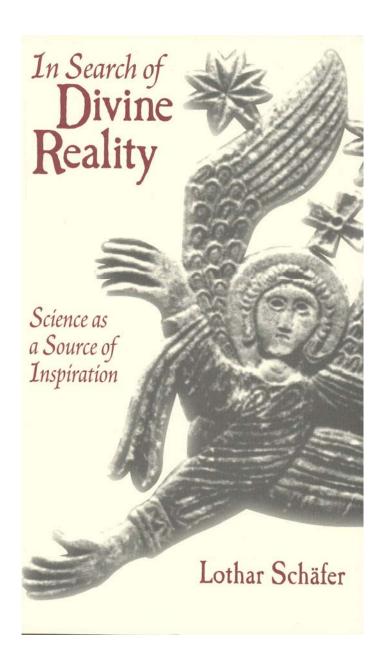
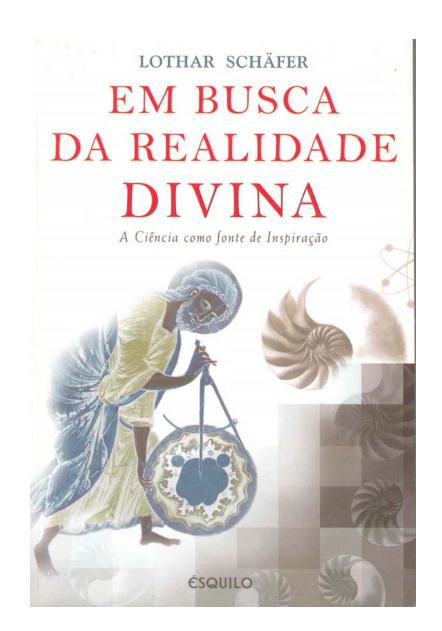
# Quantum Reality, the Importance of Consciousness in the Universe, and the Discovery of a Non-Empirical Realm of Physical Reality:

Lothar Schäfer

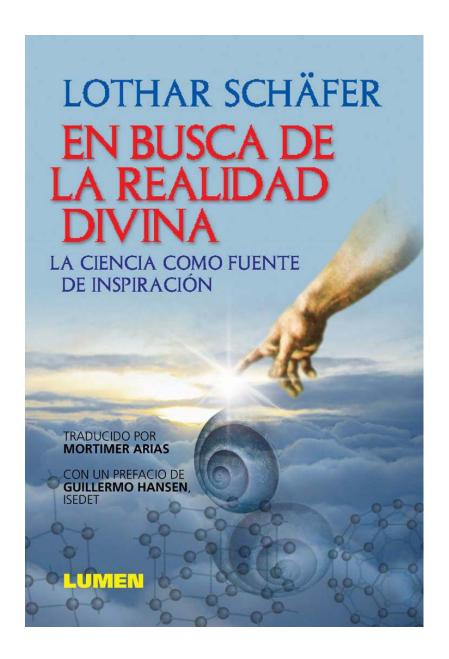
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#### Sri Aurobindo

"The teaching of Sri Aurobindo starts from that of the ancient sages of India: that behind the appearances of the universe there is a reality of being and consciousness, a self of all things, one and eternal. All beings are united in that one self and spirit but divided by a certain separativity of consciousness, an ignorance of their true self and reality in the mind, life, and body."

#### 20th Century Physics

Physical reality is not what it looks like.

It is now possible to propose:

- 1. The Basis of the Material World is Non-Material.
- 2. Reality is an Indivisible Wholeness.
- 3. Quantum Entities possess Properties of Consciousness in a Rudimentary Way.

Physics has discovered a nonempirical part to physical reality.

### 1.The Basis of the Material World is Non-Material

#### Schrödinger's Quantum Theory:

currently the only theory which allows calculating the properties of polyatomic molecules.

In this theory the electrons in atoms and molecules are not tiny material particles, little balls, but standing waves

Max Born:

The nature of these waves is that of **probability waves**. They are probability fields, mathematical forms.

### Probabilities are dimensionless numbers, ratios of numbers.

Probability waves are empty, carry no mass or energy, just information on numerical relations. Yet, all visible order in the universe is determined by their interference.

Interference of atomic wave functions: molecules.

Of molecular wave functions: intermolecular interactions (including those at the basis of the chemistry of living cells).

Reality is based on phenomena which transcend the materialism of classical physics.

### In modern science this finding was unexpected, but new it is not.

Plato:

(~428-328 B.C.)

Real atoms are mathematical forms.

Pythagoras:

(6th Century B.C.)

"All things are numbers...
The harmony of the cosmos is based on the ratios of numbers"

### 2. Non-Locality or Non-Separability of Reality

Revealed in experiments in which quantum entities act instantaneously on each other over arbitrarily long distances.

In the world of ordinary things no signal, no influence is able to move at a speed faster than the speed of light.

In the quantum world, influences can act instantaneously over long distances.

### In Experiments regarding **Bell's Theorem** it has been found:

Decisions made by an observer in one laboratory may have an instantaneous effect on the outcome of experiments performed in another laboratory, a long distance away.

Two particles which at one time interact and then move away from one another, can stay connected and act as though they were one thing, no matter how far apart they are.

Physicists call such effects "Non-local".

If reality is non-local, the nature of the universe is that of an indivisible wholeness.

#### Everything is connected.

#### Menas Kafatos and Robert Nadeau:

"The Conscious Universe" (Springer Verlag, 1990)

have drawn a remarkable conclusion from this phenomenon:

Since our Consciousness has emerged from this wholeness and is part of it, it is possible to infer that an element of consciousness is active in the universe.

Cosmic Consciousness!

#### 3. Aspects of Mind

Elementary particles display aspects of consciousness in a rudimentary way

In Single Particle Interference

Experiments, Which-Way Information destroys Coherence.

Quantum objects can react to the flow of information, like a mind.

At the foundation of ordinary things, entities with mind-like properties are found.

#### John Archibald Wheeler:

"...information sits at the core of physics, just as it sits at the core of a computer. Information may not be just what we learn about the world. It may be what makes the world."

#### Sir Arthur Stanley Eddington

"The universe is of the nature of a thought or sensation in a universal Mind."

### Aspects of Mind come in many phenomena to the fore:

Non-material probability waves: closer to the nature of a thought than that of a thing.

In quantum jumps:

Quantum systems react spontaneously. A mind is the only thing that we know that can do this.

#### In this way:

If one pursues the nature of matter to its roots, at the level of atoms and molecules all matter is lost and all of a sudden one finds oneself in a realm of non-material forms.

Here Physical Reality reveals that it appears to us in two Domains:

One is open and empirical.

The other is hidden and non-empirical.

#### Reality has a dual structure:

Actuality

the empirical realm of material things
Potentiality

a realm of non-material, non-empirical forms.

The non-empirical forms are also real because they *can* manifest themselves in the empirical world and act in it.

The true nature of reality cannot be derived from the experience of the visible order of the world. The visible world conceals or covers up, as it were, the realm of the non-empirical forms, from which it emanates.

At its frontiers, observable reality does not fade into nothing but into something non-empirical.

### There is a Non-Empirical Part to Physical Reality.

#### In one of the Vedantic texts, the *Sruti*, one finds the Sanskrit *sloka*:

"Asad va idam agra asit".

"At first the universe was there, but non-existent".

Here the word *asat* does not mean absolute non-existent, but it means *subtle*, *fine* and *unmanifested*.

Thus, the sloka given above means that the universe existed in an extremely subtle, unmanifested state before it became manifest in a differentiated state.

#### According to Indian teaching:

The material universe emanates out of Brahman, but the universe is already hidden in Brahman before it emanates, like a tree in the seed; that is, the universe is not absolutely non-existent before it emanates because it already exists as a *potentiality* in Brahman

Immanuel Kant (1724-1804) There is the world of appearances and of things in themselves. We know only the things in the way in which they affect us. This distinguishes the sensible world from the intelligible world. The noumena are intelligible – that is, mind-like.

The concept of non-empirical reality: self-contradictory? A Scandal? How can something be real if it is not material and cannot even be experienced? However, entities do exist, of which we can have no experience and yet they are real because they *can* express themselves in the empirical world and have an effect on us.

#### Non-Empirical States:

#### 1. Superposition States

In a *superposition state* a system is not in a state of actuality, but of potentiality. The system is not part of the actual world, but it has the *potential* to appear in it. In such a state, a particular property does not have an *actual* value, but *many potential* values.

Such states are non-empirical: observation destroys them.

#### 2. Virtual States

All material systems contain empty states, called *virtual*. They are non-empirical because they are empty. **There is nothing there to observe.** Nevertheless, they are *real*, because they have the potential, *Aristotelian potentia*, to express their logical order in the empirical world.

#### A free electron:

### a simple example of an object in a superposition state.

Quantum theory predicts for such an object a state in which the probability of presence is non-zero and the same everywhere.

#### We write: P=const

In this state an electron does not have a definite position in space. It is, so to speak, nowhere. Its state is a *superposition* of a multiplicity of possibilities to be found in many different locations in space.

### No empirical object could exist in such a state.

### Empirical objects are always *somewhere*.

If at point a, P(a) = 1 (unity); and P = 0 everywhere else. Indeed, if a number of detectors in different locations search for the electron in P=const, all of a sudden it will appear in one of them, unpredictably in which one.

In this process the state P=const is transformed into state type P(a)=1.

The former is necessarily destroyed by the observation.

### Central to the revelation of a non-empirical reality:

#### The Phenomenon of Coherence

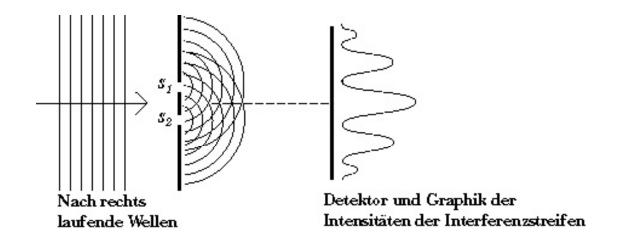
Coherence is the ability of single quantum entities to *interfere*. That ability is apparent in *interference phenomena*.

Interference is always observed when the same experimental result can be achieved for a single quantum object by different classically conceivable and indistinguishable possibilities.

**Example: Double-Slit Experiments** 

#### Young's Double-Slit Experiment

When light waves run against a barrier with two slits in it,  $S_1$  und  $S_2$ , each of the slits will be the source of waves which spread out in all directions and interfere with each other.



At the Detector: An Interference Pattern.

#### Outcome of a Young's Double-Slit Experiment with Light.

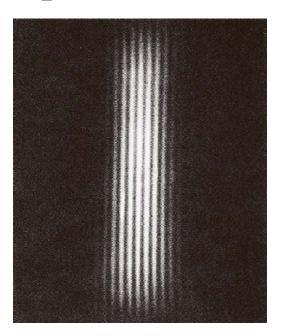
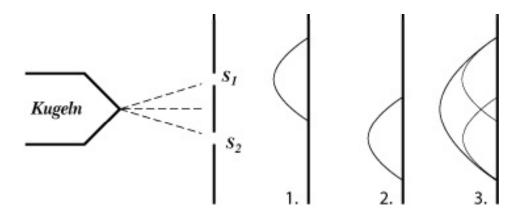


Figure courtesy Wolfgang Rueckner and Paul Titcomb, "A lecture demonstration of single photon interference," Am. J. Phys. 64, 184-188 (Feb. 1996).

### Mass Particles (Bullets) Passing a Double-Slit



When ordinary bullets are propelled through two slits, there is no interference. The impacts on the detector simply form two piles which after some time will coalesce into a single pile.

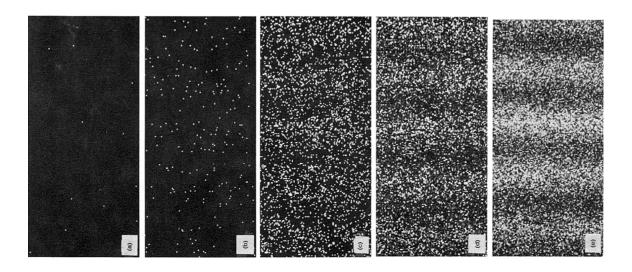
### When *electrons* are propelled through a double slit:

Each one will leave a tiny mark on a detector, like a little bullet. But an electron cannot be aimed at a particular spot of the detector. Aim up, and it may fly down; aim low, and it may fly high.

Each single electron will impact the detector in a completely random way.

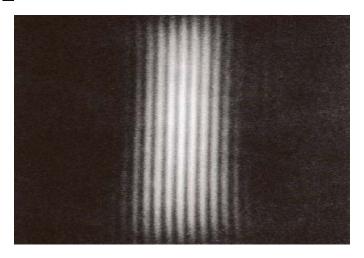
But, when many random acts are combined, a hidden, deterministic order comes to the fore.

### The Emergence of an Invisible Order in Single Particle Interference Experiments



The accumulation of single seemingly random events reveals an underlying complex order. That order is *non-empirical*, because every attempt to observe it destroys it.

### Outcome of a Young's Double-Slit Experiment with Electrons.



Three ways to get the picture: 1. Shoot a high intensity electron beam through two slits (many e<sup>-</sup> at the same time). 2. Shoot one electron at a time (in isolation) through the slits and collect the impacts. 3. Shoot one electron, each, through a billion identical diffraction instruments and collect the impacts.

**Graphs courtesy of** A. Tonomura, J. Endo, T. Matsuda, T. Kawasaki, and H. Exawa, "Demonstration of single-electron buildup of an interference pattern," *Am. J. Phys.* **57**, 117 (Feb. 1989).

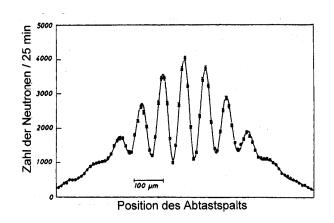
## Coherence A general property of quantum systems

#### **Neutron Interference by a Double Slit**

(R. Gähler, A. Zeilinger, "Wellenoptische Experimente mit sehr kalten Neutronen", Physik und Didaktik 3, 1994, 217; transl. from Am. J. Phys., **59**, 1991, 316.)

*Neutrons from a nuclear reactor cooled to l* =  $\sim$ 2 nm.

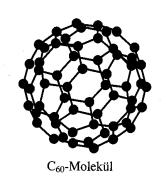
Double slit: two polished glass edges brought together until they formed a slit. A boron wire with a diameter of 104 mm was placed into the middle of the glass slit, effectively creating two slits with a diameter of 22 mm.

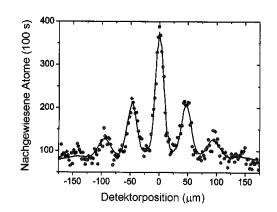


Interference pattern of neutrons obtained with a double slit. Dots represent the experimental results; the solid line represents the quantum mechanical predictions.

## **Coherence – The Ability to Interfere**

# The Interference of Fullerene Molecules, C60, by a Double Slit





(Anton Zeilinger (M. Arndt et al., "Wave particle duality of C60", Nature **401**, 680, 1999).

Molecules exciting a furnace at 900 K,

v = 117 m/s, 1 = 4.6 pm.

The slits should be the same size (order of magnitude) as 1. Diameter of C60 = ~3 nm. Slit width used ~100 nm.

## **Virtual States**

A second class of non-empirical states is found in the empty states of atoms and molecules.

All material systems exist in Quantum States. But every system consists not only of the state which it is occupying when it is observed, but also of countless other, invisible states, which are empty.

Quantum chemists call empty states *virtual*. They are part of physical reality but, since they are empty, not of the empirical reality.

Virtual states are mathematical forms, patterns of information, but they are more than mere formulae or ideas of mathematical forms.

They contain the empirical possibilities of a system. Since they **can** manifest themselves in the empirical world, their nature is that of potentiality in the Aristotelian sense.

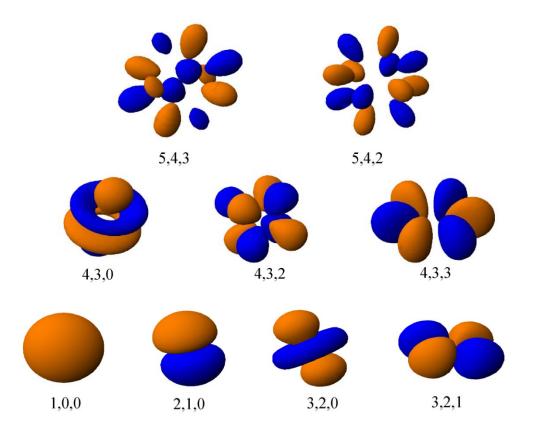
When a system makes a transition into a virtual state, that state becomes an empirical state.

The virtual states are part of the realm of potentiality in physical reality.

## The Hydrogen Atom

contains infinitely many states called *orbitals*. One is occupied, the others are empty – virtutal.

Each orbital is characterized by a wave function. The squares of the wave functions determine the probability to find an electron in the space surrounding an atom..



Atomic orbitals  $|\Psi_{n,l,m}|^2$  of the H-atom.

#### Each state has its characteristic wave form.

The 'Orbital Viewer' Program by David Manthey, <a href="http://www.orbitals.com">http://www.orbitals.com</a> was used.

When a given H-atom is in its most stable (1,0,0)-state, then we have to think that the other states - (2,0,0); (2,1,0); (3,0,0); (3,1,0); (3,2,0)...- also exist in this atom.

### But not as empirical forms, since they are empty.

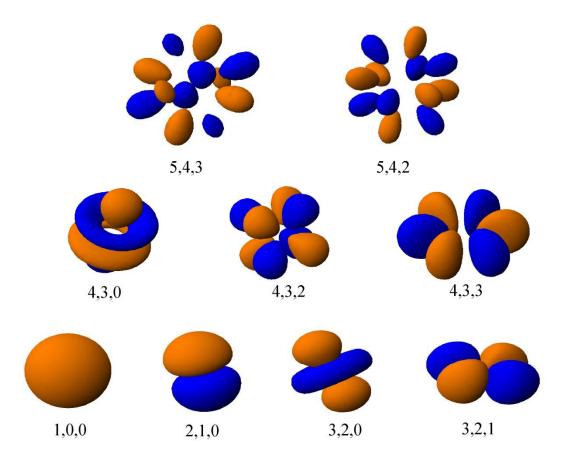
They exist as forms of *potentiality* which have the potential to appear in the empirical world. They exist in the sense that their logical order is part of the constitution of a system and contains its empirical possibilities, completely determined by the conditions of the system and *a priori* predictable.

The order of virtual states is pre-established, before it manifests itself in the empirical world.

# What happens when a virtual state is actualized?

In the (1,0,0)-state: probability of presence is that of a sphere. When the atom makes a transition to the (4,3,0)-state, that state becomes an actual state while the former is now virtual. In that process the spherical probability distribution will vanish and doughnut-like forms appear.

In the (4,3,3)-state, forms like a bracelet come to the fore; and increasingly complex forms can emerge, like the gothic shapes of states (5,4,3) and (5,4,2).



Atomic orbitals  $|\Psi_{n,l,m}|^2$  for some n,l,m-states of the H-atom. The 'Orbital Viewer' Program by David Manthey, <a href="http://www.orbitals.com">http://www.orbitals.com</a> was used.

### From this model it is seen:

At the atomic and molecular levels, the emergence of new and complex forms is not from nothing—de nihilo—but from the actualization of virtual states whose logical order already exists before it is empirical.

Since all material systems consist of atoms and molecules, none of them can be claimed to achieve the emergence of complex order out of nothing.

## DNA is no different.

For every collection of nucleotides, there is a high density of empty states. Populating virtual states of DNA – a mutation – may lead to variations in phenotype, which natural selection then evaluates. The important point is: the complex order of the biosphere is not created by chance and is not emerging from nothing, as Darwinians claim, but from a virtual order – a realm of information – which already exists before it is an empirical order. Quantum Jumps from one state to another are ruled by chance, but the order of the states on which the jumping will land is not. In principle, the entire
universe as a quantum system.
Its occupied states form the visible
part of actuality. Its virtual states form the
non-empirical realm of potentiality.
The former contain everything that is actual;
the latter, everything that is possible.

Virtual Cosmic States
Form a Realm of Plato's Ideas

### Virtual states:

## Parmenidian Entities.

Parmenides: motion is possible only, if empty space exists, into which an object can move. Since he also believed that there is no empty space, he claimed that there can be no motion.

Quantum systems refine and confirm the Parmenidian principle:

A system needs empty (virtual) states in order to be able to change.

# The Difference between Darwinism and the Quantum Perspective is simple:

The QP assumes an underlying nonempirical order which is not stored in empirical forms but in the realm of potentiality in physical reality. The potentiality of molecular virtual states is of a special kind because molecular states are *stationary states* which endure in time.

Physicist David Bohm (1917-1992):

Ultimate reality is an unknowable wholeness. But the wholeness is not being, but process. "Undivided Wholeness is Flowing Movement"

(Bohm, [1980] 1981:11).

## Out of the constantly changing flux

certain temporarily enduring and relatively independent aspects can be abstracted, which are the elements of the empirical world; *among them, mind and matter* (Bohm, [1980] 1981:152)

. In this view material particles are not eternally enduring structures but rather like ephemeral vortices in the flowing stream. Moreover: "In this flow, mind and matter are not separate substances. Rather, they are different aspects of one whole and unbroken movement."

(Bohm, [1980] 1981:11)

# Hans-Peter Dürr (2004: 102) has compared the cosmic potentiality to an *ocean*.

When the surface is flat and motionless, it is a reality in which the Spirit has not yet expressed itself. Because the ocean is not *Being* but *Process*, soon waves begin to show on the surface. They superimpose, build up, get taller and form white crests. If one flies across the Atlantic, the crests are seen from above as isolated patches. They *seem* like separate particles but are part of the same contiguous system of waves.

In the same way, the world seems to be made of separate things. In reality, things are nothing but crests of contiguous waves – separated by nodal planes.

### In this non-material ocean

which is alive and mind-like, the waves constantly build up to new empirical possibilities, and to new forms of thinking which may find consciousness in us.

There is a continuous flux from the evolution of tendencies to empirical events – and from empirical events to new tendencies. Each new state of potentiality carries in it, like a stamp, the memory of the last event.

For this reason Hans-Peter Dürr has called this process a learning process (2004: 103).

### In the material world,

the actualization of potentiality waves leads to new empirical structures. In our minds, it leads to new elements of consciousness from which the learning process starts out anew.

In the same way in which potentiality waves can trigger visible reactions of measuring instruments, they can trigger brain states, expressing concepts in our minds. In the same way in which the brain has evolved sensitivity to light waves by developing eyes, it has evolved neuronal networks which are sensitive to potentiality waves.

In the evolution of the comic potentiality, the Cosmic Spirit is learning.

# Virtual States revive the ancient Idea of "Forms as Metaphysical Principle of Being."

(J. Hirschberger, Geschichte der Philosophie, 1976; 1.24.)

Pythagoreans: number is the arché of all things. "Thus, the principle of all being is no longer seen in stuff, but in form."

(Arché is the source, or fundamental origin of the being of all things.)

The concept of virtual states takes physics right into the center of historic traditions of spirituality. Virtual state wave functions are pure, non-material forms, in which matter abandons itself or has not yet appeared. In Aristotle's metaphysics there was only one *pure* form:

Similarly, the actualization of the empirical reality out of virtual states is like an emanation out of a wholeness that is One.

In the metaphysics of Plotinus (205-270), God is the One and the world is not a creation of the One, but an emanation, due to a necessary flowing over of the Divine.

"The One is all. All is out of the One."

(Hirschberger, 1976, p.304).).

# In the metaphysics of St. Augustine (354–430):

The eternal forms have the important function as the lasting und immutable essence of things.

He believed that they exist in the mind of God.

Thus, it is possible to think that, through the realm of virtual states, Divine Reality is shining into human reality.

Non-empirical reality is the liaison reality where the Spiritual and the Physical merge and transcend the human comprehension.

## Carl Gustav Jung: Archetypes

In the first half of the twentieth century Swiss psychiatrist Carl Gustav Jung (1875–1961) believed to have found empirical evidence for the existence of a realm of non-empirical forms or structures which can appear spontaneously in our consciousness, influencing "our imagination, perception, and thinking" (Jung, [1959] 1990: 44).

## He called these forms or images the archetypes

(Jung, [1959] 1990: 4).

As "typical modes of apprehension" the archetypes shape the conscious contents of our mind by regulating, modifying and motivating them.

(Jung, [1960] 1981: 137),

## Jung: The Collective Unconscious

In order to be able to live, to give meaning to life, and to develop a conscious Self, human beings constantly need to reach into this realm of forms which he called the *collective unconscious*.

"A psychic system of a collective, universal, and impersonal nature which is identical in all individuals.

... It consists of pre-existent forms, the archetypes, which can only become conscious secondarily and which give definite form to certain psychic events."

(Jung, [1959] 1990: 43).

# Jung: The Realm of Archetypes: Wholeness and Potentiality.

Beyond the narrow confines of our personal psyche the collective unconscious is, "a boundless expanse full of unprecedented uncertainty, with apparently no inside and no outside, no above and no below, no here and no there, no mine and no thine, no good and no bad. ... where I am indivisibly this and that; where I experience the other in myself and the other-than-myself experiences me. ... There I am utterly one with the world, so much a part of it that I forget all too easily who I really am."

(Jung, [1959] 1990: 21.)

## Carl Gustav Jung:

Archetypes are pre-existent forms,
Universal Ideas. By having the potential to
become conscious in us, they form a realm of
potentiality. They are non-empirical entities
because they "have never been in
consciousness" before.

(Jung, [1959] 1990: 42).

Thus, the birth of the Conscious Self is from a Realm of Non-Empirical Forms.

## Proposal:

The entire web of reality is spun out of non-material, non-empirical and mind-like forms.

The non-empirical reality that Jung discovered, the non-empirical reality that the quantum phenomena reveal, and the non-empirical reality out of which life is emerging – all are one and the same realm of potentiality - **the medium of Spirit** - where science, philosophy and religion dissolve into the single order of the One

## It is possible to show:

In the same way in which the brain has evolved eyes to be sensitive to light waves, it has evolved neuronal networks which are sensitive to potentiality waves, like the ordinary measuring instruments of physics.

We are on-line to a realm of forms, which can appear spontaneously in our consciousness.

Many will find such thoughts disturbing. However, we should have the courage for a enlightened and liberated science that does more than manipulate nature.

"Like the meridians as they approach the poles," Teilhard de Chardin wrote. "science, philosophy and religions are bound to converge as they draw nearer the whole"

Teilhard [1955] 1959, 30).

European Manifesto 2006. "Toward an Openminded Science." Le Monde, Feb 22. J. Arsac, M. Beauregard, R. Chiao, F. Dyson, B. d'Espagnat, N. Guessoum, S. Klein, J. Kovalevsky, D. Laplane, M. Molina, B. Newsome, P. Perrier, L. Schäfer, C. Townes, and T. X. Thuan. "Religious or metaphysical ways of thinking should not, a priori, interfere in the ordinary practice of science. However, we also consider that it is legitimate, indeed necessary, to reflect, a posteriori, on the philosophical, ethical and metaphysical implications of scientific discoveries and theories."

## Hegel (1770-1831):

In his philosophy, the "absolute Spirit" is the primary structure of reality and everything that exists is the actualization of this structure.

### Absolute Idealism:

Spirit is everything, creates everything, and Thinking and Being, Subject and Object, the Real and the Ideal, the Human and the Divine – all are One.

To this Hegel added the concept of *Evolution*:
God is in our history and in all cosmic processes of Becoming. He abandons Himself in the world in order to find Himself.

All the elements of our empirical world – material particles, the galaxies, our consciousness, life – have emanated out of the wholeness, the flux of potentiality. Thus, all empirical phenomena have somehow a common root in the realm of non-empirical forms.

Vice versa, if reality is wholeness, the Cosmic Consciousness is a part of us.

Hegel: the Cosmic Spirit
himself is thinking in us, becoming conscious of himself.

### "The Truth is the Whole.

The Whole is nothing but the Spirit which is perfecting itself in its Evolution."

(Hegel, Phenomenology of Spirit, 1807 [1986], p.24)

Like in a never ending prayer, the Fascination with God, Brahman, Weltgeist, Nous, Logos, Cosmic Consciousness – whatever the name people chose - has been a permanent obsession of the human mind.

And now: against the will of most physicists, signs of Spirit are emerging in physics.

Somehow we were spat out of the wholeness and we have the feeling of a loss. This is the Biblical story of the eviction from Paradise. But Paradise is not a garden of sensual pleasures, not a land of plenty, but the non-material realm of the mind-like wholeness of reality.

We have a longing to return.

It is the basis of all mystical experiences, of our spiritual needs.

It is the longing of our consciousness to get entangled with the Cosmic Consciousness.

# Hans-Peter Dürr (2004: 101) on making contact with the Wholeness of Reality:

"What human beings call God springs from an overwhelmingly intense experience which is connected with the feeling of self-abandonment in the sense of the loss of the Ego. It is a turning to the mystical I, a joyous surrender, which is devoid of any fear because, in the deep Ego, the I expands to the unfathomable whole."

## The Gospel of Thomas

Dublin, Bardic Press, Second Edition, 2004, p. 193:

*113*.

His disciples said to him, "On what day will the Kingdom come?" (He said,) "It will not come by expectation. They will not say, 'Look here', or, 'Look there,' but the Kingdom of the Father is spread out on the earth and men do not see it:

That is the non-empirical realm of Reality.

In sacred places, like the Cathedral of Chartres, at one time the Cosmic Spirit burst out of the ground and cast itself into stone. On some days, the feeling of a transcendent Presence in such places can be overwhelming.

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