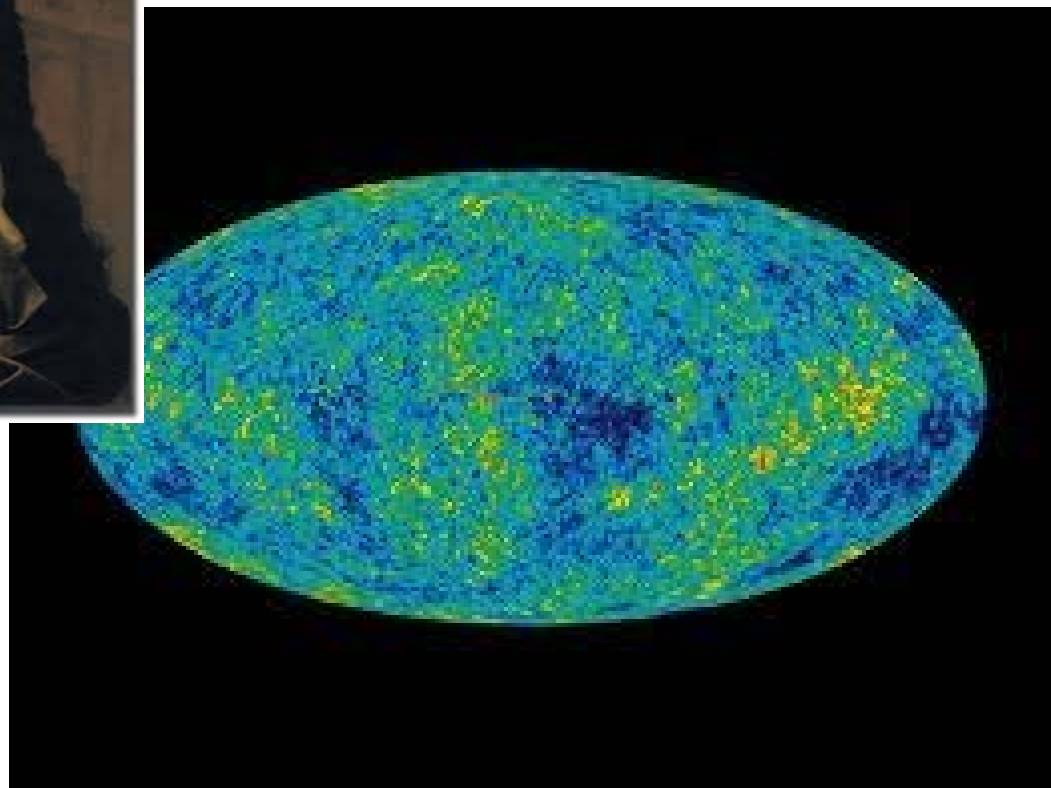
The relational meaning of information in dynamic processes in reality

A.U. Igamberdiev and J.E. Brenner



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Philosophy in Reality: Scientific Discovery and Logical Recovery

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Abstract: Three disciplines address the codified forms and rules of human thought and reasoning: logic, available since antiquity; dialectics as a process of logical reasoning; and semiotics which focuses on the epistemological properties of the extant domain. However, both the paradigmatic-historical model of knowledge and the logical-semiotic model of thought tend to incorrectly emphasize the separation and differences between the respective domains vs. their overlap and interactions. We propose a sublation of linguistic logics of objects and static forms by a dynamic logic of real physical-mental processes designated as the Logic in Reality (LIR). In our generalized logical theory, dialectics and semiotics are recovered from reductionist interpretations and reunited in a new synthetic paradigm centered on meaning and its communication. Our theory constitutes a meta-thesis composed of elements from science, logic and philosophy. We apply the theory to gain new insights into the structure and role of semiosis, information and communication and propose the concept of 'ontolon' to define the element of reasoning as a real dynamic process. It is part of a project within natural philosophy, which will address broader aspects of the dynamics of the growth of civilizations and their potential implications for the information society.

Keywords: dialectics; epistemon; information; logic in reality; natural philosophy; ontolon; semiotics

1. Introduction

Philosophy, science and logic are systems of thought devised by human beings to describe their world and what it means to exist in it. In the classical West and to a certain extent in the East, throughout history, there was no separation between the disciplines. However, the value of philosophy, especially today in the West, has been diminished by several major errors: the work of Aristotle and other classical Greek, and later Western European thinkers has been misused and misunderstood, without the proper attention paid to necessary corrections and extensions made possible by modern science. The value of dialectics as the basis of reasoning, and the need for a logic based in science rather than language are major examples. In the last 100 years, phenomenology and semiotics have been proposed to bridge the gap between knowledge and reality, but all suffer from reliance on the epistemic principles of classical linguistic logic. Dialectics, in particular as expressed by Hegel, was diverted from its initial objectives and used to support limited political-economic idealism and ideologies.

The objective of this paper is to define a philosophy of and in reality that effects a 'rejunction' with some less familiar insights of Aristotle and recovers them to serve the current social objectives of the emerging information society. Rapidly, there is in Aristotle the basis not only for modern bivalent linguistic logic, but also for a logic that refers to actualizations and potentialities in a physical world of processes. We will propose an extension and development of and to the second logic of Aristotle

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Time and Life in the Relational Universe: Prolegomena to an Integral Paradigm of Natural Philosophy

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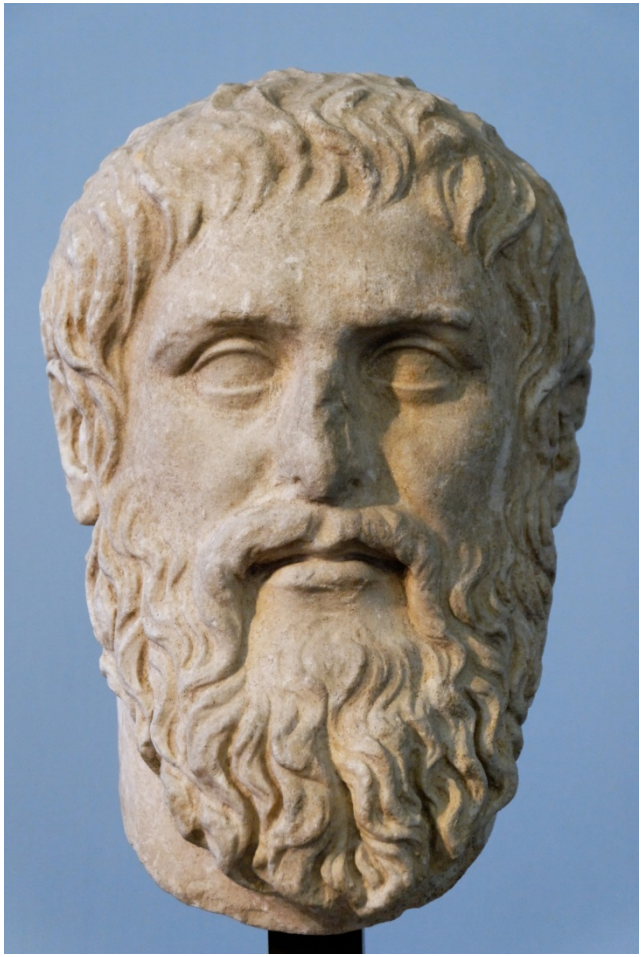
Abstract: Relational ideas for our description of the natural world can be traced to the concept of Anaxagoras on the multiplicity of basic particles, later called "*homoiomeroi*" by Aristotle, that constitute the Universe and have the same nature as the whole world. Leibniz viewed the Universe as an infinite set of embodied logical essences called monads, which possess inner view, compute their own programs and perform mathematical transformations of their qualities, independently of all other monads. In this paradigm, space appears as a relational order of co-existences and time as a relational order of sequences. The relational paradigm was recognized in physics as a dependence of the spatiotemporal structure and its actualization on the observer. In the foundations of mathematics, the basic logical principles are united with the basic geometrical principles that are generic to the unfolding of internal logic. These principles appear as universal topological structures ("geometric atoms") shaping the world. The decision-making system performs internal quantum reduction which is described by external observers via the probability function. In biology, individual systems operate as separate relational domains. The wave function superposition is restricted within a single domain and does not expand outside it, which corresponds to the statement of Leibniz that "monads have no windows".

Keywords: Leibniz; monad; internal quantum state; relational biology; reflexive psychology; self

1. Introduction: Relational Ideas in Philosophy and Science

After Thales (c. 624-546 BC), who formulated the concept of substance and is recognized as the first philosopher, Anaximander (c. 610-546 BC) became the founder of scientific thinking [1]. His definition of the primary substance as *apeiron* introduced the idea of potentiality in philosophical thought. According to Anaximander, "things are transformed one into another according to necessity and render justice to one another according to the order of time" [1]. Time orders things by separating them in a way that the simultaneous contradiction is avoided. While Pythagoras (c. 570-495 BC) is regarded as the founder of mathematics, and Parmenides (c. 540-470 BC) was the founder of logic, Anaxagoras (c. 510-428 BC) can be considered as the founder of the relational science. Anaxagoras claimed the multiplicity of "seeds" called later by Aristotle *homoiomeroi*—the particles having same nature as the whole [2]. *Nous* (mind) in the philosophy of Anaxagoras orders all homoiomeroi and can be related to the philosophical idea of pre-established harmony. Later, the relational concept of knowledge was developed in detail by Aristotle (384-322 BC) who, in his tractate *De Anima (On the Soul)*, attributed the notion of self to the internal determination within living systems [3], and introduced two types of time in *Physica*, one which is measured and one by which we measure, suggesting that our visible world is generated by a reflexive loop that involves these two types of time [4]. This loop assumes the minimum action that cannot be further divisible, which provides a possibility of the

Plato (427-347 BC): dialogue "Parmenides"



The Existence of Being generates multiplicity (of "monads")

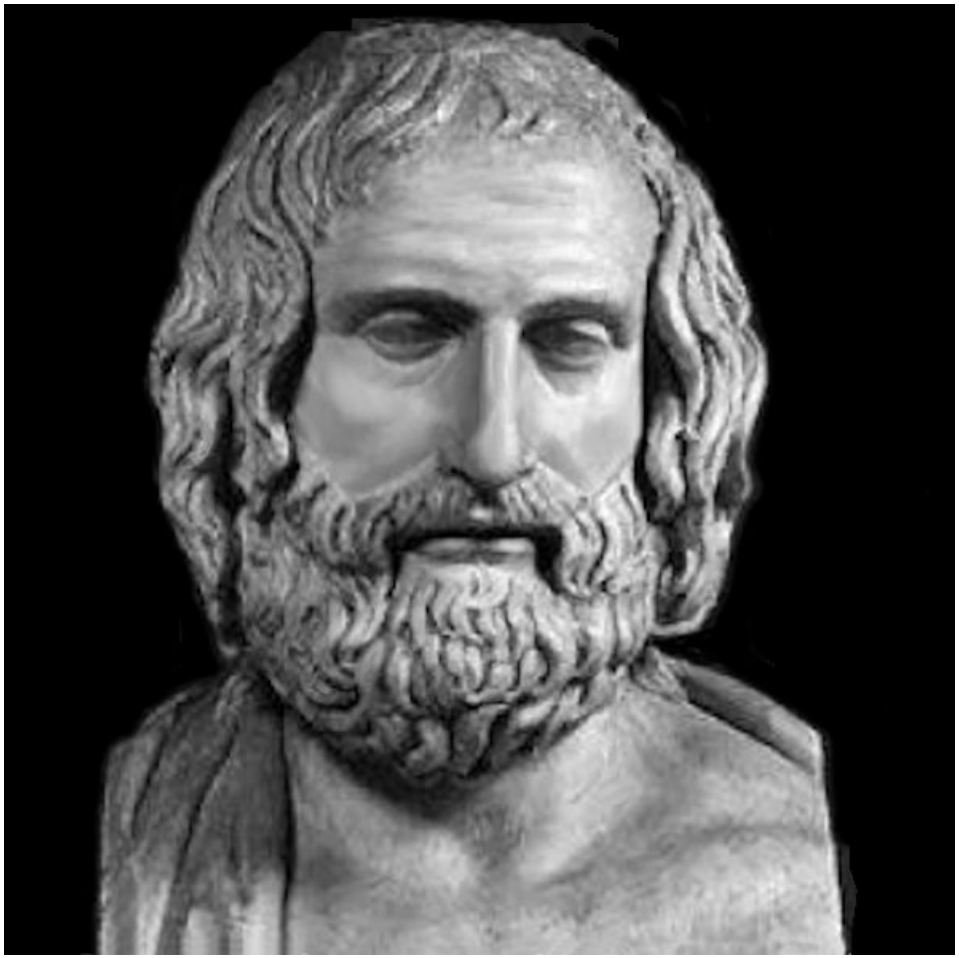
The **One** cannot be made up of parts and cannot be a single part, because a part must be section of a whole, in order to be different from **many**.

The **Existing One** represents a duality of being and existence

Existing **one** appears as **many**

Being-in-itself vs Being-in-the-World

Anaxagoras (510-428 BC)



Anaxagoras was the first to bring philosophy to Athens

Born in Clazomenae in Asia Minor, lived in Athens, charged with impiety and went into exile in Lampsacus

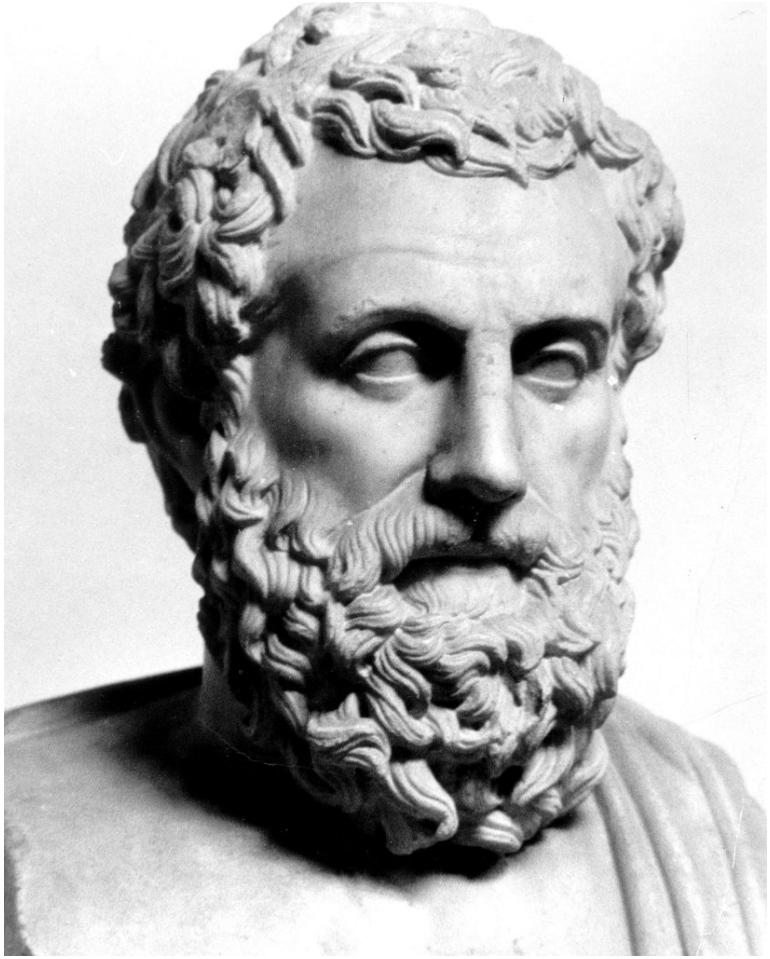
Anaxagoras claimed the multiplicity of *homoiomeroi* – the particles having same nature as the whole.

The concept of Nous in the philosophy of Anaxagoras corresponds to the idea of pre-established harmony in Leibniz philosophy.

Being-in-itself vs Being-in-the-World

- Parmenides and Heraclitus
- Plato and Aristotle
- Husserl and Heidegger

Being-in-the-World

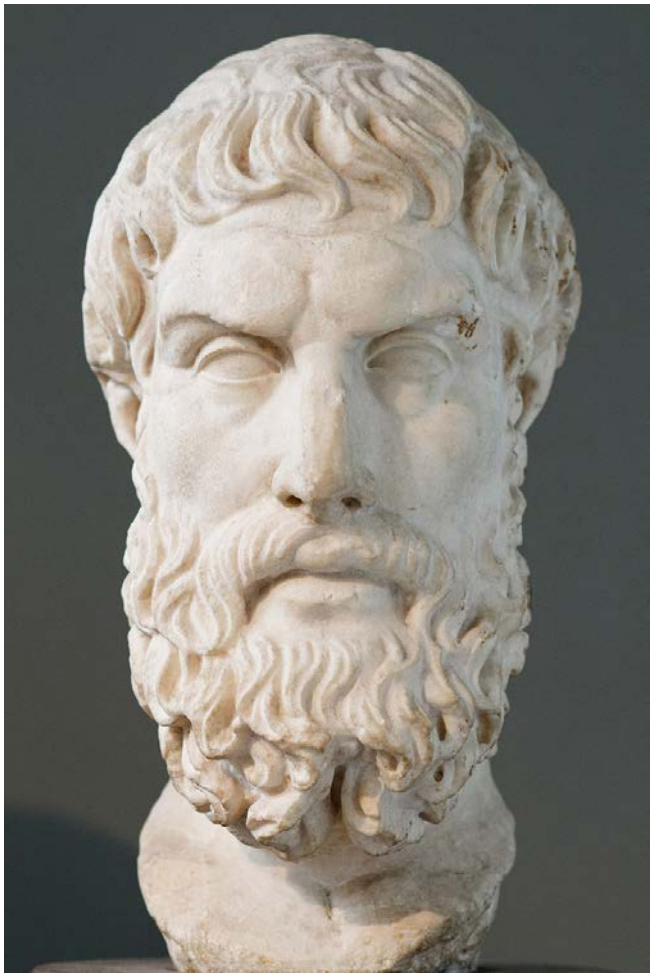


Aristotle (384-322 BC)

Heidegger (1889-1976)

Heidegger's influence on natural sciences including physics is much less pronounced than it could be. He admitted that his "*Sein und Zeit*" is a completely imperfect attempt to enter into a temporality (*Zeitlichkeit*) of being (*Dasein*) after Parmenides.

Epicurus (341-270 BC)



- Epicurus postulated an unpredictable movement (swerve; swerving) of atoms called by Lucretius ***"clinamen"*** (plural: ***clinamina***) which introduces potentiality in the universe of atoms and makes it more diverse and variable.
- These deviations initially appear arbitrary, but they can be controlled resulting in higher levels of organization.
- In this picture, finally, human consciousness appears which controls them further.

Information and *clinamen*

- Without ***clinamina*** that enlarge the field of potentialities, a strictly deterministic universe would not be able to evolve and generate a multiplicity of events, phenomena and realizations – IT WOULD NOT HAVE INFORMATION!
- Clinamen can be restricted by imposing ***information*** which results in generation of higher levels of organization.

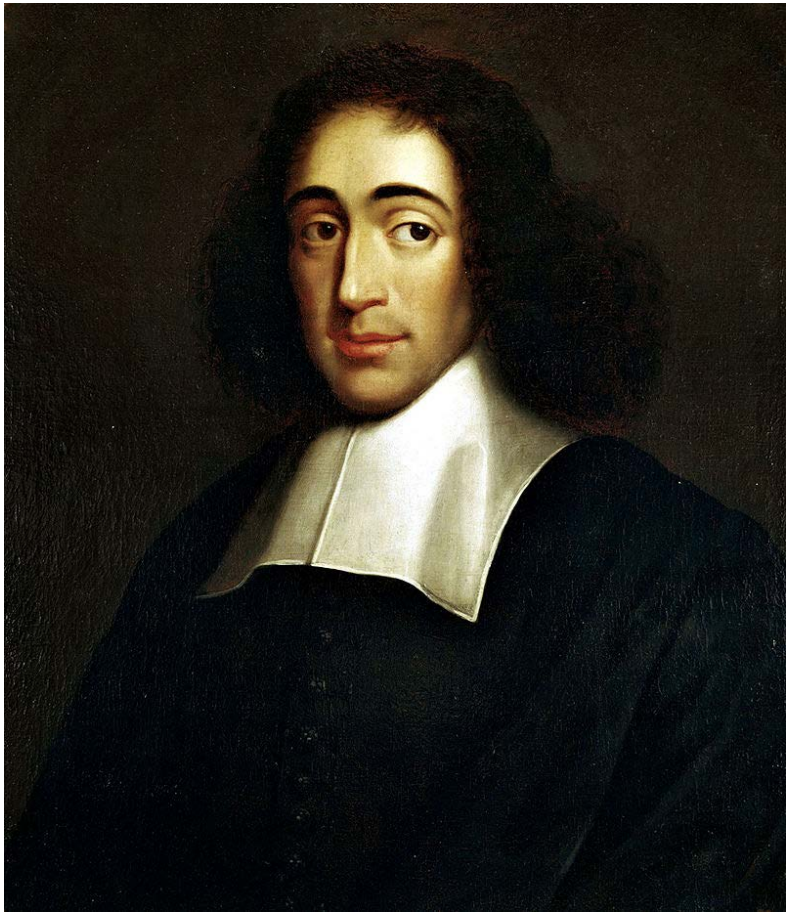
Information

- The notion of information arises within the perpetual evolutionary process occurring in the reality of existing Being (*Dasein*)
- Fundamental uncertainties in the dynamics of individual entities can be reduced in the course of their communication (*discourse*) according to the ***information*** that they possess

Descartes (1596-1650) and the main idea of New European Philosophy

- *Res extensa – Res cogitans*
- Two independent essences
- Can be united in brain (in epiphysis)
- The analogue of “epiphysis” is cytoskeleton in the concept of Hameroff and Penrose – **IQS**

Spinoza (1632-1677)



- Substance as ***causa sui***
- Substance ***geometrizes*** the world in the course of its self-actualization
- The basic property of cognition is a capacity of a body to build a trajectory of its movement across other bodies according to the ***information*** about arrangement of these bodies in the space external to that body.

Leibniz (1646-1716)

- *Res cogitans* in its multiplicity generates *Res extensa*
- Real world differs from other potential worlds by its maximal variety at maximally possible order
- Monad is non-divisible and non-destroyable
- Monad is the basic element of creation, while matter and space are relational to it

Leibniz and relational logic

- In Plato's dialogue "Parmenides", the origin and development of multiplicity follows from the logic imposed by the ***existence of one*** through the self-referential process of generation of numbers.

- According to Leibniz, a change is less a transformation than an ***ordered revelation of the entity***, and the creation stands outside the temporal order.

- Following Parmenides, Plato and Leibniz, we can say that the primary substance is rather not a number, as it was originally suggested in the philosophy of Pythagoras, but ***numbers are generated*** through the activity that introduces them.

Monad and calculation

- A monad's internal decision to perform calculation procedure is the initial cause, which is viewed as an event that can be evaluated externally via the spatiotemporal representation.

- According to Leibniz, monads are self-sufficient internally, they have no windows to look through toward outside.

- Really, there are no windows to perceive the other's self, but the internal program of a monad harmonizes its spatiotemporal representation in the world in itself, like performing the modeling of this window.

Ontolons

- The actual dynamics of events in reality takes place via interaction of individual conceptual units of existence, which we call ***ontolons***.
- They are relevant to Leibniz' monads and possess a defined ***internal structure*** that dynamically reacts to external stimuli and adapts to them.
- Ontolons are characterized by the fundamental ***uncertainties*** in their dynamics (called clinamina by Epicurus) that can be reduced in the course of communication between these entities.

Logic of existence

- Propositions about what exists could be known a priori if we complete an infinite analysis, but, since we cannot, we can only know them empirically.

- Monads/ontolons put mathematics into motion. The programs of all monads define the spatiotemporal physical world.

- The program, that monad runs, simulates the whole physical world.

- The internal logical motion proceeds in parallel with a physical motion that has a price (physically described as spending energy).

Generation of opposites

- In the discourse of ontolons, the generation of opposites results in their unification into more complex structures and in the destruction of actual structures that do not fit the process as a whole.
- Meaningful ***information*** appears in the network of communicating ontolons as ***reality in potential form***.
- Different outcomes for the dynamic behavior of a system imply a possibility of their reduction by acquiring the ***information*** necessary to reduce the potential field in the most optimal way.

Relational nature of information

- Information processes operate in the relational world of communicating individual substances (ontolons) with resulting causal reduction of ***previous actualities*** and generation of ***new potentialities***.
- The nature of information can be summarized by its designation as a ***dynamic process in reality***, whose elements possess the uncertainties that can be reduced in the continuous evolution and generate new uncertainties.

Informational constraints

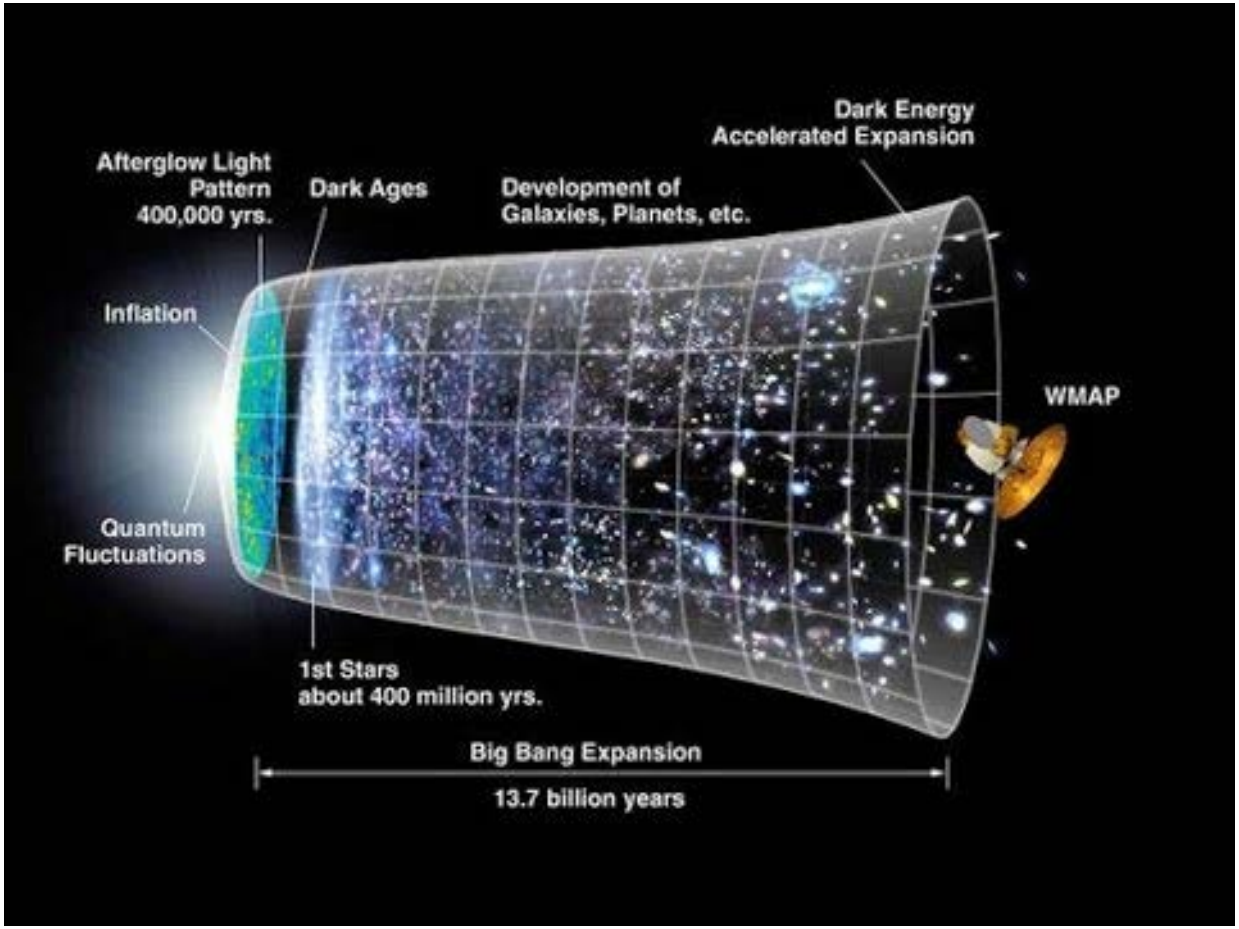
- The informational ***constraints*** correspond to the rules in which logical relations hold between ***actual and potential states***, and continuously generate an emerging included ***middle state*** that is fundamentally operational and relational within the total objective dynamic reality.
- The new ***rationality*** of the information concept arising to Lupasco, Brenner and Wu Kun makes possible a new ***relationality*** in the structures of knowledge.

Leibniz and relational physical Universe

- Space-time, while having relational properties, for the observability condition should meet the criteria of universality upon certain limits – BACKGROUND INFORMATION ENCODED IN THE FUNDAMENTAL CONSTANTS

- The challenge to physics is not to resolve the problem of relational versus substantial space-time but to explain how the **observable substantial perception** of spatiotemporality arises from the set of relations generated by multiple perceptions of the individual monads.

Substantial time-space of modern physics



Despite of the relational nature of space-time, we can still use the models that are based on the uniform time flow and on representation of the Universe as a unitary domain

BACKGROUND INFORMATION

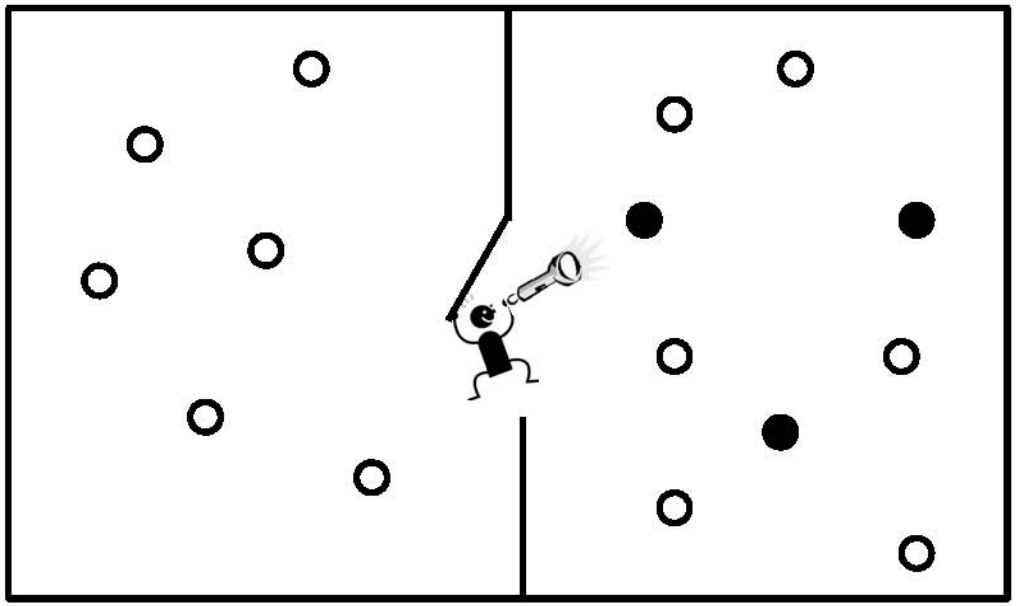
- The computational process is based on the activity **linking mathematical equations to materialized physical world**

- It consumes energy which lower limit is defined by the set of Planck's values, i.e. by the physical structure of the Universe

- Effective quantum computation can be performed via the maintenance of a **long-living decoherence-free internal state**

Physical limits of computation – the nature of the background information

- Based on Heisenberg's energy–time uncertainty ratio
- The maximum rate of elementary operations as calculated from this ratio is $2E/\pi\hbar$
- The minimum amount of time $t_{\text{flip}} = \pi\hbar r/2e^2$ to perform a quantum logic operation on the two particles



Maxwell's Demon – he calculates

Landauer – Wheeler principle

- Real calculations involve physical objects, so there will be fundamental physical limitations to what may be calculated in real world, which in turn imposes fundamental limitations on implementing the laws of physics

- The Planck's quantum is the unit that defines a limit to which the world can be computed (Liberman 1989)

Limits of observation propagation

- Causal horizon limits the volume of space within which information may propagate in the time t since the origin of the Universe, $\sim(ct)^3$
- The maximum rate of elementary operations $2E/\pi\hbar$, which would be attained by an ideal quantum computer
- The minimum tick length of a clock with energy E is $\Delta t = \pi\hbar/2E$

Bekenstein bound

$$kER/\hbar cS \geq (1/2)\pi$$

- k is the Boltzmann's constant
- R is the size of the system (assumed spherical)
- S is the entropy

- This limit is saturated for the case of a black hole
- It allows estimation of the maximum number ($\sim 10^{123}$) of elementary operations since the Big Bang

Quantum measurement theories – concepts of background information

Theory	Author	Explanation of measurement
Copenhagen	Bohr, Heisenberg	Collapse of wave function in interaction with measurement device
Multi-world	Everett	Wave function is only real and it does not collapse
Pilot-wave	De Broglie, Bohm, Hiley	Wave function and its actualization coexist and interact in a dual reality
Consistent histories (including environmental decoherence)	Griffiths, Omnes, Gell-Mann, Hartle	Refinement of wave functions through self-consistence or environmental fitness
Gravitational collapse	Penrose	Objective collapse of wave function when space curvature reaches the value of Planck's mass
Semiotic	Christiansen	Refinement of wave functions through significative validity

Three basic fundamental constants

Constant	Symbol	Relation to measurement
Gravitational constant	G	Reduction of superposed potential states during measurement
Speed of light	c	Finite velocity of observation propagation
Quantum of action	$\hbar$	Causal consistency of the measurement process

Three basic fundamental constants

Best of possible worlds?

- Considering fundamental constants we face the fundamental question of Einstein ”whether God had any choice in the creation of the world”

- If there is no choice we live in the best (the simplest in hypothesis and richest in phenomena) of all possible worlds (Leibniz) despite of the fact of the common sense that it is not perfect (which can simply mean that it cannot admit all coexistences)

- If there is a choice, it could be realized in other universes, but the observability (and hence existence) of these universes has to be substantiated

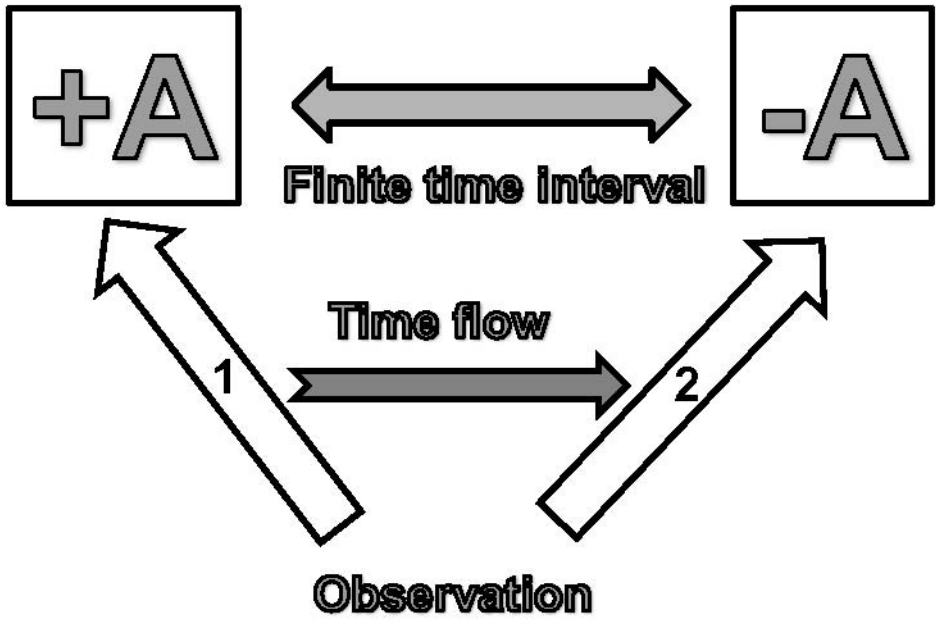
Time

- Time separates contradictory statements by generating the sequence of their appearance

- Time appears as a logical saver from paradoxes: the self-reference softens the notion of equality. In this sense, time is precisely that degree of freedom which allows a thing to change and yet to still be itself.

- Time metalogically resolves paradox in the real world, and an evolving system realizes a proof of incompleteness for the system to describe time evolution under finite velocity of observation propagation.

Time and observation



Finite velocity of observation propagation. The opposite statements A and –A can be viewed as separated by finite time interval. This avoids contradiction and corresponds to the system's evolution. The direction of time flow is determined by the fact that observation 1 precedes observation 2.

Relational biology

Coherent states and computation

- The main condition for applying computation to the physical world is that it should be stably performed

- In such complex systems as biological organisms, to proceed with a high precision of the output, biochemical processes should preserve quantum coherence over the time of the order of a second

Three principles of living organization (Schrödinger)

Principle	Description
Aperiodic crystal	A small group of atoms in living systems produces orderly events
Negentropy	Living system is fed by negative entropy (extracts order from the environment)
Zero temperature	Life maintains virtually zero temperature of its quantum state

Three major principles of living organization according to Erwin Schrödinger in his book "*What is Life*" (1944)

Leibniz and relational biology

- To understand the nature of living beings, we need to analyze in detail the problem of self.

- When we formalize the decision-making (i.e. living) system, we transform it into a program for a macroscopic computer without any internal point of view and freedom of will.

Who computes? (The problem of self)

- Schrödinger (1945) was the first who suggested that the nature of self is quantum mechanical, i.e. the self is a state beyond quantum reduction, which generates emergent events by applying quantum reduction externally and observing it

- The self non-locally resides inside the quantum state while the locality of space resides outside

- Life emerges to incorporate basic computation principles and in the course of evolution to overcome physical limits of computability of the world

Relational biology: Rashevsky and Rosen

- The relational biology, introduced by Nicholas Rashevsky (1954) and Robert Rosen (1991), describes life as ontologically independent generic phenomenon. The development of relational biology, which is substantially based on Leibniz paradigm, will result in resolution of the contradiction of reductionism and holism in the description of living systems.

- In fact, the conceptual basis of reductionism follows from the acceptance of substantiality of the space-time, while the basis of holism is the substantiality of the spiritual “one” governing the multiply divided “matter”. The relational approach would aim to reveal the limits of both reductionism and holism and provide a paradigm in which the unity of life, space-time and consciousness will receive a new far-reaching understanding and clarification.

Effective temperature

- Organisms exploit thermodynamic gradients by acting as heat engines to drastically reduce the effective temperature of certain macromolecular complexes (Matsuno, 2006).

- The effective temperature of the coherent state of the actomyosin complex was calculated (from emitted quanta) as near 10^{-3}K

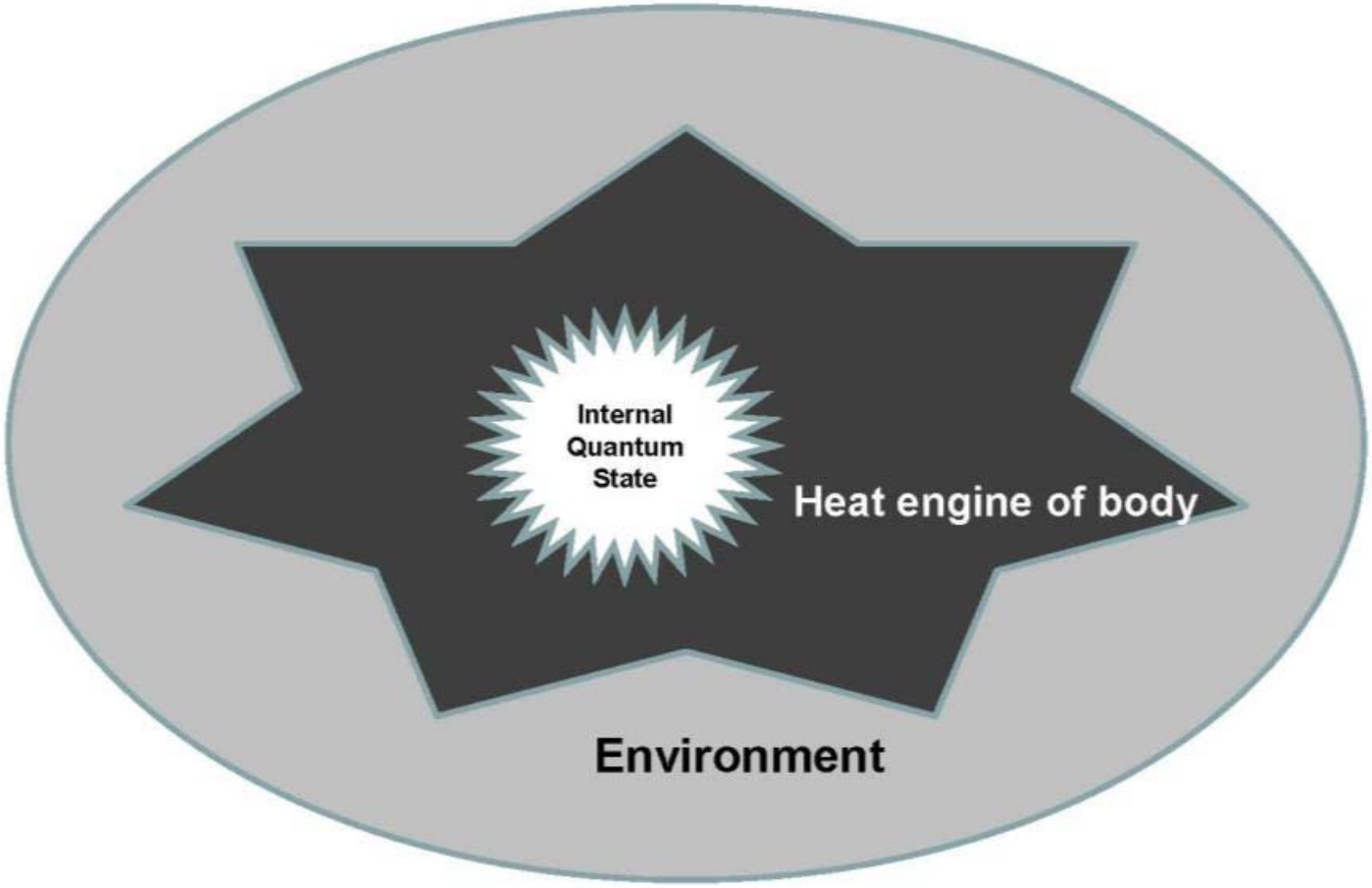
- In the processes associated with mind, the effective temperature can be even much lower

Internal quantum state

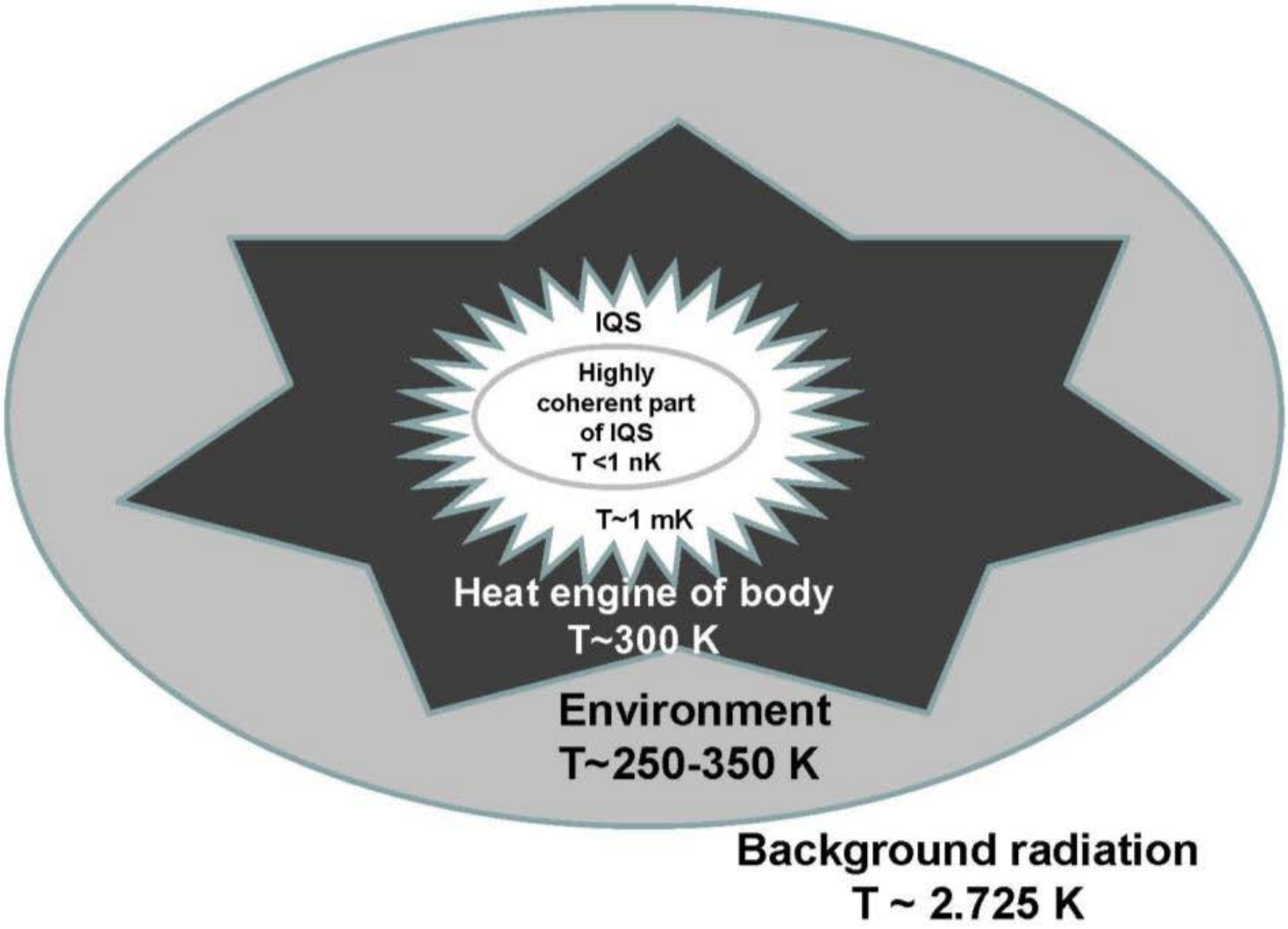
- The coherent state with very low temperature is delocalized within this engine, which operates between its “body” temperature of ∼300 K and the temperature of delocalized coherent state which is $<10^{-3}$ K

- Unexpectedly long decoherence times exist in biological systems allowing the maintenance of internal quantum state (**IQS**)

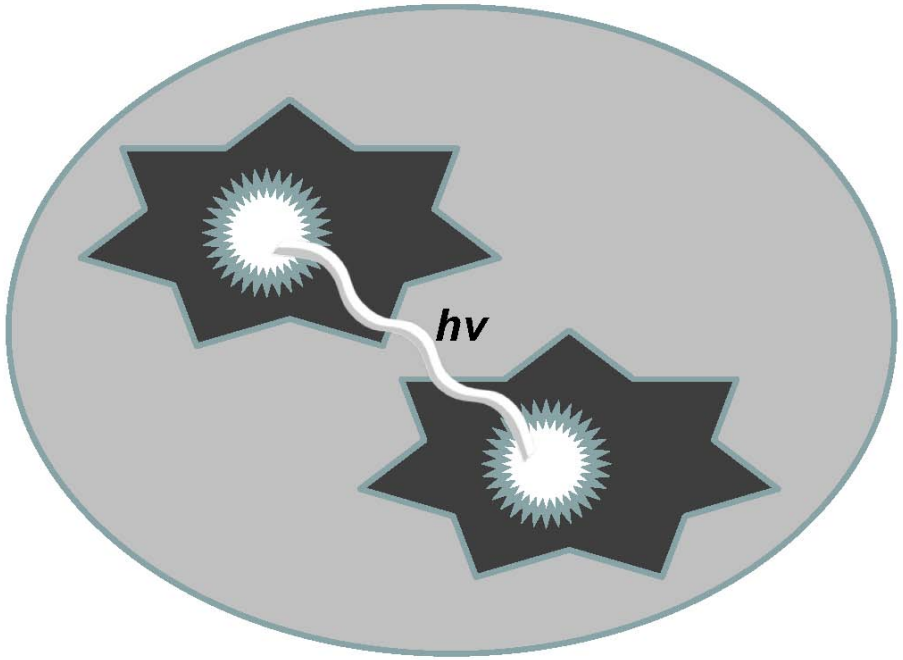
- The state described by the Bose–Einstein statistics and shielded from the temperature of microwave background radiation of the Big Bang, which currently is 2.725 K



General representation of living system, which includes the internal quantum state, the heat engine of the body shielding this state, and the environment supplying body with energy



The representation of living system including actual temperatures of the internal quantum state (IQS) with its highly coherent part corresponding to perception and consciousness, of the heat engine of body, of environment, and the background radiation of the Universe.



Representation of two living units (e.g. cells) with their internal quantum states interacting via emission of weak energy coherent photons

Conclusion

- Reality can be described as a set of self-maintained reflective systems exhibiting themselves externally on the macroscales and interacting via perpetual process of signification through reducing the microscale.

- This introduces the universal computable laws harmonizing the interaction of reflective systems.

- The evolutionary growth of information occurs via the language game of interacting programs, representing an open process without frames.

Conclusion (continued)

- Possessing free will and consciousness, we may accept this world as a suitable place for living or reject it (i.e. express optimistic or pessimistic ethical view), but its mathematically formulated physical parameters may strictly correspond to its observability by embodied living organisms having internal digital structure with alphabet and grammar, which generates a unique solution for the appearance of free will and consciousness