

The Uniqueness Hypothesis



The Inanimate Universe and its
Consequences for Mankind

Scientific Fundamentals of a
Cosmic Civil Religion

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Space – The final frontier! Stars pass by us against the blackness of outer space and a sonorous off-screen voice intones mankind's future role in the universe. This is how *Starship Enterprise* has set out since 1966, taking us on new expeditions through the galaxy, continually in search of new forms of life. Today well over a half of all people believe in the existence of extraterrestrial life. Films such as *Star Wars*, *Alien*, *Independence Day*, *Mission to Mars* and *War of the Worlds* have firmly implanted aliens in our imagination. If the universe of the popular science fiction culture is characterised by any one thing, then it is overpopulation.

For many scientists the universe is also a vast house of life where it is only a question of time before we meet our neighbours. For them, the notion that extraterrestrial life exists is postulated on the immense number of stars that could possibly be accompanied by planetary systems. It is estimated that there are 100 billion galaxies in the universe whose sizes range from dwarf galaxies with a few hundred thousand stars to giants such as the magnificent Sombrero galaxy, home to 800 billion stars. In 1960 the astronomer Frank Drake formulated an equation which remained uncontested for many years, according to which there must be between one hundred and one million planets with a highly developed technical civilisation in the Milky Way alone.

The fine tuning of the universe has also proved particularly convincing to scientists. The most important physical constants in our cosmos are so precisely tailored to the emergence of stable atoms and planetary orbits as well as the formation of galaxies that a certain hypothesis gained credibility: All this has been arranged in a planned manner for the purpose of bringing forth life. This is the core of the anthropic

principle. Life is declared to be a fundamental feature of the cosmos and its manifestations are sought in all areas of the universe.

I. The Uniqueness Hypothesis

However on the basis of the research results of the last ten years the situation has changed significantly. Evidence is mounting that the existence of extraterrestrial life is considerably less likely than previously assumed. In their 2001 book *Rare Earth* the astronomer Donald Brownlee and the geologist Peter Ward gathered together for the first time all those arguments that spoke *against* the existence of extraterrestrial life. Since then the run of bad news *for* the possible existence of extraterrestrial neighbours has continued unabated. The formation of planets for example is far less common than previously assumed. Observations of the 1500 light year distant Orion Nebula have shown that the majority of protoplanetary discs of dust and gas, so called proplyds that form within the orbit of newborn stars, are as a rule, burnt up, swallowed or broken down and blown into space by the solar wind. Nine out of ten protoplanets don't appear to survive this phase, being unable to form a stable compact mass. It is a race against time, or the attempt to "build a skyscraper within the calm at the eye of a tornado", as *Science Magazine* described it. This would appear to be confirmed by the fact that only 5% of all nearby stars have proven to have planets at a close enough orbit. This is significantly less than astronomers had expected. In addition, around half of all celestial bodies belong to double star systems, making planet formation and stable orbits even less likely.

The roundabout 200 exoplanets discovered to date are exclusively gas giants such as Jupiter or infernos such as Mercury. They traverse extremely eccentric elliptical orbits around their central star, orbits which have nothing in common with the virtually circular orbits of the planets around our sun. This means that these exoplanets are either too near or too far from their sun in order for life to develop. In addition, strong tidal forces are exerted on the planets as they pass close to the star. They are kneaded and heated by the gravitational force and are

subject, if they possess a solid surface and a suitable chemical composition, to extreme volcanic activity. It is not just the earth but the regular form of our solar system itself which is special, with the virtually circular orbits of its planets, in particular that of the earth, proving so conducive to the formation of life.

However for organic, carbon based life there are a series of further complex preconditions. Water in a liquid state is just as important as the decisive protective mechanism that allows for the initial formation of an atmosphere conducive to life: a magnetic field. Molecular compounds on a carbon basis are instable and are broken down by the high energy cosmic radiation composed of particles with extremely high velocities such as protons and heavy atomic nuclei as well as hard gamma radiation. In order for a rocky planet as small as the earth to produce a magnetic field of sufficient strength it requires a large, liquid iron core that functions like a dynamo, generating a magnetic field that is capable of deflecting the stream of cosmic particles. It has become clear that there are in fact whole galaxies which are completely devoid of such heavy elements as iron. A number of scientists go even further, considering a relatively large satellite such as our moon stabilizing the orbit around the sun, and even plate tectonics as found on our earth, generating separate continents and islands that have produced the necessary diversity of life, as indispensable for the formation and the spreading of biological life. Plate tectonics is also required for the permanent supply of fresh silicates that can bind acids and acidic gases in the atmosphere of a young planet.

Consequently, nothing today is able to support the idea that the universe is fertile out to its very remotest corners and that the explosive power of life can barely be contained. The best proof of this, surprisingly enough, is to be found right before our eyes. To this day we puzzle over the origin of organic life on earth, an event, a fundamental process, that doesn't appear to have repeated itself as one would actually expect. If, back then, organic life emerged from dead matter, why doesn't this take place anymore? Why isn't the initial ignition of life being continually repeated, why can't it be continually

observed across the entire planet, above all considering the unique diversity of possible forms of life? Why hasn't it been possible to at least simulate primary biogenesis? In a larger context we should ask ourselves why the other conceivable forms of life on a mineral or metal basis, which science fiction authors – supported by serious scientists – have described extensively, are not to be found on earth, especially considering the abundance of necessary raw materials? We don't even know whether organic life was formed in the upper layers of the biosphere, supplied with energy from the sun, and from there sunk into the lightless depths of the seas and even penetrating kilometres below the sea bed. To all intents and purposes it could have occurred in a reverse process. We are impressed by the so called *extremophiles* because we look at them as testimonies for the robustness of life itself. But our admiration for them makes us blind for the fact that all biological life has only one origin, and this origin is not a fountain of ever pouring new forms of life, no, it was in the opposite a unique event that has not been reproduced since about 3.8 billion years ago. In other words, life in its magnificent diversity and richness is after all only ONE, it could even be considered as the history of a single organism.

Fact is that the origin of this one carbon based life form on our planet remains unexplained to this day – and is likely to remain so for ever. Maybe only because the origins of life changed the environment such as life could never originate again. However, the assumption that there is extraterrestrial life, regardless of how clearly we can imagine it, remains completely unsubstantiated. The search for intelligent life in space has proven unsuccessful to date. Whether with radio waves, X-rays or laser flashes the answer has always been the same: no connection under this number. Even on Mars we have failed to find one single bacterium or even the remains of a single microbe. The existence of Methane, which on earth is exclusively produced by bacteria, is no longer admissible evidence in support of the thesis that there was ever life on the red planet or on Saturn's moon Titan – where this gas was first discovered in January 2005 by the Cassini mission.

There is a second, abiotic route to the production of Methane as has been recently demonstrated by the researchers Mukul Sharma and Chris Oze at the University of Dartmouth. Thus the latest advances in the fields of astronomy, astrochemistry, astrobiology and astrophysics point to a conclusion that initially appears shocking:

Life on earth is unique within an otherwise lifeless universe.

The French philosopher and mathematician Blaise Pascal (*1623, †1662) has described, in the course of similar conjectures in his *Pensées*, how it feels: „The eternal silence of this infinite space makes me shudder“. However this *Pascalian horror* could prove to be a therapy for the mankind of the 21st century, a salutary shock. For the assumption of extraterrestrial life functions like a cheap substitute for religion and bad metaphysics. These speculations about virtual, parallel or other such complex manifestations of life that we are supposedly unable to perceive as a consequence of our three or four dimensionality or our lack of electromagnetic senses, are witnesses to a stalled process of enlightenment. Behind all these unsubstantiated claims rests something far removed from an inquisitive spirit of exploration. It is an especially pure form of that fear of the recognition that we are alone in our otherwise dead universe. Our fantasy produces living beings of all types in order to make the universe less inhospitable – for even the most terrifying *Borg*, *Species*, *Alien* or other such progeny of our space nightmares are to be preferred to the contemplation of an ice cold endless nothing whose nocturnal face is composed solely of starlight, glinting at us through the veil of the past. The sceptical-religious bearing of a Blaise Pascal is in this respect both more realistic and fruitful.

II. The Carrier of Life

If one accepts the uniqueness hypothesis then it is a small step to a further supposition that may at first appear presumptuous. We have, with an eye to the epidemic violence, the wars, the cowardly homicides and the destruction of both civilization and nature, grown accustomed to a certain disdain in respect of our own human species. According to

a widespread conviction the human race is actually heading towards its inevitable downfall – it is too stupid to recognise its role and its responsibilities. Consequently the following axiom sounds like a provocation to modern ears:

Mankind is the highest and most intelligent form of life in the universe.

If one assumes that mankind as a result of its technical civilization has established itself as the only life form in the universe capable of making the interplanetary, and in short, interstellar leap, and that the earth is the only planet in the universe on which there is any life at all, what follows as a result of these postulates?

Humanity has the duty to carry the miracle of life out into the universe.

Whether it is the transformation of Mars into an inhabitable planet by means of terraforming or the sending of robot manned satellites with DNA, microbes and seeds to neighbouring solar systems: we must extend the horizon of life! That is a task far greater than securing the immediate survival of our own species. This is a task demanding a truly godlike magnanimity from us mortal beings, providing us with the opportunity to transcend ourselves.

Mankind is the carrier of life.

Maybe in future our whole grandeur will lie in this. Mankind could be remembered for all times as the life form that provided life with its only chance and was responsible for disseminating it throughout the universe. In millions or billions of years from now mankind will be remembered as the species that first carried the seed of life from this fertile planet earth out into the burning wilderness and the freezing deserts of space. Maybe this is our highest and most important task as mankind. Perhaps beings of which we have no conception today will, in the distant future, look back at us with fascination and gratitude as *their* extrasolar or extragalactic creator, although we were only carriers.

III. Overview Effect

Within manned space travel there is a phenomena that strengthens the consciousness of the uniqueness of life in a highly concrete form. Frank White has called it the *Overview Effect*. In his book of the same name he describes how, as a result of their stay in space, astronauts' understanding of their own existence, the existence of mankind and the living nature on their planet, is fundamentally transformed. Astronauts are recruited according to a highly rational and technically oriented profile. To date they have needed to be healthy, skilled and highly reliable engineers and ideally fighter pilots. Spirituality or religiosity can't be considered a part of their mental repertoire. However, when they return from their space flights they are different people. They have seen the earth and space from a perspective that has transformed their psyche. The sight of the blue planet from the lunar orbit as it floats before the backdrop of a deep black, star encrusted universe extending in all directions with neither up nor down, appears to generate an overwhelming, immediately sensuous feeling for the infinite even in the most sober of minds – a feeling for the vulnerability and the dangers that exist for this miracle of the universe. White is convinced that the generalisation of this perspective will be the next step in the evolution of human consciousness, extending its influence to everything else, our earthly politicians, religions, social relations, economic forms and sciences. That is why he appeals for an expansion of manned space flight in order for it to become the motor of world reform, not as a result of its discoveries alone, but far more due to the new vision of the earth and life it provides. The German futurologist Matthias Horx also presented us before the millennium's close with a *bashful and belated plea for space travel*. His argument: "Pictures. Pictures of the blue planet. Pictures from *out there*... I would argue that these pictures possess a far greater 'historical power' than we have previously realised... Quasi from the background of our perception, these pictures from space have facilitated a fundamental *change in perspective*, if you like: an expansion of consciousness." Horx goes so far as to suggest that without these pictures there would

never have been an ecological movement. He is at pains to defend manned flight, which in terms of industry is unlikely to generate any benefits or gains. However it is precisely in this encounter between man and space that he sees the potential for a secular, enlightened myth, a myth needed by a global civilization breaking down all barriers in a continual process of exploration.

And it is precisely this liberating effect that is contained in the idea that life needs mankind, that mankind is not the goal but the carrier of creation, that it is mankind who must nurture the delicate plant of life and carry it out to the stars.

IV. Refutation of the Anthropic Principle

The uniqueness hypothesis collides head on with the *anthropic principle* mentioned at the start, a term first coined by the cosmologist Brandon Carter in 1973 on the occasion of the 500th birthday of Copernicus. In its *weak* form it states that there must be at least some regions in the universe in which life on a carbon basis is possible, which applied to man means that our position in the universe must be a privileged one in order for us to be able to observe this. In its *strong* version the anthropic principle postulates that the universe had to be created as it is in order for an intelligent being to arise to observe it. The anthropic principle has even proved acceptable to a large number of physicists and astronomers as it provides an incredibly *fine adjustment* of the universe. The slightest divergence from the value of the known natural constants would produce a completely different universe. In none of the alternative universes would life be possible. Either the galaxies wouldn't have formed and matter following the big bang would immediately disappear into black holes, the formation of massive planets in stable orbits around a sun would be impossible or electrons would collapse into the nucleus. The structure of the universe known to us is tuned with an amazing precision to the formation of continuously stable concentrations of matter such as stars, planets and galaxies. Thus the notion that life in general and mankind in particular

is the meaning and goal of this cosmic process proves extremely seductive.

I am convinced that the anthropic principle is incorrect. The existence of life is not, under any circumstances a necessary consequence of the physical order of the universe. It is not even possible to explain its emergence as a result of chance. This thesis was already proposed by the biochemist Jacques Monod in 1970 in his legendary book *Chance and Necessity*. However the category of chance does not do justice to the unique character of an event that has only occurred once in the entire history of the universe. And this is exactly what the uniqueness hypothesis claims. A term that has been previously reserved for religion would seem more appropriate at this point: Life is a *miracle*, in fact the only miracle of nature. Earth is the only place where dead cosmic matter has succeeded in crossing the threshold of life, where the universe has brought forth a variety of different organs of sight and a spirit with which it is capable of observing itself and in places even understanding itself. That at least is a thesis that can be examined and refuted at any time. In contrast the anthropic principle cannot be put to the test and in principle cannot be refuted. It is therefore, as we have learnt from the epistemologist Sir Karl Popper, unusable as a scientific hypothesis.

Furthermore, the content of the anthropic principle is unsatisfactory, it is completely incapable of explaining a number of features of life, whether it be the impenetrable character of the transition from inorganic to organic matter and our inability to reproduce this process, or life's astronomical rarity. Quite the opposite, the anthropic principle would seem to suggest that life should flourish throughout the entire universe, at least in the proximity of our galaxy which is subject to the same physical laws. In contrast the uniqueness hypothesis declares the existence of life to be a phenomenon that has only occurred one single time in the history of the universe – and will never occur again. *Maybe* the universe with its physical laws was prepared for the emergence of life, however this is *definitely not* the case with the universe in its physical form. Life appears to be the great surprise of the universe.

This assertion goes much further than the argumentation of Ward and Brownlee in *Rare Earth* where the two authors only exclude the possibility of complex animal life forms on other planets, maintaining that the existence of extraterrestrial micro-organisms is likelihood. As soon as we receive signals from intelligent life from outer space or find mere bacteria fossils on Mars or comets (without terrestrial DNA, of course), then the uniqueness hypothesis has failed. Until then it provides us with the best explanation of the available scientific observations. Above all it provides a better explanation than any other hypothesis of why the primary biogenesis can no longer be observed – although all the physical and biological preconditions exist *somewhere* on earth today exactly as they did four billion years ago. The uniqueness hypothesis doesn't just assert the uniqueness of life on earth but the uniqueness of the emergence of life itself, an event that will never occur again. This act of creation was absolutely unique and the universe will not receive a second chance of life. The grandeur, beauty and rarity of this event indicate how mankind is unlikely to be the purpose and goal of this cosmic drama, as the romantic anthropic principle would suggest. However mankind could play an important role in continuing this unique creation of life.

V. Mankind as the Shepherd of Life

The German philosopher and National Socialist Martin Heidegger considered the essence of technology to be the fateful result of occidental subjectivity. He considered subjectivity and technology to be such dangerous enemies of *Being*, supposedly fallen into obscurity since early antiquity, that only National Socialism appeared potent enough to counteract the essence of technology on a planetary scale. Heidegger continued to formulate these ideas even after the fall of the Third Reich. As the Nazis were unable to meet his expectations in this conflict, Heidegger, in his so called *Humanismusbrief* from 1947, devised a new agent for the ontological final battle against technology: Man. The real humanism, proclaimed Heidegger, is to be found where man acts as the *shepherd of Being*: “In the essential grace of the

shepherd, whose honour lies therein, he is called by Being itself into the essence of its truth... *true humanity holds good, in the service of the truth of Being.*” This pastoral idyll attempts to disguise the reactionary motif at its heart, a motif fundamentally hostile to progress, to modernity and, yes, in its most general formulation even to time itself. The truth of Being as proclaimed by Heidegger is only to be found in the distant, profoundly transfigured past, as man and the gods sat together around the hearth. The dream presiding in its midst is concerned with freedom from time, with timelessness in the form of an eternal antiquity. However it appears that even Heidegger may have suspected that the fires of early antiquity had been extinguished for ever when he said in a famous *Spiegel* interview in 1976, shortly before his death: “Only a god can save us.” His entire philosophy can be seen as the rear guard action of a metaphysical warlord who categorically refused to admit that he may have been in error. However we may be able to learn from his mistakes. For example, it is not necessary and not even plausible to denounce the essence of technology, which he called the *Gestell* (*framework*), as the worst crime against Being. If there is any one thing that will help us to fulfil the grand task of planetary, interplanetary and interstellar survival then it is technology. Heidegger never experienced that fascination for technology as the manifestation of a *second nature*, whose creator is not (or as Heidegger would say: *no*) god, but mankind itself. Neither would he have troubled himself with the following theological speculation: If god had not desired it, mankind would certainly not have been equipped with this gift of *second creation*. This fascinating human capacity to develop technology, whose achievements the information theorist Marshall McLuhan celebrated as “extensions of man”, not only left Heidegger cold but the majority of philosophers since Kant.

The German-Jewish philosopher and ethicist Hans Jonas is one of a minority of thinkers who has dealt with the cosmological dimensions of human existence. In his 1979 book *Das Prinzip Verantwortung. Versuch einer Ethik für die technische Zivilisation* (*The Imperative of*

Responsibility: In Search of Ethics for the Technological Age), an incomparably more mature and better informed technology critique than Heidegger's amateurish pleadings, Jonas formulates a version of Kant's categorical imperative: "Act so that the effects of your actions are compatible with the permanence of genuine human life on earth". Several years later he extended the perspective and asked whether the discovery of intelligent life in space would help us in answering the central questions of human existence. He negated this and referred in an informed manner to the problem of a genuine dialog with distant civilizations where every question and answer would necessarily be separated by decades if not centuries. "We have our hands full ensuring that our signal received somewhere in outer space doesn't prove to be our death notice", he noted with bitter irony. However, in this 1988 lecture he also presented the outlines of a new idea whose visionary potential has up to now not been salvaged. Out of a sense of concern for the exploitation of nature and our technical capacity for self destruction he postulated an elementary human responsibility: "It, [this responsibility], tells us that we must now protect from ourselves that godly cause in the world we have endangered, coming to the aid of the helpless deity. It is the responsibility of the knowing power – a cosmic responsibility, as it is a cosmic experiment that could fail along with us... We know this one thing, with us and in us, in this part of space and in this instant of our fatal power, the cause of God trembling on the scales."

Is it possible on this basis to develop, for the first time, an enlightened and civil ideal of man on a cosmic scale? An ideal that is concrete enough and as engaging, charismatic and beautiful as the old dreams of mankind's predestination? The uniqueness hypothesis and the tasks following from it could succeed in returning mankind to his central position in the universe and thus to the plan of creation, a mankind that has been debased for so long as a result of its own actions.

VI. The Eighth Day of Creation

The translation of this expansive and abstract seeming conviction into social and political praxis is not to be achieved with a party program or a religious sect, but only with a new *civil religion*. The term indicates a new perspective, a standpoint based on supra-temporal values, sending out impulses for political action. These values do not of themselves need to have a religious origin. The American “pursuit of happiness” is not proven by scripture, however it constitutes, together with the idea of individual independence, the heart of the American civil religion. We can now formulate such a standpoint with supra-temporal validity and that without recourse to a specific religious source. As opposed to a Cosmo-Theology as developed by Steven Dick in 1998 in order to protect deism from the consequences of the possible discovery of extraterrestrial intelligence, a cosmic civil religion is not a sacral religion or a substitute for religion. However it is probably the most ambitious attempt to date to find a common statement of faith for all believers and non-believers. It does not favour any particular persuasion and refuses to argue over their respective contents. Nevertheless it has a distant, collective goal in sight, a common human mission. It goes beyond all individual religions and practices of faith to form the first *ecumenism of the human species*. Man is not the goal and purpose of creation, however, as a species he has found a task that fills each individual member with an indivisible dignity, independent of the extent to which he is engaged in this task. This vision does not need a strong deity, neither does it stand in its way.

This conception of mankind as the carrier of life constitutes a form of naturalistic transcendence. However this transcendence contains a message that will come up against opposition when it is translated into the various cultures of faith. For Christians this message says: God wants progress! For, it is only technical and social progress which will place mankind in the position to participate in creation. This could succeed in explaining, for the first time, why God gave man the capacity for scientific knowledge and the specific human creative power that is technology.

On this basis the religiously motivated scepticism towards the modern evolutionary theory proves unnecessary, the creation of life remains a miracle, and is – as far as we know to date – a unique event in the history of the universe. The theory of *intelligent design* clings dogmatically to the historical verity of the biblical text in order to salvage the action of God within nature. The stubborn claims in the face of all scientific evidence that the world was created 6,000 years ago and that man could not be descended from the apes as he was already made by god on the fifth day of creation are obsolete. The miracle of life is completely maintained through the uniqueness hypothesis, even taking into consideration all scientific knowledge. Furthermore, science and technology regain a place in a possible plan of creation. The great scientists and explorers from the Renaissance to the time of the enlightenment who laid the foundations for today's technical civilization saw it as their religious duty – often in the face of opposition from the church – to find God within his creation. That the book of nature is written in the language of mathematics was considered by many, including Galileo, to be equivalent to a *second revelation*. To this day Christian theology has been unable to honour the human capacity to develop technology as an additional gift of god. Scientific knowledge and technical advances are suffered by the Christian church as further stages in the unending process of secularisation. It is only against this background that reactionary dogmas such as intelligent design have proven successful, fuelling Christianity's metaphysical impoverishment.

A cosmic civil religion on the basis of the uniqueness hypothesis could establish this connection. A civil religion cannot in any event exist independent of the sacral religion of the respective culture, that is, if it is to develop into a force for social and political change. The task of a civil religion is to help people to connect their customary articles of faith to new, concrete tasks, achieving a confirmation of their original belief in the process. The Christians among us for example can attempt to imagine God's words on the *eighth day of creation*. As he drove Adam and Eve out of paradise, parting from them at the eastern gate of

the garden of Eden with the words: "Go forth, populate the earth and make the new species great, the fruits of which I have placed in you. When you have come to adulthood you shall continue my work. On the eighth day of creation man shall become the shepherd of life. He shall carry forth life as my work and my message throughout the heavens and into all corners of space. This shall be his task and his test. If he should succeed then his violation of my prohibition to eat the fruit from the tree of knowledge will not have been in vain."

This thought suggests a new cosmic form of the blessing spoken by the pope at high church ceremonies and currently restricted to the planet earth *Urbi et Orbi* [lat. "In the city and around the globe"]. Soon human beings will be travelling far out into this infinite space in order to complete the work of creation, carrying life out into space. They will fulfil the promise that God made through the person of the prophet Isaiah [65,17]: "I am about to create new heavens and a new earth." Thus this new circle of life, the cosmic circle is worthy of its own blessing: *Urbi et Orbi et Mundi*.

I have a dream that in the distant future, in millions or billions of years we will be remembered as the first pioneers of life, and that I can be proud to have been a human being, a being of this species that will be held in honour for all eternity because it was able to correctly answer the question concerning the meaning of its existence. For that reason: Rise, brothers and sisters! Onto the stars!

Appendix

Books

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- Daniel Wabbel (Hrsg.), *Leben im All. Positionen aus Naturwissenschaft, Philosophie und Theologie*, Patmos 2005
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A number of natural constants that are critical for the structure of the universe

$e = 1,602\ 177\ 33 \cdot 10^{-19}$ C	Electron charge
$m_e = 9,109\ 389\ 7 \cdot 10^{-31}$ kg	Rest mass of the electron
$m_p = 1,672\ 623\ 1 \cdot 10^{-27}$ kg	Rest mass of the proton
$c = 299\ 792\ 458$ m/s	Speed of light (vacuum)
$G = 6,672\ 59 \cdot 10^{-11}$ m ³ /kg·s ²	Gravitational constant
$\hbar = 6,626\ 075\ 5 \cdot 10^{-34}$ Js	Planck's quantum of action
$\epsilon_0 = 8,854\ 187\ 817 \cdot 10^{-12}$ F/m	electromagnetic field constant
$m_p/m_e = 1836,153$	Proton-electron mass ratio

The Drake or Greenbank equation (1960)

$$N = R_* \cdot f_s \cdot f_p \cdot n_e \cdot f_l \cdot f_i \cdot f_c \cdot L$$

N = Number of technically intelligent civilizations in a galaxy

R* = Average rate of star formation in a galaxy per year

f_s = Number of sun-like stars

f_p = Number of stars with a planet system

n_e = Number of planets with an ecosphere

f_l = Number of planets with life

f_i = Number of planets with intelligent life

f_c = Interstellar communication, i.e. the degree of interest of a civilization in making contact, i.e. search for foreign life

L = Lifetime of a technical civilization