Speculations on the First Contact:
Encyclopedia Galactica or the Music of the Spheres?

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Introduction

The purpose of the Seminar on the Cultural Impact of Extraterrestrial Contact, sponsored by the Foundation For the Future, was the study of the long-term impact—for our terrestrial civilization—of a dialogue between humankind and a highly advanced extraterrestrial society. According to the organizers, humanity's interaction with other galactic civilizations will likely have a greater positive impact than almost any other event in the Third Millennium. Over the last 40 years, several speculations about the characteristics, contents, and social impact of the discovery of an extraterrestrial message were made by scientists and scholars all over the world.

Based on a hypothetical distribution of advanced technological civilizations in the galaxy, Sebastian von Hoerner (1961) estimated that the civilizations we will find will probably be much older than we are, and they will be more advanced. He considered that our chance of learning from them might be the most important incentive for our search. According to these ideas and due to the large interstellar distances, the extraterrestrial contacting signals would already contain high-information messages (including an introduction to a language). There might be some *speaking* and *listening*, but *mutual exchange* of knowledge would be rather limited because of the long time scale involved.

Shklovskii and Sagan (1966) and Sagan (1973, 1980) took all these original ideas and extended them into the concept of *Encyclopedia Galactica*. They imagined that a hypothetical network of civilizations in the galaxy compiled all the accumulated knowledge from each independent evolutionary history and put it at the disposal of the emerging technological societies. After the detection of an extraterrestrial message, they foresaw big technological gains, hints, and leads of extraordinary value. They speculated about all sorts of scientific and technological results, ranging from a valid picture of the past and future of the universe through theories of fundamental particles to whole new biologies. They also made conjectures that we might learn from the views of distant and venerable thinkers of the deepest values of conscious beings and their societies. Finally, the most speculative and seductive argument to pursue in the search for extraterrestrial signals is that we can obtain information that may help us to solve our political, social, or environmental global crises and thereby pass through our *technological adolescence*.

These dreams dominated the scientific and popular literature over the last 40 years, including most of the presentations made in this workshop. Very little discussion took place around the basic hypotheses behind these ideas.

The purpose of this essay is twofold: The first purpose is the introduction of restrictions to some of the original hypotheses about the technological characteristics and intentions of the extraterrestrial civilizations. The second is the construction of different communication scenarios, based on the inclusion of ethical and artistic *universal* principles.

To do that, we will analyze the proposed characteristics of the extraterrestrial supercivilizations that would have the hypothetical capability to send interstellar messages with high-information content. We will present a series of arguments to reject the concept of advanced civilizations transmitting omnidirectional signals in a full-time mode. In this way, we will place a limit on the detectability of these high-information messages. Then we will comment on the life expectancy of our contemporary terrestrial civilization, with special emphasis on the consequences generated during the last 50 years of the nuclear era. The present state of the planet Earth and the long

violent human history create an urgent need for a deep and strong ethical, societal mutation. Otherwise, our species will become extinct.

All technological civilizations that already have passed through their technological adolescence, and have avoided their self-destruction (by misuse of advanced technologies or by environmental degradation of their home planet), must have developed ethical rules to extend their societal life expectancy. In doing so, they must have learned how to respect the natural evolutionary times of other beings in the universe. To build this scenario, we will introduce the concept of *Lex Galactica*, based in Kantian ethical principles, as hypothetical guidelines for advanced civilizations in how to contact emerging societies. If the advanced galactic civilizations are unable to check the level of technical and ethical evolution of the possible recipients of their signals, they will be unable to send high-information-content messages due to the *Lex Galactica*. Using these alternative boundary conditions, we will discuss different contact scenarios and their possible message characteristics. We will consider the possibility that the first message from an advanced technological society would include some extraterrestrial artistic manifestation.

Hypothetical Characteristics of Advanced Extraterrestrial Civilizations

In order to provide a frame of reference around which we can develop different contact scenarios, according to the technological and cultural levels of development of extraterrestrial civilizations, we will make a short review of the scientific literature on this topic. In 1964, the soviet scientist N. S. Kardashev established a general criterion regarding the types of activities of extraterrestrial civilizations that can be detected at our present level of development. The most general parameters of these activities are apparently ultrapowerful energy sources, harnessing of enormous solid masses, and transmission of large quantities of information of different kinds through space. According to Kardashev, the first two parameters are prerequisite for any activity of a *supercivilization*. He suggested the following classification of energetically extravagant civilizations:

TYPE 1: a level "near" the contemporary terrestrial civilization with an energy capability equivalent to the solar insulation on Earth (between 10^{16} and 10^{17} Watts).

TYPE 2: a civilization capable of using and channeling the entire radiation output of its parent star. The energy utilization would then be comparable to the luminosity of our Sun, about 4×10^{26} Watts.

TYPE 3: a civilization with access to power comparable to the luminosity of the entire Milky Way Galaxy, 4×10^{37} Watts.

Kardashev also examined the possibilities in cosmic communication, which attend the investment of most of the available power into communication. A Type 2 civilization could transmit the contents of 100,000 average-sized books across the galaxy in a total transmitting time of 100 seconds. The transmission of the same information to a target ten million light-years distant—a typical intergalactic distance—would take a transmission time of a few weeks. A Type 3 civilization could transmit the same information over a distance of ten billion light-years, approximately the radius of the observable universe, with a transmission time of three seconds.

Sagan (1973) considered that Kardashev's classification should be completed using decimal numbers to indicate a difference of one order of magnitude in energy consumption. For example, a civilization *Type 1.7* expends 10^{23} Watts, while a civilization *Type 2.3* expends 10^{29} Watts. Sagan also suggested that, in order to be more accurate, a letter could indicate the societal information level (degree of their accumulated knowledge). According to Sagan, a Class A civilization will have 10^6 bits of information; a Class B, 10^7 bits; a Class C, 10^8 bits; and so on. Under this classification, our terrestrial civilization is *Type 0.7 H*. According to Sagan (1973), the level of the first extraterrestrial civilization that could make contact with us would be between *1.5 J* and *1.8 K*. A galactic supercivilization would be *Type 3 Q*, while a hypothetical civilization with the capacity to control a federation of galaxies would be *Type 4 Z*.

Dyson (1959, 1966) used the same hypothesis of infinite exponential expansion of technological progress and energy consumption. Instead of receiving large amounts of information by interstellar messages, he proposed to detect evidences of astroengineering technological activities. He proposed a search for huge artificial biospheres created around a central star by an intelligent species as part of its technological growth and expansion within a planetary system. This giant structure would most likely be formed by a swarm of artificial habitats and miniplanets capable of intercepting essentially all the radiant energy from the parent star. This would be

one of the typical limits to a Kardashev Type 2 civilization.

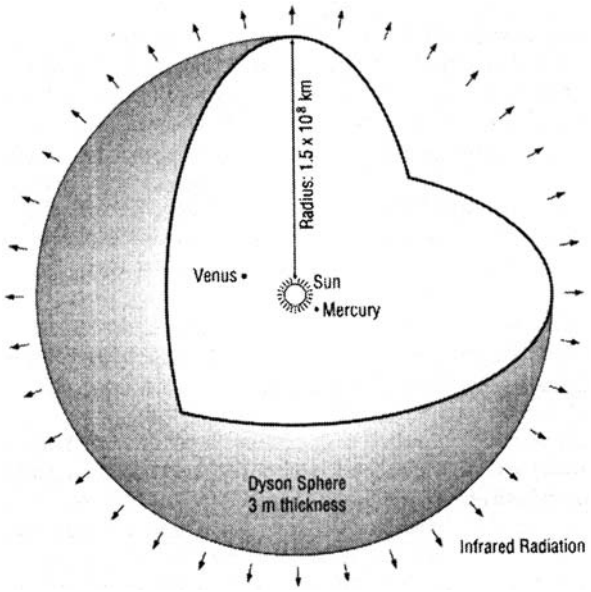

Figure 1: In 1959, Freeman Dyson suggested that very advanced civilizations, bound only by the presently known laws of physics, may surround their parent star with spherical shells made from dismantled planets. A representation of this idea applied to our solar system, using the mass of Jupiter to form a sphere at one astronomical unit from the Sun is shown in the figure. From Lemarchand (1994) ©*SETIQuest*.

According to Dyson, the mass of a planet like Jupiter could be used to construct an immense shell, which could surround the central star and have a radius of one astronomical unit. This kind of object—known as a *Dyson Sphere*[1]—would be a very powerful source of infrared radiation. Dyson predicted the peak of the radiation at 10 μm. Several searches for this kind of objects were carried out unsuccessfully during the past 30 years.

Another characteristic feature analyzed by von Hoerner (1961), Kardashev (1964), Sagan (1973, 1980), and others is that communication among galactic civilizations would be one-way only. This is due to the large propagation time of electromagnetic signals across interstellar (civilizations Type 1 or 2) or intergalactic (civilizations Type 3) distances. Under these conditions, with signal propagation times greatly exceeding the characteristic evolutionary lifetime of the transmitting civilization, exchange of questions and answers among galactic partners will be practically impossible. For Kardashev and Sagan, the transmission should carry the maximum amount of information—each side transmitting its entire knowledge at once. This is the historical reason why most people believe that the detection of an extraterrestrial intelligence signal will automatically imply the existence of a huge message with all sorts of practical knowledge for our society to consume.

Sagan (1974) put it in these words: "The most likely reason for us to use radio if alternative, more efficient means exist is this: the more advanced civilizations are looking for the dumb, emerging technical societies and seeking to give them information that may help them make their $L^{(2)}$ a large number."

But can we really believe that any of these hypothetical Type 2 or 3 civilizations are really transmitting all their knowledge in a full-time and omnidirectional mode using electromagnetic means to certain unknown emerging societies…employing energies equivalent to the total outputs of a star or a galaxy…giving the recipient civilizations very advanced knowledge without any information about their evolutionary and ethical stages…knowing that this hypothetical "practical information" could put in danger the very existence of the recipients when the new knowledge is used without adequate ethical controls?

In the following sections, I will try to show that if any of these advanced galactic societies really exist, they would never send any high-information message without knowing the societal evolutionary stage of the recipients. Before going to that particular point, let me say why these hypothetical Type 2 or Type 3 civilizations may not exist, or—if they do exist—would have a very different profile to the one described by Kardashev and others.

The arguments against the existence of Type 2 and Type 3 civilizations are the following:

1. Transmitting Strategy Arguments: Far-reaching, omnidirectional beacons are extremely energy consuming. No good arguments have ever been put forward to explain why a Type 2 or 3 civilization should not make use of the enormous economic advantage of using directional and intermittent emission beamed successively towards each target star.

1. The concept of this extraterrestrial construction was first described in 1937 in the science fiction novel *Star Maker* by Olaf Stapledon.

2. Here L indicates the lifetime of a civilization in years. This number is generally used as a factor of the Drake Equation.

2. Limits to Growth: Between the late 1950s and the early 1970s, the developed societies of planet Earth experienced an exponential growth in most of their technoeconomical indicators (Maddison, 1991 and 1995). In this societal environment, the scientific community had a sense that there were no limits to growth, and therefore, the contact scenarios proposed in the scientific literature[3] were developed using these assumptions. In the early 1970s, due to the publication of the first world models by Meadows and Meadows (1972), Mesarovic and Pestel (1974), and several others (see review by Bruckman et al., 1982), all these images were shifted into the opposite direction. Taking into account these new elements to understand the very long-term dynamics of societal systems, Kardashev's implicit assumption of exponential energy consumption growth is probably wrong. If we analyze the energy consumption per capita over the whole human history, we will find that it follows a succession of logistic-type curves with a saturation niche for each technology of energy production. From my personal point of view, a realistic scenario of the very-long-term evolution of the energy consumption of technological civilizations must consider these constraints. Those civilizations with very long lifetimes—and interest in interstellar communication—will have reached a saturation niche of energy production and consumption that will be in harmony with their own environment and societal needs. Under these circumstances, a steady state or a very low energy consumption growth should be expected. For an advanced society, the steady state niche would remain stable during periods comparable with the society's lifetime.

3. Delta *t* Estimator Argument: If whatever we are measuring can be observed only in the interval between times t_{begin} and t_{end}, if there is nothing special about t_{now} we expect t_{now} to be located randomly in this interval. Gott (1993) showed how to estimate t_{future} with a 95% confidence level as $[(1/39)\ t_{past} < t_{future} < 39\ t_{past}]$. This equation tells us that the length of time something has been observable in the past is a rough measure of its robustness not only against the calamities of the past, but also against whatever calamities may affect its observability in the future. All that is required for this equation to work is that in the end, our position as an observer turns out not to have been special. Sagan and Shklovskii (1966) defined this effect as the *Principle of Mediocrity.*[4] Using this *Delta t* argument, Gott established that space colonization is not an important factor in the sense that galactic colonists and their descendants must not dominate the numbers of intelligent observers in the universe. In this context, civilizations significantly larger than our own must be sufficiently rare that their individuals do not dominate the total. Thus, we do not expect to see a Dyson sphere civilization within our galaxy, or a Kardashev Type 3 civilization within the current observable universe's horizon.

4. Experimental Facts: Recent full-sky surveys for ultra-narrowband microwave signals at a preferred hydrogen frequency (e.g., $\nu = 1.42$ GHz) would be detectable out to 22 megaparsecs, within which there are something like 10^{14} stars. Unfortunately, no supercivilization was detected by any of the META sky-surveys at Harvard and Buenos Aires (Horowitz and Sagan, 1993; Lemarchand et al., 1997). These experiments ruled out the hypothesis of a civilization Type 2 or 3 transmitting omnidirectional, electromagnetic messages in a full-time dedicated mode at $\nu = 1.42$ GHz, within a sphere of approximately 70 million light-years. We can conclude that there are no such civilizations in the Milky Way; nor in M31, the nearest galaxy like our own; nor in M33 or M81 or the Whirlpool Nebula or Centaurus A; nor the Virgo cluster of galaxies.

Is There Intelligent Life on Earth? Earthlings as Members of a Technological Adolescent Society

Carl Sagan (1973, 1980) called attention to the fact that our civilization—for the first time in its evolutionary history—has the technological capability to destroy itself. He metaphorically defined this particular period as *technological adolescence*. Our civilization could collapse due to the failure to solve our

3. For example, Sagan (1974) used these words: "...However, an expanding technology would seem to be characterized by increasing energy consumption. This is indeed a major aspect of the current environmental crisis. The expanding technology of a civilization much in advance of ourselves would be able to channel enormous amounts of energy into interstellar communication."

4. The *Principle of Mediocrity* is an extension of the *Copernican Principle*, where it is established that the Earth does not occupy a privileged position in the universe. Darwin established, in terms of the natural selection mechanism, that we are not privileged above other species. Our position around an ordinary star in an ordinary galaxy in an ordinary supercluster continues to look less and less special.

mutual aggressions (e.g., human maldevelopment, arms race, population explosion, starvation, global warning, ozone depletion, etc.). If most of the galactic civilizations fail in their pass through this evolutionary path, the possibility of making contact among them would be negligible. Herein, we will develop a brief description of one of the most dangerous planetary challenges: the military arms race.

Lewis F. Richardson (1881-1953), British meteorologist and founder of mathematical sociology, conducted an interesting study about the temporal distribution of deaths caused by interhuman violent events (from individual murders to world wars). The results of the study were published posthumously in *Statistics of Deadly Quarrels* (1960). Using data from 1820 to 1945, he found that the historical statistics could be explained by a simple mathematical power law. The extrapolation of this distribution shows that if humankind does not make a deep change in its social behavior to eliminate violence, humankind will disappear in less than a thousand years. Unfortunately, the evolution of technologies of mass destruction (nuclear and biological arms) has dropped the curve to a shorter horizon of 100 years or so. Figure 2 shows an account of these findings.

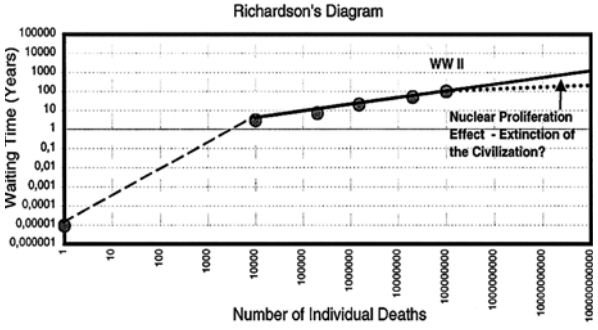

Figure 2: Richardson's diagram of the distribution of deaths caused by interhuman violent events (from individual murders to world wars). The data may be explained by a mathematical power law. The extrapolation indicates that if we do not change our social behavior, we will disappear as a civilization in the next thousand years. Due to the spreading of nuclear and biological mass destruction arms, this temporal horizon was shortened to only 100 years. The time scale goes from 30 seconds to 100,000 years, while the number of deaths rises from 1 to 10^{10}. Cohen (1995) estimated Earth's maximum Human Carrying Capacity between 3×10^9 and 4×10^{10} inhabitants. A very interesting result, found by Gott (1993), shows that the extraterrestrial civilization populations would have the same size as the terrestrial one.

From an evolutionary point of view, if our society does not start generating a strong and deep *mutation* in its social and environmental attitudes, its life expectancy is something between 30 and a thousand years. This is a very short time to exchange information and wisdom across interstellar distances by electromagnetic means.

Is there intelligent life on Earth? A short look to human history shows that the largest organized human efforts so far have always been self-destructive. The worst example was the nuclear arms race that took place during the Cold War. Figure 3 shows the evolution of the destructive power of nuclear arsenals in the United States and the former USSR/Russia after World War II. The destructive power is expressed in millions of TNT tons or megatons (MT). During the 1970s, we reached the absurd and irresponsible value of 25,000 MT. For comparison, all of the shells, missiles, and bombs (including the atomic bombs of Hiroshima and Nagasaki) used in World War II had only 3 MT. An estimate was developed of how much destructive power would be needed for a second-strike capability, or Mutual Assured Destruction (MAD), which means that each country, after having been fully attacked by the enemy, could strike back and successfully destroy the enemy. The level of 400 MT was the size of retaliatory force estimated to achieve MAD's level required for deterrence (Levi, 1983).

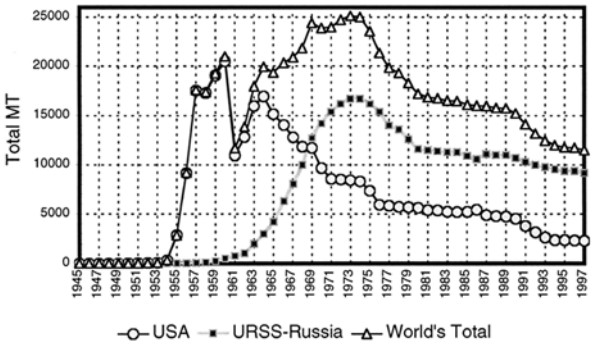

Figure 3: Evolution of the destructive power of nuclear arsenals in the United States and the former USSR/Russia after World War II, expressed in millions of TNT tons (megatons). From Lemarchand, based on data published over several years by *The Bulletin of Atomic Scientists* and *SIPRI Yearbook*.

Using the data of the total nuclear destructive power provided in Figure 3 and the evolution of the population on planet Earth during the period 1954-1997, we built a new indicator: *the destructive power per each living person*. Figure 4 shows the nuclear destructive power in tons of dynamite for every individual human.

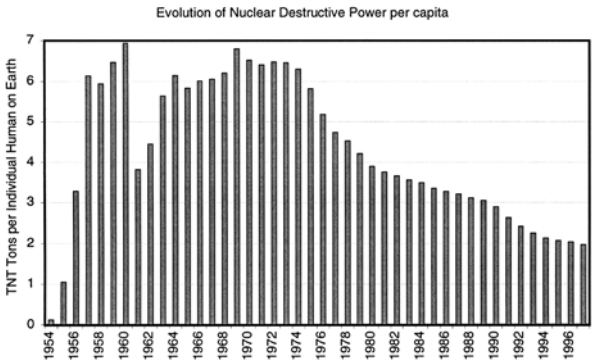

Figure 4: Nuclear destructive power per capita on planet Earth. The indicator is expressed in tons of dynamite per individual living person. It shows a decrease from almost 7,000 kg of dynamite per capita in 1969 to 2,000 kg in 1997. From Lemarchand, based on data published over several years in *The Bulletin of Atomic Scientists*, *SIPRI Yearbook*, and Maddison (1995).

Table I shows the geographical distribution of military expenditures, expressed in 1995 constant dollars, as a good measure of human aggression—although we usually call it "defense." World military expenditure is still declining, but the rate of decline is slowing down. Estimates of world totals indicate that the rate of decline was less than 1% in real terms in 1997, compared to an average annual reduction of 2.5% during 1993–1997. Military expenditures in 1997 corresponded on average to 2.6% of the world's gross national product and $125 per capita.

The waste of human, technological, and economic resources in military activities is not the only evidence against intelligent life on Earth. A few other shocking examples are the following: more than one billion persons live in absolute poverty (three times the European Community's population); more than 100 million have no shelter; 950 million are chronically malnourished; more than 900 million are unable to read or write; a third of the whole planet's population does not have access to safe water (two billion people); more than 800 million are starving every day; 150 million children under age five have malnutrition; the 20% of the world's population that live in the most-developed countries control 90% of the total world's gross national product. As a consequence of irresponsible human activities, we have also generated environmental degradation, greenhouse effect, ozone depletion, etc.

Geographical Regions	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
World Total	1066.0	1047.0	1003.0	887.0	810.0	779.0	756.0	716.0	708.0	704.0
Africa	12.6	13.3	12.3	11.2	10.6	10.7	9.7	9.2	9.4	8.8
Americas	410.0	405.0	386.0	338.0	358.0	342.0	325.0	309.0	295.0	290.0
North America	390.0	385.0	369.0	325.0	342.0	325.0	307.0	289.0	273.0	268.0
Central America	0.8	0.8	0.9	0.6	0.6	0.6	0.6	0.6	0.5	0.5
South America	19.2	18.9	16.0	12.1	15.3	16.5	16.6	19.6	21.2	21.9
Asia (excluding Central Asia)	95.0	99.5	102.0	105.0	108.0	110.0	112.0	115.0	119.0	120.0
Europe	500.0	483.0	447.0	360.0	279.0	265.0	259.0	235.0	235.0	234.0
Middle East (excluding Iraq)	39.6	36.9	47.0	64.2	45.0	42.1	41.2	38.5	42.1	43.3
Oceania	8.9	8.8	8.8	8.8	9.1	8.9	9.2	8.9	8.7	8.8

Table I: Military expenditure by region. The figures are in billion U.S. dollars at constant 1995 exchange rates. From *SIPRI Yearbook* 1998, p. 214.

According to the conclusion of seven world models (Bruckman et al., 1982), there is no known physical or technical reason why basic needs cannot be supplied for all the world's people into the foreseeable future. These needs are not being met now because of social and political structures, values, norms, and worldviews—not because of absolute physical scarcities. Continuing "business as usual" policies through the next few decades will not lead to a desirable future—or even to meeting basic human needs. It will result in an increasing gap between the rich and the poor, problems with resource availability, environmental destruction, and worsening economic conditions for most people.

Finally, the vital arena to understand in order to work on almost any global problem is that of values; goals; and individual, social, and political will: why people are what they are and make the decisions they make, and especially, how such things can be changed.

I do not think we should be very proud in communicating these truths about planet Earth to our galactic fellows. Obviously, we have many things to be solved on our home planet before dreaming of becoming a member of any hypothetical *Galactic Club*. On the other hand, it is utopian to think that the extraterrestrials would tell us their recipes on how we should solve these and other main "local" problems. Our species is responsible for them and it is our duty to solve them. We must not look into the sky for answers to the problems we have here in front of our eyes.

From Kantian Ethics to Lex Galactica

If most of the galactic societies have a similar destructive evolutionary trajectory, the number of communicative civilizations will be very small. If the metaphor of *technological adolescence* is correct, we may consider that we are living in a very particular moment of our civilization's history when we may

start our self-destruction. In order to avoid it, our species must make a deep transformation of human individual behavior in three main aspects,[5] which are *Intra-individual* or *Somatic, Interindividual* or *Social*, and *Exosocial* or *Habital*.[6]

In order to improve the lifetime of a technological civilization, it is impossible to have superior science and technology, and inferior morals. This combination is dynamically unstable and we can guarantee self-destruction within the lifetimes of advanced societies (10^5 to 10^6 years?). At some point, in order to avoid their self-destruction, all intelligent species in the universe must produce this ethical breakthrough among the members of their societies in order to achieve harmony in their planetary environment. Otherwise, the probability of global extinction would be very high and consequently their societal life expectancy would be very short. What kind of ethical principles should guide this transformation or *social mutation?* We consider that Kantian ethics provides some good elements to start the discussion.

Kant's outstanding contribution to moral philosophy was to develop with great complexity the thesis that moral judgments are expressions of practical, as distinct from theoretical, reason. For Kant, practical reason or the rational will does not derive its principles of actions by examples from the senses or from theoretical reason; it somehow finds its principles within its own rational nature. Kant argued that willing is truly autonomous if, but only if, the principles that we will are capable of being made universal laws. Such principles give rise to *categorical imperatives,*[7] or duties binding unconditionally, as distinct from hypothetical imperatives, or commands of reason binding in certain conditions that we desire for certain ends. Kant seemed to hold that *universalizability* is both necessary and sufficient for moral rightness. Kant arrived at the ideal of "the kingdom of ends in themselves" or of people respecting each other's universalizing wills. This has been an enormously influential idea, and its most distinguished recent exponent has been John Rawls (1980).

The exploration and development of ideas related to ethical principles regarding cultures beyond the Earth is in its childhood. Only Fasan (1970), Lupisella and Logsdon (1997), Narveson (1985), and Ruse (1985) have presented some speculations in these directions.

My thesis is that all the civilizations should evolve ethically at the same time they evolve technologically. When these civilizations reach their technological adolescent stage, they must perform the *societal mutation* or become extinct. After learning how to reach a synergetic harmony among the individual members, their groups and their habitat, they would extend this *praxis* to the rest of living beings, including their hypothetical galactic neighbors. Their own evolutionary history will teach them the Kantian principle of respecting each other's universalizing wills. Being aware that each planetary evolutionary path is unique, these advanced civilizations will have a noninterference policy with the evolutionary process of underdeveloped societies. This galactic quarantine hypothesis—based in Kantian ethics—is defined here as *Lex Galactica*.

Some useful ideas in the direction of the evolution of societal ethical stages—applied to the study of several terrestrial cultures—were developed originally by Piaget (1971) and extended by Kohlberg (1973). In his pioneer works, Kohlberg established a correspondence between Piaget's cognitive evolutionary stages and his moral judgment stages. According to his view, the final ethical evolutionary stage is based on "universal principles." Besides the formal criticism that these ideas received by other scholars (Carracedo, 1989), I consider that these are good starting approaches for the exploration of our speculations about the concept of *Lex Galactica*.

If the *Lex Galactica* principle is used, we might expect that very limited amounts of practical information would be available for emerging societies to consume. Obviously, we can expect great exchange of information between advanced civilizations at the same level of development. Those civilizations with large lifetimes can establish dialogues with interstellar partners and evaluate which kind of information can be shared with each civilization.

Earthlings' electromagnetic transmissions have revealed their existence to the universe only within a sphere of approximately 70 light-years around the Sun.[8] Distant advanced societies will be unable to recognize that some primitive intelligent life is around our Sun, and consequently they will be

5. For a complete description of these aspects see C.A. Mallmann, "On Human Development, Life Stages and Needs Systems" in F. Mayor (Ed.), *Human Development in Its Social Context*, UNESCO, Paris, 1986.

6. Here we use the word "*Habital*" in reference to the concept of *Habitat*.

7. In its most famous formulation, a categorial imperative states that "the *maxim* implied by a proposed action must be such that one can will that it become a universal law of nature."

unable to "calibrate" our technological and ethical evolutionary level to start sending their "knowledge" to us. As shown in the previous section, access to technologies thousands of years more advanced than our present ones could cause our self-destruction if those technologies become available to terrorists or other deranged leaders. These advanced civilizations would not want to place potentially destructive knowledge at the disposal of any "ethically underdeveloped" society. Such knowledge could be a threat to the emerging society's survival. Any civilization needs time to work out adequate moral restraints on its own behavior.

Message Contents: Encyclopedia Galactica or the Music of the Spheres?

Based on the arguments presented in the previous section, if there is something resembling Sagan's concept of *Encyclopedia Galactica*, it would probably be encrypted in such a way as to allow detection only by the ethically more advanced civilizations, those civilizations that already know how to be responsible with the power of knowledge and high technology. To avoid detection by the emerging societies, they will probably use exotic technologies, based in subtle, unknown—to us—laws of nature (Lemarchand, 1992, 1994, and 1997). In any case, these advanced civilizations will be totally "transparent" for us.

A different possibility is the case in which advanced civilizations might try to contact emerging civilizations by sending only beacon signals: a typical artificial signal, very easy to recognize among the galactic cacophony, but without any message or content. This signal will attract our attention and will let us introduce ourselves to this unknown galactic partner. In this way, the extraterrestrials will have a chance to calibrate our technological and ethical development. In a second run, they could send practical knowledge according to our needs, using the Kantian ethical principles or *Lex Galactica*.

We can also include, in the last group, those nearby advanced civilizations that are within a sphere of 70 light-years and have already detected us by our military and planetary radar signals, TV carriers, etc. They will probably have devices with the sensitivity needed to decode our weakest signals and obtain more information about us. Again, their transmissions will be designed specifically for our needs.

Finally, these advanced societies could use a different approach to call our attention. Instead of sending hundreds of Terabits of scientific and technical knowledge, they could send us some manifestations of their artistic production.[9] For example, some piece of their "Music of the Spheres" or some images of their pictorial arts. Would it be possible for us to get a correct interpretation of these art creations? (Lewis, 1972; von Hoerner, 1974; *The New York Times*, 1989; Lemarchand and Lomberg, 1996; Vakoch, 1999). An attempt to send not only a beacon signal, but also a "compact" of art productions could be an interesting solution to the limitations imposed by *Lex Galactica*. Of course this should also be done in a delicate way in order not to generate a deep cultural shock to the recipient society by sending them complete art galleries. A few manifestations will be enough to initiate "conversations."

It has been shown that there are several patterns in art and nature that can be considered as universal as mathematics for their employment in interstellar communication attempts (von Hoerner, 1974; Lemarchand and Lomberg, 1996). Our species has a much longer tradition in dealing with the arts than with science and technology. Manifestation of human symbolic thinking started with our first artistic expressions. It could be natural to think that it would be much easier to "contemplate" an extraterrestrial piece of art than to "interpret" the correct application of an extravagant technology.

For example, the technologically and symbolically superior *Homo sapiens* began to populate Europe some 40,000 years ago. According to anthropologists, the reason for our species' success was the development of language, not simply the intuitive level of understanding and rudimentary communication characteristic of Neanderthals, but symbolic, syntactic language. This innovative characteristic is fundamental to our ability to think; it is more or less synonymous with symbolic thought, and the intelligent property is simply impossible in its absence.

8. Considering the description earlier about the way we waste our human, economic, and technological resources in military programs, probably none of the hypothetical technological civilizations within this 70 light-years sphere will be interested in contacting us.

9. A special Round Table to discuss this particular topic between artists and scientists was organized by G.A. Lemarchand and J.G. Roederer during the First Iberoamerican School on Astrobiology: Origins from the Big Bang to the Civilizations, Instituto de Estudios Avanzados (IDEA), Caracas, Venezuela, November 28–December 7, 1999.

Read (1954) considered that art, or more precisely the aesthetic experience, is an essential factor in human development, and, indeed, a factor on which *Homo sapiens* has depended for the development of his highest cognitive faculties. The "creative explosion" responsible for modern humans is perhaps most dramatically witnessed in the Upper Paleolithic art. The oldest known painted image was found in December 1994 in the Ardèche Valley of southeast France (Chauvet et al., 1996). These staggering images proved to be doubly remarkable, for not only have radiocarbon tests established them to be over 36,000 years old—nearly twice as old as those found at Lascaux—but they also are powerful, sophisticated works of art rather than crude sketches.(10)

Art and science are creative activities. In the act of creation, a sentient being brings together two facets of reality and, by discovering a likeness between them, suddenly makes them one. This act is the same in Bach, Einstein, or Leonardo da Vinci. The spectator who is moved by the finished work of art or the scientific theory relives the same discovery; his appreciation is also a re-creation.(11) The work of art or of science is *universal* because we have the possibility to re-creation it. We are moved by the symphony, we follow the theorem because we discover again and seize the likeness that the creator first seized. The act of creation is therefore original but it does not stop with its originator. The act of appreciation reenacts the act of creation, and we are (each of us) actors; we are interpreters of it.

An extraterrestrial symphony, an abstract image, or a new aesthetic manifestation will help us to expand our symbolic capacities to new, unexpected frontiers.

Figure 5: Detail from "Panel with the Horses," slide n. 12, of the Grotte Chauvet-Pont-d'Arc cave pictures and one of the oldest known paintings on planet Earth. Used by permission and elaborated with the support of the French Ministry of Culture and Communication, Régional Direction for Cultural Affairs–Rhône-Alpes, Régional Department of Archaeology.

Humans' art age is at least one order of magnitude older than the invention of mathematics and more than two orders of magnitude older than the invention of radio waves technologies. If we place the value of 36,000 years as the first known manifestation of human symbolic thought(12) in Upper Paleolithic art, we can use the Principle of Mediocrity or the Delta *t* argument to estimate with a 95 percent confidence level that our species' interest in the arts will last between 923 and 1,404,000 years into the future. Obviously, the pleasure that each artistic manifestation generates is highly dependent on our individual cultural values. Extraterrestrial art would be completely different from any other artistic experience we have had before. In one way or another, each single artistic creation is always unique. The essential issue is that in the process of contemplating any art manifestation, we are participating in some kind of recreating activity. We always are rediscovering a new

10. The first age estimate was only 32,400 years, but recent recalibration of the Carbon 14 method determined this new age of 36,000 years. (E. Bard, La Datación por Carbono 14 se Renueva, *Mundo Científico*, No. 206, pp. 37-41, November 1999).

11. This view, that science is as integral to the culture as the arts, was the theme of Jacob Bronowski's address to the British Association for the Advancement of Science in 1955, "The Educated Man in 1984," and of Sir Charles P. Snow's eloquent Rede Lecture, *The Two Cultures and the Scientific Revolution*, Cambridge University Press, New York, 1959. Recent versions of the same statements were published—among others—by A. C. Crombie, "Experimental Science and the Rational Artist in Early Modern Europe," *Daedalus*, Vol. 115 (3), p.49-74, 1986; A. I. Miller, *Insights of Genius: Imagery and Creativity in Science and Art*, Copernicus, New York, 1996; and A. I. Tauber (Ed.), *The Elusive Synthesis: Aesthetics and Science*, Kluwer Acad. Pub. Dordrecht, 1996.

12. We are using factual data only. Probably symbolic thought started much earlier. Recently, Dr. Ivan Turk, a paleontologist at the Slovenian Academy of Sciences in Ljubljana, found an ancient bone flute segment at a Neanderthal campsite. It is the first flute ever associated with Neanderthals and its age was estimated at 43,000 to 82,000 years. The confirmation of this discovery could show that a second terrestrial species (Neanderthal) developed music much earlier than *Homo sapiens* developed painting. The most amazing thing is that four holes of the flute match our modern diatonic musical scale.

pattern, a subtle new order, or a new hidden symmetrical-asymmetrical organization.

Conclusions

According to the scenarios explored in this essay, we consider that there are good theoretical and empirical reasons to think that the original hypothesis of a universe populated by supercivilizations making omnidirectional transmissions is incorrect. Those original scenarios imposed the view that the discovery of an extraterrestrial signal will be strongly associated to the existence of a message with all sorts of advanced scientific, technological, and sociological recipes. In this view, all the advanced galactic (and extragalactic) societies would be irresponsibly spreading all their accumulated knowledge across the universe, knowing nothing about the technological and ethical characteristics of the possible recipients.

The existence of very advanced technological civilizations is highly conditioned by very large societal lifetimes. The analyses of the history of our incipient technological human society shows that we are facing the dangerous *technological adolescent era*, when our civilization could become extinct in the following 30 to a thousand years. Probably most of the technological civilizations have to pass through a similar *adolescent era*. In any case, the only possibility to avoid self-destruction is a deep and strong societal mutation, based in some sort of Kantian ethics. The long-term application of these ethical principles to the societal dynamics will generate some kind of *Lex Galactica*. The implementation of these ethical guidelines would prohibit placing potentially destructive knowledge at the disposal of any ethically underdeveloped society. This knowledge could be a threat to the survival of the recipient civilization.

From these assumptions, we can derive the following observational predictions:

- No omnidirectional electromagnetic transmissions with high-information content will be observed.
- Only beacon, low-information signals should be sent, in an intermittent and target mode, to those stars that have planets suitable for life. For detecting terrestrial-type planets, extraterrestrials can use advanced space interferometry techniques (Beichman et al., 1999). We should expect this type of signals from all the stars at distances over $[35 + (t_f\text{-}2000)/2]$ light-years, where t_f is the observing date in years and $t_f \geq 2000$.
- An alternative transmission strategy could be the addition of some extraterrestrial artistic creations to the beacon signals. Extraterrestrial art contemplation would help us to expand our perceptive horizons.
- Those nearby advanced societies that have already received our initial radio transmissions, with the technical capability to detect and decode our weakest signals, will have some idea about our technological and moral level of development. These civilizations may be transmitting to us high-information messages or those chapters from their *Encyclopedia Galactica* that our civilization is in a position to understand—but only those stars at distances $R_t < [35 + [(t_f\text{-}2000)/2] + \tau]$ light-years, where R_t is the distance at the observing date t_f and τ is the time that the extraterrestrial society needs to analyze and evaluate our technological and ethical stage.
- We may also be able to detect some radiation leakage from nearby civilizations, but this will probably be with very low-information content. The same thing would happen with any serendipitous detection of evidences of technological extraterrestrial activities (Dyson, 1959; Lemarchand, 1994 and 1997).

Indeed, our position relative to the SETI outcome is very much like that of an adolescent setting out on life's journey: the possibilities are infinite, the future is wide open, and we have grand plans, but much of the shape of that future hangs not only on what we do, but also on what the "others" are doing. Today we have no answer to the question: Are we alone in the universe? Until we have that answer, we must do what most adolescents do very poorly: we must wait.

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