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Three explanations for extraterrestrials: sensible, unlikely, mad

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Abstract: The Fermi Paradox (or Question) has moved back into central focus. This is for a number of reasons, not least the evidence for both the abundance and antiquity of many extra-solar systems, the extrapolation of current technological trends to suggest that even inter-galactic colonization (by self-replicating machines) is plausible (if not desirable), and the recurrence of evolutionary solutions (convergence) in the terrestrial biosphere suggesting that features such as intelligence and tool-making are not fortuitous outcomes, but frequent if not universal. Here I review the three possible solutions to the Fermi Paradox. First, extraterrestrials certainly exist (and may be abundant), but for one reason or another (probably mundane) we have not yet met them, or at least found evidence for their existence. Second, against all expectations, we are alone. Third, we have entirely misunderstood the sort of universe we live in and have become unwitting hostages to a strict materialist explanandum that in refusing to acknowledge the other realities of our Universe has derailed any prospect of explaining the apparent absence of extraterrestrials.

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Introduction

Anybody who considers the question of extraterrestrial life has to agree that Enrico Fermi hit the nail on the head when he asked: 'Where are they?' In the interests of historical accuracy, we would be remiss if we overlooked Gray's (2015) point that the comments Fermi made – in the context of that celebrated conversation in Los Alamos (Jones 1985) – were apparently more to do with the likelihood or otherwise of interstellar travel as against the problem that aliens did not regularly drop in for gin and tonics. This point – concerning the apparent lack of aliens, not their propensity for G&Ts – subsequently has been articulated in detail by many others, beginning with such notable contributions as Hart (1975) and Tipler (1980). More recently the expectation that there *must* be extraterrestrials has been reinforced by several separate lines of evidence. Most obviously these are: the likely number of extrasolar planets suitable for habitation (e.g. Wandel 2015), plausible extrapolations of current technologies to build self-replicating probes to enable even an inter-galactic diaspora (e.g. Wiley 2011; Armstrong & Sandberg 2013), and the prevalence of convergent evolution, including tool-making and intelligence (e.g. Conway Morris 2003, 2015*a*; Flores Martinez 2014). Increasingly the view is that when it comes to the existence of extraterrestrials then something does not add up. Everything seems to point to their existence, but to reiterate: Where on earth are they?

That is the problem in a nutshell. And not for want of thinking, as several overviews of the Fermi paradox (e.g. Brin 1983; Webb 2002; Ćirković 2009) make clear. In their several ways these and similar reviews are not only judicious but in collectively exploring the various alternatives for those ostensibly absentee extraterrestrials have a sort of recurrent drumbeat that somehow the answer is obvious but we keep on missing the point. In any event, short of something like First Contact (the White House, of course), a Cretaceous dinosaur trackway (in Texas, naturally) complete with the footprints of an alien film-crew (clever of Mortimer to spot the imprints of the camera-tripod), or the equivalent to the *Marie Celeste* – found spinning through the Kuiper belt – (e.g. Haqq-Misra & Kopparapu 2012), then one might wonder if there is much more to be usefully said.

When it comes to the existence of extraterrestrials all I can do is to try and keep an open mind. Let me say at the outset, however, that my own contributions to this area (e.g. Conway Morris 2005, 2011, 2015*b*) are so slender that they hardly place me in a position of any authority. Where I might have something useful to say revolves around evolutionary convergence, and here at least the sheer ubiquity of convergence in the terrestrial biosphere suggests that in areas as disparate as biochemistry, locomotion and intelligence what we see on Earth will have close counterparts 'out there'. From this approach alone any argument that we are alone (or so rare as to make no difference) would seem to need some special justification. Combine this with the series of other (and independent) lines of enquiry, then any declaration that the only biosphere in the Milky Way (or perhaps the entire visible universe) is here on Earth would verge on the fantastic. Or does it? For better or worse let me offer three alternatives to the Fermi paradox: obviously right, obviously wrong and insane. Unfortunately it

is beginning to look like last one is actually the correct answer. To proceed:

The sensible view

This is the territory of 'everybody knows', a comfort zone of received truths that the Bloomsbury group developed into a high art and is now to be found across the Academy in support of innumerable lost causes. Anyway, the argument goes as follows: Yes, aliens are there (well somewhere, and in parenthesis here I leave aside the possibility of extraterrestrials in the form of non-carbon-based life, e.g. Bains 2004; Benner *et al.* 2004) but with apologies to all the server is down. Please wait for further announcements. From our very local perspective it is all rather irritating, but not to worry: extraterrestrials are not necessarily common but certainly they exist. All we have to accept is that for one reason or another, the chances of actually meeting them are very low. No matter, as we gaze into the night sky we can be rest assured that 'out there' a necklace of civilizations spans the Milky Way: some nascent, a few in full flower and too many in terminal collapse. At any one time there will be at least one such functioning civilization – after all here we are – but overall, probably not very many. As I write, let us say that across the Milky Way there are five, but frankly who knows? The trajectory of each and every society will no doubt differ, but in any event across the galaxy civilizations come and go. Most are short-lived and there is an end to it.

We certainly can add a gloss to the fact that however unlikely it is that we will ever meet extraterrestrials, in the grand scheme of things their existence is practically guaranteed. First of all the arguments based on convergent evolution (e.g. Conway Morris 2003, 2015*a*; see also Flores Martinez 2014) give me at least some confidence that something analogous to a sentient human is very much on the cards rather than it being the evolutionary fluke that forms a core belief of the great majority of evolutionary biologists (e.g. Simpson 1964; Diamond 1995; Mayr 2004). This is not to say that all intelligences are the 'same' (e.g. Herzing 2014), but on the other hand one can also target those parts of a galaxy where all things being equal intelligences are more likely to emerge (Morrison & Gowanlock 2015). In passing, and in my view this is still underappreciated, there are two additional factors relevant to this particular argument. First, recall that a substantial proportion of the molecular machinery required for such complex structures as eyes (e.g. crystallins, see for example Tomarev & Piatigorsky 1996) and brains (e.g. synaptic connections, see for example Alié & Manuel 2010) have evolved long before the structures in question emerged; self-evidently such machinery has been co-opted for a novel function. Second, evolution in the context of the emergence of complexity goes far beyond the standard Darwinian formulations, not least in the area of self-organization where it is clear that structures such as the eye effectively self-assemble (e.g. Eiraku *et al.* 2011; Dawes *et al.* 2014). So too in their own way examples of convergent evolution are increasingly put into the context of 'attractors' (e.g. Wilson *et al.* 2007). Collectively these lines of evidence suggest that the outcomes of evolution are likely to be far more restricted than is currently supposed and accordingly the terrestrial biosphere should provide a reliable guide to its many alien counterparts. Nor need this predictability be restricted to close analogues of the Earth. Arguments can be made that even terrestrial extremophiles have reached the limits of every physicochemical niche in the universe (Conway Morris 2011). Moreover, even on planets that are radically different in such features as atmospheric density, the universal scaling laws and constraints such as Reynolds Number will still allow sensible inferences as to what the corresponding biological form must be.

One important qualification in this discussion of the prevalence of extraterrestrials, if not humanoid-like forms, is the appealing idea that the history of the universe is marked by one or more so-called phase transitions (e.g. Ćirković & Vukotić 2008). From this perspective the mantra of 'Same today, same tomorrow, same *ad nauseum*' maybe seriously misleading. Particularly interesting are the proposals (e.g. Annis 1999) that the intense pulses of radiation released in the form of gamma-ray burst (GBRs), and especially the so-called long-GBRs that evidently result from the collapse of supermassive stars, have the potential to severely damage a biosphere (e.g. Galante & Horvath 2007; Atri *et al.* 2014; Piran & Jimenez 2014). If in the case of an inhabited planet such bursts were in sufficient proximity and/or sufficiently energetic then in principle they could repeatedly frustrate at least the emergence of terrestrial intelligences. The escape clause, however, is that this only remains true until such time that the frequencies of such bursts – and corresponding planetary disruption – decline to a low enough level that the required interval of several hundred million years of relative safety are available and so ensure that the evolutionary steps from 'reptile' to 'sentient mammal' can proceed to 'completion'. This assumes, of course, that the terrestrial time-table of evolutionary transitions is broadly applicable elsewhere and while this might (or might not) apply to features such as eukaryosis, with the emergence of a multicellular organism with differentiated tissues (aka an animal) it seems the putative time-tables may not differ by more than an order of magnitude. This, one should stress, is the view of a biologist. Physicists *sensu lato* (e.g. Livio 1999; Carter 2008) approach the problem from a necessarily different perspective. All have agreed the latitude in planetary timescales of evolution are subject to many imponderables. Perhaps, however, one aspect of the so-called 'Hard Steps' in the evolutionary programme that has been more neglected is that Darwinian evolution has, as already noted, a remarkable knack of co-option in that biological components can be readily re-deployed for novel functions. Such is evident, for example, with the evolution of bacterial tubulins that are a *sine qua non* in eukaryosis (e.g. Duggin *et al.* 2015). Combine this with the repeated evolution of complex systems, such as internal membranes and organelles in bacteria (e.g. McInerney *et al.* 2011), then it might transpire that the so-called 'Hard Steps' (and here we include multicellularity and nervous systems) are less of an obstacle than is usually thought.

To return, however, to the question of phase transitions in the context of gamma-ray bursts. Because the decline in their

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frequency will be a galaxy-wide (if not universe-wide) phenomena, we really ought not be too surprised if, more or less as I write, popping up all over the Milky Way are individuals with names like Fermi who declare 'Now, that's very odd: where is everybody?'. There might, however, be at least two problems with this hypothesis. First, there is a strong link between low metallicity stars, rates of stellar formation and the overall likelihood of GBRs (e.g. Jimenez & Piran 2013). In this context dwarf galaxies are definitely not places to bring up the children, whereas in contrast the Milky Way is relatively benign. Second, the timescales of this proposed phase transition have some latitude and if one takes even a conservative estimate of the timing of a galactic diaspora, it would be a curious coincidence if we just happened to be the very first species to spawn its Fermi.

One more important qualification to the question of how we might go about finding those pesky extraterrestrials is called for. As already mentioned much of the debate as to where 'they' live, what 'they' look like, and how 'they' choose to conduct their lives, has been conducted on the assumption that extraterrestrials will be like us, only nicer, cleverer, more long-lived and in every other sense simply better. Science-fiction writers such as Isaac Asimov and Arthur C. Clarke skilfully depict such a Galactic Club. How one goes about joining such a Club (one, for example, might subscribe to the Zoo hypothesis of Ball (1973) and in this context see also Fogg 1987 and Forgan 2011) encourages further exercises in imagination. Anycase, assuming that whatever else happens all extraterrestrials have to start off as carbon-based planetary products, there is a growing realization that our own technological trajectories now seem to be taking us in an entirely new direction. In other words, Darwinian systems (with tiresome habits like needing to go to the lavatory several times a day, not to mention dying) are currently evolving, or if you prefer mutating or even metastasing, into machine-based intelligences (e.g. Ćirković & Bradbury 2006; Armstrong & Sandberg 2013). Not only that, but as Ćirković *et al.* (2005) point out the transition to silicon-based intelligences implies that sooner rather than later the environment becomes of nugatory importance so that time-honoured adaptive strategies, at least in a Darwinian context, become an irrelevance. And where might all this end? Should we look towards so-called Jupiter' (Sandberg 1999) or 'Matrioshka' brains (Bradbury 2001), parked either on the edges of a solar system and/or the galactic margins so as to dissipate as effectively as possible the colossal amounts of heat that will be generated? Such objects might be difficult to find, but any such anomalous infrared source will provide the vital clue (e.g. Wright *et al.* 2014) that our 'descendants' have indeed entered new realms. As we will see below, however, initial surveys for comparable structures have drawn a blank. Even more speculative is the question of quite what any sort of 'Jupiter brain' might be 'thinking'. Will solving a more complex version of a trillion quadratic equations be so rewarding? In any event, it is far from obvious that such 'brains' would have any particular interest in us mere mortals.

So in one way or another, the 'sensible view' is surely the right one. Extraterrestrials undoubtedly exist and however bizarre their shape or manifestation, do not worry because one day, if the human race survives, we will know. Whether that would bring us any comfort is an entirely different question. Perhaps then to escape this uncomfortable conclusion let us now turn to the obvious alternative. Extraordinary as it seems, we are in fact completely alone.

The unlikely view

Fermi, or if you prefer Hart and Tipler, were right. Extraterrestrials do not exist. Perhaps if Fermi had been asked in 1950, during that famous lunch, how many solar systems there might be, he might have paused and then responded 'Some, but not so many'. That at any rate was the received wisdom until the revolution in the discovery of extra-solar planets. Now the galactic bean-counters know that not only are there stars a-plenty (in the Milky Way about a 100 billion), but that Earth-like planets will be two a penny. Yes, important factors such as relative widths and stabilities of habitable zones, chemical composition of the planet (e.g. Barnes *et al.* 2009; see also Chopra & Lineweaver 2016), behaviour of adjacent gas giants, availability of moons, not to mention the star type, are potentially confounding factors (see also Gowanlock *et al.* 2011, Fritz *et al.* 2014) and so must be taken into account. Nevertheless, when it comes to estimating the relative frequency of planets that are close facsimiles of the Earth (e.g. plate tectonics, daughter planet (aka the Moon), oxygenic photosynthesis, etc), such considerations will inevitably trim the roster of candidates, but not to the extent that the Earth is unique (the 'Rare Earth' hypothesis).

So, should not these remarks be applied to the argument given above that extraterrestrials may not be common, but in odd corners of the galaxy they continue to pursue their lives? In principle this is correct but the stumbling block that makes matters much worse is that it is now evident that, rare or not, many such worlds far predate the age of the solar system. This is not by a relatively short interval, equivalent to the Phanerozoic (c. half a billion years). Rather on average it is a couple of billion years (Lineweaver 2001; also Lineweaver *et al.* 2004), while at least some solar systems could easily be twice our age. On this timescale the evolutionary dice necessary for the ultimate emergence of intelligences are being thrown many, many times. In the spirit of the Drake equation we can adjust the figures to our mutual convenience but given the likelihoods of first the emergence of intelligence, as well as the subsequent development of technologies that apart from anything else ensure the long-term survival of the species, then the Fermi paradox comes home with a vengeance. Not that there are no extraterrestrials. There are, but we could never know about them because we would not be here. At least, however, we would have the theoretical satisfaction of knowing that our distant ancestors, in the form of Cambrian fish such as *Pikaia* and *Metaspriggina* (Conway Morris & Caron 2014), were absolutely delicious on toast, especially if washed down with a properly cooled Montrachet. But as we *are* here, then it follows that the likelihood of any sort of alien sentience (and with whatever sort of 'end point') remaining 'unobserved' (be it in the fossil record, discovery of a probe, etc) must be vanishingly small.

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What might be taken as a variant on these speculations is Bostrom's (2008) riff on why we must keep our fingers firmly crossed that, for whatever reason, we will continue to fail to find any evidence for extraterrestrial life. As he points out the discovery of even microbial life on Mars (and here we assume that there has not been local panspermia, e.g. Gladman *et al.* 2005; Worth *et al.* 2013) would for us be grave news, while anything akin to a Martian trilobite would be positively terrifying. As he paradoxically remarks: 'Dead rocks and lifeless sands would lift my spirit' (p. 72). The reason is that evidence of such independent originations would suggest that complex life to be a near-certainty beyond the solar system. In other words the separate emergence of life on Mars would be compelling evidence that it can readily occur anywhere else and, as already argued, we would be beaten to the post. Alternatively, as Bostrom also points out, if we are the only sentient species in the visible universe this does not mean that the future is free of threat, but we can anticipate such dangers and, all things being equal, humans have a most promising future (see also Bostrom 2003*a*).

And there are other ways we might test this supposition. Earlier I introduced the idea that from being Darwinian products we are now self-evolving into machine-like forms. Leaving aside whether this is as feasible as is generally supposed, not least because of the knotty question of consciousness, a parallel assumption that is more familiar involves the ever-increasing demands for almost unlimited amounts of energy. Solutions such as a so-called Dyson sphere (Dyson 1960) are a common currency in the SETI literature, and more specifically is the identification of three technological levels, whereby Level II entails harnessing the energy of the adjacent star, while the somewhat more ambitious Level III corrals the resources of an entire galaxy (Kardashev 1964; see also Ćirković 2015). In any event, when it comes to the detection of either a Level II or Level III civilization then the signal would be the detection of a powerful source of mid-infrared radiation. Clearly the Milky Way is not at a Level III situation, but a survey of other galaxies would be an excellent test for extraterrestrials because one might assume that each galaxy represents an independent experiment. In other words, even if extraterrestrials are quite rare in any given galaxy, across the cosmos the probabilities will increase that surely somewhere a Kardashev type III civilization will arise. And such surveys have already been undertaken. Extending the work of Wright *et al.* (2014; see also Zackrisson *et al.* 2015), Griffith *et al.* (2015) drew upon roughly 30 000 candidate galaxies and then by a rigorous process of exclusion arrived at some 563 sources that were the most promising in terms of infrared anomalies, that is overall redness. A handful warrant more attention as possible Kardashev type III structures, but the preliminary conclusion is that if they exist at all they are very rare. Correspondingly by looking at objects that are obvious infrared candidates and comparing this with their corresponding radio emissions (the ratio being denoted as q), then all things being equal a Kardashev object would be much quieter in terms of radio emission. Of the 93 suitable objects Garrett (2015) again noted some potential anomalies, but concluded that engineering on a galactic scale was at best very rare.

All these speculations and hypotheses aside, it is difficult to avoid the conclusion that Fermi (or at least his Paradox) was correct. By any reasonable calculation aliens should be 'there', but they are not and none of the many explanations holds water. We are totally alone. In all other respects this is nonsense, and so leads me to the last – and alas correct – explanation.

We do not exist

This proposal, of course, is totally mad but unfortunately it is the correct solution to Fermi's paradox. In an attempt to make it slightly more palatable, let me suggest that just as the gilded Eurocrats live in a state of constant irritation because 'their' Europe is teeming with the 'wrong sort of voter', so we happen to live in the 'wrong sort of universe' or to be more precise in a universe where the question of extraterrestrials will have to be entirely re-formulated. Under this banner there are a gratifying range of alternative possibilities, but they fall broadly into three categories. Some themes are in common, but in their own way each offers a radically different solution to the Fermi paradox.

The first possibility is that sentient extraterrestrials remain in the universe, but in one way or another become 'invisible' to our current technologies (e.g. Smart 2012). Such transcension hypotheses have the advantage that in principle they are extrapolations of current evolutionary and technological trajectories, but suffer from twin disadvantages (from our perspective). First, the proposed transition interval between 'visible' and 'invisible' is suggested to be almost instantaneous (perhaps a few hundred years), although in this respect many of hypothesized technological transitions of a Kardashev-like nature are also likely to be geologically almost instantaneous. The more acute disadvantage is that the putative extraterrestrials involved in the process of transcension enter their alternative 'worlds' (perhaps black holes!) that from our perspective are entirely conjectural. On the more positive side this first option ('ET become invisible') has the immediate advantage of explaining their 'absence' and in presupposing trajectories that are actually physically possible invites us to investigate the 'foot-print' of either their 'departure' or current 'habitation'. In some ways this idea may not be so different from my third option, but differs in some important respects that would make it far more difficult to test.

The second category of explanation is that the universe we think we live in is virtual, constructed by 'people' who may (or more likely do not) have our interests at heart. Can we really believe that our Universe is a virtual construct? If we consign this suggestion to the realm of science fiction, then it is no more than an amusing conceit, or to put it more charitably an intriguing thought experiment. Stephen Baxter has written in this genre (and much else besides), not least in his superb story *Touching Centauri* (Baxter 2002). But is it only science fiction? In a more technical paper (Baxter 2001) he suggests that the available computational power to make our 'Universe' is

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certainly roomy on a human scale but cosmologically miniscule, say about 100 light years in diameter. So as and when those pesky humans start launching probes to distant 'bodies' and/or train lasers to bounce light off such virtual bodies then the game will be up. In other words because of the limits of computation that sustains our 'Universe', at a certain distance from the Earth supposed bodies have to remain virtual. In *Touching Centauri* Baxter explains what happens next: It may not be an eschatology but it has a horrible ring of truth.

Suggesting that our Universe is virtual is an open invitation to test the hypothesis (e.g. Beane *et al.* 2014), although it hardly seems likely that any research agency would fund such an enterprise. Their reaction would be little different from that of Milan Ćirković. He is forthright in his insistence that this notion is more than stretching our credulity. As he writes in his 2009 paper: 'It is difficult to objectively assess the value of solipsist hypotheses as solutions to FP [Fermi's Paradox]. Most of them are either untestable in principle …. They violate a sort of 'naïve' realism which underlies practically the entire scientific endeavor' (p. 16), and he continues 'we mention the solipsist hypotheses mostly for the sake of logical completeness, since they are in any case a council of despair. If and when all other avenues of research are exhausted, we could always turn toward these hypotheses' (p. 17).

But what if, and with the exception returned to below, all other avenues *are* sterile? Bostrom (2003*b*; see also Bostrom 2005, 2009; Bostrom & Kulczycki 2011), for example, argues (and here I paraphrase) that as almost certainly 'somebody' got 'here' before us, *ipso facto* we must be part of their simulation. Amusingly, and as an aside, if we do dwell in some sort of simulation then, despite the sneers of the 'moderns', who deride our predecessors for thinking they inhabited a Ptolemaic universe (nor, let us not forget, were capable of constructing precision astronomical instruments such as the Antikythera mechanism (Freeth *et al.* 2006)), ironically our virtual universe would be uncomfortably close to the one envisaged by those 'credulous' ancients. Recall that it was they who imagined the stars to be tiny holes in the cosmic canopy hinting at the light of pure creation beyond. In much the same way the ancients thought the firmament actually *meant* something (waters above, waters below and so on), while the music of the spheres was a reality that to the ear (and mind), which was atuned could be heard (see also Gray *et al.* 2001). Shakespeare, as usual, got it right. Listen to Lorenzo's words in *The Merchant of Venice*:

> *Sit, Jessica: look how the floor of heaven*
> *Is thick inlaid with patines of bright-gold*
> *There's not the smallest orb which thou behold's*
> *But in his motion like an angel sings,*
> *Still quiring to the young-eyed cherubins;*
> *Such harmony is in immortal souls;*
> *But, whilst this muddy vesture of decay*
> *Doth grossly close it in, we cannot hear it.*
>
> Merchant of Venice, Act V

Medieval Venice had its drawbacks, but was it much worse than the world we now inhabit?

The third alternative, which I think is more open to demonstration, is that the universe we live in is not in a strict sense 'virtual', but nevertheless is not at all as we imagine it to be. Rather than proposing a *Matrix*-like solution to our 'existence', with its overtones of totalitarian control combined with whimsy (the Nazis had a strong track record in this department), our Universe consists of a series of intersecting orthogonal realities. Here there might be some connections not only to the transcension hypothesis but also to such speculations as those offered by Haisch (2014) who explores the possible connections between living in a simulated universe and how this is related to the vexed question of consciousness. Importantly, and echoing St. Augustine, such a 'world' need neither be circumscribed nor is it one that is given a starting shove (aka Big Bang) and then left to get on with its own devices. Should either Haisch's radical redescription of a universe where reality is a product of consciousness (rather than the *vice-versa*), or my more unorthodox views sketched below, transpire to be on the right track, then we are invited to live in an infinitely more complex and interesting world than those sweet creatures who call themselves materialists realize.

In these scenarios 'extraterrestrials' are simply part of the game and are as integral (or irrelevant) to our existence as anything else. Although his remarks are placed in the context of our living in a simulation, Bostrom (2003*b*) makes an important point relevant to this discussion when he writes: 'If we are living in a simulation, then the cosmos that we are observing is just a tiny piece of the totality of physical existence … While the world we see is in some sense 'real', it is not located at the fundamental level of reality' (p. 11). Bostrom is quick to point out that quite what is meant by a fundamental level is open to question; as he cautiously notes 'the metaphysical status of this claim is somewhat obscure' (p. 12). Moreover, although coming from a very different angle Ćirković *et al.* (2005) also remind us that while there might be a right-hand analogue to Gould's famous left-wall of evolutionary possibilities in that there are most likely limits to biological complexity this constraint is less obvious in the case of intellect and knowledge (see also Conway Morris 2013). In other respects I doubt that the concepts of reality delineated by Bostrom and Ćirković share much metaphysical ground (for what it is worth in this regard, my money is with Bostrom), but if we can make a case that our world is not quite as 'common-sense' dictates then we might be more fruitfully employed in sorting out what sort of 'world' we really do inhabit, rather than fretting about the existence (or otherwise) of extraterrestrials.

Anycase, mindful that what now follows will be dismissed as lunacy by my few remaining readers, let me introduce Jeff Kripal's *Authors of the impossible* (2010). Not that this is the only useful source, but has the twin advantages of being intelligently dispassionate and at one level almost anthropological. In any event, to save time, let us focus on the chapter Kripal devotes to Charles Fort, these days eponymous with the *Fortean Times*. Good heavens!! The *Fortean Times*, the paranormal? It is pure Virginia Woolf territory: 'Darling, how can you possibly believe such things ….?'. But we'll leave our chums in Islington and North Oxford to huff and puff about

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much more important things (such as the democratic 'deficit' of the EU, the Turner Prize and whatever other pieces of nonsense they wish to devote their far from negligible intellects to) and return to Kripal and his portrayal of Charles Fort. Not only was he fascinated by facts that he called 'damned', but to this end Fort spent a good part of his waking hours culling from newspapers and other sources the innumerable examples of the unexplained. So, by 'damned' Fort did not mean, of course, matters diabolic, but paranormal observations that in the supposedly cold-light of day would be regarded as the products of those who ought to be certified. Except, that is, for the inconvenient fact that first the instances Fort compiled were simply too numerous to be brushed under the carpets of rationality and moreover the witnesses themselves were usually sober, intelligent and perhaps on a day-to-day basis rather unimaginative folk.

For scientists words like 'paranormal' are usually found in close association with 'career-suicide' and the like. One could, I suppose, suggest that the paranormal 'exists' in as much as demonstrably all humans are psychic wrecks and that in the final analysis all this reveals is our fathomless capacity for make-believe and wish fulfilment. Yet what I find so striking with these occurrences is that to say that delusion and fraud are sufficient explanations is surely more incredible than acknowledging that the sorts of occurrences given by Charles Fort (and many others) are so ubiquitous that they demand an explanation that reaches far beyond sociology or anthropology, let alone mass delusion. To my way of thinking the inescapable conclusion is that parallel 'worlds' intrude or intersect with ours. Usually such intersections are only for a short time, and even if they are recurrent seldom, if ever, are they predictable. If one wanted to subscribe to the relatively more orthodox suggestion of our living in a Baxter-like virtual world, then one might suggest that these paranormal 'intrusions' are little more than glitches in 'transmission', points of contact where the 'message' becomes garbled. The reason, I think, we should be suspicious of such a formulation is that the observers and witnesses are often more than passive bystanders. In many cases the 'events' experienced bear directly on the people concerned, not least in terms of predictions, admonitions and warnings. Take time out to talk to the chap on the Clapham omnibus. Before long he'll say something along these lines 'Rum thing, you know, hadn't given it a thought, she was in perfect health, and there I was hundreds of miles away and she stood there, smiled and said everything would be alright, and then she just vanished. Rum thing, if you ask me'.

Time to pick yourselves off the floor, suppress those roars of laughter and concede that not only am I entirely off-piste, but first raise an eyebrow and then adopt a tone one might employ on meeting a dog of uncertain temperament. Politely you ask: What on earth do any of these final meanderings have to do with the appointed topic of the existence (or otherwise) of extraterrestrials? The answer is: Everything. In my opinion, as presently construed and constructed the search for extraterrestrials is a snare and delusion, or at least as seen through the eyes of NASA, SETI, Breakthrough Initiatives and the like. Of course we deal with incomplete data, but be it from the fossil record, radioastronomical eavesdropping, or the infrared search for Kardashev type III technologies, in all cases we not only draw a blank but will continue to do so for as long as we care to devote the resources to this enterprise. Hints as to the correct solution have already been delineated by Baxter, Bostrom, Haisch and others. Until, however, we are willing to see the world in terms of the many dimensions that novelists such as Charles Williams (e.g. Williams 1931, 1937) have so penetratingly delineated, then we will remain blissfully unaware that our 'world' is but a minute corner of a series of inter-penetrating realities where time and space are, for want of a better word, merely rationalizations of existence, analogous to the world of Abbott's flat-landers. To conclude, of course extraterrestrials exist, but not at all in the way you ever dreamt possible.

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References

Alié, A. & Manuel, M. (2010). The backbone of the post-synaptic density originated in a unicellular ancestor of choanoflagellates and metazoans. *BMC Evol. Biol*. **10**, e34.

Annis, J. (1999). An astrophysical explanation for the great silence. *J. British Interplanetary Soc*. **52**, 19–22.

Armstrong, S. & Sandberg, A. (2013). Eternity in six hours: intergalactic spreading of intelligent life and sharpening the Fermi paradox. *Acta Astronaut*. **89**, 1–13.

Atri, D., Melott, A.L. & Karam, A. (2014). Biological radiation dose from secondary particles in a Milky Way gamma-ray burst. *Int. J. Astrobiol*. **13**, 224–228.

Bains, W. (2004). Many chemistries could be used to build living systems. *Astrobiology* **4**, 137–167.

Ball, J.A. (1973). The zoo hypothesis. *Icarus* **19**, 347–349.

Barnes, R., Jackson, B., Greenberg, R. & Raymond, S.N. (2009). Tidal limits to planetary habitability. *Astrophys. J*. **700**, L30–L33.

Baxter, S. (2001). The planetarium hypothesis. A resolution of the Fermi Paradox. *J. British Interplanetary Soc*. **54**, 210–216.

Baxter, S. (2002). Touching Centauri. In *Phase Space: Stories from the Manifold and Elsewhere*. HarperCollins, London, 380–408.

Beane, S.R., Davoudi, Z.S. & Savage, M. (2014). Constraints on the universe as a numerical simulation. *Eur. Phys. J., A* **50**, e148.

Benner, S.A., Ricardo, A. & Carrigan, M.A. (2004). Is there a common chemical model for life in the universe? *Curr. Opinion Chem. Biol*. **8**, 672–689.

Bostrom, N. (2003*a*). Astronomical waste: the opportunity cost of delayed technological development. *Utilitas* **15**, 308–314.

Bostrom, N. (2003*b*). Are you living in a computer simulation? *Philosophical Quart*. **53**, 243–255.

Bostrom, N. (2005). The simulation argument: reply to Weatherson. *Philosophical Quart*. **55**, 90–97.

Bostrom, N. (2008). Where are they? Why I hope the search for extraterrestrial life finds nothing. *MIT's Technol. Rev*. **111** (3, May/June), 72–77.

Bostrom, N. (2009). The simulation argument: some explanations. *Analysis* **69**, 458–461.

Bostrom, N. & Kulczycki, M. (2011). A patch for the simulation argument. *Analysis* **71**, 54–61.

Bradbury, R.J. (2001). Life at the limits of physical laws. *Proc. SPIE* **4273**, 63–71.

Brin, G.D. (1983). The "Great Silence": the controversy concerning extraterrestrial intelligent life. *Quart. J. Royal Astronomical Soc*. **24**, 283–309.

Carter, B. (2008). Five- or six-step scenario for evolution? *Int. J. Astrobiol*. **7**, 177–182.

Chopra, A. & Lineweaver, C.H. (2016). The case for a Gaian bottleneck: the biology of habitability. *Astrobiology* **16**, 7–22.

Ćirković, M.M. (2009). Fermi's paradox – the last challenge for Copernicanism? *Serbian Astronomical J*. **178**, 1–20.

Ćirković, M.M. (2015). Kardashev's classification at 50+: a fine vehicle with room for improvement. *Serbian Astronomical J*. **191**, 1–15.

Ćirković, M.M. & Bradbury, R.J. (2006). Galactic gradients, postbiological evolution and the apparent failure of SETI. *New Astron*. **11**, 628–639.

Ćirković, M.M. & Vukotić, B. (2008). Astrobiology phase transition: towards resolution of Fermi's paradox. *Orig. Life Evol. Biospheres* **38**, 535–547.

Ćirković, M.M., Dragićević, I. & Berić-Bjedov, T. (2005). Adaptationism fails to resolve Fermi's paradox. *Serbian Astronomical J*. **170**, 89–100.

Conway Morris, S. (2003). *Life's Solution: Inevitable Humans in a Lonely Universe*. Cambridge.

Conway Morris, S. (2005). Aliens like us? *Astron. Geophys*. **46**, 4.24–4.26.

Conway Morris, S. (2011). Predicting what extraterrestrials will be like: and preparing for the worst. *Phil. Trans. Royal Soc. Lond., A* **369**, 555–571.

Conway Morris, S. (2013). Life: the final frontier for complexity? In *Complexity and the Arrow of Time*, ed. Lineweaver, C.H., Davies, P.C.W. & Ruse, M., pp. 135–161. Cambridge University Press, Cambridge.

Conway Morris, S. (2015a). *The Runes of Evolution: How the Universe Became Self-Aware*. Templeton.

Conway Morris, S. (2015*b*). Bioastronomy. In *52 Things you Should Know About Palaeontology*, ed. Cullum, A. & Martinus, A.W., pp. 30–31. Agile Libre Mahone Bay, Nova Scotia.

Conway Morris, S. & Caron, J-B. (2014). A primitive fish from the Cambrian of North America. *Nature* **512**, 419–422.

Dawes, L.J., Sugiyama, Y., Lovicu, F.J., Harris, C.G., Shelley, E.J. & McAvoy, J.W. (2014). Interactions between lens epithelial and fiber cells reveal an intrinsic self-assembly mechanism. *Dev. Biol*. **385**, 291–303.

Diamond, J. (1995). Alone in a crowded universe. In *Extraterrestrials: Where are they?*, ed. Zuckerman, B. & Hart, M.H., pp. 157–164. Cambridge University Press, Cambridge.

Duggin, I.G., Aylett, C.H.S., Walsh, J.C., Michie, K.A., Wang, Q., Turnbull, L., Dawson, E.M., Harry, E.J., Whitchurch, C.B., Amos, L.A. *et al*. (2015). CetZ tubulin-like proteins control archaeal cell shape. *Nature* **519**, 362–365.

Dyson, F.J. (1960). Search for artificial sources of infrared radiation. *Science* **131**, 1667–1668.

Eiraku, M., Takata, N., Ishibashi, H., Kawada, M., Sakakura, E., Okuda, S., Sekiguchi, K., Adachi, T. & Sasai, Y. (2011). Self-organizing optic-cup morphogenesis in three-dimensional culture. *Nature* **472**, 51–56.

Flores Martinez, C.L. (2014). SETI in the light of cosmic convergent evolution. *Acta Astronaut*. **104**, 341–349.

Fogg, M.J. (1987). Temporal aspects of the interaction among the first galactic civilizations: the "Interdict hypothesis". *Icarus* **69**, 370–384.

Forgan, D.H. (2011). Spatio-temporal constraints on the zoo hypothesis, and the breakdown of total hegemony. *Int. J. Astrobiol*. **10**, 341–347.

Freeth, T., Bitsakis, Y., Moussas, X., Seiradakis, J.H., Tselikas, A., Mangou, H., Zafeiropoulou, M., Hadland, R., Bate, D., Ramsey, A. *et al*. (2006). Decoding the ancient Greek astronomical calculator known as the Antikythera mechanism. *Nature* **444**, 587–591.

Fritz, J., Bitsch, B., Kührt, E., Morbidelli, A., Tornow, C., Wünnemann, K., Fernandes, V.A., Grenfell, J.L., Rauer, H., Wagner, R. *et al*. (2014). Earth-like habitats in planetary systems. *Planet. Space Sci*. **98**, 254–267.

Galante, D. & Horvath, J.E. (2007). Biological effects of gamma-ray bursts: distances for severe damage on the biota. *Int. J. Astrobiol*. **6**, 19–26.

Garrett, M.A. (2015). Application of the mid-IR radio correlation to the Ĝ sample and the search for advanced extraterrestrial civilizations. *Astron. Astrophys*. **581**, L5.

Gladman, B., Dones, L., Levison, H.F. & Burns, J.A. (2005). Impact seeding and reseeding in the inner Solar System. *Astrobiology*. **5**, 483–496.

Gowanlock, M.G., Patton, D.R. & McConnell, S.M. (2011). A model of habitability within the Milky Way galaxy. *Astrobiology* **11**, 855–873.

Gray, R.H. (2015). The Fermi paradox is neither Fermi's nor a paradox. *Astrobiology* **15**, 195–199.

Gray, P.M., Krause, B., Atema, J., Payne, R., Krumhansl, C. & Baptista, L. (2001). The music of nature and the nature of music. *Science* **291**, 52–54.

Griffith, R.L., Wright, J.T., Maldonado, J., Povich, M.S., Sigurđsson, S. & Mullan, B. (2015). The Ĝ infrared search for extraterrestrial civilizations with large energy supplies. III. The reddest extended sources in *WISE*. *Astrophys. J. Suppl. Ser*. **217**, e25.

Haisch, B. (2014). Is the universe a vast, conscious-created virtual reality simulation? *Cosmos History* **10**, 48–60.

Hart, M.H. (1975). An explanation for the absence of extraterrestrials on Earth. *Quart. J. Royal Astronomical Soc*. **16**, 128–135.

Haqq-Misra, J. & Kopparapu, R.K. (2012). On the likelihood of non-terrestrial artefacts in the Solar System. *Acta Astronaut*. **72**, 15–20.

Herzing, D.L. (2014). Profiling nonhuman intelligence: an exercise in developing unbiased tools for describing other "types" of intelligence on earth. *Acta Astronaut*. **94**, 676–680.

Jimenez, R. & Piran, T. (2013). Reconciling the gamma-ray burst rate and star formation histories. *Astrophysical J*. **773**, e126.

Jones, E.M. (1985). Where is everybody? *Phys. Today* **38**, **11**, 13.

Kardashev, N.S. (1964). Transmission of information by extraterrestrial civilizations. *Sov. Astron*. **8**, 217–221.

Lineweaver, C.H. (2001). An estimate of the age distribution of terrestrial planets in the universe: quantifying metallicity as a selection effect. *Icarus* **151**, 307–313.

Lineweaver, C.H., Fenner, Y-S. & Gibson, B.K. (2004). The galactic habitable zone and the age distribution of complex life in the Milky Way. *Science* **303**, 59–62.

Livio, M. (1999). How rare are extraterrestrial civilizations, and when did they emerge? *Astrophysical J*. **511**, 429–431.

Mayr, E. (2004). Are we alone in this vast universe? In *What Makes Biology Unique? Considerations on the Autonomy of a Scientific Discipline*, pp. 209–217. Cambridge University Press, Cambridge.

McInerney, J.O., Martin, W.F., Koonin, E.V., Allen, J.F., Galperin, M.Y., Lane, N., Archibald, J.M. & Embley, T.M. (2011). Planctomycetes and eukaryotes: a case of analogy not homology. *Bioessays* **33**, 810–817.

Morrison, I.S. & Gowanlock, M.G. (2015). Extending galactic habitable zone modeling to include the emergence of intelligent life. *Astrobiology* **15**, 683–696.

Piran, T. & Jimenez, R. (2014). Possible role of gamma ray bursts on life extinction in the universe. *Physical Rev. Lett*. **113**, 231102.

Sandberg, A. (1999). The physics of information processing superobjects: daily life among the Jupiter brains. *J. Evol. Technol*. **5**, 1–34.

Simpson, G.G. (1964). The nonprevalence of humanoids. *Science* **143**, 769–775.

Smart, J.M. (2012). The transcension hypothesis: sufficiently advanced civilizations invariably leave our universe, and implications for METI and SETI. *Acta Astronaut*. **78**, 55–68.

Tipler, F.J. (1980). Extraterrestrial intelligent beings do not exist. *Quart. J. Royal Astronomical Soc*. **21**, 267–281.

Tomarev, S.I. & Piatigorsky, J. (1996). Lens crystallins of invertebrates. Diversity and recruitment from detoxification enzymes and novel proteins. *European J. Biochem*. **235**, 449–465.

Wandel, A. (2015). On the abundance of extraterrestrial life after the Kepler missions. *Int. J. Astrobiol*. **14**, 511–516.

Webb, S. (2002). *If the Universe is Teeming with Life . . . Where is Everybody? Fifty Solutions to the Fermi Paradox and the Problem of Extraterrestrial Life*. Copernicus Books.

Wiley, K.B. (2011). The Fermi paradox, self-replicating probes, and the interstellar transportation bandwidth. arXiv: 1111.6131.

Williams, C. (1931). *Many dimensions*. Faber & Faber, London.

Williams, C. (1937). *Descent into hell*. Faber & Faber, London.

Wilson, P., Wolfe, A.D., Armbruster, W.S. & Thomson, J.D. (2007). Constrained lability in floral evolution: counting convergent origins of hummingbird pollination in *Penstemon* and *Keckiella*. *New Phytol*. **176**, 883–890.

Worth, R.J., Sigurdsson, S. & House, C.H. (2013). Seeding life on the moons of the outer planets via lithospermia. *Astrobiology* **13**, 1155–1165.

Wright, J.T., Mullan, B., Sigurdsson, S. and Povich, M.S. (2014). The Ĝ infrared search for extraterrestrial civilizations with large energy supplies. I. Background and justification. *Astrophysical J*. **792**, e26.

Zackrisson, E., Calissendorf, P., Asadi, S. & Nyholm, A. (2015). Extragalactic SETI: the Tully-Fisher relation as a probe of astroengineering in disk galaxies. *Astrophysical J*. **810**, e23.