E.T. OR NOT E.T.? THAT IS THE QUESTION.

By

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Abstract: Attempts to detect electromagnetic signals from extraterrestrial intelligences have hitherto proved fruitless, and no plausible solution has been provided for the 'Fermi Paradox' that does not entail the non-existence of radio broadcasting and interstellar travelling exoplanetary civilisations. Yet life itself, and even intelligent life, of a non-technological kind, may be abundant.
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Section 1: Introduction.

In 1961, the American radio-astronomer, Frank Drake, organised a meeting at the radio-telescope at Green Bank, West Virginia, then the headquarters of the US National Radio Astronomy Observatory, as a follow-up to Project Ozma (1960; see Drake, 1961a), which had tried, without success, to detect radio signals emanating from putative intelligent inhabitants of planets orbiting the stars Epsilon Eridani (K2V) and Tau Ceti (G8V), 10.5 and ~12 light years away respectively. Cocconi and Morrison (1959) had proposed that efforts should be made to search for such signals, focussing on the 21 cm wavelength, ~1.4276 GHz frequency band, associated with interstellar hydrogen.

His preparations for the meeting led him to produce the now-famous (or notorious, depending on one's perspective) Drake Equation (Drake, 1961b).

$$N = R_* f_p N_e f_l f_i f_c L \,. \tag{1}$$

Here, N is the number of civilisations in the Milky Way Galaxy whose electromagnetic emissions are detectable; R_* is the average rate

of star formation per year in our Galaxy; f_p is the fraction of those stars with planets; N_e the average number of those planets that may develop an ecosystem; f_l the fraction of those planets that succeed in developing life; f_i the fraction of these that develop intelligent life; f_c the fraction of these that develop interstellar communication; and finally, L, the average length of time such civilisations survive and continue to send interstellar communications (SETI Institute, 2020).

The first comment to be made on the equation is that N_e is redundant; clearly, a planet that failed to develop life would not, *per definitionem*, have an ecosystem. We will have more to say about the equation later.

Section 2: Life, 'Intelligent' Life, and Techno-Life.

Bar-On, Phillips and Milo (2018) point out that the human population of this planet (7.7 billion in mid-2019[1]; 7.785 billion as of 18th May, 2020[2]) is only a small fraction of its total biomass. Plants, fungi, bacteria, archaea, protists and viruses together account for 543.2 Gt C (Gigatonnes of carbon) out of a total of 550 Gt C, or 98.7636%. Animals, they say, constitute 2 Gt C, or 0.3636%, of which arthropods constitute 1 Gt C, fish 0.7, molluscs 0.2, livestock 0.04 and humans 0.06 Gt C (livestock figure corrected). Their animal biomass figure must be an under-estimate, on the basis of their own calculations, as 100 – 98.7636 = 1.2364%, and 1.2364% of 550 Gt C is 6.8002 Gt C.

Mayr (1992, 1995) argues that the existence of extraterrestrial life is by no means the same as that of extraterrestrial *intelligent* life. He points out, as Bar-on, Phillips and Milo (op. cit.) do, the preponderance of non-intelligent life on *this* planet. The argument – put forward by Carl Sagan, among others (Sagan and Drake, 1997) – that:

> **'Since intelligence and technology have a high survival value it seems likely that primitive life forms on the planets of other stars, evolving over many billions of years, would**

[1] https://population.un.org/wpp/Publications/Files/WPP2019_Highlights.pdf.
[2] https://www.worldometers.info/world-population/.

occasionally develop intelligence, civilization and a high technology'

is completely false. Advanced technology does not *have* a 'high survival value' – indeed, it may very well have the opposite, as the effects of anthropogenic climate change, resource depletion, biodiversity loss and over-population may eventually prove.

Sagan and Drake's linkage of intelligence and technology – of the advanced, industrial kind – is also false. Mayr (op. cit.) is correct to point out that intelligence *per se* has no such survival value – plants, bacteria and archaea are perfectly well able to survive and thrive without a single atom of intelligence between any of them, and we 'intelligent' humans – along with the rest of the animal kingdom – would be in a very bad way indeed without the plants!

But let the reader imagine an extraterrestrial civilisation *without* advanced technology, but with plentiful intelligence. Such a civilisation could have a Stonehenge; it could have its equivalent of the Pyramids, the Parthenon, and the Sistine Chapel. It might have produced its own version of Leonardo da Vinci, Michelangelo, Mozart, Monet and Van Gogh. Yet because it did not produce radio signals detectable by the SETI Institute, it would not count.

Section 3: They Must Be Humanoid, Mustn't They?

Those of us who are aficionados of television science fiction programmes have grown accustomed to laughing at the assumption in *Star Trek* and other such shows that the aliens will all be humanoid – that they will all share the same basic body shape as ourselves, with a trunk, four limbs, and a head.

Lineweaver (2008), in demonstrating that human-like intelligence is not a 'convergent feature' of evolution, also proves the fallacy of this idea: for not only is there no reason to suppose that humanoid intelligence is likely to result from convergent evolution, but neither is there any reason to suppose that human body shape (which evolved from that of Pliocene primates ancestral to the human precursor *Australopithecus afarensis*, such as *Ardipithecus ramidus*, also ancestral to the chimpanzees, see White, *et al*, 2009), will do so.

The point is not facetious, and a mere matter of laughing at the follies of film or television science fiction script-writers. The brain of an adult bottlenose dolphin, *Tursiops truncatus*, and that of an adult human, are roughly comparable in mass: 1.5-1.6 kg, compared with 1.3-1.4 kg[3]. Its encephalisation quotient (EQ) is 4.14, compared to the human 7.0, and its brain-body mass ratio, given a brain mass of 1.5 kg and a body mass of 120 kg, is 1.25%, compared to that of a human (brain mass 1.4 kg, body mass 75 kg) of 1.86% (Marino, 2004; Cairó, 2011).

We have, in cetaceans, an example of non-human intelligence. Dolphins, whales and porpoises have not, and will never, paint an equivalent of Botticelli's *The Birth of Venus*, or write their version of Dostoevsky's *The Brothers Karamazov*; nor will they ever discover Euler's Identity – but they are still intelligent, whatever that slippery word means.

Orbiting some other star in our Galaxy, or one of the Magellanic Clouds or the Andromeda Galaxy, there may well be a planet harbouring a mammal-like marine species, or even a whole family of genera of species, of aquatic intelligences like the cetaceans; but the SETI Institute will never hear from them, either.

Section 4: The 'Freak Accident' of Life?

Davies (2011) points out that there was a debate between biologists and biochemists who believed that life on Earth, or anywhere else it might have arisen in the universe, was a 'freak accident', and those who regarded it as a 'cosmic imperative', listing Monod (1972) representing the former camp, and de Duve (1995) the latter.

The Miller (1953) and Miller-Urey (Miller and Urey, 1959) experiments demonstrated that it was possible to produce amino acids from a reducing atmosphere similar to one thought to be like that of the primitive Earth (methane, water vapour, ammonia and molecular hydrogen), and similar to that of Saturn's moon, Titan, although very much warmer. (Titan's lower atmosphere consists of 94.2% nitrogen, 5.65% methane and 0.099% hydrogen; Catling and Kasting, 2017).

[3] See: http://faculty.washington.edu/chudler/facts.html.

Amino acids, polycyclic aromatic hydrocarbons (PAHs) and other ‘organic’ chemicals (the nomenclature is confusing here, because the word ‘organic’, in this instance, does *not* signify of organic origin – ‘carbon chemicals’ and ‘carbon chemistry’ would be better terms) have been found present in meteoritic material, most notoriously, perhaps, given the claims made about it in 1995, concerning the alleged presence in it of ‘microfossils’, in the Martian meteorite discovered in Antarctica on 27th December 1984, Allen Hills 84001 (ALH84001); (Botta and Bada, 2002; Halevy, Fischer and Eiler, 2011; Koike, *et al*, 2020).

However, carbon compounds – even an abundance of carbon compounds – do not add up to life. They are rather like a great heap of children’s Lego bricks, awaiting the children needed to come and assemble them into whatever their imaginations create with them. Life is not carbon compounds, but a unity made from them, and furthermore, it is a dynamic and purposive unity. That, in fact, is the essence of life.

So the choice is not a false dichotomy between ‘freak accident’ and ‘cosmic imperative’. There was and is no such imperative. Carter (1974) was right to insist on the ‘weak’ anthropic principle, in that our position as observers in the universe is privileged in time (and therefore in space); but the ‘strong’ anthropic principle (Davies, 1982, pp.120-122), that our universe is such that observers *must* evolve within it, has no merit. That they *have* done so is a fact; but to move from *have* to *must*, in this case, is a *petitio principii*. There is no *intrinsic* reason why, given the laws and constants of physics as they are, and the initial physical conditions of the universe as they were, that intelligent life, qualifying for ‘observer status’, would eventually evolve within it. Life, as such, failing to make this particular grade, has a far higher statistical probability (Mahecha, 2015; Davies, 2016).

Barrow and Tipler (1986) argue, as a consequence of their ‘anthropic cosmological principle’, that if there had been advanced extraterrestrial civilisations, visitors from them would long ago have come from them, and landed on our Earth.

Section 5: Fermi's Question – "Where is Everybody?"

Jones (1985) gives an account of the occasion, in the Summer of 1950, when Enrico Fermi visited the Los Alamos National Laboratory in New Mexico, and had lunch there with Edward Teller (the 'Father of the Hydrogen Bomb' and model for Stanley Kubrick's *Dr Strangelove*[4]), Emil Konopinski and Herbert York, the former having worked with Fermi on the first nuclear reactor at the University of Chicago, and at the Manhattan Project during the war, the latter another nuclear physicist who worked on the Manhattan Project, and who became the first director of the Lawrence Livermore National Laboratory, Livermore, California, 1952-1958.

The conversation began light-heartedly, with discussion of a cartoon drawn by Alan Dunn[5], that had recently appeared in the *New Yorker* (20th May issue), blaming extraterrestrials for a spate of thefts of trash cans from New York. Fermi, amused like his companions, commented that it was a good theory, because it accounted for two phenomena[6]: the disappearance of the trash cans, and the appearance of so many 'flying saucer' sightings.

There had been a spate of them, beginning with the first observation of so-called 'flying saucers' or 'flying discs' by a pilot named Kenneth Arnold, near Mount Rainier in Washington State, on 24th June 1947, followed shortly thereafter by the notorious incident at Roswell, New Mexico, 363.068 km (22 5.6 miles) from Los Alamos, that was the top story in the *Roswell Daily Record* for Tuesday, 8th July, 1947: "RAAF Captures Flying Saucer on Ranch in Roswell Region", which was corrected the following day by a USAAF official, who told the newspaper that the alleged 'flying saucer' was, in fact, a weather balloon. This statement is disbelieved to this day by 'UFO-logists', and regarded as evidence of the US Government's

[4] See: https://news.stanford.edu/news/2003/september24/tellerobit-924.html.

[5] Obituary in: https://www.nytimes.com/1974/05/22/archives/alan-dunn-cartoonist-is-dead-at-73-poelike-features-many-collected.html.

[6] The instrumentalist, unified explanation of seemingly disparate phenomena, without reference to any supposed underlying physical or metaphysical reality, is what Plato and the medieval philosophers would have called 'saving the appearances' (Greek: σωζειν τα φαινομενα, *sōzein ta phainomena*). See: Lloyd, 1978.

'cover-up' of its knowledge of extraterrestrials (see Festinger, Riecken and Schachter, 1956; Festinger, 1957).

Fermi then surprised his colleagues by bursting out with the question: "Where is everybody?" It was apparent to them all that he meant extraterrestrials. He performed a quick series of calculations, similar to Drake's, and also made an estimate of how long it would take an advanced technology-possessing extraterrestrial civilisation, equipped with interstellar space-flight capability, to visit all parts of our Galaxy.

He concluded that, if such a civilisation or civilisations existed, it or they ought to have visited Earth by now, and probably even many times over (von Däniken, 1968, argued this had happened, of course, on the basis of spurious evidence and a wholly pseudo-scientific argument[7]). The fact that they had not done so was proof that (1) interstellar space-flight is impossible; or (2) if possible, is considered to be not worth the effort; or (3) technological civilisation does not last long enough for it to happen.

There is, of course, another possibility, namely that (4) technological civilisations with the potential to develop a capacity for interstellar space-flight have never arisen elsewhere in the first place; and this seems likely, given our failure to detect any radio or other electromagnetic signals from intelligent extraterrestrial sources since the active search for them began.

It is not that there has not been time for such civilisations to develop: Lineweaver, Fenner and Gibson (2004) point out that our Galaxy's Galactic Habitable Zone (GHZ[8]), the region of Galactic space lying in the plane of the Galactic disk, stretching between 7 kiloparsecs from the densely-packed centre of the Milky Way (and consequently unaffected by the high numbers of life-destroying supernovae that take place there) and 9 kiloparsecs, contains numerous stars like our Sun (8.5 kpc from Galactic centre, p.4), that may harbour complex life, but most of them (~75%) are rather older – by an average of ~1 billion years (p.6). If technology-possessing

[7] The 1999 edition published by Berkley Books, New York, describes von Däniken's tome as 'a work of fiction', and makes the usual legal disclaimer relating to names, characters, places and incidents.

[8] The inner region of this – 68% of it, comprises < ~10% of all the stars ever formed in our Galaxy (Lineweaver, Fenner and Gibson, op. cit., p.6).

intelligent life were as abundant as some suppose, then civilisations well in advance of ours ought to exist.

Hart (1975) argues that interstellar space flight at a maximum speed of 0.09-0.1 *c*, with (for example) the crew of the spaceship in suspended animation or enjoying very much longer lives than the present human norm (or presumably, both), would be perfectly feasible physically (pp.129-131). Relativistic reduction in flight-time duration would be very short, however: at 0.1 *c*, ~0.995 s would pass for every 1 s passing on Earth (if it is an Earth ship) or the alien home world, if it is extraterrestrial.

He points out that, at that speed, if – on our acquisition of interstellar travel capability of the kind he describes – we were to send out colonising expeditions to the one hundred nearest stars, all within 20 light-years of our Sun, and each of these colonies had the ability to send out their own expeditions, which could then, on founding their colonies, launch their own expeditions, and so on, then if there is no pause between trips, then, at that rate, most of our Galaxy would be traversed in 650,000 years. If, on the other hand, the time between voyages (of exploration and colonisation) is roughly the same as that taken up by the length of a single voyage, the total traversal time is doubled to 1,300,000 years (p.133).

An interstellar space-faring civilisation would, given that our Galaxy is over 10 billion years old, have had ample time to reach us, he says, unless they did not set out until less than 2 million years ago (ibid.).

He asks the same question Fermi asked, which is why, if such a civilisation or civilisations exists or exist, that there have been no extraterrestrial visitors to Earth. He dismisses the 'ancient astronaut' and 'UFO' hypotheses[9], and concludes (p.135) that no such civilisations exist, and that to search for their radio signals is probably a waste of time and money.

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[9] The latter referring to the idea of current visitation by extraterrestrial intelligences, some of whom are alleged to have abducted humans, for whatever purpose. The most plausible explanation the present author can find for this phenomenon, apart from fraud and attention-seeking behaviour, is hallucination, induced by the hallucinogen, N,N-dimethyl-tryptamine, produced in the brain itself, and related to the neuro-transmitter serotonin (5-hydroxy-tryptamine). The contents of the hallucinations, however, are constructed from the belief-systems, mental images, and fragments of memory of the persons having them. See: Luke, 2011.

Section 6: Conclusion – The Value of *N*.

To return, finally, to Drake's Equation, where we began. If we were to re-write it as:

$$N_l = R_* f_p f_l \,, \tag{2}$$

where N_l is the total number of planets in our Galaxy harbouring any form of life, then we may *speculate* (and that is all we *can* do, given the paucity of evidence) that 10% of the stars in the Milky Way have terrestrial-mass planets (see Lineweaver, Fenner and Gibson, op. cit., p.6), that 0.1% of these planets orbit their parent stars in their Circumstellar Habitable Zones (CHZs), aka 'Goldilocks Orbits', and that 90% of these have at least some form of life. If there are 200 billion stars in the Milky Way (a conservative estimate, see Frommert and Kronberg, 2005), that would give a figure for N_l of 18 million planets in our Galaxy inhabited by some form of life. If there are as many as 400 billion stars in the Milky Way, then of course that number is doubled, to 36 million.

This suggests that the probability, *P*, for *any* given star to become a harbinger of life (of any sort) is given by 18/200,000 = 0.00009 (9×10^{-5}), which is small, but not impossible, and this seems eminently plausible. This would include stars which no-one would suppose would be suitable for life, and certainly not carbon-based, oxygen-breathing life of the Terran sort, such as Sirius A (Alpha Canis Majoris, A1V, 8.7 light years away), although Voltaire (François-Marie Arouet, 1694-1778) depicts it as being so in his *Micromégas* (1752).

We could speculate further, and hazard a guess as to how many of these planets harbour *intelligent* life, bearing in mind that 'intelligence' need not mean 'advanced technology possessing' intelligence. However, this would be fruitless, as we do not – as yet, at any rate – possess the means of detecting such life over interstellar distances, whereas we may, before too long, possess the means to

detect life, *per se*, via the analysis of biosignatures in the atmospheres of exoplanets possessing them (Seager, 2014).

To date, there have been no detections of any radio, microwave, or other electromagnetic signals that it has been possible to confirm are both of extraterrestrial origin and sufficiently structured, coherent and plausibly information-containing, to warrant the description 'intelligent'. (It is indeed another problem entirely how we would set about deciphering any interstellar messages if we actually received them.)

With the N of equation (1) equal to 0, we can only, for now, conclude that either f_c is 0, or that L is so short that radio-telescope-possessing civilisations, if they exist elsewhere, destroy themselves or disappear in the blink of an eye. This does not bode well for our own survival prospects.

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[10] Abbreviations used: DOI = Digital Object Identifier; BibCode = Bibliographic Code; ISBN = International Standard Book Number; ISSN = International Standard Serial Number; pbk. = paperback; hdbk. = hardback; *PNAS = Proceedings of the National Academy of Sciences of the United States of America*.

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