Lingua Extraterrestris

lessons in universal communication
or the designer's understanding of CETI
in science and fiction

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2010

in memory of

Stanisław Lem

1921-2006

Table of contents:

Abstract

With no hard evidence for the existence of extraterrestrial intelligence (ETI), communication with ETI (CETI) remains a scholarly exercise with great potential for speculation and experimentation.

The purpose of this paper is to explore CETI as the most general instance of the communication process. A custom method is used to analyse both historical and fictional examples of CETI from the perspective of the theory and practice of exchanging information. This appraoch is based on decisions:

1. to treat both scientific and fictional examples of CETI as equally informative and valid; since none of the scientific endeavours in CETI proved successful, the credibility of CETI depictions in the works of fiction is seen as equal to its credibility in the works of science;
2. to use a hybrid communication model for investigating CETI; because none of the existing models of terrestrial communication covers the full scope of the CETI problem, a custom model is proposed that combines elements of the Shannon-Weaver and the Jakobson models of communication.

As a result of this investigation, a possibility for expanding on the f_c term of the Drake equation is identified, and interpreting it through four aspects of the generalised communication process (Channel, Contact, Context, Code) suggested.

Introduction

lingua franca — CETI — working model — science and fiction — Stanisław Lem — Drake equation + X

Everything starts on Earth.

Ludwig L. Zamenhof was a Polish Jew born in Białystok, a multinational city where "the inhabitants were divided into four distinct elements: Russians, Poles, Germans and Jews; each of these spoke their own language." [1] In 1887, in Warsaw, he published a book with grammar for Esperanto—a language, that he designed himself. Since then it has became one of the most popular constructed international auxiliary languages in the world.

[1] *Zamenhof, 1929 cited in Matthias, 2002, p.23*

As a combination of the linguistic qualities of Slavic, Germanic and Romance languages, Esperanto was intended to answer the need for lingua franca in the 19th-Century Europe of multinational countries. Now, it still serves the purpose of inter-human communication. Since the creation of the computer, programming languages have been developed to facilitate communication between humans and machines, as well as machines themselves. Plankalkül was the first high-level programming language, developed by Konrad Zuse on the basis of the model he designed in the years 1943-1945[2], and responding to the new area of communication that mankind had begun to be involved in. Simultaneously, other domains of human-related communication became apparent. After observing animals' methods of signification (as in the case of the "dances" of bees discovered by Karl von Frisch in the 1920's)[3] re-

[2] *Giloi, 1997, abstract*

[3] *Cobley & Jansz, 2004, p. 122*

searchers started to investigate "designative processes among the speechless creatures," [4] which led to establishing zoosemiotics—an independent field of study, parallel to anthroposemiotics. According to Thomas A. Sebeok, *Homo Sapiens* and all other earthly creatures play just a small part in the universe of sign sources. To complement the terrestrial origins of semiosis, Sebeok also included the semiosis of organic extraterrestrial provenance in his classification (Fig. 1.1),[5] thus indirectly identifying yet another domain of communication that humankind relates to: communication with extraterrestrial intelligence, commonly abbreviated to CETI.

[4] *Sebeok, 1994, p. 19*

[5] *Cobley & Jansz, 2004, p. 128*

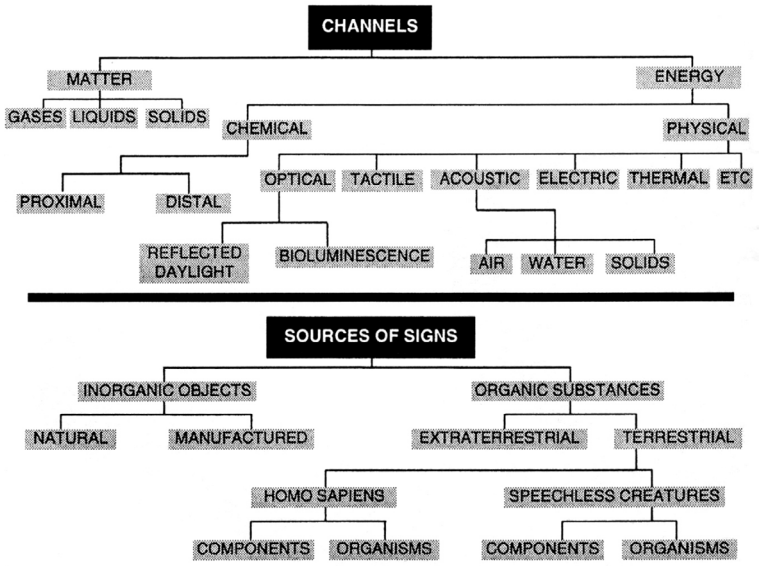
This, however, is nothing new. With the boom in television broadcasting in the middle of 20th Century, which came along with the use of UHF and SHF radio communication with satellites and spacecraft, man-generated electromagnetic radiation penetrated Earth's layer of ionised atmosphere and progressed into space, making our planet detectable in radio wavelengths[6]. Thereby, humankind became the sender (information source) of the Shannon-Weaver model of communication[7]. From this point, in terms of CETI, potential existence of of our broadcast's receiver (destination) is just enough to consider communication possible—with a dramatically low probability, but still not disproved.

[6] *Wedlake, 1973, pp. 199-206*

[7] *Sebeok, 1994, p.120*

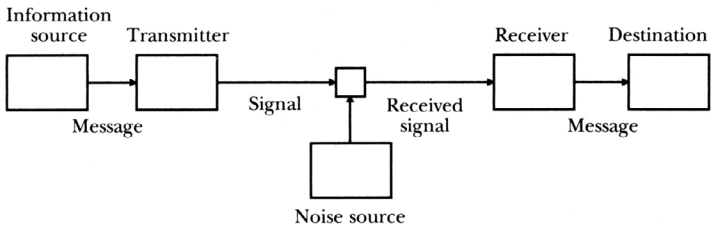
This is the CETI that draws my attention.

In this paper I wish to focus on CETI as an opportunity to investigate the limits of communication. Because CETI, being an academic discourse, offers the most universal conditions for examining communication as a process, I believe it can help addressing issues that would not be that apparent, if considered in the terrestrial context. By attaining deeper insight into CETI, I believe we can better understand communication as a phenomenon.



[8] *Cobley & Jansz, 2004, p. 128*

FIG. 1.1—SEBEOK'S CLASSIFICATION OF CHANNELS AND SOURCES OF SIGNS[8]



[9] *Sebeok, 1994, p. 120*

FIG. 1.2—SHANNON-WEAVER GENERAL COMMUNICATION SYSTEM[9]

CONTEXT

ADDRESSER MESSAGE ADDRESSEE

CONTACT

CODE

[10] *Jakobson, 1960, p. 353*

FIG. 1.3—JAKOBSON MODEL: FUNCTIONS OF VERBAL COMMUNICATION[10]

For the purpose of this enquiry I assume that establishing contact with ETI is possible, though the possibility is inestimable and hence—its value irrelevant. My methodology of investigation will consist in deconstructing existing models of communication. To my mind, neither the Shannon-Weaver model of a general communication system, nor the Jakobson model of language functions is general enough to serve as a comprehensive tool for the analysis of CETI. The Shannon-Weaver model focuses on technical aspects of transmission (channel), omitting such important aspects of language communication as e.g. context (Fig. 1.2).[11] The Jakobson model encompasses linguistic properties of verbal communication (i.e. contact, context, code), though with no regard to the special nature of telecommunication, e.g. the channel that would support CETI or the inevitable lagging inherent to cosmic conversations (Fig. 1.3).[12] In order to comprehensively analyse CETI, I suggested my own working model based on four domains deriving from the Shannon-Weaver and Jakobson models, and reinterpreted for the purposes of the CETI discourse: channel, contact, context and code. With this framework for investigation and with the intention to reflect on the factual and imaginary potential of CETI, I shall feed my working model with examples of CETI of varying provenance, following the advice of John L. Casti in *Paradigms Lost*:

[11] *Shannon, 1948; (see Appendix 2)*

[12] *Jakobson, 1960, pp. 355–376*

> In matters of the imagination, in a search for alternatives we have to leave the mainline scientific community behind and turn to the science fiction writers and philosophers for some mind-bending, yet physically feasible, candidates.[13]

[13] *Casti, 1990, p. 394*

My selection will comprise historical ventures deployed by scientists and radio-astronomers, but also fictitious scenarios invented by science fiction writers and filmmakers. Thereby—as a designer and a communicator—I hope to attain a better understanding of what the process of communication is.

Because of the methodology I have chosen for my investigation, the selection of science-fiction works is critical. A non-biased attitude, scientific faithfulness and a comprehensive approach to the problem of CETI are the most important characteristics I search for. Ultimately, all these qualities can be found in the works of Stanisław Lem. Besides Lem's devotion to scientific accuracy in terms of elaborating on tomorrow's technology, his in-depth philosophical reflection is a unique feature when compared to other science fiction writers. In his work futuristic technology and distant cosmic worlds serve as a mirror, in which Lem aims to find a portrait of the human psyche and analyse it. Moreover, contrary to other science fiction authors, Lem gives an informed critique of mankind's progress and space endeavours, inquiring about the reasons and purpose of human presence outside Earth. Apart from our vogue human curiosity and the fact that we are technically capable of space travel, why do we need to explore Cosmos at all? Why do we wish to find alien life forms out there? Would it be comforting for us to know that there are some other beings living elsewhere in the Universe, that terrestrial life is not just a single case of some random synthesis of organic components that randomly led to the emergence of humankind? In one of his articles Lem claims:

> From a scientifical standpoint, we do not like such significant creatures as humans to come into existence by rare chance. For there cannot be any science at all, where everything depends on gamble. [translation MK][14]

[14] *1978, p. 11; (see Appendix 1.2)*

This also reflects popular concerns that were raised after the publication of Darwin's *The Origin of Species* in 1859, when people struggled to accept the fact that human is not an exceptional creature created by God, but an effect of millions of years of evolution.[15] But if ETI was discovered—would this bring our sense of exceptionality into question yet again?

[15] *Evans & Selina, 2005, pp. 3–5*

Because of these aspects of Lem's attitude towards science fiction, and the quality and richness of his work, I have decided to refer to three of his novels: *Solaris*, *His Master's Voic*e and *Fiasco*, all of which deal with CETI, and each one from a different point of view.

In the end, I plan to revisit the Drake equation, which estimates the number of detectable ETI civilisations in the Galaxy.[16] With focus on the equation's sixth variable—the f_c factor—I wish to suggest its dissection into four constituent sub-factors. Rooted in theory and practice of communication design, the four sub-factors are aimed at bringing new cross-disciplinary expertise to the ETI discourse. It is hoped that such approach will address not only the general goals of the search for extraterrestrial intelligence programme (SETI), but also serve its more specialised spin-off, which main interest lies in communication: the CETI.

[16] *Drake, 2003*

CHANNEL

Rhinolophus ferrumequinum — Sebeok — Voyager 1 — — 1420 MHz — First Contact — Solaris

Firstly, let us consider an example.

Rhinolophus ferromequinum (Greater horseshoe bat) is a species of bat in the *Rhinolophidae* family living in central Europe. Like most nocturnal predators, it relies on senses other than vision to navigate and hunt. *Rhinolophus ferromequinum* uses echolocation, i.e. emitting sonic signals and detecting their echo, and perceiving the closest environment by analysing the delay and shape of the reflection. With some calls of more than 100 dB in sound intensity (e.g. noctule bat), which is comparable to loudness of a compressed air hammer,[17] why is it that we cannot hear the bats' cry?

[17] *Schober & Grimmberger, 1993, p. 41*

The reason is very simple—the frequency range of human hearing. Although both *Homo Sapiens* and *Rhinolophus ferromequinum* send signals using acoustic properties of air, due to the difference in wavelength we fail to recognise bats' calls. *Rhinolophus ferromequinum* generates signals between 77 and 83 kHz,[18] while the human hearing range reaches only up to 18 kHz (Fig. 2.1).[19] This makes us physically incapable of hearing *Rhinolophus ferromequinum* shrieks. Similarly, due to such limitation we are unable to see electromagnetic radiation of radio wavelengths, infrared light or hard X-rays and gamma rays, as these are respectively below and above the visible light spectrum that is detectable to our vision apparatus.

[18] *ibid., p. 94*

[19] *ibid., p. 38*

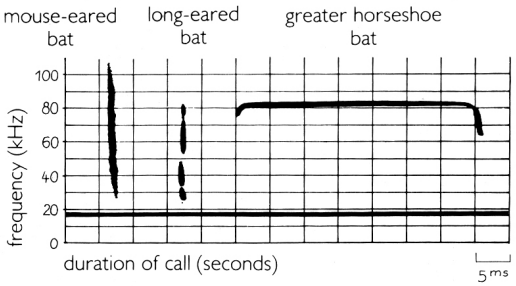
Thus, in terms of communication, channel "is merely the medium used to transmit the signal from transmitter to receiver," [20] and can be considered as an agency of certain characteristics, and capable of carrying sings. Thomas A. Sebeok, in his classification of channels, identified a vast number of different types of media and their properties, which can be utilised for potentially any type of signification.[21] Alongside channels that are perceptible for humans (e.g. visible light, audible acoustics or tactile contact), Sebeok also distinguished other—naturally undetectable for *Homo Sapiens*. Several of these listings (i.e. optical or thermal) are in fact just one omnipresent physical phenomenon varying only in frequency: electromagnetic radiation. Therefore, as we can see, what constitutes a communication channel may be regarded in terms of its essence (energy? matter? if energy, then physical or chemical?) or in terms of its intrinsic properties (e.g. frequency of an electromagnetic wave). These two factors determine whether a signal is detectable to the receiver, or not.

[20] *Shannon, 1948, p. 381; (see Appendix 2)*

[21] *Cobley & Jansz, 2004, p. 128*

The Golden Record sent onboard the Voyager 1 spacecraft on September 5th 1977 represents the most obvious and straightforward way of reaching a potential extraterrestrial interlocutor—actually sending a physical object. In Voyager's case this was a gold-plated copper disk with: greetings spoken in 55 terrestrial languages, ambient sounds of Earth, 115 analogue images and a 90-minute long selection of music.[22] The record was designed to be played at the rate of 16–2/3 revolutions per minute, with diagrammatic instructions on how to play it drawn on its cover (Fig. 2.2). With all this content the Voyager record is a poetic and time-specific portrait of humankind's culture and civilisation, addressed to the human temptation of commemorating our existence and marking our presence—to the very same extent, as it is a real attempt at communicating with ETI. US president Jimmy Carter in his message, featured on the Golden Record as the 116th image, declares:

[22] *JPL, 2010a*



Echolocation signals of various bat species. The vesper bats (mouse-eared, long-eared) emit short frequency modulated (FM) pulses which pass through a wide frequency range within a few milliseconds. The horseshoe bats emit constant frequency (CF) pulses of long duration in a very restricted frequency band. The upper hearing capability of humans is approximately 18 kHz (based on Gebhardt, 1985).

FIG. 2.1—BATS' CALLS RANGE COMPARED TO HUMAN HEARING RANGE [23]

[23] *Schober & Grimmberger, 1993, p. 38*

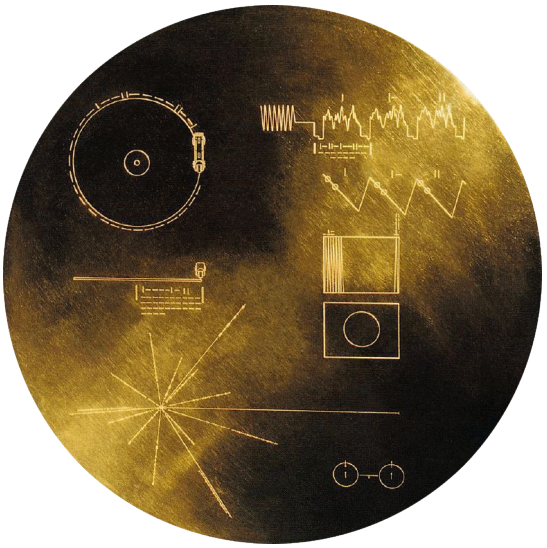


FIG. 2.2—VOYAGER GOLDEN RECORD: COVER IMAGE [24]

[24] *JPL, 2010c; (see Appendix 3)*

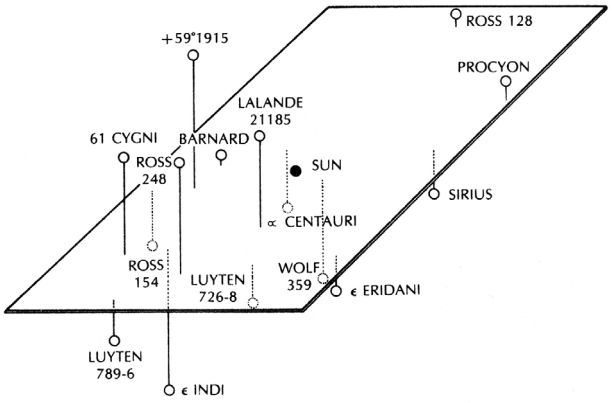


FIG. 2.3—THE FIFTEEN NEAREST STARS TO THE EARTH [25]

[25] *Casti, 1990, pp. 389-390*

> We cast this message into the cosmos. It is likely to survive a billion years into our future, when our civilization is profoundly altered and the surface of the Earth may be vastly changed [...] This is a present from a small, distant world, a token of our sounds, our science, our images, our music, our thoughts and our feelings.[26]

[26] *JPL, 2002*

But suppose an extraterrestrial civilisation intercepted Voyager 1—would they be able to read the Golden Record? What would they understand out of the instructional graphics detectable as an image only in visible light spectrum, if their vision organ received only high frequency ultraviolet radiation? Would this still be an image? Provided they had a device enabling them to switch from acoustic waves played from the record's soundtrack to VHF radio waves which they would normally hear with their VHF ears—would such signals still convey something organised in a harmonious fashion that we are used to calling music? The channel incompatibility may become an insurmountable barrier in communication in Voyager's case, and even though the record was intended as a message to extraterrestrial civilisations, it is more probable that Voyager 1 remains mankind's message in a bottle AD 1977, a token of our presence amongst all universal creation.

Assuming that our civilisation started around 10,000 years ago with the end of the Neolithic era, it would take 4 such civilisations to fully develop and die consecutively before Voyager 1 finally reached the sun's nearest star—Proxima Centauri.[27] During these 40 millennia *Homo Sapiens* might become extinct, change its attitude towards extraterrestrials and decide not to seek any contact, or just visit Proxima Centauri onboard an interstellar spaceship of the future, long before Voyager would reach half of its distance. And even if one day we do reach the level of technological development necessary for propagating objects with the speed of 0.1 c (one-tenth the speed of light, equivalent to almost 30,000 km/s), it would still

[27] *JPL, 2010b*

take a lifetime to arrive at one of the stars in the sun's nearest neighbourhood, shown in Figure 2.3.[28] Waiting for an answer would yet double this duration, resulting in something between 100-200 years needed for one return exchange of interstellar post. And what about farther stars? Because of this, sending a message onboard a spacecraft cannot be regarded as a feasible or practical channel to communicate with ETI.

[28] *Casti, 1990, pp. 389-390*

As we can see now, it is the velocity at which a signal would be sent, that is the decisive factor in choosing an appropriate channel for interstellar communication. And since—as corroborated by Albert Einstein in his special theory of relativity[29]—the speed of light is the greatest possible speed that any physical entity can attain, then electromagnetic radiation (which is also light) is currently most suitable for transmission over great cosmic distances.[30]

[29] *Schwartz & McGuinness, 2005, p. 106*

[30] *Heidmann, 1997, p. 124*

Thus, back to *Rhinolophus ferromequinum* and the problem of matching the transmission frequency with the extraterrestrial's hearing range. With the electromagnetic spectrum spanning from Gamma rays of wavelength smaller than a single Ångström, up to Extremely Long Frequency radio waves almost as long as the Earth's radius, there is a great potential for channel diversification within one medium, which is fluctuations in the electromagnetic field. In 1959, Giuseppe Cocconi and Philip Morrison published an article in Nature, in which they calculated that "it would be possible, despite the colossal distances between stars, to exchange radio signals, and thus communicate" with ETI[31]—provided that both participants had comparable emitters and receivers, as well as sufficient and similar radiating powers. Moreover, "from the whole vast spectrum of possible wavelengths, they also recommended using the 21-cm [1420 MHz] emission from hydrogen atoms." [32] This radio frequency (also known as UHF or the decimetre band) offers, according to Cocconi and Maorrison, the best channel for inter-

[31] *ibid., p. 112*

[32] *ibid., p. 112*

stellar radio transmission, due to the abundance of hydrogen in the universe, and it "could serve as a universal standard for the community of galactic civilizations." [33]

[33] *Heidmann, 1997, p. 112*

As it has been hitherto shown, there are existing channels adequate for interstellar communication. However, there is also need for compatibility between the two ends of the "wire." If we send a message using radio waves, whereas our prospective interlocutor detects only neutrinos beams,[34] there can never be communication. This however, is not an obstacle for science fiction. In his popular novelette, meaningfully titled *First Contact,*[35] Murray Leinster describes an extraordinary case of a terrestrial spaceship meeting an alien spacecraft in the Crab Nebula. Upon contact, an object is placed between the two ships by the extraterrestrials—later it turns out to be a mechanical translator, which serves as a platform facilitating communication through two distinct channels: humans rely on their air-propagated speech and hearing, while the aliens use electro-magnetic radiation in microwave (EHF) band. After exchanging first communication, Tommy Dort explains how strange to human understanding alien forms of communication can really be:

[34] *ibid., p. 125*

[35] *Leinster, 1945*

> "That means they have telepathy?"
> "M-m-m. Yes, sir, [...] Also it means that we have telepathy too, as far as they are concerned. They're probably deaf. They've certainly no idea of using sound waves in air for communication. They simply don't use noises for any purpose." [36]

[36] *ibid., p. 147*

And even though Leinster lets his characters succeed in their first encounter with the extraterrestrials, an informed reader will not go astray by putting translation from one channel to another side by side with true communication. It is again the case of *Rhinolophus ferromequinum*—we can tune its calls to our hearing range, but

that does not mean we can understand it. There are still problems posed by other elements of the working model of communication devised for this paper: contact, context and code.

Leinster's *First Contact* is in fact a very fast-paced adventure story, focusing more on action than constructing a coherent, scientifically viable world. Contrary to that, a very contemplative approach characterises *Solaris* written by Stanisław Lem—the renowned philosophical science-fiction novel about the impossibility of comprehending an alien mind. Leinster is very optimistic about future technology and humankind's conquest of the universe. Also, his envisaged picture of the aliens is extremely anthropocentric in terms of how they behave, what they think and do. Lem on the other hand gives an account of a place in the space that is very different to Earth—the planet Solaris, covered with a mysterious sentient being called "the ocean." There is little known about it, apart from the fact that it interacts with scientists based on a space station orbiting Solaris. Everything starts after radiating Solaris with hard X-rays—"Perhaps the ocean reacted to the irradiation with a counter-irradiation, perhaps it probed our brains and penetrated to some kind of psychic tumour." [37] Nonetheless, Solaris begins to read the crews mental images and memories, and projects them back in form of the visitors—unexplained phenomena, which on one hand could be superficially perceived as humans (e.g. Rheya, Kelvin's late wife), on the other hand however, they are objectively nothing more than just a vague conglomerate of neutrinos. They lack any memories prior to their arrival on the space station and are seemingly indestructible (self-repairing?). Is this what communication with ETI may possibly look like? If so, then what is the channel used by Solaris? Can we even consider these phenomena to be projected through a channel at all? Evidently, everything that happens on Solaris is far beyond human understanding. And this should not really be a surprise—this is ETI, definitely not from our world,

[37] *Lem, 2003, p. 77*

free of any anthropocentric expectations and different in every possible aspect. Such is also the channel through which Solaris actually addresses/examines/assaults the cosmonauts' minds. Having determined neither the nature, nor the features of the channel, the crew cannot answer Solaris. Hence, communication—something essentially bilateral—is hampered.

As it was discussed, the first step in establishing communication with ETI should begin with finding one channel (alternatively, several compatible channels) to facilitate the transmission. From all imaginable media that can carry meaningful signals into space, humankind has learned to utilise only one suitable medium so far, which is radio. There are certainly many more prospective channels to be discovered with the development of science and technology, as it was also the case in the past. But even now, due to numerous physical and civilisational conditions, we can utilise just a small fraction of all possible radio wavelengths. Regardless of which frequency one might decide to use, once the common channel has been negotiated the next element of the working model can be discussed: contact.

CONTACT

Holy Grail — Um-hum! — LGM 1 — Fiasco — CE3K

1. No one knows where it is.
2. No one knows what it looks like.
3. There is even no certainty, whether it existed at all.
4. All attempts to find it were unsuccessful.
5. Steven Spielberg directed a popular film about the search for it.

What is this?

This is the SETI programme (search for ETI), an important part of which is CETI. But whoever thought of the Holy Grail was also right. In fact, SETI can be somehow considered as today's search for the Holy Grail. Being a hunt for evidence of our civilisation's contemporary beliefs and paradigms, both the Holy Grail and SETI remain an almost supernatural promise for reassurance: the Grail is a Christian relic and in the medieval ages was considered a tangible proof of Jesus Christ's life and divinity; the existence of ETI would validate Darwin's theory of evolution and natural selection, and also support the notion that our own existence on Earth is not just a matter of blind chance.

This analogy (the first three points in the above list in particular) stresses yet another aspect of communication with ETI, which is also the second element in the working model developed for the purposes of this investigation—recognising the contact. In terms of communication, contact is the stage when all sides consciously

agree to participate in an exchange of signals. Roman Jakobson describes contact with regard to its phatic (term coined by Bronisław Malinowski) function of communication, which is:

> Primarily serving to establish, to prolong, or to discontinue communication, to check whether the channel works ("Hello, do you hear me?"), to attract the attention of the interlocutor or to confirm his continued attention ("Are you listening?" or in Shakespearean diction, "Lend me your ears!"—and on the other end of the wire "Um-hum!").[38]

[38] *Jakobson, 1960, p. 355*

This stage of setting up the grounds for communication needs to take place in parallel with establishing the first fundament, which means properly defining the channel—any emission can be called transmission only after an answer signal to the initial channel--opening calls has been received. This is also exactly what all babies do while still unfamiliar with their command over the speech channel—"they are prone to communicate before being able to send or receive informative communication." [39] Thus, establishing contact should be seen as a process of exercising the channel: simultaneous filling the aether with calls and scanning for detectable signals, and venturing communication whenever an interlocutor is recognised.

[39] *ibid., p. 356*

Also, in the context of SETI, contact has always been idealised and glamourised, envisaged as an event that raises no doubts about its special nature, or any ambivalence towards the origins of the extra-terrestrials. It was usually fantasised as a surprising discovery of an alien call, indicated by a sharp spike on an oscilloscope or a regular hum played in loudspeakers. This is a matrix scenario for many human–alien telecommunication encounters in numerous science--fiction works, e.g.: *Contact*, directed by R. Zemeckis and based on the novel by C. Sagan; S. Spielberg's *Close Encounters of the Third*

Kind; or D. Twohy's *Arrival*. However, the practical explorations of SETI raise much more confusion and uncertainty about the nature of signals than it has ever been anticipated in most of fictional work.

In 1967, two English researchers (S. Jocelyn Bell Burnell and her thesis supervisor, A. Hewish) registered a regular electromagnetic signal from a distant source. They cautiously decided to investigate the discovery before announcing it to the public. Because of a very regular pattern of the emission, the object perfectly matched the criteria used by SETI researchers to distinguish potential signals produced artificially by extraterrestrial civilisations from natural phenomena. "Among themselves, they called the source 'Little Green Men 1' (LGM1); then they discovered LGM2, and later LGM3." [40] Eventually, the mysterious source of signals turned out to be a rapidly rotating neutron star—a pulsar—which "emits two powerful beams of radio waves that sweep a whole region of space at every rotation." [41] Whenever this beam points towards Earth, we register it as a strong short pulse of radiation—hence the name "pulsar", derived from the full term: pulsating stellar object. Pulsars stand out to such extent, that astronomers use them as cosmic lighthouses to navigate across stars. Yet, regardless of how important to someone a lighthouse signal might be, it would do no more than mark a particular point in space. Moreover, because dispatching a meaningful content always involves some sort of modulation altering either amplitude, or frequency, or any other property of the signal, and this, according to our current scientific knowledge, exceeds the capabilities of a neutron star—hence, pulsar-generated impulses do not carry any message, but are capable only of taking hold of one's attention, Thus, although pulsars made SETI researchers redefine their criteria when searching for regularities in the cosmic randomness, each regularity still needs to be closely investigated and interpreted individually.

[40] *Heidmann, 1997, p. 150*

[41] *ibid., p. 169*

Under closer scrutiny, establishing contact appears to be a combination of more factors than just being in the right place at the right time. Being privileged to put the products of ones imagination on a par with the scientific hard facts, science-fiction authors can envisage possible human encounters with extraterrestrials and freely elaborate on their nature. Such an explicit case is closely investigated by Stanisław Lem in his novel *Fiasco*. Everything necessary to make contact seems to be in place: the earthling representatives' CETI mission arrives in the Zeta system of the newly discovered Harpyiae constellation exactly at the same time when the Quintan civilisation is supposed to have entered the "window of contact." This is a stage in the civilisation evolutionary model when, according to Ortega, Nilssen and Tomic, a civilisation is at the peak of its communicative capabilities.[42] But despite all the calculations and predictions, contact should never be taken for granted. Torn by a conflict between two major antagonists, the Quintans are not interested in contacting human ambassadors. Moreover—whether against themselves or to repulse possible visitors—they build an orbital coating made from countless satellites surrounding the planet, in order to block access to Quinta. They also emit a full spectrum white noise to jam all electromagnetic-based communication on and around the planet. Each and every attempt to contact the Quintans proves unsuccessful—it is replied either with silence, or physical retaliation. After a number of futile ventures, human ambition and desperation leeds to a critical point, in which the earthlings decide to enforce contact. Harrach, the first pilot, suggests a rather brutal ultimatum: "We will tell them, 'If you do not answer our signals, we will destroy your moon, and this will be the first warning. We are determined: we want contact.'" [43] This is later issued to Quinta. Nevertheless, the planet remains silent, even though confronted by drastic measures: its moon and ice ring are destroyed and the debris from the exploded satellites bombard the surface of the planet. Eventually, the Quintans allow the human

[42] *Lem, 1987b, p. 92*

[43] *ibid., p. 221*

ambassador scout to land, but ultimately because of his fatal negligence Quinta is obliterated by the CETI mission. The compulsion to contact the extraterrestrials brings a result opposite to the peaceful contact of intelligences that was initially intended—"the founders of the SETI Project did not have in mind contact with an intelligence upon a battlefield littered with the corpses of the host." [44] Consequently, an attempt to establish contact turns into the fiasco because of humans' blind persistence and aliens' reluctance. Thus, not only the purely technical feasibility of initiating contact, but also human and ETI inclination towards communication with alien species, are the issues that need to be addressed prior to planning an interstellar intercourse.

[44] *Lem, 1987b, p. 232*

Steven Spielberg investigates a different case of communicating with ETI in his film *Close Encounters of the Third Kind*,[45] which also refers to the problem of channel. Contact here is shown as something exclusive, addressed only to a few humans and communities targeted by the aliens. One of the contactees is Roy Neary who experiences a close encounter during which he receives a transmission. There is no reference in the film to any particular nature of the message, apart from the fact that it is some sort of an irresistible mental image. Roy describes it as following:

[45] *Close Encounters of The Third Kind, 2001*

> Weird. I know this sounds crazy, but ever since yesterday on the road. I've been seeing this shape. In shaving cream and pillows... Damn it, I know this. I know what this is. This means something. This is important.[46]

[46] *Close Encounters of The Third Kind, 2001, 40:54–41:40 min.*

He tries to visualise this by modelling it with clay, potato mash, pieces scavenged from the garden, but still it remains beyond his comprehension for the longer part of the film. Ultimately, he realises that what has been communicated to him is a meeting point. Simultaneously, scientists intercept a radio transmission

Fig. 3.1—Roy Neary seeks for the meaning of the mental image[47]

[47] *Close Encounters of The Third Kind, 2001*

marking the same place—the Devils Tower in Wyoming—and a local community in Dharamsala receives a five-tone message used as a communication code, which later in the film is transcribed into a sign language (originally designed by Zlotán Kodály to teach music to deaf children). Here the attempt to contact humans is a multi-channel enterprise addressed to various individuals, involving appropriate tactics and enough patience—until humans can actually comprehend, admit and accept that this is a close encounter with ETI.

Contact can be established either by chance, or on purpose, or even subconsciously. However, as presented above, contact is always a bipolar condition: it always involves at least two parties and defines one's awareness of another's communication. In this way, contact is a state of awareness, when one becomes a receiver of a transmission (as specified by the Shannon-Weaver model of communication) or an addressee of a message (according to the Jakobson model). An absolute prerequisite for establishing contact is to find a shared channel. After that, consciousness of communication can arise on both sides of the "wire": we may become aware of the intelligent and purposeful character of ETI's broadcasting, but simultaneously, we may as well become apparent to ETI as such source of signals. In either case, this is contact—and the only indisputable proof for establishing it is receiving an answer.

CONTEXT

Hollywood — anthropomorphic chauvinism — speaking lion — Strzemiński — Pioneer 10 — Starship Troopers

Hollywood is right!

At first it may seem ridiculous to see an alien who comes from a different planet, and who closely resembles human physicality in terms of its body layout, limbs functions or even physiology. Yet, this is exactly the case in many popular films, such as *Close Encounters of the Third Kind*, *Star Wars*, *Star Trek* or even *Transformers*. In some movies, e.g. *The Day the Earth Stood Still* (both 1951 and 2008 versions), aliens even adopt human body. Interestingly enough, in all these Hollywood productions the appearance of the extraterrestrials adheres to the way they communicate, i.e. with speech and hearing (acoustic properties of air in wavelengths detectable for humans), and employing familiar codes such as body language, semaphore or even English. This builds a coherent picture of a human-like creature speaking human languages. On one hand, if a "hollywood" alien wants peoples' acceptance and empathy, it must not be too unearthly and different from us. On the other hand, it is an alien, so it should not resemble humans too much, but still retain some obvious traits of its unearthly provenance. If aliens are to communicate with humans, they need to look like them.

Surprisingly, this show-business play with conventions reflects a serious scientific and philosophical debate on anthropomorphism. ETI enthusiasts believe that there exists a certain set of challenges

that need to be overcome during the progression of life from the primitive to the intelligent. According to them, regardless of where life evolves, it faces the problems that once had been solved on Earth. Consequently, these evolutionary traits are believed to be universal enough, to produce similar results in any advantageous place in the space. Jonh L. Casti gives a following list:

> The usual argument is the following anthropomorphic chain:
>
> 1. Common problems constrain common solutions.
> 2. ETI civilizations have in common with us the problem of cognitive accommodation to a shared world.
> 3. Natural science as we know it is our solution to this problem.
> 4. Therefore, natural science is likely to be ETI's solution, too.[48]

[48] *Casti, 1990, p. 405*

This anthropomorphic bias is criticised by philosopher Nicholas Rescher, who claims that even if extraterrestrials did exist, we would have hardly anything in common with them, because of the unimaginable differences between our world and the alien world. Rescher's polemic focuses on the fact that there is no such thing as a universal blueprint for intelligent life. Different habitats mean different challenges, as well as different solutions to the problems presented to life, even though each environment can be subject to common laws of nature. Rescher illustrates this with an example:

> Admittedly there is only one universe, and its laws, as best we can tell, are everywhere the same. We share the universe with all life forms. However radically we differ in other respects (in particular those relating to environment, to forms of life, and its mode of civilization) we have a common background of cosmic evolution and a common heritage of natural laws. And so if intelligent aliens investigate nature at all, they will investigate the same nature we ourselves do. But the sameness of the object of contemplation does nothing to guarantee the sameness of the

> ideas about it. It is all too familiar a fact that even where human (and thus *homogeneous*) observers are at issue, different constructions are often placed upon "the same" occurrences. Primitive peoples thought the sun a god, and the most sophisticated among the ancient thought it a large mass of fire. We think of it as a large thermonuclear reactor, and heaven only knows how our successors will think of it in 3000 A.D. As the course of human history clearly shows, there need be little uniformity in the conceptions held about one selfsame object by different groups of thinkers.[49]

[49] *Rescher, 1982, p. 90*

Thus, there is no reason why it should be assumed, that there could be any common basis for communication with intelligent extraterrestrials. Nothing allows us to believe, that we can share any sort of alien context—the general background of a life form, encompassing its natural, physical and mental qualities. Particularly when it comes to culture. Roman Jakobson characterises context as the referential function of communication,[50] but does not elaborate on this much. To define what is context in the working model, we need to refer to Ludwig Wittgenstein's remark about a talking lion:

[50] *1960, p. 353*

> If a lion could talk, then we could not understand him. [...] Thus if he shouted "Hi, folks!" at feeding time at the zoo, we would not know how to take his remark, although it is correct English, as we do not share his form of life.[51]

[51] *Heaton & Groves, 2009, p. 165*

Not sharing the same form of life is an impediment which, according to Wittgenstein, disqualifies inter-species communication. Consequently, supposing an "Alienish" speaking human wished to explain the whole concept of sexual reproduction to an alien, e.g. a homogenous sentient ocean—Lem's Solaris—would there be any chance for the human to become understood? Sharing the same context is essential for comprehension—in this particular case,

knowing the structure of multicellular beings is a prerequisite for understanding the purpose and role of sexual reproduction of life on Earth. Therefore, expecting the sentient ocean to grasp the reason why humans must not mate with any of one's close relatives (which is fundamental for understanding terrestrial cultures, religions and taboos) without explaining the context of sexual reproduction is bound to fail.

But context is also a social construct, changing dynamically and defined collectively. Polish avant-garde artist and art theoretician, Władysław Strzemiński, coined the term "consciousness of seeing," by which he referred to the mental abilities of recognising objects, depicted in various ways, and subject to certain features promoted by economic and social circumstances throughout the history of human civilisation.[52] Strzemiński uses the term "realistic," which in his definition describes the level of coherency between the current socio-economical order and the contemporariness of the style of an image. To define and illustrate this concept, he cites Plato, who lived—as Strzemiński proves—between two distinct epochs:

[52] *1958*

> "Is not the bed, that is nearer of further, of the same size? Then should this bed not be drawn in the same size as well? Is drawing of a bed—standing far away—as smaller not just an illusion? Are the painters who draw according to this perspective not just producing illusion, hence lying" (Approximate quotation.) [sic!] [translation MK].[53]

[53] *ibid., pp. 80-81*

Strzemiński claims that Plato represented the old "silhouette-style" seeing, which was then replaced by the new "solid-style", hence he argued against the new seeing. He considered linear perspective——a then avant-garde invention of "solid-style" enthusiasts—as false, unnatural and contradictory to his understanding of realism. Plato's context in this respect was still based in the old "silhouette-style"

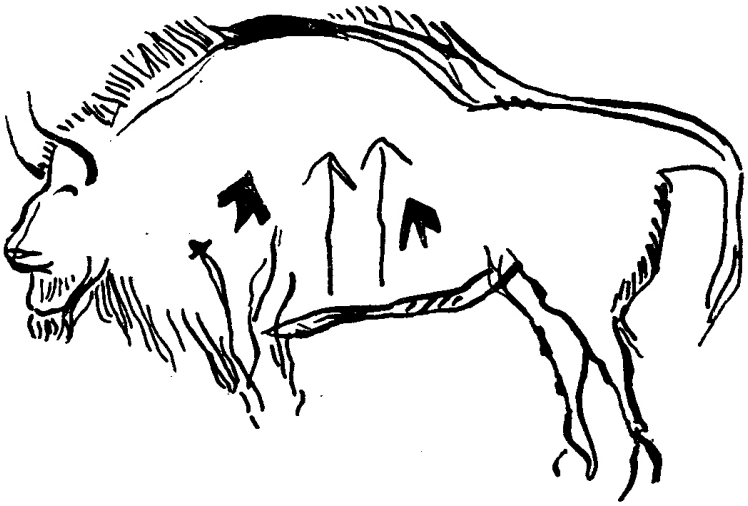


Fig. 4.1—outline-style seeing: lines inside a closed shape [54]

[54] *Strzemiński, 1958, p. 24*

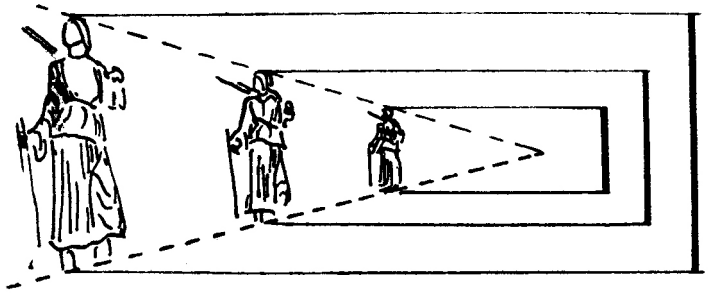


Fig. 4.2—solid-style seeing: linear perspective [55]

[55] *ibid., p. 79*

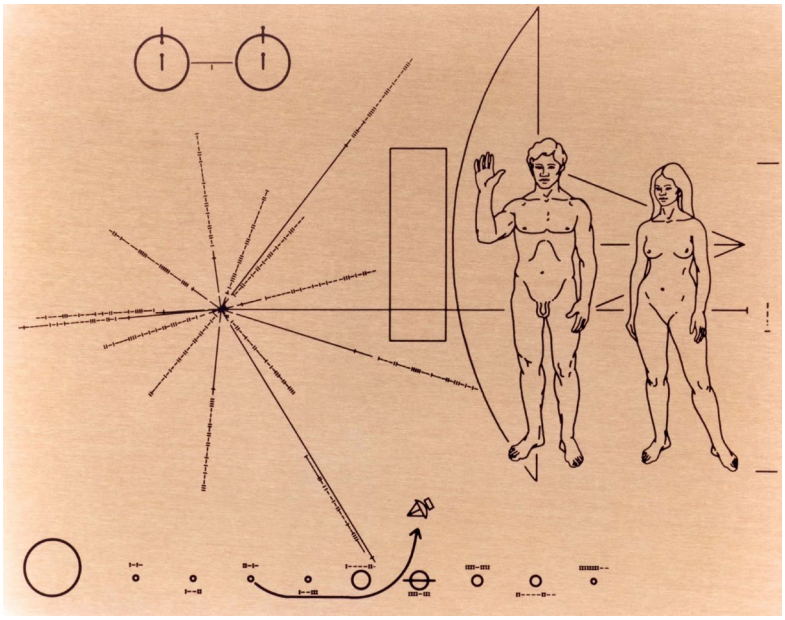


Fig. 4.3—the pioneer plaque: humans in front of pioonier 10 [56]

[56] *Sagan, Sagan & Drake, ca. 1972*

method of depicting depth in the image, constructed by the order of planes. Therefore, he could not read and comprehend contemporary images, in which the illusion of space was built with scaling and positioning of objects. Thus, context is also a time-specific property.

Nowadays, we can comprehend medieval paintings and their role because we know the historical context of the Middle Ages. This is not the case with palaeolithic art, which is still subject to many contradictory interpretations. If we received a message sent from a hypothetical human settlement 10.000 light-years away from Earth, we would probably not understand neither its purpose, iconography nor meaning, just like we cannot fathom the paintings in Lascaux or Altamira. Consequently, intelligent extraterrestrials should not be able to read and comprehend images and diagrams engraved on the metal plaques sent onboard the Pioneer 10 spacecraft in 1972?[57] The plaque is drawn according to a certain convention in art and design, which the extraterrestrials might not necessarily be acquainted with. Linear drawings of a male and a female *Homo Sapiens*[58] are legible to contemporary humans, but provided that the interceptors of Pioneer 10 would prevail on the level of early cave drawings apprehension (Strzemiński's "outline-style" seeing), they could well assume that we are made of several separate body parts (i.e. faces, hair and man's chest drawn as a separate closed shape) and our body surface is home for long worm-like beings (single lines defining knees, abdomens or collarbones). On the other hand—provided that the extraterrestrials have just recently acquired "solid-style" seeing, against which Plato raised so much criticism—they could as well conclude that humans on the plaque are shown in a dramatic foreshortening, standing actually far ahead of Pioneer's outline in the back, and therefore *Homo Sapiens* must certainly be not more than 50 cm tall. This is because Pioneer's drawing of humans standing before the spacecraft follows a convention of representing objects in horizontal projection, which has

[57] *NASA*

[58] *Sagan, Sagan & Drake, ca. 1972*

been developed by terrestrial technicians as a tool for size comparison. The context of the sender and the receiver is therefore key to deciphering, comprehending and also, importantly, interpreting a message.

But context can be manifested in a more straightforward way, and even more dramatically, just as in case of the extraterrestrials shown in Paul Verhoeven's film *Starship Troopers*.[59] In a form of quasi-newsreel, it tells the story of interplanetary war fought between humans and Bugs—large arachnoid creatures colonising Cosmos. Whereas the main plot focuses on war experiences of a group of college friends, the subplot deals with an uneasy comparison of human and alien intelligence. "By human standards they are relatively stupid," observes the college science teacher, "...but their evolution stretches over millions of years. And now they can colonize planets... by hurling their spore into space."[60] From the beginning of the conflict there is no intention for communication whatsoever—the Bugs' only interest lays in the uncompromising expansion of their own species. Alas, human unawareness of the nature of the Bugs leads to heavy losses during the first offensive. "To fight the Bug... we must understand the Bug,"[61] admits Sky Marshal Tahat Meru, and human attitude towards the hostile arachnoid intelligence radically shifts. Military intelligence officer Carl Jenkins investigates into the bug mental and behavioural patterns, which eventually leads to discovering the existence of Brain Bugs—rare immovable worms living deep inside caves that plan strategies for warrior Bugs, facilitate communication with them and control the swarm's behaviour. Finding and subsequently capturing a Brain Bug turns the tide of the war. Humans are later able to learn that the Bugs are the species exhibiting a handbook example of swarm intelligence——a decentralised and self-organising collective, behaviourally similar to the types thriving naturally in large caste populations, e.g. bees or termites. These revelations are the first step to know-

[59] *Starship Troopers, 1999*

[60] *ibid., side A, 7:20–7:35 min.*

[61] *ibid., side B, 9:06–9:11 min.*

ing the enemy, its goals and context. In the final scenes of the film Jenkins actually reads the Brain Bug's mind, eventually proving that comprehension is possible. Interestingly enough, just a scene earlier, we can see hundreds of troopers run disorderly to their Brain Bug POW, call themselves, gather around the confined Bug and behave exactly like a Bug swarm. Thus, direct analogies between human and arachnoid civilisation patterns can be observed: militant and hierarchical organisation of society, little regard to the interests of individuals, superficially chaotic swarm behaviour, irresistible need to conquer and colonise the space. Even though all these striking similarities can help understand the mechanics of an alien race, the human and the arachnoid civilisations are unable to coexist, because both their raison d'être is constant expansion. The TV correspondent summarises it in his very last words: "It's an ugly planet, a Bug planet... a planet hostile to life as we—— Aaaah! Help me!" [62]

[62] *Starship Troopers, 1999, side B, 6:56–7:08 min.*

So again, Hollywood is right!

In contrast to the case of channel and contact, finding a common context is impossible. This is simply because it cannot be modified or changed, as it is inherent to our current place in the cosmos. Nevertheless, in the absence of any tangible evidence showing that developing a platform which mediates different contexts is impossible, it should be regarded conceivable to manage communication between two alien civilisations despite even the most profound differences. The more similar ETI's shape and environment would be to ours, the more accessible it could be to human understanding and vice versa.

CODE

Rosetta Stone — natural laws — Lincos — Arecibo Message — HMV — Independent Thinkers

> And the decree should be written on a stela of hard stone, in sacred writing, document writing, and Greek writing, and it should be set up in the first-class temples, the second-class temples and the third-class temples, next to the statue of the King, living forever.[63]

[63] *Simpson, 1996, pp. 258-271 cited in The British Museum n.d. a*

This is the final sentence of the hieroglyphic inscription on the Rosetta Stone, found in 1799 by Napoleon's army in the Egyptian town of el-Rashid. Until this discovery and a series of ensuing examinations of the Rosetta Stone inscriptions, ancient Egyptian hieroglyphic writing was an unintelligible riddle for the researchers. First, it was approached by Thomas Young, an English physicist, who realised that some hieroglyphs decode the sounds of the royal name of Ptolemy. Thereafter, it was deciphered by a French scholar, Jean-François Champollion, who proved that in fact all hieroglyphs represent sounds of the ancient Egyptian language. Thus, it is largely owing to the Rosetta Stone and the three different writing systems in which the edict had been engraved, i.e.: "hieroglyphic (suitable for a priestly decree), demotic (the native script used for daily purposes), and Greek (the language of the administration)," [64] that the Egyptian hieroglyphs could be compared to other ancient languages and hence—eventually decoded. Interestingly enough, it has been deciphered despite some differences in context, as the code-breakers shared neither the same language with the hieroglyph writers, nor their position in social hierarchy, nor their religion.

[64] *The British Museum, n.d. b*

Nevertheless, they could refer to the very basic and everlasting aspects of human life on Earth, such as subsequence of night and day, rhythm of vegetation or local topography.

Code is an integrate part of language and any form of communication. Historically, most of human languages have been developed naturally, many of them being abandoned or forgotten, with their elements and rules becoming obscure throughout hundreds of years. Investigation into the true meaning of Egyptian hieroglyphs was an investigation into the meaning of code and therefore, it revealed what Roman Jakobson later described as a metalingual layer of language, in his model of communication functions: "Whenever the addresser and/or the addressee need to check up whether they use the same code, speech is focused on the CODE: it performs a METALINGUAL (i.e., glossing) function." [65] Although Jakobson refers mainly to spoken language in his work, the model that he proposes can relate to all forms of communication in general. Thus, CETI should also be regarded in terms of code—its compatibility on both ends of the line, and the metalingual domain of the message. Code—after channel, contact and context—is the last impediment in establishing a working communication, not only with ETI, but with anyone.

[65] *1960, p. 356*

Let us presume, for the purposes of this paper, that we did intercept a message from an extraterrestrial civilisation addressed to the intelligent inhabitants of Earth. In such a situation we would face a much bigger challenge than in the case of Egyptian hieroglyphs, starting with almost no contextual data at all. Young and Champollion—unlike the presumed receivers of an alien signal—were familiar with the environment and most basic facts of ancient Egyptian existence, to which the Rosetta Stone text frequently referred: levels of human kinship, status in social hierarchy, the value of crops, the concept of currency, etc.[66] Contrary to that, in

[66] *Simpson, 1996, pp. 258-271 cited in The British Museum, n.d. a*

an interplanetary discourse humankind would be destitute of the knowledge of the extraterrestrial extra-linguistic context, while at the same time facing potentially anything: either a human-like civilisation described in *First Contact*[67] or a rapacious intelligent swarm depicted in *Starship Troopers*,[68] or a planet-size monocultural entity from *Solaris*.[69] The inability to share context with an extra-terrestrial interlocutor would seriously decrease the chances for developing a bilaterally understandable code. Hence, the idea of utilising the universal background common to all creatures living in our galaxy— —natural laws e.g. of physics, mathematics and logic. And because, as mentioned before:

[67] *Leinster, 1945*

[68] *Starship Troopers, 1999*

[69] *Lem, 1974*

1. Common problems constrain common solutions.
2. ETI civilizations have in common with us the problem of cognitive accommodation to a shared world.
3. Natural science as we know it is our solution to this problem.
4. Therefore, natural science is likely to be ETI's solution, too.[70]

[70] *Casti, 1990, p. 405*

it could have been assumed that such a pan-cosmic background exists. But human language of describing potentialy universal phenomena proved to be not so universal after all...

Lincos—Lingua cosmica designed by Professor Hans Freudenthal and published in 1960—is one such attempt. It is a constructed language based on mathematics and basic logic. Set on foundations that are supposed to be natural and universal, Lincos is aimed at facilitating communication free of any dependance on local reference, as a semiotically autonomous code.

> In the ET case we can rely neither on a known language nor on an extra-linguistic context. All we can do is to speak pure Lincos. The language is to be taught through the language itself, used one-way in an absolutely pure fashion.[71]

[71] *Bassi, 1992*

```
Ha Inq Hb     ?x 4x=10    Ha says to Hb: What is the x such that 4x=10?
Hb Inq Ha     10/4        Hb says to Ha: 10/4.
Ha Inq Hb     Mal         Ha says to Hb: Bad.
Hb Inq Ha     1/4         Hb says to Ha: 1/4.
Ha Inq Hb     Mal         Ha says to Hb: Bad.
Hb Inq Ha     5/2         Hb says to Ha: 5/2.
Ha Inq Hb     Ben         Ha says to Hb: Good.
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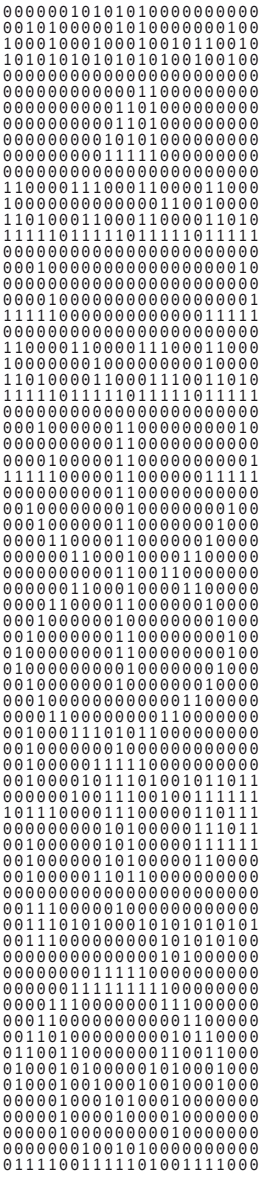
[72] *Bassi, 1992*

FIG. 5.1—LINCOS: SAMPLE OF A CONVERSATION (CHAP. ON BEHAVIOUR) [72]



[73] *University of Utah, n.d.*

FIG. 5.2—ARECIBO MESSAGE: RADIOGLYPH COMPOSED IN BINARY [73]

Lincos is supposed to somehow self-organise itself in the receiver's mind by dint of countless repetition. Freudenthal designed a programme intended to gradually educate the receiver of a Lincos message on Lincos language: first by explaining binary numbers and algebra, then by subsequently introducing more sophisticated concepts, such as punctuation and time, human behaviour or the principles of mechanics. Although Lincos has a written form (consisting of binary numerals and mathematic symbols adapted mainly for human reference) it is predominantly a spoken language, expressed in radio signals of varying wavelength and duration. Unfortunately, Freudenthal did not define Lincos phonetics.

Another form of coding, intended as self-organising and depending on mathematics, was used to create the Arecibo Message, developed by Frank Drake and his team, and sent from the Arecibo radio telescope in Puerto Rico on 16th November 1974.[74] The Arecibo Message was a sequence of 1679 binary pulses. A receiver in the globular cluster M13, towards which the message was sent, was supposed to reorganise the signal from a string into a matrix of 23 columns and 73 rows, which thereby would reveal a pictorial message composed of inactive (0) and active (1) cells. Because 23 and 73 are prime numbers, there are only two possible ways to rearrange 1679 cells in a complete rectangle, and only one layout would produce a meaningful, i.e. symbolic, output.[75] Thus, provided that the extraterrestrials knew the binary system and the properties of prime numbers, and that they adhered to human ideals of completeness and symmetry, they should be able to correctly decode the Arecibo radioglyph.

[74] *Cornell University, 1999*

[75] *University of Utah, n.d.*

Both coding techniques—Lincos and the Arecibo Message—are based on mathematics and the binary numeral system in particular. This feature is noteworthy. Binary notation is the most basic of the comprehensive numeral systems, as it employs only two values. It also supports a straightforward interpretation of quantised data,

and offers a reasonable resistance to noise and data loss. On the other hand, the binary system—like any other numeral system—is a constructed concept, a product of human culture developed over centuries—it is not a natural phenomena. Therefore, is this not too far-fetched to assume binary notation to be as easily apprehensible to the extraterrestrials, as it is to humans?

The distinction between culture-dependant and natural codes is a central theme in Stanisław Lem's *His Master's Voice* philosophical science-fiction novel. Dr Hogarth, who also narrates, explains:

> There exist, speaking in the most general way, two kinds of language known to us. There are ordinary languages, which man makes use of—and the languages not made by man. In such a language organisms speak to organisms. I have in mind the so-called genetic code.[76]

[76] *Lem, 1999, pp. 142-143*

He refers to a genuine characteristic of all "acultural" codes, which contrary to the natural or constructed human languages are defined by the universe's intrinsic properties. A presumed example of such a code is the Master's Voice—a mysterious neutrino emission registered at the Mount Palomar observatory, later believed to being produced by ETI. Hogarth gives his account of a series of attempts to decode the signal, none of which give satisfactory results. Not until exposing samples of various substances to the Master's Voice amplified neutrino emission, did the scientists prove its "acultural" nature. "An 'acultural language' is something more or less like Kant's 'thing-in-itself.' One can fully grasp neither the code nor the thing," continues Dr Hogarth,[77] stressing that human languages used for describing natural phenomena (e.g. the atomic models of deoxyribonucleic acids) can never be as universal, as the "acultural" codes they interpret, because human codes refer to the concepts existing in human culture, and therefore are not semantically

[77] *ibid., p. 143*

autonomous. Hogarth recapitulates:

> A state of complete "acultural" purity in principle cannot be achieved. The idea that, in sending to another civilization an envelope containing models of atoms, it would be possible to eradicate from such a letter all traces of culture—that idea is based on an illusion. The trace can be greatly reduced, but no one, not in the entire Cosmos, is or ever will be able to reduce it to zero.[78]

[78] *Lem, 1999, p. 144*

In the light of the distinction between the two kinds of codes outlined in Lem's *His Master's Voice*, neither Lincos nor the Arecibo Message can be regarded as an "acultural" code. The use of a constructed binary numeral system stands contrary to the idea of employing natural laws as a common context necessary for interpreting code. Hence, Lincos and Arecibo Message remain dependant on human context and cannot be expected to be accessible for ETI.

Lincos and the Arecibo Message have yet another thing in common: both these endeavours export languages forged by humans, i.e. codes bearing reference to the earthling culture. Normally, if one goes to Berlin, one does not teach Berliners to speak one's language—on the contrary, one acquires German beforehand, alternatively relies on the current lingua franca (nowadays English). Why should this practice not be followed in the case of interplanetary intercourse? Freudenthal designed Lincos (Lingua cosmica) as a universal language, yet still expected extraterrestrials to learn the terrestrial context. But what if the case was opposite—if humans could learn cosmic languages and thereby help establish interstellar Esperanto? Sir Patrick Moore addresses this idea in his interviews with individuals, to whom he refer as Independent Thinkers. One of them was Mr Bernard Byron of Romford, England, who claimed to know three cosmic languages: Venusian, Plutonian and Krügerian,

Fig. 5.3—mr bernard byron writing in venusian[79]

[79] *One Pair of Eyes: Patrick Moore, 1969?*

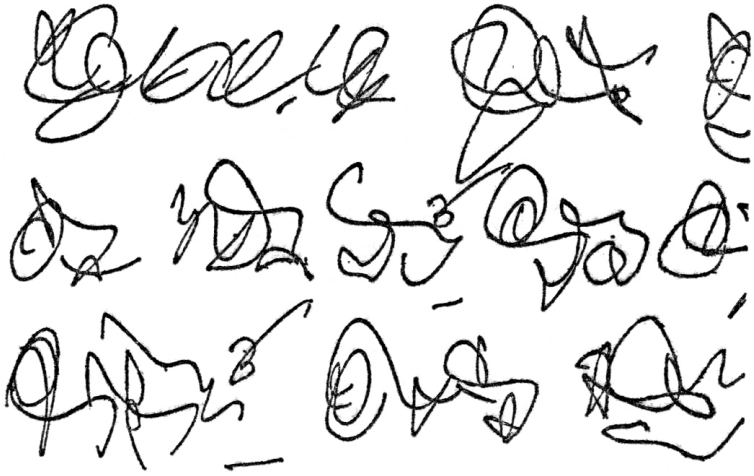


Fig. 5.4—sample of venusian: mr byron's translation of hamlet[80]

[80] *Moore, 1976, p. 149*

which had been "transmitted to him by rays, which means, in effect, by telepathy." [81] Samples of these languages were given by him both in speech and writing, and Moore concluded that Byron "moves in a realm of unknown, which [...] makes it very difficult for us to disprove him." [82] Moore also mentions two other Independent Thinkers: Cedric Allingham, who avowed that he had a close encounter with the extraterrestrials, during which he communicated with them in semaphore, because they did not speak English; and George Adamski, who claimed to have met aliens several times, during which they initially used semaphore, but on a later occasion they decided to employ English.[83] Inspired by these accounts, Moore ponders the question of what language could be employed in the future, when humankind could become involved in an interplanetary intercourse with many intelligent species. It will unlikely be Byron's Krügerian, because Krügerians have two independent lungs and "Krügerian words tend to be strung together, and the result sounds like a stream of running water." [84] On the other hand, Moore accepts a possibility that one day Venusians may become more frequent visitors to Earth, and Venusian language becomes as widely taught in terrestrial schools, as French is today. Eventually, he concludes that "if ever we have a cosmical Common Market [...] we should retain good, old-fashioned English." [85]

[81] *Moore, 1976, p. 148*

[82] *One Pair of Eyes: Patrick Moore, 1969?*

[83] *Moore, 1976, pp. 86-87*

[84] *ibid., p.149*

[85] *ibid., p. 149*

Regardless of whether English language is a feasible candidate for cosmic lingua franca, it is certain that after establishing contact via one channel and finding a way to accord with ETI's context, one of the sides of the prospective dialogue would need to face the problem of breaking the code. Provided that we find the CETI "Rosetta Stone" to decipher ETI's transmission, humankind would be able to get involved in a real cosmic communication. Consequently, those ETIs, which would use a code that is not decipherable and understood, would be excluded from any meaningful intercourse.

Conclusions

Fermi Paradox — Drake equation — N > 1 vs. N = 1 — — Ch · Ct · Cx · Cd — C for CETI

Utilising the same channel, sharing the awareness of contact, coexisting in one common context and employing the same code are the necessary elements for communication to take place in general. This is also the case with communication with ETI. However, CETI's main concern ever since its conception has been connected with a much more general issue—the factual absence of the interlocutor. The lack of any hard evidence for the existence of extraterrestrial civilisations is in direct contradiction to the abundance of the possibilities for life to emerge across the universe. Formulation of this dilemma is credited to Enrico Fermi, after whom it is called the Fermi Paradox.[86]

[86] *Casti, 1990, pp. 340-341*

One of the early experiments, which aimed at resolving the doubts expressed in the Paradox, was Frank Drake's Project Ozma, conducted on April 11, 1960. Drake listened to Tau Ceti and Epsilon Eridani radio emissions at 1420 Mhz waveband, suggested earlier by Morrison and Cocconi. The project, excluding a false alarm, resulted in detecting no extraterrestrial signals. However, it encouraged Drake to encapsulate the credo of SETI in a simple reductionistic formula, which estimates "A number *N*, which is the number of detectable civilizations in our galaxy." [87] It has become known as the Drake equation and marked the start of the scientific discourse on humankind's chances for detecting ETI.

[87] *Drake, 2003*

The Drake equation comprises eight variables, which define the astronomical, physical and social terms for emergence, and detection of ETI at any given time:

[88] *Drake, 2003*

$$N = R \cdot f_p \cdot n_e \cdot f_l \cdot f_i \cdot f_c \cdot L \quad ^{88}$$

[ASTRONOMICAL] [CHEMICAL] [SOCIAL]

Not all of the terms of the equation can be estimated with the same accuracy. For instance, R (the number of stars formed annually in our galaxy) or f_p (the fraction of these stars that are of solar type) are currently best scientifically understood and calculated. Others, such as f_i (the fraction of all lifeforms in our galaxy that develop intelligence) or L (the amount of time emergent civilisations exist and continue being detectable), are still nothing more than an astronomer's lucky guess. As a result, including at least one of the uncertain terms into the equation makes the whole undetermined.

Being a manifesto, rather than a real tool designed to provide us with scientifically viable answers, the Drake equation has triggered a holistic discourse on the number of ETIs in our galaxy. It is outlined by John L. Casti in his *Paradigms Lost*,[89] where he confronts the viewpoint of the ETI enthusiasts with the viewpoint of the ETI sceptics. The supporters (Carl Sagan, Philip Morrison, Frank Drake, et al.) believe there are more communicating civilisations in our galaxy than just the one that emerged on the planet Earth. According to them, the resolution to the Drake equation is beyond any doubt—$N > 1$. Hence, it is important to persist in our search for alien civilisations. On the other hand, ETI antagonists (Nicholas Rescher, Frank Tipler et al.) claim that chances for the emergence of ETI are too small, almost negligible. And even if intelligent life is somewhere out there, beyond our galaxy, it could be so far away, that communication would be pointless or even impossible. Thus, humankind is practically alone in the universe—$N = 1$.

[89] *Casti, 1990, p. 387-413*

At this stage it is important to define what *N* precisely stands for, and what the term "detectable civilizations" indicates, effectively. *N* relates only to the civilisations we can detect by the means provided by our sensory and mental capabilities, and the technology we develop. Therefore, the search for ETI became inevitably biased towards e.g. radio communication, which we had learned to use. If there was a civilisation trying to make contact by utilising a medium not yet "detectable" for human science, we would not include it in the *N* number. Furthermore, if there was another civilisation, which emission we would "detect," but fail to recognise its intelligent and purposeful origin—this would not increase the *N* number either. From this point of view, the equation should be regarded only in terms of the anthropocentric bias, which it directly stems from.

Thereby, the Drake equation is a useful theoretical concept that offers a framework for organising activities surrounding the SETI programme. Its significance lies in identifying and acknowledging the importance of the factors responsible for the emergence of communicating civilisations in our galaxy, rather than being the encouragement for the research into exact values of the equations terms, and the *N* number in particular. But what is the importance of the Drake equation for CETI, which is the main issue here? Although communication stays not in the centre of the equation's focus, Drake takes it seriously into account as genuine evidence for both intelligence and technology. If we detect an organised and modulated radio broadcast (so far we can rely only on this particular part of the electromagnetic spectrum), it should mean beyond any doubt that a communicating civilisation emerged in that particular place in space. However, the Drake equation is insufficient for the purposes which are of interest for CETI researchers. In order to shed new light on the specific aspects of the communicative intercourse with ETI, I suggest to expand on the sixth variable

of the formula—the f_c factor. It stands for this fraction of those intelligent ETIs, "which give rise to a technology which we might detect, or which might communicate—that's what the '*C*' means."[90] Dissected into specific and approachable elements, the f_c could be considered a product of four sub-variables: C_h, C_t, C_x and C_d. Thus, the revised formula would look like this:

[88] *Drake, 2003*

$$N = R \cdot f_p \cdot n_e \cdot f_l \cdot f_i \cdot C_h \cdot C_t \cdot C_x \cdot C_d \cdot L,$$

where:

$$C_h \cdot C_t \cdot C_x \cdot C_d = f_c$$

All four factors have been discussed before in separate chapters. C_h stands for channel and describes a fraction of those communicating ETI, who utilise the same channel of the same characteristics as we do. C_t denotes contact—it indicates those of the channel-sharing ETIs, who are fully aware of our radio broadcasting into space or/and become apparent to us as communicating ETI. C_x is context and is defined by a fraction of those consciously transmitting ETI addressers/addressees, whose context would be understandable for the interlocutor. Finally, C_d denotes code and is a proxy for a fraction of those contextually accessible ETIs, whose code could be decoded and interpreted.

Estimating the value of these four factors is a completely separate challenge. Here, the main purpose is to suggest possible tools, that can prove useful for the CETI exploration and discussion. In a fashion similar to the one, in which the original Drake equation accelerated and structured the discourse on SETI, the suggested model may be of benefit to the CETI community. At this point, trying to find the closest guess either for the f_c factor, or any of the f_c sub-factors appears purposeless—simply because too many variables of the original Drake equation still cannot be calculated within the satisfactory scope. Hence, the f_c factor can be regarded as an

intellectual tool for academical reflection or critical analysis, rather than a scientific formula designed to yield a reliant value output.

Despite all this, one thing is certain—including the suggested $f_c = C_h \cdot C_t \cdot C_x \cdot C_d$ sub-formula into the Drake equation would even more reduce the ultimate value of the N number. It could also bring us even closer to a conclusion, that even though we might not be the only intelligent species in the universe, we are indeed living in solitude.

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List of images

Acknowledgements

I wish to thank:

Ken Hollings,
for the enlightened direction and the encouragment to write;

Jessika Strataki,
for the tireless help to structure my thoughts;

Dotty Kultys,
for the perfectionistic proof-reading;

and
Mela Yerka,
for everything, including patient support and constant inspiration.

Marek Kultys

Appendix 1.1

14

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Czy jesteśmy sami

W KOSMOSIE?

W ubiegłym roku potykałem się na łamach prasy krajowej i radzieckiej z astronomem profesorem Józefem Szkłowskim z Radzieckiej Akademii Nauk. Profesor Szkłowski, który dawniej twierdził, że istnieje wiele cywilizacji, wymienił swój optymistyczny pogląd na mniemanie, że cywilizacja ziemska jest praktycznie jedyna i jeśli już nie we wszechświecie, to w każdym razie w naszej galaktyce czyli w całej Drodze Mlecznej. Polemizowałem z nim podnosząc, że pesymizm jest jeszcze przedwczesny. Jednakże przybór danych, przede wszystkim astrofizycznych, które uzyskaliśmy w ciągu ostatnich lat, a nawet miesięcy, był taki, że poważnie nadwątlił mój uprzedni optymizm. Jeśli nawet nie optymizm co do gęstości występowania cywilizacji, to w każdym razie moje oczekiwania, że sprawa nawiązania kontaktu nie jest beznadziejnie trudna.

Pozwolę sobie w największym skrócie rzecz przedstawić, poczynając od tego jak się ona wylania-ła w szatach naukowych. Nie będę bawił się w opowiadanie prehistorii. Że od zamierzchłych czasów ludzie itd... Nie! Wszystko zaczniemy od późnych lat pięćdziesiątych, kiedy to Cocconi i Morrison ogłosili w piśmie amerykańskim artykuł, w którym mówili, że gdyby cywilizacje kosmiczne istniały, mogłyby porozumiewać się drogą radiową. Niewiele czasu upłynęło i w roku 1960 astronom amerykański Drake w obserwatorium Green Bank w Stanach Zjednoczonych „uruchomił" program OZMA. Nasłuchiwało się wtedy dwie gwiazdy, Tauceti i jakąś drugą. Aparatura i cały projekt kosztowały około miliona dolarów. Jest to bardzo skromna kwota w porównaniu z projektem Cyklop, o którym już od paru lat mówi się w Ameryce. Projekt ten miałby kosztować grubo ponad 29, a niektórzy mówią, że nawet 50 miliardów dolarów. Miliard to 1000 milionów, różnica więc jest istotna. Inwestować oczywiście warto, jeśli ma się rozsądne nadzieje na odbiór jakichkolwiek sygnałów.

10 itd

W 1970 roku odbyła się w Biurakanie pierwsza amerykańsko-radziecka konferencja na temat łączności kosmicznej. Oficjalnie nazywała się Communication Extraterrestria Intelligence – w skrócie CETI. Będę mówił jak to wyglądało niecałych osiem lat temu w Biurakanie i cośmy się w międzyczasie takiego dowiedzieli, co podważyło moje optymistyczne mniemanie, bo jeszcze wtedy można było utrzymywać, że 10^3 a nawet 10^5 cywilizacji, czyli zamieszkałych światów może istnieć w naszej galaktyce. Przeciętna odległość międzycywilizacyjna była w szacunkach stale z roku na rok powiększana, dlatego, że nie odbierano żadnych sygnałów. W programie OZMA nastąpiła kumpa badań zarówno amerykańskich jak i radzieckich, a nawet australijskich. Zebrano tyle materiału, iż można go dziś opracować statystycznie. Badania przeprowadzano w najrozmaitszych wariantach, koncentrując się na poszczególnych układach gwiezdnych, a nawet innych galaktykach poza naszą Drogą Mleczną. Sygnały odbierano w kilkuset różnych częstotliwościach radiowych. Zaciekle dyskutowano. W czasie tych dyskusji uczeni dochodzili do niezbitych przeświadczeń co do tego jakie pasmo częstotliwości będzie najwłaściwszym przenośnikiem sygnałów.

Później przychodzili inni, którzy logicznie wyjaśniali, że nic podobnego i twierdzili, że całkiem inne pasmo będzie najlepsze. Było to trochę tak, jakby ktoś będąc kawalerem i szykując się do korespondencji miłosnej z przyszłą wybranką, wybrał sobie całą masę papierków w najpiękniejszych kolorach, cudowne koperty, dał na nich wydrukować dookoła serduszka itd. A jedyna słaba strona tego przedsięwzięcia byłaby taka, że żadnej wybranki na razie nie ma i nie ma z kim korespondować. Ale wszyscy byli tak absolutnie przekonani, że prędzej czy później w końcu ktoś się zameldaje, że te właśnie sprawy były naczelne. To znaczy kwestionowanie samego istnienia innych uchodziło za niezasadne. Było to oczywiście racjonalne, bo jakby zacząć od tego, że nikogo nie ma, wtedy w ogóle nic nie warto robić. Stąd można powiedzieć, był duży optymizm w tym oczekiwaniu.

Według wiedzy dzisiejszej, która właściwie nie różni się specjalnie od tej, która panowała lat temu osiem, w zakresie planetologicznym i powstawania gwiazd, w mgławicy spiralnej takiej jak nasza, powstają w ramionach, gazowo-pyłowych zgęstki. Zgęstki te z czasem zaczynają się koncentrować. Robią się coraz bardziej podobne do płaskiego placka ze zgrubieniem centralnym, takiego jaki można wywałkować z ciasta na stolnicy. Po jakimś czasie dzięki kondensacji powstają w nim planety, a z centralnego wybrzuszenia powstaje gwiazda centralna. W ten sposób powstają systemy słoneczne. Jest to obraz bardzo przemawiający do umysłu tak długo, dopóki nie zaczyna się badać go matematycznie. Wówczas powstają grupy problemów, z którymi wszyscy mieli kłopoty. Twórcą tego obrazu był Laplace i matematycznie nawet nie usiłował go badać, bo nie miał żadnych danych na warunki graniczne. Zakładamy, że istnieją pewne prawa, które są uniwersalne i powszechnie ważne. Np. prawo zachowania momentu, prawo zachowania energii itd. Wiadomo więc, że gdy mamy wirującą chmurę gazową, to powszechne ciążenie sprawia, że cząsteczki będą ciążyły dośrodkowo. A wirowanie spowoduje właśnie spłaszczenie się w placek. Ale są również siły promieniste i magnetyczne, które przeciwdziałają zbyt silnemu zagęszczeniu się centrum. Po jakimś czasie, kiedy dochodzi do zgęszczenia, temperatura podwyższa się. A podwyższona temperatura oznacza promieniowanie idące odśrodkowo. To promieniowanie powoduje, że cały obłok gazowy staje się elastyczny i przeciwstawia się siłom grawitacyjnym ściskającym go, podobnie jakby reagowała okrągła gąbka plastykowa, gdybyśmy chcieli ją ścisnąć. Im bardziej ściskamy, tym bardziej chce się rozprężyć.

Jak wobec tego mogło dojść do powstania planet? Skądinąd wiadomo, że nie jest to zjawisko nadzwyczajne. Istnieją układy gwiazdowe krotne i prawdopodobnie istnieją też liczne systemy takich galaktyk jak nasza. Czyli, że jakoś natura daje sobie radę. Nie wiedzieliśmy jednak jak to się dzieje i optymiści mówili: skoro to jakoś tam powstaje, czy ważne jest żebyśmy już teraz znali mechanizm szczegółowy? Jeżeli będziemy mówili o planetogenezie, wtedy oczywiście trzeba będzie bardzo dokładnie to zbadać. Ale skoro planetogeneza w naszych rozważaniach jest tylko przesłanką wstępną dalszych rozważań dotyczących już łączności z cywilizacjami, zakładamy optymistycznie, że planet jest huk. I tak się mniej więcej robiło. Tylko potem okazało się, że trudności w sporządzeniu modelu matematycznego systemów planetarnych są olbrzymie. W układach planetarnych zachodzą pewne regularności, np.. prawo Titiusa-Bodego, które polega na tym, że najpierw mamy środkową grupę małych planet, a potem planety olbrzymy. Wszystko wskazuje, iż jakieś prawidłowości działały, ale bardzo dokładnie nie można było ich ustalić. Dopiero parę lat temu zauważono, że miał rację pewien astronom, który przed konferencją biurakańską wysunął hipotezę, której się w naukach przyrodniczych bardzo nie lubi, bo wygląda jakby była sporządzona ad hoc. Powiedział mianowicie, że była sobie gdzieś w odległości paru lat świetlnych gwiazda. A tutaj był taki wirujący placek – mgławica, w której miało powstać słońce planetarne. Nagle ta gwiazda zamieniła się w gwiazdę Nową i wysłała fale udarowe na galaktykę. Gdy dotarły tutaj, nastąpiły rozmaite, bardzo ciekawe i skomplikowane rezonanse. Tak popularnie mówiąc zachowała się względem całego układu jak spychacz w stosunku do rozmaitego śmiecia. Dała takiego kopniaka wszystkiemu, że powstały różne fale i diabli wiedzą co jeszcze. Jednym słowem, powstał system słoneczny, którego bez kopniaka by nie było. Jest to bardzo nielubiana przez przyrodników droga. Zakłada istnienie z boku siły pomocniczej. I teraz jak obliczyć, jak często i w jakiej odległości powstające systemy planetarne dostają takie pchnięcie. Czy ono musi być bardzo specyficznie skierowane, czy nie, żeby powstał układ planetarny, w którym będzie mogło powstać życie? Czy wyliczenie tego jest w ogóle możliwe? Jest to rozmnożenie potwornej ilości bardzo skomplikowanych problemów, na które trudno odpowiedzieć. Jedno jest dzisiaj prawie już pewne. Faktycznie była Nowa! Zostało to wykryte, bo w materiale meteorytowym stwierdzono istnienie pewnych izotopów aluminium, które musiały zostać tam niejako wmrożone. Mniej więcej przypada to na 4 miliardy 700 milionów lat temu. Sam proces formowania się dysku trwał około 100 milionów lat i wtedy właśnie zdarzyła się korzystna okoliczność z Nową, która dała pchnięcie. Zaraz oczywiście można sobie pomyśleć, że gdyby gwiazda Nowa trochę bliżej nas powstała, ale już w trakcie istnienia życia, które byłoby wysoko rozwinięte, to oczywiście skutki byłyby wręcz odwrotne. Dzisiaj zresztą sądzi się, że od czasu do czasu (w interwałach astronomicznie dużych) bywały takie przejścia naszego systemu planetarnego, łącznie z kawałkiem rękawa spiralnego, w którym siedzimy. Przechodząc koło gwiazd, które w tym właśnie momencie miały ochotę eksplodować jak Nowe lub Super Nowe, Ziemia otrzymywała kolosalne ilości promieniowania bardzo twardego.

Dosyć nagminnie powtarza się, to co profesor Szkłowski powiedział przed 17 czy 18 laty, że zagłada dinozaurów była w dużej mierze spowodowana właśnie tym, iż Ziemia dostała wtedy potężną dawkę bardzo twardego promieniowania kosmicznego przechodząc koło gwiazdy Nowej. Nie wiemy czy będzie można kiedykolwiek to sprawdzić. Obecnie ustalenie tego jest na granicy niemożliwości.

W roku 1970 znane już były prace amerykańskiego astronoma Dole'a, który pierwszy zaczął „bawić się" w modelowanie matematyczne powstawania planet. Posługiwał się przy tym odpowiednio zaprogramowanym komputerem. Okazało się, iż przy losowym rozłożeniu materiałów w obłoku pierwotnym, rzeczywiście te sympatyczne planety chcą się w ten sposób układać do Słońca, że najpierw powstają małe planety, potem większe i znowu mniejsze. Przyczyną zjawiska jest segregacja materiału. Lżejszy leci dalej, a cięższy zostaje bliżej. Mówię oczywiście w potwornym uproszczeniu i każdy szanujący się profesor astronomii o wysokim ciśnieniu krwi, mógłby dostać apopleksji słysząc mnie.

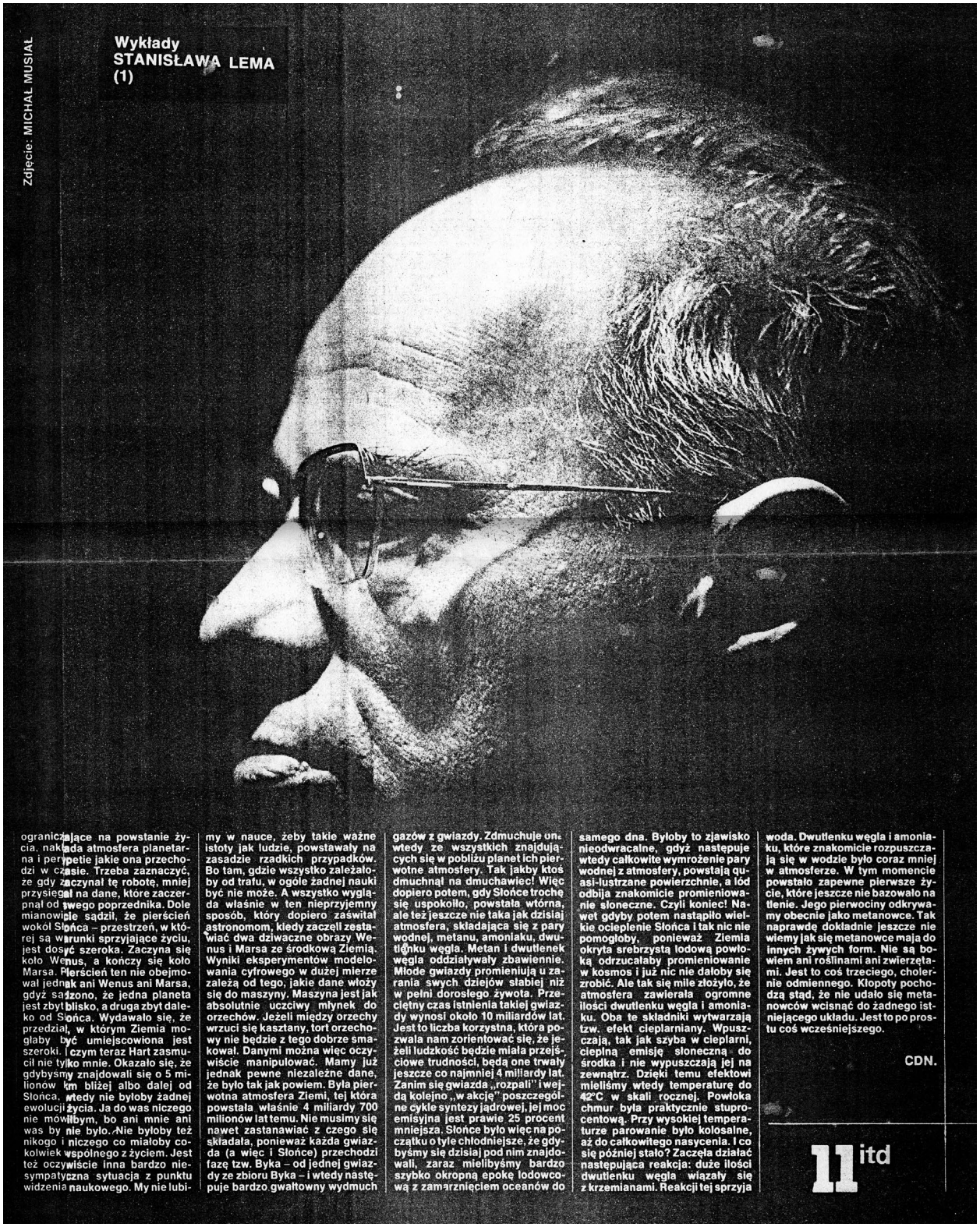
Początkowo sądzono, że to czy planety są dalej czy bliżej od swojego słońca, nie ma większego znaczenia. W latach pięćdziesiątych, kiedy astronomia była rozwinięta, optymistycznie przedstawiano taki obraz: na Merkurym, jako najbliższej Słońcu planecie, życie powstać nie mogło. Tam temperatura jest taka, że po słonecznej stronie ołów może się roztapiać od promieniowania. Wenus prawdopodobnie porastają tropikalne dżungle. Są efekty cieplarniane, wywołane dużą ilością dwutlenku węgla w atmosferze, czyli życie niewątpliwie istnieje. Na Ziemi z grubsza wiemy jak wszystko wygląda. A Mars – zimno przykro i do domu daleko, ale życie możliwe, bo wskazują na to kanały. Później zaczęło się badanie systemu słonecznego sondami. Wtedy uczonych spotkały dwie niespodzianki. Jedna olbrzymia i wstrząsająca. Okazało się, że Wenus jest rodzajem piekła, gdzie padają deszcze z kwasu siarkowego, temperatura przeciętna wynosi 500° a ciśnienie przekracza 90 atmosfer i o życiu nie ma mowy. Druga niespodzianka też była przykra. Na Marsie nie jest wcale tak strasznie zimno jak sądzono. Białe czapy biegunowe wcale nie są utworzone z dwutlenku węgla, jak sam sądziłem i takie głupstwa w książkach wypisywałem, tylko po prostu całkiem zwyczajnie z zamarzniętej wody. Jednym słowem, Mars znajduje się w permanentnej epoce lodowcowej, tylko, że lodu nie jest tam tak dużo, jakby było w podobnych warunkach na Ziemi.

– W 1977 roku uczony Hart zaczął prowadzić badania, uściślając program pierwotny, który rozpoczął Dole, polegający na komputerowym modelowaniu warunków powstania życia, przy czym ten starszy człowiek robił to w jednym z ośrodków NASA. Interesował się głównie tym, jakie warunki

Appendix 1.2

14

Lem, S., 1978.
Czy jesteśmy sami w kosmosie? (Are We Alone in Space?).
itd — Tygodnik Studencki, 944-945 (52-53), p. 11.



Wykłady
STANISŁAWA LEMA
(1)

Zdjęcie: MICHAŁ MUSIAŁ

ograniczające na powstanie życia, nakłada atmosfera planetarna i perypetie jakie ona przechodzi w czasie. Trzeba zaznaczyć, że gdy zaczynał tę robotę, mniej przysięgał na dane, które zaczerpnął od swego poprzednika. Dolemianowicie sądził, że pierścień wokół Słońca – przestrzeń, w której są warunki sprzyjające życiu, jest dosyć szeroka. Zaczyna się koło Wenus, a kończy się koło Marsa. Pierścień ten nie obejmował jednak ani Wenus ani Marsa, gdyż sądzono, że jedna planeta jest zbyt blisko, a druga zbyt daleko od Słońca. Wydawało się, że przedział, w którym Ziemia mogłaby być umiejscowiona jest szeroki. I czym teraz Hart zasmucił nie tylko mnie. Okazało się, że gdybyśmy znajdowali się o 5 milionów km bliżej albo dalej od Słońca, wtedy nie byłoby żadnej ewolucji życia. Ja do was niczego nie mówiłbym, bo ani mnie ani was by nie było. Nie byłoby też nikogo i niczego co miałoby cokolwiek wspólnego z życiem. Jest też oczywiście inna bardzo niesympatyczna sytuacja z punktu widzenia naukowego. My nie lubimy w nauce, żeby takie ważne istoty jak ludzie, powstawały na zasadzie rzadkich przypadków. Bo tam, gdzie wszystko zależałoby od trafu, w ogóle żadnej nauki być nie może. A wszystko wygląda właśnie w ten nieprzyjemny sposób, który dopiero zaświtał astronomom, kiedy zaczęli zestawiać dwa dziwaczne obrazy Wenus i Marsa ze środkową Ziemią. Wyniki eksperymentów modelowania cyfrowego w dużej mierze zależą od tego, jakie dane włoży się do maszyny. Maszyna jest jak absolutnie uczciwy młynek do orzechów. Jeżeli między orzechy wrzuci się kasztany, tort orzechowy nie będzie z tego dobrze smakował. Danymi można więc oczywiście manipulować. Mamy już jednak pewne niezależne dane, że było tak jak powiem. Była pierwotna atmosfera Ziemi, tej która powstała właśnie 4 miliardy 700 milionów lat temu. Nie musimy się nawet zastanawiać z czego się składała, ponieważ każda gwiazda (a więc i Słońce) przechodzi fazę tzw. Byka – od jednej gwiazdy ze zbioru Byka – i wtedy następuje bardzo gwałtowny wydmuch gazów z gwiazdy. Zdmuchuje on wtedy ze wszystkich znajdujących się w pobliżu planet ich pierwotne atmosfery. Tak jakby ktoś dmuchnął na dmuchawiec! Więc dopiero potem, gdy Słońce trochę się uspokoiło, powstała wtórna, ale też jeszcze nie taka jak dzisiaj atmosfera, składająca się z pary wodnej, metanu, amoniaku, dwutlenku węgla. Metan i dwutlenek węgla oddziaływały zbawiennie. Młode gwiazdy promieniują u zarania swych dziejów słabiej niż w pełni dorosłego żywota. Przeciętny czas istnienia takiej gwiazdy wynosi około 10 miliardów lat. Jest to liczba korzystna, która pozwala nam zorientować się, że jeżeli ludzkość będzie miała przejściowe trudności, będą one trwały jeszcze co najmniej 4 miliardy lat. Zanim się gwiazda „rozpali" i wejdą kolejno „w akcję" poszczególne cykle syntezy jądrowej, jej moc emisyjna jest prawie 25 procent mniejsza. Słońce było więc na początku o tyle chłodniejsze, że gdybyśmy się dzisiaj pod nim znajdowali, zaraz mielibyśmy bardzo szybko okropną epokę lodowcową z zamarznięciem oceanów do samego dna. Byłoby to zjawisko nieodwracalne, gdyż następuje wtedy całkowite wymrożenie pary wodnej z atmosfery, powstają quasi-lustrzane powierzchnie, a lód odbija znakomicie promieniowanie słoneczne. Czyli koniec! Nawet gdyby potem nastąpiło wielkie ocieplenie Słońca i tak nic nie pomogłoby, ponieważ Ziemia okryta srebrzystą lodową powłoką odrzucałaby promieniowanie w kosmos i już nic nie dałoby się zrobić. Ale tak się miło złożyło, że atmosfera zawierała ogromne ilości dwutlenku węgla i amoniaku. Oba te składniki wytwarzają tzw. efekt cieplarniany. Wpuszczają, tak jak szyba w cieplarni, cieplną emisję słoneczną do środka i nie wypuszczają jej na zewnątrz. Dzięki temu efektowi mieliśmy wtedy temperaturę do 42°C w skali rocznej. Powłoka chmur była praktycznie stuprocentową. Przy wysokiej temperaturze parowanie było kolosalne, aż do całkowitego nasycenia. I co się później stało? Zaczęła działać następująca reakcja: duże ilości dwutlenku węgla wiązały się z krzemianami. Reakcji tej sprzyja woda. Dwutlenku węgla i amoniaku, które znakomicie rozpuszczają się w wodzie było coraz mniej w atmosferze. W tym momencie powstało zapewne pierwsze życie, które jeszcze nie bazowało na tlenie. Jego pierwociny odkrywamy obecnie jako metanowce. Tak naprawdę dokładnie jeszcze nie wiemy jak się metanowce mają do innych żywych form. Nie są bowiem ani roślinami ani zwierzętami. Jest to coś trzeciego, cholernie odmiennego. Kłopoty pochodzą stąd, że nie udało się metanowców wcisnąć do żadnego istniejącego układu. Jest to po prostu coś wcześniejszego.

CDN.

11 itd

Appendix 2

11–20

Shannon, C.E., 1948.
A Mathematical Theory of Communication.
The Bell System Technical Journal,
Vol. 27 (July, October), p. 381

several variables—in color television the message consists of three functions $f(x, y, t)$, $g(x, y, t)$, $h(x, y, t)$ defined in a three-dimensional continuum—we may also think of these three functions as components of a vector field defined in the region—similarly, several black and white television sources would produce "messages" consisting of a number of functions of three variables; (f) Various combinations also occur, for example in television with an associated audio channel.

2. A *transmitter* which operates on the message in some way to produce a signal suitable for transmission over the channel. In telephony this operation consists merely of changing sound pressure into a proportional electrical current. In telegraphy we have an encoding operation which produces a sequence of dots, dashes and spaces on the channel corresponding to the message. In a multiplex PCM system the different speech functions must be sampled, compressed, quantized and encoded, and finally interleaved

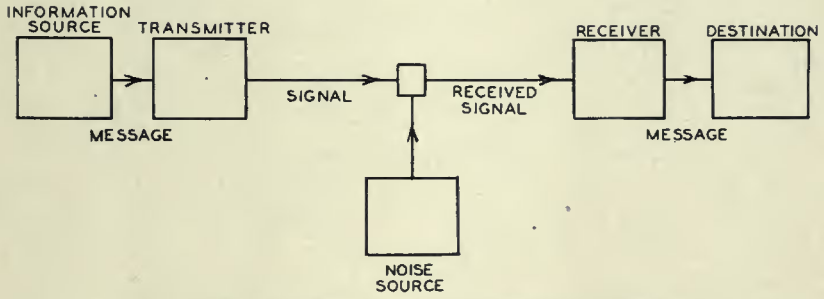


Fig. 1—Schematic diagram of a general communication system.

properly to construct the signal. Vocoder systems, television, and frequency modulation are other examples of complex operations applied to the message to obtain the signal.

3. The *channel* is merely the medium used to transmit the signal from transmitter to receiver. It may be a pair of wires, a coaxial cable, a band of radio frequencies, a beam of light, etc.

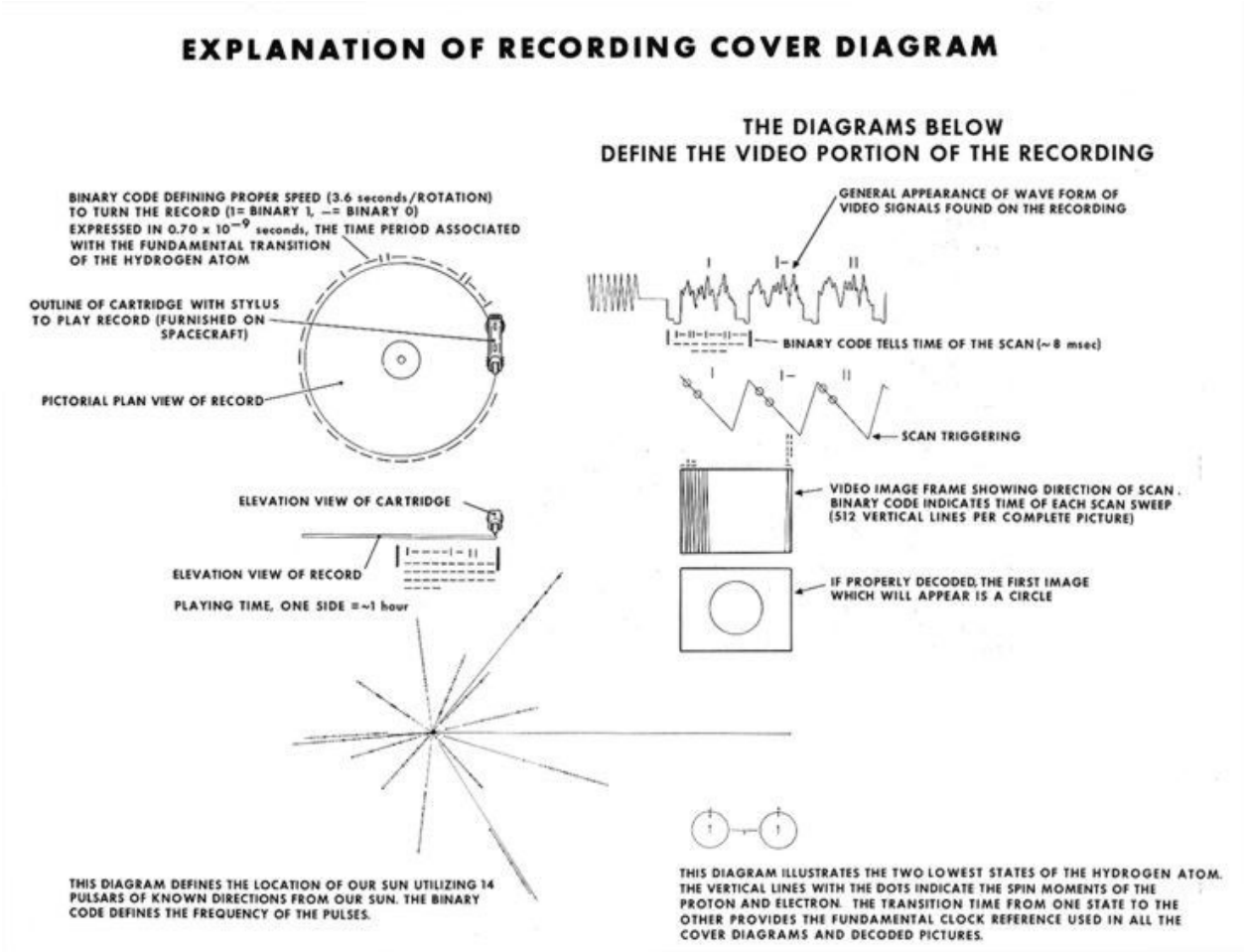
4. The *receiver* ordinarily performs the inverse operation of that done by the transmitter, reconstructing the message from the signal.

5. The *destination* is the person (or thing) for whom the message is intended.

We wish to consider certain general problems involving communication systems. To do this it is first necessary to represent the various elements involved as mathematical entities, suitably idealized from their physical counterparts. We may roughly classify communication systems into three main categories: discrete, continuous and mixed. By a discrete system we will mean one in which both the message and the signal are a sequence of

Appendix 3

24 JPL: Jet Propulsion Laboratory, 2010c.
Voyager – Golden Record: Explanation of Recording Cover Diagram.
Available at:
http://voyager.jpl.nasa.gov/spacecraft/images/VoyagerCover.jpg_2big.gif



Appendix 4

Kultys, M., 2012.
Lingua Extraterrestris—visual abstract;
Astrobiology Science Conference; 16-20 April 2012; Atlanta, GA, USA;