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# BOOK REVIEW

*If The Universe Is Teeming With Aliens . . . Where Is Everybody? Fifty Solutions to the Fermi Paradox and the Problem of Extraterrestrial Life*. By Stephen Webb. Copernicus Books, New York, 2002. 304 pp., $27.50 (hardcover), ISBN 0387955011.

> *So, I am spending my time in seeing how many new viewpoints I can take of what is known. . . . Maybe that's why young people make success. They don't know enough. Because when you know enough it's obvious that every idea that you have is no good.*
>
> Richard P. Feynman (1918–1988)[1]

An urban legend (corroborated by historical research!) says that the great physicist Enrico Fermi (1901–1954) at a lunch asked 'Where is everybody?' aiming his remark at the obvious absence of extraterrestrial civilizations (henceforth ETCs) or their manifestations. Being a mathematical prodigy, it was easy for Fermi to estimate that, even going at a modest fraction of the speed of light, the time it would take to cross galactic distances is small compared to the Universe's age. The simplest estimate tells us that the characteristic timescale for touring the Milky Way is about $10^7$ years for using the technologically acceptable velocity of 1% of the speed of light. This is more than three orders of magnitude smaller than the age of the Galaxy (12–14 Gyr). Assuming there are other technological civilizations out there and that we are an average one, some will be more advanced and others less so. So the question arises: where are those that are more advanced?

Fermi's question[2] has attained almost a cult status in subsequent decades, especially after the inauguration of the first serious Search for ExtraTerrestrial Intelligence (SETI) projects in 1960s. After a period of 'contact optimism', which lasted till about mid-1970s, we have witnessed wakes and tides of interest in SETI during the last quarter of century. Today, we perceive a rapid development of the nascent science of astrobiology, which strives to address the following canonical questions: How does life begin and develop? Does life exist elsewhere in the Universe? What is the future of life on Earth and in space? Obviously, Fermi's question is tightly intervowen with all three. In the same time, astrobiology strengthens linkages between science, technology, and the humanities, creating an integrated view of

our world that will be beneficial, helping to define the roles that future generations will play as stewards of our global environment and its resources. Therefore, we have every reason to devote attention again to the challenging problem of existence (or otherwise) of ETCs.

There are scientific problems which are so difficult that literally dozens of solutions are proposed in the research literature. Origin of life on Earth in biology or the nature of narrow absorption lines in quasars in astronomy are examples of such problems. The origin of gamma-ray bursts **was** such a problem in astronomy until recently, when it was triumphantly solved by tremendous advances in both observations and theory. However, no such 'big' problem is more challenging and fascinating than the problem of extraterrestrial intelligent life, and especially the aspect dealing with Fermi's paradox. *If The Universe Is Teeming With Aliens... Where Is Everybody?* by the U.K. physicist Stephen Webb (Hereafter referred to as '*Where is Everybody?*'), thus sets out to perform an ambitious task of investigating all relevant solutions to the problem. The aim of this book is to expound Fermi's paradox in all details and to offer a comprehensive list of solutions proposed in the literature so far. Thus, the book will be useful to the specialist and layman alike, though probably for different reasons. To researchers in biology, astronomy, and cognitive sciences, it will be useful as both a compendium of ideas and a wealth of research challenges for making precise quantitative models. On the other hand, Webb's book has a tremendous potential for public outreach, and communication of modern scientific ideas to the general public in the best manner of two great, unfortunately late, astrobiologists, Carl Sagan (1934–1996) and Sir Fred Hoyle (1915–2001).

The very concept of this book is an excellent antidote to scientific dogmatism which easily arises in fields with so little empirical knowledge and so many conflicting theoretical ideas; it is this dogmatism which, unfortunately, makes synthetic reviews, such as Webb's, so rare, in spite of the explosive development of astrobiology. This book is best to read in tandem with Ward's and Brownlee's recent astrobiological treatise *Rare Earth*.[3] There are many points of contact, and ideas are obviously complementary, especially since Webb devotes the largest part of the discourse to scenarios which in one way or another imply rarity or uniqueness of the terrestrial-type conditions. *Rare Earth* certainly makes understanding of some of Webb's points significantly easier, especially in the last two Chapters. There is no special background knowledge required, although some understanding of modern astronomy and biochemistry will be immensely useful to a prospective reader.

Introductory parts (Chapters 1 and 2) contain a wealth of historical and anecdotal material about Fermi and his dinner party paradox (as well as some other paradoxes in the history of science), making for refreshing and instructive reading. The book's substance comes in three large chapters, corresponding to what Webb perceives as the main watershed in attempts to address Fermi's paradox: Chapter 2 considers solutions of the paradox which deny the main premiss by claiming

that ETCs **are** here (#1 through #8); Chapter 3 deals with the replies contending that they exist, but have not yet communicated (#9 through #30); Chapter 4 is comprised by those solutions accepting the conclusion that, in some sense to be further specified, we are alone (#31 through #49). A final Chapter, very brief, deals with the single solution (#50), which the author finds the most convincing (more on it below).

Webb's book appears almost exactly two decades after arguably the finest review article on the topic, David Brin's 'The "Great Silence": the Controversy Concerning Extraterrestrial Intelligence.'[4] In the meantime, there have been very important advances, especially in extrasolar planet detection and biochemistry of early life. Other relevant developments concern the role of catastrophic occurrences in the history of terrestrial life, our improved understanding of Galactic chemical evolution, as well as planetary formation and evolution, and discoveries of a number of extremophile lifeforms potentially having their extraterrestrial counterparts. *Where Is Everybody?* contains a wealth of information on these topics, masterfully weaved into a colorful tapestry of an engaging intellectual quest. Most of the hypotheses Webb reviews are attractive proposals in their own right; but he takes into account several distinguishing parameters and motivations, some of them of quite recent origin. Notably, Webb's insistence on favoring 'non-sociological' explanations of the paradox (i.e., excepting those which assert that ETCs for some reason do not **wish** to contact us) is highly commendable, being perfectly in tune with the general tone of modern astrobiological discussions.

Among many merits of this book, the most obvious one is its relaxed style which enables easy digesting of occasional portions of complex material. There are such portions present, in spite of the book being occasionally marketed in the 'Popular Science' sections. One of its very best features is quite explicit emphasis on the multidisciplinary nature of the task. As such, it delights with many side issues, some of them making the book worth in themselves. Agreeable digressions include such gems as Smolin's self-reproducing evolutionary Universe theory (pp. 56–59), the puzzling Voynich manuscript (pp. 119–120), or Chomskyan neurolinguistics (pp. 224–226). In addition, there is a lot of material scattered throughout the book which can serve as a neat introduction to astrobiology at the undergraduate level.

The book contains a wealth of references to popular culture, notably SF publications and movies, which is legitimate and commendable, since the same cultural aspects motivated a large number of researchers in astrobiology. After all, a large part of the discourse about extraterrestrial life and intelligence that people encounter is in form of fiction and other recreational contexts. What is a bit less commendable is Webb's cultural bias, since all his references in this domain are to books (and movies) of Anglo-American science-fiction. This is a pity, since some of the best relevant SF appeared outside of that cultural milieu; shining examples that come immediately to mind are Stanislaw Lem's *His Master's Voice* and *Fiasco*, as well as Strugatsky's *Roadside Picnic* (and the brilliant 1979 movie *Stalker* made by Andrei Tarkovsky using this novel as its basis). The omission is even more

serious, since some of these books offer a detailed hypotheses, elaborated as much as some of Webb's solutions; see, for instance, the chapter on neutrino-encoded alien message in *His Master's Voice*.

On the technical side, *Where Is Everybody?* passes with flying colors. The volume is robustly made, as well as aesthetically pleasing. Graphical design of the book is attractive, though somewhat unconventional. Some of the illustrations are truly splendid (e.g., the tearing of the Berlin wall, p. 132, or the atmospheric ozone depletion, p. 168), and the book is a rarity in being almost entirely free of typographical errors. It has a large bibliography, which is generally satisfactory, with some exceptions listed below.

And still... One misses too many relevant issues for this book to be the definitive review of the problem of extraterrestrial intelligence. I shall mention several personal misgivings which are of wider importance and about which a prospective reader should certainly be warned.

The division of proposed solutions into three large groups is certainly satisfactory. What I really desired, however, was a succinct comparative analysis at the end of each major Chapter (3–5) giving main pros and cons of the solutions presented, possibly in tabular form. Even if these assessments were subjective, they would still be useful since they would highlight the most important points in sometimes intrinsically confusing hypotheses. In addition, such summaries would motivate reasonable polemics and comparative analysis of the issues involved. However, after reading each major chapter of *Where Is Everybody?* one is left with a feeling that similar credability can be assigned to many of the hypotheses presented, which clearly is not the case. Also, it is a bit strange that in a book devoted to search for extraterrestrial **intelligence** the question 'What is intelligence?' is not tackled until page 218! While it is clear that these fundamental issues are usualy not part of the concern of a practicing astrobiologist, still it seems that a comprehensive review must delve deeper into foundational topics than Webb undertakes. While discussing UFOs and other non-viable solutions of Fermi's paradox, he does, from time to time, consider philosophical and methodological issues, but unfortunately, it seems that his epistemology stops at the very beginning of a serious discourse. In such immature fields, philosophy of science is not just a side hobby or a luxury; it is *sine qua non* of any rational investigation.

Some solutions of Fermi's paradox offered by Webb are not very serious, and that **does not apply only** to the jocular #1. For instance, #24 (ETCs developing different mathematics) is not only incorrectly formulated,[5] but rather incredible as the solution of the very real problem. The same applies to #29 (cloudy skies prevent development of science **everywhere else**) and #30 (particle horizons limit detectivity of ETCs). The latter is essentially *non sequitur*, since Fermi's question applies to our Galaxy, as the fundamental unit of the cosmological distribution of matter. To claim that ETCs are beyond our cosmological horizon is the same as to claim that we are alone; it actually begs the question. To this, one is tempted to add another problematic feature: solutions which are **made** non-serious by poor presentation.

The treatment of the 'Berserker' solution (#22) is an example. Its main idea is that the self-replicating extraterrestrial probes will act destructively against other civilizations (or simply advanced lifeforms), instead of colonizing or peacefully exploring. The idea has been suggested several times both in SF literature and in SETI discussions at conferences or in newsgroups, but Webb quotes perhaps the least appealing source, Fred Saberhagen's 'Berserker' novels. We read that it 'has been criticized on several grounds,' but we do not learn by whom. On the contrary, in the best review predating Webb's book (Brin's article), it is selected as one of only two entirely satisfactory solutions to the problem. In addition, this solution has been seriously misrepresented; when one uses the version of Brin (or, for SF fans, Gregory Benford in his 'Galactic Center' novels) most of the 'problems' dissolve; they are artifacts of Webb's presentation.

If the Devil really lies in the details, than his unholy presence taints some sections of Webb's book more than others. There are two basic types of problems in those details. One, more of the annoyance type, is the lack of exact references and original sources at many places. For instance, if we read about the fascinating (though, of course, completely ludicrous) idea of a serious chemist that the Martian moons are artificial satellites launched in 19th century (p. 39), than we would like to know the exact source of such a hilarious claim – and we don't get it. The other, more serious problem, is the lack of some important pieces of the story for quite a few of those 50 solutions. For example, in discussing the possibility of an alien presence in the Solar System, Webb does not mention the well-known case of near-Earth object 1991VG, whose unlikely orbit prompted serious inquiry into whether it might be of alien origin.[6] Limits on the detectability of astroengineering with the present technology would be very useful at several points in the book, but this important issue has not been considered at all! Similarly, solution #39 (The Galaxy is a dangerous place) mentions in passing the idea of deadly neutrinos originating in terminal collapses of massive stars, but fails to attribute it properly to Juan Collar who first suggested it in (the highly visible) *Physical Review Letters* article in 1996.[7] Solution #34 ('We are the first') fails to reference arguably the most important recent work in this respect, the paper by Charles Lineweaver,[8] which is the first attempt to give a quantitative treatment of the ages of terrestrial planets throughout the Milky Way. Lineweaver's result that, on the average, Galactic Earth-like planets are 6.4 ($\pm$ 0.9) Gyr old certainly impacts more than one hypothesis proposed to account for Fermi's paradox.

In such an ambitious project, some redundancy is unavoidable. However, one would expect redundancies to be of a subtler nature than simply rephrasing an entire solution, depending on the emphasis of the original authors. The most blatant example is distinguishing between #8 (God exists) and #31 (the Universe is here for us), which are even located in different chapters, although they both distill to the same simplistic anthropocentric idea. Also, the rather well-known 'Zoo Hypothesis' of John Ball (#5) is just a special case of the general 'Interdict Hypothesis' (#6). As if that wasn't enough, both of these solutions are in fact special cases of

an even more general suggestion, #23 ('They have no desire to communicate')! If Webb's approach were historical, this would have some justification (if one can argue that the ideas developed independently, or were differently motivated), but this is obviously not the case.

To this category of demerits, one may add several odd unsupported assertions whose source is either fashion ('It is also worth emphasizing that the success or failure of nanotechnology will determine whether we ever develop Bracewell-von Neumann probes.' – p. 126; in spite of all nanotechnological hype, there is simply no discernible reason why interstellar probes could not be a purely macro-technological endeavor) or a personal prejudice as far as the philosophical side of the problem is concerned ('Such a discovery [of extraterrestrial signals] would cast in doubt the WAP and SAP' – p. 147; if WAP is tautologous, as claimed only a page earlier, nothing can cast it in doubt; but, more importantly, there is no *prima facie* reason why a discovery of carbon-based planetary life elsewhere would do anything but confirm the observation-selection effects on which WAP is based[9]). Although these statements do not play any role in Webb's argument, their presence taints the overall achievement.

In general, the treatment of the 'catastrophist' solutions (e.g., #22, #27, #39, #40) is rather incomplete and biased; this is seen even in the distribution of the material between the chapters. Annis' ingenious hypothesis that gamma-ray bursts can regulate the development of complex life on the Galactic scale is put into Chapter 5 ('We are alone') instead of Chapter 4 ('They exist unnoticed'), although the author himself admits that according to this hypothesis 'there is nothing special about Earth or humanity; there may be tens of thousands of ETCs in our Galaxy at or near the same stage of development' (p. 172). In addition, the whole idea of 'Galaxy as a dangerous place' is mispresented by asserting that we should search for an explanation of our own existence if the risks are high *ceteris paribus*. That is not so, since any risks (say, supernovae explosions) are stochastical, and we need to use Bayesian probabilistic formalism to determine whether some occurrence is likely or unlikely. In this context, the observation selection effects are all-important, since we cannot, obviously, observe complete lack of life in the Galaxy. Webb's treatment of 'luck' shows his 'optimistic' bias in an amusing way: talking about the danger of overpopulation, he writes that 'If we are lucky, the world's population will... reach a steady state' (p. 125). However, when it comes to the danger to life from nearby supernovae '... luck is a poor sort of explanation' (p. 169).

As for the preferred solution of the author (#50), it is a bit of an anticlimax; as if in a murder mystery novel or film, after lots of suspense, masterful psychology, ingenious deductions, and unexpected plot twists, you discover that the killer is the butler who found the body, since all other persons involved turn out to have unshakeable alibis. This is not to say that the solution is itself flawed; after all, **there are** some exciting detective novels (e.g, some of George Simenon's best) with exactly this kind of structure. Still, without disclosing too much, it seems that two natural tendencies of any author of review texts, namely to give a satisfactory

conclusion to the whole project and to express a personal expert opinion on it, conflicted in this case. As a result, we receive a patchwork quilt solution into which too much is subsumed (and assumed!) and too little explicated and interpreted. Personally, I do not find the concluding solution persuasive, but that is not a serious misgiving as far as the book is concerned, since little space is actually devoted to it.

This brings us to probably the most obvious attraction of *Where is Everybody*. The solutions Webb offers are many, and everybody will find at last a couple to her/his own taste. As noted by Jorge Luis Borges, from Homer onward we know that making long lists is a matter of style, apart from often being a necessary enterprise. One of the 'secret' pleasures of reading Webb's book is that everybody can choose his/her favorites out of 50 or so candidates (even with the redundancies mentioned above) candidates. My personal 'top five' picks are, #32/#39 (Life can have emerged only recently/The Galaxy is a dangerous place), #11 (Percolation theory), #22 ('Berserkers'), and #7 ('Planetarium hypothesis'/Simulation argument). Enjoy making your own list!

All in all, Webb's book is a worthy addition to the rather small library of serious monographs on extraterrestrial life and intelligence. It is far from being perfect, and some of its flaws are really hard to excuse. One should not take it at face value without at least some acquaintance with other important review literature in the field, notably Brin's seminal article. But it is still a valuable contribution to the field in which, paradoxically enough, this sort of synthetic study is sorely lacking at exactly the time when it is most needed. As mentioned above, it is very difficult to find a book even similar to it, and it certainly is more than worth its (rather low) price. Its re-reading potential is great, and it will be interesting to follow how many new and exciting astrobiological studies currently planned or on the way will influence the solutions Webb lists – or add new ones. Even if you take large chunks of it with a grain of salt, *Where is Everybody?* deserves a place on the bookshelf of any person curious about the Universe and life in it, in both professional and lay domains.[10]

## Notes

[1] Quoted in Gleick, J. *Genius: The Life and Science of Richard Feynman* (Pantheon Books, New York, 1992), p. 326.

[2] Or Fermi's paradox, or the 'Great Silence' problem, or astrosociological paradox, or any other of many monikers the same problem has had during the last half of century.

[3] Ward, P. D. and Brownlee, D. 2000, *Rare Earth: Why Complex Life Is Uncommon in the Universe* (Springer, New York).

[4] Brin, G. D. *Q. Jl. R. astr. Soc.* **24**, 283 (1983).

[5] Most mathematicians are **not** Platonists (though many **great** mathematicians were). Distinguished Platonists, like Gödel and Penrose, freely admitted they were the minority view.

[6] E.g., Steel, D. *The Observatory* **115**, 78 (1995); **118**, 226 (1998).

[7] Collar, J. I. *Phys. Rev. Lett.* **76**, 999 (1996).

[8] Lineweaver, C. H. *Icarus* **151**, 307 (2001).

[9] In fact, Fermi's paradox itself is based on the same observer self-selection which underlies WAP; see, e.g. Bostrom, N. *Anthropic Bias: Observation Selection Effects in Science and Philosophy* (Routledge, New York, 2002).

[10] It is a pleasure to acknowledge invaluable technical help of Richard Cathcart, as well as useful discussions with Irena Diklić, Mark A. Walker, Robert J. Bradbury, Ivana Dragićević, Slobodan Popović, and Nick Bostrom.

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