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by

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ABSTRACT

The tremendous progress in science and technology that has occured in the 20th century, has made it possible to follow the 15 billion year evolution of the Universe and the 3.5 billion year evolution of life on Earth. Both of them were guided by a handful of basic laws and constants of Nature, which suggests that the Universe was endowed from the beginning with the ability to produce life, intelligence and technology, with the many advantages and dangers that accompany them. But what is for us to come next? Self-destruction is highly probable, because of the desire to dominate others, the rapid depletion of our natural resources, the pollution of the environment, and the development of nuclear weapons, all of which may be Nature's ways to eliminate civilizations that go against its goals. Unselfish societies, on the other hand, are more likely to reach stable existences, which suggest that they must be more in line with the goals of Nature. Our intellectual and spiritual growth, therefore, possibly assisted also by technology, may help us reach these loftier goals. Such advanced civilizations, with potential lives of millions of years, must be in touch with each other throughout the galaxy, and must also be aware of our existence. A galactic ethic, however, may require that new civilizations must first solve their own problems, before they will get invited to join the galactic society. Our future, therefore, depends probably totally on us.

1. A CENTURY OF MIRACLES

The 20th century has really been a century of miracles. Typical examples are the following: The Wright brothers flew the first airplane in 1903, in 1957 Sputnik I opened the doors of outer space, and in 1969 Neil Armstrong became the first human to step on the moon. In 1938 Grote Reber built the first radio telescope in the back yard of his home, and in 1965 Pentias and Wilson confirmed through radio studies the Big Bang. In the 1950's we began to understand the structure of DNA and RNA, and now we are about to start to decipher the human genome, i.e., the make-up of all the human genes of which we have more than 100,000. Also in the 1930's we began to understand the structure of the nuclei of the atoms, and in 1945 we used the first atom bomb in Hiroshima, that killed 100,000 people.

Now we know that we live in an expanding Universe, 98% of which is made of H and He, both of which were formed during the Big Bang. The other 2% consists of the so called heavy elements, that were produced much later in supernova explosions of the more massive stars. The 4 most common of the heavy elements are: O,C,Ne,N, that account for 75% of the total. He and Ne, however, are noble gases and hence chemically inactive. So the 4 most

common, chemically active elements in the Universe are H,O,C,N, which are also the 4 most common chemical elements of life on Earth, accounting for 98% of its biosphere. This shows that the chemical composition of life on Earth is in harmony with the chemical composition of the Universe, which suggests that life may be reasonably common in the Universe.

Now we understand how the Earth uses the greenhouse effect to maintain livable temperatures and liquid water on its surface, and how the ozone layer in its atmosphere protects life on land from the dangerous UV-rays of the Sun. We also know that life paved its evolution by producing large quantities of oxygen through photosynthesis, the process it uses to make its food (sugars). The availability of free oxygen in the atmosphere of the Earth (a clear sign of the presence of life on a planet, because free oxygen disappears fast if it is not steadily replenished), made it possible to develop multicellular organisms (~800 m.y.a.), because the presence of free oxygen allows the extraction of nearly 18 times more energy from sugars than what it can be extracted from them through fermentation in the absence of oxygen. Finally, protected by the ozone layer, that was developed from the free oxygen, life conquered also the land (~400 m.y.a.) and started a new era of biological evolution that ultimately led to our technological civilization. It is evident, therefore, that Nature provided life on Earth with the proper conditions to evolve towards an advanced technological civilization, a process that may have occurred in a significant fraction, (a ~1 per million stars) of the 400 billion suns of our galaxy.

2. THE LAWS OF NATURE AND THEIR EFFECTS ON EVOLUTION

Life is a highly complex phenomenon. As a result it requires highly complex molecules, which only carbon (organic compounds) and silicon (silicones) can produce, being the only chemical elements with 4 valences among the reasonably abundant elements. Carbon is about 10 times more common than silicon in the Universe, but on the surface of the Earth silicon is 600 times more common than carbon. The reason is that carbon compounds are mostly gaseous, while silicon compounds are mostly solid and therefore were incorporated in much larger quantities. Still, life chose the less abundant carbon, because CO_2 dissolves easily in water, where it can continue its metabolic processes, while SiO_2 (sand) is insoluable in water and represents a chemical dead end.

At the Big Bang, hydrogen was formed first and helium followed soon after. However because at close range the electromagnetic repulsion between 2 protons is slightly (~2%) stronger than their nuclear attraction (Dyson, 1971), helium-2 cannot be formed without neutrons. Neutrons, however, were less common than protons (1n for every $7p^+$) and as a result only one helium nucleus (alpha particle) was formed for every 12 hydrogen nuclei (protons). If all the hydrogen had been converted into helium, life would have become impossible, because hydrogen is a key element of water and of all organic compounds, but also because helium stars would have had much shorter lives and would have emitted very powerful UV radiation, that would have made life impossible with its delicate chemistry.

Another important event in the early history of the Universe was the fact that the synthesis of chemical elements stopped at helium. The merger of 2 helium nuclei could have produced a beryllium nucleus, but Be-8 is highly unstable and decays in $2x10^{-16}$ sec. This

blocked the formation of heavy elements at the Big Bang. The nuclei of many highly stable chemical elements are made of multiples of alpha particles (C-12, O-16, Ne-20, Mg-24, Si-28, S-32, Ca-40). It was, however, a step of critical importance for the development of life.

Important was also the fact that the electromagnetic force between a proton and an electron is $2x10^{39}$ (a huge number) larger than their gravitational attraction. This implies that if the number of electrons in the Universe was infinitesimally smaller, or larger, than the number of protons (about an extra, or less, electron for every 10^{18} protons), the electromagnetic repulsion between the negatively, or positively, charged stars and their planets would have been stronger than their gravitational attraction. As a result there would have been no planets around the stars, and hence no life.

One may argue that Nature could have had a stronger gravitational constant G, that determines the strength of the force of gravity. Dicke (1962), however, has shown that the luminosity of a star increases proportionately to at least G^4 and may be proportional to as much as G^8. Therefore even by doubling the value of G, we would increase the luminosity of a star by a factor between 16 and 256. This would reduce drastically the life-span of a star and would make it a strong emitter of ultraviolet radiation, which is lethal for life because it destroys its delicate molecules. It is quite obvious, therefore, that the Universe was endowed from the beginning with the proper laws and constants of Nature. This allowed it to build the complexity needed for life, and to have long lasting sources of energy to support its slow evolution for billions of years (Papagiannis, 1978a,b). Our Universe continues also to expand, and as a result the planets are endowed with intermediate temperatures between the hot temperatures of the stars, and the cold (2.7°K) cosmic backround, which provides an ingenious thermodynamic system to build molecular complexity on the planets. The fact that Nature was endowed *ab initio* with properties that allowed it to produce advanced civilizations, that are able to comprehend the miracle of the whole creation, has been called "the Anthropic Principle" (Carter, 1974).

Life on Earth, provided with energy from the Sun and with liquid water from the Earth, managed to follow its own long evolution, which may have been supported by occassional "mass extinctions". Finally life on Earth has reached the level of an advanced technological civilization, that occasionally is also capable of introspection.

3. THE DANGERS OF TECHNOLOGY

Technology is not only a great asset, but also a dangerous tool in the hands of a civilization that has not yet settled its priorities and its long term objectives. As a result we are bound to face many problems in the 21st century, including: overpopulation, enhancement of the greenhouse effect, depletion of the ozone layer, exhaustion of many of our natural resources (oil, natural gas, etc.), pollution and destruction of the environment (acid rain, et al.), the danger of a nuclear war, etc. (Papagiannis, 1984)

Suffices to say that our present stockpile of nuclear weapons is about a million times greater than the Hiroshima bomb, that killed 100,000 people in 1945. We also have immensely better means of delivery. It is interesting to mention also that if the population of the Earth were to continue to increase at its present pace of about 2% per year, in 1,000 years the

population of the Earth would be about 10^{18} people, which would amount to about 1,000 people per square foot of land, including Antarctica and the Sahara Desert. Also if our energy consumption were to continue to increase at its present pace of 3% per year, in 1,000 years we would be needing more energy than the total energy output of our Sun (Papagiannis, 1988).

It is obvious, therefore, that we cannot continue to live at the present frenzied pace for much longer, even if our technology were to produce new energy sources, such as controlled nuclear fusion. The colonization of space in our solar system, though possible and very likely, will not solve the problems of overpopulation either. The reason is that in order to keep the population of the Earth constant at around 6 billion people, which we are bound to reach by the year 2,000, we would have to ship into space about 300,000 people per day. But even with huge spaceships, that could carry into space 300 people and their belongings, it would require the launching of 1,000 such huge spaceships per day. This would not only be very expensive, but it is also likely to destroy the ozone layer of the Earth.

From the above it follows that our Universe is not suitable for highly materialistic and rapidly expanding societies, which are bound to self-destruct. Hence, the only possible solution would be to change our current materialistic traits and convert into a society that maintains a steady population, avoids excesses of all kinds, and in general thrives more on intellectual and spiritual pleasures than on materialistic possessions. This is bound to be the case with all other technological civilizations in the Universe, which as a result is bound to consist of peaceful, non-materialistic societies that last much longer, while the materialistic ones are bound to have very fleeting existences.

4. TOWARDS A NEW WORLD AND HOW TO REACH IT

From the above it follows that we live in a very critical period in the history of life on Earth, and it is up to us to destroy it, or to build on our blue planet a long lasting, peaceful civilization. Advancing towards higher intellectual and spiritual states is often called "the Theistic Principle" (Harrison, 1981).

Which way we are going to go is not only a matter of choice, because mentally we would all like to go toward a peaceful, longlasting society, governed by love and consideration for our fellow people. Unfortunately, however, embedded in our genomes are selfish genes that used to give, and may still do, considerable advantages to those that possess them. They are genes that make us aggressive, domineering, ready to lie, to steal, to commit adultery, to desire other people's possessions, etc.

Actually in the early evolution of man during the past 2-3 million years, these genes were highly desirable, because those that possessed them had a better chance to survive, as well as to pass their genes to more descendants. Stealing someone else's food left the victim hungry and the thief full. Mating with other people's women allowed men to pass their genes to more descendents. Taking other people's possessions made the aggressors richer and the defendants poorer. These genes, therefore, offered significant advantages to those that possesed them. As a result they became quite common in the human genome, as they had already in most wild animals. Trying to go against them is not easy. The problem seems

to get even worse because our leaders, who have a strong desire to be in charge, seem to possess them at even higher levels, and as a result have led us repeatedly into wars.

It is interesting that one can also find all these admonitions in the Ten Commandments (Exodus 20.1), half of which advise us on our relations with our fellow human beings. For our civilization on Earth to survive, we must learn to suppress, or better to get rid of these genes, which we often call "the devil in us," and try to justify some of our unethical acts by saying "the devil made me do it." It is also interesting that the Judeo-Christian religion believes that the devil was initially an angel, who later fell from the grace of God. In a way this is similar to what happened to the genes that we are now trying to subdue, though still not very successfully, if we were to look back into the two World Wars of this century, and to the many other local wars.

It is true that spiritual leaders throughout history have managed to reach high levels of exaltation, in which the power of the brain dominated almost completely the desires of the body. But they were only few, and most of them had tragic endings, as it happened with Socrates, Jesus Christ, and Mahatma Gandhi. Obviously education is an important tool in our efforts to build a new world of peace and justice. But the ultimate crisis seems to be approaching very fast, and we may not have much time left to change our world.

A parallel, or alternative solution may be to solve the problem through genetic engineering, which in its studies of the human genome may be able to locate these undesirable genes, and find ways to neutralize them. This approach, of course, has the disadvantage that for a while we may have half of the population with aggressive genes and half without them, who may easily get subjugated by the others. It is also possible that the elimination of the agressive genes may make our society too lithargic. Let us hope, however, that an educational, spiritual, or even a genetic approach will become effective, or possibly a combination of all three, that will change the attitudes of the people of the Earth, and will bring a long lasting peace, equality, and spiritual happiness to our planet.

5. SOME CLOSING THOUGHTS

We have seen that the fundamental properties and laws of Nature led to the formation of solar systems, and to the origin of life in at least one of them. Life slowly modified the environment and finally evolved into a technological civilization, that is now going through a critical period that may lead to self-destruction. How are we going to solve all these difficult problems?

Aristotle has a good suggestion in the opening statement of his book on Metaphysics, that says: "The search for the truth is both easy and difficult. Easy because no one can ignore it completely, and difficult because no one can possess it totally. But if all of us were to work together, contributing some more and some less, we will slowly manage to comprehend the whole grandeur of Nature." We are all climbing the same mountain, the peak of which is the ultimate truth. Unfortuantely, the scientists and engineers are climbing it from one side and the philosophers and theologians from the other, with very little, if any, communication with each other. Let us all start sharing our thoughts, as Aristotle advised us, and try to build a new world without inflated egos and insatiable materialistic desires, a

world that would be in harmony with the objectives of Nature.

Maybe then, other more advanced civilizations in our galaxy will judge us to have reached adulthood and will invite us to join the galactic network of long lasting, peaceful, intellectual and spiritual civilizations that may inhabit our Milky Way.

Working towards such a goal, will be the noblest contribution we can make for the generations to come and for the fulfillment of the whole process of cosmic evolution.

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