CONTINUOUS PSI-FIELDS AND COLLECTIVE PHENOMENA

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Résumé: Nous construisons la théorie générale des champs PSI continus dans le cadre de la synthèse bioquantique, puis nous l'appliquons à la résolution générale de deux phénomènes PSI collectifs : conscience globale et champs morphiques de Sheldrake.

Abstract : We build the general theory of continuous PSI fields within the frame of the bioquantum synthesis, then we apply it to the general solving of two collective PSI phenomena: global consciousness and Sheldrake's morphic fields.

0 – Introduction

It was shown in [V1] that the fundamental physical frames were the Structured Outer World OW and its quantum dual, the Structured Inner World IW. Both universes are 3-dimensional and double. OW is the "substantial" component and IW, the "non-substantial". Elements of OW are "material", while those of IW are "virtual". Consequently, a coordinates system $[z^i(l),z^{*i}(l)]_{i=1,2,3}$ on OW will localize a substantial object of complexity l, while its quantum dual $[\varphi^a(l),\varphi^{*a}(l)]_{a=-,0,+}$ will localize a virtual object of same complexity, both objects having non-zero size, except when l = 0.

Definition 1: A structured object $[\varphi^a(l),\varphi^{*a}(l)]_{a=-,0,+}$ of IW is called a *wavy pattern of complexity l.*

If they do exist, PSI-processes can only involve virtual objects (such as minds, for instance) for, if they involved substantial objects (such as biological bodies and organs), they would have been detected for long with conventional (i.e. non quantum) instruments. Now, it is clear that PSI-signals can definitely not be ordinary signals. This is the reason why, in bioquantum theory, the dynamical variables of PSI-fields are wavy patterns, while structured objects of OW now serve as mere dynamical parameters. The situation is thus similar to that of ordinary field theory, but the geometrical construction is different. In ordinary field theory, the "external" space (or space-time) M does play the role of a parametric space but it is the base space of a fibration E -> M and ordinary fields are sections of this fiber bundle, for one is interested in the *expansion* or the *propagation* of physical fields *through M*. So, the x-dependence is explicit and in the continuous case, the corresponding functional space is infinite-dimensional: there are infinite degrees of freedom $\varphi^a(x)$ on M (or just an open set of it), one for each base point x of M. A typical example is the Lagrangian of particle physics in a simple universe (real domain):

(1a) $$L(\varphi^a,\varphi^{*a},\partial_i\varphi^a,\partial_i\varphi^{*a}) = \partial_i\varphi^a\partial^i\varphi^*_a - m^2\varphi^a\varphi^*_a$$

where m is the mass of the field. The space dependence is clearly explicit in the kinetic term and is transferred to the Lagrange equations:

(1b) $$\partial^i[\partial L/\partial(\partial^i\varphi^*_a)] - \partial L/\partial\varphi^*_a = \partial^i\partial_i\varphi^a + m^2\varphi^a = 0$$

which lead to the well-known Klein-Gordon equations for the quantum oscillator φ. The situation is somehow ambiguous, as the dynamical variables here are assumed being the three φ^as, which are associated to three internal degrees of freedom and are therefore finite-dimensional. However, one

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cannot directly measure them, independently of their space (or space-time) dependence, as they are considered as being non-observable in themselves. We believe it is a false problem. The reason is that, in so-called "classical mechanics", the dynamical parameter is time and one has a fibration with base **R** and sections $x^i(t)$ (i = 1,2,3). So, the functional space of *curves* $x^i(t)$ is indeed infinite-dimensional but this does not prevent points x^i of ordinary 3-space to be observable in themselves at all. We rather think that people limit themselves in observing only "external" processes, thus sticking (voluntary or not) to the good old *Cartesian* view, despite dealing with quantum stochastic objects. Saint Thomas, if one prefers.

In this paper, we handle wavy patterns in themselves, as mechanicians handle point-like corpuscles in themselves. This enables us to give very general definitions of PSI-fields and show how they can theoretically explain collective PSI-phenomena such as global consciousness [N], or Sheldrake's morphisms within the frame of Jung's collective unconscious [S1,2,3]. A short review of the new possibilities offered by the bioquantum synthesis to the global consciousness problem can be found in [V2]. In any cases, we will be light-years away from the naïve viewpoint of materialists as exposed in [C] or [E], for instance.

1 – PSI-sources : charges and currents

We start out with the basic ingredients of PSI-field theory: PSI-charges and their currents.

Definition 2: A *PSI-charge distribution* is a distribution ρ: IW -> **R** such that

(2) $\rho[\varphi(l),\varphi^*(l)] = \Sigma\, c_\alpha(l)\delta(|\varphi(l) - \varphi_\alpha(l)|)$

where the summation is on the greek index α, which runs from 1 to some positive integer N, δ is Dirac's singular distribution and the constant coefficients $c_\alpha(l)$ are the *PSI-charges*.

Thus, as ordinary charges are concentrated in structured objects z(l), PSI-charges are concentrated in the wavy patterns $\varphi_\alpha(l)$. Let:

(3) $u^a(l) = £_X(l)\varphi^a(l) = e^i[z(l),z^*(l)]\partial_i(l)\varphi^a(l)$ and $v^a(l) = £_{X^*}(l)\varphi^a(l) = e^{*i}[z(l),z^*(l)]\partial^*_i(l)\varphi^a(l)$

where $£_X(l)$ and $£_{X^*}(l)$ are the structured Lie derivatives with respect to the tangent vector fields $X(l) = e^i[z(l),z^*(l)]\partial_i(l)$ and c.c., respectively. X and X* form a natural base of the tangent bundle TOW of OW. From (3), one can build two structured vector fields J and J' with components:

(4) $J^a = \rho u^a(l)$ and $J'^a = \rho v^a(l)$

Definition 3: J and J' are the *PSI-currents* produced by the PSI-charge distribution ρ.

Lemma 1: If $\varphi(l)$ is analytic on OW or an open set U of it, then J'= 0 on OW or U.

Proof: Thanks to the Prigogine trick, the Cauchy-Riemann theorem for analytic functions can be straightforwardly extended to the structured case. So, $\varphi(l)$ analytic on OW or an open set U of it => v (l) = 0 on OW or U => J' = 0 on OW or U.

Theorem 1 (Conservation of PSI-charges). One has:

(5) $£_X(l)\rho + \nabla_a(l)J^a = 0$ and $£_{X^*}(l)\rho + \nabla_a(l)J'^a = 0$,

where $\nabla_a(l)$ is the Levi-Civita connexion on IW.

Proof: Let $C(l) = \int_{\Omega(l)} \rho[\varphi(l),\varphi^*(l);z(l),z^*(l)]d\Omega(l)$ be the total PSI-charge over the structured object $[z(l),z^*(l)]$ of OW, $\Omega(l)$ being a virtual volume of IW. The Lie derivatives $£_X(l)C(l)$ and $£_{X^*}(l)C(l)$ measure the PSI-charge variations along z- and z*-curves of OW of the total PSI-charge contained in the virtual volume $\Omega(l)$. Over each structured object $[z(l),z^*(l)]$ of OW, the corresponding PSI-currents going through the virtual surface $\Sigma(l) = \partial\Omega(l)$ of $\Omega(l)$ in the $\varphi^a(l)$-directions are

$$\int_{\Sigma(l)} n_a(l)J^a[\varphi(l),\varphi^*(l);z(l),z^*(l)]d\Sigma(l) \quad \text{and} \quad \int_{\Sigma(l)} n_a(l)J'^a[\varphi(l),\varphi^*(l);z(l),z^*(l)]d\Sigma(l)$$

respectively, where $n(l)$ is the normal external to $\Sigma(l)$. Applying Gauss' theorem extended to the structured case thanks to the Prigogine trick, the surface integrals become the volume integrals:

$$\int_{\Omega(l)} \nabla_a(l)J^a[\varphi(l),\varphi^*(l);z(l),z^*(l)]d\Omega(l) \quad \text{and} \quad \int_{\Omega(l)} \nabla_a(l)J'^a[\varphi(l),\varphi^*(l);z(l),z^*(l)]d\Omega(l)$$

respectively. These last expressions being respectively equal to $-£_X(l)C(l)$ and $-£_{X^*}(l)C(l)$ (decreases of PSI-charges), one finally gets:

$$-£_X(l)C(l) = -\int_{\Omega(l)} £_X(l)\rho[\varphi(l),\varphi^*(l);z(l),z^*(l)]d\Omega(l) = \int_{\Omega(l)} \nabla_a(l)J^a[\varphi(l),\varphi^*(l);z(l),z^*(l)]d\Omega(l)$$
$$-£_{X^*}(l)C(l) = -\int_{\Omega(l)} £_{X^*}(l)\rho[\varphi(l),\varphi^*(l);z(l),z^*(l)]d\Omega(l) = \int_{\Omega(l)} \nabla_a(l)J'^a[\varphi(l),\varphi^*(l);z(l),z^*(l)]d\Omega(l)$$

which are nothing else but the integral expressions of (5).

Corollary: If $\varphi(l)$ is analytic on OW or an open set U of it, then $£_{X^*}\rho = 0$ on OW or U.

Indeed, from lemma 1, $\varphi(l)$ is analytic on OW or U => $J' = 0$ on OW or U and from (5b), this implies that $£_{X^*}\rho = 0$ on OW or U.

We are now ready to give a physico-mathematical definition of *spirits* and *souls*.

2 – Elementary PSI-fields and waves

We first look at the "static" situation, limiting ourselves to the real domain. Similar constructions are done in **C**.

Definition 4: A *real scalar PSI-field* on IW is an application Ψ: IW -> **R** solution of a set of functional equations of the form:

(6s) $\quad F[\Psi,\varphi(l),\varphi^*(l)] = K\rho[\varphi(l),\varphi^*(l)]$

where K is an *external (or "material") coupling constant*. A *real vector PSI-field* on IW is an application Ψ: IW -> $\mathbf{R}^3$ solution of a set of functional equations of the form:

(6v) $\quad F^a[\Psi^b,\varphi(l),\varphi^*(l)] = \frac{1}{2} K^a_b\{J^b[\varphi(l),\varphi^*(l);z(l),z^*(l)] + J'^b[\varphi(l),\varphi^*(l);z(l),z^*(l)]\}$ $\quad$ (a,b = -,0,+)

where the K^a_bs are *internal (or "virtual") coupling constants*.

The "dynamic" situation can be similarly defined, replacing PSI-fields Ψ by their *flows* $\Psi_{[z(l),z^*(l)]}$ on IWxOW, such that, over each structured object $[z(l),z^*(l)]$ of OW, $\Psi_{[z(l),z^*(l)]}$ is a scalar or vector PSI-field satisfying definition 4. In practical applications, one usually demands that PSI-fields be at least C^2 on IW or an open set V of it and C^1 on OW or an open set U of it. Furthermore, if the medium is isotropic, then $K^a_b = K'\delta^a_b$ and the internal coupling constants can be reduced to a single one.

Definition 5: A *real scalar (resp. vector) PSI-wave* on IW is a homogeneous solution of (6s) [resp. (6v)].

In other words, a real scalar PSI-wave on IW is a solution of $F[\Psi,\varphi(l),\varphi^*(l)] = 0$ and a real vector PSI-wave on IW is a solution of $F^a[\Psi^b,\varphi(l),\varphi^*(l)] = 0$. In the dynamical situation, these equations become $F[\Psi,\varphi(l),\varphi^*(l);z(l),z^*(l)] = 0$ and $F^a[\Psi^b,\varphi(l),\varphi^*(l);z(l),z^*(l)] = 0$ respectively. Thus, just like ordinary waves are source-free fields, PSI-waves are source-free PSI-fields.
From vector PSI-fields and waves, one can build tensor PSI-fields and waves of any rank tensoring upon the vielbeins $\varepsilon_a[\varphi(l),\varphi^*(l)]$ and $\varepsilon^*_a[\varphi(l),\varphi^*(l)]$ of IW. For instance:

$$\Psi^{ab}\varepsilon_a\varepsilon_b \ , \ \Psi^{ab^*}{}_c\varepsilon_a\varepsilon^*{}_b\varepsilon^c \ ,\ldots$$

The same obviously holds for PSI-sources.

Definition 6: (Spirits and souls)
Let p be a non-negative integer. A *spirit of rank p* is a p-tensor PSI-field on IW. A *soul of rank p* is a p-tensor PSI-wave on IW.

In particular, a spirit (resp. soul) of rank 0 is a scalar PSI-field (resp. PSI-wave); a spirit (resp. soul) of rank 1 is a vector PSI-field (resp. PSI-wave). An example of a soul of rank 0 is the gravitational vacuum $V_{int}[\varphi(l),\varphi^*(l)]$ of IW (and c.c.). An example of a spirit of rank 1 is the vielbein $\varepsilon_a[\varphi(l),\varphi^*(l)]$ (and c.c.) of IW, which represents the gravitational field on IW. An example of a spirit of rank 2 is the metrical tensor $\gamma_{ab} = Tr_3(\varepsilon_a\varepsilon^*{}_b)$ on IW, with $Tr_3(.)$ the trace of SU(3).

3 – Structured PSI-fields and waves

All that has been said and done until now is restricted to elementary (i.e. non structured) PSI-fields. To understand the functioning principles of collective PSI-phenomena such as global consciousness, Jung's collective unconscious or Sheldrake's morphic fields (his so-called *formative causation*), we need go a step still further and consider *structured* PSI-fields and waves or, in the "spiritual" language we adopted in the previous section, *structured spirits and souls*.
The mathematical process is the same as for substantial objects of OW and wavy patterns of IW. Wavy patterns $[\varphi(l),\varphi^*(l)]$ of IW are now considered as being *individual subjects* (in quantum duality with *individual objects* $[z(l),z^*(l)]$ of OW). We give ourselves a probability distribution:

(7) $P[\varphi(l),\varphi^*(l);\eta(l),\eta^*(l)]$

For instance, the centred Gaussian law:

(8) $P[\varphi(l),\varphi^*(l);\eta(l),\eta^*(l)] = [2\pi|\eta(l)|^2]^{-3/2}\exp[-|\varphi(l)|^2/2|\eta(l)|^2]$

with $|\varphi(l)|^2 = \varphi^a(l)\varphi^*{}_a(l)$ and a similar expression for $|\eta(l)|^2$, the scalar product having to be computed with respect to the *conformal* metric on IW. We then get a higher-level scale, namely $L = |\eta(l)|$, where $\eta^a(l)$ and c.c. are fluctuations.

Definition 7: L is called the *PSI-scale*. It is the scale of collective PSI-processes.

What this amounts to is that we now have stochastic states $[\Phi(L,l),\Phi^*(L,l)]$ in place of individual wavy patterns $[\varphi(l),\varphi^*(l)]$, with mean values:

(9a) $<\Phi^a(L,l)> = \int_{\Omega(l)} \varphi^a(l)P[\varphi(l),\varphi^*(l);\eta(l),\eta^*(l)]d\Omega(l)$
(9b) $<\Phi^{*a}(L,l)> = \int_{\Omega(l)} \varphi^{*a}(l)P[\varphi(l),\varphi^*(l);\eta(l),\eta^*(l)]d\Omega(l)$

where $\Omega(l)$ is a given volume of IW containing all the wavy patterns involved in the collective process, and fluctuations:

$$(10) \qquad L^2 = \langle\Phi^a(L,l)\Phi^*_a(L,l)\rangle = \int_{\Omega(l)} \varphi^a(l)\varphi^*_a(l)P[\varphi(l),\varphi^*(l);\eta(l),\eta^*(l)]d\Omega(l)$$

with L, the PSI-scale, function of the complexity scale l. Applying the Prigogine trick then enables one to reason in the randomized frame of the $[\Phi(L,l),\Phi^*(L,l)]$s and use deterministic PSI-fields and waves to describe collective phenomena in IW. So, we are set back to the previous section with the $[\Phi(L,l),\Phi^*(L,l)]$s replacing the $[\varphi(l),\varphi^*(l)]$s, the new evolution operator $\Xi(L,l)$ connecting the individual wavy pattern $\varphi(l)$ to the structured one $\Phi(L,l)$:

$$(11) \qquad \Phi(L,l) = \Xi(L,l)\varphi(l) \ , \ \Xi(0,l) = Y(l) \qquad \text{(Heaviside's distribution)}$$

4 – Global Consciousness [N]

We now have enough theory to propose a general solution to the global consciousness problem. We begin with fixing the complexity scale l to that of the brain (0.1m for the human specie) and we see *minds* as highly structured wavy patterns of characteristic "size" l. We will consider them *globally*, as a whole. So, we assume that the wavy patterns $[\varphi^a(l),\varphi^{*a}(l)]$ which mathematically model them contain all their intrinsic complexity*, including the characteristics of the specie in question*, and this complexity is given by the evolution operator U(l) at scale l: $\varphi(l) = U(l).\varphi(l_{min})$ and c.c., with l_{min} the minimal complexity scale, that we can fix at the micrometer scale ($1\ \mu m = 10^{-6}m$). This minimal scale will then be that of neurons and $[\varphi^a(l_{min}),\varphi^{*a}(l_{min})]$ will model "elementary" neuro-chemical signals.
A mind is a PSI-charge c(l). As an ordinary charge (mass included), it can be either positive, negative or zero. Any objective variation will generate individual PSI-currents $J^a = c(l)u^a(l)$ and $J'^a = c(l)v^a(l)$. Therefore, each mind is a "PSI-generator" or a "PSI-pump", depending on whether the energy of the PSI-field (or "PSI-energy") it produces is positive or negative.
Let us now turn to a large group of N individual minds, distributed all around the world, with no particular affinities between them. In non-critical situations, each one of them produces his own PSI-field according to the previous processes. Consequently, they are *mentally disconnected*.
Each mind carrying a PSI-charge c_α ($\alpha = 1,\ldots,N$), the total PSI-charge distribution is given by (2). There is a single PSI-field covering all minds, it is an application $\Psi[\varphi(l),\varphi^*(l)]$ on IW. If it is dynamical, it also explicitly depends on parameters $[z^i(l),z^{*i}(l)]$ of OW. As such fields are collective here, they will correspond to collective spirits of rank n. Ψ is generated by the psychological system made of the N minds. So, it covers all of them and varies from one mind to another. When N is very large, Ψ can be seen as a continuous PSI-medium. It is then a solution of a set of PSI-field equations with minds as PSI-sources. Statistically, its internal dynamics also depends on two sets of parameters: order parameters and structure parameters. Order parameters are made of PSI-currents and PSI-fields. Structure parameters are socio-psychological, analogue to thermodynamical parameters: socio-psychological disorder is measured by an entropy, socio-psychological agitation stands for temperature, there is the notion of socio-psychological pressure (a mental pressure) and the last structure parameter is the population density. In normal situations, the socio-psychological entropy is maximal, meaning the PSI-medium is highly symmetric.
What happens when a critical situation occurs?
Our fellow's attention is captured and a collective phenomenon happens, as individual minds are reorientated towards a single direction, that of the crisis. The PSI-scale $L = |\eta(l)|$ diverges, meaning the individual PSI-field generated by a single PSI-source extends to all individuals involved. The transition is thus second-order, with a spontaneous or provoked symmetry breaking, the PSI-medium looses symmetry, its socio-psychological entropy decreases and a partitioning in energetically favourable and unfavourable domains appears. The situation is similar to the appearance of Weiss domains in a ferromagnetic: energetically favourable domains will grow, as they are filled with individuals feeling concerned about the crisis, while energetically unfavourable domains, filled with

individuals not concerned with the crisis, will simply reorientate towards a collective configuration maximizing their potential PSI-energy.

We argue that what is observed on EGGs (ElectroGaïaGrams) is a PSI-scale effect and not an ordinary scale one and that the weak signal/noise ratio is due to the fact that measures are done with respect to the objective world OW and not to the subjective world IW, which is the suitable one. Therefore, pertinent PSI-informations are drown into quantum noise and it is very hard if not technically impossible to get a coherent structure out of experimental datas. One faces a similar problem with so-called Electronic Voice Phenomenon (EVP), hence the legitimacy of the scientific doubt about it.

The potential PSI-energy can be described by a Landau model:

$$(12) \qquad P(\Psi^2) = a_0\Psi^2/2! + a_2\Psi^4/4! + \ldots + a_{2n}\Psi^{2n}/(2n)! + \ldots$$

where the a_{2n} depend on the structure parameters. Notice that a_0 plays the role of the "mass" of Ψ. In the n = 1 approximation (Higg's model), the minima of (12) are given by:

$$(13) \qquad dP/d\Psi = a_0\Psi + a_2\Psi^3/3! = 0 \Rightarrow \Psi_0 = 0 \,,\ \Psi_1 = +(-3!a_0/a_2)^{1/2} \,,\ \Psi_2 = -(-3!a_0/a_2)^{1/2}$$

The minimum $\Psi_0 = 0$ is no longer stable if $a_0 < 0$ since $d^2P/d\Psi^2 = a_0 < 0$. However, for the new minima Ψ_1 and Ψ_2 to arise, one also needs $a_2 > 0$. Above the transition threshold, Ψ is highly symmetric and the only minimum is $\Psi_0 = 0$. This minimum is stable when $a_0 > 0$. Below the transition threshold, Ψ has lower symmetry and the zero-states are Ψ_1 and Ψ_2.

<u>Definition 8</u>: The zeros of $dP/d\Psi$, where $P(\Psi,\Psi^*)$ is the potential PSI-energy of the PSI-field Ψ, are called the *Zen states* of Ψ.

Consider now the Earth. Topologically, it is a Riemann sphere S^3, as it has SO(3)-symmetry (spheric symmetry). This means that an object like the Earth is a geometrical object of OW with SU(2) symmetry up to the sign, since $SO(3) \cong SU(2)/\mathbf{Z}^2$. By the wave-matter duality, we so deduce that there exists a "virtual" (i.e. non-substantial) dual to the Earth, with same symmetry.

<u>Definition 9</u>: the dual to the Earth through the wave-matter duality is called the *virtual Gaïa*.

The virtual Gaïa is therefore an object of the Inner World IW. As living beings are distributed on the surface of the Earth, their minds are distributed on the surface (i.e. the boundary) of the virtual Gaïa. What makes minds "stick" to that surface is the gravitational field $e_a[\varphi(l),\varphi^*(l)]$, $e^*_a[\varphi(l),\varphi^*(l)]$ of the virtual Gaïa, just as substantial bodies stick to the surface of the Earth thanks to its gravitational field $e_i[z(l),z^*(l)]$, $e^*_i[z(l),z^*(l)]$.

<u>Definition 10</u>: A *conscious mind* is a mind that can perceive the objective reality, that is, a mind which is connected to the Outer World OW through the Quantum World QW *and back*: there is a *two-way* mapping

$$(14) \qquad \Omega(l) \leftrightarrow QW \leftrightarrow OW$$

where $\Omega(l)$ is an open set of IW centred on the conscious mind $[\varphi(l),\varphi^*(l)]$.

Notice, however, the fact that the mapping (14) being two-way does not imply that the correspondence between $\Omega(l)$ and OW is one-to-one for as much.

We can now give an acceptable definition of *Teilhard de Chardin's noospheres*.

Definition 11: A *Teilhard de Chardin's noosphere* is a *sphere of consciousness*, that is, a sphere onto which all conscious minds of a given specie are distributed.

We thus do not have a single noosphere, but as many as there are species with a brain/mind system.

5 – Sheldrake's Formative Causation [S1,2,3]

Sheldrake's formative causation is based on the self-organization of ordinary fields and waves that leads to the building of wavy patterns. The main result we are going to establish in this final section is therefore the following theorem on morphogenesis:

Morphogenetic Theorem: Sheldrake's Morphic Fields are wavy patterns of increasing complexity.

Before proving this theorem, we first define Jung's Archetypes and associated processes, as they will be useful in the proof.

Definition 12 (Jung's Archetypes)
A *Jung Archetype of complexity l* is a wavy pattern [A(l),A*(l)] such that [A(l),A*(l)] is the mean value (9a-b) of a collective state [Φ(L,l),Φ*(L,l)], L being a PSI-scale. A Jung Archetype is also called a *collective unconscious*.

A Jung collective unconscious is therefore much more general than a conscious mind, as it appears as the mean value of a (discrete or dense) collection of conscious minds belonging to the same class (and thus, carrying the same characteristics). As a direct consequence of its definition:

Lemma 2: A Jung Archetype is *PSI-scale-independent*.

Proof: this is clear from the very definition of a statistical mean value.

Any stochastic state [Φ(L,l),Φ*(L,l)] on IW can be built out of its Jung's Archetype [A(l),A*(l)] up to fluctuations [η(l),η*(l)]:

(15) $\Phi(L,l) = A(l) + \eta(l)$, $\Phi^*(L,l) = A^*(l) + \eta^*(l)$, $L^2 = |\eta(l)|^2$

Definition 13 (Personality)
The fluctuating part [η(l),η*(l)] in (15) is called *personality*.

Definition 14 (Objectification and subjectification)
Let p: QW -> OW and q: QW -> IW be the natural projections from the Quantum World to the Structured Outer World and to the Structured Inner World, respectively. The *objectification process* is a quantum transformation Obj: IW -> OW such that Obj := poq^{-1} and the *subjectification process* is the reciprocal quantum transformation Subj: OW -> IW such that Subj := qop^{-1}.

We are now ready to establish the

Proof of the Morphogenetic Theorem:

It will be a biophysical proof, done step by step by recurrence. Our work frame will be OW, as it is the physical frame in which phenomena are observed and measured. So, wavy patterns, Jung's Archetypes and personalities will be objectified and the representation will be the field representation $\varphi^a = \varphi^a[z(l),z^*(l)]$ (a = -,0,+), hence the differences in the way the structure operators Cut, Copy and Paste act when applied to structured objects [z(l),z*(l)] of OW or to wavy patterns [φ(l),φ(l)] (or [Φ(L,l),Φ*(L,l)] in the collective case). See below. Thnaks to the wave-matter duality, a similar proof can be established in IW only replacing the $z^i(l)$s (i = 1,2,3) by the $\varphi^a(l)$s and the $\Phi^a(L,l)$s by collective objects $Z^i(L,l)$ (and c.c.), the PSI-scale remaining the same.

Step 1

It is the longest, as we have to detail all the structure rules and operations that we need.
Our fundamental elements are atoms, which we assume to be point-like, meaning we do not worry about their composite structures. The complexity scale is therefore minimal, of order the Angstrom: $l_{atom} \sim 10^{-10}$m. Let $C(l_{atom})$ be a finite collection of atoms containing at least the C-H-O-N quadruplet (Carbon, Hydrogen, Oxygen and Nitrogen). Projected onto OW, these atoms exhibit their corpuscular behaviour, while projected onto IW, they exhibit their wavy behaviour. Consequently, to each corpuscular atom in OW is associated an elementary atomic wave $[\varphi(l_{atom}),\varphi^*(l_{atom})]$ in IW and conversely, through the wave-matter duality, which reduces to the wave-corpuscle duality at $l = l_{atom}$. All the atoms constituting the collection $C(l_{atom})$ are likely to combine, forming molecules. The links between them being electro-chemical, these links are of a purely wavy nature. In other words, waves link matter. Atomic waves superpose and interfere. However, only constructive interferences can give a link and only stable configurations can form. Stability can be strong or weak. Unstable configurations are destroyed by internal or external perturbations. There so exists selection rules based on constructive interferences and global stability that rules the ways molecules can form from our base collection $C(l_{atom})$ of atoms. Such processes are the basics of chemistry. For instance, taking C and H, aromatic molecules have chemical formulas C_nH_{2n+2} with n, a positive integer. Their shapes is determined by the topology of their electrochemical links and one can extract topological invariants, such as the number of holes, for instance.
Constructive interferences of atomic waves, global stability based on a Lyapunov criterion [GS] and global control of the molecular structures based on a Pontryaguin principle of maximal energy [M,B] are the main biophysical structure rules. As for basic operations, they are: cut, copy and paste. Atoms being assumed to be elementary, they cannot be cut. If $[z(l_{atom}),z^*(l_{atom})]$ represents the point-like atom in OW:

(16a) $\mathrm{Cut}.z(l_{atom}) = 0$ (and c.c.)

The “Paste” operation is a mere concatenation:

(16b) $z_1(l_{atom}).\mathrm{Paste}.z_2(l_{atom}).\mathrm{Paste}\ldots\mathrm{Paste}.z_{N(atom)}(l_{atom}) = z_1(l_{atom})\oplus z_2(l_{atom})\oplus\ldots\oplus z_{N(atom)}(l_{atom})$

where $\oplus$ is the concatenation operator and $N(atom) = \mathrm{Card}[C(l_{atom})]$. In particular:

(16c) $\mathrm{Paste}(p).z(l_{atom}) = z(l_{atom})\oplus z(l_{atom})\oplus\ldots\oplus z(l_{atom})$ (p times) $= pz(l_{atom})$

for any positive integer p. Notice that a same atom can be found at different places in a given molecular structures. “Copy” replicates an atom:

(16d) $\mathrm{Copy}(p).z(l_{atom}) = [z(l_{atom}),z(l_{atom}),\ldots,z(l_{atom})]$ p times.

For atomic waves, things are different. One has:

(17a) $\mathrm{Cut}(p).\varphi(l_{atom}) = \varphi(l_{atom})/p = \mathrm{Copy}(p).\varphi(l_{atom})$
(17b) $\mathrm{Paste}(p).\varphi(l_{atom}) = \varphi(l_{atom})\oplus\varphi(l_{atom})\oplus\ldots\oplus\varphi(l_{atom})$ (p times) $= p\varphi(l_{atom}) = \varphi(l_{atom})$

for any positive integer p. As for the Paste operation, it is a set of constructive interferences making a *single* wave:

(17c) $\varphi_1(l_{atom}).\mathrm{Paste}.\varphi_2(l_{atom}).\mathrm{Paste}\ldots\mathrm{Paste}.\varphi_{N(atom)}(l_{atom}) = \varphi_1(l_{atom})\oplus\varphi_2(l_{atom})\oplus\ldots\oplus\varphi_{N(atom)}(l_{atom})$
$= \varphi_{1\ldots N}(l_{atom})$

Since atoms are assumed to be elementary in this proof, they have same Jung's Archetype $A(l_{atom})$ given by (9):

(18) $A^a(l_{atom}) = \langle\Phi^a(L,l_{atom})\rangle = \int_{\Omega(latom)} \varphi^a(l_{atom})P[\varphi(l_{atom}),\varphi^*(l_{atom});\eta(l_{atom}),\eta^*(l_{atom})]d\Omega(l_{atom})$

and c.c. Divergences between atomic waves can be computed as the PSI-scale:

(19) $L^2(l_{atom}) = \langle\Phi^a(L,l_{atom})\Phi^*_a(L,l_{atom})\rangle = |\eta(l_{atom})|^2 =$
$= \int_{\Omega(latom)} \varphi^a(l_{atom})\varphi^*_a(l_{atom})P[\varphi(l_{atom}),\varphi^*(l_{atom});\eta(l_{atom}),\eta^*(l_{atom})]d\Omega(l_{atom})$

The biological result is a new finite collection $C(l_{mol})$ of stable molecules synthesized from the base collection $C(l_{atom})$ of atoms (ions included). $C(l_{mol})$ contains $C(l_{atom})$ as well as the five nucleotides A,C,G,T and U. The molecular scale $l_{mol} \sim 1nm = 10^{-9}m$. Atomic informations are stored in collective states $[\Phi(L,l_{atom}),\Phi^*(L,l_{atom})]$ and are objectified when projected onto OW through the Quantum World QW. In particular, the atomic personality $[\eta(l_{atom}),\eta^*(l_{atom})]$ is objectified into specific corpuscular characteristics $[\xi(l_{atom}),\xi^*(l_{atom})]$, thus enabling differentiation as soon as the elementary level. As for the Jung atomic Archetype making molecules, it is the same for all atoms, that is, a point-like object surrounded by a spherical wave in the objective representation. Molecular information is preserved, while atomic information is averaged through the Cut, Copy and Paste operations, which reduce atomic collective states $[\Phi^a(L,l_{atom}),\Phi^{*a}(L,l_{atom})]$ to their Jung Archetype $[A^a(l_{atom}),A^{*a}(l_{atom})]$ [see (18)]. Coherent molecular structures appear, decreasing atomic entropy.

Step 2

We renew the whole procedure of Step 1 on the collection $C(l_{mol})$, regarding molecular structures as the new "point-like" objects (the new "base bricks"). To the corpuscular molecule $[z(l_{mol}),z^*(l_{mol})]$ is associated a molecular wave $[\varphi(l_{mol}),\varphi^*(l_{mol})]$ through the wave-matter duality. Molecular combinations and chainings follow the same structure rules as in the previous step. Cut, Copy and Paste operations act as follows:

- For molecular structures:

(20a) $Cut(p).z(l_{mol}) = [z_1^{(q1)}(l_{atom}),\dots,z_p^{(q_p)}(l_{atom})]$ for $1\le p\le N$, $Cut(p).z(l_{mol}) = 0$ for $p > N$

where N is the total number of atoms making a given molecule and we included the electrical charges $(q_1,\dots,q_p)$ of atoms so that $q_\alpha = 0$ for electrically neutral atoms and $q_\alpha = \pm$ for ions ($\alpha = 1,\dots,p$).

(20b) $Copy(p).z(l_{mol}) = [z(l_{mol}),\dots,z(l_{mol})]$ p times
(20c) $z_1(l_{mol}).Paste.z_2(l_{mol}).Paste\dots Paste.z_{N(mol)}(l_{mol}) = z_1(l_{mol})\oplus z_2(l_{mol})\oplus\dots\oplus z_{N(mol)}(l_{mol})$

with $N(mol) = Card[C(l_{mol})\backslash C(l_{atom})]$, the total number of synthesized molecules. (20a,b,c) then leads to macromolecules such as enzymes and the DNA/RNA couple. Notice in passing that the DNA double helix is left-hand as are neutrinos. This shows that chiral asymmetry is present at complexity scales much higher than the particle one. The direct consequence of (20c) is

(20d) $Paste(p).z(l_{mol}) = pz(l_{mol})$

- For molecular waves, now:

(21a) $Cut(p).\varphi(l_{mol}) = \varphi(l_{mol})/p = Copy(p).\varphi(l_{mol})$
(21b) $Paste(p).\varphi(l_{mol}) = p\varphi(l_{mol}) = \varphi(l_{mol})$
(21c) $\varphi_1(l_{mol}).Paste.\varphi_2(l_{mol}).Paste\dots Paste.\varphi_{N(mol)}(l_{mol}) = \varphi_1(l_{mol})\oplus\varphi_2(l_{mol})\oplus\dots\oplus\varphi_{N(mol)}(l_{mol})$
$= \varphi_{1\dots N}(l_{mol})$

meaning a molecular wave behaves like an atomic one. What guarantees the validity of (21a,b,c) is the fact that the mathematical representation of $\varphi(l_{mol})$ is *irreducible*, because of internal correlations (inter-dependence of the linked atomic components): once the molecule is formed and stabilized, its wave makes a single physical entity, despite its composite.

The molecular Jung Archetype is:

(22) $A^a(l_{mol}) = <\Phi^a(L,l_{mol})> = \int_{\Omega(lmol)} \varphi^a(l_{mol})P[\varphi(l_{mol}),\varphi^*(l_{mol});\eta(l_{mol}),\eta^*(l_{mol})]d\Omega(l_{mol})$

while molecular divergences are computed by:

(23) $L^2(l_{mol}) = <\Phi^a(L,l_{mol})\Phi^*_a(L,l_{mol})> = |\eta(l_{mol})|^2 =$
$= \int_{\Omega(lmol)} \varphi^a(l_{mol})\varphi^*_a(l_{mol})P[\varphi(l_{mol}),\varphi^*(l_{mol});\eta(l_{mol}),\eta^*(l_{mol})]d\Omega(l_{mol})$

The biological result is a new finite collection $C(l_{mac})$ of stable macromolecules synthesized from the base collection $C(l_{mol})$ of molecules. $C(l_{mac})$ contains $C(l_{mol})$ and, in particular, the DNA/RNA cycle. The macromolecular scale $l_{mol} \sim 10nm = 10^{-8}m$. Molecular informations are stored in collective states $[\Phi(L,l_{mol}),\Phi^*(L,l_{mol})]$ and are objectified when projected onto OW through the Quantum World QW. In particular, the molecular personality $[\eta(l_{mol}),\eta^*(l_{mol})]$ is objectified into specific corpuscular characteristics $[\xi(l_{mol}),\xi^*(l_{mol})]$, thus enabling molecular differentiation. As for the molecular Jung Archetype $[A(l_{mol}),A^*(l_{mol})]$ making molecules, it is the same for all molecules, that is, a 1D chain of point-like objects surrounded by a single wave in the objective representation. This chain can be open or closed (*cyclic molecules*). Macromolecular information is preserved, while molecular information is averaged through the Cut, Copy and Paste operations, which reduce molecular collective states $[\Phi^a(L,l_{mol}),\Phi^{*a}(L,l_{mol})]$ to their Jung Archetype $[A^a(l_{mol}),A^{*a}(l_{mol})]$ [see (22)]. Coherent macromolecular structures appear, decreasing molecular entropy.

<u>Step 3</u>

The procedure should now become to be quite familiar, as it is always the same. To the corpuscular macromolecule $[z(l_{mac}),z^*(l_{mac})]$ is associated a macromolecular wave $[\varphi(l_{mac}),\varphi^*(l_{mac})]$ through the wave-matter duality. Cut, Copy and Paste operations remain the same as in step 2, replacing l_{mol} by l_{mac} and l_{atom} by l_{mol}. In particular, we retrieve the replication trick of genetics.

The biological result is a new finite collection $C(l_{prot})$ of stable proteins synthesized from the base collection $C(l_{mac})$ of macromolecules. $C(l_{prot})$ contains $C(l_{mac})$ and, in particular, all the proteins coded by the DNA/RNA cycle. The proteic scale $l_{prot} \sim 100nm = 10^{-8}m$. Macromolecular informations are stored in collective states $[\Phi(L,l_{mac}),\Phi^*(L,l_{mac})]$ and are objectified when projected onto OW through the Quantum World QW. In particular, the macromolecular personality $[\eta(l_{mac}),\eta^*(l_{mac})]$ is objectified into specific corpuscular characteristics $[\xi(l_{mac}),\xi^*(l_{mac})]$, thus enabling macromolecular differentiation. As for the macromolecular Jung Archetype $[A(l_{mac}),A^*(l_{mac})]$ making macromolecules, it is the same for all macromolecules, that is, a 1D chain of molecular Archetypes surrounded by a single wave in the objective representation. Again, this chain can be open or closed (*cyclic macromolecules*). Proteic information is preserved, while macromolecular information is averaged through the Cut, Copy and Paste operations, which reduce macromolecular collective states $[\Phi^a(L,l_{mac}),\Phi^{*a}(L,l_{mac})]$ to their Jung Archetype $[A^a(l_{mac}),A^{*a}(l_{mac})]$. Coherent proteic structures appear, decreasing macromolecular entropy.

We now live the mechanico-chemical realm of so-called *inert systems* to enter that of *living systems*.

<u>Step 4</u>

The procedure remains obviously the same. But complexity is now high enough to build *autonomous* system, that is, complex systems satisfying the

Autonomy Principle: A given complex system is said to be autonomous if and only if it can manage the whole of its internal functioning by itself and, in particular, all energy and fluid transformations and tranferts from any of its component to any other. □

The biological result is a new finite collection $C(l_{cell})$ of stable living cells synthesized from the base collection $C(l_{prot})$ of proteins. $C(l_{cell})$ contains $C(l_{prot})$. The cellular scale $l_{prot} \sim 1\mu m = 10^{-6}m$. Proteic informations are stored in collective states $[\Phi(L,l_{prot}),\Phi^*(L,l_{prot})]$ and are objectified when projected onto OW through the Quantum World QW. In particular, the proteic personality $[\eta(l_{prot}),\eta^*(l_{prot})]$ is objectified into specific corpuscular characteristics $[\xi(l_{prot}),\xi^*(l_{prot})]$, thus enabling proteic differentiation. As for the proteic Jung Archetype $[A(l_{prot}),A^*(l_{prot})]$ making proteins, it is the same for all proteins, that is, a 3D closed assembly of macromolecular Archetypes surrounded by a single wave in the objective representation. Cellular information is preserved, while proteic information is averaged through the Cut, Copy and Paste operations, which reduce proteic collective states $[\Phi^a(L,l_{prot}),\Phi^{*a}(L,l_{prot})]$ to their Jung Archetype $[A^a(l_{prot}),A^{*a}(l_{prot})]$. Coherent cellular structures appear, decreasing proteic entropy.

Step 5

The biological result is a new finite collection $C(l_{ptis})$ of stable prototissues synthesized from the base collection $C(l_{cell})$ of living cells. $C(l_{ptis})$ contains $C(l_{cell})$. The prototissular scale $l_{ptis} \sim 10\mu m$ to $100\mu m$. Cellular informations are stored in collective states $[\Phi(L,l_{cell}),\Phi^*(L,l_{cell})]$ and are objectified when projected onto OW through the Quantum World QW. In particular, the cellular personality $[\eta(l_{cell}),\eta^*(l_{cell})]$ is objectified into specific corpuscular characteristics $[\xi(l_{cell}),\xi^*(l_{cell})]$, thus enabling cellular differentiation. Cellular division is a straightforward consequence of the Cut operation acting on cellular fields, while cellular adherence is of the Paste operation acting on the external membranes of the cells. As for the cellular Jung Archetype $[A(l_{cell}),A^*(l_{cell})]$ making living cells, it is the same for all cells, that is, a 2D closed assembly of proteic Archetypes surrounded by a single wave in the objective representation. Prototissular information is preserved, while cellular information is averaged through the Cut, Copy and Paste operations, which reduce cellular collective states $[\Phi^a(L,l_{cell}),\Phi^{*a}(L,l_{cell})]$ to their Jung Archetype $[A^a(l_{cell}),A^{*a}(l_{cell})]$. Coherent prototissular structures appear, decreasing cellular entropy.

Step 6

The biological result is a new finite collection $C(l_{tis})$ of stable tissues synthesized from the base collection $C(l_{ptis})$ of prototissues. $C(l_{tis})$ contains $C(l_{ptis})$. The tissular scale $l_{tis} \sim 1mm$ to $0.1m$. Prototissular informations are stored in collective states $[\Phi(L,l_{ptis}),\Phi^*(L,l_{ptis})]$ and are objectified when projected onto OW through the Quantum World QW. In particular, the prototissular personality $[\eta(l_{ptis}),\eta^*(l_{ptis})]$ is objectified into specific corpuscular characteristics $[\xi(l_{ptis}),\xi^*(l_{ptis})]$, thus enabling prototissular differentiation. Prototissular separation is a straightforward consequence of the Cut operation acting between pasted external cellular membranes. As for the prototissular Jung Archetype $[A(l_{ptis}),A^*(l_{ptis})]$ making prototissues, it is the same for all prototissues, that is, a flabby and weakly dense assembly of cellular Archetypes surrounded by a single wave in the objective representation. Tissular information is preserved, while prototissular information is averaged through the Cut, Copy and Paste operations, which reduce prototissular collective states $[\Phi^a(L,l_{ptis}),\Phi^{*a}(L,l_{ptis})]$ to their Jung Archetype $[A^a(l_{ptis}),A^{*a}(l_{ptis})]$. Coherent tissular structures appear, decreasing prototissular entropy.

Step 7

The biological result is a new finite collection $C(l_{org})$ of stable organs synthesized from the base collection $C(l_{tis})$ of tissues. $C(l_{org})$ contains $C(l_{tis})$. The organic scale $l_{org} \sim 10mm$ to $1m$. Tissular informations are stored in collective states $[\Phi(L,l_{tis}),\Phi^*(L,l_{tis})]$ and are objectified when projected onto OW through the Quantum World QW. In particular, the tissular personality $[\eta(l_{tis}),\eta^*(l_{tis})]$ is objectified into specific corpuscular characteristics [$\xi(l_{tis}),\xi^*(l_{tis})$], thus enabling tissular differentiation. As for the tissular Jung Archetype [$A(l_{tis}),A^*(l_{tis})$] making tissues, it is the same for all tissues, that is, a much more consistent and stiffer assembly of prototissular Archetypes surrounded by a single wave in the objective representation. Organic information is preserved, while tissular information is averaged through the Cut, Copy and Paste operations, which reduce tissular collective states [$\Phi^a(L,l_{tis}),\Phi^{*a}(L,l_{tis})$] to their Jung Archetype [$A^a(l_{tis}),A^{*a}(l_{tis})$]. Coherent organic structures appear, decreasing tissular entropy.

Step 8

The biological result is a new finite collection $C(l_{ORG})$ of stable organisms synthesized from the base collection $C(l_{org})$ of organs. $C(l_{ORG})$ contains $C(l_{org})$. The organism scale l_{ORG} ~ 1cm to 10m. Organic informations are stored in collective states [$\Phi(L,l_{org}),\Phi^*(L,l_{org})$] and are objectified when projected onto OW through the Quantum World QW. In particular, the organic personality [$\eta(l_{org}),\eta^*(l_{org})$] is objectified into specific corpuscular characteristics [$\xi(l_{org}),\xi^*(l_{org})$], thus enabling organic differentiation (and specialization, as a direct consequence). As for the organic Jung Archetype [$A(l_{org}),A^*(l_{org})$] making organs, it is the same for all organs, that is, a consistent assembly of tissular Archetypes surrounded by a single wave in the objective representation. Organism information is preserved, while organic information is averaged through the Cut, Copy and Paste operations, which reduce organic collective states [$\Phi^a(L,l_{org}),\Phi^{*a}(L,l_{org})$] to their Jung Archetype [$A^a(l_{org}),A^{*a}(l_{org})$]. Coherent organisms appear, decreasing organic entropy.

The procedure should stop at some finite step S for which entropy is either zero (deterministic systems) or too weak to permit a new application of the Cut, Copy and Paste operations. So, the length of the complexity chain is controlled by entropy alone and this is quite remarkable. As we do not know the value of S yet, we cannot rigorously assert that our present proof is complete. But we doubt that this value is S = 9, or even S = 10, as S = 9 is the step of animal societies and S = 10 can be that of animal civilizations (assembly of animal societies). We leave the reader make his (her) own deductions about these two next steps, applying the same procedure as in previous steps.

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