
From Thermodynamics to Biology: A Critical Approach to ‘Intelligent Design’ Hypothesis

Policarp Hortolà

*Universitat Rovira i Virgili (URV), and Institut Català de
Paleoecologia Humana i Evolució Social (IPHES), Tarragona*

ABSTRACT

When scientific method is not scrupulously followed, we move from objective to subjective knowledge. An example is provided by theistic cosmogonies, such as, the so-called theory (hypothesis, in reality) of ‘intelligent design’ (ID). It claims adequacy with all of the criteria defining scientific theory, thus placing it on an equal footing with evolutionism. Its motto can be summarised as ‘evolution – yes, but by divine design, not by natural selection.’ In this paper, the author expounds some of the thermodynamic and biological arguments implying that ID is an intrinsically religious notion that does not meet any scientific requirements and that simply represents another attempt to make cynical use of science in favour of unscientific postulates.

Keywords: *scientific method, Darwinism, antievolutionism, neocreationism, cosmic history.*

INTRODUCTION: SCIENCE AND SCIENTIFIC METHOD

Science is an intellectual activity that aims at explaining phenomena that occur in the universe through natural causes. Contrary to what one might suppose *a priori*, culture plays a crucial role in science; as stressed by Ruse (1999: 246–249). In order to explain universal phenomena, science works with its own methodologies, which, because of their origin, are referred to as ‘scientific method’ (an abridged explanation of the characteristics of scientific method can be found, *e.g.*, in Hatfield 1998). The word ‘method’ comes from Ancient Greek μέθ- [meth-] (after or beyond) and ὁδός [hodos] (path or way). Thus, ety-

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mologically, scientific method is the path that leads to scientific knowledge.

Scientific method has been continuously active since the seventeenth century, when the work *Instauratio Magna* containing ‘Novum Organum Scientiarum’ was published by Sir Francis Bacon (2004 [1620]). Scientific method seeks ‘objective knowledge’, which is equivalent to ‘inter-subjective knowledge’. In other words, knowledge that different people admit as the same. For example, in temperate latitudes, during the autumn different individuals may be asked whether they feel cold or hot. Some will reply that they are cold, while others will answer that they feel hot. This example reflects subjective knowledge, because each individual has his/her own perception of the phenomenon of temperature. However, if these same individuals are asked to evaluate the temperature by reading a thermometer, they will all agree upon the result. This is inter-subjective knowledge, and is therefore objective.

Scientific method can be represented by a simple algorithm or workflow diagram composed of four sequential phases: Observation, Hypothesis, Testing (of the hypothesis), and Thesis (see Figure below).

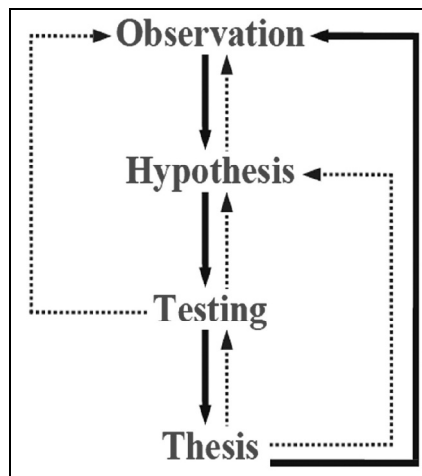


Fig. Workflow diagram of scientific method.

Continuous line arrows specify the required path, and dotted line arrows indicate complementary optional paths. In this method, we can go back by skipping a step if necessary, but we cannot move forward by jumping into one

The Observation phase can be qualitative or quantitative, and is either obtained directly by the researcher or taken from specialised literature, especially from the generalization of scientific journals. The Hypothesis phase provides a provisional explanation for a given phenomenon; that is, a supposition. The hypothesis may include other subordinate hypotheses and can raise associated questions. For example, if we accept the hypotheses '*Prehistoric humans manufactured tools*' and '*The tools that prehistoric humans manufactured could be of lithic raw material*', one can then raise the question '*Which lithic raw materials did prehistoric humans use to manufacture their tools?*' Testing can be experimental, mathematical or both. The latter is very often the case. In the experimental hypothetical Testing category, the observer actively prepares special circumstances to produce a specific phenomenon, whether of quantitative or qualitative type. Quantitative phenomena can, by definition, be quantified – for example, weight can be determined directly with a scale. There are also some qualitative types that are indirectly quantifiable, for instance colour. Colour is associated with a specific wavelength that can be determined with a spectrophotometer. According to mathematical testing, hypotheses based on quantitative observations – or at least quantifiable in terms of presence/absence of a phenomenon – are tested by numerical or statistical methods. In the final phase ('Thesis'), a proposition is inferred from applying logical reasoning to the results of the 'Testing' hypothesis; that is to say, a 'position' is taken and a scientifically proven hypothesis results. A set of related theses on a particular topic constitutes the basis of a scientific theory. The formulation of theses and scientific theories requires following the principle of parsimony or 'Ockham's razor', that Sober (2015: 2) explains by stating that '*a [scientific] theory that postulates fewer entities, processes, or causes is better than a theory that postulates more, so long as the simpler theory is compatible with what we observe.*' It should be noted that, when in the academic sphere, we speak of 'a doctoral thesis', in fact we are referring to the last, culminating stage of scientific method; although generally without realising it.

Scientific method is a recurring feedback process: the more observations, hypotheses, contrasts and theses we have, the more of the same are generated. In scientific method, we can go back by skipping a step if necessary, but we cannot move forward by jumping one. If we do (*e.g.*, pass directly from Hypothesis to Thesis), then we shift from objective to subjective knowledge.

THE 'INTELLIGENT DESIGN' HYPOTHESIS: ORIGINS AND CONCEPTUAL BASES

In Western culture, the non-secular traditional paradigm of the explanation of biological diversity is from the Bible's text of *Genesis*, accepted literally, outside of any hermeneutics. The certainty of the biblical story has been such that it had even allowed calculating the exact date of Creation and other events of this religious story. The most renowned author in this type of computation is undoubtedly the Anglican archbishop of Armagh and Prelate of Ireland James Ussher (2003 [1650, then 1658]). According to this cleric, the world was created on Sunday, October 23rd, 4004 BC; Adam and Eve were ousted from Paradise on Monday, November 10th of the same year; and Noah's ark alighted on Mount Ararat on Wednesday, May 5th, 1491 BC.

While the scientific revolution was consolidated from the seventeenth century, with the new astronomy, finalism was still valid in the field of biology until the nineteenth century. This ideology claims that, in an orderly and rational world, diversity cannot be explained by causes other than the act of Creation. Presently, conventional forms of Creationism are still based on literal interpretations of the Bible's *Genesis* story. They are propagated in fundamentalist and evangelical Christian sects (Pennock 2002, 2003). Reactionary religious fundamentalism is the foundation of anti-Darwinism that is still rampant in modern societies. According to Mirkovic (2011), *'Postmodernism, with its rejection of the objective truth and arguing that the scientific narrative was just another meta-narrative, unwittingly, unlocked the door for the onslaught of reactionary religious fundamentalism'*.

In contrast to previous creationist tendencies, the so-called theory (hypothesis, in reality) of 'intelligent design' (ID) has rapidly gained adherents even within modern-day Catholicism, no doubt because of its attempts to provide a 'scientific' patina to its arguments. There is general agreement to consider Phillip Johnson as the founder of the ID movement. At the beginnings of the 1990s, this author published a very successful book entitled *Darwin on Trial* (Johnson 1991). The second edition of the book, with some minor changes, was published in 1993. Johnson, a Professor of Law at the University of California at Berkeley from 1967 to 2000, and Emeritus Professor of Law since this time, had been assistant to the President of the US Supreme Court, Earl Warren, known especially for having led the research commission for the murder of President Kennedy.

The assumptions of ID hypothesis supposedly align with all criteria defining scientific theory, thus rendering it capable to contend with evolutionism on an equal footing. The anti-Darwinist movement of ID, apart from the failed strategies of its more or less literalist predecessors, tries to boldly attack evolutionary biology, by searching for any insurmountable gaps with which to overthrow the theory of natural selection. In the best-case scenario, its motto can be summarised as '*evolution yes, but by divine design, not by natural selection.*' That is to say, ID proposes an evolutionary force guided by the hand of God, and its supporters are frequently referred to as 'theistic evolutionists' (Ruse 2015: 154). In the absence of viable peer-reviewed scientific journals where they could publish their 'findings', the propaganda device of ID is diffused through books and articles distributed by publishing houses specializing in Christian apologetics, creationist magazines and Internet sites. The de-facto official representative of the ID movement is the Center for Science and Culture, created in 1996 – by Johnson, among others – as an integral part of the Discovery Institute, based in Seattle, WA. Bruce Chapman, a Catholic and member of the Republican Party who held various positions of responsibility during the Reagan administration, chairs this ultra-conservative private institute, which was founded in 1990. The Center for Science and Culture (n.d.) explains what ID is: '*The theory of intelligent design holds that certain features of the universe and of living things are best explained by an intelligent cause, not an undirected process such as natural selection.*' The ID hypothesis is rooted, therefore, in the idea that there is a kind of intelligent designer. Although, in principle, the idea of God is not a *sine-qua-non* precondition for ID, its intellectual promoters usually concede that the supposed 'designer' should have the attributes of what, in monotheistic traditions, is considered to be God. The ID proposes three seminal arguments: 1) adjusted universe, 2) irreducible complexity, and 3) specified complexity.

The first argument, adjusted universe, maintains that the complexity of the natural world of which humans form a part can only be explained by the existence of superior intelligence. The universe has a series of physical characteristics that make life possible and that cannot be attributed to random phenomenon. The presence of an intelligent designer is presumed to be requisite to the existence of the circumstances that ensure the conditions required to maintain life in accordance to a pre-planned template. This argument is intimately related to the so-called 'strong anthropic principle', which maintains that intelligent life is

a consequence of the evolution of the universe: there is only one step leading from this idea to that of a universe fitted to the human scale.

The argument of irreducible complexity maintains that, at the biochemical level, there are unique (non-redundant) systems composed of several interacting parts. Each of these contributes to the basic function of a part of an organism, while the elimination of any one of them would cause the system to dysfunction. Natural selection could not create irreducible complex systems because it operates within systems that are already organised. Some examples of irreducible complexity include biological mechanisms such as the functional macromolecular aggregates of bacterial flagella and cilia, the ATPase enzyme molecule, or the adaptive mechanism of the immune system. This argument was formulated by Michael Behe, one of the few members of the Center for Science and Culture trained in scientific research (Professor of Biochemistry in Lehigh University, Bethlehem, Pennsylvania). He is also author of *Darwin's Black Box* (Behe 1996), one of the most celebrated works by ID followers, since it was written by an active biochemist with good credentials as a scientist – that does not mean that he is infallible.

The argument of specified complexity maintains that the structural details of living things, especially the sequence patterns in macromolecules such as proteins and DNA, have specified complexity. That is to say, the probability that they occur can be expressed by a numerical value smaller than a certain theoretical threshold value. According to ID, when something has specified complexity, it is assumed to have been produced by an intelligent being, and, by extension, to have been intentionally ‘designed’ rather than produced by any natural process. A clarifying case is provided by contrasting, for example, a poem *versus* a single letter of an alphabet: whereas the former is both complex and specific, the latter is specific, but not complex. Another example is a paragraph based on sequences of randomly chosen letters that would be complex, but not specific. This concept was introduced by William Dembski, one of the most active militants of ID. Dembski is a mathematician and theologian, as well as a Research Professor in Philosophy at the Baptist Theological Seminary of the Southwest, in Fort Worth (Texas), and the author of two of the ‘horse battle’ books of ID: *Intelligent Design* (Dembski 1999) and *No Free Lunch* (Dembski 2002). As pointed out above, specified complexity depends on a theoretical value. This value – which represents the threshold of probability below which a specific event of the known universe could not be attributed to chance but to an intellect – is called ‘universal

probability bound' (Appendix 1). It is worth mentioning that, although the basis for calculating universal probability bound was modified later (Dembski 2005), its numerical values remain identical.

The 'scientific' arguments of ID (irreducible complexity and specified complexity) are not new in terms of their substance, but only in the way they are raised. Given the media boom and the attempts to introduce ID in schools, especially in the U.S., scientists, philosophers and even lawyers have been forced to pronounce against it in the mass media, scientific journals and even courthouses (*e.g.*, AAAS 2013 [2002]; Branch 2007; Brauer, Forrest, and Gey 2005; Mervis 2006). Intellectual debates are common (*e.g.*, Dembski and Ruse 2007). Discussing irreducible complexity and specified complexity separately is feasible and has traditionally been done (Pigliucci 2001). However, this is unnecessary, since they all converge on the argument of the adjusted universe. This influential argument has been widely developed at the Center for Science and Culture by the Cuban astrophysicist Guillermo González (currently Assistant Professor at the State University Dance in Muncie, Indiana) and by the philosopher and theologian Jay Richards (ex-Vice President of the Discovery Institute and current Assistant Professor at the Catholic University of America in Washington, D.C.). These authors published *The Privileged Planet* at the beginning of the twenty-first century (González and Richards 2004), inspiring a video documentary with the same title, conceived as a complement to the book, and aimed for the general public. The argument of the adjusted universe can also be found in Part I, question 2 of the *Summa Theologiae* by Saint Thomas Aquinas (2009 [1265]). It is the fifth and most outstanding of Aquinas' five ways of demonstrating the existence of God ('order in the world'). Similarly, *Natural Theology*, a work by the English archdeacon William Paley (2005 [1802]), repeatedly cites an analogy very commonly used (before and after) by the defenders of teleological arguments to prove the existence of God: just as there can be no clock without a watchmaker, so there can be no universe without God.

THERMODYNAMICS, BIOLOGY, AND 'INTELLIGENT DESIGN'

Although presently we only have reliable proof of life on Earth, the 'improbability' of life elsewhere in the universe can only be considered from a theoretical point of view. If we follow the calculations of Dembski, the probability of finding any form of life beyond our planet is very unlikely. However, even intelligent life is fairly (or very) likely

if we follow the probabilistic calculations by astrophysicist Frank Drake, presented in 1961 during a meeting and later published (Drake 1965), and known as the ‘Drake equation’ (Appendix 2).

Evolutionary selection, principles and laws operate both on the biological and cosmic levels (Grinin 2015). Several explanations for the natural complexity of the cosmos – whether composed of a single universe or multiple universes – can be offered. Nothing indicates that parallel universes, with the same or different physical properties, cannot exist, or that there are/were many universes formed from different Big Bang events. Therefore, if there are multiple universes – perhaps a quantised system of universes (Gehrels 2011) – then, is there a sole intelligent designer for all of them or a separate one for each universe? The key question is whether or not a universe originated from ‘nothing’ is possible. In this sense, such a natural creation *ex nihilo* has been argued previously (*e.g.*, Tryon 1984; Lincoln and Wasser 2013).

The connection between time and God is another essential issue. An omnipotent god as that of Judeo-Christian tradition should be timeless. Nevertheless, as said by Davies (1983: 44):

If time belongs to the physical universe, and is subject to laws of physics, it must be included in the universe that God is supposed to have created. But what does it mean to say that God caused time to come into existence, when by our usual understanding of causation a cause must precede its effect? Causation is a temporal activity. Time must already exist before anything can be caused. The naive image of God existing before the universe is clearly absurd if time did not exist – if there was no ‘before.’

While the act of Creation presupposes an order that comes from another higher order (God), the evolutionary fact emerges from the dialectical opposition between a tendency to order – the ancient Greek philosophy's κόσμος [kosmos], the thermodynamics' Gibbs energy or biology's life – and another to disorder – the ancient Greek philosophy's χάος [khaos], the thermodynamics' entropy or biology's death –. The exchange of entropy plays a fundamental role in irreversible chemical reactions of living systems (Zivieri *et al.* 2017). Minimum energy dissipation and quickest descent characterise the physical bases of individual development (Zotin and Zotin 1997). According to Dobovišek *et al.* (2014), ‘as a rule, biological processes are non-linear and take place far from the equilibrium.’ In this sense, we can em-

brace the Preface written by Faustino Cordón for a foreign edition of *The Origin of Species* (Darwin 1970 [1859]: 23), stating:

... the first quality that a living thing must have to be selectable is that of being forced to perish in its natural environment; death can be said to be the agent of perfection, and, ultimately, of the origin of life. The tendency to fall into disorder with the devaluation of energy, which, as a general law of reality, is stated in said [second] principle of thermodynamics, is what paradoxically determines, under certain conditions, the creation of a growing order. The theory of natural selection explains, then, how, within the evolutionary process of the whole of reality, mutually determines the processes that regulate increasing disorder and those in which a growing order is created, such as biological evolution on Earth [our own translation from Spanish].

Evolving systems – from primitive physical systems to complex biosystems – could ‘*involve similar processes which are phenomenological manifestations of the second law of thermodynamics*’ (Schneider and Kay 1994). Additionally, according to Prigogine and Wiame (1946), ‘*It is easy to demonstrate that in a living organism the production of entropy related to metabolism of molecules far exceeds that related to other causes of irreversibility*’ [our own translation from French]. From the field of ‘Big History’ – linking cosmic, natural and social history, from the Big Bang to present (e.g., Christian 1991, 2004), – mathematical models to describe important features of both biological and social macroevolution have been described by Grinin, Markov and Korotayev (2015 and refs. therein).

Living things are chemical systems with emergent properties, that is to say, with properties that transcend the physico-chemical level and are not directly deducible from the single components of such chemical systems (Bunge 1979: 75–123). In the words of Luisi (2016: 245):

Another important point about emergence is that life itself can be seen as an emergent property. The single-cell components, such as DNA, proteins, sugars, vitamins, lipids, etc., or even the cellular organelles such as vesicles, ribosomes, etc., are per sé inanimate substances. From these non-living structures, cellular life arises once the space/time organization is defined. The consideration that life is an emergent property gives the notion of emergence a particular significance. No vitalistic principle, no transcendent force, is invoked to arrive at life – and this, as mentioned already, has two consequences: (1) the mechanism of life, at least in principle, can be explained in terms of molecular

components and their interactions; (2) it becomes conceivable to make simple forms of life in the laboratory.

Most likely, the first simple organic molecules were synthesised by random and thermodynamic events led to complex biomolecules and, ultimately, to living things. Much work has been carried out on the origins of life on Earth (Lazcano 2010). In this area, the pioneering work (theoretical and experimental, respectively) of Oparin (1938 [1924]) and Miller (1953) on the ‘primordial soup’ is well known (see a re-analysis of Miller's original samples in Johnson *et al.* 2008). The evolution of life can be described in terms such as entropy production, irreversible thermodynamic flows, or information theory (Castillo and Vera-Cruz 2011 and refs. therein). Furthermore, randomness is linked to the increase of biological organization in ontogenesis and evolution (Longo and Montévil 2012). Michaelian (2011) has proposed a mechanism for the reproduction of nucleic acids (DNA and RNA) ‘*without the need for enzymes, promoted instead through UV light dissipation and diurnal temperature cycling of the Archean sea-surface*’. The pre-biotic emergence of self-replicating nucleic acids has also been treated statistically (England 2013).

Regarding order, as a phenomenon related to life, Schrödinger (1967 [1944]: 85–86) pointed out:

... it appears that there are two different ‘mechanisms’ by which orderly events can be produced: the ‘statistical mechanism’ which produces ‘order from disorder’ and the new one, producing ‘order from order’. To the unprejudiced mind the second principle appears to be much simpler, much more plausible. No doubt it is. That is why physicists were so proud to have fallen in with the other one, the ‘order-from-disorder’ principle, which is actually followed in Nature and which alone conveys an understanding of the great line of natural events, in the first place of their irreversibility. But we cannot expect that the ‘laws of physics’ derived from it suffice straightaway to explain the behaviour of living matter, whose most striking features are visibly based to a large extent on the ‘order-from-order’ principle. You would not expect two entirely different mechanisms to bring about the same type of law – you would not expect your latch-key to open your neighbour's door as well.

Concerning the probability that first forms of life would emerge, as related to the creationist discourse, Doolittle (1984) wrote:

If I have made my point, the next time you hear creationists railing about the ‘impossibility’ of making a particular protein,

whether hemoglobin or ribonuclease or cytochrome c, you can smile wryly and know that they are nowhere near a consideration of the real issues. Comfort yourself also with the fact that a mere thirty years ago (before the Watson and Crick era) no one had the slightest inkling how proteins were genetically coded. Given the rapid rate of progress in our understanding of molecular biology, I have no doubt that satisfactory explanations of the problems posed here soon will be forthcoming.

Complex biomolecules like DNA do not possess the perfection attributed by ID supporters. There are amino acids encoded by more than one combination of nucleotides, sometimes errors occur during replication, there may be viral sequences inserted into higher genomes, *etc.* Does this demonstrate a perfectionist intelligent first cause? Even in the case of a believer, natural selection is closer to an almighty God than such an imperfect design, as argued, for example, by Ayala (2006: 34). Moreover, in accordance with Monod (1972 [1970]: 43), '[the biosphere] *does not contain a predictable class of objects or of events but constitutes a particular occurrence, compatible indeed with first principles, but not deducible from those principles and therefore essentially unpredictable.*' In other aspect, we agree with Pigliucci (2010: 185) when he states that ID '*is not science because it invokes the supernatural, in violation of the methodological naturalistic approach that has characterized science since Bacon, and in fact all the way back to Aristotle.*'

CONCLUSION: SCIENCE VERSUS 'INTELLIGENT DESIGN'

A good example of how we are moving from objective to subjective knowledge, when scientific method is not followed scrupulously, is that of theistic cosmogonies; that is, explanations of the origin of the universe based on a God. Theistic cosmogonies are based on passing directly from an observation ('*there is an entity we call "universe"*') and a hypothesis ('*the universe has been created by God*') to a thesis ('*there is a creator God*'), without testing the hypothesis. In reality, theistic cosmogonies are not tested because the existence of a creator God is considered to go beyond the physics laws of the universe, as something that is simply uncontrollable. In his *Logik der Forschung*, Karl Popper (1959 [1934, imprint '1935']) formulated a criterion of demarcation between science and metaphysics in terms of 'falsifiability': a theory is only scientific if it allows to be demonstrated as false. The existence of any kind of God – or of demon – can only be approached from the subjective knowledge of the faith of each one, be-

cause it is not falsifiable and, hence, is a metaphysical question very far from the scope of scientific objective knowledge. Furthermore, in the famous McLean versus Arkansas Board of Education trial, the memorandum opinion of judge Overton (1982) described as critical characteristics of science the following: ‘(1) *It is guided by natural law*; (2) *It has to be explanatory by reference to nature law*; (3) *It is testable against the empirical world*; (4) *Its conclusions are tentative, i.e. are not necessarily the final word*; and (5) *It is falsifiable*.’

In short, ID is an intrinsically religious notion that does not meet any of requirements of science. It just represents one more attempt to make cynical use of science in favour of unscientific postulates.

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APPENDICES

*Appendix 1***Universal probability bound (Dembski 1999)**

The 'universal probability bound' establishes the maximum number of physical events that could have happened to the universe from the Big Bang.

The numerical value of the 'universal probability bound' – which can be passed into information in the form of *bits* – is obtained as the inverse of the product of the following approximate values: (1) the number of elementary particles in the observable universe (10^{80}), (2) the maximum rate per second to which transitions can occur in the physical state of matter (10^{45}), which is the inverse of the 'Plank time' or the oldest moment of time in which the laws of physics can be used to study the nature and evolution of the universe, and (3) one billion times longer than the estimated age of the universe in seconds (10^{25}). Therefore, universal probability bound = $1/(10^{80} \cdot 10^{45} \cdot 10^{25}) = 1/10^{150}$. Consequently, each physical event in the universe has had a probability (p) to happen by chance of $p \geq 1 \cdot 10^{-150}$, and whatever event in the universe whose probability of occurring be $p < 1 \cdot 10^{-150}$ (e.g. the DNA molecule) should not be attributed to chance.

*Appendix 2***Drake equation (Drake 1965)**

The 'Drake equation' establishes the approximate number of civilizations technologically advanced in our galaxy, by identifying the specific factors that could play a role in the development of these civilizations. There is no unique solution to this equation; however, scientists that examine such specific factors usually accept it.

The equation is written as $N = R_* \cdot f_p \cdot n_e \cdot f_i \cdot f_c \cdot L$, where N = number of broadcasting civilizations (i.e. that dominate electromagnetic radiation) in the Milky Way, R_* = rate of formation of stars, per year, suitable for the development of intelligent life, f_p = fraction of stars with planetary systems, n_e = number of planets, per planetary system, with an environment suitable for life, f_i = fraction of suitable planets on which life actually emerges, f_l = fraction of life-bearing planets on which intelligent life evolves, f_c = fraction of civilizations with a technology that releases interstellar signals of their existence into space, and L = time lapse, in years, a civilization releases interstellar signals of their existence into space.