Earth-Cosmos Binary

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Abstract
What should be done with the cosmos? This is an ethical question of profound importance. Furthermore, prospects for advanced technology mean that this is a question that humans may someday need to answer. This paper proposes one type of answer, the Earth-Cosmos Binary (ECB), in which Earth and its vicinity are preserved for humans and other existing Earth-life while the rest of the cosmos is allocated for the radical optimization of moral value. The ECB constitutes a balance between the moral view of preserving Earth and the rest of the cosmos in its current form and the moral view of converting the cosmos into something of greater moral value. Arguably, Earth and its vicinity is the portion of the cosmos most worth preserving due to the special nature of Earth. The paper considers a variety of arguments for and against the ECB, finding a strong but not definitive case in favor of it. The paper also presents variants of the ECB which may have additional moral value under certain conditions.

Keywords: ethics, preservation, replacement, cosmos, Earth, space settlement

1. Opening Concepts

1.1 Optimizing The Cosmos

The Big Question: What should be done with the cosmos?

The cosmic genie: Suppose humans uncover a genie that will grant exactly one wish. The genie cannot violate the laws of physics, and therefore is not magic, but it can do everything that is possible within the laws of physics. In particular, it is able to alter the makeup of the accessible portion of the cosmos as fast as is physically possible and for as long as is physically possible. The genie can (among other things) send spacecrafts to distant exoplanets, terraform, and build Dyson swarms. One further constraint: the genie cannot do its own moral reasoning. Humans can ask the genie to follow some specific moral framework (e.g., "maximize expected utility"), but they cannot ask the genie to come up with its own moral framework (e.g., "do whatever is good or right"). In this situation, what should humans wish for?

The cosmic genie is a thought experiment,[1] but actual technological breakthroughs may approximate it. Some existing scholarship on potential future artificial intelligence (AI) and nanotechnology paints a picture of major technological breakthrough with implications of potentially astronomical proportion (e.g., Drexler 2013; Bostrom 2014).[2] It is not known if or when this or other

[1] A thought experiment is an imaginary concept or situation used to challenge and refine people's thinking on some topic, such as people's moral intuitions. Thought experiments are commonly used in philosophy research, including moral philosophy (Brown and Fehige 2023).

[2] These technologies are postulated to be able to achieve atomic-scale precision in manufacturing (nanotechnology) and science and technology breakthroughs beyond what human minds can achieve (AI), enabling radical breakthroughs in many domains, including space travel.

advanced technology will be developed. However, it is at a minimum plausible that humans may, in the not too distant future (e.g., within upcoming decades), have the capacity to substantially alter the accessible portion of the cosmos, which has been estimated to include up to around 10^9 galaxies (Armstrong and Sandberg 2013). In practice, actual human technology may not be as powerful as a hypothetical genie, but it may nonetheless be able to do a lot. The Big Question may be more than just a hypothetical.

Even if there is only a small probability of it being more than just a hypothetical, the stakes are so extremely high that it merits consideration. In recent years, much attention has gone to extreme low-probability, high-consequence catastrophic risks, but little attention has gone to extreme low-probability, high-consequence positive events (Rowell 2020). Attention to The Big Question is therefore warranted, whatever the probability may be of humanity acquiring capability comparable to the cosmic genie.

Questions of what should be done are fundamentally a matter of ethics. As with other ethics questions, there is likely to be debate and disagreement on The Big Question. Hints of disagreement can be found in existing literature, for example in debates on whether or not it is morally acceptable to terraform other planets (Sparrow 1999; Fogg 2000; McKay and Zubrin 2002; Schwartz 2012), in calls to use the cosmos to maximize some notion of welfare of humans and/or other sentient beings (Bostrom 2008), or of life (Mautner 2020) or ecological flourishing (Owe 2023), and in broader literature debating the ethics of outer space (Schwartz and Milligan 2016; Smith and Abney 2019; Schwartz et al. 2023) and the distant future (Tonn 2002). However, The Big Question has not yet been studied in much detail.

This paper outlines one type of answer to The Big Question. Here we are interested in the general structure of the answer and not in particular details. That includes details about specific ethical frameworks: utilitarianism, ecocentrism, etc. The proposed structure can be compatible with a range of ethical frameworks; this is one of its attractions. Analysis of specific ethical frameworks and other details is left for future research.

1.2 Replacement of Humans and Other Earth-Life

Radical optimization: An extreme alteration of some entity so as to make this entity optimized according to some optimization criterion. The entity can be an object (e.g., a rock) or a set of objects (e.g., the rings of Saturn) and can also include other phenomena such as electromagnetic radiation. Radical optimization entails rearranging the entity so that a certain criterion is optimized: for example, rearranging a planet into a giant mind for some combination of information processing and experiencing subjective well-being. Radical optimization can conceivably be done at any scale, from the microscopic to the astronomical. The optimization criterion can be a singular value (e.g., happiness) or a plurality of values aggregated in some way (e.g., an aggregate of happiness and biodiversity). The optimization criterion will typically be derived from some underlying ethical framework, in which "optimal" means "most morally good".

The radical optimization of the cosmos is one type of answer to The Big Question. This raises the question of what that means for life on Earth. First consider humans. The following concerns a type of situation that could potentially occur under certain circumstances. This situation can be important even without considering the cosmos, but it is also central to certain answers to The Big Question.

The Difficult Question: Given the opportunity to replace humans with something that is, in all morally relevant respects, superior, such that all humans would die, should this opportunity be taken?

It is plausible, and perhaps very likely, that human beings do not constitute the optimum configuration of matter according to a variety of moral standards. Humans are an artifact of evolution, not a product of moral optimization. To the extent that humans are optimized for anything, it would be their own biological (i.e., reproductive) success within their rather broad ecological niche. If humans

were to wish for the cosmic genie to maximize, for example, some notion of welfare, the genie may proceed to replace humans with something that is more capable of producing or experiencing welfare. Ditto for other conceptions of moral good. In other words, the genie may radically optimize human bodies into something of greater moral value.

The Difficult Question is difficult because it involves an extreme divergence of major moral intuitions. One intuition is that moral value should be optimized. If there is opportunity to make something better, then it is good to do so. A related intuition is that the human species is not a morally relevant category, meaning that being a member of the human species does not automatically confer moral value. Work in environmental philosophy has long advocated against *speciesism*, meaning the practice of valuing one species over another for no reason other than its status as a particular species (Singer 1975; Curry 2011; Owe et al. 2022). The favored species is typically humans, in which case the speciesism is *ethical anthropocentrism*.[3] Research in transhumanism and human enhancement considers that human nature can be improved upon, and that it may be moral to do so (Persson and Savulescu 2012), even if it results in human extinction (Shiller 2017). In the astrobiological context, it has been argued that it may be optimal for human civilization to sacrifice itself to advance the moral value of an extraterrestrial civilization, or vice versa (Baum 2010), though others have argued for ensuring the survival of each civilization (Haley 1963; Fasan 1970).

A countervailing intuition is that humanity, despite all its flaws, is good, and it would be a major loss for humanity to be gone; indeed human extinction may be a catastrophe of immense proportion. A related intuition is that it would be unfair and overly demanding to ask humans to cause the death of themselves, their friends and family, and everyone else they care about. Indeed, some perspectives argue that optimization should not be the primary moral objective. Non-consequentialist moral theories (e.g., deontology and virtue ethics) are commonly focused on other concepts besides optimization; even within the scope of consequentialism, some frameworks call for doing good without necessarily optimizing goodness (Jamieson and Elliot 2009). Finally, there is the intuition that there is value in preserving things in more-or-less their current form, such as is common in the domain of environmental preservation (Rolston 2020). Preservation does not require complete stasis, but it does entail maintaining conditions within some range: the amount of change must stay within some limit. The preservation of humanity still permits humanity to change, but it does not permit humanity to be made extinct.

In some scenarios, the distinction between preservation and replacement can be blurry. For example, it has been proposed that humans may someday merge with their technological creations into a new form of entity that transcends current human biology but retains a certain cognitive and cultural humanness (Kurzweil 2005). This may occur, for example, via human minds being uploaded into computers (Hanson 2016). If radical optimization involves phenomena such as these, then answering The Difficult Question may depend on how these hybrid scenarios are evaluated. For purposes of this paper, we set these possibilities aside to focus on the (arguably more probable) scenarios in which radical optimization clearly involves human replacement.

The Difficult Question-Variant: Given the opportunity to replace Earth-life with something that is, in all morally relevant respects, superior, such that all Earth-life would die, should this opportunity be taken?

[3] Ethical anthropocentrism, the view that humans are morally superior, can be distinguished from ontological anthropocentrism, the view that humans occupy a central or privileged place in the universe (Owe and Baum 2021). For example, ethical anthropocentrism might claim that humans are morally superior to other animals, whereas ontological anthropocentrism might claim that humans are not animals. A common instance of ontological anthropocentrism is the use of the word "animals" to mean "animals other than humans", which goes against the scientific finding that humans are members of the animal kingdom. These concepts of anthropocentrism are distinct from the observation that this entire conversation about values is grounded exclusively in human moral perspectives because (for now) humans are the only participants in the conversation.

The Variant is a non-anthropocentric articulation of The Difficult Question. To a large extent, the difficulty of The Difficult Question is not about humans per se, but instead is about the living beings that exist at the time when the question is faced.[4] One can reject ethical anthropocentrism and still be troubled by The Difficult Question. Or, one could not value humans at all, instead valuing other species, and be troubled by the Variant. The trouble comes from the dilemma of replacing everything currently good and familiar with something new and different and better.

1.3 A Reconciliation

Two possible answers to The Difficult Question are as follows:

Preservation: The view that humans and other Earth-life should be preserved, even under the possibility of radical optimization.

Replacement: The view that humans and other Earth-life should be replaced if doing so brings greater moral value, especially via radical optimization.

This paper presents an answer to The Big Question that, contingent on details discussed below, may constitute an optimal balance between preservation and replacement:

> *The Earth-Cosmos Binary (ECB)*: Preserve Earth, plus some surrounding vicinity of Earth, for humans and other Earth-life. Radically optimize the rest of the accessible cosmos for some conception of moral value.

A sketch of the ECB appears in Figure 1.

Figure 1. Earth-Cosmos Binary. The boundary geometry shown here is an illustrative sketch.

The ECB has three variables: (1) where to set the boundary between (a) Earth and its surrounding vicinity and (b) the rest of the cosmos; (2) in what way to optimize the rest of the accessible cosmos, or what optimization criteria to pursue; and (3) what to do on Earth and in its surrounding vicinity. These variables can be set in many ways. Therefore, the ECB is not a singular answer to The Big Question, but instead is a class of answers that all have the same ECB structure. This paper comments on how the three variables can be set, but it does not offer singular answers for how they should be set. Instead, the focus is on the merits of the ECB structure. Details of how to set the three variables is left for future research. There are also variants of the ECB, discussed in Section 3.

Though the ECB has not previously been analyzed in depth, various aspects of it have gotten some prior attention. As is often the case (Camarena 2020), these ideas may have been first explored in science fiction. The earliest discussions of ECB themes that we are aware of are in science fiction. In *Diaspora* (Egan 1997), Earth is left for a variety of biological and enhanced humans, while the superior disembodied and computerized intelligences exist in simulated realities running on hardware located

[4] The Variant is *biocentric*, meaning that it favors life over non-life. Some environmental philosophy research has advocated for biocentrism (Taylor 1986). Other research has argued for also valuing at least some abiotic entities, such as art (Budd 1995) and mountains and rivers as parts of ecosystems (Rolston 2020). The Variant could be rewritten in a non-biocentric form without loss of generality.

throughout the Solar System. In *Robot* (Moravec 1998), it is suggested that the superior beings (in this case AIs and enhanced humans) should be allowed to pursue their goals away from Earth, leaving regular humans to pursue their own ambitions on Earth. In *Accelerando* (Stross 2005), the situation is reversed: Earth and the inner solar system are occupied by advanced AIs while humans are pushed further out into the cosmos.

In the academic literature, the idea of the ECB can be traced to the concept of "planetary parks", which are regions of planets that are intentionally preserved in their original form when humans settle on other portions of the planets (Cockell and Horneck 2004; 2006).[5] De Garis (2005) proposes that advanced AI might—but would not necessarily—replace humans with something that is in some respects superior, and that humans will be deeply divided over whether to build such AI. This divide essentially maps to differing perspectives on The Difficult Question. Bostrom (2014, p.219-220) considers using AI to turn almost the entire accessible universe into "hedonium", which is an arrangement of matter that optimizes pleasurable experience. Under this proposal, the Milky Way galaxy would be preserved for humans and Earth-life. Bostrom advocates for this proposal, making an argument similar to what is below described as the moral compromise argument. Finally, Holt (2021) considers a humankind so technologically mature that it could colonize outer space and then sever all ties with Earth. At that point, the remaining Earth biosphere could be preserved or replaced with something else. Holt argues that Earth's biosphere should be preserved and that humans should not sever ties with it, on grounds that it would be in our own best interest and that the Earth biosphere is of great moral value of its own.

2. Evaluating the Merits of the Earth-Cosmos Binary

Whether the ECB should be pursued depends on how various arguments and factors are resolved. Important examples are surveyed in this section; a comprehensive evaluation, considering the full range of potential arguments and factors, is beyond the scope of this paper.

2.1 The Moral Compromise Argument for the ECB

A major attraction of the ECB is that it offers a compromise—potentially a very strong compromise—between preservation and radical optimization. Essentially, the ECB divides the cosmos into two parts: one for preservation and another for radical optimization. This does entail sacrifices for both sides: there is no radical optimization within Earth's vicinity and there is no opportunity for Earth-life to expand beyond Earth's vicinity.[6] The ECB nonetheless accommodates the moral intuitions in favor of preserving humans and other Earth-life while also accommodating, to some degree, the moral intuitions in favor of radical optimization.

The structure of the cosmos suggests that the ECB could offer a very high degree of accommodation to both preservation and radical optimization. In other words, neither side would sacrifice much. Earth constitutes a very small portion of the cosmos. The Sun is just one of an estimated 10^{11} to 10^{12} stars in the Milky Way; the Milky Way is just one of an estimated 10^{11} to 10^{12} galaxies in the universe (ESA 2025). The entire universe may not be accessible, but even if only a small portion of it is, that could still constitute a much larger region than Earth. The ECB could allocate the entire Solar System or potentially even the entire Milky Way to preservation and still leave almost all of the accessible cosmos for radical optimization. Thus, the loss for the replacement view could be extremely small.

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[5] A related concept is the Zoo Hypothesis, the idea that one or more extraterrestrial civilizations have intentionally hidden themselves from Earth-life. This has been proposed as a resolution to the Fermi Paradox (Ball 1973; Crawford and Schulze-Makuch 2024). In the Zoo Hypothesis, Earth is effectively a planetary park.

[6] The lack of opportunity for Earth-life to expand beyond Earth's vicinity assumes that Earth-life would have no role in radical optimization.

Furthermore, Earth-life has thus far done very little with any region outside the Solar System. There have been just five interstellar probes: Voyager 1, Voyager 2, Pioneer 10, Pioneer 11, and New Horizons. Aside from these probes, the only other engagement between Earth-life and extrasolar space has been via artifacts of extrasolar space (mainly electromagnetic radiation) reaching Earth, such as for stargazing and astronomy. The ECB could limit Earth-life's opportunity for future space missions and astronomy, but perhaps not to an extreme degree. Regardless, other facets of life on Earth could continue more-or-less in their current form, perhaps with some substantial but non-radical improvements from the cosmic genie or the advanced technology.

2.2 The Radical Optimization Argument Against the ECB

It can be argued that Earth and its vicinity should not be preserved, and instead that it should be radically optimized. In other words, radical optimization is more important than preservation such that no compromise should be made. This argument draws parallels to environmentalism on Earth: Perhaps the important part is not what something is or was at a given time, but how good it can be. For example, one might see moral value in natural ecosystems due to their complexity, richness, and diversity of life. In this case, it might be better to turn a desert into a forest than to preserve the desert. Similar arguments have been made in favor of terraforming lifeless planets (McKay 2009; Grinspoon 2016) and spreading Earth-life into space (Margulis and West 1997; Mautner 2020). The logic here is sound: given that moral value should be optimized, if radically optimizing Earth and its vicinity would bring about more moral value, then it would be morally good to do so.

It is indeed correct that from this perspective, the ECB is morally suboptimal. Arguments against speciesism and anthropocentrism are relevant in this context. We find the arguments against speciesism and anthropocentrism to be absolutely compelling: it is wrong to favor a species (human or other) due to the mere fact of it being that species. We likewise have some sympathy for this version of the radical optimization argument. Still, we find there is a compelling case for the ECB instead of full radical optimization for reasons discussed throughout this paper. However, the case is not definitive: we cannot definitively reject this version of the radical optimization argument.

Another version of the radical optimization argument comes from a moral perspective in which the moral goal should be to minimize certain conceptions of harm. For example, negative utilitarianism seeks to minimize unhappiness or suffering (Smart 1958; Griffin 1979). From this perspective, it may be appropriate to eliminate all life on Earth so that there would be no more harm (Knutsson 2021). The elimination of harm may be achievable via radical optimization, in which case the ECB is again morally suboptimal. We disagree with this moral perspective: we favor increasing goods alongside the reduction of harms, and we are deeply skeptical of the notion that the harms on Earth outweigh the goods, such that elimination should be pursued.

2.3 The Cosmic Preservation Argument Against the ECB

It can be argued that no radical optimization of the cosmos should be pursued, whether via the ECB or other approaches. This is essentially to say that the cosmos should be preserved in roughly its current form, analogous to arguments for environmental preservation on Earth. The cosmos is inherently dynamic and cannot be preserved in its current form in perpetuity. Nonetheless, it can be preserved from rapid and radical alteration by Earth-originating civilization. Note that this is a much more extensive form of preservation than has been discussed previously. Sections 1.3 and 2.1 consider the preservation of Earth-life. The cosmic preservation argument calls for the preservation of the entire cosmos, including its vast abiotic portions.

A case for cosmic preservation can be made based on the moral value of processes that are

"natural" in the sense of being unaltered by technological civilization.[7] Environmental ethics research sometimes argues that there is moral value in preserving and continuing Earth's natural evolutionary history, and that this provides a basis for protecting existing biodiversity (Rolston 1988). A similar argument has been made for the moral value of astronomical processes as a reason for humans to preserve extraterrestrial environments as they are (Rolston 1986; Milligan 2015).[8] This argument sees moral value in natural processes even where no life is involved, as these processes are the creative forces underlying everything that exists in the universe, including life on Earth (Rolston 1986). Some further argue that it would be geocentric to impose Earth-based conceptions of moral value onto other planets and celestial places (Milligan 2015; Schwartz 2018).

We are skeptical of the cosmic preservation argument. The basic logic checks out: if the entire cosmos should be preserved in (more or less) its current form, then there would be no point in the ECB or other radical optimization because the cosmos is already in its optimal form. However, we doubt that the entire cosmos should be preserved in its current form. To the contrary, we believe that, for at least a large portion of the cosmos, any value of preserving natural cosmic processes is likely to be outweighed by the value of turning the cosmos into something better. It seems clear that Earth, with all its life and vitality, is of much greater moral value than other known planets.[9] It is almost unthinkable to suggest that it would be good for Earth to be converted into another dead planet. Conversely, it seems clearly good to convert other planets into Earths, or more generally to convert the cosmos into something of greater moral value.

2.4 The Optimality Argument for the ECB

It is possible that both the radical optimization argument and the cosmic preservation argument are incorrect, and that the ECB may actually be the optimal configuration of the cosmos, at least for some form of the ECB with some specification of its three variables.

The optimality of the ECB could follow from the tension between radical optimization and preservation. Perhaps there is value to preservation, but this is only one finite value to be weighed against other finite values. The improvements created through radical optimization could be one of these other values. What to do may depend on whether, for that something, the value of preservation exceeds the value of radical optimization, as it is not possible to both preserve and radically optimize the same thing. The value of preservation may be strongest for Earth due to its biosphere and general planetary dynamism. It could be the case that the value of preservation exceeds the value of radical optimization on Earth but not in the rest of the cosmos. In that case, the optimality argument would be correct and the ECB would be optimal.

2.5 The Hybridization Argument Against the ECB

The case for the ECB hinges on there being value to the spatial separation between preservation and radical optimization. Alternatively, there could be more value to a hybrid structure in which radically optimized entities and existing forms of Earth-life coexist alongside each other.

A case for hybridization can be made on grounds that Earth-life and radically optimized entities would be of mutual benefit. Perhaps Earth-life could provide functional assistance to radically optimized entities, though this may be unlikely if the radically optimized entities are sufficiently

[7] There is a different sense in which everything is "natural": everything consists of matter and follows the laws of nature; nothing is supernatural.

[8] Other arguments for the moral value of abiotic extraterrestrial environments have been made, such as due to the aesthetic quality of extraterrestrial landscapes (Schwartz 2018). These arguments may provide less basis for cosmic preservation due to the possibility of radically optimizing these conceptions of moral value. Perhaps a cosmic genie could radically improve the aesthetic quality of extraterrestrial landscapes.

[9] It remains possible that the search for extraterrestrial intelligence (SETI) will identify planets that are similarly full of life and vitality.

superior. If nothing else, perhaps radically optimized entities might enjoy having Earth-life around, such as in the role of a pet or a specimen of historical interest. Likewise, perhaps Earth-life would benefit from exposure to radically optimized entities, such as to receive help in addressing various problems on Earth.

We are skeptical of the hybrid structure. The removal of the spatial separation between preservation and radical optimization implies that Earth is not substantially preserved. It is difficult to imagine much value to preserving Earth-life without also preserving Earth. For example, if the radically optimized entities might enjoy Earth-life as pets, they might get even more enjoyment out of Earth as something akin to a wildlife preserve. The idea of radically optimized entities interacting with Earth does show that there could be value to versions of the ECB in which the boundary is somewhat blurry. Nonetheless, we believe that it would be better to maintain some form of spatially separated binary structure.

2.6 The Infinite Value Argument Against the ECB

It is sometimes proposed that the possibility of infinite value in the cosmos poses severe challenges for moral evaluation (Dubey and Laguzzi 2021; Wilkinson 2023). This issue derives from the common mathematical supposition that $\infty+x=\infty$ for any finite or infinite x. If this is the case, then as long as moral value extends into the infinitely distant future, it does not matter what happens along the way. This is an issue of conceptual importance for all moral theories that aggregate value across space and time.

The issue of infinite value is of particular relevance to scenarios involving expansion into outer space, including but not limited to the ECB and other potential answers to The Big Question. Given the finite habitability of Earth, something elsewhere in the cosmos is needed to achieve infinite value. Current physics suggests that infinite value may be impossible, such as due to the heat death of the universe, but the matter has not been conclusively resolved (Mack 2021; Manheim and Sandberg 2021; Edwards 2023; López-Corredoira and Marmet 2022). As long as there is some nonzero probability of infinite value, then the mathematical issue persists. In that case, there may be no moral distinction between the ECB and the alternatives, as long as they each have some nonzero probability of resulting in infinite value. Resolution of the infinite value argument requires technical analysis beyond the scope of this paper.

2.7 The Political Compromise Argument for the ECB

If humans discover a cosmic genie or invent advanced technology, then they may disagree amongst themselves about what to wish for or do with it. Indeed, disagreement on matters of ethics is an enduring feature of human populations. Political compromise entails identification of a position that all relevant human parties are willing to agree with. The ECB may not resolve all political disagreement. In particular, there could still be disagreement over how to set the three ECB variables. Nonetheless, given the difficulty of The Difficult Question, it is plausible that the ECB could be a major point of political compromise.

Political compromise can be morally valuable as a matter of conflict resolution. Disagreement over The Big Question could result in violence, perhaps even large-scale war. The worst-case scenario could be a war so large that it destroys human civilization, perhaps even resulting in Earth-originating civilization never doing anything further with the cosmos. If advanced technology is developed in time scales of decades or perhaps even centuries, it may be done in a world with nuclear weapons. The world currently possesses an estimated 13,400 nuclear weapons (Kristensen and Kile 2020). The organization Global Zero (2025) has presented a plan for full nuclear disarmament by 2045, though recent events such as the Russian invasion of Ukraine suggest a more sluggish pace for disarmament (Notte and Bidgood 2022). The potential for nuclear war to constitute a civilization-ending catastrophe

is a matter of ongoing research (Baum 2015; Scouras 2019). Even if nuclear war would not cause such an extreme catastrophe, it would still constitute a major harm. Ditto for large-scale wars fought with other weapons. Even small-scale violence would be a loss.

Given the astronomical stakes of The Big Question, it is not unreasonable to suppose that there could be war. Prior research has proposed that there could be war between (A) rival sides on the question of whether or not to build advanced technology in the first place (de Garis 2005) and (B) rival groups each seeking to build advanced technology on their own terms (Miller 2012). The ECB could help with both scenarios. Regarding (A), debate over whether to build advanced technology may hinge on the threat it poses to humans; this is the case in the scenario of de Garis (2005) and other work such as Joy (2000). The ECB is a way to build advanced technology without threatening humans. Regarding (B), research in AI ethics has documented a strong but not universal orientation toward anthropocentrism in both the overall field of AI ethics (Owe and Baum 2021) and in specific projects oriented toward advanced AI (Fitzgerald et al. 2020). This suggests that many developers of advanced technology may have an affinity for preservation of humans, but with some favoring radical optimization. Perhaps all developers could agree on the ECB.

Political compromise can also be morally valuable as a matter of procedural justice: no participating party is forced to accept something they object to. This is another reason to favor the ECB, insofar as it is indeed a point of political compromise. However, there are limits to this value. A just process arguably should account for the perspectives of all parties affected by a decision, not only those participating in the decision. Decisions on The Big Question could affect everything that exists on Earth and the entire accessible cosmos into the distant future. It is physically impossible for all affected parties to participate. The best that can be done may be some sort of proxy representation (Tonn 1996; O'Neill 2001). The task is further complicated by the fact that The Big Question involves decisions on which types of future individuals to create, such as future humans vs. future radically optimized entities. All of this reduces the extent to which a consensus among humans involved in handling the cosmic genie or developing advanced technology could be procedurally just.

2.8 Handling Uncertainty About The Big Question

There are several sources of uncertainty surrounding the ECB as an answer to The Big Question.

One source of uncertainty is in the implementation of potential answers to The Big Question. Nothing like radical optimization has ever been done before, and it is not currently known how well it would work. Indeed, discussions of radical optimization sometimes propose that it may fail, resulting in zero value. In one type of scenario, an advanced AI system interprets its instructions differently than humans intended (as computers are wont to do). For example, humans may attempt to instruct the AI to maximize happiness, but instead the AI converts the accessible cosmos into mere pictures of smiley faces, which are not actually happy (Loosemore 2014). An entire cosmos of smiley faces may be of zero moral value. That would be a catastrophic loss relative to the current state of affairs in the cosmos, which at least includes humans and other Earth-life.

There is also uncertainty about the politics of The Big Question. Because technology akin to the cosmic genie does not yet exist, there has not yet been significant debate about what to do with it. The extent of disagreement over what to do remains uncertain. Perhaps disagreement would be intense or even catastrophically violent. Or, perhaps disagreement would be more limited.

A different source of uncertainty is on how in principle to answer The Big Question. This is an instance of "moral uncertainty", meaning uncertainty about which moral values should be used (MacAskill et al. 2020). Any disagreement over how to answer The Big Question could indicate that humanity has not fully thought through all aspects of The Big Question and may have not yet identified the correct answer. Indeed, human morality has changed significantly over the years and may continue to change in the future (Danaher 2021); this suggests that current understandings of morality may be

flawed, and likewise that people today should hold some degree of moral uncertainty.

Given uncertainty about The Big Question, there is value to approaches that are crafted with this uncertainty in mind. The ECB does well in this regard, but other approaches are also worth noting.

The ECB is attractive as a hedge against some of the uncertainty described above. Even if the implementation of radical optimization fails, resulting in zero moral value where it is implemented, the ECB will still at least have moral value from Earth and its vicinity.[10] The ECB could reduce political disagreement, which could avoid catastrophic violence. If political disagreement would otherwise be limited, then the ECB does not add much value, but it would not make things worse. With respect to moral uncertainty, the ECB is attractive because it implements two moral concepts, preservation and radical optimization, and provides a high degree of accommodation to both, as discussed in Section 2.1.

An alternative approach to answering The Big Question is to abstain from providing an immediate answer and instead arrange a process for answering it at some later time, especially after having given The Big Question more careful consideration. Prior literature has proposed this as an "AI nanny" (Goertzel 2012), in which an AI guides the process for more careful consideration, or a "long reflection" (Ord 2020), in which humans lead the process.[11] Such an approach does not constitute an argument for or against the ECB per se. Instead, it can be taken to be an argument against attempting to implement or even study the ECB or other answers to The Big Question at this time. Given the opportunity, the idea of postponing decisions on The Big Question may have some merit. Evaluating the merits of postponement is beyond the scope of this paper. What can be said is this: If there is opportunity to postpone, and if postponement would be a wise course of action, then current analyses of The Big Question, such as this paper, would at least provide a head start. Alternatively, if decisions cannot or should not be postponed, then current analyses of The Big Question are that much more important and urgent.

It is possible that even after extensive inquiry into The Big Question, a definitive answer would not be reached. Indeed, philosophers have been studying ethics for millennia and consensus is nowhere in sight. In the absence of a definitive answer, it may be necessary for humanity to make its best guess on what to do. That could mean pursuing a specific course of action across the cosmos such as the ECB. Alternatively, it could mean abstaining from acting. It could be argued that it would be inappropriate to alter the cosmos despite uncertainty about how it should be altered. Doing so may be incautious or hubristic.[12] We are skeptical of this argument. Arguably, certainty should be as high as possible, but virtually all decisions have some uncertainty, especially important large-scale decisions. It is essential to be able to make these decisions despite the persistence of *some* uncertainty. The optimal timing of decision-making given lingering uncertainty and the potential to reduce it is an important topic beyond the scope of this paper.

3. Variants of the Earth-Cosmos Binary

The essence of the ECB is to answer The Big Question by preserving some region and radically optimizing some other region. The ECB preserves Earth plus some vicinity of it, but other geometries are possible for the boundary between preservation and radical optimization. The ECB also radically

[10] This specifically applies to scenarios in which the wrong thing is radically optimized, as in the smiley face example. There could be other scenarios in which the implementation failure results in a failure to maintain the Earth-cosmos boundary, in which case the value on Earth and its vicinity could also be destroyed.

[11] If humanity gains the technological capacity to pursue radical optimization across the cosmos, that could also come with changes to human morals, though technological change does not necessarily coincide with moral change.

[12] Under certain interpretations of the precautionary principle, no major transformative actions should be taken unless it is certain that they would be good (Sunstein 2002). Human hubris has arguably caused major problems such as climate change (Sadler-Smith and Akstinait 2021); pursuing the ECB or other radical optimization of the cosmos could be similarly hubristic, causing major unforeseen problems.

optimizes the rest of the cosmos according to one fixed optimization criterion, but other geometries of radical optimization are also possible. Other geometries are explored here. The geometries are given terminology under the following format: "[geometry of preserve boundaries] [geometry of radical optimization]". This terminology format is also used in "Earth-Cosmos Binary": the preserve boundary is between Earth and the cosmos, while the radical optimization geometry is a binary between the preserve and the rest of the cosmos. At the end of the section, an expanded terminology is introduced for variants in which the moral values of radical optimization are determined by extraterrestrial beings.

3.1 Earth-Cosmos Ternary and Further Recursion

If and when the ECB is established, it may begin with radical optimization in the region just on the other side of the boundary from Earth. That would be the closest region from Earth where radical optimization could be performed and so it makes for a likely starting place. The radical optimization may then expand outwards from there.

Suppose that during the process of outward expansion, new concepts or techniques for radical optimization are discovered. For example, if the process is led by an advanced AI, then that AI may learn new concepts as it proceeds. Indeed, current AI systems are already capable of some degree of learning, though presumably much less learning than this sort of advanced AI. By this point, there has already been some radical optimization within some region immediately surrounding the Earth-plus-vicinity preserve. The initial radical optimization has proceeded according to concepts or techniques that have since been found to be suboptimal. Moral value could potentially be increased by going back and redoing these regions, that is by re-radically optimizing the initial radical optimization.

The prospect of re-radical optimization raises the same issues as the radical optimization of Earth. It would be a second iteration of The Difficult Question. Should the initial radical optimizer replace itself? Likewise, the matter could be resolved by a second iteration of the ECB. Instead of redoing the initial band of radical optimization, it could be left in its initial form. A new boundary would be set. On the outer side of the boundary, radical optimization would proceed using the new and improved concepts or techniques. The result would be an *Earth-Cosmos Ternary*: three concentric value domains as sketched in Figure 2a. Following the same logic, there could be subsequent iterations producing an *Earth-Cosmos Quaternary*, an *Earth-Cosmos Quinary*, or even indefinite recursion in an *Earth-Cosmos Infinary* as sketched in Figure 2b. Evaluation of the merits of these various structures could proceed in a similar fashion as described above.

3.2 Earth-Cosmos Pienaries

The issue of political compromise speaks to a deeper underlying issue: the human population is morally diverse, with different people favoring different moral values (Haidt et al. 2003), including those favoring a plurality of moral values. It is possible that moral diversity would persist even after an extended process following a postponement of answering The Big Question—for comparison, philosophers have been studying morality for millennia and continue to lack consensus on basic questions, while various nations and political factions continue to maintain adversarial relations.

Instead of insisting on one consensus answer to The Big Question, a multitude of answers could be pursued. Under this approach, Earth and its vicinity could remain morally and politically divided in the same way that it currently is. The rest of the cosmos would be divided into segments, each of which would be radically optimized according to a different optimization criterion corresponding to a different set of moral values. The exact distribution of segments could be set according to some moral or political process to be determined through future research or by the participants in the process. As an illustrative example, a United Nations committee could identify an initial list of optimization criteria, and then a global vote could be held to decide how much weight to give to each criterion. The boundaries segment between segments may be set radially in a geometry similar to pie slices,

henceforth termed a *pienary*. Figure 3a sketches an *Earth-Cosmos Bipienary*, meaning an Earth-Cosmos Binary overlayed with pienary geometry. Figure 3b sketches an *Earth-Cosmos Infipienary*, meaning an Earth-Cosmos Infinary overlayed with pienary geometry. Pienaries may be politically advantageous by avoiding the need to reach global consensus. Likewise, evaluation of the merits of pienaries may be similar to evaluation of political compromise for the ECB (Section 2.7). An additional issue is on the allocation of the cosmos to different factions. As Figure 3 illustrates, there is no requirement that each faction receive an equal allotment.

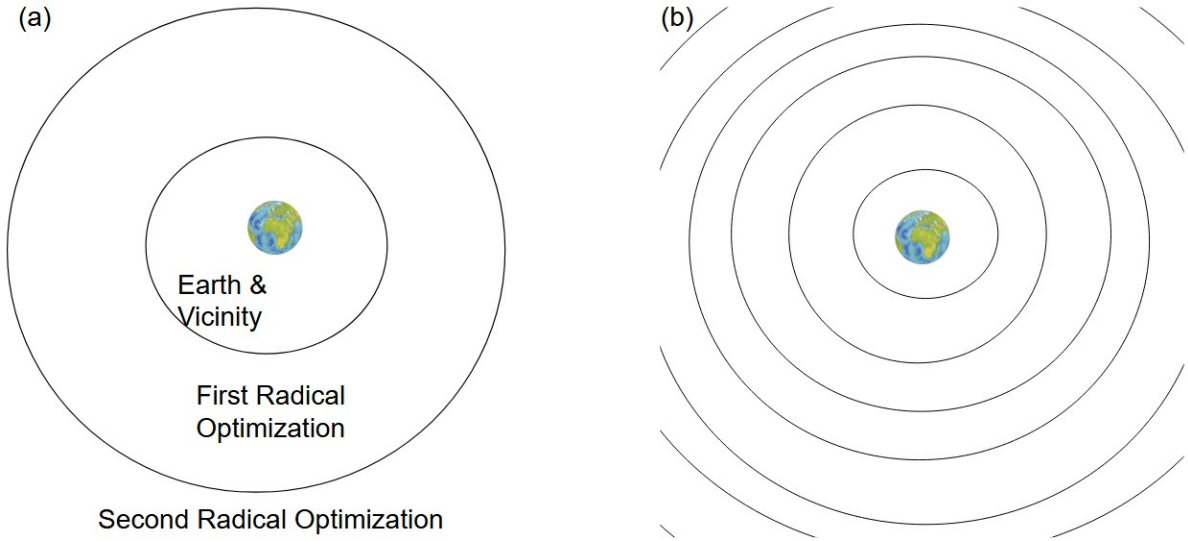

Figure 2. (a) Earth-Cosmos Ternary; (b) Earth-Cosmos Infinary. Boundary geometries shown here are illustrative sketches.

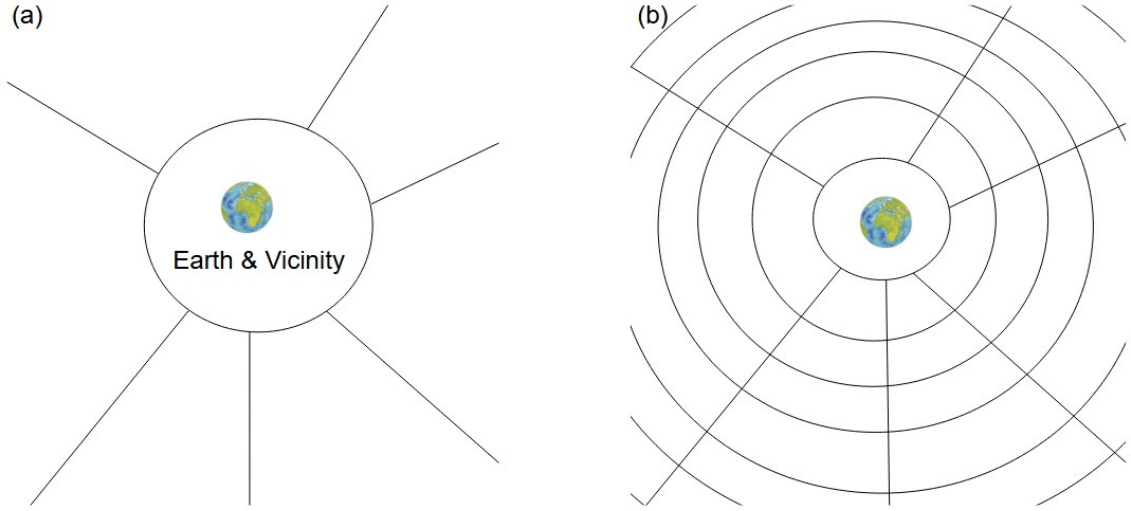

Figure 3. (a) Earth-Cosmos Bipienary; (b) Earth-Cosmos Infipienary. Boundary geometries shown here are illustrative sketches.

3.3 Indigenous Cosmic Spheres

At present, Earth is the only known inhabited planet. However, the search continues for extraterrestrial life, intelligence, etc. It remains possible that, elsewhere in the cosmos, there are other living and/or

intelligent beings. More generally, there may be other places of special moral significance in the way that Earth may be of special moral significance. These places may likewise be worth preserving in the same way that the ECB preserves Earth. Indeed, several scholars have argued for a variety of moral values present in extraterrestrial places (Rolston 1986; Milligan 2015; Schwartz 2019; Lupisella (2016). ECB designs that do not account for this may destroy such places via radical optimization. Doing so may be morally suboptimal in the same way that radically optimizing Earth may be morally suboptimal. There may additionally be a case for preserving these places analogous to the moral compromise argument for preserving Earth (Section 2.1).

Within the human population, people who live in a place where they have deep history are known as Indigenous.[13] Similarly, it can be said that all humans are indigenous to Earth, and furthermore that any extraterrestrial populations are indigenous to wherever in the cosmos they are from. On Earth, many Indigenous human populations have been treated quite poorly, including with acts of genocide. It is now commonly recognized that poor treatment of Indigenous human populations is a mistake. If and when humanity expands into outer space, there may be opportunity to avoid repeating this mistake.

Therefore, instead of radically optimizing the entire cosmos outside of Earth's vicinity, select extraterrestrial locations could be preserved. Such preserves, which may be termed *exopreserves*, could resemble national parks on Earth, and planetary parks, lunar land reserves, and solar system heritage zones (Cockell and Horneck 2004; 2006; Capper 2022; Oman-Reagan 2016a; 2016b), or something much larger. The exopreserves would protect populations and any other sources of moral value that are indigenous to that location. We term this design *Indigenous Cosmic Spheres*. In this terminology, "spheres" is used in a more abstract sense, akin to "spheres of influence". They do not need to be "spherical" in the mathematical sense and instead can be of any geometry.

Indigenous Cosmic Spheres specifically refer to the boundary between the regions that are preserved and the regions that are radically optimized. Grammatically, it is analogous to "Earth-Cosmos". If the radical optimization uses a single standard of value, as in the ECB, then the result is an Indigenous Cosmic Spheres Binary, as sketched in Figure 4. Alternatively, if the radical optimization uses multiple standards of value, then other geometries can result. Figure 5 sketches an Indigenous Cosmic Spheres Infipienary. The exopreserves in Figures 4 and 5 all preserve exoplanets and their vicinities, though exopreserves could also focus on preserving other things besides exoplanets.

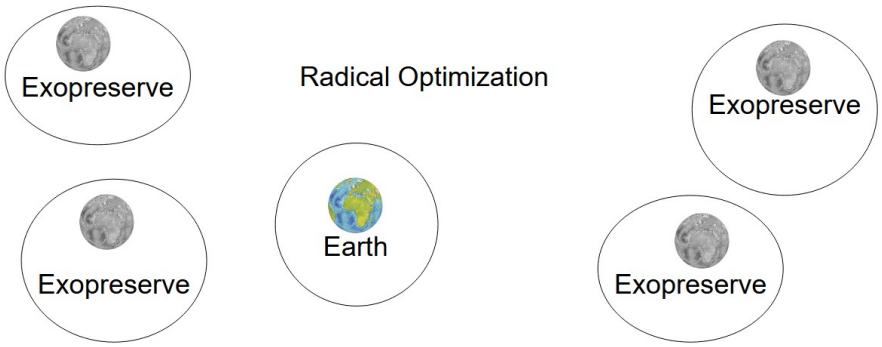

Figure 4. Indigenous Cosmic Spheres Binary. Boundary geometries are illustrative sketches.

[13] On the role of Indigenous peoples in space expansion, see Milligan (2023).

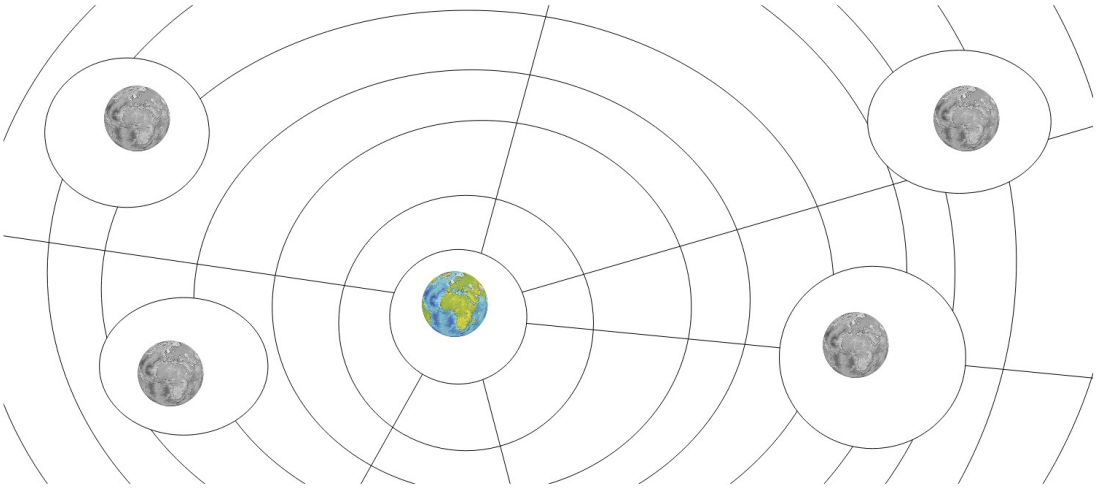

Figure 5. Indigenous Cosmic Spheres Infipienary. Boundary geometries are illustrative sketches. The planet in the center is Earth; the other planets are exopreserves.

3.4 Extraterrestrial Value Sources

The Indigenous Cosmic Spheres Infipienary sketched in Figure 5 illustrates an attribute of all frameworks considered thus far: all radical optimization emanates from Earth. This is *ethically geocentric* in the sense that it places Earth at the moral center of the cosmos (Fogg 2000). Ethical geocentrism can be distinguished from empirical geocentrism, which situates Earth at the geometric center of the cosmos. Arguably, ethical geocentrism is morally wrong because it favors Earth values for no reason other than the fact that the values are from Earth. The issue here is analogous to *ethical anthropocentrism*, in which humans are morally favored over other species for no reason other than the fact of them being human.[14] Arguably, both ethical anthropocentrism and ethical geocentrism constitute biases that can result in morally suboptimal outcomes.

An unbiased pursuit of moral value in the cosmos should be open to the possibility that other (non-Earth-originating) civilizations may have moral values that equal or exceed that of humans and other Earthlings (Baum 2010; Vakoch 2014). Other civilizations may also have values that complement Earth values, such that the best values would be some combination of both. A non-ethically-geocentric answer to The Big Question would consider extraterrestrial values on equal footing with Earth values. Let us assume that when humans initially answer The Big Question, no extraterrestrial civilizations are involved in the decision. This could be because no contact with extraterrestrial civilizations has yet been made, as is currently the case. Under this assumption, humans would answer The Big Question in a way that accounts for the possibility of later encountering extraterrestrial civilizations and considering their values. It is plausible that extraterrestrial civilizations would not be encountered until Earth-originating radical optimization spreads across the cosmos, because those civilizations may be hard to find from Earth but easier to find after spreading across the cosmos.

If one extraterrestrial location is found to have moral values that are superior to all others, the non-preserve cosmos could be re-radically optimized according to these values. The effect would be an initial wave of radical optimization emanating from Earth across the accessible cosmos, followed by a second wave of radical optimization emanating from the extraterrestrial location. This process is sketched in Figure 6. The extraterrestrial value source in Figures 6 is assumed to be an exoplanet,

[14] See footnote 1 for elaboration on ethical anthropocentrism.

though value sources could be other objects than planets.[15]

Accommodation of extraterrestrial value sources requires new terminology. The terminology format used thus far, "[geometry of preserve boundaries] [geometry of radical optimization]", has nothing to indicate the source of moral value used in radical optimization. Instead, the terminology has assumed that radical optimization emanates from Earth. That assumption is no longer valid. To accommodate extraterrestrial value sources, the terminology is expanded to the format "[geometry of preserve boundaries] [source of value] [geometry of radical optimization]". Thus, "Earth-Cosmos Binary" as sketched in Figure 1 becomes *Earth-Cosmos Earth Binary*, while "Indigenous Cosmic Spheres Infipienary" as sketched in Figure 5 becomes *Indigenous Cosmic Spheres Earth Infipienary*. Figure 6 shows the transition from *Indigenous Cosmic Spheres Earth Infinary* to *Indigenous Cosmic Spheres Exoplanet Infinary*, for some unspecified exoplanet.

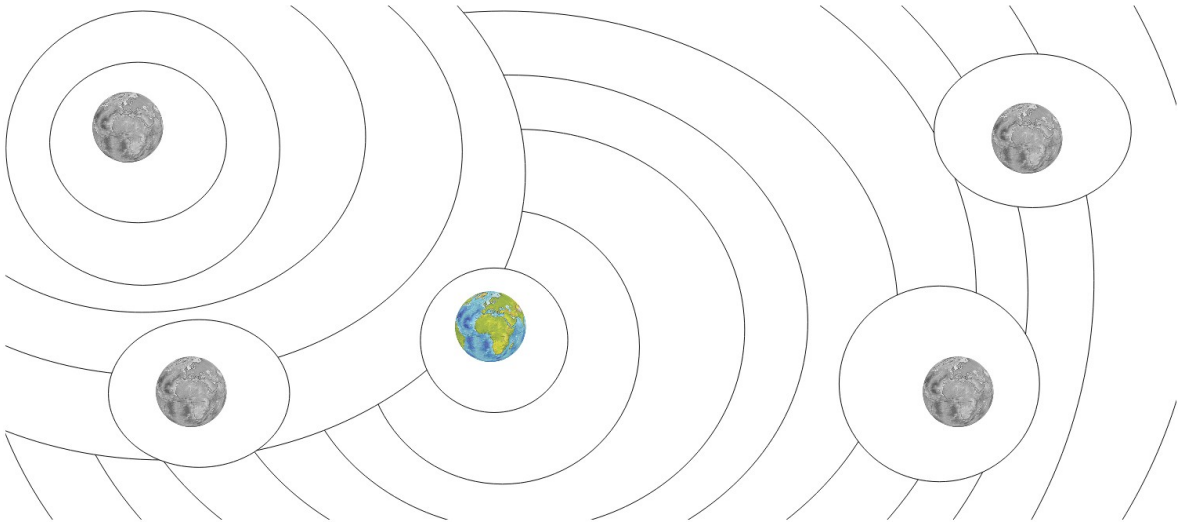

Figure 6. Transition from Indigenous Cosmic Spheres Earth Infinary to Indigenous Cosmic Spheres Exoplanet Infinary. Boundary geometries are illustrative sketches. The planet in the center is Earth; the other planets are exoplanets.

The Indigenous Cosmic Spheres Exoplanet Infinary sketched in Figure 6 recognizes that extraterrestrial values may be superior to those of Earth. However, it still assumes that there is one superior value framework that should be pursued across the accessible non-preserve cosmos. A case can be made for a more pluralistic approach advancing a diversity of values originating from across the cosmos, similar to how the Earth-Cosmos Pienary accommodates a diversity of values originating from Earth. Pienaries allocate slices of the cosmos emanating from a single value source, be it Earth or somewhere else. New geometry is needed to accommodate multiple value sources. Figure 7 sketches what can be called an *Indigenous Cosmic Spheres Multisource Infipienary*, in which infipienaries emanate from multiple value sources, each of which is also preserved. Each infipienary is allocated an adjacent region of the cosmos.

[15] The same applies for the value sources in Figure 7, to be introduced below.

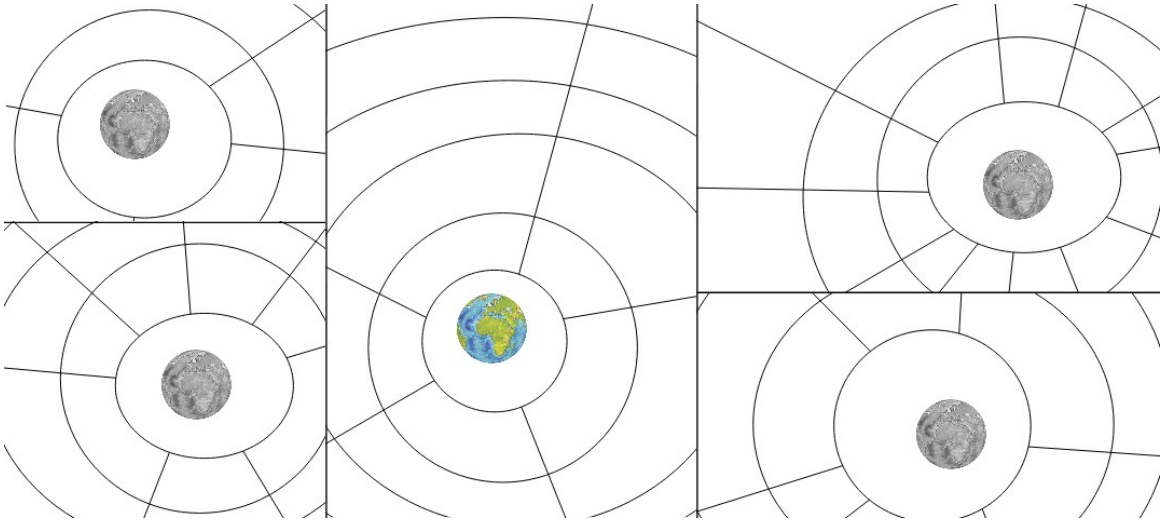

Figure 7. Indigenous Cosmic Spheres Multisource Infipienary. Boundary geometries are illustrative sketches. The planet in the center is Earth; the other planets are exoplanets.[16]

Extraterrestrial value sources raise novel issues. Politically, there are issues deriving from the relative power of Earth-originating radical optimization and extraterrestrial civilization(s). Perhaps the Earth-originating radical optimization would be more powerful, perhaps due to it being a radical optimization using the resources of a substantial portion of the cosmos. In that case, allocating some portion of the cosmos to extraterrestrial value source(s) involves the Earth-originating radical optimization voluntarily deferring to the extraterrestrials. For this to occur, humans may need to build this deference into their answer to The Big Question. This requires a certain generosity and high-mindedness from humans. It is unclear whether humans answering The Big Question would accept this.

Alternatively, perhaps the extraterrestrial civilization(s) would be more powerful, perhaps due to them being older and more technologically advanced. In that case, the extraterrestrial civilization(s) may overturn Earth-originating radical optimization by force. No human generosity is needed for this. However, this begs the question of why such an advanced civilization had not already radically optimized the accessible cosmos in the first place. The Fermi Paradox is relevant here: if some extraterrestrial civilization has already radically optimized the accessible cosmos, then current human astronomy presumably would have already detected it. Or, perhaps Earth is already contained within something akin to an exopreserve that is designed to hide the radical optimization from Earthlings, as in the Zoo Hypothesis solution to the Fermi Paradox (Ball 1973; Crawford and Schulze-Makuch 2024).[17]

A third political possibility is for Earth-originating radical optimization and extraterrestrial civilization(s) to have roughly equal power. This may be exceedingly unlikely, requiring an unusual coincidence. Nonetheless, in this type of scenario, there may need to be political negotiation similar to negotiation between humans on their initial answer to The Big Question.

Extraterrestrial value sources also raise moral issues. One is the issue of how to compare human and extraterrestrial values. It is plausible that extraterrestrial values could be superior to human values, such that the optimal approach is the Indigenous Cosmic Spheres Exoplanet Infinary, in which radical optimization switches from human to extraterrestrial values. This entails a decision of whether to make this switch, which raises issues of how to make that decision. The switch would presumably be made if

[16] *Author note: The journal version of this paper has the wrong image for Figure 7. It shows an infinary, not an infipienary. I regret the error, and I hope it does not cause a massive loss of value for the cosmos.*

[17] Recent scientific interest in unidentified aerial phenomena (UAP) of potentially extraterrestrial origin (Cloete et al. 2023) could further clarify the potential of Earth as an exopreserve.

the extraterrestrial values are found to be superior to the human values. It is not obvious how to establish criteria for judging the relative merits of novel value systems. Finally, the Indigenous Cosmic Spheres Multisource Infipienary entails a division of the cosmos into separate units. There is the moral question of how the division should be done, as well as the political question of what divisions would be accepted by the relevant parties.

4. Answering The Big Question

The ECB and its variants offer one promising set of partial answers to The Big Question. They are partial because they leave open the questions of what specifically to optimize for in the radical optimization(s) and how to manage the preserve(s). Answers to these questions are beyond the scope of this paper. Ditto for questions of whether to pursue an ECB or variant in the first place, and if so, which variant to choose. The answers will depend on details including the selection of specific ethical frameworks; the effectiveness of implementations of potential answers to The Big Question; the handling of moral and empirical uncertainty; the extent of political disagreement about The Big Question, including the risk of that disagreement escalating to catastrophic war; the viability of postponing the answering of The Big Question to give it more careful deliberation; the geometric structure of the cosmos as it relates to the placement of boundaries; the existence of extraterrestrial value sources; and the particulars of alternatives to the ECB and its variants. Such matters could be pursued in future research.

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