge is heading towards a non-mechanical reality; the Universe begins to look more like a great thought than like a great machine. Mind no longer appears to be an accidental intruder into the realm of matter... we ought rather hail it as the creator and governor of the realm of matter."

and also:

"Physicists are shy from the truth because the truth is so alien to everyday physics. A common way to evade the mental Universe is to invoke 'decoherence' — the notion that 'the physical environment' is sufficient to create reality, independent of the human mind. Yet the idea that any irreversible act of amplification is necessary to collapse the wave function is known to be wrong: in 'Renninger-type' experiments (see De Baere, 2005), the wave function is collapsed simply by your human mind, seeing nothing.... The Universe is entirely mental."

This worldview is fully defensible from the viewpoint of quantum physics, and it does not leave the material world completely aside, but considers the latter as a secondary phenomenon. As argued before, a reconciliation of the matter versus mind worldviews could be based on the classical theory of panpsychism: each material modality intrinsically contains mental aspects (Edwards, 1967, Strawson, 2003, Skrbna, 2005, and also thoroughly discussed by De Quincey, 2010). Another, important, proposal stems from Primas (2003 and 2009), hypothesizing a dual-aspect approach in which mind and matter are seen as complementary aspects of the same reality, an idea that originates from Pauli. In this challenging theory, separate mental and material domains exist that are both derived from a "timeless holistic reality" that represents a primordial and symmetric unity, and that can be described by modern quantum theory. The two non-interacting, but time entangled and

quantum correlated domains, are thought to arise through a time-reversal symmetry breaking, creating two modes of time: a tensed (mental) time and a tenseless (material) time. The first satisfies the rule of advanced causality (acting from the future) and the second one, that of the more common, retarded causality (acting from the past). Thus the time arrows in the two domains have opposing time-directions. This theory, that was also discussed by Atmanspacher (2011) and also by Jahn and Dunne (2007), resembles the proposal of Di Corpo and Vannini (2011), that is based on the Klein Gordon wave equation (see section 6 and 7). Symmetry breaking is also an essential aspect of the cosmological interpretation of consciousness as proposed by King (2011), who also made clear that the phenomenon of entanglement between particles can only be maintained through wave functions extending back to one particle at the creation event of the pair, in addition to a wave forward in time to the other particle.

Henry and Primas, by no means, stand alone in this view of a mental aspect of reality: in his 2003 article in *Scientific American*, Jacob Bekenstein summarized a current trend that was started by John Archibald Wheeler, which suggests that scientists may "*regard the physical world as made of information, with energy and matter as incidentals.*"

Bekenstein (2003) also argued:

"Ask anybody what the physical world is made of, and you are likely to be told 'matter and energy'. Yet if we have learned anything from engineering, biology and physics, information is just as crucial an ingredient." And "What is the fundamental theory like? The chain of reasoning involving holography suggests to some, that such a final theory must be concerned not with fields, not even with space/time, but rather with information exchange among physical processes. If so, the vision of information as the stuff the world is made of, will have found a worthy embodiment".

Following the Hungarian physicist Eugene Wigner, the quantum physicist Walker (see for references Walker, 1998) proposes to add a term to the Schrödinger equation that would make it nonlinear. This would then explain what causes the collapse of the wave: a measurement of information. This added term, that basically expresses the transfer of information that takes place with the wave collapse, would disappear once the measurement is performed. Interestingly, this term would indeed signal the involvement of the observer. By introducing the same "*information term*" in Dirac's equation. Walker derived another possible interpretation: reality is consciousness observing itself. Dirac's equation thereby became simply the equation, indicating "*an observer observing*".

Walker also pointed out the close connection between space and probability. He interpreted Einstein's four-dimensional space-time as time plus an ordering of events that are probable but do not happen (in, what we call, "space"). The only thing that exists, ultimately, is the observer, who consciously experiences his/her world. The sequence of conscious experiences, in this concept, is time, and the set of possible events represents space. Thus, the universe is the observer observing, (Fig. 14), and the particular, experiential, information is stored in a universal quantum field.

The function of this quantum field could be cognitive: some particular quantum states could record memory, according to Walker (1998) helped by the phenomenon of quantum mechanic tunneling of electrons at the synaptic cleft of neurons. Yasue and Jibu (1995) and Umezawa (1993) focused on a bio-plasma of charged particles that interact with the electromagnetic field, an ideal vehicle for a merge of the sensory quantum field with the memory quantum field, and also an ideal vehicle for

the creation of classical reality. Consciousness could arise from the interaction between the electromagnetic field and molecular fields of water and protein. Furthermore, these authors maintain that the evolution of the neural wave function is not random, as would result from the traditional quantum theories, but optimized under a principle of "least neural action". Random effects of consciousness are replaced by a "cybernetic" consciousness which is more in the tradition of the self as a free-willing agent.

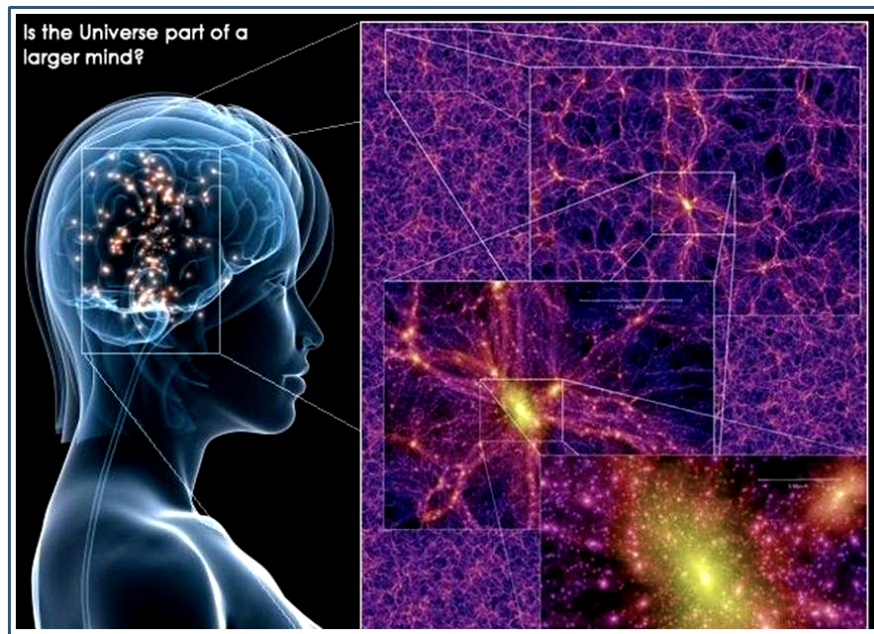


Fig. 14: Is Individual Consciousness an expression of a larger Universal Consciousness and/or Cosmic Intelligence?

As depicted earlier, King (1989) and Vannini and Di Corpo (2008, 2009) suggested models for consciousness based on the transactional interpretation of quantum mechanics, (see Cramer, 1986, Fantappiè, 1942, and also section 6). According to Fantappiè the “feeling of life” is a property of anticipated wave states: in order to counterbalance the deadly effects of entropy, life needs to feed on syntropy: negative energy, waves and energy which move backwards in time. Syntropic phenomena are generated by “final causes”, called attractors, that absorb converging waves from the future.

According to the “supercausal” model of consciousness of Chris King, the constant interaction between information coming from the past and information coming from the future leads to that quantum entities that, as mentioned earlier, are always confronted with bifurcations between past and future causes. This involves fractal structures and chaotic dynamics that enable free choices to be performed. Consequently consciousness is a property of all living structures in which each biological process is forced to choose between information coming from the past and information coming from the future (King, 1989, 2003, 2011). These models attribute consciousness to principles of relativity, quantum physics, and fractal geometry. On the basis of established physical applications of these theories, it would, in principle, allow experimental testing to falsify them.

Resonant proteins in the plasma membrane or associated with the intracellular cytoskeleton of neurons in the brain, that are quantum noise-protected, may also play a role in the detection of coherent forms of quantum information (see, for instance, the quantum brain models of Marshall,

1989, Beck and Eccles, 2003, Eccles, 1994, Penrose and Hameroff, 2011, and Stapp, 2009), as recently reviewed by Vannini, 2008, and Hu and Hu, 2010, as well as by Tarlaci, 2010a and 2010b). Some elements of these models are illustrated in Fig. 15. See for a recent and excellent review on quantum approaches to consciousness studies also Atmanspacher, (2011).

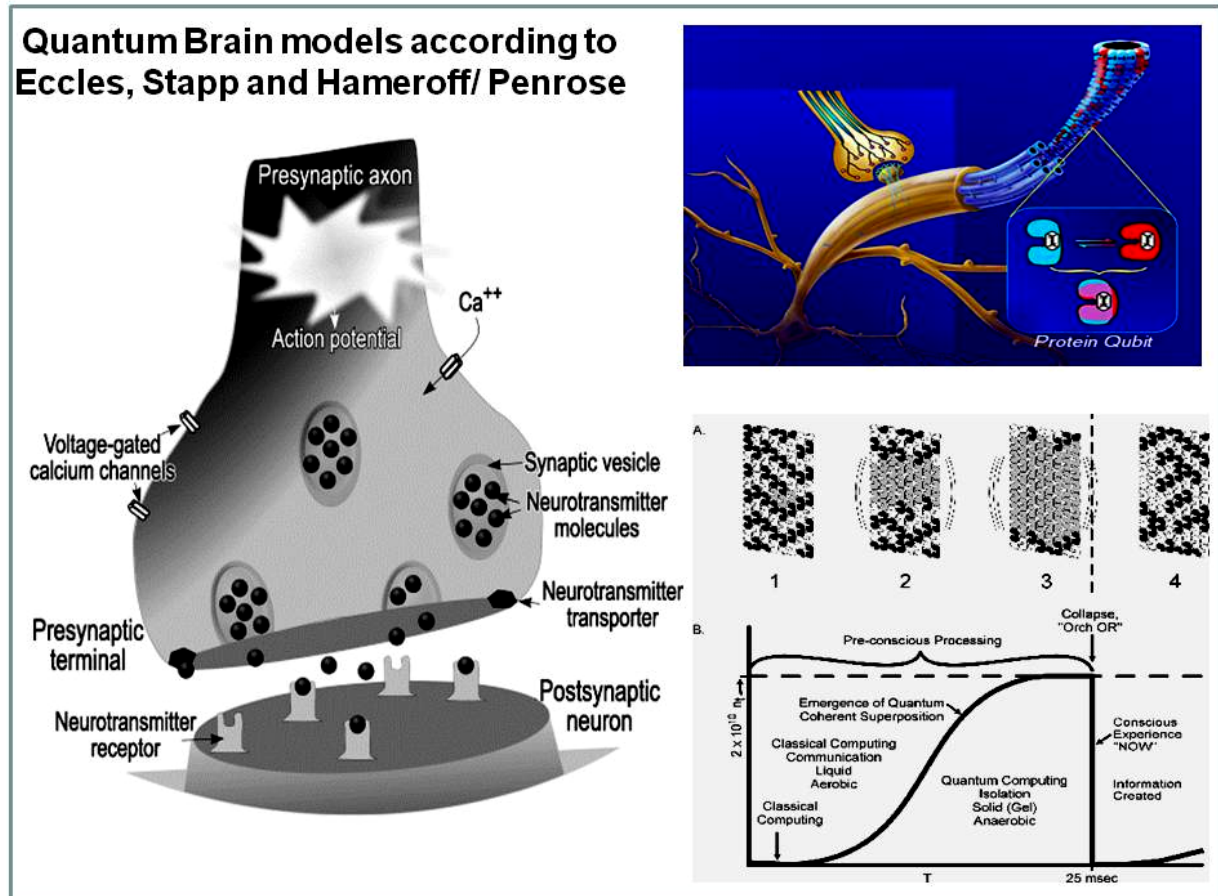


Fig. 15: Quantum brain models based on the probability character of synaptic transmission and the operation of decoherence-protected ion-channels (below right) and/or resonating proteins in neuronal membranes (left) and micro-tubuli (upper part right). In the model of Penrose and Hameroff, a conscious event is depicted as an accumulation of quantum coherent states that collapses to a conscious experience due to a quantum gravity mediated orchestrated reduction (inset below right).

In the Penrose-Hameroff model (Penrose and Hameroff, 2011) "pre-conscious" superposition/quantum computing originates in neuronal microtubules and is sustained on the order of 25 msec (i.e. coherent 40 Hz), until objective reductions ("conscious events") occur (see also Fig. 15). The authors postulate that "subjective reduction" is what happens when an observer measures a quantity in a quantum system: the system is in a "superposition" of possible states until it is observed, the observation causes the system to reduce (or "collapse") to a specific state.

Objective reduction was proposed by a Penrose in his attempt at unifying Relativity Theory and Quantum Theory. The neuronal proteins somehow act as antennas and "tune" the objective reduction which, in this manner, is self-organized, or "orchestrated". According to Penrose, the collapse of the wave function is what gives the laws of nature a non-algorithmic element. Otherwise we would simply be machines and we would have no self-consciousness.

It was argued, however, that de-coherence in the wet and warm brain is orders of magnitude too fast to make quantum effects relevant on physiological time scales (Tegmark, 2000). It was also questioned why microtubuli were chosen as instrumental in the induction of quantum consciousness, since microtubuli are not special to neurons but rather are cell support structures that are abundantly found in almost all tissues in the body. Yet, a convincing rebuttal to Tegmark have been published in answer to these questions by Hagan et al (2002). It is of interest to note also that recent research indicates that an aspect of biological quantum non-locality has been observed in the coherence of induced magnetic dipoles involved in muscle contraction, that is in single acting filaments (see Hatori and Matsuno, 2001, Matsuno, 1999 and 2000), and that quantum coherence therefore may also play a role in other parts of the body. Hameroff claims that classical theories of consciousness have failed to stand up to scrutiny. “*Classical theories based on complexity, emergence, and so forth, have yet to make any testable predictions, and are not, as far as I can tell, falsifiable,*” he said. Yet, Vannini and Di Corpo (2008), prefer the models of King and Fantappiè, being models that attribute consciousness to principles of order which have been already discovered and used for physical applications (laser, superconductors, etc.), making it possible to imagine experimental tests which could falsify them.

It is of interest, in this respect, that Hiley and Pylkkänen (2005) have indicated that active information from a non-local “mind field” can, in principle, influence passage of mind/matter barriers through quantum tunneling as earlier proposed by Walker. In cellular processes such as exocytosis, in a dynamic attractor state, energy can be redistributed between the non-local quantum potential energy field and the classical energy of the cell without violating the principle of conservation of energy.

In conclusion: current models with regard to potential quantum aspects in brain function and manifestation of intelligence obtained a promising position in the ongoing study of human-, as well as universal (cosmic) consciousness. An important question is, if elsewhere in the universe the required conditions suitable for the creation of life are manifest. In that case we should rather think in terms of a participatory universe in which various modalities of intelligence actively participate in the fabric of cosmic reality (see Kauffman, 2008, Wheeler, 1987, and Fig. 14).

6. The physical basis for an universal information field.

Various attempts have been made earlier to define a physical basis for a universal consciousness and/or a general information field (see for an introduction of the term, Eijkman 1998). Apart from the seminal work of Jung and Pauli (1955) on collective consciousness and synchronicity, and that of Bergson (1991) on matter and memory, Bohm (1980), Susskind (1994) as well as ‘t Hooft (2001) and Bekenstein (2003), described the world as an information storing hologram. Hagelin (1987), and Sarfatti (2011) described a unified information field and a “psychosphere”, respectively, based on quantum physics, integrating various aspects of the work of the earlier mentioned Bohm, Heisenberg, Pribram, Eccles, Stapp, Fröhlich and Umezawa. In the studies of Wolf (2008) tachyons (particles traveling backwards in time) were considered as instrumental in the creation of universal consciousness and discussed in a religious context, while Sarfatti (2011) proposed retrocausal (back from the future) holographic image computing. Di Biase (2009a and 2009b) proposed a quantum holographic model of brain-consciousness-universe interactions, based on the holonomic neural networks of Karl Pribram, the holographic quantum theory developed by David Bohm, and based

on the non-locality property of the quantum field described by Umezawa, a subject that also was thoroughly discussed by Mitchell and Staretz (2011).

In the “Noetic Field Theory” of Amoroso et al. (1997, 1999), vacuum (zero-point) quantum fluctuations and gravitation were introduced as potential mechanisms explaining non-local information exchange. So called noetic effects couple operators of a noetic field to specific loci of pumped Fröhlich-like coherent states. This was seen as a phase regulator into the patterns of Pribram's holonomic formations. The pumping mechanism for this process is inherent in the self organization of the system. The radiation pressure of the Bose states, Fermi-quasi-particle transitions, vacuum zero point fluctuations, and string dynamics are considered to be instrumental in driving this dynamic transpersonal 'memory of being'. This was supposed to be a dynamic Hilbert space storing archetypal forms of the personality or psyche. Recently Sheldrake (2012) provided an interesting discussion on the assumptions of mainstream scientific dogma and speculated on the physical basis for his earlier developed hypothesis of morphic resonance that could also be related to an universal information field.

In the abovementioned studies, the human brain is generally seen to function as an interface between individual and such a universal consciousness. It is worthwhile therefore to take a further look at a number of potential modalities for such an “information” domain in the following.

a) The Zero-point energy field and storage of information

Space has been a hotly debated concept in the history of science. Since quantum physics predicts that empty space is inherently unstable, both Newton's absolute space and Einstein's spacetime have been replaced by the vision of a space that is full of spontaneous activity and that seems to have a life of its own and was called the “zero-point energy field”. The results of the earlier Michelson/Morley experiment seemed to clearly invalidate the concept of an aether, a term originating from early Greek philosophy. However, this left a serious problem as to the nature of interstellar space, since in a totally empty space there is no apparent medium for waves to propagating in.

Zero-point energy is fundamentally related to the Heisenberg uncertainty principle. Roughly speaking, the uncertainty principle states that complementary variables (such as a particle position and momentum) cannot simultaneously be measured with infinite precision. In particular, there cannot be a state in which the quantum system exists motionless, for then its position and momentum would both be completely determined with real precision. Therefore, the lowest-energy state (the ground state) of the system must have a distribution in position and momentum that satisfies the uncertainty principle, which implies its energy must be greater than the minimum of the potential well (Fig. 16).

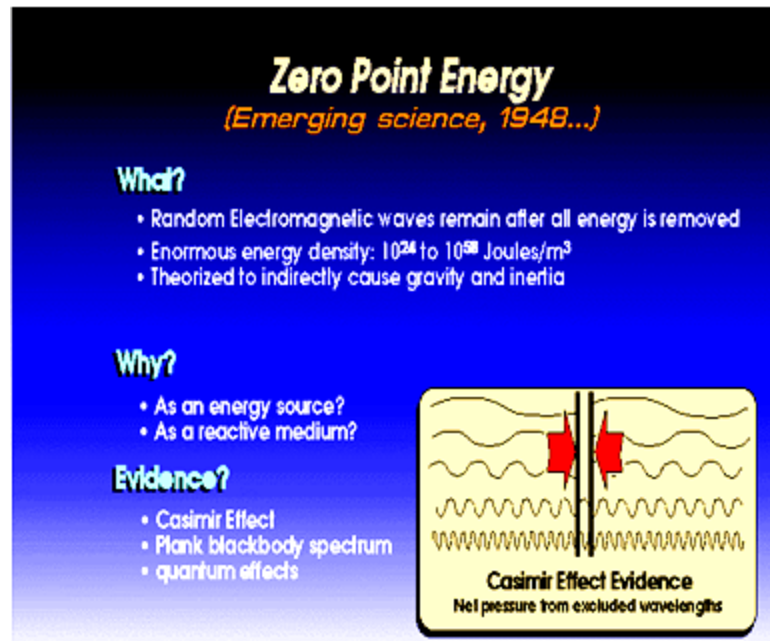


Fig. 16: Properties of the Zero point energy field and its demonstration in the Casimir effect.

The force carrier of the electromagnetic field is the photon. At a microscopic level, therefore, the interaction between the constituent particles of matter and the quantum vacuum involves photons being exchanged between the virtual particles of the vacuum and the quarks and electrons in matter. Basically, any charge in elementary matter, may distort, or "polarize", the quantum vacuum in the immediate vicinity, through attracting virtual particles with opposite electrical charges and repel virtual particles with similar electrical charges.

In quantum field theory, the fabric of space is visualized as consisting of fields, that at every point in space and time exhibit a quantum harmonic oscillator, interacting with neighboring oscillators. Further, and also critically importantly, the wave solutions are in pairs. This means that whenever the phase arrangements of intersecting plane waves produce an electron, they will also necessarily produce the opposite phase positron next to it (they will also have opposite spin states). This explains matter-antimatter pair production, which is occurring everywhere in space all the time, because space vibrates in two distinct patterns (particles and quantum fields) that are constantly switching (see also Fig.19). Splendid work on teleportation, both in theory and experiment as reported in Nature by Sudbury (1997) and Bouwmeester et al. (1997) and in line with the work by Marcer and Schempp (1997), makes it clear that non-local quantum information represented by entanglement of particles in this field could be recovered locally as useable information.

b) (Quantum) gravity and dark energy

A major discovery in astrophysics in the late 1990s was the finding (from supernovae redshift-luminosity observations), that the expansion of the universe is accelerating. This led to the concept of "dark energy", which is in effect a resurrection of Einstein's cosmological constant. The universe now appears to consist of about 70 percent dark energy, 25 percent dark matter and five percent ordinary matter (see Fig. 17). Zero-point energy, in principle, has the required property of driving an accelerated expansion, thus having the requisite properties of dark energy, but to a much larger

degree than in fact required, i.e. 120 orders of magnitude! It has been put forward, as mentioned above, that information in the Universe is stored in a holographic constellation (see Fig. 14 and 7). Interestingly, holographic technology represents an extension of the earlier mentioned double-slit experiment, although it uses coherent laser beams to create an interference pattern, that provides the holographic image. Gerard 't Hooft, at the Utrecht University in the Netherlands, proposed the holographic principle, that claims that anything that happens in a volume of spacetime can be described by data on the boundary of that volume. How is zero-point energy and the supposed holographic fine-structure of the universe related to the phenomenon of gravity and gravity fields?

It has been suggested that a gravity field can function as a temporal information medium between two spin-correlated elementary particles. According to this theory, no information signal travels between particle A and particle B: the gravity field simply seems to “know” about their spinning. According to Rovelli, the gravitational field has a quantum structure; it is composed of “gravitational quanta” with the Planck scale.

Recently, Erik Verlinde (2010), from Amsterdam, The Netherlands, proposed a revolutionary new perspective to gravity, that is presently extensively discussed. He stated: “*the universality of gravity suggests that its emergence should be understood from general principles that are independent of the specific details of the underlying microscopic theory*”. According to his theory the force of gravity in the empty space between two particles is produced by a difference in information content: displacement of mass generates a change in information that requires energy which is then compensated for by a force of attraction. Thus gravity, according to this view, is identified with an “entropic” force caused by changes in the information associated with the positions of material bodies.

Verlinde derived equations clearly showing that gravity has all the characteristics of an entropic effect, and presented clear arguments that gravitational attraction between massive bodies can be considered as resulting from nothing more than a growth in number of bits required to describe the particular system of massive bodies: implying a displacement of information. He thereby rejects the popular hypothesis of gravitation being caused by supposed graviton particles. In line with the earlier mentioned theory of 't Hooft, his description of the physical system is holographic in nature, with bits describing reality residing at holographic screens. In fact Verlinde's concept starts from this holographic principle. Imagine a spherical screen with radius R surrounding a physical system of mass M . According to the holographic principle, all the physics that takes place within the screen can be described by bits of information that can be thought to be located on the screen. The holographic screen is not a physical screen, but rather a thought construct created to represent the information contained in a physical system. A particle with mass m is positioned near an object surrounded by a spherical holographic screen. The energy is evenly distributed over the occupied bits, and is equivalent to the mass M that would emerge in the part of space surrounded by the screen. He argues that the central notion needed to derive gravity is information. More precisely, it is the amount of information associated with matter and its location, measured in terms of entropy. Changes in this entropy when matter is displaced leads in this manner to the reaction force that we call gravity. In recent publications (see Lee et al., 2010a, 2010b and 2012 and Munkhammar, 2010), it is suggested that the particular entropic effect put forward by Verlinde, has a quantum mechanical origin, is based on quantum information and represents an entanglement force.

Verlinde's idea also has major implications for a further characterization of the dark energy, mentioned above. Our universe expands, and this expansion is even accelerating. Current consensus is to attribute this phenomenon to the influence of dark energy (Poccia, 2010). Although dark

energy represents a large part of total energy within the Universe (Fig. 17), it's density is very tiny and therefore only notable at cosmic length scales. When expressed in natural units, the cosmic dark energy density has a value of 10^{-123} Planck units. This tiny value presented a big mystery, as mentioned above. Straightforward estimates for the dark energy density, based on quantum field theoretical considerations, result in values (again in natural units) close to unity. So, indeed the measured dark energy density is smaller than this by a gigantic factor of about 123 orders of magnitude. This discrepancy has been termed "the biggest embarrassment in the history of theoretical physics".

Verlinde therefore put up the question "can dark energy, just like gravity, be understood as an entropic effect?" It appears that determining the entropic force exerted on the entire observable universe, indeed yields an effect with the right order of magnitude to explain the cosmic dark energy (or cosmic acceleration). It thus seems that a dark energy effect correctly emerges from Verlinde's holographic description.

It may be speculated that dark energy and dark matter may be related to the ongoing storage of universal information, implying that the ever growing information drives the expansion of the visible universe. Such storage could be imagined in the form of a presently unknown modality of energy. Since the earlier mentioned quantum zero-point energy field encompasses the potential for information storage, and is made up of virtual but paired particles/antiparticles (with net zero mass), it would therefore be an alternative candidate for explaining dark energy.

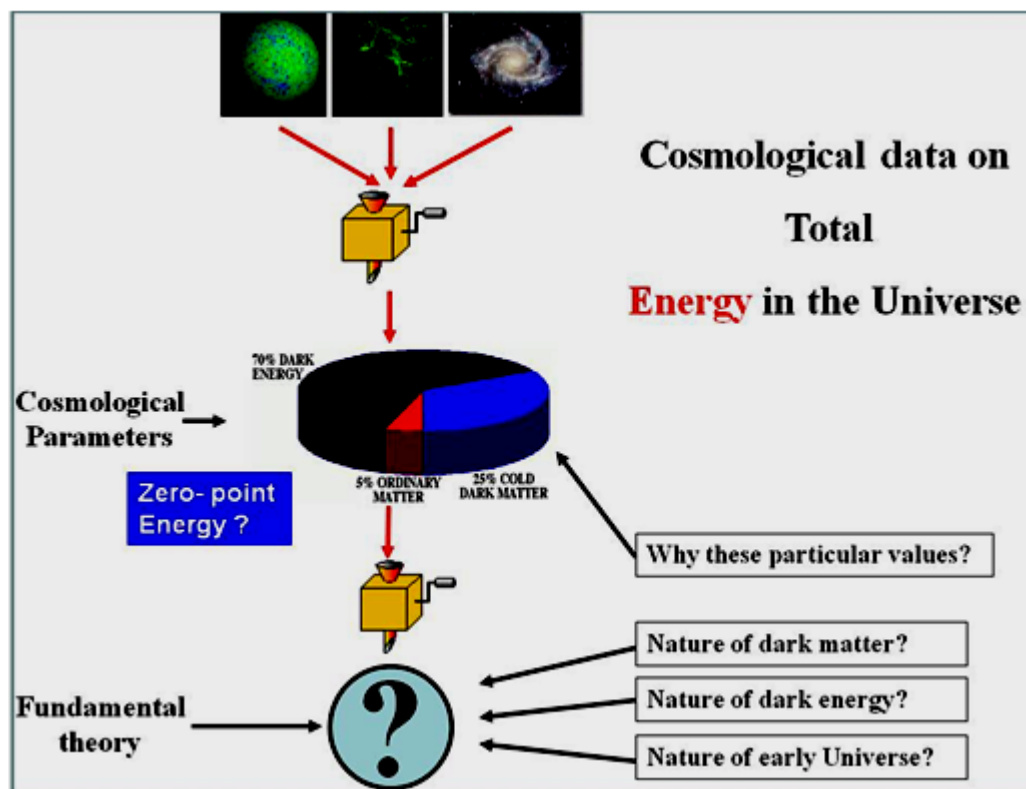


Fig. 17: Only a very small portion of our Universe is composed of the matter we know: as much as 96% is, so called, dark energy/matter.

The observation that pieces of matter can mutually exert gravity forces as a compensation for the displacement of mass and information, may also have implications for the manifestation of

consciousness at a much smaller scale: namely in the human brain. The neuronal flow of information with an extremely high density as it occurs in our nervous system (note the transport of neurotransmitters, the trans-membrane ion fluxes, resonating proteins, movements of the cytoskeleton among other entities), may locally induce changes in quantum gravity, including quantum entanglement. In the quantum/brain model of Penrose and Hameroff (2011), quantum gravity is instrumental in the orchestrated reduction of clusters of coherent tubular proteins (see Fig. 15), resulting in the collapse of their coherent state to conscious experiences. Locally perturbed quantum gravity may also enable a “pulling” towards potential future events, in the sense of attractor states, in a non-linear (chaotic) system, as it has been postulated for the brain (Skarda and Freeman, 1987, Hiley and Pylykkanen, 2005).

It should be further tested whether information processing in the brain is also related to the projection of information on virtual screens, according to the holographic principle. As hypothesized by ‘t Hooft en Verlinde, such screens surround matter/energy particles to store their specific information content. Holographic projections of events in the individual brain, in principle, may therefore extend the mind outside the body and in a bidirectional mode can provide a continuous communication with a universal holographic information field as initially proposed by David Bohm. As mentioned above, more recently, a holonomic perception of the universe has been put forward by ‘t Hooft (2001), and Bekenstein (2003), as a central model in modern physics, as well as by Di Biase (2009) and Mitchell and Staretz (2011), in relation to the nature of consciousness.

Holography was also suggested as a mechanism for storage of data in the brain, as put forward by Pribram (1991). Pribram hypothesized that the neurons, axons, and dendrites of the brain create wave-like patterns that cause a holographic interference pattern. According to Pribram, such a holographic theory may explain some of the mysteries of the brain, including the enormous capacity of the brain for the storage and retrieval of information. By the 1970's, several other researchers have expanded Pribram's theory. They proposed that our ability to detect familiar objects is similar to recognition holography. A related technique, known as interference holography, could explain our ability to perceive differences in a object that has changed. They also studied individuals with photographic memories and proposed the idea that memory is related to an individual's ability to create holographic images in the brain. People with outstanding memories are better able to access larger portions of their brains.

One special characteristic of a hologram is the ability to create a virtual image. This virtual image is in fact a three-dimensional extension in space that only appears to exist, but contains no substance. We generally believe that we are able to clearly distinguish between “external and internal” events in relation to our body, however, more recent research on holographic systems has shown that this division is not as clear as we perceive. Holograms are not necessarily created by light, but can be formed in the presence of any wave action. To view the brain as a hologram, we should be aware of the mechanisms that create an interference pattern. The holographic process involves both a reflection and reference beam. In the brain, past experience might function as the reference beam, while new incoming information and anticipation of the future produces the reflection beam, that in concert may create such an interference pattern. Almost immediately, the new information then becomes part of the "reference beam" and thus memory storage and learning have taken place.

This type of processing is usually described by Gabor quanta of information, representing wavelets that are used in quantum holography. These wavelets are actually the basis of MRI, PET scans and other types of imaging technologies. Gabor wavelets are in fact Fourier transforms that convert

complex spatial (and temporal) patterns into component waves. Holograms can correlate and store a huge amount of information, and have the advantage that the inverse transform returns the results of correlation into the spatial and temporal patterns that form the elements of the dynamic universe.

A hologram analogy is valid, not only for all of our senses but also for what is called extrasensory perceptions. The brain (and every cell of the body) may partly function as a quantum device. And every quantum entity has both a local (particle) and a nonlocal (wave) aspect. Very large amounts of local and non-local information can be processed in this holographic manner including, theoretically, the entire space/time history of the self-learning organism. In other words, the totality of human subjective experiences as well as those of other intelligent species in the cosmos, can be pictured as a multimedia hologram in resonance with the zero-point field and, in this manner, even the entire universe can be envisioned as a self-learning and organizing holistic system (Mitchell and Staretz, 2011, see also section 9).

c) Time reversed flow of anti-matter

A universal information field also has been connected to the phenomenon of a time reversed flow of antimatter, that started through symmetry breaking and quantum fluctuation in the quantum vacuum at the Big Bang, following the process of creation of matter/antimatter as related to particle symmetry (see Di Corpo and Vannini, 2011).

Fig. 18, below, schematically shows this cosmological interpretation on the basis of the energy/momentum /mass equation (see also section 7). In summary it contains the following elements:

- On the left, the “Big Bang” as the start of our universe, from which moment matter, energy, the laws of mechanics and the visible universe, as governed by the law of entropy, were initiated.
- On the right, the “Big Crunch” of the universe, from which antimatter, anti-energy and a supposed transcendental universe, governed by the syntropic laws of life, will be initiated.
- The expansion rate of the visible universe would, at least according to this cosmic model, gradually decrease, under the effect of the gravitational force. When it reaches a zero point, the visible universe begins to implode and time is reversed.
- Similarly, the anti-universe, or transcendental universe, starts from the right with the Big Crunch, moves backward in time and, when it comes to the point of time reversal, starts to move forward in time.

The energy/momentum/mass equation states that, following the Big Bang, there was exactly the same amount of matter and antimatter. A major question that physicists ask is: why do we live in a universe mostly made of matter and what has happened actually to antimatter?

If we accept the negative, backwards in time, solution of the energy/momentum/mass equation as valid, antimatter is described as moving backwards in time. As mentioned above, at the moment of the Big Bang, the same amount of matter and antimatter was created. In the concept of Di Corpo and Vannini, antimatter immediately started to move backwards in time, while matter and energy started to move forward, avoiding any interaction and annihilation. Consequently, according to this equation, the universe consists of the same amount of matter and antimatter, but these two aspect of reality move in opposite directions that come into contact only indirectly through a supposed central

point of time reversal (see Fig. 18). According to this interpretation all that is divergent is governed by the laws of entropy, whereas all that is convergent is governed by the law of syntropy.

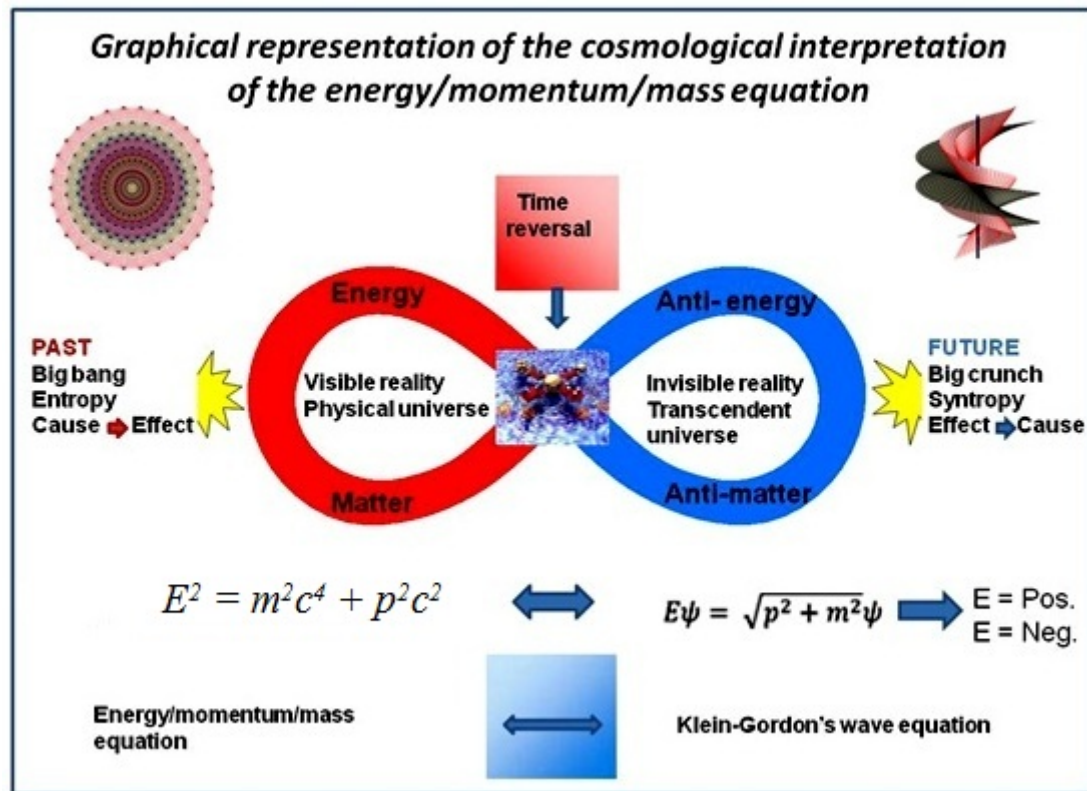


Fig. 18. Graphical representation of the cosmological interpretation of the energy/momentum/mass equation (after Di Corpo and Vannini, 2011).

The energy that comes from the future (syntropy) is differentiated, and is assumed to be structured in the form of complex attractors, that are hierarchically organized and articulated, with their starting point in the Big Crunch. Life may, in this manner, be a physical manifestation of these attractors and would represent the organization of a supposed transcendental universe. Since a final Big Crunch is implicit in this theory, a cyclic model of birth and death of our universe is implied (see also section 7 and 9).

Consequently, in this model, that includes a transcendental domain, different parts of the brain can, non-locally, decode messages from other distant parts of the universe, without having to wait for classical electrical and chemical signal keys for sensory input and motor output, that move slower than light. The particular (coherent order) parameter landscape is phase- and amplitude-locked into the distributed pattern of the electrical and chemical signals in a set of creative feedback-control loops. According to this theory, the imprinting action of the electrical and chemical signal patterns on the postulated, intrinsically mental, landscape can thereby induce our inner conscious qualia and explains the “binding phenomenon” that enables the conscious mind to induce an undivided wholeness (Di Corpo and Vannini, 2011).

7. The many faces and concepts of Time

Time is very likely not what we experience as such. The Wheeler-DeWitt equation suggests a model in which all of time is laid-out (just as the space dimension is laid-out), and all times are equally real: there is no special "now", no distinction between past and future. In fact, "past" and "present" do not exist - the movement of time is considered to be just an illusion of human perception. Most physicists would favor this model as the most accurate representation of time. As mentioned before, it is also indicated as "block universe", because all of space/time can be viewed as being laid-out as an unchanging four-dimensional block. Yet, we all feel a "flow" of time, in which an unknown and unfixed future becomes our present moment before, in its turn, it is being relegated to the past. How can we reconcile the latter feeling with the concept of a block universe, in which all of time is laid-out, and there is no moving "now"? It follows that the feeling we have of the passing of time is nothing more than an illusion of human perception due to the asymmetry of the time axis: we can remember the past, but we cannot remember the future..., as was previously put forward by Albert Einstein.

It is of interest to mention here that, since a so called "Two-Time Physics" (2T-physics) was formulated in 1998, evidence has been mounting that the ordinary formulation of physics, in a space-time with three space and one time dimensions (1T-physics), is insufficient to describe our world. Recently, a field theoretic description of 2T-physics has been established. Amazingly, the best understood fundamental theory in Physics, the Standard Model of Particles and Forces (SM) in 3+1 dimensions, is reproduced as one of the "shadows" of a parent field theory in 4+2 dimensions. But even more amazing is that this emergent SM has better features than the ordinary SM in 1T-physics (Bars et al. 1998, 2007). This idea may be in line with the earlier mentioned Mind/Matter hypothesis of Primas (2003), that is based on a dual time frame of tensed (mental) time and tenseless (physical) time, residing in separate domains that exhibit quantum entanglement but do not directly interact. The latter implies that mind cannot be reduced to matter and vice versa.

Bidirectional time was also highlighted in the theory of Di Corpo and Vannini as treated above. On the basis of the original work of Fantappiè, as early as 1931, Di Corpo (2011) and Vannini (2008 and 2009) proposed the following:

"In 1925 Oskar Klein and Walter Gordon formulated a probability equation which turned out to be very instrumental in quantum mechanics. In 1926, Schrödinger simplified Klein-Gordon's equation in his famous wave equation (ψ) in which only the positive solution of Klein-Gordon's equation was considered, which treats time in an essentially classical and unidirectional way, with a well defined before and after the collapse of the wave function. In 1927 Klein and Gordon reformulated their equation (2) again as a combination of Schrödinger's wave equation (quantum mechanics) and the energy/momentum/mass equation of special relativity (1)." (see Vannini, 2008, 2009 and Fig. 18).

$$E^2 = m^2 c^4 + p^2 c^2 \quad (1)$$

Energy/momentum/mass equation.

Where E is the energy of the object, m the mass, p the momentum and c the constant of the speed of light ($p \geq 0$).

$$E\psi = \sqrt{p^2 + m^2} \psi \quad (2)$$

Klein-Gordon's wave equation

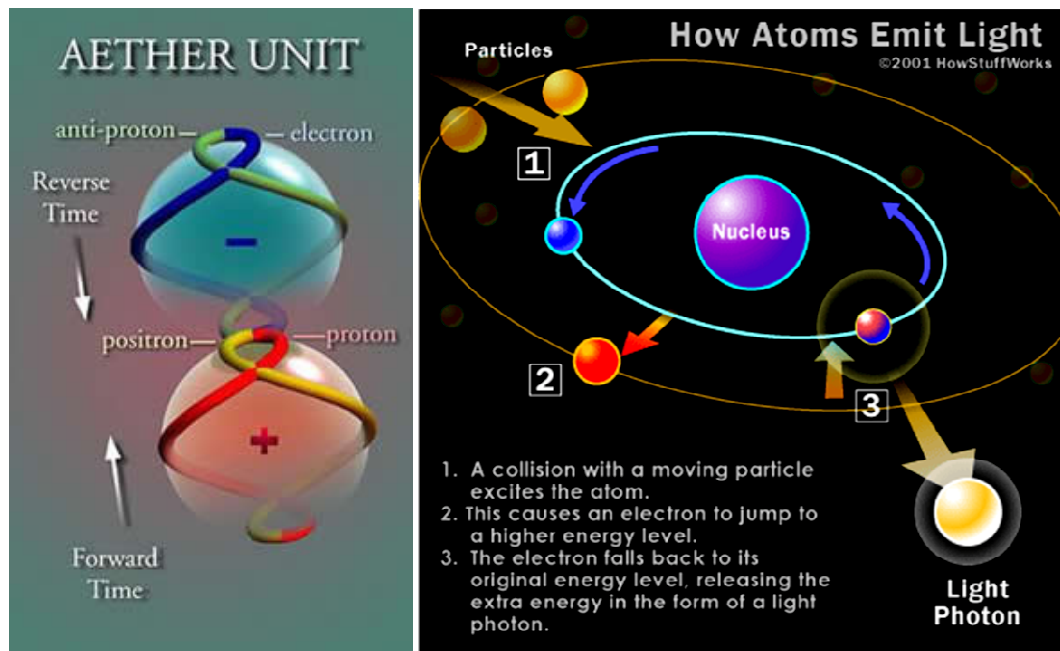


Fig. 19: The fluctuating pair of particle/antiparticle (aether unit), in the zero-point energy field, that intrinsically exhibit forward and reverse time modalities (left), while the figure at the right depicts that photons can be exchanged between elementary particles and play a crucial role in the communication at the atomic and sub-atomic level. Individual photons may carry different energies, according to their particular wavelength and frequency.

The Klein-Gordon wave equation depends on a square root and, in principle, yields two solutions (equation 2 and Fig. 18): the positive solution describes waves which diverge from the past to the future (retarded waves); the negative solution describes waves which diverge from the future to the past (advanced waves). Yet, the negative solution seemed to introduce final causes and teleological tendencies in science. Therefore, traditional scientists considered it to be unacceptable. However these ideas were challenged through the discovery of the particle/anti-particle symmetry. The antiparticle of the electron, was experimentally observed in 1932 by Carl Anderson in cosmic rays and was named positron. Thereby Anderson became the first scientist to prove the existence of the negative energy solution and this concept, subsequently, was no longer a mathematical absurdity. The Dirac equation also predicted a universe made of matter which moves forwards in time and antimatter which moves backwards in time (see Fig. 19).

In computational science this is called “forwards and backwards chaining” in which one can determine both backwards (following inheritance) and forwards as to what an object represents. The concept of time symmetry versus our common linear perception of time invited further considerations on the very nature of consciousness. The duality of time, that started with Dirac’s famous equation of the electron, has been used more recently by King to describe his concept on brain structures (King, 1989, 2003). King stated that these structures face continuous bifurcations which derive from the encounter of information which comes from the past (diverging waves, causes) and information which comes from the future (converging waves, attractors).

A number of earlier considerations underline the concept of a bi-directional character of time:

- According to Wheeler (1990), and Feynman’s electrodynamics, emitters coincide with retarded fields, which propagate into the future, while absorbers coincide with advanced fields, which propagate backward in time. This time-symmetric model leads to predictions identical with

those of conventional electrodynamics. For this reason, according to these theories, it is impossible to distinguish between time symmetric results and conventional results.

- In his *Transactional Interpretations of Quantum Mechanics* (see Fig. 20), Cramer stated that:

"Nature, in a very subtle way, may be engaging in backwards-in-time handshaking" (see also above). "The transaction between retarded waves, coming from the past, and advanced waves, coming from the future, gives birth to a quantum entity with dual properties of the wave/particle. Thus the wave property is a consequence of the interference between retarded and advanced waves, and the particle property is a consequence of the point in space where the transaction takes place. The transactional interpretation requires that waves can really travel backwards in time. This assertion seems counterintuitive, as we are accustomed to the fact that causes precede effects. It is important to underline however that, unlike other interpretations of QM, the transactional interpretation takes into account special relativity theory which describes time as a dimension of space, as mentioned earlier. Of note, the completed transaction erases all advanced effects, so that no direct advanced wave signaling is possible: The future can affect the past only very indirectly, by offering possibilities for transactions." (Cramer, 1988, 2005)

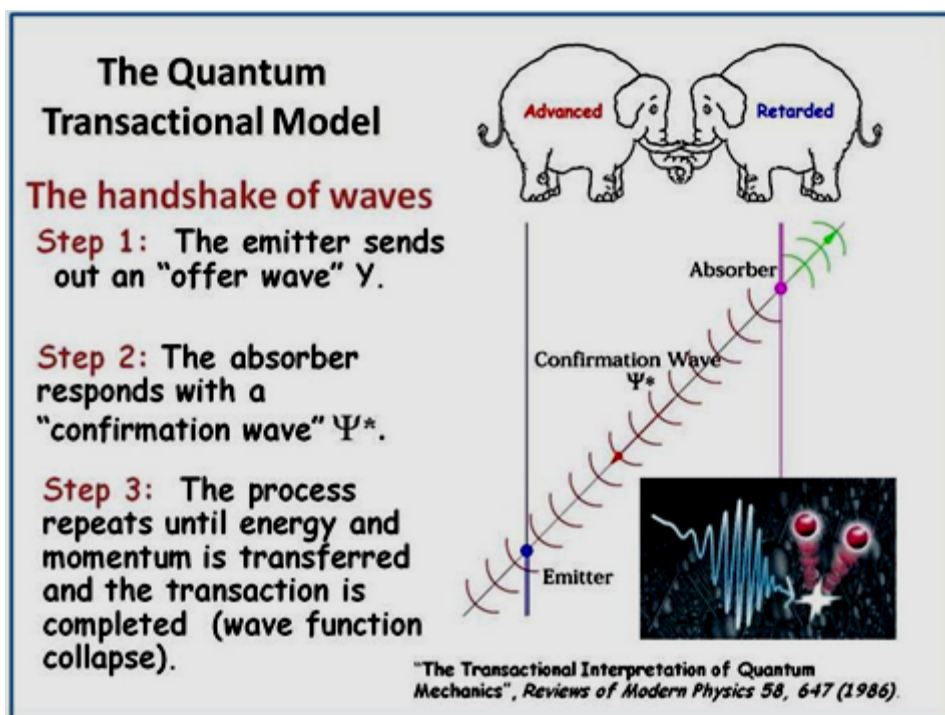


Fig. 20: The Transactional interpretation of Quantum mechanics by John Cramer

- Aharonov's team and various collaborating groups (see Aharonov, 2010, Merali, 2010), studied whether the future events can influence the past, by sophisticated quantum physics technology. Aharonov concluded that a particle's past does not contain enough information to fully predict its fate, but he wondered, if the information is not in its past, where could it be? After all, something must regulate the particle's behavior. In 1964, Aharonov, then in New York, proposed a new framework called time-symmetric quantum mechanics. Recent series of

quantum experiments in about 15 other laboratories around the world seem to actually confirm the notion that the future can influence results that happened before those measurements were even made. Generally the protocol included three steps: a “pre-selection” measurement carried out on a group of particles; an intermediate measurement; and a final, “post-selection” step, in which researchers picked out a subset of those particles on which to perform a third, related measurement. To find evidence of backward causality, information flowing from the future to the past, the effects of, so called, weak measurements were studied. Weak measurements involve the same equipment and techniques as traditional ones but do not disturb the quantum properties in play. Usual (strong) measurements would immediately collapse the wave functions in superposition to a definite state. The results in the various cooperating groups were amazing: repeated post-selection measurement of the weak type changed the pre-selection state, clearly revealing an aspect of non-locality.

Thus, according to Aharonov and associated research teams, it appears that the universe might have a destiny that interacts with the past, in order to bring the present into view. On a cosmic scale, this idea could also help explain how complex life arose in the universe against very high odds, supporting the idea that the required knowledge was inherited from a common information pool. It follows also that the idea that quantum uncertainty only is relevant for micro-events, but would not be important with regard to macro events, may be incorrect (see also section 8). The implication would be that the particles that existed at the time of the early universe, were situated so precisely that, fourteen billion years later, human beings would exist and scientists would be looking for the origin of life and even for a “theory of everything”.

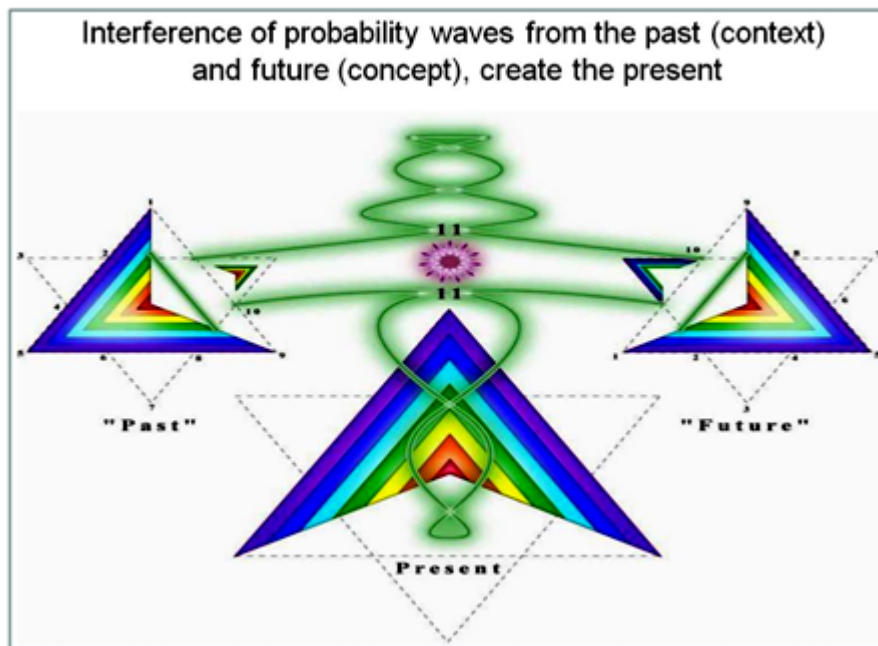


Fig. 21: Perception of the present in the brain, occurs through the interference of wave information from the past and that from the future.

The basic question raised here is, what is the relationship between the initial cosmic data, and the higher level order that existed later in cosmic evolution? The first possibility is that the order we see at present is only apparent: at closer inspection there is no general order in what we see around us today. The second option is that there was in fact a high level of order imbedded in the data at the

time of the early universe, leading to the apparent order in nature we see at the present time. In that case it would imply that order was somehow imbedded in the initial fluctuations. The latter should not be seen as a sort of included complete “blueprint” for the construction of the universe, but rather like a “recipe”, containing a set of general, but internally consistent, rules.

Finally, one can argue also that free will plays an autonomous causal role that is not determined by physics; if so, that would be an important part of the causality in operation. This is for many a clearly controversial point, and some even deny that free will or choice truly exists. However, we should realize that performing science itself would not make any sense if our minds could not rationally choose between alternative theories on the basis of the available data. This is the more so, considering that if we advocate a bottom-up mechanistic view, in the sense that the mind simply follows the “commands” of its constituent electrons and protons, we position ourselves as mindless machines. A reasoning mind, able to make rational choices, is clearly a prerequisite for the academic subject to design studies, perform experiments and to interpret and report the particular data. The proposal that rationality is illusory, being just the inevitable outcome of micro-physics, therefore cannot account for the existence of science as a rational enterprise.

A free choice is also evident if one realizes that each present decision is based on information (memory) of the past and anticipation of the future (Fig. 21). In this framework, one could also recognize the possibility that free will too is an active causal factor, not directly determined by the underlying classical physics. It is possible that quantum processes play a key role here in the superposition of past and future wave information, as suggested, for example, by Stapp (2009) and King (2003). The conclusion is that higher levels of causation are very likely causally effective and underlie our complex existence, even though this is not contained within the present physics picture of reality.

Whitehead (1961) stated that the ultimate (i.e. fundamental) metaphysical principle is creativity or becoming. Creativity is the eternal aspect of the universe through which there is an endless becoming of actual entities, i.e. drops (quanta) of experience, that are interdependent. He argued that any particular occasion does not passively copy the past: in the act of self-creation it refreshes the design of the past, thereby inventing its novel present, while preparing for its possible futures. Whitehead calls these takeovers ‘prehensions’. The rather complex verb ‘toprehend’ means to engulf, perceive and transform. There is an ultimate reality which (1) arranges an orderly character on creativity so that the becoming of actual entities is not purely chaotic and (2) functions in the selection of repeatable patterns. These induce “eternal objects”, pure potentials of the universe that are enacted in the world. Consequently, our universe exhibits some general systematic metaphysical character (Whitehead, 1961). Creative experience has a tendency towards greater complexity, novelty, and value through a desire to be in harmony with the ultimate in the nature of actual events. Life might be seen as “wedding fact to value” and the universe develops towards an ever increasing beauty (Whitehead, 1961).

8. Processing of information during the origin and evolution of life

Current (mainstream) biology and medical sciences seem rather conservative in spite of the spectacular advances in genetics, molecular biology, the impact of (bio)-technology and the modern aim for “evidence based medicine”. Apart from system biology, there is surprisingly poor interrelation with areas of modern physics such as quantum physics and chaos theory. It is as if

biologists are taken blindfolded to concepts such as random evolution, and automated organisms that are destined to replicate selfish genes and memes. In addition one finds cripple attempts to explain away free will and consciousness, finally ending up by picturing nature and cosmos as the accidental products of “a blind watchmaker” (Martin, 2005). It would certainly be an attractive thought-experiment to picture how Darwin would rewrite his evolution theory now if he had known about epi-genetics, horizontal gene transfer, the impact of symbiosis and cooperation on cell function and that of empathy on survival. Other novel aspects are the presence of quantum mechanical mechanisms in warm and wet macro-systems, and the potential role of information in relation to first life and subsequent evolutionary steps. This is not said to imply that Darwin’s basic concept (mutation/selection) was not one of the most ingenious and valuable inventions in modern science: we know now that his famous efforts are unfinished and also that his legacy is sometimes misused by materialists who claim that we can do without natural intelligence (not to be confused with intelligent design), as the prime factor in biological evolution (see for the latter Powell, 2012, Davison, 2012).

Needless to say, we should certainly welcome “evidence based medicine” as opposed to unscientific medicine, but should also realize that evidence based is not necessarily derived from classical physics or by definition based on materialistic/reductionistic approaches. In other words: evidence based should obtain a broader and more holistic context in light of the advances in modern physics and studies in consciousness, implying that their elements of non-locality and entanglement have to be taken into account seriously. In this framework, for instance, endogenous modalities of healing that are repeatedly and objectively observed (impact of meditation, placebo effects, remote healings, as well as that of mental states on immune function etc.) deserve intense scientific investigation. In general, the complementarity of mind and matter should be a leading principle instead of being explained away as a disturbing factor in biomedical and clinical research. Avoid the dangers of the double-blind state: if one hesitates to think whole-istic one could at least try to be bio-logic...

The central role of information processing in biological evolution requires the presence of informational aspects of matter (see Strawson, 2010, Edwards, 1967 and Skrbina, 2005) and the build up of an integral and collective memory of universal nature as being expressed in the dynamic processing of the building blocks of life organisms. Let us look at one example: after the Big Bang earth metals such as iron, were formed and went through the evolution in a succession of very different contexts: for example, they were first present in minerals, then micro-organisms, then plants, and finally in mammals and humans (such as parts of certain enzymes and red blood cells). The particular atoms, with their elementary particles, thereby built a context-dependent information about the interactions that were associated with various conditions (as a kind of metaphor, called particle memory), implying storage of information with a non-local character (see Charon, 2004).

The unfolding of this type of information must entail an overall cosmic process: one where a dynamic (collective) reservoir of vibrational patterns, as present at the micro-level, can exchange information, for instance, with life organisms (Fig. 22). Thus, in evolution, the universe was not only unfolding the initial information that was available, but also was building up new information through superpositions and guided selection of such vibrations. Since the human body, including our brain, also consists out of elementary particles/waves, our organism is an intrinsic part of a universal quantum field and intimately connected to the whole universe and its universal knowledge field. Wave interference of novel information (mostly related to anticipation of the future) and stored information (related to past experiences) provides continuous exchange of individual

information with the universal information domain, in which our extended brain represents an entangled, interfacing, unit in a holonomic manner.

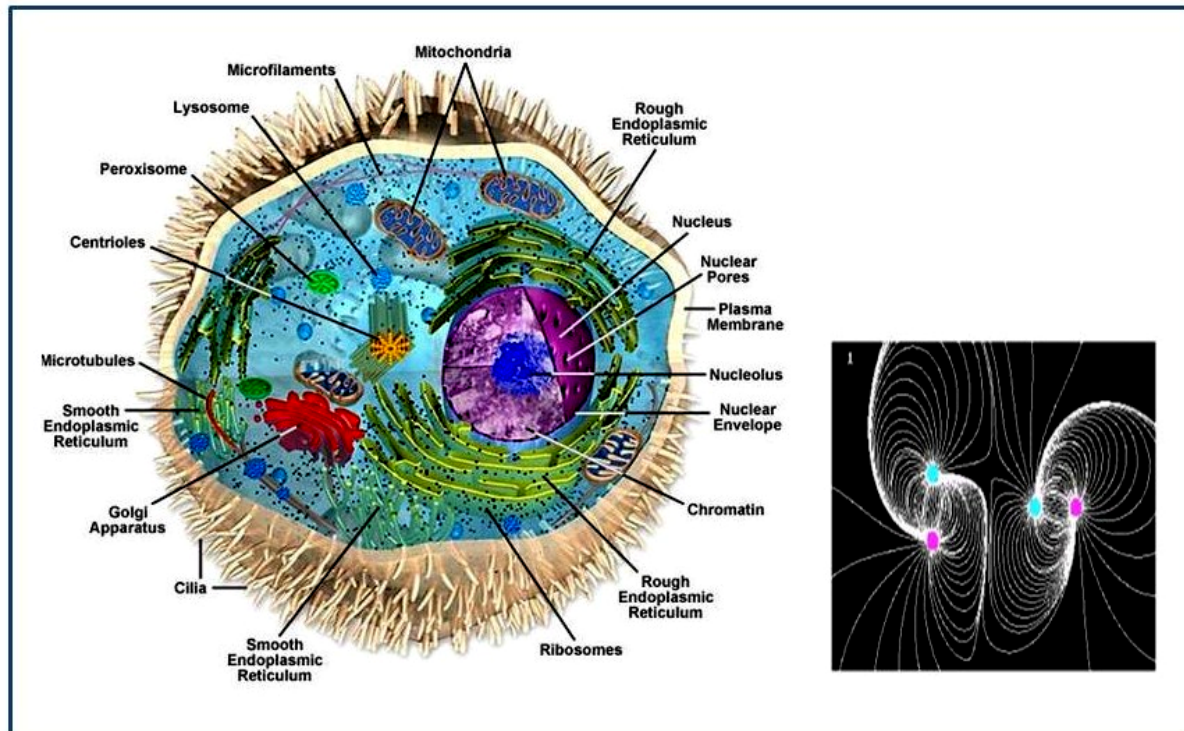


Fig. 22: A schematic representation of the functional structure of the cell (left). The assembly of the first replicating cell in evolution may have been mediated by particle/wave interactions, “woven together” in a network of quantum information (see cartoon right).

It follows that humans are not passive observers but are an active part of the integral quantum field on the basis of the abovementioned principle of “entanglement”. This provides an intense connection with universally stored information during the processes of perceiving, knowing and communicating. This may also explain the subjective perceptions of color and smell (and other, so called, qualia), as well as the aspect of binding of brain functions that leads to highly coordinated action of billions of neurons.

In this manner the conscious human mind can receive sensory and extrasensory information and be regarded as a biosensor of the universe. The creation and development of individual consciousness requires continuous interaction with the outer world and efficient communication channels. Language and the use of symbols can be seen as the last stage of cognitive evolution and in this framework provided an essential instrument. Human language requires a kind of internal representation (of the “detached” kind) that only humans have and was the basis for self-consciousness.

Since humans and nature in general have evolved from the same origin and have the same physical constituents, the patterns of their evolution and the processes of their manifestation in diverse and complex levels would have to show some similarity in basic structure at the micro-scale. Some have claimed that the deepest structures of being are mathematically defined.

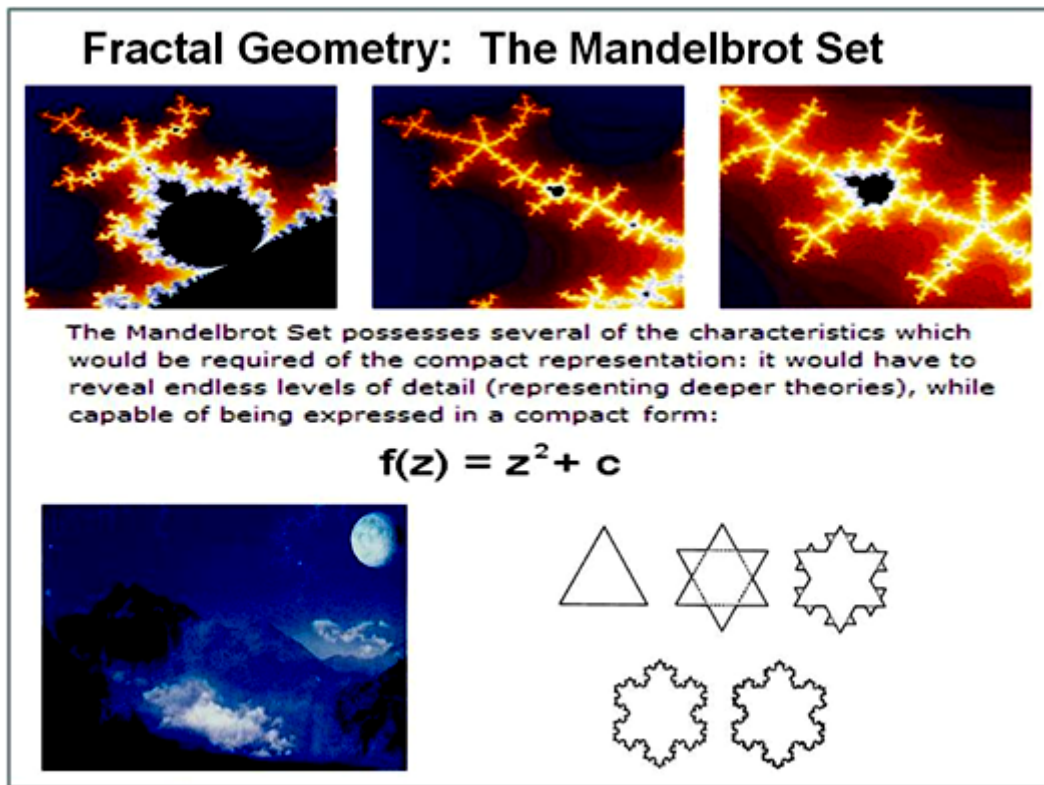


Fig. 23: The simple equations of the Mandelbrot set are used for mathematical visualization. The Mandelbrot set is the set of values of c in the complex plane for which the orbit, under iteration of the complex quadratic polynomial $z_{n+1} = z_n^2 + c$ remains bounded. That is, a complex number c is part of the Mandelbrot set if, when starting with $z_0 = 0$ and applying the iteration repeatedly, the absolute value of z_n remains bounded however large n gets. Images of the Mandelbrot set display an elaborate boundary that reveals progressively ever-finer recursive detail at increasing magnifications (see for example the landscape, inset left under).

The quantum physicist Wigner (1960) raised the fundamental question why mathematics is so “unreasonably” effective in the basic description of natural phenomena. One example is the discovery of both simple and complex mathematical structures such as fractals, that may lay at the basis of such a natural process. In the words of Benoit B. Mandelbrot, the originator of fractal geometry, “a major and surprising impact of fractal geometry and the chaos theory is that in the presence of a complex pattern there is a good chance that a very simple process is responsible for it.” This discovery is known as the principle of self-similarity, which has been claimed to explain the structures and evolvments of all natural entities (see, Fig. 23). Fractal figures are, in fact, a result of the interaction of attractors that are part of a geometrical figure. They show, for example, in a visual way, what happens when syntropy (increase in complexity through compressing information) and entropy (decrease in ordering, requiring more information) interact together. The prominent role of attractors is that chaotic processes in a biological system can grow towards an end-point on the basis of projection of a future event that might lead to a useful adaption: it implies the possibility of “feeling a future condition” that, for instance, provides a gradual evolutionary advantage or can even induce major quantum jumps that may have been instrumental in the creation of innovative solutions or even the creation of a new species that exhibits major qualitative changes compared with the particular predecessors.

Fractal processes may thus play a significant role in biological processes in general and brain function in particular. Brain anatomy shows fractal patterns (see King, 2006) and the chaotic organization is used in a beneficial way to make selection in the multiple brain states possible. Within the chaotic setting, selections can aim at attractors that enable integration of potential future states. For any person it is essential to “feel the future”, thereby enacting a kind of backward causation to improve perception and future action of the individual. In this way one is, at the same time, protected from a deleterious overflow of information. The brain, in this manner, becomes equipped with reductive functions to secure that we can handle life threatening situations in a non-ambivalent manner.

Another blind spot in evolutionary theory is the possible influence of non-local quantum information transfer in the bio-construction of the first primitive cells, in which information processing and replicating abilities are at stake rather than complexity per se. According to Davies (2003) and the same author in Abbott (2008), quantum mechanics provides a way to drastically shorten the trajectory of matter to life, by exploiting the parallel processing properties of superpositions and wave interference. It is quite likely that bio-systems selected potential life components from a great number of nonliving states through wave superpositions.

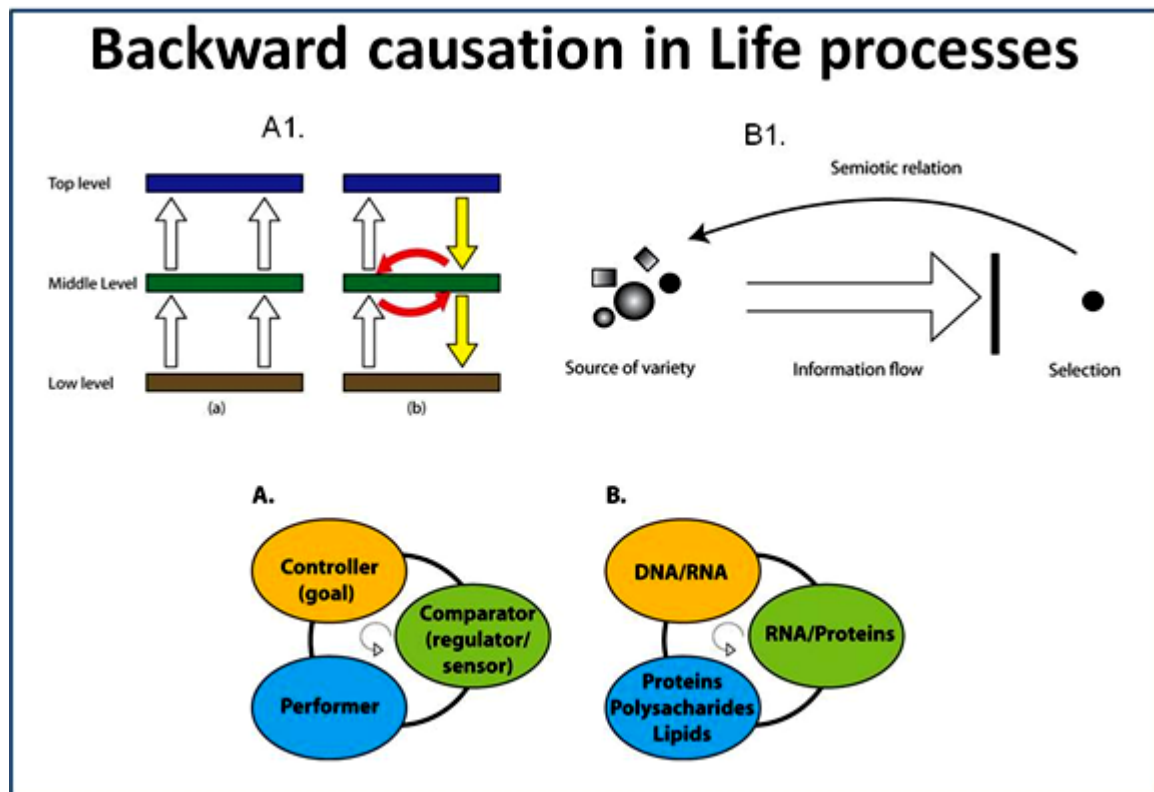


Fig. 24: Backward (downward) causation in (neuro)-biological processes on the basis of (see A1.b) a space of possibilities, at an intermediate level, in a circular mode (upper left inset). Feed-back control is shown as a comparator that determines the difference between a system state and goal and provides an error signal activating the controller to correct the particular error, a mechanism that operates for example in the DNA/RNA protein synthesis machinery (lower part). B1: Input information as a source of variety initiates an information process that is finalized when information selection is accomplished, that is then taken as informative for the input semiotic relation, subsequently a new information round is started (above right, modified from Auletta et al.).

The transition from non-life to life can, in this manner, be considered as a quantum-mediated process in which the environment served as a sort of measuring device that enabled the material expression of the particular wave patterns. These dynamic conditions also enable top-down causation (Fig. 24), by information control, that is likely to play a central role in evolution and comprises aspects that are basic for any information acquisition process, namely mutual information and information selection (see also Patel, 2001, and Mc Fadden, 2001).

But what is information control really? This is not related to Shannon's (1959) theory of communication (in the context of controlled transmission), that is a general theory of information. This theory is centered on signal/noise discrimination, the message is already selected and well defined from the start: the selection among several alternative states already occurred at the level of input or sender. The crucial item here is only to reliably transmit the sequence of bits that has been selected, in the presence of potential disturbances. In contrast, a real information theory, for instance that of Wiener's (1948) starts with an input as a source of variety and has the selection only at the end of the information-processing. Thus, a message here is rather the message selected by the receiver. It goes without saying that any information reception will be subject to the initial variety, in addition to the influences of disturbance, dispersion, and use of any of this information, at the most elementary level, already constitutes information selection (see also section 2).

This is of major relevance for biological systems, since they are confronted with an environment that includes sources of uncertainty, and for this reason such systems do not have control from the start of the information that has been sent. Even inside a single cell there is such a problem, due to the modularization of the different subsystems. Consequently, in this case, the control must somehow be exerted while having only a limited pool of resources

In other words: if a sort of recipe for life was present non-locally in the context of bidirectional time and potential backward causation, how did this information influence evolutionary processes such as self-assembly and auto-catalysis? (see Paul Davies in: Abbott et al., 2008). According to the traditional information theory, the main item is reliability, understood as the matching between input and output. However, in biological phenomena one has a condition in which the receiver does not have full control over the input and therefore is forced to "guess" the nature of the input by taking the received partial information rather as a sign of it. As mentioned above, at any biological level, the receiver is in general flooded with incoming data, and has to separate background data (important but constant) and noise (irrelevant data) from relevant information, data that are needed for some purpose and may be expressed in algorithmic terms (see Fig. 25).

Therefore, information control consists in information selection, often involving a sort of guess from a certain point of view, and this represents the goal of the system. For instance, a bacterium searching for an energy source may use a specific temperature gradient (the received information) as a sign of this source. In this framework it is necessary to state how goals and feedback control are linked (see Murphy, 2011).

Information control via feedback is not the only way to have control via information, yet it plays a fundamental role in living systems, being involved in any homeostatic process. In conclusion, in any information exchange we have selection at the end, not at the start. That is, if the output selection is saying something about the input, the receiver starts a new information process aiming at the source, thereby inverting somehow the ordinary flow of information from the source to the receiver, and in other words enters the process of backward causation

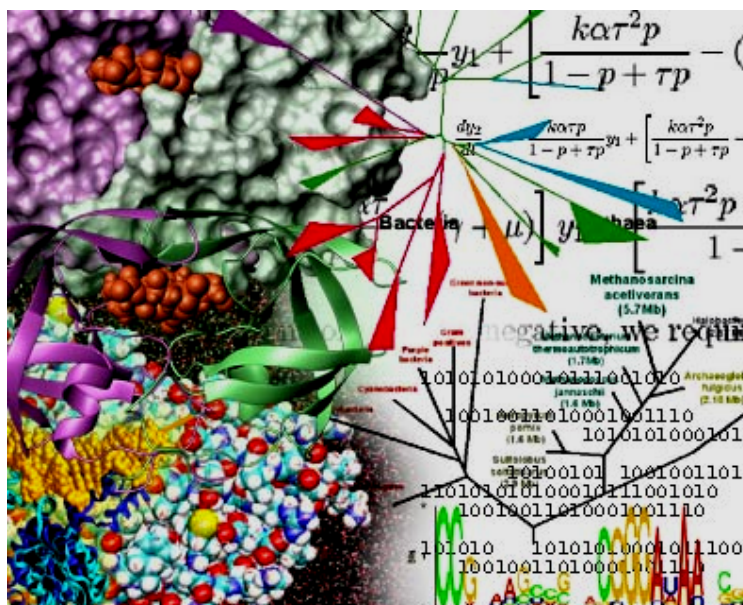


Fig. 25: Biological information may have a mathematical foundation.

Were quantum mechanical mechanisms acting upon primordial information instrumental in the origin of first life and the construction of the first homeostatic and replicating cells? In this framework one should realize the extremely complex structure of the cellular machinery, not only its versatile plasma (outer) membrane, that is equipped with transport, channel and signal-transducing proteins, but also within the cell the various organelles, for instance involved in the production of energy and storage of genes. The genome is read out to produce several 100.000 functional proteins in the cytoplasm, involved in a network of metabolic and repair processes as well as in intracellular movements (see for quantum mechanical mechanisms in genetics Patel, 2001, Mc Fadden, 2001, Schempp, 2003, and Fig. 22). If one realizes further that survival implies a fine-tuned homeostatic effort, we may conclude that it is highly unlikely that all of this was coming together by pure chance, even if it took billions of years to let these chains of events be developed into a coordinated cellular network. Only by a primordial recipe or through backward causation that enabled a “feeling of a future structure” that would support life, this amazing becoming can be imagined. A collective memory of the whole nature was therefore a prerequisite for the origin of life. On the basis of a combination of these elements, in a concerted action, it was possible that, as treated above, parallel innovations in biophysical complexity occurred. Only expressed in wave functions such quantum states could be brought in superposition, yet only after an intelligent search and selection process in nature. One prominent example was the construction of whole series of individual proteins, each having an exact spatial structure, in order to render them functional as enzymes or to be instrumental in the cooperation of large series of functionally related proteins in regulatory or cell-protective processes in the whole organism.

Proteins display a 3-dimensional structure and, for example, they are functioning as enzymes and membrane proteins for trans-membrane transport of endogenous and xenobiotic compounds (Meijer, 1989, 1999) or function as receptors for neurotransmitters and psychoactive compounds (see i.e Hameroff’s theory of general anesthesia). Conformational changes in signal proteins in the cell that regulate DNA function and repair (see Fig. 26) can in this way also lead to perturbation of gene expression. Spatial changes in membrane receptor and signal proteins, under the influence of environmental factors, can also induce chemical changes in DNA that, for instance, can silence or activate genes, resulting in epigenetic changes that can be crucial in the evolution of living entities.

Protein function thus depends on 3-dimensional shape: its spatial conformation. Individual proteins are synthesized as linear chains of amino acids which somehow "fold" into 3-dimensional conformations. The precise folding depends on attractive and repellent forces among various amino acid side groups, but is at present not fully understood. "Hydrophobic" groups that repel water, attract each other and bury themselves within the protein interior and also mediate dynamic conformational changes. So called London forces arise from the fact that atoms and molecules which are electrically neutral and spherical symmetrical, nevertheless have permanent electric dipoles due to asymmetry in their electron distribution. The electric field from each fluctuation dipole couples to others in electron clouds of adjacent (non-polar) amino acid side groups (see Hameroff and Penrose, 1996).

Due to inherent uncertainty in electron localization, London forces exhibit quantum effects that may couple to "zero point fluctuations" of the quantum vacuum. Quantum dipole oscillations within hydrophobic pockets were first proposed by Fröhlich (1968) to regulate protein conformation and engage in macroscopic coherence, while Conrad (1994) suggested that ongoing quantum superpositions of various possible protein conformations occur before one is selected. Quantum coherent superposition in hydrophobic pockets may occur routinely in certain brain proteins as a requisite for consciousness (Hameroff and Penrose, 1996). It is of interest that quantum coherence can explain the probing of magnetic fields in the brain of migrating birds (see the excellent review of Arndt et al., 2009).

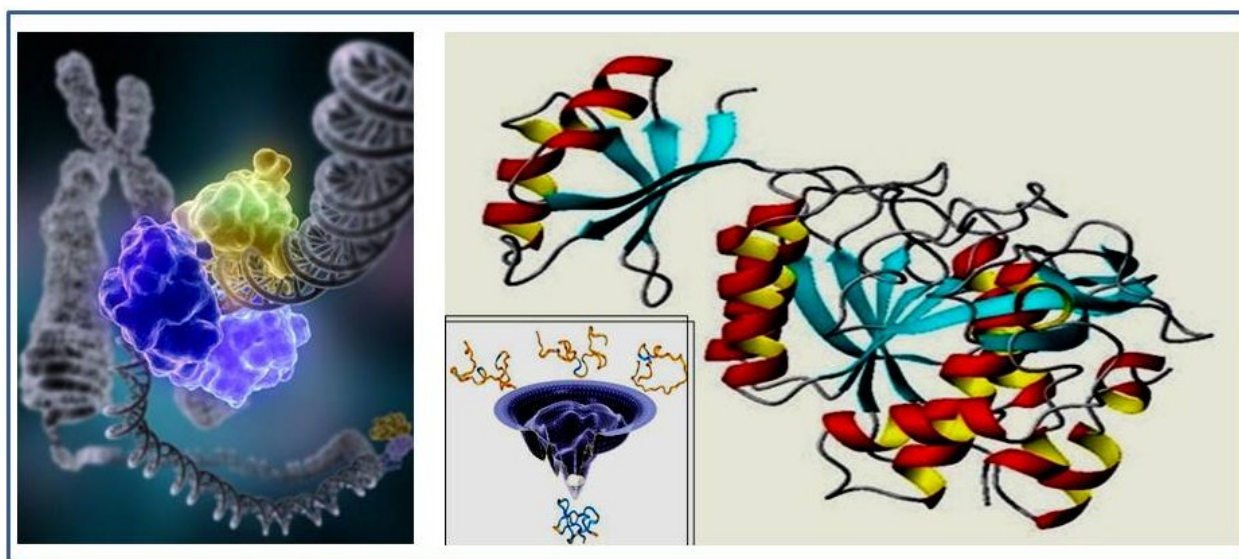


Fig. 26: A protein complex (blue and yellow), associated with a string of DNA as a gene-regulatory factor (left) and the 3-dimensional structure of a protein that can exhibit resonance (inset in the middle).

It seems well-established that various animals are able to derive direction information from the geomagnetic field. Some mammals perceive the Earth's field as a polarity compass, distinguishing "north" and "south", while birds and reptiles rely on an inclination compass that discriminates between "polewards" and "equatorwards" and that exploits both the intensity and the gradient of the field. In this brain phenomenon quantum spin information may play a crucial role.

Another indication that quantum effects can occur in warm and wet systems, stems from research on photosynthesis. Many publications now provide evidence for quantum coherent effects in

cellular conversion of solar energy into energy-rich substances (see Fröhlich, 1968 and e.g. Yasue and Jibu, 1995), as mediated by an interplay of a series of specific proteins in the cell.

The particular photosynthetic complex is a membrane-bound system with many embedded functional subunits. The energy conversion starts with the absorption of an incident photon by a pigment molecule, e.g., a chlorophyll, porphyrin, or a carotenoid molecule embedded in a protein structure, the antenna complex (see Fig. 27). It has been suggested that a “wavelike” sampling of the energy landscape or even a quantum search algorithm might permit to find the fastest route from the antenna to the reaction center (Engel et al., 2007, see Fig. 27).

This hypotheses also implies that information processing in biological systems may occur in tandem, at both the traditional classical and the quantum levels. Through this quantum aspect, for example, when living cells replicate, each cell would be fully aware of its sister cell’s relative locations and states. This may explain how such replication is able to construct the morphology and dynamics of an embryo subject to the master blueprint of their DNA, and how, when the embryo is complete, self-repair/immune system is brought into play to restore such locations and states

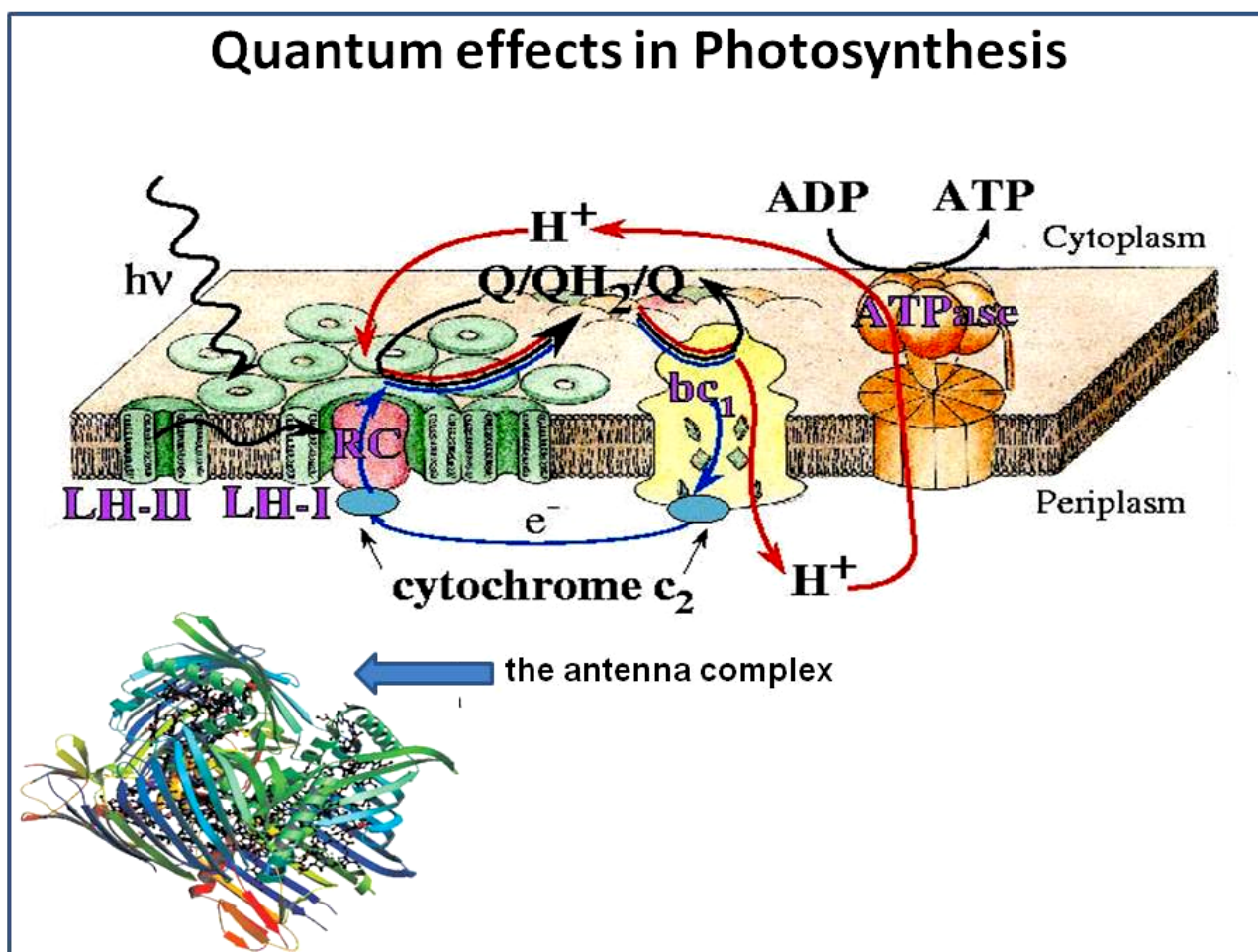


Fig. 27: The biological process of Photosynthesis as a membrane-bound system with many embedded functional subunits (upper part), functioning as an antenna complex (left below), entertaining a “wavelike” quantum search algorithm that finds the fastest route from the antenna to the reaction centre.

In this manner the evolution of proto-cells to living cells may have been guided by quantum information. Davies concluded: *"Science proceeds as if the past was the home of explanation; whereas the future and the future alone holds the key to the mysteries of the present. When that first cell divided, the meaning of that division was to be discovered in the future, not in the past!"*

9. The Construction of Reality: an Integral Model

In this final section the author attempts to capture the various informational aspects, mentioned above, as well as his perception of reality, in a comprehensive scheme. This scheme is based on the central concept of a universal consciousness in the form of a quantum knowledge field that is penetrating the whole of reality, as earlier proposed by various quantum physicists (see Bohm, 1987, King, 2008, Primas, 2003, 2009) and system biologists (see László, 2005 and 2007).

Life, being an universal syntropic process of creating and maintaining new forms through selecting and compressing of relevant information, somehow takes place within a continuous entropic process, in which the increasing disorder intrinsically is coupled to an expansion of information required to describe such a state of disorder (Vedral, 2010). These contrasting aspects of information processing are demonstrated in the increased complexity of the genetic system (unfolding of information), combined with a highly efficient storage (compression of information), as realized during evolution in genetic material such as DNA. These processes could only occur through the constant interaction with the environment, in conjunction with mutation and selection, epigenetic influences, as well as through horizontal and vertical gene transfer. Thus, entropy, as described in the second law of thermodynamics is inherently a state of increasing disorder. Its counterpart is syntropy (also called neg-entropy), in which information was systemized and compressed producing an increasing order. Syntropy is realized, among other things, through the integration of (new) information in the organization of life, but also in the systematic collection of selected information in the performing of science. The latter, for instance, included the formulation of the laws of nature and the "translation" of various aspects of the supposed underlying implicate order, among others through mathematical description.

Einstein showed that matter can only tend to obtain the speed of light, but can never reach it; on the contrary, (anti)-matter can only move at a speed higher than the speed of light, flowing, according to special relativity, from the future to the past: this situation is known as the inversion of the time arrow. In this way, quantum mechanics arrived at a description of the universe which is symmetrical with respect to time: on the one hand there is matter which moves from the past to the future, on the other hand there is anti-matter which moves from the future to the past (see Wheeler, 1990, Primas, 2003 and 2009, Vannini, 2005, and Di Corpo and Vannini, 2011). As Penrose has also shown, the space-time description which is now emerging is incompatible with traditional concepts of causality and determinism (Penrose, 1989) and according to Primas, mind and matter belong to separate but quantum entangled time domains, due to symmetry breaking.

One could say that life is evolving in such a way that the universe can increasingly observe itself (Linde, 2004). Humanity and, perhaps, other intelligent species elsewhere in the universe thereby represent the "bio-sensoring" instruments of the universe. This gives us a special responsibility, in the sense that each of us is part of something larger and that we, as an individual expression of the Universal consciousness, may participate in the glory and beauty of this astounding system (see Whitehead, 1961).

The Construction of Reality, depicted in the diagram of Fig. 28, is presented as the unfolding of basic information, which, initially, was present in a quantum-information field (black), which consisted of quantum energy, exhibiting an implicate and symmetric order. This field can also be seen as a Universal consciousness, containing highly compressed information about all the available data from the present and the future (4-dimensional information from all time). In the integral scheme in Fig. 28, the unfolding of this information is expressed in a "dual" process consisting of:

- the processing of wave information in a transcendental domain (left column);
- the unfolding of information in the organization of a material world (right column).

These separated processes do not imply the introduction of a kind of "Cartesian dualism", because they are strictly correlated, assuming that any form of matter also contains mental information, as exemplified in the wave/particle principle, as a basis for the description of nature. More classically, this duality of substance was described as panpsychism (see Edwards, 1967, Griffin, 1997, Skrbina, 2005, de Quincey, 2010, and Strawson, 2009).

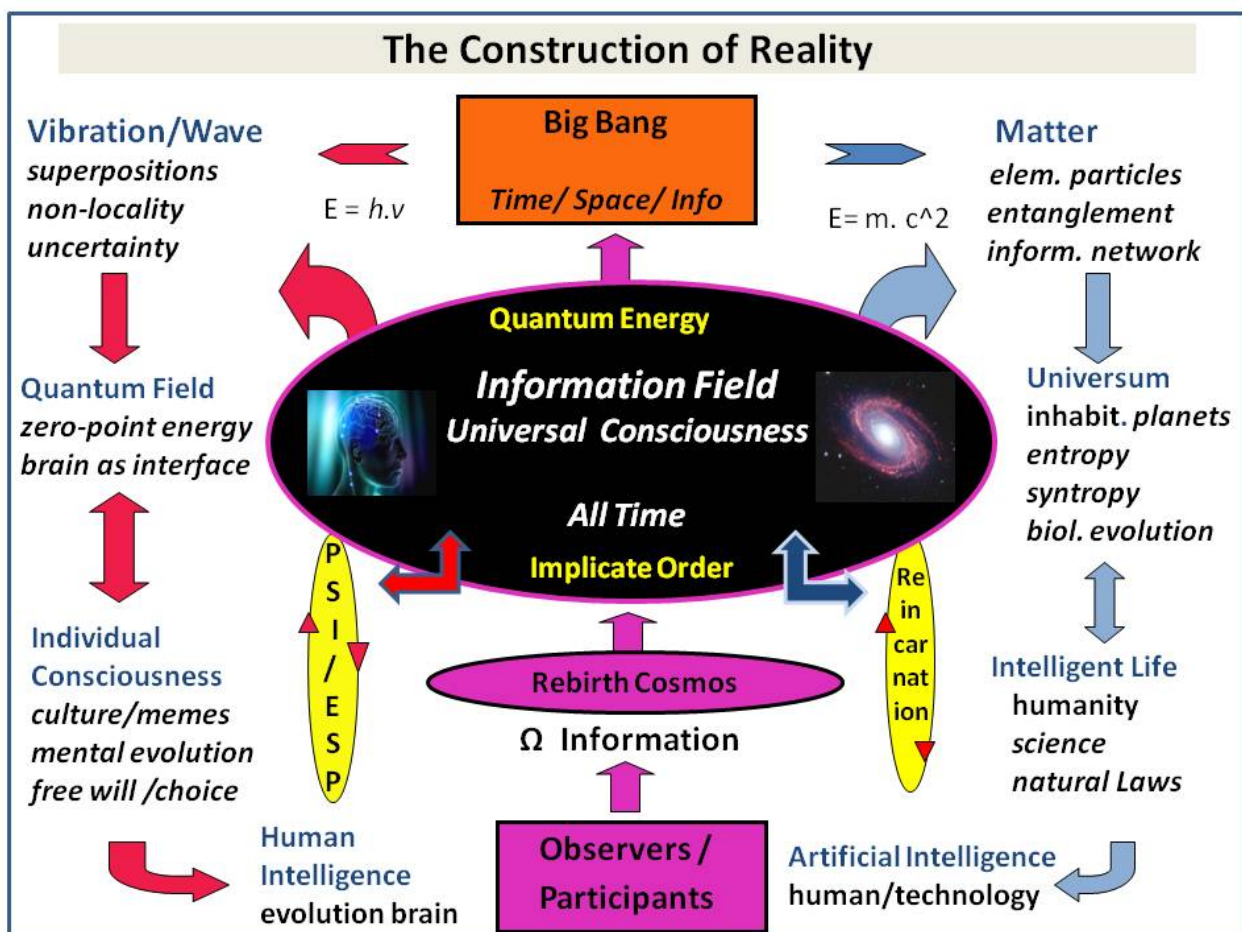


Fig. 28. An integrated scheme depicting the Construction of Reality, with its material (right part of the figure) and mental (left), aspects. This concept assumes a central quantum information field, that provides the very basis for creation of our universe and dynamically evolves further through cyclic feed-back processes from the present reality, in which natural (among others human) and artificial intelligence play crucial roles in observation and participation (see text for further explanation).

Alternatively, the mental and material modalities represent complementary aspects of a unitary reality (Primas, 2003). The informational aspects of the field comprises, among others, the history of all interactions of the participating wave/particles as described above. This basic information is also reflected in the, so called, intrinsic (Fisher) information as treated in section 2 (see Frieden, 2004), and such information can, in principle, be stored in the so called zero-point energy field (see Amaroso, 1999, László, 2005, 2007, Mitchell and Staretz, 2011). The Big Bang, is supposed to be initiated by a quantum fluctuation and/or by symmetry breaking in a primordial quantum field, (see pink arrow in the upper part of Fig. 28). Subsequently, the universe developed through a well orchestrated expansion process (Linde, 2004, Hawking and Mlodinov, 2010).

Universal consciousness thus implies a dynamic field of information, with a continuous and bidirectional flow of generated information, that originates from the entire universe, including our own world. Extra-sensory communication (ESP) in telepathy and premonition and PSI-type of experiences, (clairvoyance, and near death experience (NDE) phenomena, yellow ellipse on the left), as well as the exchange of individual information in the supposed cycle of life and death (by Eastern religions and early Christianity called reincarnation, ellipse in yellow on the right), are also depicted in this scheme. The latter cyclic process implies that death, that is often seen as a passage into another domain, is rather a continuation of an existing state, since individual (mental) information is, at any moment, already expressed in this universal knowledge field (Wolf, 1996).

The physical basis for the supposed quantum information field follows from the principles of quantum physics: each elementary particle has, simultaneously, a wave (informational) aspect. The wave/particle units are quantum entangled/correlated and they can store information by superposition (wave mixing), and form standing waves through resonant vibration. In these holonomic interaction they can also gain information from the future, according to the principles of "backward causation" and/or transactional mechanisms (see sections 5 and 6).

The depicted universal knowledge domain bears a 4-dimensional structure displaying uncompressed time (in contrast to our common unidirectional time), as has been defined earlier as "the block universe". As mentioned above, it can be described in physical terms as the "zero-point information or vacuum field". It is supposed to permeate the entire universe and represents a relatively large part of the total energy of the cosmos. As put forward by Mitchell and Staretz (2011): *"This field is ubiquitous, non-local, cannot be attenuated, lasts indefinitely (e.g. never loses coherence), can store unlimited quantities of information and any portion of it decodes the whole just like a hologram does."* The brain functions as an interface through producing resonant conditions tuned to the same frequency as the standing waves of that frequency in the field. Every macro-scale physical object in nature is, in this manner, represented as a 4-D space- time reality that has its own unique hologram, being a non-local information structure. It contains the complete event history of that particular object and the entire objective as well as the subjective reality experienced, in case that a living organism is involved. The holographic information that is stored in the field, is recoverable through resonance by an individual organism and also by other organisms if an emotional connection exists (for instance in telepathic or synchronic experiences between two separated individuals). The particles that constitute our organism and brain can thus be described as point information (standing waves) within the supposed quantum field and, consequently, form an integral part of it.

Biological evolution with its well-known aspects of mutation, selection, survival and cooperation, can be described in this framework by the unfolding of information from the past and integrating that from the future. This process can be envisioned through information exchange with the above 4-dimensional quantum field. In the framework of biological evolution, this universal knowledge

field also explains that specific protein structures and cellular processes with irreducible complexity could be produced and that, eventually, living cells came into being. The unexplained phenomenon of emergence, e.g. the emergence of entirely new properties from basic elements that do not contain that particular property can, alternatively, be explained by the aforementioned "backward causation": future higher complexity may influence its building blocks backwards in time so that, due to constant feedback, new properties result.

The construction of Reality, in this concept, is basically composed of two, inextricably linked, processes:

- A. The material aspect of reality is represented in Fig. 28, right column: the formation of various forms of matter from the elementary particles during the initial expansion phase. This occurred in a fine tuned manner so that stellar systems, including habitable planets, could be formed. These processes intrinsically developed according to the laws of nature, including their specific values and combination of physical constants, that were also expressed in the field as entangled information. This process seems ultimately aimed at the evolution of (intelligent) life and the creation of beauty in the universe (see Whitehead, 1961). Human science revealed these natural laws and physical constants and produced, more recently, artificial intelligence. Integration of the human-like and machine-like intelligence (called "singularity", see Kurzweil, 2005) in different parts of the cosmos, will ultimately lead to comprehensive and lasting observation of the living universe.

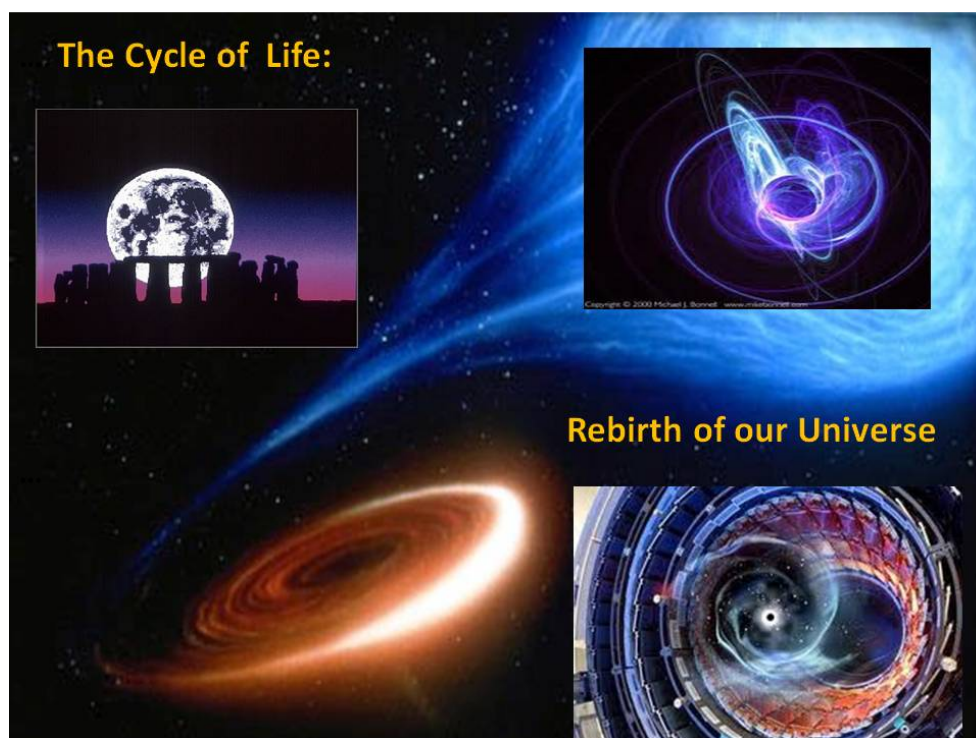


Fig. 29. Integral collection and compression of information from the entire history of the present universe may provide potential opportunities for programmed transmission into a novel baby-universe (see cartoon below, right). Rebirth of our own universe may occur in the far future and in this manner may have happened in the distant past at the supposed "Big Bang". Of note, the latter term is likely a misnomer since the universe probably started small, there was likely no sound, nor an explosion but rather a directed quantum fluctuation in a basic information field (cartoon upper right).

By means of gathering and compression of all of the past and present information, the potential for the start of a new universe is produced. The final stage of this process was previously indicated as the Omega Point (Ω Information, in Fig. 28, as put forward by Teilhard de Chardin, see ref. U. King, 1996, and more recently described by Barrow and Tipler, 1986, and Tippler, 1995). See for a tentative representation of the rebirth of the universe from an ultimate black hole, Fig. 29.

- B. The mental domain of reality is represented in the left column of Fig. 28: All matter/energy entities also contain relational information according to particle/wave quantum physical principles. This wave aspect implies the principles of uncertainty, non-local connections and possible superposition (mixing) of wave information. The information network that is formed in this way is expressed in the previously mentioned quantum wave field: the "zero-point energy field" that encompasses matter/anti-matter properties with bi-directional time modalities. The human brain sends and receives information, and operates in this manner as a bi-directionally operating interface between individual and universal consciousness. Life, in this conceptual scheme, is regarded as an integral relational network of its elementary building blocks (bio-molecules, also containing non-physical/mental codes) that is permanently in contact with the supposed universal knowledge field. Bound information (see Frieden, 2004, and section 2), describes both the physical and the mental aspects of this integral network. Information is thus the grounding aspect of both individual and universal consciousness, and therefore is considered to be more fundamental than matter (section 5).

As mentioned above, information exchange with the field may also include individual information as reflected in intuition, serendipity, synchronicity and other modalities of extrasensory perception (see Radin, 2006, Grof 1987, Jahn 1997, 2004, De Quincey, 2010) including other PSI phenomena such as clairvoyance, remote viewing and premonition (Griffin, 1997, Mc Ginn, 1999). These aspect are indicated on the left in Fig. 28, in the vertical yellow ellipse. Fig. 28 also includes the item of past life memories and reincarnation (ellipse on the right). For an interesting report on the latter aspect, one is referred to the link of Phipps in the reference list).

In the scheme, human consciousness is undergoing further evolution by a continuous integration of cultural elements such as metaphors/memes and scientific data as produced on the basis of free will and individual choice (Fig. 28, right, below). Free will (choice) should be seen as a fundamental aspect in the different stages of evolution, metaphorically seen as already being present in the formation of atoms, macromolecules, and multi-cellular systems, as well as in the final development of human intelligence. Every experience can be seen as the convergence of information from the past (memory) and of "feeling" from the future (anticipating future events). The combined information is then "mixed" into the perception of the present. Each moment of experience therefore constitutes a crossroad at which a direction should be selected (free choice or will of the individual). Free will, therefore, is seen not only as the key driving force in personal development but also as a crucial factor in the evolution of global and cosmic processes (Fig. 28, bottom left).

This process of storing universal information also includes the processing, and internet-like distribution, of knowledge, as well as the compression of this information in the form of future (re)-formulation of the laws of nature. It also implies an ongoing communication and circular causality between the individual and its exo-world (see Wassenaar, 1994), and the latter should therefore include the universal information field as proposed here. The underlying implicate order, as an essential part of the universal consciousness, is viewed upon as containing the primordial recipe for

the development of life and is the basis for the unfolding of the initially compressed information (see Fig. 28, information field in the center).

The entangled flow of mental and material information, pictured in the scheme, obtains a circular character through a final integration of the two knowledge domains at the Omega Point, ultimately resulting in a final state of our present universe and the birth of a subsequent version of it. The resulting (highly compressed information) is seen as an ultimate “theory of everything” which is then used as initial information for the next cycle. An ultimate “theory of everything” is defined here as a final statement of self-contained, internally self-consistent and compressed information that can be used as the input for a more refined version of the previous one (see bottom center of Fig. 28). Taking these different aspects into account, the Universe can be seen as a living organism, since it is self-observing, stores information, is therefore self-learning in a process of regeneration and reproduction (rebirth, see Fig. 30).

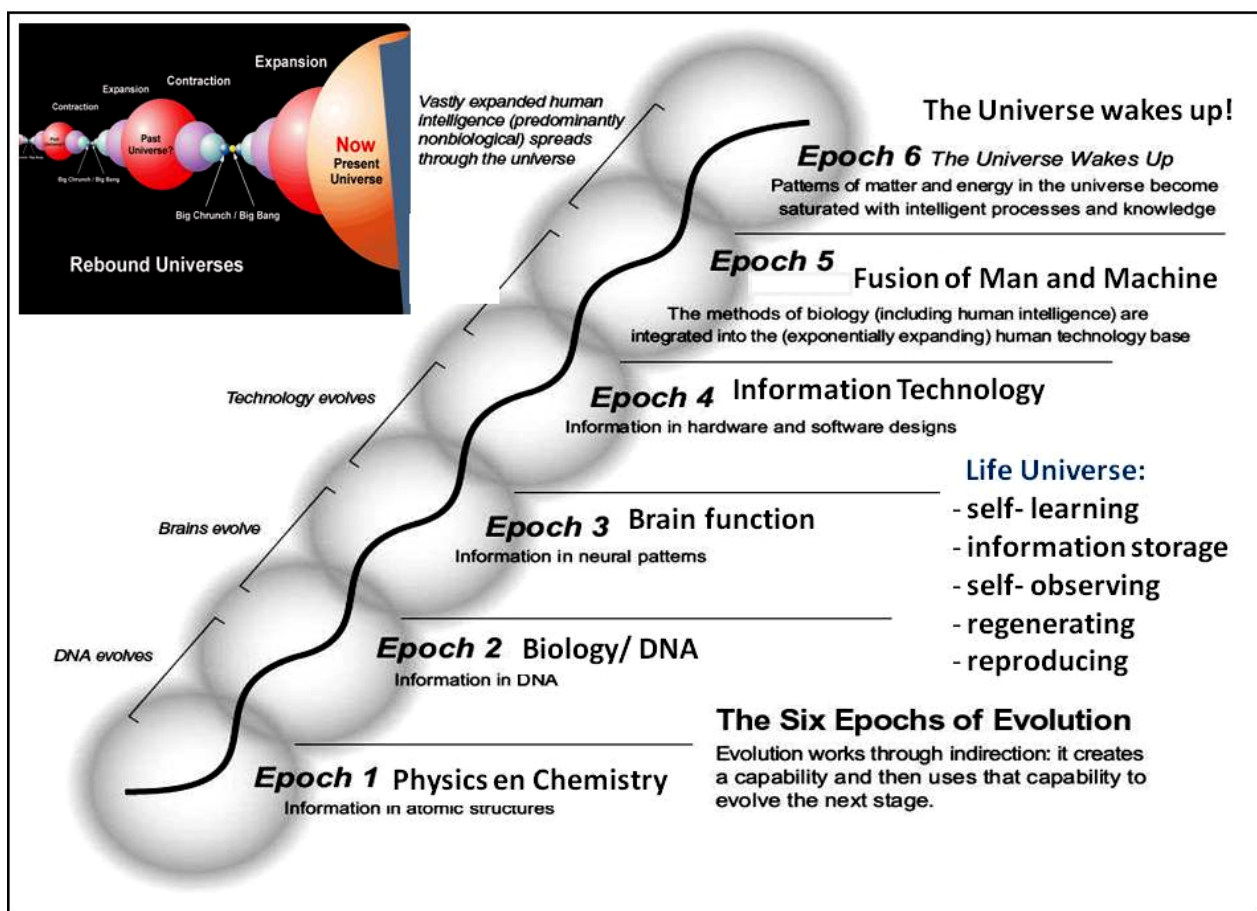


Fig. 30: The future history of a “Life” Universe (for features see inset middle right), pictured in six epochs and finalized in epoch 6, in which the Universe wakes up through saturation with information and knowledge (see for trans-humanism and future technology: Kurzweil, 2005, Greenfield, 2003, Bostrom, 2005, and Kaku, 2007). Final information, in compressed form, may subsequently be transferred to a next version of the universe (rebound universe, see inset upper part left). (After Kurzweil)

Human evolution is, in this view, an intrinsic part of cosmology in which intelligence plays a role in the birth and rebirth of the universe (called the rebound universe, see Fig. 30). This is often pictured as a circular process in which in each new “cycle” identical information is extracted and transferred. However such a model could, instead of a circular process, rather be better described by a

mathematical well defined, spiral process (Fig. 31), in which in each cycle novel information is gained and added.

In other words: each new version of our universe will start with more sophisticated knowledge! In relation to this metaphoric representation of the cosmic process, it is probably no coincidence that we consistently encounter spiral structures in the micro- and macro-structures of our universe: in the path of elementary particles (upper middle part of Fig. 31), in the winding structure of DNA, in the arrangement of leaves on and forms of seeds of plants, in the typical form of certain shells, in tornadoes, in orbits of planets, and even in structures of galaxies and black holes (Fig. 31, below on the left). Ancient geometry provided the well-known Fibonacci spiral (see Fig. 31, upper part left). This primordial structure may reflect an underlying information matrix that has a mathematical basis (see an interesting discussion in Wigner, (1960): “*The Unreasonable Effectiveness of Mathematics in the Natural Sciences*”). Interestingly, it was suggested earlier that the natural geometry of the cosmological, quantum mechanical as well as personal information gradients of all information systems, follow the same topology of the spiral vortex (Tenen, 2002).

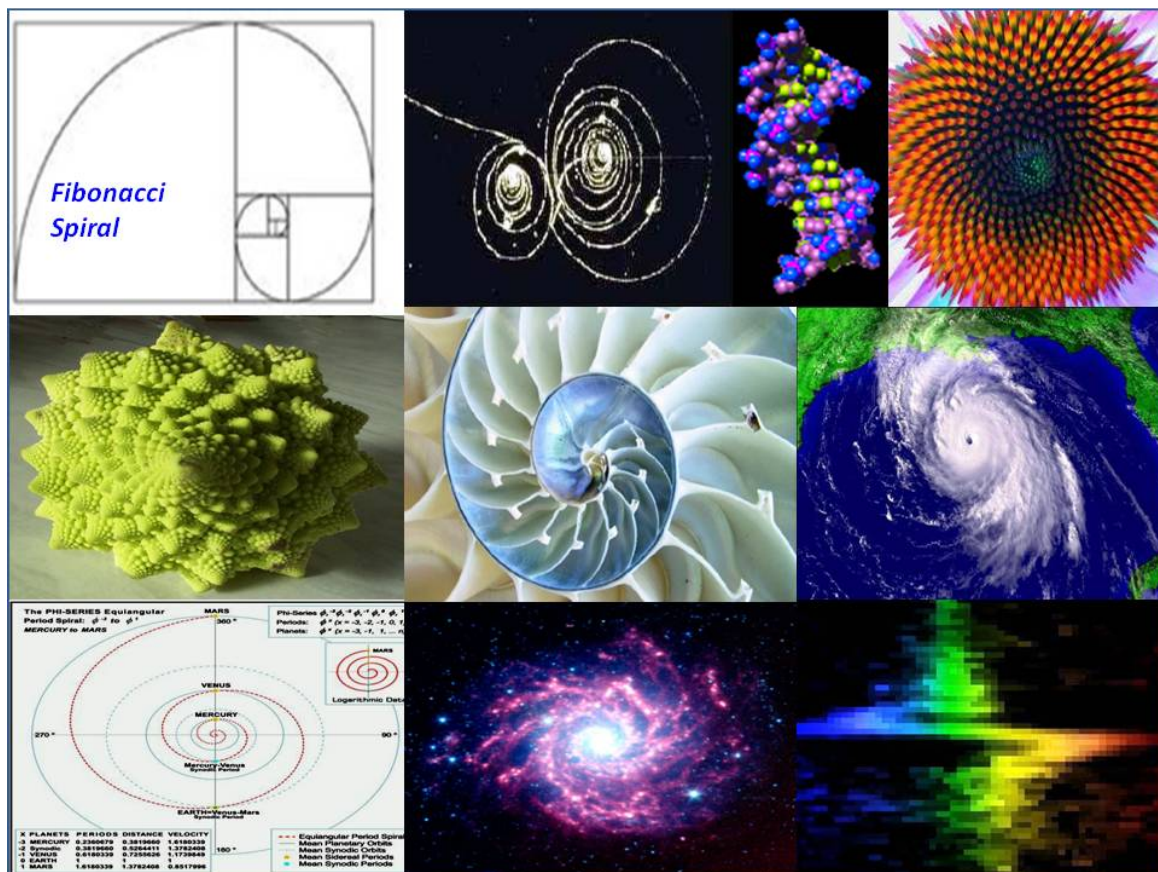


Fig. 31: Spiral geometry as a fundamental aspect of nature on micro- and macro scales.

Finally, at least one important question remains: if our Universe restarts itself through recurrent symmetry breaking, producing a division of mind and matter, what would be the potential role of information in this astounding process? It stands to reason that only the perspective for the evolution of intelligence afforded the potential for the Universe to observe itself in greater detail in a self-learning mode. Only bio-friendly information, coupled to a universal memory, provided a recipe for creation of life and finally for intelligent and participating observers. Due to its entangled

state with the material world, a universal source and knowledge field fulfills the necessary condition to function permanently as a bridge between the mental and material domains. In this manner it can also be instrumental in the ultimate reconciliation of this seemingly catastrophic separation of mind and matter. Of note, it was the gnostic prophet Mani (216-276 AD), who projected that reconciliation of mind and matter is the very aim of the Universe and will be brought about through the saturation of matter with light!

10. Conclusions

The view presented in this essay, on the development of life and cosmos, through an interplay of entangled mind/matter domains, with a central role therein of a universal information field, as pictured in Fig. 28, may provide a coherent framework for further research in physics and biology, as well as for the future studies of consciousness. The integral nature of this view may also be helpful for a more fruitful dialogue between materialists/reductionists (matter is primary) on the one hand and idealists (consciousness is primary) on the other, who usually reject each other's world view as "not defensible". The latter qualification should be considered as unscientific, and ignores the fact that breakthroughs in science often occur at its boundaries: where very different concepts are allowed to interact and even, at some point, may merge into a single one. In such a scientific endeavor, information should be positioned as the most fundamental aspect of the architecture of reality.

11. Epilogue of wise words

"What we observe is not nature itself, but nature exposed to our method of questioning."

Werner Heisenberg

"He who knows does not speak, he who speaks does not know."

Lao Tzu

"People like us, who believe in physics, know that the distinction between past, present, and future is only a stubbornly persistent illusion."

Albert Einstein

"Materialism is the philosophy of the subject (consciousness) that forgets to take account of itself. By ignoring mind in nature we ignore the only way we know the world – because the "world" is, for each of us, wholly a creation of our own mind, based on the imperfect sense data we receive from the objective world."

Arthur Schopenhauer

"Science may be described as the art of systematic over-simplification."

Karl Popper

"There is no matter as such! All matter originates and exists only by virtue of a force. We must assume behind this force the existence of a conscious and intelligent Mind. This Mind is the matrix of all matter."

Max Planck

"How wonderful that we have met with a paradox. Now we have some hope of making progress."

N. Bohr

"If you hold opposites together in your mind, you will suspend your normal thinking process and allow an intelligence beyond rational thought to create a new form."

N. Bohr

"Someday we'll understand the whole thing as one single marvelous vision, that will seem so overwhelmingly simple and beautiful that we may say to each other: 'Oh, how could we have been so stupid for so long? How could it have been otherwise!'"

J. A. Wheeler

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