

This article was downloaded by: [András Balázs]

On: 22 November 2013, At: 11:21

Publisher: Routledge

Informa Ltd Registered in England and Wales Registered Number: 1072954
Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH,
UK



World Futures: The Journal of Global Education

Publication details, including instructions for authors and subscription information:

<http://www.tandfonline.com/loi/gwof20>

The Ontological Roots of Human Science: the Message of Evolution—The Physics of Freedom (Choice)

András Balázs^a

^a Department of Biological Physics , Eötvös Lóránd University , Budapest, Hungary

Published online: 12 Nov 2007.

To cite this article: András Balázs (2007) The Ontological Roots of Human Science: the Message of Evolution—The Physics of Freedom (Choice), World Futures: The Journal of Global Education, 63:8, 568-583

To link to this article: <http://dx.doi.org/10.1080/02604020701413019>

PLEASE SCROLL DOWN FOR ARTICLE

Taylor & Francis makes every effort to ensure the accuracy of all the information (the "Content") contained in the publications on our platform. However, Taylor & Francis, our agents, and our licensors make no representations or warranties whatsoever as to the accuracy, completeness, or suitability for any purpose of the Content. Any opinions and views expressed in this publication are the opinions and views of the authors, and are not the views of or endorsed by Taylor & Francis. The accuracy of the Content should not be relied upon and should be independently verified with primary sources of information. Taylor and Francis shall not be liable for any losses, actions, claims, proceedings, demands, costs, expenses, damages, and other liabilities whatsoever or howsoever caused arising directly or indirectly in connection with, in relation to or arising out of the use of the Content.

This article may be used for research, teaching, and private study purposes. Any substantial or systematic reproduction, redistribution, reselling, loan, sub-licensing, systematic supply, or distribution in any form to anyone is expressly forbidden. Terms & Conditions of access and use can be found at <http://www.tandfonline.com/page/terms-and-conditions>

THE ONTOLOGICAL ROOTS OF HUMAN SCIENCE: THE MESSAGE OF EVOLUTION—THE PHYSICS OF FREEDOM (CHOICE)

ANDRÁS BALÁZS

Department of Biological Physics, Eötvös Lóránd University, Budapest, Hungary

The original proposal of H. H. Pattee (1971) of basing quantum theoretical measurement theory on the theory of the origin of life, and its far reaching consequences, is discussed in the light of a recently emerging biological paradigm of *internal measurement*. It is established that the “measurement problem” of quantum physics can, in principle, be traced back to the internal material constraints of the biological organisms, where *choice* is a fundamental attribute of the self-measurement of matter. In this light, which is shown to be a consequence of Pattee’s original suggestion, it is proposed that biological evolution is a gradual liberation from the inert unity of “subject” and “object” of inanimate matter (as “natural law” and “initial conditions”), to a split biological existence of them and, as a consequence, the “message of evolution” is *freedom*, rather than complexity in itself. Some classical philosophical systems are brought into context to show that the epistemologies of several strictly philosophical systems of the social sciences are well acquainted with the problem and their solutions support our conclusions.

KEYWORDS: Bearings on the social sciences, biological split between dynamical law and initial conditions, evolution of the embodiment of dynamical law, indirect self-reference, internal quantum measurement.

INTRODUCTION: THE MEASUREMENT PROBLEM IN QUANTUM THEORY

The measurement problem (“quantum ontology”) of quantum theory can be formulated in the following way.

First, let us make clear its significance.

Without any recourse here to the more recent frame of “internal measurement” (e.g., Matsuno, 1989; Conrad, 1993; Balázs, 2004c; see the next section), quantum mechanical measurement (or *actualization*) theories can be regarded in two ways. On one hand, it might be said that their subject matter does not belong logically to quantum dynamics (the time evolution): we are in practice concerned

Address correspondence to András Balázs, Department of Biological Physics, Eötvös Lóránd University, H-1117 Budapest, Pázmány sétány 1., Hungary. E-mail: balazsandras2002@yahoo.com

with the *probability of occurrence* (in a superposition of possible states with different probabilities) of this or that event (state) (in biology we would have quantum electrodynamics in general (e.g., Vitiello, 1996)); so that the so-called measurement-problem (Why is it the case that the unique measuremental outcome is a *particular state*, amounting to the “collapse of the superposition”?) in its usual formulation is an unnecessary “no-go” one (e.g., Primas, 1981). On the other hand, it might be said that it is the *cornerstone* of quantum mechanics: it is the realization (actualization) of a particular state, which is otherwise non-existing (*in the operational sense*) in between quantum measurements. To emphasize this latter view (that we prefer, too), the corresponding measurement theories are called different “*interpretations*” of quantum mechanics (without which we do not know ontologically–epistemologically *what* we are measuring).

To be specific, let us take two *exophysical* and two *endophysical*¹ (Primas, 1992, 1994) measurement theories. Of the first two, the so-called Copenhagen interpretation (e.g., Heisenberg, 1958; Bohr, 1963; Weizsaker, 1971; Stapp, 1972) is similar in structure to the positivistic attitude of relativity theory (what we cannot directly *measure*, does not exist in the strict sense). Quantum dynamics with its superposed probabilities evolving in continuous time refers to evolving “objective tendencies” (Heisenberg, 1993) at best, not reality. The only reality is what is *discontinuously actualized* in a measuremental situation. It is unrepeatable and unique. The “system” and the “measuremental device” have an in principle “*cut*” (the “Heisenberg-cut”) between them. The “system” is described by *quantal*, whereas the “measuremental device” by *classical*, laws. Bohr’s version of this interpretation adds that there are *complementary observables* (properties) (Bohr, 1963), which cannot be observed simultaneously with arbitrary precision, yet are mutually necessary to characterize the “measuremental situation,” the holistic nature of “system + measuremental device.” In his view, this irreducible coupling of the two sides is inherently related to the integrity of Planck’s action constant *h*. Thus, within this interpretation, the actualization process is described as a “quantum jump” from the world of superposed *probabilities (potentialities)* (the “wave packet”) to the world of *real existence* (“reduction of the wave packet”) of one component (see also, e.g., Wigner, 1967).

The ultimate consequence is that in this interpretation, the Universe is a probabilistic “shadow – Universe” without actual measurements, its evolution is that of probabilities, not of real particles, even if due to large masses, it arbitrarily nearly *approximates* the motion of classical objects (“reality”). *Matrix mechanics*, with its *observable* matrix elements (quantum transitions) was a naturally following formulation.

The second exophysical interpretation chosen, due basically to von Neumann, puts under focus the “Heisenberg–cut.” He observes the *in principle arbitrary position* of this “cut” between “system” and “measuremental device.” The second part of this relation, the measuremental device, should in principle be described also by quantum dynamics. Thus an *additional device* is needed to measure the “system + measuremental device” aggregate. And so on. This is known as “Neumann’s infinite regress.” *The measuring device, in fact, can be taken as the extension of our sensory organs*. So the regression passes through our sensory organs, nervous

pathways, the central pathway, up to the brain. The only possible termination is then (human!) *consciousness* (Neumann, 1955; London and Bauer, 1938).

This is also a self-contained and logical construction, even if its consequences are “hair-raising” (Primas, 1981).

In the Copenhagen view, then, sensory organs can be described as entirely *classical* in their functioning, whereas in Neumann’s analysis, it is the end-product of the regression series, that is, *consciousness*, which is conceived to be “*classical*” (in a quantal world) with its highly “non-quantal” nature. We show below that this consequence of having necessarily an *in principle classical component*, holds true in so-called “objective” (“endophysical”) measurement theories, too.

In fact, choosing the so-called Everett interpretation (Everett, 1957), the followings can be noted. Being practically the first real “objective” measurement theory, there is no “collapse” or “reduction of the wave packet” in it. Its basic assumption is that there are “branches” of time-evolving states, *existing* in a parallel fashion, of which the measuremental apparatus plus “*memory*” chooses in the measuremental situation: there are “corresponding states” of the “object” and “measurement apparatus + memory,” where the “state function (wavefunction) of the object” is also expressed by the latter states. This results in a splitting and *choice* of states. We are aware of (registrate) only that “branch” that our memory state chooses, as *existing* in our *special “world”* (the “many-world” hypothesis).

It is, however, implicate in this theory that the assertion “the memory state chooses” is ill-defined, *if the memory is not a priori classical* (e.g., Primas, 1981). Thus, *an a priori classical component enters again the scheme*.

Finally, in the modern so-called decoherence frame, which is also a true endophysical theory, it can be shown that a kind of “Heisenberg-cut” is implicitly supposed again. In fact, in this scheme we order a wave function to the Universe (a so-called *pure state*, a superposition), and choosing an “object system” we note that the object system cannot then have a pure state, too, only a statistical mixture (i.e., the statistical ensemble of a spoiled superposition). The same holds true for its “environment.” The basic assumption is that in the transition from the universal pure state to the “mixed state” of the object, of course a “measurement” can happen *objectively*: the surrounding chooses “what mixture is emerging” from the (“measuremental”) collapse (Zurek, 1981, 1991; Guilini et al., 1996). Practically, a “*decoherence*” is supposed to be transposed from the environmental mixture state to the object state. Thus, as it has been noted, we have again the “Heisenberg-cut” between “system” and its “environment” (the “rest of the Universe”) in our in principle description. So again we are back with subjectivity, at least as an in principle classification (object/environment).

GENERAL CONSIDERATIONS ON PROTOBIOLOGY AND EVOLUTION

Turning now to our more specific subject matter, in 1971 H. H. Pattee published a article with the title “Can Life Explain Quantum Mechanics?” (Pattee, 1971). In it, he advocated the view that the origin of life had to be a *quantum theoretical “measurement process”* with ancient proteins as “*measuring apparatuses*” and ancient

nucleic acids (as copolymers) acting as *measuremental records* of the catalytic “measurements” (the idea being, that it is improbable that quantum measurement began by “classical devices”). In conclusion, the author arrived at the result that the theoretical frame possibly reached would be useful for regarding *both* the origin of life *and* the “measurement problem” of quantum mechanics.

Since that time, a number of authors (e.g., Conrad, 1989; Matsuno, 1989; Gunji, 1992, 1993; Liberman et al., 1989; Igamberdiev, 1993; Balázs, 2003, 2004a) investigated the problem, and by now a certain unanimity has been reached. The basic notion of these authors is quantum-molecular *information processing* within the system (as material indirect self-reference, see later), where *internal quantum measurements*, as mesoscopic, irreversible *processes*, are used for the internal, controlling (processing), regulating task *in general* for (open) quantum systems. This approach would particularly suit biology, as organisms (i.e., in an elementary form, the cell) are considered (by onto- and phylogenetically) *natural molecular computers* (Matsuno, 1995). The common idea of the concept of internal measurement is to *combine* reversible *quantum dynamics* and irreversible (*classical*) *quantum measurement* in a joint *internal* process: technically (e.g., Conrad, 1989); in principle, trying to remain within the usual frame (Balázs, 2003, 2004a,b) and, as its introducer, conceptually between the two (Matsuno, 1989). More recently, Pattee summarized his leading ideas of the field (Pattee, 1993, 1995). Below, we will, in a natural way, be concerned mostly with our own scheme, yet, we will comment on the related concepts of others.

In fact, as a point of departure, based largely on the aforementioned development, trying to go somewhat beyond Pattee’s results, we proposed recently a tentative physical mechanism for the introduction of internal measurement in a consistent scheme *as the origin of the genetic code* as the primordeal quantum theoretical internal measurement process, and hence, in our view, of the origin of life (Balázs, 2003, 2004a,b, 2006).

The central *biological* idea of ours is that a premeval *deterministic* (dynamic) Heisenberg-event happened in the history of the Universe *locally*, in a *self-referential way*. This resulted in a *classical–symbolical record* (or, rather, *memory*) and perturbed *quantum dynamical object system*, as the factorization of the ancient RNA—proto-protein system into *corresponding* (“relative”) states of amino acid residues and coding codons of tRNA-like RNAs within the *same system* (the latter amounting to the self-reference). (We used specifically Everett’s formalism in Balázs (2006), as an appropriate tool for the description of *directed* (*dynamically supported*) *internal measurements*.) The time-reversal symmetry being broken (like in every *exophysical* quantum measurement (Belinfante, 1975; Primas, 1992), which was *represented internally* by the otherwise *endophysical* primordeal biological self-measurement), there may have arisen a natural internal process to *restore* the endophysical time-inversion symmetry, exactly because the measuremental event was *internal* to the system (we termed the required description of this event “endogenous exophysical,” referring to the supposed event as partly exophysical, partly endophysical in its emergence). The resulting “exophysical” system, originating from the premeval self-measurement, dynamically evolves toward the previous primordeal *endophysical* state (time symmetry) by an internal

nonlinear self-referential recursive time series (see also Primas, 1994). Thus the arisal of (*time*) *symmetry restoration* is fundamental in our model of the basic biological process, just like similar symmetry restorations are in the above mentioned corresponding “internal measurement” frames of other authors (see later).

The scheme, briefly sketched above, is based on the *classically functioning* side of biopolymers. For example, the genetic code functions in a highly classical (one-to-one) way (e.g., Primas, 1993). The process is assumed to be excitation (—energy-matter—) dependent. The primary process of living matter is based on this local “dis-unity” (*disequilibrium*): the system, being in a way “excited out” of unity with the rest of the Universe by the proper “endogenous exophysical” *self-measuremental* “quantum jump,” has as its primary internal process to *drive for unity* with the rest of the Universe in a *special biological route of return* to physical equilibration: by regression (to its previous state), that is, along regressive time- reversal *asymmetry relaxation*. As it was indicated, this scheme of ours is closely related to the (similarly arising) “equilibration- “ or “restoration-force” concept of Matsuno (1989) and Conrad (1989) (upon external perturbation of the system).

We note that by the coming about of *additional, symbolic* quasiclassical molecular measuremental record degrees of freedom in the primordeal material self-measurement (i.e., the genetic code), the system is rich enough to allow for the above-stated emergence of *indirect* material self-reference (Hofstadter, 1979) by the corresponding coded proto-proteins, which close the self-reference back on the RNA/DNA system. So the former (the self- reference) is resolved in a natural way by the time reversal process, as a space-like, discrete, *algorithmic* internal measuremental (*reversed*) chain of internal interactions, in accordance with the Post-definition of symbol (time process mapped onto space, Post, 1965; see also Balázs, 2003, 2004a,b). The quantal and classical aspects of biopolymers alternately join the chain (see also later). This process, in our view, forms the appropriate basis for the “symbol- constrained dynamics” of Pattee (e.g., Pattee, 1972a) and its elementary manifestation (as the *reverse process* to the code origin) is the RNA (/DNA) directed production of protein- enzymes (and, in particular, the production of ancient *replicases*).

On the basis of this biological scheme of ours, it is our thesis here that ordinary (inanimate) matter is as well a subject than an object, but this fact is *brought out* (is *observable*) only by biological existence, in connection with the very emergence of *internal measurements*. (A related view is upheld, for example, by Matsuno (1984, 1993) and Conrad (1989).)

In the course of the investigation of these relations in what follows, we try to show that possibly *the quantum theoretical measurement process is a consequence of biological laws*, rather than being a mystery within physics itself (which paradigm is already implicit in Pattee’s results) (compare Matshuno, 1993).

In summary, the general premise underlying the discussion of the present article can be considered in either of two ways. On one hand, it can be stated that every (open) physical (quantal) system possesses a capability of (“internal”) measurement (e.g., Matsuno, 1989; Conrad, 1993); on the other, that only life possesses such a capability (Pattee, 1971; also e.g., Balázs, 2003, 2004a,b, 2006). We

think that only the relative fertility of either of these ideas will settle the question. Accepting here the “only life measures” paradigm, *which we think is deeply rooted in the “orthodox” (Copenhagen) interpretation of quantum mechanics* (“only life is in principle classical”), we have a definite positive sharp presupposition for considering the naturally emerging “why life?” question in relation to the measurement problem.

THE PHYSICAL SELF-UNITY (EQUILIBRATION) OF THE UNIVERSE AND THE BASIC BIOLOGICAL SPLIT: (INTERNAL) MEASUREMENTS (INITIAL CONDITIONS) AND (INTERNALIZED) LAWS

In fact, there is no such a space-time structure in the Universe as “natural law.” The singular initial condition (“Big Bang”), natural law, and physical quantities (called “observables” in quantum theory) jointly form the special, unique *history* of the Universe.

The former constituents of matter (initial conditions and dynamical laws) are self-identical, unsplit, forming a kind of *unified* implicit “object” and “subject” of matter. In fact, every event in historical time is unique, theoretically unrepeatably.

It was Wigner who pointed out that the dichotomy between initial conditions and dynamical laws is characteristic of human natural sciences (in particular, physics) (Wigner, 1964). In fact, physical dynamical laws function as input-output “transformation machines” with input: initial conditions → output: solution some *t* time later by the use of some algorithm. Quantum dynamics, especially, mimics the working of a digital computer (Deutsch, 1985).

Parallel to this, in biology we specifically deal almost exclusively with (material) *constraints* on the underlying interactions (dynamics), as it is well-recognized today (see, e.g., Pattee, 1972a; Waddington, 1972a; Gunji, 1994). Internal quantum dynamics is said to be hierarchically constrained by the semiotic controls of the *biological system itself*, in a way like languages constrain themselves (grammars), to perform simple and coherent functions (e.g., Pattee, 1972b, 1997). We know, by now conventionally, that the biological organism is a special kind of finite quantum automata in these terms (e.g., Pattee, 1966; Waddington, 1972b; Balázs, 2003). The point is that *successive dynamical steps are subject to successive (internal) measurements* (the classical constraint side of the internal dynamics).

Tentatively, then, it follows from our own scheme, that the general *mechanism* of the basic biological process is as follows. The original premeval, internal “quantum jump” (transition), aiming to follow in its *relaxation* the special biological dynamic time process of return to the *unity with the rest of the Universe*, is of a necessarily *indirect* nature (just because the time inversion symmetry is lost), it is held back (bound, inhibited) by *space-mapped symbols* (the genetic code and, consecutively, the enzymatic/ribozymal 3D constraints). Quantum indeterminateness is partially transformed into classical (one-to-one, unambiguous) *internal measuremental constraint (control) processes*, so into relatively *freely usable* classical *choice-constraints*, for the *optimum releasing* of the underlying quantum dynamics (Balázs, 2003).

This is the primary function of internal constraints (measurements): they are first of all *inhibitory* agents, with consecutive special release modes (setting the proper initial conditions) (Balázs, 2004b).

It is then not hard to realize that physical dynamical laws, as we know them, on the other hand, are but also *special types of constraints* (Pattee, 1972b) in a generalized sense. In fact, they are the special “computer-algorithms” of human science by which the automata-like computations (transformations) of the initial conditions (input) to an other moment (output) along the *t*-axis are carried out.

We venture to risk here to assume a basic map, as opposed to pure analogy, between (quantum-) dynamical law and its embodiment, a hardware-implemented “natural automata”: the biological organization.

In fact, it is easily seen that “biological computation” is ultimately constrained to the process: input: setting *itself* as initial condition -> finding a natural source of matter-energy excitation to produce (maintain) *itself* algorithmically -> having *itself* as output (*to be the next initial condition*). Biological information, or its reverse side, (internal) measurement, is, as Pattee has shown (Pattee, 1979, 1995), exactly the setting of initial conditions.

Thus, taking literally the *mapping of external dynamical laws to internal material constraints* of the biological system, we arrive at the conclusion that the living organism, by its structure, is an *embodiment, a representation of physical (dynamical) laws*.

Biological embodiment of dynamical law (structure), constraining its own underlying time-process (dynamics) and the surroundings to produce (maintain, *repeat*) itself, is *prior* to the sophisticated *human natural science*, making measurements (setting initial conditions) and applying transformations in time (algorithms), that is, dynamical laws. Law is known to become a law exactly by representing the time-process under question through repeatable algorithms under the same initial conditions (through invariance principles, Wigner, 1964). In this way, we look on the *stability (robustness) of living matter as invariance under space-time operations* (i.e., a *law-like*) property.

As ordinary inanimate matter cannot split up spontaneously in its fundamental inseparable duality of law and initial conditions, the basic *biological split* of them comes about *one level up*, on the level of (*material*) *representations*, between the constraining body of the organism (“law”) as “subject,” and the *same structure’s* inside/outside initial conditions (as “object”). The (relative) split thus arrived at persists in a creative “disequilibration” from the molecular level up (compare Matsuno, 1989; Conrad, 1989; Gunji, 1994), between constraining (law-like) biological structure and its *own* required initial conditions. This can be recognized more pronouncedly in the animal kingdom, where the well-characterized life functions are directly based on physical disposability (space-time invariance) and apparent autonomic activity in fixing the consecutive initial conditions of the systems.

By our basic supposition, the primordial *origin of the split* was the origin of the genetic code, the first object that in a way was split up in the history of matter (the Universe): it is a *classical* (symbolical) *entity (memory)* besides being a quantal structure, and as a *classical* (one-to-one) constraint, it sets in an indirect, converging

self-referential reversed time-series (internal measuremental “algorithm,” “*software*”) the system’s (phenotypic) consecutive initial conditions. These, in turn, ultimately determine in a *postponed*, autopoietically *safe way* (by intermediate, materially “processed information”) the initial conditions of the *hardware* of the code, that is, those of the RNA/DNA molecules themselves, closing the indirect (or “weak,” Gunji, 1994) self-referential loop.

Surveying the field, corresponding alternative theories that have as cornerstones different “disequilibrations” are that of Matsuno (1989) (disequilibrium by a kind of “local delay of the propagation of action” and a following internal measuremental equilibration-chain by which the consecutive subsystems serve as serial (if fuzzy) boundary conditions on the next subsystem in an open quantum system under external perturbation); Varela (1975, 1979) (self-reference, “autopoiesis”: the energy of the external excitations is used for internalization from the environment equal, but usually more energy and structure to at least *maintain the same internal excitation*); Gunji (1992, 1993, 1995) (rather than to introduce a meta-set in a self-referential convergence series as Varela does, *states self-reference as logical inconsistency*, which is, in his view, the fundamental agent underlying the *autonomy* of life); Conrad’s “fluctuon model,” evoking a molecular internal “measurement force” restoration of disequilibrium (caused by external perturbations) in living systems (Conrad, 1993); and the molecular computer model of the neuron (Lieberman et al., 1989)—all exhibiting similar views, using, in this way or the other, the *equilibration force—internal measurement* approach.

The irreversibility of internal measurements and self-repetition (of itself as its own initial condition), are what lend living matter the capacity to *be* a more or less evolved (correct) independent representation of physical dynamical laws. Specifically, what the organism assimilates during the life-cycle (for which there exists internal *a priori expectation*, that is, internal constraint), is submitted to a set of prevailing internal “materialized natural laws,” that is, space-like *constraints*; in a sense, a self-constrained, internal measuremental *collapse series of its own* wavefunction takes place (Balázs, 2004a,b,c). Those internal/external perturbations, for which (*as yet*) no such prevailing expectation (constraint) corresponds, remain pure quantum indeterministic (“quantum noise”).

To decide the question of whether or not the internalized-materialized existing laws are more evolved, we have the *biological* theory of evolution (natural selection) to judge (relative independence from external/internal initial conditions).

In summary, we agree with Pattee that the biological organism “decides on what, when and where” a measurement (on itself or on the surroundings) is carried out (Pattee, 1993). In this respect, we must also agree that the fundamental of a *biological* theory of quantum measurement and so the theory of evolution must be first of all an evolutionarily fixed *deterministic self-measuremental chain of matter* as the *evolution of choice* (see, e.g., Pattee, 1995; Conrad, 1996).

The evolutionary ladder is about there being more and more flexible, complicated, and extended material constraint-sets (describable as *material* information processing) resulting in more and more *free choices* of initial conditions for the *same* materially represented dynamical laws, with the two extreme cases of no splitting (inanimate matter) and full splitting (human natural science).

In this way, *biological existence is a quantal disequilibrium of matter*, a violation of the passive (inert) unity of laws and initial conditions in the Universe.

THE DYNAMICS OF BIOLOGICAL DISEQUILIBRATION—THE TIME PROCESS OF THE OBJECT—SUBJECT DICHOTOMY: THE INHERENT “AIM” OF LIFE

As it has been noted earlier, in our model, partly supported by independent authors, the life process (cycle) has a definite inherent “aim”: to regress (relax) toward the primordial endophysical (time symmetric) state.

Primas has shown (1992) that a quantum system in itself (“endophysically”) is holistic in relation to a holistic Universe (“God’s panorama”) but, what *exists* for us as observers is *exophysics*, that is, a contextual measurement in a Boolean (yes–no) frame of reference of the experimental settings, breaking this holistic symmetry.

Then, in our frame, the internal symmetry broken is the bidirectional time reflection symmetry of the (endophysical) laws of physics. This follows from our own interpretation of the concept of “internal measurement” (i.e., introducing it on a common footing with usual “exophysics”).

To put it in an other way, the primary inherent “aim” of biological organisms, thus, is the ultimate *ceise* of the subject–object dichotomy, the unification of law and initial condition (the recovery of the endophysical existence), but the equally important, coupled secondary underlying “aim” is to avoid *direct* return to unity (equilibration) and seek its own special initial conditions in order to achieve symmetry equilibration through a *special biological route*. This is called, in the field of biophysics, the principle of structural stability (and self-reproduction) in the special externally observable internal *time process*. Its basis is *exactly the lack of capability of direct return* (i.e., time-inversion symmetry) from the primordial self-measurement (so that it has to *construct* its own past).

Concerning other works,

- We support Matsuno’s internal (molecular) measurement-chain process where the global condition of energy conservation is recovered locally through a process of successive equilibrating internal measuremental events.
- Varela’s self-reference theory is also supported by our scheme in that it is the *process* (convergence) of disequilibrium (in his scheme, bare indirect self-reference) what underlies structural stability (Varela, 1979).
- Gunji’s theory of *autonomy as a consequence of logical inconsistency* is confirmed in that autonomy is brought about by the internal process of perpetual dismissing the inconsistency (which corresponds, in our terms, to disequilibrium).
- Although Conrad and Liberman appear to be less stringent on the epistemological meaning of the internal process *globally*, they also uphold the internal quantum measuremental chain-restoration force description.

In our own model, the internal split of matter as self-measurement, self-information is *not* only a philosophical notion but a central biophysical one: the natural passive, endophysical self-reference of matter, given by the inert *direct* unity of dynamical law and initial conditions, is transformed by the primordial internal split to a *mediated* self-reference (nonlinearity) (internal measuremental relaxation chain) in biology with its special physically founded “aim” (time inversion symmetry restoration).

Also, as it was noted earlier, our scheme supposes different kinds of more or less *efficiently represented physical laws*, as represented by different species of organisms on the evolutionary ladder.

As it was pointed out earlier, too, concerning the central issue here, although the (internal/external) initial conditions of living matter themselves *are not arbitrary*, indeed it is a matter of choice *how, where, and when to produce them* (see also Pattee, 1993). Thus, the above described disequilibrium of matter (splitting up of dynamical law and initial conditions) gives way to both the general “force” (e.g., Conrad, 1989) to return to unity (equilibration) and also the *possibility of internal choice* (how, where, and when to apply it, Balázs, 2004a).

Matsuno’s scheme, just as Conrad’s, in these terms, is also a “choice-theory” with its *internal measuremental constraints* (as internal boundary conditions) *chosen* by the system. However, in our own frame, the transition from the inanimate to the animate world involves a *discrete step* (the premeval “Heisenberg–event,” the primordial “endogenous exophysical” self-measuremental step: the origin of the genetic code).

It is again Pattee’s view what is closest to ours, stating explicitly this role of *freedom* in the quantum measuremental process (Pattee, 1993), which sets initial conditions for further time evolution (dynamics).

Pattee clearly recognizes the evolutionary character of the required (self-referential) set of dynamic constraints (e.g., Pattee, 1967, 1982, 1993, 1997), pointing out that life evolves *via* these remarkably error-free control symbols (or “non-holonomic” constraints, which can not be integrated out of the dynamical equation), exerting continuous *measurement* (or classical constraints) on itself and the surrounding world. In his view, the control system ranges from primitive to highly evolved ones but *depend* on the underlying quantum dynamics, forming a continuous range of different “sophisticated” quantum measuremental processes from the primitive to the more evolved. This concept discards simple formal automata theoretical standpoints as well as pure quantum dynamical (naive reductionist) views, and corresponds to the basic alternating microscopical-quasiclassical (mesoscopical) aspects of biopolymers, as described earlier in the different frames, with reference to the internal measurement chains (see, e.g., Balázs, 2003, 2004c). However, we do *not* agree with Pattee that “law begins where control ends for the organism.” We suggest that probably the opposite holds: *there exists (materialized) law* (as a living system, as the split between law and initial conditions) *where there is a control*.

Thus, the fundamental biological existence *is freedom (as choice)* on one hand, and *it is biological law* (lack of freedom for the organism), *on the other*. It depends on whether we consider the biological constraint-set *with context* (i.e., externally)

as *choice* in a probabilistic Universe; or *without context* (a pre-established internal physical “aim” (symmetry restoration) to follow *deterministically*), that is, internally.

SUMMARY AND CONSEQUENCES ON THE SOCIAL SCIENCES: THE PHILOSOPHICAL MESSAGE OF BIOLOGICAL EVOLUTION

Of the earlier discussions, it follows that the essence of the relation of the biological system to the surrounding inanimate matter, may be formulated in the endophysics-exophysics dichotomy (which are larger categories than internal/external measurements) as such:

- The biological organism *in context* (interaction) with the environment (operationally: in a quantal “observational situation”) belongs to the realm of a (contextual) *externalist* description.
- In the *context-free case* (realized in the premeval inanimate existence of matter), the special biological internal “aim” (physical symmetry) of return back to such a state is dictated deterministically in an *internalist* description.

The former case belongs to the observable life process, the latter to the (inanimate) prerequisitional state, and the teleonomical drive and final “aim” of it.

The two forms of relations belong to alternative (in fact *complementary*) existences: the latter (endophysical), to an unsplit existence of biological matter; and the former to the special, split (“self-observing”), biological process of matter.

Thus the hierarchical biological individual process (and also *phylogenesis*) evolves to *choose* its initial conditions in accordance with its internalized, materialized natural laws (in the external viewpoint), *in order to* be able to freely direct its existence in accordance with its *internal special biological “aim” of self-maintenance and self-reproduction* (in the internalist viewpoint).

In this sense, a context-free (“*an sich*”) endophysical existence corresponds to an unsplit, “blind,” *apparent* complete “free will” of inanimate matter, which is in fact the *complete lack of freedom* (of the direct unity of dynamical laws and initial conditions); and an exophysical existence corresponds to a fight for a—in a sense—*real* “free will” by integrating, internalizing physical laws into its structure as material constraints.

Relying on (originating from) the endophysical existence of inanimate matter, and, having acquired *endophysically determined* yet exophysically *realizable* “*aims*” above its blind physical unity, the whole biological process amounts to *material self-discovery*; *genetically fixed correct inherent embodiment of the internalized natural laws* amounts to *freedom*.

In fact, it is an endophysically determined “aim” according to what rule the organism generally selects (“chooses”). But that “aim” (rule) constitutes the system’s very existence in a fundamental way: it evolves through choices *against direct* (physical) *return* to unity, utilizing an indirect way. The ultimate “aim” is thus *physically predetermined* (essentially an endophysically rooted “aim”);

nonetheless it is a (biological, exophysical) “aim,” a *choice*, all the same. This is brought about by the primordial, fundamental split between quantum dynamical law and initial conditions, that is, *between cause and effect*. The fact that the system selects (chooses), accordingly, means, in fact, *liberation from blind necessity*.

In summary, from the primordial (chemical) evolution to a splitting of “measuring and measured” in human science, there comes about, in a long process of biological evolution, a self-exploration of matter, the internalization and materialization of natural laws, amounting to *the liberation of initial conditions*.

It should be made clear here that the general standpoint advocated earlier is, by philosophical standards, by no way new. In fact, some outstanding elder, and also more recent classical philosophical systems were partially or entirely inspired by biological evolution, *all of them* emphasizing, in this form or the other, the evolution toward freedom (e.g., Hegel, 1958; Bergson, 1902; Chardin, 1955). In the context of the earlier considerations, perhaps these adequate, if sometimes contradictory, foundations of these philosophical systems can be brought unto a common basis, due to what we have learnt from biological evolution.

In this way, either “spirit” (metaphysically: “wanting itself,” Hegel), or, conversely, “evolving matter” (by materialist Marx), or the “existent” (by postmodern Heidegger) *comes into being* (not only by Man’s creative act, but) *generally* during the course of biological evolution. The “*hidden*” (self-identical) appears as *Physis* due to the appearance of *Logos* (Heidegger, 1976) and results in a *world of freedom*, in the freedom of “spirit” or “matter” or the “existent” *from itself*.

Also, the aforementioned fundamental context-free—context-sensitive viewpoints were (if not in this extreme form), in connection with the philosophical concept of free will, examined long ago by Kant (1788) and Schopenhauer (1903) with similar results as arrived at here.

It appears to us, that fundamentally a very deep notion (deeper than the post-modern Heidegger must possibly have intended it) of “forgetfulness of existence” must be at the bottom of the well and, in our own view, it is this that is gradually uncovered in biological evolution: in connection with a generalized “anthropic principle,” we can decipher Nature with our mathematics because this discovering amounts to a *rediscovery of our own* (past) existence. In fact, discovering the Universe is discovering our own existence and, hence, *ruling our existence*. (This idea, of course, is again by no way new: its origin can be traced back to Socratic epistemology (see Plato, 1984).)

The “message of evolution,” then, is *independence* (from the system’s initial conditions as exerted by the external/internal world), thus *freedom*, not complexity in itself. Evolution is progressing from relative elementary biological freedom, as constrained by a physical “aim” (equilibration, symmetry restoration), toward real, absolute freedom through gradual *ruling the very fulfillment of that internal “aim.”*

“Freedom is the recognition of necessity” (Hegel). In our terms: internalization of natural law.

The extraordinary feature of biological evolution is that it is continued in human history and culture, and as such, it is continued as a common enterprise of humanity as a species, rather than simply the evolution of individuals. The new, *social “aim” of existence* of humankind is the accumulation of material wealth, so

producing a material environment which fully liberates the constantly emerging “initial conditions” of the individuals of human society. If reached this aim, human society will indeed be *completely free* (of blind “necessity”).

CONCLUDING REMARKS

It has been shown in the present article that there *might be* an alternative approach to the quantum theoretical measurement problem other than the usual purely physical formal and dynamic theories.

The approach proposed is based on an emerging general *biological* theory, whose central idea is *internal measurement* and a certain special *biological approach* to the *laws of physics and initial conditions*.

Specifically, for our part, we have put forth a scheme in which the usual distinction between physical law and its initial conditions, split in human natural science, is interpreted as just corresponding to the *most evolved form* of a biological splitting between an internal measuremental space-like constraint-system (representing physical dynamical laws) and the internal/external (own/extended) bodily states (or physical initial conditions) of the *same biological structures*. Having a specific internal, pure physically rooted “aim” (equilibration of the dynamical symmetry of time reversal), biological onto – and phylogenesis proceed toward ruling the satisfaction of that internal “aim,” through ruling its own existence by liberating its own internal/external initial conditions.

This process amounts (in an “external” context) to the gradual evolution toward liberty (“free will”)—toward the “*physics of freedom*” (*choice*); a rediscovery of the physical roots of the biological system’s existence, that is, the rediscovery of the *Universe of itself*.

It appears, then, that human natural science is a prerequisite of the end-product of this development, forming the evolutionary foundation of the evolutionally new, human enterprise.

Naturally, much further work is needed to clarify more the aforementioned concepts in a self-consistent biophysical theory, and also the possible philosophical bearings of the common thesis reached in this respect.

NOTE

1. Exophysical: inclusion of an observer in the system; endophysical: exclusion of an observer from the system. Both terms were *worked out* in detail mathematically by H. Primas (for they are inequivalent even mathematically).

REFERENCES

- Balázs, A. 2003. On the physics of the symbol—matter problem in biological systems and the origin of life: Affine Hilbert spaces model of the robustness of the internal quantum dynamics of biological systems. *BioSystems* 70: 43–54.
- . 2004a. What does a molecule want? The myth of the self-replicating molecule (comments on the selfish-gene paradigm). *BioSystems* 73: 1–11.

- . 2004b. Is there a molecular Nirvana Principle? Towards a unified resolutorial model of the biological symbol–matter dichotomy. *BioSystems* 77: 1–10.
- . 2004c. Internal measurement: Some aspects of quantum theory in biology. *Physics Essays* 17(1): 80–94.
- . 2006. Some introductory formalizations on the affine Hilbert spaces model of the origin of life. I. On quantum mechanical measurement and the origin of the genetic code: A general physical framework theory. *BioSystems* 85: 114–125.
- Belinfante, F. J. 1975. *Measurement and time reversal in objective quantum theory*. Oxford: Pergamon Press.
- Bergson, H. 1902. *Creative evolution*. London: MacMillan.
- Bohr, N. 1963. *Essays 1958/1962 on atomic physics and human knowledge*. New York: Wiley, p. 60.
- Chardin, T. P. 1955. *Ouvres*, Ed. M. Mortimer, 1, Paris: Seuil.
- Conrad, M. 1989. Physics and biology: Towards a unified model. *Applied Mathematics and Computation* 32: 75–102.
- . 1993. The fluctuon model of force, life and computation: A constructive analysis. *Applied Mathematics and Computation* 56: 208–259.
- . 1996. Percolation and collapse of quantum parallelism: A model for qualia and choice. In *Toward a science of consciousness*, Eds. Hameroff, S. R., Kaszniak, A. W., and Scott, A. C. Cambridge: MIT Press.
- Deutsch, D. 1985. Quantum theory, the Church–Turing principle and the universal quantum computer. *Proceedings of the Royal Society A* 400: 97–117.
- Everett III, H. 1957. “Relative state” formulation of quantum mechanics. *Reviews in Modern Physics* 29: 454–462.
- Guilini, D., Joos, E., Kiefer, C., Kupsch, J., Stamatescu, I.-O., and Zeh, M. D. (Eds.), 1996. *Decoherence and the appearance of classical world in quantum theory*. Berlin: Springer.
- Gungi, Y. P. 1992. Form of life: It is possible but not necessary. *Applied Mathematics and Computation* 47: 267–288.
- . 1993. Form of life: Unprogrammability constitutes the outside of a system and its autonomy. *Applied Mathematics and Computation* 57: 19–76.
- . 1994. Autonomic life as the proof of incompleteness and Lawvere’s theorem of fixed point. *Applied Mathematics and Computation* 61: 231–267.
- Gunji, Y. P., Sadaoka, H., and Ito, K. 1995. Inter and intracellular computational models based on Boolean vs. non-Boolean inconsistency. *BioSystems* 35: 213–217.
- Hegel, G. W. F. 1958. *System der Philosophie, Zweiter Teil, Die Naturphilosophie. Samtliche Werke, Neunter Band*. Stuttgart: Frommanns Verlag.
- Heidegger, M. 1976. *Einführung in die Metaphysik*. Tübingen: Niemeyer.
- Heisenberg, W. 1958. *Physics and philosophy*. New York: Harper and Row, ch. 3.
- . 1993. Personal communication, quoted by Stapp, H. P. in *Mind, matter and quantum mechanics*. Berlin: Springer.
- Hofstadter, D. 1979. *Goedel, Escher, Bach*. New York: Basic Books.
- Igamberdiev, A. U. 1993. Quantum mechanical properties of biosystems: A framework for complexity, structural stability and transformations. *BioSystems* 31: 65–73.
- Kant, E. 1788. *Kritik der Praktischer Vernunft*. Riga: no publisher specified.
- Lieberman, E. A., Minina, S. V., and Skhlovsky-Kordi, N. E. 1989. Quantum molecular model of the neuron and a pathway to the union of sciences. *BioSystems* 22: 135–154.
- London, F., and Bauer, E. 1938. Translated in J. A. Wheeler and W. Zurek (Eds.), *Quantum theory of measurement*. Princeton, NJ: Princeton University Press.

- Matsuno, K. 1984. Is matter inanimate?: Protobiological information from within. *Origins of Life* 14: 489–496.
- . 1989. *Protobiology: Physical basis of biology*. Boca Raton: CRC Press.
- . 1993. Being free from ceteris paribus: A vehicle of founding physics on biology rather than the other way round. *Applied Mathematics and Computation* 56: 261–279.
- . 1995. Quantum and biological computation. *BioSystems* 35: 209–212.
- Neumann, J. 1955. The mathematical foundations of quantum mechanics. Princeton, NJ: Princeton University Press, ch. 5–6.
- Pattee, H. H. 1966. Physical theories, automata and the origin of life. In *Natural automata and useful simulations*, Eds. Pattee, H. H., Edelsack, E. A., Fein, L., and Callahan, A. B., 73–105. Washington: Spartan Books.
- . 1967. Quantum mechanics, heredity, and the origin of life. *Journal of Theoretical Biology* 17: 410–420.
- . 1971. Can life explain quantum mechanics? In *Quantum theory and beyond*, Ed. Bastin, T., 307–319. Cambridge: Cambridge University Press.
- . 1972a. Laws and constraints, symbols and languages. In *Towards a theoretical biology*, Ed. Waddington, C. H., vol. 4, 248–258. Chicago: Aldine Publishing Comp.
- . 1972b. Physical problems of decision-making constraints. *International Journal of Neurosciences* 3: 99–106.
- . 1979. The complementarity principle and the origin of macromolecular information. *BioSystems* 11: 217–226.
- . 1982. Cell psychology: An evolutionary approach to the symbol–matter problem. *Cognition and Brain Theory* 5(4): 325–341.
- . 1993. The limitations of formal models of measurement, control and cognition. *Applied Mathematics and Computation* 56: 111–130.
- . 1995. Evolving self-reference: Matter, symbols, and semantic closure. *Communication and Cognition—Artificial Intelligence* 12(1–2): 9–27.
- . 1997. The physics of symbols and the evolution of semiotic controls. In *Santa Fe Institute studies in the science of complexity*, Proceedings Volume, Redwood City: Addison-Wesley.
- Plato 1984. *The complete works of Plato. Vol I., Phaido*. Budapest: Európa Könyvkiadó. (in Hungarian)
- Post, E. L. 1965. Recursive unsolvability of the problem of thue. In *The undecidable*, Ed. Davis, M., 292–303. Hewlett, New York: Rowen Press.
- Primas, H. 1981. Chemistry, quantum mechanics and reductionism. *Lecture notes in chemistry*, vol. 24, Springer-Verlag.
- . 1992. Time asymmetric phenomena in biology. *Open Systems and Information Dynamics* 1(1): 3–34.
- . 1993. Mesoscopic quantum mechanics. In *Symposium on the foundations of modern physics 1993. Measurement, irreversibility and the physics of information*, Eds. Lahti, P. J. et al., 324–337. Singapore: World Scientific.
- . 1994. Endo- and exo-theories of matter. In *Springer series in synergetics*, Eds. Atmanspacher, H., and Dalenoort, G. J., 163–193. Berlin: Springer-Verlag.
- Schopenhauer, A. 1903. *About freedom of will*. Budapest: Franklin Society. (in Hungarian)
- Stapp, H. P. 1972. The Copenhagen interpretation. *American Journal of Physics* 40: 1008–1116.
- Varela, F. 1975. Calculus for self-reference. *International Journal of General Systems* 4: 243–253.
- . 1979. *Principles of biological autonomy*. New York: North-Holland.

- Vitiello, G. 1996. Structure and function. In *Towards a science of consciousness, The first Tucson discussions and debates*, Eds. Hameroff, S. R., Kaszniak, A., and Scott, A. C., Cambridge: MIT Press.
- Waddington, C. H. 1972a. Form and information. In *Towards a theoretical biology*, Ed. Waddington, C. H., vol 4, 109–141. Chicago: Aldine Publishing Comp.
- . 1972b. Epilogue. In *Towards a theoretical biology*, Ed. Waddington, C. H., vol 4, 283–289. Chicago: Aldine Publishing Comp.
- Weizsaker, C. F. 1971. The Copenhagen interpretation. In *Quantum theory and beyond*, Ed. Bastin, T., 25–32. Cambridge: Cambridge University Press.
- Wigner, E. P. 1964. Events, laws and invariance principles. *Science* 145: 995–999.
- . 1967. Remarks on the mind–body question. In *Symmetries and reflections. Scientific essays of Eugene P. Wigner*. Bloomington–London: Indiana University Press.
- Zeleny, M. (Ed.) 1981. Autopoiesis: a theory of living organizations. In *The North-Holland series in general systems research* Ed. Dr. Klir, George, vol. 3., New York: North-Holland.
- Zurek, W. H. 1981. Pointer basis of quantum apparatus: Into what mixture does the wave packet collapse? *Physical Reviews D* 24: 1516–1525.
- . 1991. Decoherence and the transition from quantum to classical. *Physics Today* Oct. 1991: 36–44.