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The reports of expunction are grossly exaggerated: a reply to Robert Klee

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Abstract

Recent paper by Robert Klee in this journal argues that we should endorse a form of cosmic pessimism due to the inevitable destruction of Earth and humanity, allegedly meaning the complete and total annihilation of all traces of humanity's existence ('human expunction'). It could be shown that both the physical basis and philosophical methodology used by Klee to reach those bleak conclusions are at best premature and at worst unwarranted and misleading. Even worse, they reflect a mindset of unjustified and narrow-minded technological and societal pessimism, which contributes to the erosion of the Enlightenment values, the loss of public interest in space research and colonization, and could indeed increase vulnerability to real – as opposed to uncertain eschatological – global risks humanity is facing in this millennium.

Letter

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In a recent paper in this Journal, the philosopher Klee (2017) attempts to argue that we are facing inevitable and complete doom (or 'expunction') as entailed by the laws of physics and that we should embrace such a conclusion and draw philosophical and moral consequences from it. He outlines the results of physical eschatology, which allegedly indicate such necessary expunction and offers a bleak and ultra-pessimistic view of the survival of future human descendants and traces of the human culture. If that were indeed the case, the topic would certainly have deserved lots of considerations; however, Klee's claims are at best weak and at worst outright wrong and misguiding.

In particular, I wish to argue for the following four theses, which roughly correspond to major parts of Klee's narrative and are diametrically opposite to his claims:

(1) Future news about the evolution of physical universe are not at all that bad.
(1) There is no reason to doubt the feasibility of both interplanetary, interstellar and even intergalactic flight.
(2) There is no rational reason to doubt the capacity of intelligent observers to change their physical environment on a large scale.
(3) The biggest threat to the feasibility of such grand feats and indeed the future of humanity comes, at present, from undue pessimism and closed-minded focus on the local and limited, as contrasted with the cosmic vision of (post)humanity.

Before I discuss each of these key points a paragraph on the formal insufficiencies of Klee's paper is necessary. The paper contains multiple errors of fact, like the number of man-made probes leaving the solar system; it is not four, but five, since Klee conveniently (for his thesis about the decay of contemporary space research) ignores the *New Horizons* probe launched in 2006. This false information is repeated in multiple places in the text. Strictly speaking, those five probes are not the only man-made artefacts on escape trajectories: there are at least four identified solid-fuel boosters, which have left the solar system as well. Arguably, it is a minor point, but it is not an isolated case. Contrary to Klee, Pluto has not one, but *five* moons: Charon, Styx, Nix, Kerberos and Hydra (e.g., Stern *et al.* 2015). On page 380, Klee seems to conflate the red giant branch (RGB) stage and the asymptotic giant branch (AGB) stage of stellar evolution; these are two separate phases of stellar evolution and cannot be used interchangeably. While in the older study of Rybicki and Denis (cited by Klee) the Earth comes closest to be engulfed by the expanded Solar envelope during the thermal pulses in the AGB phase, newer calculations of Schröder & Connon Smith (2008) suggest that the sun will indeed engulf the Earth near the tip of the RGB phase. (Not that it is particularly relevant for the conclusions, as will be discussed below.) This brings us to another big problem with Klee's paper: its poor and outdated scholarship. With a single exception, all Klee's references belong to the last century/millennium, which is certainly not the way to contribute to a novel and dynamic field like astrobiology (or physical eschatology or future studies). Fundamental references of relevance to the subject matter are omitted. While some of the relevant newer work is cited below, it is important to keep this in mind while evaluating Klee's claims and his unwarranted pessimism.

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Future: long-term sunshine with a few clouds

Physical eschatology is a nascent discipline, which deals with the future evolution of astrophysical objects, including the universe itself and is thus both a counterpart and a complement to conventional cosmology (Adams & Laughlin 1997; Ćirković 2003). While physical eschatology teaches us that the universe is indeed apparently winding down, the temporal scope of these processes is mind-numbing. For instance, while the Milky Way and M31 will merge in a couple of billion years, the resulting galaxy will remain as a well-defined entity until about 10^{19} years have elapsed since the Big Bang – meaning that we are living early in the *first millionth of the first percent* of our stellar system's history! Clearly, our confidence in predictions on extreme timescales characterizing physical eschatology should not be unduly high, especially when one proclaims that key philosophical and moral issues follow from such predictions.

There are many serious possibilities (significantly more so than bizarre and pseudoscientific *misuses* of the anthropic reasoning Klee deems important enough to discuss) related to the topology of the universe/multiverse at large scales, which have been at least vaguely outlined in the literature on physical eschatology by cosmologists and physicists (e.g., Linde 1988; Garriga *et al.* 2000; Freese & Kinney 2003). They have suggested several strategies advanced technological civilizations could employ to prolong their survival indefinitely; we can discuss merits and demerits of these ideas, but the very fact that *they have been formulated this early* on timescales of both biological and cultural evolution should tell us that (i) contrary to Klee's assertions, laws of nature do not preclude indefinite survival and (ii) it is entirely reasonable to assume that in the deep time of physical eschatology, much better and effective solution will be found by amassed ingeniousness and insight of thousands of generations of future scientists and engineers, some of which will likely be cognitively enhanced beyond anything we could predict at this moment.

Therefore, blanket statements like 'the future news is very bad' are simplistic and untrue as serious statements of science. We can *at best* broadly delineate the realm of threats and possibilities for survival. As Mark Twain's famous quip paraphrased in the title would have it, bad news are grossly exaggerated.

Future agencies and capacities

We are currently living in the anthropocene, still somewhat controversial, but more and more accepted label for the geological time unit in which human influence on the whole of the Earth system became the dominant factor (e.g., Frank & Sullivan 2014; Zalasiewicz *et al.* 2014). If we have already managed to leave a geological footprint – how could any speculation about limitations of human/posthuman capacities up to a few *billion* years into the future be taken seriously? A billion years ago, deep into the Precambrian supereon, the Earth was unbelievably different from the one today, in practically all aspects; a contemporary observer would have had a hard time to imagine today's Earth with its forests and cities and singing birds and traffic jams and libraries and anthropogenic climate change.

To try to guess – and even more extremely, to *refute* – the extent of capacities of our post-post-…posthuman descendants billion years hence strikes me as not only naïve but incredibly hubristic as well. After all, an incredibly rational and measured philosopher as Auguste Comte argued in mid-19th century that the chemical composition of stars will forever remain a mystery, not to mention the cases such as the statement attributed to the IBM chairman and CEO Thomas J. Watson in mid-20th century about the market need for about five computers. The latter case is illuminating since there are technologies whose timescales of development are many orders of magnitude smaller than either astrophysical or geological timescales – and some of those technologies will enable our descendant's efficient reversal of adversary trends (both natural and anthropogenic). Already envisaged macro-projects of geoengineering (e.g., Govindasamy & Caldeira 2000) could easily provide the solution for both anthropogenic global warming and longer-term cooling tendencies related to the end of the current interglacial period. By the same token, even longer-term adversary changes such as arresting the plate tectonics and the associated carbon sequestration could be dealt with in a similar manner. The ratio of timescales for geophysical and technological changes experienced so far is so huge that such intentional extension of our capacities to influence the physical environment – envisaged long ago by such visionaries like Percy B. Shelley and Herbert G. Wells – cannot be excluded in any way. Klee's criticism of terraforming is also naive, at best; his rhetorical question, 'how would we transport the enormous tonnage of necessary raw materials to Mars?' (p. 385) should be best considered by an analogy. Suppose one of the pilgrims aboard *The Mayflower* had a momentary vision of the Empire State Building; he would better not talk about it in order to avoid the questions like 'how could one ever hope to transport so many glass windows across the Atlantic?' For an accessible account of terraforming see Beech (2009) and references therein.

There are ways in which we could modify planetary orbits *perfectly in accordance with the laws of physics* (e.g., Korycansky *et al.* 2001). This will make feasible modifying planetary orbits in order to avoid the worst consequences of the RGB and AGB phases of Solar evolution. Even better, we could rejuvenate the sun and prolong its Main Sequence lifetime, as suggested long ago by Criswell (1985), obtaining useful building material and nuclear fusion fuel along the way. Interstellar flight has been subject to many important and detailed studies on the level of engineering – since, as Klee seems to misunderstand, it has been established long ago that it is indeed *physically possible* (e.g., Forward 1986; Zubrin 1999; Crawford 2009; Long 2012). Even intergalactic flight seems to be quite feasible for advanced technological communities (Armstrong & Sandberg 2013); and consequences of it for cosmology itself have been recently discussed (e.g., Olson 2015). And contrary to Klee's bland assertion, the Oort cloud of our Solar System does not present any serious obstacle to interstellar flight – no more than the existence of birds is a serious obstacle to air traffic (note: *some* airplane incidents *are* caused by birds; no one has ever argued that the existence of birds makes air travel unfeasible).

The fact that we have in some cases quite complex ideas and scenarios of engineering such grand feats which are entirely in accordance with the laws of physics is astonishing in and of itself. While Roger Bacon and Leonardo da Vinci envisioned many modern technological solutions and Percy B. Shelley wrote about human control of the climate and other issues still in our future, the temporal difference has been only several centuries in all these cases. To expect that we could reasonably predict technological development – *or its absence!* – on the timescale of several thousand, or 10^6, or 10^9 years is *more radical* and correspondingly less serious than to expect that a neolithic inhabitant of Çatal Hüyük could come up with a blueprint for the Large Hadron Collider.

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Remember the basics of post-positivist scientific methodology: we never assess a hypothesis about the world in isolation. This has to apply to hypotheses about future technology which do not violate any laws of nature; if Klee maintains that something will never be achieved, it is *a priori* on exactly the same footing as the opposite statement that the same will, in fact, be achieved. That would be true even for true 'wild cards', i.e. hypotheses so radical that they have not yet been conceived. In cases of hypotheses discussed in the literature, we need to take into account all existing discussions before we shift our probabilities in a Bayesian manner. This pertains to practically every segment of Klee's discussion. If the probability of Klee's being right about the *impracticality* (as distinct from unfeasibility!) of interstellar travel was originally 50%, after getting acquainted with the arguments summarized in the book of Long (2012), for example, it has to decrease; how much is open to the debate about details. Ditto for other technologies enabling prolonged and possibly indefinite, survival of our descendants, as well as other intelligent species in the universe.

Cosmic pessimism as impractical and immoral

In assessing the general worth of cosmological pessimism espoused by Klee, consider first how most of the apocalyptic doom-saying around us is not only empirically wrong but also incoherent. When you hear someone, be he a street prophet or a wise academic in humanities, arguing that the 'end of the world is approaching,' the very first natural thought is how vacuous is any such claim: what else could it do? How do they imagine the end of the world *receding*? Subsequently, consider that most of the announced apocalyptic ends of the world have turned to be spectacularly wrong thus far – and squarely belong to the realms of pseudoscience or pseudoreligion. This is not to claim that there are no dangers in our future; on the contrary, there is a legitimate spectrum of more or less probable global catastrophic risks which could threaten our future survival (see the points of entry in Bostrom & Ćirković 2008). However, Klee does not discuss those – and indeed they cannot lead to expunction. Even the most brutal nuclear winter, deadly pandemics or an asteroid impact will leave around enough traces of humanity's existence and activities, which leads us to another point. If expunction is truly what we worry about, as opposed to 'mere' extinction, it is in fact rather easy and cheap to safeguard the records of humanity. Klee himself admits that our space probes in the interstellar space will survive to the physical eschatological future, eons beyond the end of Solar evolution. Therefore, what needs to be done is to launch more such probes, acting as time capsules, using technologies such as quantum lithography to inscribe maximal amount of information (which is huge; cf. Rose & Wright 2004) on their payload. Since these could be quite small, their launch on hyperbolic trajectory is not prohibitively expensive even today and will be laughingly cheap in the near future. While I fully acknowledge that this topic requires some further discussion, this is just to show that, contrary to Klee's assertion, expunction is not actually to be worrisome more than 'mere' extinction.

Finally, there is a different type of confusing the issue when discussing cosmological pessimism. If Klee's arguments are weak and insufficient, why bother at all? Should we not leave the pessimist alone, since the passage of time will anyway prove them wrong? The answer lies more in the domain of moral philosophy than physical science and is masterfully summarized by Bostrom (2003): there are opportunity costs for the delayed development of cosmic infrastructure. If we delay the development of an industrial base in space for a year today, it might easily result in tremendous loss of value a thousand or a million years down the line; hence, such delay is immoral on most ethical theories (Matheny 2007; see also Ćirković 2004). And what could more efficiently delay such a development, than the entrenched opinion that it is all fruitless and in vain? For this reason, the misguided belief in human expunction is indeed one of the most dangerous beliefs a contemporary Earthling could hold. In a highly disturbing situation in which the annual cost of obesity in the USA (2.1×10^{11} dollars) is already more than an order of magnitude larger than the annual cost of the national space research and exploration programs (1.77×10^{10} dollars) (Nunn *et al.* 2014), this defeatist and corrosive attitude should not be underestimated. We are already living in a civilization in which the enthusiasm for space research and colonization is threateningly and immorally low. This is the real danger – but it is a kind of danger which pessimism such as Klee's only fuels, instead of smothering.

Near the conclusion of his article, Klee writes: 'If the inevitability of human expunction did not matter to us now – once we become aware it as more than a mere metaphor – then why would we feel any tension about what I have written here? I believe that one does and should feel such a tension.' (p. 387) Since this is highly subjective, let me give an adequate response: the tension this reader feels is entirely due to seeing poor scholarship, unwarranted assumptions and limited imagination coopted in service of misguided and harmful cosmological pessimism.

Such pessimism is unwarranted, unsupported by our knowledge of the laws of nature, unnecessary hubristic regarding capacities of our descendants and potentially dangerous as an impediment to scientific and technological enthusiasm about the future. This does not mean that the topic itself is not a serious one and that philosophers should not participate in the debates. On the contrary, there have been some sophisticated treatments of the subject matter in the literature, fine examples being Oppy (2001) or Kahane (2014). While the present author strongly roots (e.g., Ćirković 2012) for more philosophical sophistication in dealing with complex issues of contemporary astrobiology and its ethical aspects, Klee's paper is a blind alley in this regard.

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