

# The Fundamental Biological Activity of the Universe



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**Abstract** If everything is in permanent change, can the Universe itself be fundamentally passive? Answering this question requires a clear concept of ‘activity.’ The nature of ‘action’ is a central and unsolved philosophical problem. Actions play a crucial role in the way we conceive of ourselves, life and the Universe, and the value we put on these. In four decades of research on *solar activity*, we found that activity is not a mere occurrence but a *genuine activity of the Sun*, initiated globally by the Sun using quantum processes as tools that generates suitable primary mass flows locally in the solar core that are capable of producing a working dynamo. We argue that solar activity is initiated by biological causes existing beyond the system of physical causes.

The *anthropic principle* demands an extremely special trigger initiating the Big Bang in a way suited to the development of life. The *Astrobiological Revolution* indicates the generation of complex organic molecules preferentially favorable to life even in the ‘impossible’ physical conditions present in extremely rare and cold cosmic clouds. With the help of Ervin Bauer’s biological principle, we find explanation for *biological determinism* and life’s being a ‘*cosmic imperative*.’

Modern cosmology uses obsolete Laplacean models. We show that *the biological principle in the Universe involves a continuous biological activity of the Universe* prevailing everywhere, including in ourselves. This universal activity is the basis of our life instinct and of logic too.

**Keywords** Activity (philosophy) · Solar activity · Anthropic principle · Astrobiology · Cosmology · Cosmic activity

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## Introduction

In the last centuries it has seemed that the most fundamental problem of philosophy, the mother of all question “What is life?” has remained unanswered. We think this situation arises because we live in the era of physics. Actually, nowadays there exists only one exact branch of the natural sciences: physics. Therefore if anybody wants to explain anything scientifically, it seems that the only available tool at present is physics. We call attention to an accumulating number of efforts and facts arguing that an exact biology is under development that is capable of offering scientific answers to some of the most fundamental problems of life, matter, and consciousness (Bauer 1967; Grandpierre 2002, 2008a, b, 2012a, b; Grandpierre and Kafatos 2012, 2013; Grandpierre 2014a; Grandpierre et al. 2014).

## The Biological Nature of Action

The very nature of genuine activity, including its origin and the manners in which it becomes physically manifested, is one of the greatest unsolved problems of solar activity research, biology, and philosophy (Grandpierre 2012a, b; Grandpierre and Kafatos 2012, 2013). A process is defined as a genuine activity if and only if it is not completely determined by conditions and laws of Nature but involves an element of autonomous, actually free decision and corresponding government of behavior. Accordingly, philosophers use the word “active” in the sense “creating causal power,” “adding a genuine new cause to the already existing ones.” Moya summarizes the presently popular scientific views on “action” by the following argumentation illustrating the problem of activity. Actions play:

a central role in the way we conceive of ourselves and others, as well as in the value we put on our lives. But is there any action? This question may sound bizarre, for what could be more evident than that? Philosophy, however, cannot allow itself to be satisfied with that level of evidence. We could be wrong. ... To give the reader an idea of what a reductionist attitude is like, let us start with an episode that nobody would hesitate in classifying as an action, say, drinking a glass of water. What right do we have to call this an action, and not a mere happening? Where is action in this? Well, one could say, I caused that movement, so I acted. But think that this movement can be said to be properly caused by my arm’s and hand’s movement, which in turn were caused by some muscles’ contractions, which in turn were caused by some neurons’ firings, and so on. Action as such seems to dissolve and to be reduced to a sequence of happenings. Appealing to desires will not do, for our desire for water is presumably a state caused by organic deprivation. The chain of causes extends further and further into the past and there appears to be nothing we, as agents, initiate, no action at all, only further happenings. Actions, then, seem to be nothing but specific sequences of happenings. (Moya 1990, 1–3)

Even Moya overlooks the crucial step where the decision depends on the matter of the brain initiating nerve impulses and related physical processes realizing the decision. These events manifest a causal chain that works similarly to a domino game. Knocking the first domino initiates the knocking of the second, which knocks the

third, and so on consecutively. Although it seems for Moya that “action as such seems to dissolve and to be reduced to a sequence of happenings,” the crucial step is, of course, the first knock. In moving a finger, the first knock is given by the immaterial will that has a suitable, biologically governable energy for initiating the first “knock.” Here arises the big question of how the mind can exert its influence over matter. Arguably, this is the biggest problem of science and philosophy.

The successes of modern physics are enormous and impressive. Physics considers only inanimate, inert objects that lack the creative causal powers characteristic of living organisms. Impressed by the enormous successes of modern physics, it is usual to consider that all the things of the world are inert and lack genuine causal powers. In contrast, living organisms are not inert objects. We have been successful in working out the scientific theory of genuine biological autonomy, illuminating that living organisms by their very nature are active, creating new chains of causes by their very actions (Grandpierre 2012a, b; Grandpierre and Kafatos 2012, 2013). We have found that the genuine nature of life can be characterized by systematic *work investments against inertial behavior and equilibration* and autonomous decisions (Grandpierre 2007). All life forms are characterized by their activity *maximizing the difference of their behavior from physically prescribed ones* because this difference represents the distance above death, what we usually call vitality (Bauer; Grandpierre 2008a, 2012a, b). Bending our finger is possible at will because living organisms possess genuine biological autonomy and are at least partially free from physical determinations. Necessarily, biological decisions can act only in the realm where physical determinations are incomplete—that is, at and beyond the quantum level. Biological determinations create virtual particle pairs according to biological aims. Therefore, biological determinations like decision-making originate from a deeper level beyond the quantum vacuum.

Genuine action is possible in actual reality through *free will*, which is formulated in exact scientific terms as *biological autonomy* (Grandpierre 2012a, b; Grandpierre and Kafatos 2012, 2013). It is biological autonomy that can be identified by the ‘self’ who acts. The self is the executive center of consciousness that, together with background consciousness like memory and unconsciousness, forms the mind (Grandpierre 2014a). Since in genuine action it is the ‘self’ that initiates a new causal chain, the ‘self’ is logically and causally prior to the realm of physical objects. The nature of action leads us naturally towards a deeper layer of reality that is logically prior to the realm of observable phenomena considered by physics. We may observe that the physical world can be regarded as the outer, visible layer or surface of the Universe. This world has a remarkable consistency involving a gigantic range of causal network reaching to the most distant stars.

## The Biological Nature of Solar Activity

Solar physicists formed a picture of the Sun on the basis of the available facts. According to this picture, the Sun is a hot ball of gas producing nuclear energy. Yet a series of fundamental facts have escaped due attention regarding the origin and

nature of solar activity. We have gathered together these fundamental, apparently anomalous facts and have attempted to explore their relations. In this way we have obtained a fundamentally new, more complete picture of the Sun. This new picture shows that the Sun is far closer to life than has been depicted in the past.

The most unexpected property of the Sun, on a physical basis, is that it has an anomalous but systematic *activity*. Solar activity is a term describing all the changes of the Sun, first of all the changes of its magnetic fields and the mass flows in the solar interior. Remarkably, the characteristic complex patterns of solar activity are quasi-regularly and cyclically renewed over an average period of 11 years. If the Sun were merely a hot ball of gas, such an activity could not occur. Nobody would expect that a vast mass of inert liquid or gas systematically transforms its energies and rearranges its global patterns. As Eugene Parker, one of the most eminent solar physicists, noted, on the basis of our knowledge about stellar structure, *solar activity is completely unexpected*. Solar activity is a big challenge of astrophysics. Notably, a series of other facts of solar activity deepens this challenge in a way that sheds completely new light on the nature of the problem. These facts have escaped due attention because they did not fit into the old picture.

We have shown that solar activity systematically circumvents the Second Law of thermodynamics, stating that “All kinds of energy spontaneously spread out from where they are concentrated to where they are more dispersed, if they’re not hindered from doing that” (Lambert). The spreading out—this process is also called diffusion—of magnetic energy proceeds extremely slowly, on the timescale of a billion years (Shore 1992, 178). In contrast, the patterns of solar activity are regenerated on average over 11 years. With the help of an example: a hill of sand will lose its height as time passes by, since the grains of sand slowly roll down the hillside in a way that can hardly be observed. On a long timeline, the sand hill would slowly shrink to half of its original height. In comparison, the strength of the solar magnetic field theoretically manifests a behavior like that of the hill that would shrink to half of its original height in a thousand-million-year timeline. Instead, in actual reality, this ‘hill’ shrinks its height to zero usually within 5–7 years and becomes lowland. After that it transforms itself into a ‘valley’ reaching a similar depth usually within 3–5 years. Moreover, this anomalous behavior is accompanied by a series of further anomalous facts.

The main task of control theory is to modify the input conditions of a dynamic physical system in order to obtain the expected specific final result from the output of the system. The Sun can systematically circumvent the Second Law by continuously modifying the initial and boundary conditions of physical laws in a way usual in control theory. The conditions to be controlled are the input data for the physical equations. These input conditions are controlled in a very special and systematic manner that leads to a thousand-million-fold acceleration of the magnetic field’s decay and its systematic, thermodynamically uphill regeneration. The systematic modification of the input conditions of physical laws requires an activity, an intervention from a higher level capable of establishing relations between the mass flows and the magnetic field having that kind of special algorithmic complexity, which makes the internal mass flows suited to driving a working dynamo regenerating the activity patterns. Since the chain of physical processes follows the principle of iner-

tia, such physical processes cannot intervene and modify their own course in a systematic manner. Such a systematic modification would require an engineering activity. The modifications of the magnetic field are realized by generating suitable mass flows in the solar interior, which flows are capable of transporting, annihilating, and regenerating the field by their suitable configurations.

Let us illustrate the problem with the help of an example. In thermodynamics, time has an arrow, the arrow of decay towards equilibrium. Similarly, all fruit-jars fall downwards, when they are not hindered in this by suitable shelves in the butlery. In the case of the Sun, the “fruit-jars” are not hindered from falling down. The theoretically calculated time for reaching half their height from the shelf to the floor of the “butlery” is more than thousand million years. Moreover, as these solar “fruit-jars” would approach the “floor,” their fall were become slower and slower. In sharp contrast to these theoretical calculations, in actual reality the magnetic field lines lose all their strengths within an average of 5–7 years. Additionally, all the magnetic field lines are regenerated from scratch within the next 3–5 years on average. In our example, it would not be enough to pull out the shelves from below the fruit-jars. Additionally, it would be necessary to attach suitable rockets to them to accelerate their falling down by a factor of a thousand million times. After that, it would be necessary to govern the rockets again upwards in a special way and that within 3–5 years, for at the end of the cycle all the fruit-jars are again on the shelves, but now in a top-down position. Such a feat would require enormous ingenuity. In the case of the Sun, this feat is realized by mass flows that are generated in a suitable manner in the solar interior. We hope this example is helpful in illustrating the enormous and unexpected difficulties we noticed in searching for the origin of solar activity.

The destruction and regeneration of the Sun’s magnetic activity requires a dynamo working in the Sun. The motor or the heart of solar activity is the *dynamo that produces systematically magnetic energy from mechanical motions* occurring in the solar interior (Nandy and Martens 2007). A *dynamo is a machine* that converts mechanical energy into electromagnetic energy, like one attached to a bicycle wheel. Keeping in mind the key importance of the dynamo, we can appreciate the true significance of the fact that *the dynamo is one of the truly large mysteries in astrophysics* (Carpenter et al. 2005). We think it is no wonder that the dynamo of solar activity is a truly large mystery because machines involve *functions* and *algorithmic complexity*, both of which transcend the conceptual framework of physics. Functions involve *teleology*, and teleology is alien to physics since physical objects cannot have purposes or aims. It is a matter of fact that the functioning of machines arises from human activity. Such engineering activity cannot be described by physics. Teleology is forbidden in the conceptual framework of physics.

The Sun continuously governs its own activity from its global level, initiating quantum processes in its energy-generating core in a way that induces primary mass flows producing a dynamo requiring the creation of algorithmic complexity. The algorithmic complexity of a machine arises from the boundary conditions of its components describing the way they are put together according to the working principle of the machine. This ‘working principle’ represents a higher-level principle controlling lower-level phenomena (Polanyi). Algorithmic complexity can be

characterized by the minimal length of a computer program describing the given process. Algorithmic complexity characteristic to complex machines cannot be produced in a merely physical process. If all men were exterminated, this would not affect the laws of inanimate nature. But the production of machines would stop, and not until men arose again could machines be formed once more. Some animals can produce tools, but only men can construct machines (Polanyi 1968). While purposeful beings—humans—produce the algorithmic complexity of machines on Earth, such processes are unknown in the Sun and their existence can be excluded on a physical basis. Nevertheless, there is a dynamo at work in the Sun. Does this mean that somehow purposes can arise in the Sun?

These difficulties are even more significant since it is not only a magnetic dynamo that is at work in the Sun, but also a *multi-functional* system of energy transformation that transforms all types of energy into each other in a way that regenerates the patterns of solar activity. Searching for the origin of solar activity we have found it of basic importance that the multi-functional machine is driven by *mass flows*. Since this multi-functional machine has an algorithmic complexity, the mass flows generating and regenerating it must also have an algorithmic complexity.

Owing to the results of our four-decade research program attempting to clarify the origin of solar activity, we have obtained evidence showing that rotational, magnetic, tidal, kinetic, and nuclear energies all play a crucial role in the origin of solar activity (Grandpierre 2015). We have shown that the solar atmosphere couldn't supply enough energy for solar activity; therefore it must be generated in the deep solar interior (Grandpierre 1986, 1988, 1991, 1996a, b, 2002, 2010, 2015). The new theory we have worked out is based on the recognition that solar activity is generated in the solar core. We have obtained a plausible picture of how these energies are transformed into energy forms maintaining solar activity. We have found a series of *positive and negative feedback cycles* playing a central role in solar activity. With the help of detailed numerical simulations of all the related physical processes we have found that hot bubbles, approximately the size of Budapest (having a radius of approximately 10 km), are the key tools by which solar activity is transported into the surface. At all points of these vast hot bubbles the mass flows are coupled to each other in such a special way that the result is the regeneration of solar activity at the global level. In our example, this can be compared to the traffic in Budapest, where all vehicles move in a coordinated way to produce a special prescribed output pattern at the global level. A large initial heating, making the bubble 200,000 degrees hotter than its 15-million-degree environment, is necessary so that the hot bubbles can travel a significant distance towards the solar surface. Above an initial heating of 50 million degrees, nuclear reactions become explosively accelerated and a positive feedback develops resulting in a *thermonuclear runaway* producing a huge amount of energy and the anomalous abundances of heavy elements characteristic of large solar flares.

We have developed a new, almost complete theory of solar activity. The only missing element is to find *the very first cause(s) of solar activity*: the process that initiates and governs the mass flows in the solar core. We have shown that external physical conditions and chance may play a role in the generation of these mass

flows, but they are not sufficient conditions for regenerating solar activity (Grandpierre 2015). These mass flows generate the local dynamo as well as the hot bubbles in a special way that is suited to regenerating the patterns of solar activity manifested *at the global level*. We are faced with a type of *downward causation that produces a multifunctional machine*, including the dynamo, from cycle to cycle. It is important to recall that machines are produced externally, by human activity. Yet, *in the case of solar activity the machine is produced internally*, by the Sun itself. Considering that the most significant difference between organisms and machines is that the former are intrinsically purposive whereas the latter are extrinsically purposive (Nicholson), in our search for the origin of solar activity we are led towards biology. We found the analogy of solar activity in biological actions like bending our finger. Indeed, when we bend our finger, we act from the global level of our mind to the local level of our finger. The causal chain of solar activity starts from beyond the gigantic network of physical causes, extending to the entire observable universe. The Sun initiates biological causes from a deeper layer of the Universe existing beyond the quantum vacuum by creating virtual particles suitable for realizing biological causes, namely, regenerating solar activity. Both solar activity and bending our finger are genuine self-initiated, self-governed actions involving top-down causation. In this way, we have developed a complete theory of genuine solar activity that is called the Helios Theory (Grandpierre 2018a).

## The Finger Experiment

We argue that the ability to act transcends physical behavior, because this latter is always inertial. The ability to act transcends inertial behavior. This is why genuine action necessarily transcends the physical framework. In order to make the concept of action clear and unambiguous we present a simple but compelling experiment: the finger experiment. Who would think that bending our finger and the course of solar activity show an essential similarity? Yet it is so, and exactly with respect to causality. We intentionally bend our finger in a way similar to solar activity. We act at the global level of the organism by our decision and the result is a local process, the bending of our finger. Similarly, the Sun initiates its activity from its global level and acts on the local processes in its core, initiating the mass flows that produce the primary dynamo and the hot bubbles.

The finger experiment has an extraordinary significance since it can clarify for most people that action arises from beyond physics. We can predict successfully when we bend our finger. Therefore our hypothesis that a genuine action realizes the bending of our finger is scientifically testable and provable. It is a fact that similar experiments take place in large number in our everyday life supervised by a vast number of independent experimenters and with successful results. We can consider the conclusion of the finger experiment to be scientifically confirmed. The finger experiment is elevated to an idea of revolutionary significance by the fact that it is commonplace and outstandingly radical at the same time. Its mind-changing signifi-



cance arises from the fact that everybody can understand its extraordinary deeply penetrating power. If we but recognize it, all of us are enabled to change the way we see the world. Such a change can bring about a new, life-centered age for humanity.

We have shown that biological activity like bending our finger is physically realized by biologically created vacuum fluctuations (Grandpierre 2012a, b; Grandpierre and Kafatos 2012, 2013). We have also shown that solar activity is, similarly, governed by biologically-induced quantum processes. Surprisingly, similar process plays a similar role in triggering the Big Bang that is widely thought to be initiated by quantum fluctuations. We found a fundamental similarity between bending our finger, solar activity and the Big Bang. Remarkably, the similarity is manifested in the matter of causality.

We consider that our will represents a kind of biologically governable energy (Baumeister 2012). Let us note that the very first step in the causal chain of our action is that our will creates vacuum fluctuations that are ideally suited to the mental content of the will. The first step of the ‘action’ creates virtual particles suitable for realizing the corresponding biological aim. Realizing such a feat builds a bridge between our will and the quantum vacuum. This bridge can be compared to the role the genie plays in the old fairy tale about Aladdin and his wonderful lamp.

To wit, the quantum vacuum fulfills all our wishes in an extremely delicate and powerful manner. We wish to bend our finger. That’s all, and the rest is done by our brain and a quantum vacuum. We can paraphrase the dialogue between our mind and the quantum vacuum by imagining this dialogue between Aladdin and the genie of the wonderful lamp:

Aladdin to the genie: Oh my friend, let there be a bend of my finger now!

Genie: Your wish is a command for me, my dear friend!

And there was a bend. The ‘genie’ creates exactly such special virtual particles that induce exactly such physical forces that realize the aim of bending the finger.

If a computer expert would take into account all the necessary input biocurrents to the muscles of the finger, he could work on that task day and night for years. How is it that bending our finger occurs with an utmost ease? Similarly, if a solar physicist receives the task of determining exactly all the important details of the mass flows to be generated in the solar interior that should serve as suitable rockets driving magnetic field lines in a way regenerating the solar cycle at the global level, he could work day and night for years—and still have no real chance at solving the task successfully. How is it that the Sun succeeds in solving this problem continuously?

## **Timely Thoughts on the Models of Physical Cosmology**

Modern cosmology works on the basis of deterministic cosmological models rooted in an obsolete idea of Laplace (1812). This idea was that the future motion of all physical objects was completely determined, if one knew all of their positions and speeds at one time. Since then, Laplace’s idea has become untenable. The



development of non-equilibrium thermodynamics, quantum theory, and chaos theory, among other conceptions, has made Laplace's idea obsolete. Remarkably, it nonetheless survives in cosmological models assuming that cosmological equations with suitably selected conditions can give account of the world we live in. In such a situation it is useful to keep in mind that the physical model of the Universe differs from the actual Universe in many fundamental respects. At present, we are not speaking of the model's differences from the astronomically-observed universe. We will just mention that the astronomical universe is full of forms that are missing from the physical model (Ellis 2005).

What is missing from the cosmological model that is to be found in the actual Universe?

- Fine tuning of vacuum processes to life, laws of Nature, fundamental constants (see below)
- Solar activity (see above; Grandpierre 2015)
- Complexity; algorithmic complexity that cannot be produced by the operations described by physics (Polanyi 1968; Davies 1998, Grandpierre 2008b)
- The observed continuous creation of complex molecules everywhere in the Universe (see below)
- Biofriendly laws. Life (Grandpierre 2014a; Grandpierre et al. 2014).
- Biological autonomy. Consciousness. Self-consciousness (Grandpierre et al. 2014).

This means that the physical model and the real Universe are fundamentally different. Laplacean cosmological models of physical cosmology correspond only to a surface layer of a more fundamental astrobiological or biofriendly cosmology that we are now discovering.

## The Anthropic Principle

The fundamental physical constants, the forms of physical laws, and the nature of the vacuum fluctuations that generated the Big Bang all appear to be finely tuned for life's flourishing (Barrow and Tipler 1986; Barrow et al. 2007; Dick 2009, 2010, 2012, 2013; Davies 1998, 2006; 'anthropic principle,' entry in Enc. Brit.). In the physical model, the quantum fluctuations triggering the Big Bang occur spontaneously, without physical causes. Moreover, it is not known what determines the form of physical laws and their fundamental constants. But one thing is clear: all these three factors are related to one known thing, that being life. The big question is: How?

Actually, these three factors—physical constants, laws, and vacuum fluctuations—are the tools of explanations within the conceptual framework of physics. These conceptual tools are insufficient since they leave unexplained all the related facts presented below.

In principle, there are an infinite number of possible random quantum fluctuations suited to triggering the Big Bang (Tryon). But only a very small segment of this range of possible fluctuations is suited to triggering such a Big Bang that is consistent with the existence of galaxies, stars, and life. The quantum fluctuation triggering the Big Bang represents the initial condition of the cosmological equations. The actual quantum process initiating the Big Bang can also be termed the First Cause. This formulation is suitable for putting more emphasis on the significance of this initial factor in the fabricating of the observable universe. The actual First Cause must be extremely special since it is one among the very few that are suited to the existence of life.

After this First Cause, further causes act as well. After the very initial event of the Big Bang, virtual pairs of particles from the quantum vacuum began popping in and out of existence, some of which could absorb energy and become real. Physicists think that all matter today, *from galaxies to living things*, originated from these primordial quantum fluctuations (Zyga 2012). Without the minimal variations in energy density that result from the tiny but unavoidable quantum fluctuations, one cannot account for the formation of the stars, planets, and galaxies that characterize the Universe we observe today.

Quantum fluctuations acting on the evolution of the observable universe have a far-reaching hand. These reach from initiating the Big Bang to the formation of the suitable density irregularities leading to galaxies, to the formation of the Solar System, the Earth-Moon system, to the origin and evolution of the terrestrial biosphere, and to our existence here. This means that the far-reaching hand of quantum-level processes reaches into us. Such quantum fluctuations are input elements for the Laplacean models of physical cosmology and are left unexplained by them.

We point out that it seems to be overly far-fetched to consider that Laplacean cosmological models worked out for describing the largest scale structure of the observable universe could work well not only on large scale systems but also on smaller scale systems like planetary systems and biospheres. By the way, no cosmological model attempts to derive the origin of the Solar System or the origin of life from the Big Bang, and they are clearly not suitable for accomplishing such tasks. We argue that since quantum-level processes have such a far-reaching hand influencing also small-scale processes, it is plausible to assume that their activity is responsible for the development of such apparently ‘tiny details’ like planetary systems and living beings. If so, the quantum vacuum may have a cosmic role influencing cosmic evolution. Since the quantum level is the deepest level of the physical world, a ‘cosmic activity’ realized at the level of the quantum vacuum is a fundamental and universal activity of the Universe. Since cosmic activity extends a far-reaching hand towards life, this cosmic activity has a remarkable biological aspect. If the Universe consists not only of matter and energy but information as well, life has a fundamental place in cosmology. We, therefore, consider seriously the idea of a fundamental and biological cosmic activity as manifested through the quantum vacuum everywhere. An increasingly large number of other, recently accumulated facts underpin this idea.

It was argued that atomic matter and therefore life are possible only in three-dimensional space (Gurevich and Mostepanenko 1971). As Barrow and Tipler put it in their chapter about the relations of dimensionality to life, “the dimensionality of the Universe is a reason for the existence of chemistry and therefore, most probably, for chemists also” (Barrow and Tipler 1986, 265).

Remarkably, the laws of Nature also have a form suitable for life’s flourishing. We have pointed out that the form of physical laws is derivable from the least action principle (Grandpierre 2007). The physical meaning of the least action principle is that physical objects manifest inertial behavior. This inertial behavior can be regarded as the complete opposite of biological behavior, which is characterized by the mobilization of all available energies against inertial behavior. Moreover, we have found that the inertial principle is the ideal tool in the hand of life for attaining the greatest action possible. Once a living organism has decided on a concrete action, it must act in the most economical way in order to save energy for future actions. We have concluded that the form of all fundamental physical laws is related to biology.

Among the fundamental constants occurring in the laws of physics we find the Planck quantum of action, the speed of light, the relative strengths of the four fundamental forces, and the masses of elementary particles. If the laws of Nature are the machinery by which Nature works, these fundamental constants are the buttons on it. Only relatively small ranges of the possible values are consistent with the existence of life. It is this fact that inspires the phrase “fine-tuning” to describe the cosmic conditions favorable to life, even if in the case of certain parameters the allowed ranges are not very narrow (Barrow and Tipler 1986). In the light of newly accumulating facts and arguments “it is clear that the universe appears remarkably ‘fine-tuned’ for life as we know it” (Chyba and Hand 2005). The buttons on the machinery of Nature are all set on the position “LIFE.”

The unique properties of water, carbonic acid, and the compounds of carbon, hydrogen, and oxygen are all fine-tuned for life. “The properties of matter and the course of cosmic evolution are now seen to be intimately related to the structure of the living being and to its activities; they become, therefore, far more important in biology than has been previously suspected. For the whole evolutionary process, both cosmic and organic, is one, and the biologist may now rightly regard the universe in its very essence as biocentric” (Henderson 1913, 312). Updated, more detailed, but essentially similar conclusions were reached by Wald (1962) and Needham (1965). It is claimed that not only is carbon important, but across the periodic table each element seems to be uniquely suited for life’s evolution and emergence. For example, Wald (1962) presented detailed arguments showing that phosphorus and sulfur have surprisingly many properties making them ideally suited to life’s purposes. Recently Conway Morris has shown that phosphorus and zinc bring to each cellular stage indispensable properties (Morris 2010).

Fine-tuning is present not only in the realm of inanimate matter, but also in the kingdom of the living. We are at a stage where most of the key players in particular processes of a particular biological process, such as focal adhesion formation, are known but the numerous competitive interactions in the cell and the fine-tuning

achieved by phosphorylation and protein cleavage are not yet very well understood. The main challenge is to discover how all these components work together in a concerted way. Already, Niels Bohr, one of the founding fathers of quantum physics, also noted,

An understanding of the essential characteristics of living beings must be sought, no doubt, in the peculiar organization, in which features that may be analogous by the usual [classical] mechanics are interwoven with typically atomic [quantum] traits in a manner having no counterpart in inorganic matter.... Owing to the very limits imposed by the properties of light, no instrument is imaginable which is more efficient for its purpose than the eye.... This ideal refinement suggests that other organs also ... will exhibit a similar adaptation to their purpose. (*Light and Life*) (Bohr 1933)

The extremely sophisticated orchestration of biological organization presents one of the basic facts left unexplained by physics, chemistry, and molecular biology. The functions of the living organism typically depend upon the coherent operations of molecules by the million, belonging to hundreds or even thousands of different kinds, and marshaled into order by a hierarchy of controls. A satisfying reading of life's riddle demands a rational account of its biological organization, and that has yet to be achieved (Harold 2001, 4). Harold adds: "And always in the background, just out of earshot, a murmur of mystery: how are all these activities integrated into a pattern that works, reproduces itself and persists for millennia?" (Harold 2001, 142). The almost perfect construction and working of living organisms is still a profound mystery.

Recently, Paul Davies summarized the key points arguing for a biofriendly Universe in the following form:

- The existence of life as we know it depends delicately on many seemingly fortuitous features of the laws of physics and the structure of the universe.
- A famous early example of how the laws of physics seem to be fine-tuned for life is the production of carbon in stars, which requires a numerical "coincidence" to produce a nuclear resonance at just the right energy.
- All four forces of nature are implicated in the life story. Changing the strength of any one of them, even by a small amount, could render the universe sterile.
- The masses of some fundamental particles could not be very different without compromising the habitability of the universe.
- The measured value of dark energy is 120 powers of ten less than its natural value, for reasons that remain completely mysterious. If it were 119 rather than 120 powers of ten less, the consequences would be lethal. (Davies 2006, 171)

Let us mention that the anthropic principle has already generated some successful predictions. As is told in the *Encyclopedia Britannica*:

In 1952 British astronomer Fred Hoyle first used anthropic reasoning to make a successful prediction about the structure of the carbon nucleus. Carbon is formed by nuclear reactions in stellar interiors that combine three nuclei of helium to make a nucleus of carbon. This three-body reaction is very improbable. In order to reconcile it with the abundance of carbon in the universe, Hoyle predicted that the carbon nucleus must possess an intrinsic energy level at a value almost equal to that of the sum of the three helium energies at the temperature of their combination. Under these circumstances the nuclear reaction proceeds with especial rapidity: it is said to be "resonant." Soon afterward, physicists found an energy level of carbon in precisely the place predicted by Hoyle. Other successful prediction of the anthropic principle is worked out by Weinberg in 2007 (see Ellis 2011).

## **New Perspectives in the Search for Life in the Universe – The Astrobiological Revolution**

Astrobiology is the study of the origin, evolution, distribution, and future of life in the universe: extraterrestrial life and life on Earth. Astrobiology is the science of life in the Universe. As the astrobiologist Steven J. Dick writes, with the advent of the means to explore space, the prospect of developing a truly universal science of biology now seems possible for the first time (Dick and Strick 2004, 2). The achievements of astrobiology offer new contexts and new perspectives for studying the relations between life and the universe. In this way, astrobiology explores the most universal aspects of life, laying the foundations for the biology of the future.

With the developments of deep drilling techniques, the signs of a deep hot biosphere having a total mass comparable to that of the biosphere at the surface are found in a depth of 10 km in the outer crust of Earth (Gold 1992). Life is present within much wider conditions than was previously conceived. Extremophile bacteria (organisms able to survive in extreme environments) have proved to remain not only viable in conditions of extreme temperature, pressure, and radioactivity but frequently proliferate even more there than within ordinary terrestrial conditions. The limits of life have expanded at an unprecedented and unimagined rate, including life present in deep space in conditions around  $-270^{\circ}\text{C}$ . The progress of space science made it possible to investigate organic molecules, the building blocks of life, and their conditions by direct measurements in the materials of meteorites and planets and their moons. Soon it was discovered that comets and meteorites are rich in organic materials, even in amino acids. The rapid progress of spectroscopy opened the way to detect organic molecules within planetary and extragalactic clouds as well. It has been realized that conditions necessary for life and organic molecules being the building blocks of life are ubiquitous and found everywhere even in places where it was considered to be impossible. Importantly, pieces of evidence have been found arguing that life was present on earth immediately after its surface became solid.

Instead of considering life to be a sporadic or singular event in the history of the Cosmos in its appearing on Earth, today it has become almost universally accepted among astrobiologists that life has appeared at all places in the universe where the conditions allow, and these conditions have much more range than was thought possible before.

### **Astrobiological Observations Substantiating the Lawful Development of Life in the Universe**

1. With the development of infrared spectroscopy, practically all families of organic compounds have been detected in space (Kwok 2011, 78). Organic compounds of a high degree of complexity are now known to be widespread in the Universe:

in the Solar System, in stars, in the diffuse interstellar medium, and in external galaxies. Their existence is not confined to limited classes of stars or small regions of the interstellar medium (Kwok 2011, 187). Most interestingly, these compounds are widespread in the diffuse interstellar medium where density is very low and the radiation background is also low, and they are found even in “impossible” regions of space where, according to general perception, the density is too low for the synthesis of complex molecules (Kwok 2009; Kwok and Zhang 2011; Neal-Jones and Steigerwald 2011). Until recently the rates of reactions in interstellar clouds were expected to be very slow, with minimal production owing to the low temperature and density of the clouds. The reactions needed to create complex organic molecules are familiar to scientists only at the much higher temperatures and pressures of earth and earth-based laboratories. The density of interstellar molecular clouds producing organic compounds is between  $10^{-4}$  and  $10^6$  molecules per  $\text{cm}^3$ . Compare this with a number density of roughly  $10^{19}$  molecules per  $\text{cm}^3$  for air. From our experience studying chemical reactions in the terrestrial laboratory, reactions will only occur under sufficiently high densities (allowing atoms to collide with each other frequently) and under relatively high temperatures (when atoms are moving sufficiently fast). In the rare and cold cosmic clouds both the density and temperature are extremely low, therefore the suitable collisions of atomic particles needed for forming organic compounds are extremely improbable. We note that according to Sun Kwok, who is one of the most outstanding experts in the field of astrobiology, “theoretically, this is impossible, but observationally we can see it happening” (The University of Hong Kong 2011). The improbability of the formation of these compounds is the greater, if we compare the *billion years*’ timescale of increasing measures of complexity of life on Earth (Grandpierre 2008b; Sharov and Gordan 2013) to the *several days*’ timescale of the appearing such complex organic molecules in these extreme conditions (Kwok and Zhang 2011). The production of such complex organic molecules in the environment of the stellar winds is completely unexpected on physical grounds. “How these stars manage to perform such chemical miracles has remained a mystery” (Kwok 2013, 88). Our conjecture is that a significant percentage of the atoms must be moved in a fine-tuned way to form complex organic molecules by a *biotic factor*, namely, the biological principle (Bauer 1967; Grandpierre 2007, 2013; Grandpierre et al. 2014).

2. It has been argued that it is impossible to synthesize organic materials in appreciable quantity from inorganic materials without the intervention of biological systems (Hoyle and Wickramasinghe 1999a, b). At the same time, scientists believe that more than 20% of the carbon in the universe is tied up in this extensive family of compounds, collectively known as polycyclic aromatic hydrocarbons, abbreviated as PAHs (Hoover 2014). Actually, from the more than 160 molecules identified in the circumstellar and interstellar environments, however, not one is a polycyclic aromatic hydrocarbon molecule (Kwok and Zhang 2011). Instead, they are indicated to be mixed aromatic-aliphatic molecules *similar to coal and kerogen* as well as to the prebiotic insoluble organic materials found in

meteorites. This means that more than 20% of the material of interstellar grains is similar to coal and kerogen. However, since our ability to detect large, complex molecules is limited by the present state of astronomical techniques, the actual complexity of organic molecules could be much higher than is currently known (Kwok 2011, 78). The production of coal and kerogen requires millions of years even here on the Earth. Since coal and kerogen are remnants of ancient life, this type of organic matter was thought to arise only from living organisms (The University of Hong Kong 2011).

3. Recently the first amino acid, glycine, has been discovered in interstellar dust (Kuan et al. 2003). If we envisage a soup of chemicals and the near-infinite range of possible reactions, there will be a vast decision tree of molecular arrangements that are open. Only a few tiny twiglets on the tree will lead towards life (Davies 1998, 236). Therefore the discovery of glycine is further indication for the existence of a preferentially biological effect acting everywhere in the Universe.
4. There could be as many as *40 billion Earth-sized planets* orbiting in the habitable zones of sun-like stars and red dwarf stars within the Milky Way Galaxy (Petigura et al. 2013). Recently it has become clear that microorganisms populate habitats like deep-sea hydrothermal vents, Arctic sea ice, geothermal hot springs, and extremely dry desert soils, and thrive inside rocks up to 1900 feet below the sea floor, and half a mile below the ice of Antarctica, and have survived and shown remarkable results in the adaptation capacity for photosynthetic activity within a simulation time of 34 days under Martian conditions (de Vera et al. 2012), and seem to adapt to the space environment in ways “not observed on Earth” and in ways that “can lead to increase in growth and virulence” (Kim et al. 2013). These environments and their inhabitants give us a glimpse into potentially habitable environments on other planetary bodies, where these extreme conditions might be more common. Recently, it has become evident that the Martian subsurface contains niche environments where life could develop (Chatzitheodoridis et al. 2014). There are indications that Saturn’s moon Titan can also have habitable zones, and it is well known that organic compounds are abundant there (Iess et al. 2012). Meteorites rich in prebiotic organic compounds may harbor evidence of life (Heldmann et al. 2014). Key molecules in prebiotic chemistry like dipeptides are detected in the Murchison meteorite (Shimoyama and Ogasawara 2002; Schmitt-Kopplin et al. 2010). A new experiment simulating conditions in deep space reveals that the complex building blocks of life could have been created on icy interplanetary dust and then carried to Earth, jump-starting life (Sanders 2013; Kaiser et al. 2013). Let us note that Kaiser et al. conclude that their experiments have established the feasibility that dipeptides—a key component in the assembly of proteins—can be formed in interstellar model ices abiotically at 10 K via ionizing radiation. Here we point out why their conclusion about the apparent ‘abiotic’ origin of organic molecules is wrong. Since “theoretically, this is impossible” in the actual low density conditions of interstellar clouds (The University of Hong Kong 2011), the only possible explanation that can explain both laboratory experiments and such



astrobiological observations is that not only physical laws, but also biological ones are present both in laboratories and in cosmic conditions. Since such biological laws are unknown to most researchers, they feel obliged to think that the process occurs abiotically. Nevertheless, we point out that the biological principle (Bauer 1967; Grandpierre 2007; Grandpierre et al. 2014) is present everywhere in the same way that physical laws are present in both laboratories and cosmic conditions. Certainly, only natural laws can govern dust formation as well as the formation of prebiotic molecules. If physical laws cannot explain observations, we must allow that biological laws are at work. If so, then we have found experimental evidence for the existence of a biological law of nature permeating the entire Universe.

5. The detection of infrared features in distant galaxies suggests that complex aromatic compounds were already present in the Universe as early as 10 billion years ago (Kwok 2011, 95). Scientists reported that life had begun  $9.7 \pm 2.5$  billion years ago, billions of years before the Earth was formed, based on extrapolating the “genetic complexity of organisms” [from “major phylogenetic lineages”] to earlier times (Sharov 2006; Sharov and Gordon 2013).
6. The Milky Way has an important role in the development of terrestrial life. In the past 3 billion years, the star production rate of the Milky Way galaxy has been closely correlated with the productivity of life on Earth as measured by the isotope ratio  $C^{13}/C^{12}$  (Svensmark 2006). The correlation coefficient between the two records is 0.92 and significant at the 0.9999 level. If this linkage is confirmed it suggests that the evolution of life on Earth is strongly coupled to the evolution of the Milky Way.
7. An increasingly large number of material properties have become known which seem to be fine-tuned for life. About 99% of the living parts of living organisms are made of the four elements, H, O, N, and C. The striking parallels between the relative cosmic abundances of reactive elements (especially H, C, O, and N) and the elemental composition of living matter have been pointed out by many authors (Fox and Dose 1997). Already Henderson (1913) argued early in this century that water and carbon dioxide are maximally and uniquely suited for the living state in virtually every one of their chemical and physical properties. “Water is the most extraordinary substance! Practically all its properties are anomalous” (Szent-Györgyi 1972, 9). No simulation model is currently able to reproduce these properties (Nordita Conference 2014). At present, water has more than 66 known anomalies, most of which are inevitable for life (Tuttle 2009; Huang et al. 2009; Chaplin 2015). Water is not only common in the cosmos. It is also the best known of all known substances for supporting the living state (Kenyon 1974). Oro reminds us that the composition of living matter is a better sample of the universe than is our earth (1963). The valences of carbon, oxygen, and nitrogen and the marked tendency of molecular hydrogen to escape from the surface of a condensing protoplanet easily account for the relative deficiency of hydrogen in living matter.

Steinman and Cole reported that amino acids might form peptide chains in a manner that was ‘anything but random’ (Steinman and Cole 1967). They noted that molecules tend to form compounds that are biologically preferred. “In a sense, a sort of built-in »predestination« can be identified at several levels of biological order.” This explains why the organization necessary for living systems that appeared as a rare, chance, improbable phenomenon can actually occur.

If it can be shown that these most abundant reactive elements are uniquely suited for the living state, as Henderson, Wald, and Needham have argued, then *movement toward carbon-based life is discernible in the earliest stage of cosmic evolution as a favored direction* (Henderson 1913; Wald 1962; Needham 1965). Scores of primitive Earth simulation experiments employing a variety of initial gaseous mixtures and free energy sources have demonstrated that the types of compounds that play key roles in living matter are formed in appreciable yields under simple conditions. For example, Miller has shown that more than 200 mg of amino acids are produced when a primitive gas mixture containing about 1 gm of initial methane is subjected to an electric discharge (Miller 1955). Bar-Nun et al. found that in a high temperature shock tube 30% of the initial  $\text{NH}_3$  is converted into amino acid product (Bar-Nun et al. 1970). In such experiments, the four most abundant amino acids of living matter, glycine, alanine, aspartic acid, and glutamic acid, are consistently formed in appreciable yields (Kenyon 1974). In spite of the non-biological compounds detected in these experiments a trend toward the living state long before the first life appeared is clearly indicated. The tantalizing conclusion suggested by the above survey of experimental data is that in every phase of cosmic evolution from the origin of the elements to the appearance of protocells there is a discernible preferential movement toward the carbon-based living state (Kenyon 1974, 211–212).

Sidney Fox and Klaus Dose claimed evidence that the basic laws of physics and chemistry were biased in favor of generating biologically significant molecules (Fox and Dose 1997; cited in Davies 2003). Sidney Fox also concludes that ‘amino acids determine their own order in condensation’, and that this non-random ‘self-instruction’ infuses macromolecules with crucial biological information, paving the way for life (Fox 1988, 897). Cyril Ponnampereuma, one of the early pioneers in biogenesis research, believed that “there are inherent properties in the atoms and molecules which seem to direct the synthesis towards life” (Shapiro 1986, 186–7). As it is formulated by the Nobel laureate biologist Christian de Duve (1996), life is a ‘cosmic imperative’.

There is now broad agreement among physicists and cosmologists that the universe is in several respects ‘fine-tuned’ for life (Davies 2003). If the claim that life would be written into physical laws were true, it would be astounding, not to say incredible. To claim that atomic processes include a built-in bias favoring organisms means that the laws of atomic physics effectively contain a blueprint for life (Davies 1998, 236). A physical law will not create biological information, or indeed any biological information at all. If the occurrence of an event is 100% predictable on the basis of a physical law, then the next occurrence of the same event will have no information content. Contrary to the oft repeated claim, then, life cannot be ‘written into’ the laws of physics—at least, not into anything like the physical laws that we

know at present. Davies points out, “Life works its magic not by bowing to the directionality of chemistry, but by *circumventing* what is chemically and thermodynamically ‘natural’. Of course, organisms must comply with the laws of physics and chemistry, but these laws are only incident to biology” (Davies 1998, 237). He adds, “the secret of life lies, not in its chemical basis, but in the logical and informational rules it exploits. Life succeeds precisely because it evades chemical imperatives” (Davies 1998, 238).

Until recently, life and the Universe have been seen through the glasses of physics as a side-effect of physical laws occurring only as a fluke. In the mechanical paradigm governing the science of the previous four centuries, life in the Universe has been considered as a marginal and sporadic phenomenon. For example, in his 1981 article in the *Encyclopedia of Physics*, Caws claims that “Physics is the most basic of the empirical sciences and thus has an asymmetrical relation to others, because every object in the universe has physical properties and is acted upon by physical forces, whereas some objects—subatomic particles, for example—have no chemical properties and may undergo no chemical changes, while most objects in the universe have no biological, sociological, etc. properties.” In this paper, we present evidences that biofriendly activity is actually present everywhere in the Universe including extremely rare and cold cosmic clouds. We argue here that in contrast to Caws’ claims, most objects of the universe have genuine biological properties, including the Sun, the stars, and the quantum vacuum. If so, the old view that physics provides the base for biology “because all objects we see around us, including ourselves, are made of the same fundamental particles whose interactions are governed by the fundamental forces identified and investigated by physics,” will require a fundamental revision (Ellis 2006).

We have obtained a new, wider and deeper picture of the Universe. The Universe is not made merely from elementary particles of matter. In contrast, the Universe is made, besides from elementary particles, from laws of Nature, including physical, biological and psychological laws. This means that elementary particles are governed not only by physical laws, but also by biological and psychological laws. This is why biological determinism prevails throughout the entire Universe. Under favorable circumstances, which themselves are facilitated by the biological principle, biological effects can become observable and manifested in higher and higher levels of organization. Not only the formation of organic molecules, but the formation of the first cell and higher organisms are driven by the biological principle (Grandpierre 2007, 2012a, 2013).

The Universe is not identical with the observable universe we can see with naked eyes and telescopes. Instead, the Universe is the unified whole of all observable phenomena, laws of Nature, first principles of Nature and biological autonomy (Grandpierre 2012a). Besides physics, we have also biology as a fundamental natural science (Grandpierre 2014a; Grandpierre et al. 2014) as well as psychology, by which we mean the general science of self-consciousness. In other words, the Universe is the unified whole of matter, life and mind, including the Cosmic Self (Grandpierre 2014a; Grandpierre et al. 2014). Definitely, the laws of Nature or the

Cosmic Self do not consist of atoms or elementary particles. They do not have physical properties like mass, extension, or color. Yet they are the most fundamental elements of the real Universe in which we live.

The discovery of the higher-level functions of cells offers an unexpected argument concluding that life cannot originate by physics and chance (Grandpierre 2013). Owing to advances in biology and astrobiology, as well as to the unfolding biological basis of quantum physics, the old view of an assumed 'abiotic genesis of life' will give way to a deeper, more complete, and genuine picture. In this new and more fulfilling picture, life has its own first principle that governs all life phenomena (Grandpierre et al. 2014). If life is a universal cosmic phenomenon, it is then not restricted to such 'islands of life' as the already familiar forms of life we know on Earth. As we learned in the example of solar activity, the biofriendly activity of the Universe transcends the conceptual framework of physics.

The discovery of stardust made up of organics was totally unexpected and still difficult to understand within the conceptual framework of physics. In spite of a clear lack of theoretical understanding relying on the usual mindset of physics, the observational facts are clear and definite. Sometimes these discoveries of astrobiology seem too fantastic to be true, and there has not been a lack of skeptics in the scientific community. But what we have learned is that we have to keep an open mind for unexpected discoveries and entertain new possibilities resulting from these new findings (Kwok 2013, xviii).

Summarizing the results obtained by astrobiology, we find that an increasing number of compelling facts present evidence that biofriendly laws act throughout the Universe. Let us draw the conclusion: there are laws of Nature favoring life. These laws prevail everywhere in the Cosmos, and they are not physical laws. We draw the apparently inevitable conclusion that the already recognized biofriendly laws of Nature are not physical but biological laws.

Our four-decades long studies underpin and extend the revolutionary oeuvre of Ervin Bauer (1967). The observed fact that organic molecules are formed everywhere in the Cosmos, even in extremely rare and cold cosmic clouds, can be regarded as experimental evidence for the theoretical findings of Ervin Bauer that a universal law of biology exists. We argue that Bauer's principle prevails everywhere in the Universe in the same way as physical laws prevail everywhere. The difference between the two is that biology is the control science of physics. Biology modifies the input conditions of physical laws in order to obtain the biologically required specific final result in the output of the system. Biology acts at a deeper level of the Universe than physics. Life regulates the input elements of physical laws in a manner suitable for biological purposes (Grandpierre et al. 2014). This means that the Universe is fundamentally biological and physics describes only the outer skin of its body.

The existence of the universal biological principle at the most fundamental level of the Universe explains the biofriendly nature of the Universe, including the anthropic coincidences and astrobiological findings. We have found that the quantum vacuum manifests more than the completely random behavior that is expected within the conceptual framework of physics. In the wider and deeper conceptual framework of a new, biofriendly scientific worldview containing more explanatory

tools, teleology also becomes available as a respectable tool of science (Grandpierre 2012c). We are led to discover a non-random but organized, biological cosmic activity of the quantum vacuum.

We can term the here considered fundamental biological activity of the Cosmos in short as '*cosmic activity*'. Similarly to the Sun's having solar activity, the Cosmos has also its own activity: cosmic activity. In the widest sense, cosmic activity involves also the virtual particles produced continuously by the biological principle and biological autonomy, in addition to those generated by the least action principle of physics. In this paper, we would like to call attention to the until now overlooked biofriendly activity of the quantum vacuum. The accumulating evidence has convinced us that besides the least action principle of physics, an even more profound biological principle acts at the most fundamental level of the Universe. The biological principle and biological autonomy act through creating continuously virtual particles. The physical principle generates two kinds of virtual particle pairs. The first type of them realizes physical or inertial behavior; the second type has a random nature and averages out to zero. In contrast, the biological principle generates virtual particle pairs that realize biological behavior with the help of the active contribution of the living organism itself.

Our point here is that cosmic activity involves all the biological and, in a wider picture, also all the mental activity of the Cosmos. Life and mind are inseparable, because mind is a manifestation of biological autonomy. One can speculate that the universal access of humanity to the objective laws of mathematics, logic, music, and philosophy, as well as to inspirations, intuitions, including pre-conceptual thinking and feeling, arise from the presence of cosmic activity within us. Indeed, it is not only the physical principle of inertia that acts on our being but biological and psychological principles as well. We can open our mind to logical thinking and mobilize all the mental potentials we received from Nature for the sake of exploring the potential of logical thinking available for us. When we do that, we can experience the cosmic powers in us.

Our mind has a twofold task and responsibility. One is to supervise, control, and safeguard our bodily behavior. The other is to explore all the capacities of our Nature-given mind for the sake of the Universe, including all the cosmic life forms (Grandpierre 2008a). This second aspect of our mind can be characterized as cosmic mind. Our cosmic mind works on the basis of cosmic activity. Our cosmic mind listens to cosmic activity and transmits its message into this world, in which these letters you are now reading exist. We think the omnipresence of cosmic activity and its human accessibility is responsible for the otherwise unreasonable effectiveness of mathematics in the natural sciences, as well as for the objective character of subjectively accessed logic and for the cathartic power of some pieces of art (Wigner 1960).

Behind the physical level, in the depths of Nature and our inner world, we find a layer of reality bearing similar characteristics. Thus genius, characterized by "the large infusion of the subliminal in its mental output," provides means for discovery of this hidden environment (Myers; Kelly et al. 2007, 482). Our willpower may be in a certain degree based on a more general "cosmic will" (Strömberg 1948, 277). The nearer we advance to the natural and enlivening forces of creation residing

within the depths of our inner worlds, the greater, brighter, more brilliant, and natural our life becomes.

## The Secret of Life

We have found that life has two fundamental and inseparable aspects: (i) biological autonomy and (ii) the biological principle. Genuine biological autonomy (i) is the ability to make self-induced decisions. In its highly developed, human stage it is known as free will. This self-induced decision-making is realized by the self. The self is the bridge between mind and matter, since decision-making is the way in which our mental events become manifested in the physical world. The other fundamental aspect of life (ii) is the biological principle, which is formulated by Ervin Bauer, and re-formulated as the greatest action principle by the present author (Grandpierre 2007). This biological principle is formulated in a mathematical form as an integral principle, in which the endpoints of the integral are variable and can be selected by the living organism itself. These endpoints are conditionally prescribed by Nature only in one respect, to be optimal for life. Living organisms usually live with their autonomy in harmony with this natural prescription. Nevertheless, their autonomy allows them to deviate from such natural behavior. Such unnatural deviations occur rarely in Nature. Unfortunately, they occur more frequently in the lives of modern, alienated people. But this does not change the fundamental fact that Nature prescribes that we live out our autonomy for the sake of life, to lift life as high above lethal physical equilibrium as possible. The real nature of life is to elevate all life to the heights of life. It belongs to the very basic nature of life to live and act for uplifting life as much as possible, extending and continuing the cosmic experience.

It belongs to the very basic nature of life to live and act for uplifting life as much as possible. Since the Universe is the unified whole of everything that exists, and since the Universe is living, cosmic life can, therefore, do everything. Nothing can hinder the actions of the Universe since everything that exists belongs to the Universe. This means that in the cosmic, ultimate context where the Universe exists, everything is possible. We can say that when life is omnipotent, this is magic. Since the Universe as a whole is living, life has a fundamentally magic nature. Life is extraordinary by its very nature, because its ability to surmount itself is unlimited.

Life is wider and deeper than the tiny parcel seen through the eyeglasses of the narrow mindset delimited by the science of inanimate matter. Life is the message of Nature's victory against all inertness, fixedness, and stubbornness. Life becomes present when it cleans our mind, in a cathartic attack, from all pity conflicts and narrow-minded concerns. Discovering the real nature of life has a higher significance than the discoveries of Copernicus, Newton and Einstein together—actually higher than that of all the already known discoveries of modern science and philosophy.

Life is more fundamental than physical matter. Matter is merely a superficial aspect of life. Matter is the thin skin of the vast cosmic giant: life. Life is sole actor, and matter is its tool and its trace left behind. Life is the third person aspect of the



same thing that is experienced from the first person perspective as mind (Grandpierre2014a; Grandpierre et al. 2014), when mind is meant as the soul, that is, our emotional life, and consciousness, that is, our intellectual life, together. Consciousness is much more than consciousness of matter. The physical principle is an ideal tool in the hand of the biological principle since it secures the most economic realization of biological aims. In the absence of apparent biological aims, the issuing behavior is inertial. While biological autonomy can determine the ends of the biological principle at the most fundamental level of the Universe beyond the quantum vacuum, the physical principle acts only in the upper layer, within the quantum vacuum.

Fundamental reality is present in the form of biological autonomy and the biological principle. Together they form the most fundamental nature of the Universe: cosmic Life. The entire Universe must have a biological autonomy, since biological autonomy is inseparable from the biological principle that prevails throughout all the spaces of the Cosmos. The decision-making ability of the Cosmos can be regarded as the activity of the Cosmic Self. Throughout all the immense spaces of the entire Cosmos, from the coldest corners of rare cosmic clouds to the blood circulating in our hearts and inspiring our mind, cosmic activity is permanently 2018 Cosmic Plan of the Living Universe (Grandpierre 2018b). It belongs to the nature of life that our participation is inevitable, is shaping our own contributions to it.

One day all of us will realize that life is not a tiny spark somewhere in the depths of our body, but an immense and elementary power, the reality embracing the entire Universe.

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