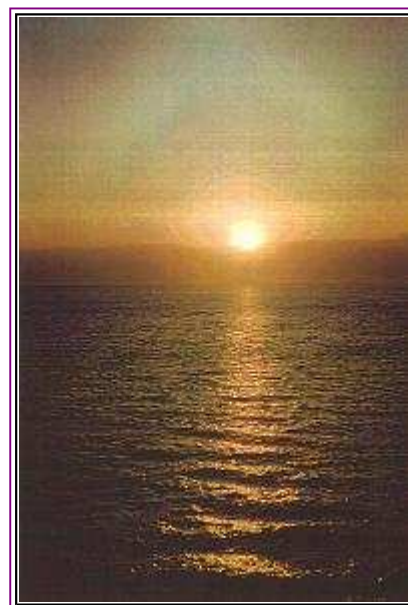




FROM THE STARS TO THOUGHT



SUMMARY: The nucleosynthesis of the chemical elements which make up the matter of the universe in the stars is interpreted as an antientropic process, made at the cost of the strong increase of cosmic entropy produced by stellar radiation. The work outlines and discusses the hypothesis that the chemistry of carbon, the main component of living organisms, started in the carbonaceous stars with the formation of various hydrocarbons, among which acetylene. This highly reactive compound then polymerised, forming linear, cyclic and heterocyclic products, which were subsequently erupted in the interstellar clouds. Given their special chemical optical and electrical properties, two main functions were attributed to these materials, which are among the most common in space: the first being the accumulation of chemical energy, the other the storage of the three key elements: carbon, hydrogen and nitrogen. It is also stressed how, with the aid of light, the biogenous molecules were synthesised in the interstellar grains by scission and combination, starting from these polymers. This second phase, partly in space and partly on planets, is characterised by a further tendency towards a reduction of local entropy, compensated by an increase of planetary entropy and by solar irradiation. This adventurous trip, from the *Big Bang* to the human brain, through various theories and hypotheses, shows how exceptional "life" is, within the general economy of the universe and how wonderful "conscience" is, within the economy of life itself. Living matter tends to the greatest possible spread, and protects its own genome by means of a complex digital system. The birth of manifold organisms in such a short time makes evolution less casual, favouring more coherent and coordinated events. Life and human conscience oppose the general increase of cosmic entropy with a steady growth of organisation and information. In some way, we find what matter loses at cosmic level in the human brain, as a splendid virtual reversed image of our surroundings.

PREFATION: Has the Universe always existed or did it start with a Big Bang? How were life and matter formed? Is man the only evolved being? What are thought and consciousness and where are they located? Essential questions, like these have always troubled men's minds. According to modern science, living phenomena can be explained on the basis of simple chemical, physical and biological laws and the properties of living material can be attributed to a tendency of systems towards complexity and self-organisation. The current work tries to bring an original contribution to this fascinating problem.

1. DISTANT AND UNCERTAIN ORIGINS, PRECARIOUS FUTURE [2]

" *Wayfarer, your footsteps are*

the way, and nothing more;

wayfarer there is no way,

the way is made with movement.

With movement one makes the way

and turning one's glance back

one sees is the path to which

one will never return, to tread.

Wayfarer, there is no way,

but wakes in the sea"

Antonio Machado

Questions about the origins of life, of man, of the earth and the universe existed in ancient cultures and sometimes they were so persistent as to become obsessive. As many solutions were proposed as there were civilisations, even extending to more abstract concepts (space, time, good, evil, etc). A series of theories, hypotheses, and beliefs have succeeded each other over the centuries, culminating in two great visions, those known as Creationism and as Darwinism [3] According to Kant, instead, man must limit himself to respectful contemplation and admiration of the Creation, given that the necessary rational presuppositions for giving life to a credible interpretation either of the origin or of the development of the universe are missing. On the other hand, the fact itself of asking the eternal question does nothing but conceal fear and the need for protection: feeling near a supreme Entity is reassuring especially when one is employed in a relentless struggle for life. Right from the start, the Creator was conceived with a human resemblance and as a being able to give life and form to all things. The Creation has been imagined as originating at times from an egg, at times from a flower or a foaming wave of the sea; at times balanced on the wings of a bird or accompanied by the thunderous rumbling of drums; other times as the sweetest music. These ancient representations seem to flourish once again in modern science: the thunder of the Creation is now called *Big Bang (Urknall)*, while the recently discovered "Music of the Sun" [4] calls to mind the ancient harmonies springing from the depths of the cosmos. The success gathered by evolutionary theory is due to scientific and sociological factors and its roots come from the empiricism typical of the modern era. This is based in on objective facts, on the revelations of controlled experiments and on the more recent developments of biochemistry and genetics, which have brought about the discovery of a mechanism for the transmission of the common hereditary base of all living beings which are coherent with the hypotheses of Darwin (1859) and which makes them credible. Besides, the possibility of rationally explaining the development of life found fertile terrain in the enlightened type of borgeous society and also in that of Marxist-Leninist leanings of the last century.

With the end of the sparring match between evolutionists and creativists [5,6], lay and religious culture in the West today appears to be inclined towards accepting the rational scheme of the theory of evolution, while the so called "state of life" or what we intend by life, continues to resist the various attempts of physical or philosophical definition. According to the most respected accepted version, "life" is "a common state of material present on the surface of the earth and in the oceans, formed by the complex combination of four principle elements (carbon, hydrogen, oxygen and nitrogen) as well as sulphur, phosphorous and traces of others [7]. It seems easier to define some fundamental characteristics which distinguish living creatures. We may present them as the following axioms:

1. Living creatures are generated only and always from other living creatures.

2. They have a defined and constant form;
3. They are made up of fundamental units (cells), affine for structure and function;
4. They possess the property of building and maintaining themselves at the expense of the chemical substances and energy, which they obtain from the environment;
5. They maintain continuous relationship with the external world and are able to react to determined stimuli;
6. Each species safeguards its genetic information;
7. They are not perennial, given that each individual is destined to disappear at the end of a predetermined life cycle (biological clock);
8. They tend to the maximum possible spread [8];
9. They are thermo-sensitive and life is only possible in a very restricted range of temperatures.

The safeguarding of genetic information (point 6) allows conservation of the information despite a general increase of chaos (entropy), thanks to a complex digital system, like that of the chromosomes. This, unlike that of our electronic technologies, based on two alternatives 1 and 0, adopts four: A,G,C,T (Adenine, Guanine, Cytosine and Thymine), which represent the letters of a living digital language. This language has demonstrated a surprising capacity for conserving the hereditary characteristics of the single species with accuracy and of defending them from the most varied external agents. Perhaps for the first time in history of the Cosmos, we are facing the capacity on the part of some molecular chains of perpetuating themselves, safeguarding the information necessary for the formation of the successive individuals, at the cost of energy captured from the surrounding environment. This is a sort of challenge to the universal tendency of increasing disorder and entropy, which finds its maximum triumph in human beings and in particular in the human mind with its capability of rational coordination and creative bursts and extending to the conquest of self-consciousness. Many biologists claim that the synthesis of life from inanimate matter will be possible in the near future. At that point the axiom 1 would fall, according to which living creatures always generate living creatures and only living creatures and thus, the last frontier between the animate and the inanimate worlds would also disappear. This ambitious objective has not yet been reached, despite the fact that we know a lot about the structure of the cells and that the “biochemical building blocks” necessary for their assembly are readily available. Other scientists consider the realisation of life in the test-tube an improbable event because of the complexity of the living matter, which has only been reached through an evolutive process of various hundreds of millions of years. Wanting to repeat this process in the laboratory in a brief time with the purely casual approach appears if not unrealistic, at least improbable. The future of this question is uncertain and it is difficult to predict how many years still remain for the classical axiom “*Viventes viventibus generantur*” (Spallanzani 1729-1799)[9]. From quarks to the galaxies and from bacteria to planetary ecosystems, nature tends towards greater complexity and selforganisation: the atomic particles become atoms and molecules: these become biomonomers and polymers, and later protobions in pluricellular structures and organisms, which in turn give rise to social and ecological systems (axiom 6) [10]. The birth in such a short time of all this plurality of organisms and structures reduces the casuality of evolution and alters the possibility of variation in favour of coordinated and coherent results, able to make order prevail over chaos.

Even before prehistory, an irresistible push to overcome every frontier characterised all forms of life. The migration of animal species, with the scope of exploring and conquering territory, expresses the tendency of planetary expansion of living matter. It is clear that such a form of globalisation does not represent a purely human and terrestrial phenomenon but rather a universal biological law. Evidence comes from the arrival of forms of primordial life on earth, transported on the backs of meteorites and comets from the depths of the cosmos. The push towards globalisation is not absent in any living being, all the less so for the vegetable world or that of microorganisms, from viruses to bacteria, to fungi and protozoons. At times the spread has come indirectly, through appropriate biological and atmospheric vectors: pollen and seeds transported by the wind and insects, seeds in the form of evanescent clouds (aerosols) or at the mercy of the wind attached to dust and sand. The phenomenon then spread from the biological sphere to the cultural sphere. *Homo sapiens* has been the main instrument, through migrations, commerce, movements, spread of knowledge and culture, thanks to science and technology [11]. The exchange of written and spoken idioms, also the various attempts to overlay dominant linguistic stock (Greek, Latin, English, Mandarin, Hindi, etc) and supplant local languages, have effectively facilitated reciprocal comprehension and cultural interchanges (*crossfertilisation*). What happened in the past repeats itself in a modern key: today two of the main motors of interchange and development are a common language (English) and the freedom of movement of people, ideas, written and telematic information. In both biological and cultural evolution one finds movements in a reverse sense with the formation of niches, isolated from the evolutive trend and from the environmental context. In the biological niches, life and development proceed slower, in small steps, and the possibilities

of interchange with the outside world are scarce (e.g. the Galapagos islands). Analogously there are cultural niches, those of single ethnic groups living an almost prehistoric life (e.g. Australian Aborigines, Indios in Amazonia etc). The sudden and unexpected collision of biological niches and the modern world can be dangerous: it can create hygiene problems with at times disastrous repercussions at a planetary level (ebola, hiv, aids etc) [12] or politico-social problems which are not easy to solve. For biology globalisation represents a completely unusual process but not without serious risks, every time established equilibriums will be upset. Innumerable plagues have afflicted mankind in the past [13]; others like AIDS are devastating the world modern and still others are about to do so (BSE, molecular diseases)[14,15]. These plagues are nothing but passing accidents in the process of globalisation occurring on our planet. Louis Pasteur's phrase is ever more pertinent, coming as an admonishment: "*Messieurs, c'est les microbes qui auront le dernier mot*".

2. SUDDEN AWAKENING

" *All the efforts of all ages, all the dedication, the
inspiration, the bright greatness of human genius,
are destined to end in the vast
death of the solar system, and the temple of
human conquests will be inexorably buried
under the detritus of a universe in ruins...*"

Bertrand Russell

Distressed by the thousand dangers of a hostile environment, man has always looked for protection and security, to the point of designing a model of the universe made in his own measures. From Ptolemy and from the ancients we inherited a reassuring picture of a static calm earth at the centre, caressed by the sun, watched over and almost protected by the other planets; man trusted himself to Divine Providence to the Last Judgement. Copernicus, Galileo and Newton brutally awakened us from this idyllic dream, which had lasted millennia. All of a sudden, we found ourselves in an earth pirouetting around the sun, and joined with it in a flight across the universe, prey to black holes, cosmic rays, asteroids and comets [16]. Today we know that the universe tends to maximise dispersion and about thermal levelling (freezing) and that it is the unexpected fruit of an immense catastrophe, the *Big Bang*. Beyond our galaxy, which we had mistaken as an immutable expression of eternal order, there are a succession of apocalyptic dramas unknown to the ancients: asteroid and cosmic collisions, explosions, births and deaths of stars and planets, encounters between giant galaxies. The sun and the stars, whose friendly light guided trusting navigators and merchants for centuries are nothing but bombs, hydrogen bombs, fed by nuclear reactions, and all predestined to go out, some sooner, some later. The unconscious fear of some universal judgement has given way to the rational certainty of an inevitable end. The universe, at one time all order and peace now appears to us in the throws of gigantic nuclear manifestations. The blue of the sky, the site of Olympus and of our ideals of highest perfection, is the theatre of menacing novas and supernovas, of lethal radiations, of solar winds, of incessant bombardments of dangerous ionised particles. From interstellar space more or less visible flashes of light reach us across dense clouds. formed by gas and cosmic dust. From these clouds, which sooner or later will collapse into stars and planets, a confusion of simple and complex organic composites are born. These are the building blocks from which carbohydrates and proteins are formed, to be assembled later into cells and living organisms [17]. We are taught that man was created in the resemblance of God as part of a great celestial project, while we discover that we are the fruit of chance: some millions of years ago a giant meteorite fell onto the earth darkening the sun and provoking darkness and intense cold or that a supernova exploded nearby inundating the earth with lethal radiation. The cataclysm condemned the dinosaurs and a great part of the living species to death, while it allowed the formation of a biological niche better adapted for the mammals. From here, the hominids started and from them came *Homo Sapiens*.

3. DUST AND CINDERS OF THE STARS

" *Our destiny in indissolvably linked to
that of the stars* "

Paul Davies

Urged by an inexhaustible curiosity, prehistoric man studied the nature around him and, with wonder, observed the connections between various phenomena. The firmament burning bright with shining stars in the clear nights strongly attracted his attention. Alternating observations, adoration and meditation, he began to put some aspects of the earth's climate, like precipitation, temperature and the play of the tides, into relation with movements of the constellations and with the systematic nearing of lunar phases. Astrology and astronomy, the first the oldest among man's inventions, were founded on a completely empirical basis. Considering the lack of adequate instrumentation and the modest knowledge, one must recognise that astronomy reached admirable levels of knowledge among independent and distant populations like the Sumerians, Assyro-Babylonians, Egyptians, Greeks, Mayas, Aztecs, Incas, Chinese, Indian Arab etc. Later, cosmology would develop from astronomy and pose problems of a more ample nature about the structure and the future of the entire universe. Having outlived the speculative approach, cosmology then developed into empirical science, thanks to the innovation of technology and means of observation, like telescopes with a wide spectrum, radio astronomy and spectroscopy [18]. "Once upon a time about 14 billion years ago, there was a terribly dense incandescent ball and its huge explosion would give rise to the origin of our universe, with its masses and galaxies, with stars, suns and planets: and on at least one of these latter one day life appeared". Thus Giulio Giorello summarised the theory of the *Big Bang* about the origin of life and the universe[19]. Opposed by many, appreciated by many, this theory today is more or less universally accepted and has formed the basis for the development of new hypotheses about life and its origins.

The initial explosion interested space and time simultaneously, signalling the start of all of physical reality. Through a progressive process of expansion and cooling, the initial temperature of several millions of degrees fell to 2.7°K of today. In the first instants elementary particles like quarks formed from the radiation together with free electrons which blocked the passage of photons: for this reason the universe was not transparent and would have seemed totally dark to a hypothetical external observer. A little after, that is at the end of the first three minutes, the temperature had fallen to less than 3000°K allowing the formation of hydrogen atoms, by combination of protons and electrons, passing thus from the era of pure energy to that of matter. On the basis of various experimental data, today it is believed that in all the stars there is an uninterrupted process of nuclear fusion with the conversion of hydrogen into helium and the emission of radiating energy. This fusion energy can feed a star for billions of years in a remarkable equilibrium between forces of gravity pressure and of radiation. When the temperature of the star is sufficiently high the nucleus of helium melts again forming first carbon and then oxygen, nitrogen, neon and other light elements. For thermodynamic reasons the chain of spontaneous reactions finishes in the stars with the formation of iron [20], while in a supernova, where enormous quantities of energy are liberated in an explosive form, chemical elements heavier than iron, like gold, lead, uranium, and so on, are formed. All these from the lightest to the heaviest will then be projected into space from the explosion of the supernova where they mix with the detritus of other older generations of stars [21]. It is clear that this 2% of matter present in the cosmos and the stability of the sun, able to burn with continuity and almost without alteration for billions of years, have represented the two factors essential for the birth of life.

This 2% of matter has furnished the elements and the molecules necessary for the assembly of the bricks of life up until the first monoorganisms and pluricellular organisms [22], while the sun has provided the energy to feed this cascade of reactions, which needs an addition of external energy to be able to evolve [23]. The energy necessary to form and break a chemical bond is modest, amounting to only 1 electronvolt (eV) per atom or electron [24]. The photons which reach us from the sun possess energy of precisely this order of magnitude, and thus they are able to set off and terminate all the chemical reactions appropriate for the assembly of life, like for example photosynthesis [25]. The number of photons present in the universe (from 100 million to 20 billion for every nuclear particle) is able to produce whatsoever chemical reaction. The organisation of inanimate matter into living matter is a complex process, which proceeds through a series of chain reactions, passing to simple composites to complex composites (cfr. Eigen's theory of hypercycles). To realise a reaction with the formation or splitting of a chemical bond it is necessary to satisfy some essential conditions like affinity, concentration and temperature. This means that two composites react with each other if they have an adequate reciprocal affinity and if the temperature (energy activation) and concentrations (kinetics) are sufficient to guarantee the trigger and maintain the reaction [26]. The existence and creation of matter obey chemical laws and the more that one goes up the scale of complexity the more are the restrictions to respect and the fewer the degrees of freedom available. Living matter is composed of four main elements: carbon, hydrogen, oxygen and nitrogen. Among these the first has such an importance that we may affirm that **the chemistry of life is the chemistry of carbon**. Among all the other

possible elements, candidates for this role (e.g. silicon) carbon has the advantage of the chemical and physical properties of some of its derivatives: For the oxidation of carbon one obtains carbon dioxide ($C + O_2 \rightarrow CO_2$) a gaseous substance soluble in water, easily recyclable and which plays a fundamental role in the photosynthesis of plants and therefore in all the vital processes. From another element which shows many chemical analogues with carbon, silicon, by oxidation one obtains silicon dioxide ($Si + O_2 \rightarrow SiO_2$) the most widespread mineral on the earth, well known in its crystalline form of quartz. Silicon dioxide is solid, insoluble, inert and not easily recyclable. This difference of chemical physical properties represents the main reason that living matter is made of carbon and not silicon. The metabolism of living matter leads to three end products: carbon dioxide (CO_2), water (H_2O) and ammonia (NH_3). The first and last are gaseous while water is liquid but evaporates easily: the three products can therefore easily mix in the atmosphere facilitating their recycling in all the planet.

In the last analysis it is this possibility of easy recycling that conditions the existence of terrestrial life.

4. THE COSMOS, DARK CASKET OF LIFE

*“A universe populated by an infinite number
of suns, around which rotate many planets, populated by
creatures, with an intellect no
different from that of mankind. Such a countless
vastness of the cosmos will end up cancelling not
only the centrality of the earth, but also that
of man ”*

Giordano Bruno, 1548-1600

Space is not empty as was once thought, but contains matter, distributed among stars, planets, nebulas and galaxies. Most of this matter, composed of hydrogen (70%) and helium (28%) in a gaseous state, formed following the *Big Bang* fills space in a uniform fashion. Only a minimal part (2%) constituted by cosmic dust is distributed randomly in interstellar space or in an aggregated way among comets, meteorites, asteroids and planets. The cosmic dust (ISM, interstellar media) is formed of ashes, erupted into space by stars dead for a time: and these ashes give birth to new generations of stars and planets [27]. In space various elements have been identified, like oxygen, carbon, nitrogen, nickel, sulphur, silicon, aluminium and iron as well as some hundred of so simple and complex organic molecules (PAH from *Polycyclic Aromatic Hydrocarbons*). Current opinion claims that most of these derivatives of carbon have formed in the interstellar grains through complex chemical reactions of photosplitting and photosynthesis. The carbon and the hydrogen derive from the photolysis of the PAH, the oxygen from photo demolition of iced water. According to this hypothesis the key molecules for the synthesis of living material derive from the **PAH**, which are in turn composed of chains of carbon and hydrogen in polycyclic hexagonal structures. This thesis is given value by the spectroscopic identification of the **PAH** in space [28] and by experimental simulations carried out in the chemical laboratory on earth [29]. To arrive at the molecules for life one can therefore imagine a sequential process, exemplified in eight main stages;

1. Formation of carbon, hydrogen, oxygen and nitrogen by stellar nucleosynthesis.
2. Subsequent stellar synthesis, of aromatic hydrocarbons formed of carbon and hydrogen (among which PAH), of water formed by hydrogen and oxygen (H_2O) and of ammonia formed by nitrogen and hydrogen (NH_3).
3. Expulsion of these substances into cosmic space.
4. Photo splitting of the **PAH** into smaller fragments in the interstellar grains.

6. Transferral onto the earth of these simple organic molecules and their more complex derivatives by comets and meteorites.
7. Synthesis on earth of biomonomers and polymers from organic molecules of cosmic origin.
8. Evolutive assembly of these chemical structures into living material.

Regarding this stimulating hypothesis, we express below some critical considerations;

1. The temperature of the interstellar grains varies according to their ubication. Those near to active stars reach temperatures of thousands of degrees, those far away temperatures near absolute zero. Temperature represents a critical parameter in most chemical reactions. On the surface of the hottest grains reactions of the gaseous phase could be favoured, in the colder ones reactions in the solid phase.
2. For the reactions of photosplitting and photosynthesis the exposure to sources of radiating energy is fundamental. Also in this case there are in nebulous zones more or less exposed and therefore zones adapt and not adapt for photo-chemical reactions.
3. The concentrations of the reagents in the grains are so low that the probability of simultaneously and efficient meeting between two three or more molecules are irrelevant. For this reason it is difficult to understand how monomers and polymers, most of which contain the four key elements; carbon, hydrogen, nitrogen and oxygen can form in these conditions.
4. These problems of a kinetic nature throw a veil of uncertainty over the hypothesis that the PAH are key products necessary for the synthesis of the so called building bricks of life and from which the other organic molecules derive.
5. It seems possible that part of the simple organic molecules like cyanidric acid, acetylene, ethylene etc, derive from the stellar synthesis as well as from photosplitting and combination of the PAH in interstellar grains.
6. Carbon is formed from hydrogen in carbonaceous stars. In nature this element is found in four forms called allotropic: soot, graphite, diamond and fullerenes. If other reactions do not occur later the carbon is then erupted in the same state into the interstellar space, where, in fact, it has been identified. Considering the great quantity of hydrogen present and the high temperature, part of the carbon reacts with the hydrogen giving rise to the simple highly reactive non-saturated hydrocarbons (methynic and methylenic radicals, acetylene, ethylene etc). These composites tend to stabilise reacting with themselves (dimerisation and polymerisation) or with other affine molecules, initiating the birth of an immense number of simple and complex organic molecules. According to this scheme, all the organic composites present in the space and on earth, may be considered substantially derived from methinic /methylenic radicals and acetylene.

As above mentioned, the **PAH** are binary carbon and hydrogen based composites concatenated in hexagonal rings and may be considered polymers, formed in the giant stars from acetylene and its derivatives. On earth they are found in tars from the distillation of carbon and petroleum[30], accompanied by analogous cyclics also containing one or more atoms of oxygen, nitrogen or sulphur. The PAH are systems with complex structures, and their chemical and biological properties, like stability, reactivity and toxicity, vary greatly from compound to compound. It is enough to think that benzopyrene, sadly known for its carcinogenicity (cigarette smoke!) is in this class. The **PAHs** are spread in the interstellar space, but are easily synthesised in the laboratory by the combustion of acetylene [31]. This latter, present in space, can be prepared in the laboratory from hydrogen and carbon at high temperatures. It is a very reactive compound, formed from only two atoms of carbon and hydrogen (C_2H_2), which tends to react with itself in a process called polymerisation, giving rise to more stable structures, among which it is worth naming **Acetylene Black**, an organic pigment and excellent electrical conductor. In a previous work [2,32] we hypothesised the existence of this black pigment in interstellar clouds, where it could play a relevant role in the transferral of electrical charge, contributing to causing the dark colour. It represents a "space warehouse" of carbon from which it is possible to obtain by photolysis and photosynthesis chemical fragments suitable for the synthesis of biogenic monomers. The carbonaceous stars are rich in carbon, hydrogen and nitrogen. It is easy to imagine how in the course of a stellar chemical reaction, and in an analogous way to the formation of PAH, also the nitrogenated heterocyclics are formed (cyclic compounds with a base of carbon, hydrogen and nitrogen). In Halley's comet, the PUMA project has identified various cyclic products belonging to this class and of fundamental importance for the chemistry of life (pyrrol, pyridine, pyrimidine, imidazol, and perhaps purine and adenine)[33]. Many of these compounds, as for example pyrrol and indol, tend to polymerise in an analogous way to acetylene [34], forming black polymers, which we have called **PHB** (*Polycyclic Heterocyclic Blacks*). The **PHB** are compact molecules, with which are transported simultaneously ternary mixes of carbon, hydrogen and nitrogen. From these modules it is possible to obtain, by photo dissociation and combination, nitrogenated and oxygenated organic molecules identical to those which make up living organisms. Polymers structurally similar to **PHBs** also exist on earth

where they have been amply studied. We know therefore that they are very sensible to oxygen, light and LASER rays, the latter provoking a real explosion of their structure [2,32]. For this reason it seems believable that in the interstellar grains the **PHB** suffer similar reactions, with the formation of organic fragments identical to those obtained in terrestrial laboratories.

Pushed by scientific and technological progress, our cosmological vision has modified and more and more often we advance the hypothesis of an extraterrestrial birth of life. Today we know that there is matter in space and that many of the molecules identified are also found on earth. The non stellar nebulas are huge black dumps of cosmic garbage, enormous accumulations of ashes, from which new stars and planets are born and will be born: life, and ourselves, are in fact the ashes and dust of the stars.

The grains in which the interstellar dust is aggregated show some interesting properties:

- Optical: diffraction and absorption of electromagnetic and corpuscular radiation;
- Electrical: charge transfer and photoelectric effect;
- Chemical: catalysts of photo chemical reactions, disassociation and combinations.

The grains behave like small space laboratories where delicate reactions occur: complex materials like **PAH** and **PHB** are split into fragments and these recombined into oxygenated and nitrogenated molecules. Thus varied key organic compounds like alcohols, aldehydes, carboxylic acids, amines, nitrils, aminoacids, phenols and other important functional derivatives of carbon may form. Living matter is formed of carbon, hydrogen, oxygen and nitrogen. To form it is necessary that these elements meet in appropriate forms (for their chemical affinity) in appropriate places and for relevant times. They come from stellar synthesis and/or cosmic synthesis in simple and combined forms. Carbon, as carbon dust, fulgines, graphite, diamond, fullerenes, carbon monoxide and dioxide, methane, ethylene, acetylene, methynic radicals etc; Hydrogen, as water Oxygen, as water; Nitrogen, as ammonia, nitrogen monoxide and dioxide; pure nitrogen. The **PAH** and **PHB** are condensed forms of carbon/hydrogen and carbon/hydrogen/nitrogen respectively. Packed into solid modules, these elements are transferred from the stars to the nebulas without dispersion (hydrogen and nitrogen, gaseous by nature, are trapped in the spaces of a solid framework). The polymerisation of the acetylene serves a double scope: compacting the key elements and accumulating chemical energy. In the interstellar clouds, the polymers are split and their fragments recombined with radical oxygenated and nitrogenated radicals coming from water and ammonia ice. The **PHBs** are good conductors, showing a pronounced photoelectric effect (transformation of light into current) and play a role in the evolution of the stellar clouds. In the cosmic chemical evolution, the **PHBs** play a triple role, as:

- **SUPPORT STRUCTURES**: mechanical, electrical and optical properties (charge transfer, diffraction and absorption of radiation, transformation of light into electrical current);
- **ACCUMULATORS**: of chemical energy;
- **SPACE WHAREHOUSES**: of carbon, hydrogen, nitrogen in the form of compact solid modules from which simple molecular fragments can be obtained (the building blocks of biogenesis).

A similar role is played on earth by the various organic polymers, highlighting the strict relationship between terrestrial and spatial chemistry and the fact that a single architectonic principle seems to organise living matter and interstellar matter. The reactions of space and the stars belong to chemical prehistory and are partially comparable to those which we usually conduct in the terrestrial laboratory. In the stars the reactions occur at very high temperatures and pressures in a reducing environment, an ideal site for the reactions between carbon, hydrogen and nitrogen. The oxygen instead, where it is present will soon be captured by the hydrogen with the formation of water [35].

The chemistry of space occurs in the grains, at temperatures near to absolute zero or locally higher according to the position, in solid systems under the action of radiation in the presence of water and ammonia ice. In these conditions the bonds must be split and reformed with precision, lacking almost totally the thermic oscillations of the base [36]. In the hottest zones reactions in the gaseous or absorbed phase prevail, nearer to conditions on earth. Thus equilibrium reactions with the formation of polyfunctional molecules (aminoacids, etc) could also be set off. The chemistry of the

biotic age, that of living matter, is more sophisticated. It is the chemistry of enzymes and in an antiradical function: it loves moderate temperatures like those of our bodies, a watery environment, an atmosphere rich in oxygen, the most aggressive of the elements present on our planet. Notwithstanding the obvious differences between the three "chemistries", stellar, spatial and terrestrial they are governed by the same laws have the same common principle: "NATURA ENIM SIMPLEX EST".

5. THE CURTAIN RISES

" *Science cannot explain the final
mystery of nature.
And this is because, in the final analysis,
we ourselves are part of the mystery which
we are trying to explain "*

Max Planck

According to spectroscopic analysis the interstellar grains are composed of a nucleus of silicon covered by a mantle of water and ammonia ice. Trapped in these icecaps one finds complex organic structures deriving from the polymerisation of reactive molecules erupted from the stars. These materials undergo high energy cosmic radiation and are split and recombined in the grains, which play a support role for the reactions in the solid, gaseous and perhaps liquid phases, making selective splitting and combinations on photosensitive molecular targets. The fragmentation of the interstellar black matter leads to free radicals able to capture oxygen from the molecules of iced water: thus new oxygenated, nitrogenated and mixed compounds are born, key products for the synthesis of monomers and polymers of a biological importance. The stellar formation of various light and heavy chemical elements, the first synthesis of organic matter and transformation of pure energy into chemical energy, represents an antientropic phenomenon, an exception to the general increase of entropy of the cosmos. The elements tend in turn to transform into organised structures (simple and complex molecules) obeying precise laws (affinity and valency). This means that every single element can combine with elements for which it has a certain affinity only in relation to preestablished (valency) ratios, while the two parameters of affinity and valency will be determined by the electronic structure of the single elements. We may try to simplify this concept by two examples: If we burn carbon (C) in an atmosphere of oxygen (O₂) carbon monoxide and carbon dioxide (CO and CO₂) always form. This means that the carbon has an affinity for oxygen and that it reacts with it always and only in the ratios 1:1 and 1:2. If we make a spark in a mixture of hydrogen (H₂) and oxygen (O₂) we will have an explosion with the formation of water (H₂O). This demonstrates that the two elements have a great affinity and that they react in the proportions 2:1. The laws of valency and of affinity have a universal validity, respecting a global principle organising matter. The chemistry of the stars and space shows up how the organisation of matter passes through phases of major and minor complexity which alternate in time:

→ stellar nuclear reaction → synthesis of elements → synthesis of molecules → polymers (PAH, PHB, acetylene black)
→ splitting into fragments → recombination of fragments → and so on.

From the simple to the complex, from the complex to the simple to return to the complex with higher levels of organisation, according to a definite antientropic process.

In five hundred million years, the earth has been bombarded innumerable times by small planets, asteroids, comets and other residue of the solar nebula. The traces of these apocalyptic collisions are still obvious in the small and large craters discovered in various regions [37]. Apart from the material damage caused by this spatial "rain" it is more than credible that with them organic molecules stored in the grains of the interstellar clouds came to our planet. Thus a mixture of reagents ready for further combinations came to be created on the terrestrial crust in the marine and lake waters. On the earth in the prebiotic era chemical reactions already sketched in space continued and others adequate for the new environmental conditions developed. The temperature passed from almost absolute zero to the mild terrestrial temperatures. The molecules no longer frozen into grains became mobile and superactive, with a great possibility of remixing in waters agitated by intense tides. The kinetic possibility of encounters and collisions and reactions greatly increased. The reaction means, now liquid and weakly acidic, favoured the dissolution of basic substances (amines) and the reactions of addition and condensation (e.g. aldehyde + nitril -> aminoacid) while the reducing environment safeguarded sensitive products (aldehydes, alcohols phenols etc) from oxidation. The water screened the UV rays participating in the reactions of hydrolysis and hydration. New possibilities of assembly into complex structures were created at the solid/liquid and solid/gas interfaces between dissolved and gaseous reagents with inorganic matrixes (clay, pyrite) and organic matrixes(melanin). The splitting of the water forms highly reactive oxygenated radicals giving rise to reactions and new composites: **the age of oxygen** started in this way. In the new terrestrial environment the increased temperature stimulated reactions previously blocked because of the lack of activating energy. A myriad of metallic ions, free or bound to opportune matrices, filled the marine environment and lakes: chemical catalysts were born which, in the biotic era, would give headway to the enzymes. The "prebiotic test-tube" became bigger and bigger, and now embraced lakes, seas and oceans: the biological soup was ready to host life. The cosmic chemistry has imprinted the terrestrial world, shaping the living world according to common architectonic principles. Everywhere chemical reactions take place: the plants and certain bacteria fix solar energy transforming it into chemical energy (photosynthesis); other organisms decompose the living matter into simpler structures using the energy contained in them. In every cell a succession of concatenated chemical processes (reduction, oxidation, hydrolysis, synthesis etc) takes place. The biochemical architecture of living beings is based on a few columns of elements (carbon, hydrogen, oxygen, nitrogen, sulphur, phosphorous etc) but it ramifies into a multitude of molecular composites: binary on the base of carbon and hydrogen (hydrocarbons); ternary with a base of carbon, hydrogen and oxygen (carbohydrates, polysaccharides, fats etc); quaternary with a base of carbon, hydrogen, oxygen and nitrogen (aminoacids, polypeptides, proteins, nucleic acids, alkaloids, lipoproteins etc) and so on. Living beings possess unique characteristics like reproducibility and specificity of their single structures, with a strict relationship between the structures and the biological role. The surprising variety of living forms and the individuality of the various organisms can be traced to the individuality of some macromolecules: the proteins. Yet these are nothing but the combinations and permutations of a few aminoacids; always the same ones for various millions of years. In all organisms food is transformed into carbonanhydride, water and ammonia through a few passages. Production and use of the energy from part of the cells is based on the same mechanism in many animals from the protozoons to mammals. Various theories have been constructed about this incredible phenomenon of life as attempts to unravel its mystery. We shall discuss a number of these in the next chapters. However, Newton's axiom always sounds relevant "*Natura enim simplex est*".

6. LIFE IN THE UNIVERSE

" *The world of the physical sciences and the world of the life sciences are still separated today by an unexplored no-man's-land* "

Mario Ageno [49]

Notwithstanding the most recent conquests of biology life remains the great mystery of the universe. In the general economy of science its origins and its function are still the object of more or less bold hypotheses on the border of science and religion. In every age numerous scientists have tried to discover the laws which regulate living beings, compared them with those of the inorganic world and tried to use the laws of physics and chemistry to give a unitary picture of their behaviour. But the many attempts were systematically disappointing. In a famous essay in 1940 Bergson

[38] thus expressed this a sensation: "all our analyses show us that life is an effort to go up the hill which matter descends. Certainly, life which evolves on the surface of our planet is attached to an organism which subjects it to the general laws of inert matter. But everything happens as if life did everything possible to free itself of these laws. It does not have the power of overturning the direction of the physical changes which determine it, the principle of *Carnot*, but, if nothing else, it acts as a force which left by itself would work in the opposite direction". The same impression is found in the works of P. Lecompte du Nouy [39], who, in the light of a careful and detailed analysis of evolution sees a systematic tendency towards the development of the brain and consciousness as a sign of a spiritual end in nature which manages to triumph over the forces of matter. The mathematician L. Fantappiè [40] formulated the theory in which he claimed the existence of a class of phenomena for which time seems to run in the inverse sense compared to the rest of matter. He called them they are called syntropy the opposite of entropy and in the scope that animates the action of the living sees a sort of cause which follows its own effect, since in the living beings something manages to overturn the normal course of time, contrasting with the general increase of disorder in the inorganic world. If for example one projects, parting from the last photogramme, a film which records a vase falling one will have the disconcerting vision of thousands of small fragments which recombine to build a vase: a scene which calls to mind the budding of a flower. The projection of an inanimate natural phenomenon appears as animated if seen according to the inverted succession of time. One then is tempted to suspect that in life one verifies something similar. A theory which opens a scenario of intrinsic temporal symmetry, reproposing the dualism of matter-spirit in a scientifically credible form. Also a profound theologian like Teilhard de Chardin [41] finds himself on a similar line of thought. Other thinkers have deepened the relationship between nega-entropy (or syntropy) and information even trying to link information with the opposite of entropy mathematically. Among these we recall O. Costa De Beauregard [42] who deepened the problem of information posing it in relation to the probability criteria (or better of improbability) of the theory of thermodynamics. Among others one should certainly mention M. Eigen [43] for his brilliant work on the evolution of the biological macromolecules. In a special way another great scientist who has fully dealt with the problem of negaentropy tracing it to a general picture of entropy should be recalled. We refer to Ilya Prigogine [44,45] and his dissipating structures far from the equilibrium which can have a sort of unnatural dynamic stability, which makes them seem in practice as if provided with negaentropy. The hypothesis which life can have found origin in the order deriving from a fluctuation happening in an open system, like that of the surface of the earth, continually radiated by the sun, seems daring but captivating. If one accepts such a hypothesis one loses the sense of the thesis of Monod which attributes the origin of life to chance, since instead, in conditions far from equilibrium some reactions which are decidedly improbable if taken in normal situations near to equilibrium become suddenly necessary and systematic. These even present the characteristic of accelerating the increase of entropy in the surrounding environment. A common element of all these theories lies in their having attributed to living matter an opposite current compared to the rest of the universe, in a certain sense acting against the universal law of increasing entropy and moving according to special laws in a context able to invert the passage of time. The different theories attribute different origins to such a phenomenon from the spiritual telefinalism of Lecompte Du Nouy to the mathematical symmetries of Fantappiè to the reductionism of Prigogine. The recent discoveries in genetics show the importance of information in explaining the mystery of life: the double helix is a digital code able to self-replicate and to defend itself against attacks from the outside external world. A sort of alien in the world of inert material which even though it does not escape entropic laws, and is perhaps limited to the thin layer of the surface of a particular planet like our earth, still manages to give rise the life of flower, to generate a protozoon, a mammal or even a man, up to forming a brain able to create works of art and to ask questions about its own origins.

The first components of matter are characterised by particles and their respective antiparticles, which interact according to quantistic rules, respecting some rigorous principles of conservation and of symmetry. At this level time does not seem to present any preferential direction: if one inverts its sense ($t \rightarrow -t$) and contemporaneously changes the particles with the corresponding antiparticles, the reactions remain identical to themselves. Time does not present any particular preferred direction as if every antiparticle were nothing other than the mirror image of the particle which corresponds to it according to an almost perfect symmetry. From the simple structure of the hydrogen atom with its precise levels of energy calculable using quantum mechanics to the dimensions of the molecules regulated by the laws of chemistry, when we put together some billions of molecules to obtain a grain of sand, we are no longer able to follow the phenomenon since it takes on an enormous number of unpredictable parameters: the grain then becomes a small chaos, in which we are not even able to predict the shape and the weight. Putting together elements known singularly the characteristics of their groups eludes us. Quantity becomes the source of uncertainty and, together with such a deficit of information, the entropy of the system increases and the sparring of time becomes much clearer. If one imagines a beach where a child has built a sandcastle, we are in the presence of something (information) which has partially reduced the entropy of the beach, giving it a well defined aspect. Neither does the disappearance of the sandcastle by the work of the wind and of the tides surprise us. We would be strongly impressed, instead, if the sandcastle had appeared alone in the course of the night on some deserted beach. A reduction of entropic disorder with the consequent appearance of some information, no matter how insignificant it is, immediately acquires the aspect of a prestigious event for which one is induced to look for a cause Brian Green [50] proposes the following explanatory example:

"Even if you put your desk in order, piled up with paper, diminishing its entropy in this way, the total entropy, that of

your body plus that of the room will increase. To order your desk a certain expenditure of energy is necessary, your body emanates heat, thereby moving the molecules of the surrounding air: if we take into account all these effects, the diminishment of entropy of the desk is amply compensated by the total increase"

These small banal examples tell us that we live in a world in which the loss of information (increase of entropy) is completely natural but in which, though, with every increase of information (reduction of disorder) there must necessarily correspond an ordinating cause, information in some way imported from elsewhere. A world where chaos does not make news, but where order and organisation generate wonder, the sense of time being turned constantly in the direction of an inexorable deterioration of the messages with the consequent increase of confusion (background noise)[51].

In our world every form of life has adopted digital information in the form of the double helix, the same digital technique which we have rediscovered to defend our electronic communications from disturbances which compromise intelligibility. Life manages to reduce its own entropy consuming chemical energy, like our information which feeds or electrical energy. But while a diskette can conserve a message for an indefinite time, the genetic patrimony of a living being is constrained to live in an organism which is able to procure it the necessary energy for conserving and improving the information of which it is a carrier, besides safeguarding the project of self-assembly. It is thus that life has invented death with the annexed instinct of reproduction.

Life appears therefore, in the light of modern science like extraordinary information but also a dramatic challenge against the own planetary environment, which tends to alter the contents. The reflection of Bergson which is quoted seems all the more prophetic and the different theories outlined here each express an aspect of the same truth, searching to identify the cause.

7. ENTROPY AND IRREVERSIBILITY

" *The more I examine it in detail,*

the more I am convinced

that in some way

the universe must have known

we were coming "

Freeman Dyson

Unlike the other forms of energy, heat, once passed from a hot body to a colder one, would never manage to make the inverse passage spontaneously. Research into the causes of such irreversibility has constituted a great problem for scientists of all times. R. Clausius in 1865 made it the object of a general law (the second law of thermodynamics) for which there were excogitated two possible interpretations: the **dynamic** which explains it in purely mechanical factors, as for example an imperfect elasticity in the colliding molecules, which would then lose a part of their kinetic energy in each collision. This theory was abandoned by Boltzmann himself, who declared himself in favour of a purely **probabilistic** interpretation of the thermodynamic phenomenon: because of the high number of molecules involved the probability that the heat passes from a cold body to a hotter one would be statistically impossible, like expecting that a billion playing cards after reshuffling over and over again go back into order. The entropy of a system, being linked to the thermodynamic probability cannot but increase continually. In such a system the statistical laws in fact exclude the possibility of passing spontaneously towards a less probable state and such impossibility is expressed by stating that the entropy increases with every irreversible transformation. Boltzmann, in the light of such an exclusively probabilistic conviction was pushed into claiming that for the universe as a whole it had no sense to speak about a direction of time. He surmised that the knowledge of the time would never have allowed a different interpretation of the irreversibility of the thermal phenomena. After the event of Relativity and Quantum Mechanics the dynamic interpretation of the second law can no longer be reasonably excluded: even a single photon emitted or absorbed by a molecule of the system or the

minimum but inevitable quantistic indetermination in the energy equation of a collision are sufficient to make the reversibility of a given phenomenon impossible. Today we may confirm therefore that the irreversibility of a system is not only something statistically improbable but comes from the very nature of our universe, where time therefore presents itself in a single well defined direction or, as one says, an "arrow"[52]. The old analogy of Ovid between time and the passing of a river comes back as ever to being current and today Boltzmann could not claim that time in the universe, taken as a whole, knows no direction. Besides, the simple observation of a phenomenon is enough to introduce a some quantistic perturbation which characterises it in an unrepeatable way and each attempt to reduce to a minimum the disturbance of the phenomenon due to the observer is made impossible by the principle of uncertainty (quantistic theory). To the statistical irreversibility of the systems there is therefore added a more general and structural one which ratifies a growth of entropy for every isolated system. A reduction in entropy is however obtainable locally only through the use of energy as in a refrigerator or a heat pump in which, though, there is made an energy greater increase in the entropy of the environment. Modern physics can express the irreversibility of a system as the reshuffling of a pack of cards, but on the part of a player **with dirty hands**.

8. MAN IN THE UNIVERSE

" *O nature, o spirit of man! How inexpressible
are the analogies which link you! Even the smallest
atom doesn't agitate or live in matter without
having its good duplicate in the mind "*

Herman Melville

According to some thinkers [39,40,41] who have recognised in the coming of man an extraordinary event even at a cosmic level, the strong development of the brain represents something more important than a banal adaptive hypertrophy of a coordinating organ: we find ourselves confronted with a higher level of living manifestation, whose distance from the vegetative animal life would be even equal to that which separates life itself from the inorganic world. More recently others [46,47,48], have seen of a new form of immaterial life in thought, that, even though hosted by man, conducts a rather independent existence, presenting even so notably similar behaviour:

- A) The tendency of safeguarding cultural, scientific and religious traditions of every ethnic group (axiom 6 pt 1)
- B) Civilisations, theories and religions are not perennial but can proliferate in other forms by fusion, compromise and more or less bitter confrontations (axiom 7, pt 1)
- C) The propension towards the maximum spread of the ideas of single individuals and entire civilisations (axiom 8, pt 1)

To such characteristics one may add one which seems to reveal a certain ancestral hierarchy: in the conscious of humanity spiritual values outweigh exclusively biological values. The mystic, the scientist, the artist seem conscious of working in an area with a more elevated value and operating in a more ample time scale, to the point of not distaining physical death to reach some great ideal. Intellectual activity is perceived by our conscience as having a more vital force, able to produce information despite the chaos of the external environment (organised anti-entropy). Thus one touches the border between biological life and thought, physical and moral laws, seeing in them some element which gives them common objectives: organising information (despite the reigning entropy) from the disorder of the environment. This course of evolution towards a great "attractor"[53,54] (as the experts of chaos theory would say) could therefore be scientifically portrayed as a struggle against disorder and ignorance by means of virtue and knowledge. On this conceptual juxtaposition it is not difficult to understand how what represents a child for the mammals, is something very similar to a disciple for a religious man or a pupil for a scientist or an artist; that the diffusion of a belief, of an artistic current or of a scientific theory has an evident affinity with the education for survival of children and in the end physical death, like evil for religion or error for the scientist, sanctions the loss of entire patrimonies of information, overcome by chaos of the entropic environment constantly hostile and in waiting (background noise). More than formal analogues, similar juxtapositions seem real forms of life acting at different levels, but having in common the struggle for survival of

genetic or cultural information, a struggle able to invent every strategy to avoid the environmental noise hiding the contents. What life against death represents for vegetative life becomes the human thought for the good against evil or truth against falsehood, different aspects of the selfsame struggle for existence. Organisation and information which try to survive death and chaos.

9. CONCLUSIONS

*"Only in situations where the variations
in entropy are obvious does time take on
a real meaning"*

John. D. Barrow [55]

We have seen how in the stars are formed, starting from hydrogen, all the elements making up the matter in the universe by an antientropic process, and at the cost of a strong increase in the cosmic entropy constituted by stellar radiation. We have then examined the formation of more or less complex molecules in space and on the planets, up to the large molecules which make up the building blocks of life, in which we see a further tendency for reducing the local entropy. This second phase is fed by the increase in entropy of the planetary environment and the solar radiation. In our planetary niche we continue to be spectators of the clearly antientropic phenomenon of life, of man and of his thoughts, all accumulated by typical characteristics of a finalised and functional organisation, conservation and diffusion of genetic and cultural information, consuming energy from the environment to feed phenomena clearly different from the general laws of inert matter. And all this still at the cost of increased planetary entropy. This chain has origins and is continually fed by the enormous energy dispersed by the sun into space. The set of all the stars in the universe together, thanks to their energy, allow the occurrence on the skin of some little planet like ours the miracle of life and of conscious thought. In this mantle of miracles we are stunned to see processes which appear to proceed against the current of the entire universe, processes of accumulation and enrichment of genetic information, of explosions of civilisations and cultures, of scientific and artistic creations and we feed the ambition that here we can make in small a sort of scaled down creation of the world.

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[3] S. Hawking, <<Dal Big Bang ai buchi neri>> Rizzoli, 1992; E. Lerner, <<Il Big Bang non c'è mai stato>> Dedalo, 1994; S. Weinberg, <<I primi tre minuti, l'affascinante storia dell'origine dell'universo>> Mondadori, 1994;

P. Davies, <<Gli ultimi tre minuti, congetture sul destino dell'universo>> Rizzoli, 1994

[4] According to helioseismology, the solar mass oscillates with discrete frequencies, originating from the resonance of stationary acoustic waves inside the sun, a phenomenon analogous to the resonance of acoustic waves in musical instruments like the violin. This produces the "tonality" of the "music of the sun". Study of the phenomenon allows

evaluation of the temperature inside the sun, its future and the forms of the light elements, which make up the planets and living matter.

[5] T.M.Birra, <<*Evolution and the myth of creationism. A basic guide to the facts in the evolution debate*>> Stanford Univ. Press, Stanford,1990; R. Jessberger, <<*Kreationismus: Kritik des modernen Antievolutionismus*>> P. Parey Berlin/ Hamburg, 1990; D.B. Mc Kown, <<*The mythmaker's magic, behind the illusion of creation science*>> Prometheus, Buffalo N.Y. 1993]

[6] The origins of creationism go back to the beginning of the 20th century. They were set down by American fundamentalist movements with the purpose of opposing the evolutionist theories. They start from the hypothesis that the creation written in the Bible is the only real explanation of the formation of the world. In American courts various trials aimed at prohibiting the teaching of evolution in schools (Tennessee 1925, Arkansas 1980, Supreme Court 1987) have taken place. Despite the negative outcome of all these trials, moral bodies which propound antievolutionary theses ("Creation Research Society", "Institute for Creation Research" San Diego, CA) have been founded. Similar movements, although difficult to evaluate for their consistency, exist in Islamic countries and in post-Soviet Russia.

[7] LA PICCOLA TRECCANI, XII (1997), p. 868, Istituto della Enciclopedia Italiana, Roma .

[8]B. J.R. Nicolaus <<*Globalizzazione una sfida biologico culturale*>> Atti della Accademia Pontaniana, Napoli L (2002) in corso di stampa.

[9] A solution to the problem could come from the discovery of biochemical factors able to limit the degrees of freedom of a causal evolution process, turning it into a partially predetermined process.

It seems credible that, in a distant past, nature invented similar "biological short-cuts", shortening the time scale of purely casual evolution. Considering the relatively brief lapse of time between the appearance of life and today, in effect it is difficult to accept the hypothesis of a purely casual process.

[10] E. Schroedinger, <<*Che cos'è la vita*>> Sansoni, Nuova Ediz. 1988.

[11] P. Omodeo, <<*Alle origini delle scienze naturali*>> Rubbettino, 2001; B. J.R. Nicolaus, <<*Verso il futuro a piccoli passi*>> Atti della Accademia Pontaniana, Napoli L (2001) ,pp.394-400; B.J.R.Nicolaus, <<*Verso il futuro a piccoli passi, l'avventura continua*>> Gazzetta Svizzera 32, nr. 12, (2001).

[12] EBOLA: Retrovirus responsible for a hemorrhagic fever, lethal in more than 80% of cases. It seems to be endemic in some types of apes, from which it passes to man, when he is in close contact or eats this meat.

HIV: Retrovirus originating in central Africa in a silent form (apes). It became virulent after its arrival in the Americas and spread in two highly pathogenic forms. The mechanism of passing to man and that of the increase in pathogenicity remain obscure, giving rise to various alarming hypotheses which have never been confirmed.

[13] Tuberculosis, Leprosy, Syphilis, Rabies, Anthrax, Measles, Chicken-pox, Cholera, Plague, Mumps, Scarlet fever, Poliomyelitis, Meningitis, Tetanus, Diphtheria, Herpes, Malaria, Schistosomiasis, Filariasis, Trypanosomiasis, Leishmaniasis, ecc.: A.Cockburn, <<*The evolution and eradication of infectious diseases*>> Baltimore, John Hopkins Press 1963; R.Dubos, <<*The evolution of infectious diseases in the course of history*>> Canad.Med.Assoc.J. LXXIX (1958), pp. 445-451; W.Mc Neill <<*Uomini e parassiti, una storia ecologica*>> Il Saggiatore 1993; B. J.R. Nicolaus, <<*L'arca di Noè : Le invenzioni della natura e della cultura*>> Collana Prometheus 21 (1995), Franco Angeli 1996; B..J.R. Nicolaus, <<*Uomo animale natura nell'evolversi dei secoli*>> Atti della Accademia Pontaniana, Napoli XLII (1994), pp. 55-96.

[14] The classical viral illnesses are now joined by those from PRIONS, which, for what we know today, are proteins without replicable genetic patrimony (genome): e.g. sheep SCRAPIE; BSE (Bovine Spongiform Encephalitis) of bovines and in modified forms in man; FSE (Feline Spongiform Encephalitis) in cats and other felines.

[15] B. J.R. Nicolaus, <<*Malattie molecolari, la maledizione del terzo millennio*>> Gazzetta Svizzera 33, nr.2 (2002) p.10; Lettura tenuta presso l'Accademia Pontaniana, Napoli il 28 Giugno 2001; in stampa come Quaderno nr. 34 (2002) dell'Accademia Pontaniana, Napoli.

[16] The earth orbits around the sun at a velocity of 30 km/sec; the solar system is transported in space by rotation of our galaxy (Milky Way) at a velocity of about 250 km/sec.

[17] It is estimated that 4,5 billion years ago, the earth and the moon formed. Following this, an intense bombardment of meteorites occurred, while the first forms of life appeared between 4.4 and 3.8 billion years ago. It is believed that the first organisms able to carry out processes of photosynthesis and to liberate oxygen in the atmosphere appeared around 3 billion years ago, while an atmosphere rich in oxygen, able to sustain the first heterotrope organisms only developed later (about 2 billion years).

The presence of organic substances in extraterrestrial objects suggests that the components essential for biopolymers could have been formed about 4 billion years ago, through non-biological reactions in space (J.Oroe, <<*Stage and mechanisms of prebiological organic synthesis*>> in S.W.Fox, <<*The origins of prebiological systems*>>, Accad.Press N.Y. (1965), pp. 137-171).

It is an open question as to how the passage from organic compounds very simple to functional proteins and to informative systems based on nucleic acids (DNA), which guarantee reproduction and conservation of functions, could have taken place. Even though without enough proof, one supposes that the primitive catalysts of the first compounds were the clays, masses of pyrite and perhaps the melanins (Blois op. cit.). The universality of the genetic code in all the living organisms represents one of the most convincing arguments in favour of the uniqueness of the origins of all living beings.

[18] Radiotelescopes are essentially instruments with large directional antennas. Pointing the radiotelescope towards an appropriate interstellar zone and integrating the signal received, it is possible to observe whether a molecule emits at the same frequency. Chemical species like ions and radicals are relatively stable and abundant in a rarefied environment in non-equilibrium conditions. In this way, some molecules which are hard to study in the laboratory but which are stable in space may be identified from the earth.

[19] G. Giorello, <<*Se il Big Bang fosse una favola*>> Corriere della sera, 25.08.2001, p. 30.

[20] Like all the biogenic elements, carbon undergoes a series of cyclic transformations and passes continually between the mineral world to that of living creatures. All the carbon of living beings comes either directly or indirectly from the of carbon dioxide (CO₂) of the atmosphere. The stars are formed by the gravitational collapse of clouds of gas and cosmic dust. In the first phases of their lives, they are heated by the gravitational energy liberated in the contraction, which is transformed into thermal energy. At a certain point, the internal temperature becomes high enough to set off reactions of nuclear fusion, which feed the star until their fuel, formed by hydrogen and helium, is used up. When the available hydrogen is burnt, the fusion of helium into carbon starts: at the same time, but to a lesser extent, the carbon captures helium, generating oxygen. When the helium is exhausted more massive nuclear reactions start, which pass through various heavy metals up to iron. At this point the chain stops given that the other reactions are endothermic.

The difference of composition of the planets in our solar system depends on the temperature of the original clouds, which is higher nearer the sun than at a distance.

[21] Supernovas are stars which explode and reach a luminosity similar to that of an entire galaxy. In the Milky Way two or three supernovas are recorded every century. The one named 1987 is famous. This inundated the earth with a rain of neutrinos of incredible density. Another was described by Kepler in 1604.

[22] The simple organic molecules tend to organise themselves into more complex molecules (glycerines, fatty acids, aminoacids, sugars, etc.) also called biomonomers. These tend in turn to organise themselves into macromolecules with living functions (lipids, proteins, carbohydrates, lignines, tannins, etc.) called biopolymers.

[23] A chemical reaction is defined as endothermic if it needs the participation of external energy to be activated.

A chemical reaction is exothermic if it does not need external energy to be activated and if it emits energy in the course of the reaction.

[24] Tearing an electron from a neutral hydrogen atom (ionization process) requires an energy of 13.6 eV.

[25] The energy involved in nuclear reactions is millions of times higher than in normal chemical reactions, being about a million eV for every atomic nucleus (1 kg of plutonium has almost the energy of a million kilos of t.n.t.). The chemical forces which hold the atoms in the molecules together (covalent and ionic chemical bonds) are millions of times weaker than the strong interactions which keep the protons and neutrons together in the nucleus. We do not perceive the strong reactions, unlike the electromagnetic and gravitational forces, because their range of action is very small (10⁻¹³ cm). The strong reactions between different nuclei have virtually no effect in the molecule, where the nuclei are almost a million times more distant (10⁻⁸ cm). If the electrons of atoms and molecules were sensitive to strong reactions, we would not have either chemistry or biology, but only nuclear physics.

[26] The 92 natural elements present on earth and in the cosmos are already matter with elevated levels of complexity. Reacting among themselves, these elements tend to reach superior levels of organisation. Each element is not able to react with any other element, even if it were in favourable conditions, like for example the collision between two atoms. The formation of a new link occurs only if the chemical affinity between the two components is such as to make the new form stable. Two affine elements can react with each other, obeying the laws on chemical valency, which establish how many atoms of one element can link to another and in what spatial configurations. Thus we have affine elements which can react with each other and other non-affine elements which produce no reaction. Reactivity and affinity depend on the configuration of the peripheral electrons of the elements and are predictable on a theoretical basis.

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[29] Three types of cloud may be distinguished: dark, translucent and expanded. All the clouds modify in time and are enriched by new material erupted by dying stars. The dark clouds, rich in organic molecules, are the main source of new planets. see. L.J. Allamandola, A.G. Thielens, J.R. Baker, in *Astrophys. J.* (1985), 290, p. 125.; P. Ehrenfreund, op.cit. ; Ohishi and Kaifu, (1998), *Faraday Discussion* 109, pp. 205-16, Cambridge UK: Roy. Soc. Chem.; Winnewisser and Kramer: *Space Science Reviews* 90, (1999), pp. 181-202 .

[30] Bitumen is made up of mixtures of hydrocarbons (natural or coming from the pyroscission of raw petroleum or mixtures of both), of a solid or semisolid consistency and a dark colour up to black. Petroleum is made up of a fluid mixture of natural solid, liquid and gaseous hydrocarbons. Petroleum and coal come from the progressive decomposition of organic substances, mainly of a vegetable nature, through a natural procedure which takes entire geological eras.

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[33] Among the most primitive celestial bodies, there are the comets, formed in the regions of the giant planets from residues of small planets. Their composition is interesting because it is indicative of their origin and the conditions of the protosolar clouds. The comets are objects of less than 1 km diameter made of ice and cosmic dust (also called big dirty snowballs). They move on heliocentric orbits at a great distance from the sun. Nearing this they heat up and lose water and dust, which form the tails we observe as they pass. cfr. P. Ehrenfreund et al., op.cit. p. 26.; Fl. Whipple, *Ap.J.* 111, (1950) pp. 375-94.

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[35] Thanks to the great affinity between the two elements, water can form everywhere in the cosmos where there is hydrogen together and oxygen together with sufficient energy for activation. The presence of water has been detected by the ISO satellite (Infrared Space Observatory, 1995), in distant regions of stellar formations, in evolved stars, in distant galaxies, and in the solar system. We find it on Mars, Venus and Jupiter, in the bodies of comets, in satellites and rings of the giant planets. It is believed that there is also water beneath the surface of Europe, one of the satellites of Jupiter. In the past Mars and Venus probably had notable quantities of water (perhaps more than the earth itself), lost in the course of time because of climatic mutations (fluctuations of the rotation axis). On the earth water is present in the liquid, solid and gaseous states; in other places in the solar system only in the form of ice or vapour. The liquid state is favoured on the earth by the constancy of the terrestrial temperature, by the presence of a permanent atmosphere and by the stabilisation of the rotation axis by the moon. It is more than credible that the presence of liquid water was of fundamental importance for the birth of life. T. Encrenaz, <<*L'acqua nel sistema solare*>> *Le Scienze*, 396 (2001), pp. 34-43; see. M.P. Bernstein, A.Scott, A. Sandford, L.J.Allamandola, <<*Dallo spazio, le molecole della vita*>>, *Le Scienze*, 373 (1999) pp. 34-42 ; E.L.O. Blakes , <<*The astrochemical evolution of the interstellar medium*>>, Twirl Press, Astronomy Publishers, 1997; M. Bernstein et al., <<*UV irradiation of polycyclic aromatic hydrocarbons in ices. production of alcohols, quinones and ethers*>> *Science* 283, (1999) pp. 1135-1138.

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