

Letter

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Author for correspondence:
Robert Klee, E-mail: klee@ithaca.edu

The importance of being sufficiently realistic: a reply to Milan Ćirković

Robert Klee

Philosophy and Religion, Ithaca College, Ithaca, New York, USA

I do not believe that Professor Ćirković's (2017) letter about my paper (Klee 2017) makes quite the case that he thinks it does, but then again I think that he misconstrues the spirit in which I wrote the paper. I wanted to take Thomas Nagel's claim that nothing that happens X billion years from now matters to us now and show that he is surely wrong if *what* happens is human expunction under the laws of physics. It is interesting to me that Professor Ćirković mostly passes over this core aspect of my argument (is it all that clear that something that far into the future should concern us?) and instead, incredibly enough, claims that the technology already exists, or shortly will exist, to fix all the hindrances to interstellar space travel that I canvass in my paper.

Physical eschatology (sic)

Professor Ćirković, in the second sentence of his letter, endorses a new discipline (of which I assume he is a practitioner) called *physical eschatology*, the second term taken directly from a long-standing field within theology, where it is usually defined as the part of theology concerned with death, judgement and the final destiny of the soul and of humankind. That does not sound much like science to me, but then Professor Ćirković, in a 2003 publication, provided a 'Resource Letter' on physical eschatology that assures his readers that the theological elements are rather downplayed in physical eschatology. The only reason he gives for physical eschatology being a 'nascent discipline' is that some big-name physicists occasionally spoke about such large and grand issues as the end-fate of the physical universe (Eddington, e.g.). Indeed, it is not so much an argued paper as a compendium of quotations from various thinkers, some famous physicists among them. Yet even in this 2003 paper Ćirković admitted on page 131 to a small theological interface with physical eschatology.

... technology may be used to predict and influence the future on a large scale. This should not be construed, however, as severing all of the links between religious and physical eschatology. (Ćirković 2003)

So, does Ćirković really want to resacralize physical nature, at least in part, when it took the rest of us and our ancestors over 300 years to desacralize nature? If the answer is yes, then do we have Ćirković hawking a potential pseudoscience in his letter about my paper?

Physical eschatology strikes me as a problematic proposed discipline for a number of reasons but just to take one of them that seems especially pertinent, any predictions about the ultimate end-state of human socio-political life run directly afoul of Sir Karl Popper's (1957) warning about the dangers of attempting to predict long-term human social history (human social history is chaotic and consists of many unrepeatable one-time events with unrepeatable causal precursors), yet Ćirković on the first page of his *IJA* letter is very sanguine about the prospects of permanent human survival, starship-like human interstellar space travel and the apparent centrality of humans to the Galaxy's fate. *Popper's warning is one reason that in my paper I focused on the larger physical facts, forces and laws, and not so much on speculative and contingent future creative human capabilities, social structures and technologies.*¹ It is speculation about the latter that seems to form the core of Ćirkovićian 'physical eschatology'.

Engineering futurism and its discontents

The details of how all the optimistic future techno-wonders of human interstellar space travel/survival that Ćirković canvasses in his letter would work and could happen as realistic pieces of human social endeavour (e.g. modifying the earth's orbit, rejuvenating the Sun to prolong its life on the Main Sequence), as in all futuristic physics of the type Ćirković advocates, are hazy, presumptive and stripped of the thousands of bugs and impasses that bedevil physically extant systems. By way of illustration, consider the 2001 Korycansky *et al.* paper (2001) that Ćirković

¹It is surely part of the confused state of this nascent discipline of physical eschatology that Ćirković cites Popper's famous 1957 book (the one I just cited above) on *The Poverty of Historicism* as an alleged core work in physical eschatology. Popper would be rolling over in his grave at such a citation, for Popper's book goes out of its way to warn against the abuses of attempting to predict future human socio-political structures and events.

cites to support his claim that we already know how to move the earth farther out from the Sun so as to avoid the future Solar cooking of the earth. The model cited is woefully *conjectural* for it

- (1) assumes in its modelling that Earth and Jupiter are on circular orbits of zero inclination (352), both false assumptions; and
- (2) by reference to older papers, especially Ahrens & Harris (1992, 431), the model has us sending high explosives or even nuclear warheads into the Kuiper Belt or the main asteroid belt to 'blast out' a series of 10^{19} kg objects so as head them towards the earth.

Ćirković mentions this engineering marvel as if it would be nothing very difficult to convince a future ten billion human beings to let the *optimistic physicists nuke the Kuiper Belt* in order to toy with our delicate biosphere's necessary conditions for being human-life-friendly. It is simply inconceivable to me that the political powers of the earth would agree to allow this – 'go experiment with someone else's family, buddy'. Here is more of that breathless engineering futurism on display.

Pointing out that somebody has sketched out and published *somewhere* an alleged rough way to do all these marvellous things, as Ćirković does over and over in his paper, is an exercise in misdirection, a ploy to *excuse the lack of plausible details and play up the wondrousness of human creative thought*. To take another case illustration of how conjectural the papers Ćirković cites in his letter can be, consider Armstrong & Sandberg's (2013) missive. This paper *speculates* about how we could explore the Universe, rather quickly, by means of self-replicating robot spacecraft which we launch by means of Dyson Sphere energy, and the said robots use either fusion rocket propulsion or matter–antimatter rocket propulsion. There are, however, a few big problems here. A Dyson Sphere is a means of harnessing the Sun's energy at a closer range than the earth's orbit by means of humongous Solar reflectors or some other collecting apparatus of enormous size. The engineering bugs and the scaling problems involved in doing that, as well its hyper-stupendous cost, make me dizzy just to think about them; but worse, no human has yet achieved ignition of a fusion reactor for more than several seconds despite intensive attempts to do so for the last 70 years. As for matter–antimatter propulsion, that is a concept directly mentioned in the TV show *Star Trek*, where the precise delicacies of how to store antimatter inside a material starship without detonating it into pieces are never explained in detail.

I have no doubt that in response to such criticisms Ćirković would offer up, as he does in his letter, the old adage about how past big shots suffered from having uttered mind-numbingly inaccurate predictions. We are advised by Ćirković on page 4 of his letter that August Comte predicted in the 19th century that the chemical constitution of the stars would be forever unknown, that some CEO of the young IBM thought there was a market at most for about five computers, or to use my own example, 300 years ago an iPad would have been *inconceivable* even to the brightest of Renaissance thinkers. Indeed, runs this kind of over-used and hackneyed argument, how would you explain the functioning of an electric toaster to, say, Cleopatra VII of ancient Egypt? You could not do it. She would remain flummoxed by the device and see it as magical.

Personally I believe that Cleopatra VII, on the historical evidence, was too well educated and sophisticated to be flummoxed by an electric toaster, but the point is forever nebulous, based on

an extremely misty collection of counterfactuals, and in the end an irresolvable fantasy; and that last term is the problem with Ćirković's lessons in physics fantasizing, whose operational details are supposedly to be left for a future time, place, politics and technology to master down to the fourth place after the decimal point. For example, he says on page 5 that

'Already envisaged macro-projects of geoengineering ... could easily provide the solution for both anthropogenic global warming and longer-term cooling tendencies related to the end of the current interglacial period.'

This is quite some degree of credulity on Ćirković's part. A 'macro-project', something merely *envisaged* at this point in time, is nevertheless sure to *provide a solution* (easily, mind you) to certain staggering problems of human long-term survival; but if one is not required to be specific and detailed in a futuristic physics proposal, if one is not required to worry about operational bugs and scaling distortions, if one is allowed to ignore the thorny details of human psychological limits and democratic budget woes, and the waxing and waning of a people's political will to do or try to do such fabulous things, then, well, *almost* anything goes. It is worse than that. The term 'macro-project' is code for something really serious, really big and stupendously expensive, and so it is a code for something governments would have to get their legislators and population to sign off on paying for, or else we must hope that some eccentric billionaire takes an interest in these projects.

Contra Ćirković, the Oort cloud contains no birds

Just to take one example of Ćirković's tendency to 'miss the trees for the forest', consider his remark on page 6 of his letter about the Oort cloud, the trillions-of-objects volume of spacetime left over from the formation of the Solar System that lies just outside the heliopause. He waves away the issue of a fast-moving interstellar spacecraft enduring a mission-impairing collision with Oort cloud debris by use of an analogical argument: birds have now and then brought down airplanes, but the percentage of such hits with respect to total number of flights is miniscule. The analogy is utterly inapt. We are going to send only a few such humanly piloted spacecraft out there at one time – spacecraft that will cost an enormous chunk of planetary treasure, by the way – and losing even one such spacecraft would be economically devastating, mission/programme-ending and fatal to the spacecraft's occupants (there are no rescue spacecraft roaming the Oort cloud, for they risk the same issue as the fast-moving spacecraft). Can anyone say, 'Ah, this is Houston mission control, lock the doors'. We could not abide even a single devastating and unrecoverable hit, unlike the human commercial air travel industry can abide.

Engineering futurists like Professor Ćirković have a tendency to see the whole cluster of issues at play in human interstellar space flight as a collection of engineering problems – which many of them surely are – at the neglect of the many *human and psychological* problems that attend such space flight. They wish to run with the idea that creative physics might conquer all, but that is merely a hope whose obvious expansiveness ought to be apparent to anyone who is educated and over 21 years of age. Will suspended animation really work – as some interstellar space travel schemes assume without any real empirical evidence? How about cryopreservation? Well, I guess either the great Hall of Fame baseball player Ted Williams (the last

person to ever bat over 0.400 during a Major League Baseball season and who had himself cryopreserved at death) will eventually be unfrozen as functional, or unfrozen as dysfunctional, or unfrozen as dead. I am willing to bet it that it will be one of the latter two, but I should be very glad for ‘Teddy Ballgame’ if it turns out to be the first one. What about the lack of natural sunlight – we know that depression ensues in some portion of the population every winter, but think about the *decades or years* of permanent winter aboard a realistic starship. Current astronauts and cosmonauts must worry about blurry vision in low gravity – the eyeballs and their internal fluids expand – so what would a 3582-day space flight do to human vision, to human muscle tone, to human psychological equilibrium, to the human craving for variety and novel stimulation (will computer games really suffice for the latter if the interstellar flight is 50 years long)? These are the *messy human* problems of long-term space flight in which engineering physics is involved only tangentially, for these problems accrue to us because of our long evolutionary history living in the earth’s biosphere. They are biosocial, or biopsychological problems that arise from our being sloppy analogue animals, not ethereal spirit beings or digital computer beings.

The substantiality of Klee’s errors of detail is grossly exaggerated

I now turn to recent developments that Ćirković thinks undermine my paper’s core points. It turns out that some long ago used booster rockets will *eventually* leave the Solar System as well as the four devices spoken of in my paper (personally, I would have thought that booster rockets are too slow-moving to escape eventual gravitational capture by some Solar System body, but in the spirit of inquiry I will grant Ćirković’s claim). It turns out that the New Horizons spacecraft will, if things go according to plan, hit the heliopause in a few decades – again, note Ćirković’s assumption that nothing will go wrong and so we should count it as *now* being among the Viking and Voyager group of interstellar or near-interstellar objects. It also turns out that Pluto has more than one moon – although a 9 by 6 by 8 km object (Styx) strikes me as pushing the definition of ‘moon’ so far that we shall have to count future conglomerations of humanly sourced space debris as moons of the earth. None of the other four moons of Pluto that I failed to mention in my paper are possible candidates for human colonization and escape from an expanding Sun – they are far too small and much too cold – and such an escape was the context in which I canvassed the extant solid bodies in the Solar System in my paper. I therefore do not see how any of these recent developments defeat the core points of my paper; which are, that the earth will be roasted into cinders by an enlarged Sun in about one billion years, and that it bothers us even now to come to know this given the current evidentially grim prospects for large-scale human interstellar space travel and resettlement.

Professor Ćirković claims in his letter on page 2 that I confused the RGB stage of the Sun’s future evolution with the AGB stage, although he admits that the earth will be immersed in the Solar surface at the ‘tip of the RGB’ stage. This is disingenuous of Ćirković, who soon after in his letter admits that the Rybicki and Dennis model (2001) that I cited in my paper puts the immersion of the earth in the AGB stage. A more honest criticism would have been to point out that we have duelling computer models here. According to Ćirković’s preferred computer model (Schröder & Smith 2008), the immersion will happen at the tip

of the AGB stage. Yet, exactly what is the complaint here, given that Ćirković admits that the earth will be immersed under the Solar surface in one or more of the mentioned stages? Even more to the point is this quote by Schröder and Smith supporting the Franck *et al.*’s model (1999) referenced in my paper.

Certainly, with the 10% increases of solar luminosity over the next 1 Gy ... it is clear that Earth will come to leave the [habitable zone] already in about a billion years time, since the inner (hot side) boundary will then cross 1 AU. (2008, 160).

The precise physicochemical mechanism for this cinderling of the earth will no doubt be endlessly refined and debated, but there is no professional doubt – indeed there is convergence on a common outcome by logically distinct means, a highly probative sign of truth – that an expunctional cinderling will take place around one billion years out from now if our human descendants have not managed to get off the earth by then.

Pessimism is cool, optimism is warm, but neither is immoral in the present epoch

The attempt to portray my paper in an ungenerous light in Ćirković’s letter is due I suspect to the main claim of his letter that pessimism about large-scale human interstellar space travel is ‘immoral’. As a bona fide futurist, Ćirković sees the human colonization of other planetary bodies as a moral obligation. I, on the other hand, think it to be something that we almost certainly shall try to do, probably under desperate conditions, even heroic conditions. That is, I hold it to be morally permitted but certainly not morally obligatory. Put another way, on the current evidence, I think we shall try but fail as a species to find a second home, for I argue that starship-like *interstellar* space travel will turn out to be something that defeats us. Maybe I am right about that, maybe I am wrong; but I do not see how my ‘pessimism’, as Ćirković calls it, can possibly be immoral. Other things being equal, it is *actions* that are the main focus of moral evaluations; yet here we have Ćirković insisting that having a serious and evidence-based view – an attitude or at most a set of beliefs – about some specific aspect of space exploration is immoral. I suppose that Professor Ćirković could argue that attitudes beget actions. Indeed they do; but why does Ćirković assume that the *required* way to react to the doom of the earth under the laws of physics is, perhaps Quixotically, to suck the planetary budget dry while trying to build some version of the USS Enterprise starship? Has it ever occurred to Ćirković that most humans would rather not face the hostility of space, but instead to make things the best we can manage to make them here on earth? What if Canada (I am one-quarter English Canadian) voted to stay here and be roasted rather than risk the terrors, uncertainties and physically hostile privations of interstellar space flight by a 66–34% majority in a national referendum. Would Ćirković then be forced to claim that one of the nicest countries on the planet is chock full of ‘immoral citizens?’ Ćirković on page 9 of his letter goes so far as to cite authors (Nunn *et al.* 2013) who bemoan the opportunity cost of spending public money on health care for the obese instead of space travel; in fact, they worry that ‘ET’ will fall into the same trap (getting fat and then sick from it) and never arrive here. Well now, that is just a bit too insensitive and elitist for my tastes, not to mention that it may also be a bit too anthropomorphic where ET may be concerned. Here is some breaking

news for Professor Čirković: fat humans are not to blame for the perennial underfunding of the US space programme.

The pessimism issue that Čirković raises in the larger part of his letter involves what in philosophy is called the ‘ethics of belief’. Other things being equal, our beliefs should be evidence-based, not wish- or faith-based. The only possible exception to this is when human society enters an existential crisis, which as I pointed out in my paper, will begin to happen around one billion years from now. Čirković appears to believe that a distant threat one billion years out from now warrants the extreme view that pessimism about our ever getting off this planet is immoral *right now*. Well, to be frank, it does not warrant any such thing. The crisis is not imminent but one billion years out from now. Hence, for now, I stand by my evidence-based worry that the human species is stuck on the third planet from the Sun. That goes double when very recently the results of a study aboard the International Space Station were announced, showing that bacteria become hardier and more drug-resistant in outer space/micro-gravity environments (Zea *et al.* 2017) – I guess that maybe suspended animation might be more difficult than folks like Čirković suspect.

Professor Čirković does not seem to understand the spirit in which I wrote the paper. I do not relish the doom I describe (and I go out of my way to say so). I would welcome a serious and *plausible* argument – that is, not a sci-fi fantasy – that would show somehow that the earth escapes in the end with many of our human artefacts intact – or even that our descendants escape outright. Professor Čirković’s letter does not provide any such argument, but instead it constitutes a kind of upbeat cheerleading on behalf of engineering futurism stapled to the idea that future technology will be quasi-omnipotent. However, I must point out, enthusiastic hope in the sci-fi powers of future technology is an attitude, not an argument.

Some loose odds and ends

On page 6 of his letter Čirković asserts that *x will never happen* is ‘*a priori* exactly on the same footing as’ *x will happen*, for any *x* that does not violate the laws of nature. This is a very strange thing to say, because requiring *x* to be consistent with the laws of nature – which were discovered in part via sensory evidence – will make *x* dependent on *a posteriori* propositions, and so *x* itself would not be an *a priori* proposition; but let us set that linguistic technicality aside. Evidentially, the quoted claim by Čirković is simply false, for the difficulty of showing either option will vary with the contingent initial conditions of the relevant system and the semantic content of *x*. For example, ‘Klee will never personally witness any event that remains always space-like separated from him whilst he lives’ is certainly true under the laws of physics, while its contradictory is just as certainly false.

On page 3, Čirković briskly waves away any extended discussion of the moribund Anthropic Principle as a waste of time and effort. I could not agree more with Čirković on that issue, but a referee for *IJA* insisted that I expand considerably that section of the paper when writing the final draft.

On page 3, Čirković writes that the ‘laws of nature do not preclude indefinite survival’ of technologically advanced and highly intelligent galactic civilizations. Well, that is rationally doubttable if the theory that the Universe is running inevitably towards a maximum thermodynamic entropy state has anything going for

it – or can we expect some upbeat technological wonder story from Čirković about how our descendants will somehow learn to harness the quantum vacuum energy so that they may ‘regenerate hydrogen *de novo*’ and carve out a cosmic volume of socially organized low entropy in the year 3 912 244 508?

On page 2 of his letter, Čirković complains profusely about the dates of my references, as if newness of a study is always correlated – which it is not – with greater accuracy of modelling or greater accuracy of fact. Here I think the different disciplines in which we were respectively trained is the source of the complaining. Philosophers still study Plato, right now, in 2017. They do not throw out Plato because he died in 399 B.C.E. Hence I do not make a fetish out of the newness of a study or a paper. Indeed, in philosophy we have the opposite bias: new and recent work is more likely to be laden with fervent implausibilities than the older and heavily analysed work that has stood the test of time. I just do not believe that it matters that Rybicki and Dennis’s model is from 2001 (besides, Čirković himself cites a paper from 2001, and one from 1997, and one from 1988 – so the basis of this complaint seems undermined to me), for if it is a fruitful and robust model then the presumption that some newer model must be better and more accurate, because it is newer, has no ground on which to stand. Beside which, what the models say is largely cross-corroborating. If, on the other hand, Čirković is complaining that I have not cited enough of the works of his fellow engineering futurists, well, that was deliberate on my part and for the reasons indicated in this letter.

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References

- Ahrens T and Harris A (1992) Deflection and fragmentation of near-Earth asteroids. *Nature* **360**, 429–433.
- Armstrong S and Sandberg A (2013) Eternity in six hours: intergalactic spreading of intelligent life and sharpening the Fermi paradox. *Acta Astronautica* **89**, 1–13.
- Čirković M (2003) Resource letter: Pes-I: physical eschatology. *American Journal of Physics* **71**(2), 122–133.
- Čirković M (2017) The reports of expunction are grossly exaggerated: a reply to Robert Klee. *International Journal of Astrobiology*. doi: 10.1017/S1473550417000416.
- Franck S, Kossacki K and Bounama C (1999) Modelling the global carbon cycle for the past and future evolution of the earth system. *Chemical Geology* **159**, 305–317.
- Klee R (2017) Human expunction. *International Journal of Astrobiology* **16**, 379–388.
- Korycansky D, Laughlin G and Adams F (2001) Astronomical engineering: a strategy for modifying planetary orbits. *Astrophysics and Space Science* **275**, 349–366.
- Nunn A, Guy G and Bell J (2014) The intelligence paradox: will ET get the metabolic syndrome? Lessons for Earth. *Nutrition & Metabolism* **11**, 34–47.
- Popper K (1957) *The Poverty of Historicism*. London: Routledge.
- Rybicki K and Dennis C (2001) On the final destiny of the earth and the solar system. *Icarus* **151**, 130–137.
- Schröder K and Smith R (2008) Distant future of the Sun and Earth revisited. *MNRAS* **386**, 155–163.
- Zea L, Larsen M, Estante F, Qvortrup K, Moeller R, Dias de Oliveira S, Stodieck L and Klaus D (2017) Phenotypic changes exhibited by *E. coli* cultured in space. *Frontiers in Microbiology* **8**, 1598.