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Positive Cosmic Redundancy Principle and the Moral Value of Becoming a Multiplanetary Species

Luca Lo Sapio ^{1*}

¹ University of Turin; luca.losapio@unito.it

* Correspondence: luca.losapio@unito.it

Abstract: After a period that could be described as a winter of human space exploration, the 1990s and the early twenty-first century have inaugurated a renewed season of expansion. On the one hand, this space spring has unfolded through the deployment of landers and rovers across the Solar System, the use of next-generation telescopes to detect potentially habitable exoplanets, the entry of new geopolitical actors, and the increasing involvement of private companies such as SpaceX. On the other hand, momentum has grown around projects aimed at establishing permanent human outposts on the Moon and Mars and eventually pursuing terraforming and colonization. Within this evolving landscape, the prospect of human settlement beyond Earth has moved from the realm of science fiction to that of scientific and technological feasibility. Around this possibility, the ethical debate has polarized into two prevailing opposing orientations: cosmic expansionism, which views space colonization as a promising avenue to secure humanity's long-term flourishing and cosmological potential; and earthism, which warns that off-world expansion may magnify future harms or foster planetary neglect. Drawing on the emerging framework of planetary bioethics, which emphasizes the primacy of Earth's ecological integrity as a normative anchor for any technological or cosmological aspiration, this article reconstructs the main lines of the debate and proposes a third theoretical and moral view construed around the positive cosmic redundancy principle (CRP). Indeed, building on the Cosmic Bet Argument, that is the preferability to bet on the cosmic importance of our species, it defends a model of positive cosmic redundancy: investments in space-related research and technologies can be ethically justified—and even desirable—so long as they are not motivated by escapism or substitutionism, but are instead guided by principles of prudence, planetary responsibility, and long-term moral foresight. Under this view, off-world expansion may contribute to humanity's cosmic resilience, yet its legitimacy remains strictly conditional on reinforcing—rather than weakening—our obligations toward the only planet that presently sustains us. Against this backdrop, the article also proposes a set of criteria to effectively apply the principle of positive cosmic redundancy, as well as a discussion regarding its effectiveness in evaluating space programs such as Artemis and other space missions

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1. Human space travel and space colonization

Across history, humankind has pushed beyond settled environments in search of resources and in response to a sustained curiosity about the unknown. Much like the exploration of our home planet, space exploration has evolved through distinct cycles, involving different actors over time, with alternating phases of enthusiasm, consolidation, and stagnation (Green, 2022, p. 2). After the first orbital flights and the historic

competition between the United States and the Soviet Union¹, the symbolic apex of this pioneering era was represented by the Apollo program, which, between 1969 and 1972, brought twelve astronauts to walk on the lunar surface for the first time (Launius, 2018). This phase—often described as the “golden age” of space exploration (Launius 2018)—was sustained by a collective imagination oriented toward interplanetary expansion and boundless progress, which in turn was fueled by Cold War geopolitics and unprecedented state investments that construed space exploration, especially human spaceflight, as a highly symbolic national and civilizational endeavor.

Yet, following the Apollo 17 mission, the prospect of further human ventures beyond Earth orbit gradually faded. Public investments are increasingly focused on scientific projects of lower symbolic impact, from automated probes and satellite missions to orbital infrastructures such as the Soviet Mir station and, later, the International Space Station, without a renewed commitment to human exploration of the Solar System. This long period, which McCurdy (2011) aptly described as a “space winter”, coincided with a cooling of the public imagination and the growing conviction, including among policymakers, that the titanic effort of the Apollo missions had been an unrepeatable luxury.

In recent decades, however, we have witnessed a renewed flourishing of space exploration. On the one hand, this has taken the form of the consolidation and expansion of space exploration through increasingly powerful technological instruments and observational capabilities; on the other hand, it has involved a renewed interest in human spaceflight, extending from crewed missions to the more ambitious prospect of establishing permanent human settlements on other celestial bodies. This conjuncture has led many observers to describe the present moment as a “new Space Age” (Capova 2016; Dick & Launius 2025).

On the one hand, robotic missions such as Cassini-Huygens (1997-2017) have explored Saturn, its rings, and its moons in unprecedented detail, paving the way for new initiatives such as NASA’s Europa Clipper mission (launched in March 2024), designed to study Jupiter’s moon Europa, one of the most promising candidates in the search for extraterrestrial life. On the other hand, advances in astronomical observation, thanks to instruments such as the Hubble Space Telescope and the James Webb Space Telescope (JWST), have enabled the detection and characterization of extrasolar systems and potentially habitable planets, reinforcing the idea, although not universally shared (Balbi, 2023), of a cosmos teeming with worlds that might host life (Lamb, 2005; Covone, 2023).

In parallel, interest in a return to the Moon has been rekindled, not as a symbolic goal but as a logistical platform for future human exploration of Mars, also fueled by economic interests, including the potential extraction of helium-3 as a resource for nuclear fusion. Programs such as NASA’s Artemis and projects developed by space agencies like ESA, CNSA, and ISRO², alongside private initiatives from companies such as SpaceX and Blue Origin, aim to transform the Moon into a permanent outpost, serving not only scientific research but also future interplanetary missions. Within this framework, the prospect of a human colonization of Mars, once the domain of science fiction, has entered the sphere of serious scientific and technological speculation, envisaging the construction of stable habitats and, in the longer term, terraforming operations and modification of the human body for addressing the hostile environments we would face (Balistreri & Umbrello 2023).

In this regard, the words of Jean-Yves Le Gall, then President of the French space agency CNES, writing in CNESMAG in 2016 about the “new space era” and the acceleration driven by private actors, although dated in some respects, are emblematic:

¹ In this respect, the Pioneer missions (1958–1978), together with Viking 1 and 2 (1975) and the Voyager program launched in 1977, can be seen as the extended culmination of this phase of widespread enthusiasm. Despite being unmanned, these missions testified to both the technological maturity achieved and the lasting symbolic resonance of space exploration beyond its initial peak.

² ESA (European Space Agency); CNSA (China National Space Administration); ISRO (Indian Space Research Organization).

“This revolution could have the unexpected effect of accelerating the pace of Mars exploration. Once estimated for 2040-2050 only six months ago, the date of the first crewed mission to Mars now appears much closer, with advocates speaking of 2030 or even 2025. [...] The enormous reduction in launch costs brought about by new reusable launch systems and related projects is turning into reality what until recently was merely an idea: sending a spacecraft capable of supporting a crew of four to six people for two years on the Red Planet.” (Le Gall 2016, p. 12)

Moreover, technological advancements and the growing involvement of both public and private actors in space travel and colonization have led some authors to speak of a genuine “second space revolution” (Capova, 2016), in which long-term aspirations intersect with political, economic, and moral questions.

This historical framework thus presents a conceptual and ethical crossroads. If recent decades have alternated between enthusiasm and disillusionment, the present moment reopens the issue in radically new terms: Should humanity pursue the colonization of other worlds? Is it ethically justifiable to devote time, resources, and energy to the dream of terraforming celestial bodies in search of a “new home” for humankind? These are the questions that the following sections will seek to address through an examination of the principal ethical positions at stake.

The ethical debate surrounding space colonization can be broadly divided into two normative orientations, each reflecting a distinct way of conceiving humanity’s destiny and the scope of its moral responsibilities³.

Facing the threat of ultimate harm, some authors have claimed that we ought to divert some resources from the short-term issues to the big hazards humanity is confronting. It is not necessary to achieve a high probabilistic estimate of our cosmic dismissal; it is sufficient to have robust data regarding the existential threats menacing humankind. Within this perspective, the effort to establish the material conditions for a “Plan B,” understood as a second planet⁴ capable of permanently sustaining human life, is framed by a view that regards cosmic expansionism as a moral imperative.

By contrast, other authors maintain that moral priority should be given exclusively to strengthening efforts to defend and protect the home planet. From this perspective, large-scale investment in space colonization is seen not merely as a misallocation of scarce resources, but as a normative distraction—one that risks weakening humanity’s sense of responsibility toward the Earth and the living beings that depend upon it. Space colonization is therefore interpreted as a strategy that may facilitate moral disengagement, insofar as it frames ecological degradation as tolerable or reversible rather than as an urgent ethical failure requiring immediate collective action.

The next two sections will examine in greater detail some of the most influential formulations of these two positions. This will be followed by the presentation of my own approach, which seeks to retain the useful normative insights offered by each perspective while overcoming the limitations that undermine them.

³ It is important to stress that the positions discussed here are intended as ideal types, within a debate that encompasses a plurality of approaches and a far richer set of nuances than can be fully addressed in the present analysis. Nonetheless, this ideal-typical framing is not distortive, as it brings into focus the two dominant positions in the debate and offers a clearer comparative lens through which my own position can be articulated.

⁴ It would be more accurate to refer to “another celestial body,” insofar as space colonization may involve the terraforming of planets as well as moons. It should nevertheless be noted that some authors have also envisioned alternative models, such as the construction of orbital space cities; however, this latter option does not currently appear to occupy a central place in contemporary discussions on space colonization.

2. Cosmic expansionism: Humanity as a Multiplanetary Species

Within what may be called the cosmic expansionism perspective, space colonization is viewed not merely as a technological possibility but as a moral imperative. The arguments supporting this view differ across ethical frameworks (deontological, consequentialist, or virtue-based) but converge on the idea that remaining confined to Earth exposes humanity to intolerable risks and prevents the full realization of its potential as an intelligent species.

From a deontological standpoint, scholars such as Gonzalo Munevar (2023) argue that space colonization constitutes a duty because it advances scientific knowledge and may yield tangible benefits, including new sources of clean energy and innovative technologies.

Munevar further underscores the epistemic and existential value of maintaining a stable human presence on another celestial body, most plausibly Mars. Indeed, understanding its geological and atmospheric history could offer valuable insights into Earth's history, which in turn might help us anticipate Earth's future (Munevar 2023). Beyond its scientific benefits, the colonization of Mars would create conditions in which human extinction becomes less likely, technological innovation accelerates, and humanity gains the transformative experience of adapting to an entirely new world.

Within a utilitarian framework, other authors-most notably Szocik (2023; 2020)-argue that space colonization may be justified insofar as it contributes to the maximization of overall human well-being. From this perspective, extraplanetary expansion is valued not merely for its immediate benefits but for its potential to extend moral concern across temporal and spatial boundaries. Space colonization is thus construed as a strategy capable of enhancing the welfare of future generations and of enabling the flourishing of life beyond Earth, provided that the aggregate balance of benefits over harms remains positive.

This view, based on cosmic expansionism, also resonates with Carl Sagan's well-known claim that all civilizations should expand into the cosmos for their survival (Sagan, 1997). For Sagan, the survival of intelligent consciousness depends on humanity's ability to transcend planetary boundaries and cope with the existential threats confronting humankind. Similarly, Nick Bostrom (2002) introduced the concept of existential risk, defined as any event that would "annihilate Earth-originating intelligent life or permanently and drastically curtail its potential" (Bostrom, 2002, p. 2). For Bostrom, mitigating existential risk constitutes a superordinate moral duty, since the entirety of humanity's future value depends upon it.

This long-term ethical orientation has been further developed by the so-called longtermists, including Toby Ord (2020) and William MacAskill (2022), who contend that the moral value of future humanity is immense and that the number of catastrophic risks is correspondingly vast. From this perspective, exploring and developing extraterrestrial environments is not an act of hubris but an extension of moral responsibility-an attempt to secure and maximize the long-term flourishing of intelligent life.

At a more pragmatic and entrepreneurial level, this cosmic vision is embodied by figures such as Elon Musk, who has repeatedly stated that SpaceX's primary goal is to make humanity a multiplanetary species. Making life multiplanetary seems to be the only way to ensure that our civilization can survive whatever might happen on Earth (Musk, 2017). Within this imaginary, Mars is not merely a scientific laboratory but a form of cosmic insurance-a "second home" designed to guarantee the continuation of humanity's evolutionary and cognitive adventure in the face of terrestrial catastrophe.

A related but distinct line of argument is developed by Harold Mautner, whose notion of panbiotic ethics explicitly departs from anthropocentric frameworks by shifting normative attention from the preservation of human life to the continuation and expansion of life as such. For Mautner (2009), if life possesses intrinsic value

independently of its specific forms, then it becomes morally desirable to promote its dissemination throughout the universe, including in its most elementary biological manifestations, rather than privileging the persistence of humanity as a species. From this biocentric perspective, the moral significance of space expansion lies not in securing a human future *per se*, but in enabling the flourishing and propagation of life itself, even if its future expressions are no longer recognizably human. In this sense, panbiotic ethics reconceptualizes life as a cosmological good in its own right, extending moral concern beyond both anthropocentrism and species-specific survival.

In sum, the cosmic perspective presents space colonization as both a moral and existential necessity. Whether grounded in the deontological pursuit of knowledge, in utilitarian calculations of collective welfare, or in the broader aspiration to preserve life and intelligence as such (Torres, 2024), this view interprets humanity's expansion into space (or in Mautner's view, life's expansion into space) as both the next stage in its natural evolution and a rational response to the fragility of its planetary condition.

3. Earthism: against becoming a multiplanetary species

A second, more critical position, which may be called earthism⁵, emphasizes the ethical risks inherent in the visions that support space colonization. Within a virtue-ethical framework, some scholars argue that the promotion of space colonization is associated with undesirable, indeed vicious, character traits. For example, Robert Sparrow writes: "Despite the absence of any living systems, however, there are still extremely complex inorganic systems on Mars. Mars has a unique geography and complex chemical and physical systems, including an atmosphere and climate. Their operations over the millennia have produced many features of striking natural beauty and vast scale. [...] In terraforming Mars, we would be drastically altering the character of a whole planet, a unique environment which includes complex inorganic systems and possesses many features of striking natural beauty" (Sparrow 1999, p. 229). As Sparrow argues, moral concern about such an undertaking cannot be adequately grounded either in a rights-based framework or in a purely consequentialist calculus. Instead, he suggests that our ethical perspective should be reoriented toward a virtue-based approach.

Drawing on Michael Slote's terminology, this involves shifting from an act-centered perspective to an agent-based ethics. While agent-focused ethics treats the moral agent as epistemically central, emphasizing the agent's perspective and motivations in evaluating actions, agent-based ethics goes further by assigning ontological primacy to the agent. On this view, what ultimately matters in moral evaluation is not the intrinsic value of states of affairs or external entities, but the character traits and moral dispositions of the agent.

Crucially, agent-based ethics avoids grounding moral concern in the alleged intrinsic value of complex inorganic systems as such. Instead, it locates moral significance entirely in the qualities of the agent who acts toward them. Although this approach may appear anthropocentric, it is not necessarily at odds with our moral intuitions regarding environments like Mars. Rather than attributing intrinsic moral status to planetary systems themselves, it assesses whether radically transforming such environments reflects virtues or vices, such as humility, restraint, respect, or hubris in the agents who undertake these actions.

Thereby, he contends that the advocates of colonizing other worlds are animated by two principal vices: hubris and insensitivity to beauty. On the one hand, they act as if they were gods to whom everything is permitted—a disposition that prevents or obstructs the cultivation of admirable traits such as humility and the capacity to acknowledge one's own limits. Indeed "the rhetoric of terraforming is quite self-consciously a rhetoric of

⁵ In this paper Earthism highlights the tendency to prioritize concern for Earth's most pressing problems, without resorting to escapist ideas grounded in the assumption that humanity has a "Plan B". It has nothing to do with the theological concept of earthism.

transformation and transcendence” (Sparrow 1999, p. 236) On the other hand, their lack of sensitivity to the intrinsic beauty of celestial bodies encourages their radical alteration, even to the point of the destruction of unique environments containing “complex inorganic systems” (Sparrow 1999, pp. 234-235).

Among the most prominent critics of the space-colonization project, particularly of Martian colonization, are Kelly and Zach Weinersmith, authors of *A City on Mars: Can We Settle Space, Should We Settle Space, and Have We Really Thought This Through?* (2023). Their book carries out a systematic debunking of what they call the Multiplanetary Species Argument (MPSA): the claim that humanity is morally obliged to find a “Planet B” to avoid extinction and that we are either ready or destined to continue our cosmic adventure elsewhere. Against the MPSA, they advance a set of interconnected arguments built around the conviction that space colonization, especially of Mars, is not feasible in the short or medium term; is far from harmless from biological, social, ethical, legal, and political perspectives; and could, in fact, worsen many of the problems already faced on Earth.

More specifically, they point out that on Mars or the Moon, the human body would suffer severe degradation due to reduced gravity (one-third of Earth’s on Mars and one-sixth on the Moon), leading to muscular atrophy, cardiovascular dysfunction, and bone loss. It is unknown whether pregnancy could even be brought to term under low-gravity conditions. Neither Mars nor the Moon offers sufficient protection against solar and cosmic radiation or solar winds, exposing inhabitants to potentially lethal doses.

Some authors have responded to these objections by suggesting that in the long term, we might modify human beings, physically and psychologically, to enable them to survive and flourish in such hostile environments (Balistreri & Umbrello, 2023). To these biological and technical counterarguments, Kelly and Zach Weinersmith, however, add further considerations concerning the inherently inhospitable nature of Mars: its unbreathable atmosphere, lack of arable soil, scarcity of liquid water, absence of accessible resources, and the need for continuous resupply from Earth, all features that render the feasibility of such an enterprise very unlikely.

While other scholars have suggested that terraforming, together with innovative technologies such as cultivated meat, might eventually mitigate these constraints (Shaw & Soma, 2022), the Weinersmiths argue that such hopes remain speculative. Moreover, even if colonization were technically achievable, the resulting settlements would hardly resemble flourishing human communities. Contrary to the rhetoric of a “new beginning” or “rebirth of humanity,” they would more likely resemble military bases or polar research stations, characterized by stringent social control, dependence on technological infrastructure, and the practical impossibility of returning to Earth, especially for the first generations of colonists. Further concerns include deep social inequalities (between investors and participants), the potential for centralized governance over every aspect of life, and a host of unresolved legal issues.

Another author who has raised significant criticisms against the idea of investing resources in space colonization is Daniel Deudney, who, especially in *Dark Skies*, has characterized astrofuturism as the Promethean ambition to colonize other celestial bodies. Deudney emphasizes that, far from providing a solution to humanity’s existential threats, space colonization may exacerbate them, insofar as it represents an illusory search for a consolatory elsewhere that ultimately conceals the replication of dynamics already experienced on Earth, particularly in conflict and power-based geopolitics (Deudney 2020).

A similar critique is advanced by James Schwartz, Linda Billings, and Erika Nesvold in the volume *Reclaiming Space*. In this work, among other arguments, the authors maintain that in order to develop a space policy-and thus also a policy of space colonization-that does not inherit or reproduce the same colonial and imperial dynamics observed on Earth, it is necessary to adopt a decolonial perspective. This requires

abandoning certain frameworks characteristic of Western culture and opening space governance to non-Western-centric influences and paradigms (Schwartz et al., 2023).

Also, from a regulatory and legal perspective, some pitfalls emerge. Indeed, the only currently binding international framework is the 1967 Outer Space Treaty, which, though intended to prevent nationalist appropriation of celestial bodies, offers, at least according to some, no clear guidance on questions of private property or citizenship. Such issues would inevitably arise once individuals are born, live, and reproduce on Mars or the Moon. Similarly, no specific legal norms exist to govern crimes committed within colonies, to safeguard colonists' rights, or to address potential secession or independence movements. These are novel and largely hypothetical scenarios, for which legislative foresight is understandably lacking.

Economic concerns further complicate the picture. Despite optimistic narratives about an emerging "space economy," there is yet no self-sustaining extraterrestrial economy: the cost of extracting and transporting resources from space currently far exceeds their potential value.

Yet the most pressing objections to space colonization remain moral rather than technical or economic. For the Weinersmiths, the "Plan B" argument—that colonization ensures humanity's survival—lacks empirical support and functions primarily as a rhetorical device. The dream of escaping Earth risks fostering dangerous forms of moral disengagement, serving as an alibi for inaction in the face of the ecological crisis. It promotes a psychology of flight, whose principal consequence would be to erode the very motivations required to protect the planet we inhabit. Ultimately, space colonization may amount to a form of escapism for technocratic elites. As the authors write:

The truth is that settling other worlds, in the sense of creating self-sustaining societies somewhere away from Earth, is not only quite unlikely anytime soon, it won't deliver on the benefits touted by advocates. No vast riches, no new independent nations, no second home for humanity, not even a safety bunker for ultra-elites. Yet we find ourselves in a world where space agencies, huge corporations, and media-savvy billionaires are promising something else. According to them, settlements are coming, perhaps as soon as 2050 or so. When they are built, they will fix just about everything. They will save Earth's biosphere or enable a wildly creative frontier civilization or provide huge economic advantages for the United States or China or India or whoever else makes the first big move. (Weinersmith & Weinersmith 2023, p. xx).

Along similar lines, Mirko Garasic has observed (2024) that the Martian rhetoric is often driven less by scientific curiosity than by a desire for escape. The promise of a "new frontier," he argues, risks de-responsibilizing politics and public opinion, perpetuating the illusion that our planetary problems can be solved elsewhere.

There are also more extreme perspectives that develop explicitly misanthropic arguments to underscore the inappropriateness of investing in technologies that could render humanity a multi-planetary species. These are the positions that Kelly Smith describes as eco-nihilist (Smith, 2019). According to these authors, human beings have consistently demonstrated throughout their history a tendency toward selfishness and an inability to act in the collective good or for the well-being of the planet they inhabit. On this view, the same dynamics would simply be reproduced on another planet. Rather than overcoming its flaws, humanity would merely export its vices and pathologies to the rest of the universe.

Additional residual considerations highlight how the possibility of contact with extraterrestrial biological entities could give rise to adverse scenarios for both such entities and human beings. On the one hand, human exploration or settlement could inadvertently destroy alien eco-biospheres, raising serious concerns about interspecies harm and irreversible environmental loss beyond Earth. From the other side, humanity

itself could be exposed, accidentally or otherwise, to unknown extraterrestrial viruses or pathogenic agents, against which no natural immunity or adequate preventive measures may exist.

In scenarios involving extraterrestrial biological entities endowed with advanced cognitive capacities or forms of civilization comparable to our own, further risks emerge. Human activity could threaten the survival or autonomy of such civilizations, whether intentionally (by undermining the moral status of those beings) (Persson, 2012) or as an unintended consequence of expansionist practices. Conversely, humanity might encounter hostile extraterrestrial agents that could seek our destruction, subjugation, or exploitation. Even in the absence of malign intent on either side, additional problems could arise from the profound difficulty of establishing reliable and mutually intelligible forms of communication (Vakoch & Punske, 2024).

In such contexts, epistemic opacity and communicative asymmetry would significantly increase the likelihood of misinterpretation, miscalculation, and mutually escalating responses. Decisions made under conditions of radical uncertainty and misunderstanding could therefore precipitate outcomes that neither party initially intended, yet which would carry severe and potentially irreversible moral consequences.

4. The premises for a third path between cosmic expansionism and earthism: cosmic bet argument and positive cosmic redundancy principle

In order to assess whether it is morally acceptable to allocate resources to the development of technologies that would enable the colonization of other celestial bodies and thereby allow humanity to become a multi-planetary species, it is useful to address a preliminary axiological question: namely, whether the continuation of our species—understood as its likely disappearance later rather than sooner—is morally preferable to its extinction, understood as its likely disappearance sooner rather than later.

If the answer to this question is that delaying human extinction is morally preferable, then it would seem to follow that becoming a multi-planetary species is, *ceteris paribus*, preferable to remaining confined to a single planet (at that point, the central question no longer becomes whether this transformation should occur, but rather when it should take place—that is, under which conditions, and according to which timelines, it would be most appropriate for it to occur). This conclusion gains additional force when one considers that humanity is, as far as we currently know, the only self-conscious form of intelligence in the universe capable of reflecting on the cosmos and on its own place within it. The loss of such a form of intelligence would therefore represent not merely a biological extinction, but the disappearance of a unique locus of moral reflection and cosmological self-understanding.

One way of motivating this preference is provided by the so-called cosmic bet argument. This argument holds that, under conditions of profound epistemic uncertainty regarding humanity's role in the universe, it is rationally and morally preferable to "bet" on the cosmic significance of our species and, consequently, on the value of its continued existence rather than on its premature extinction (Lo Sapió, 2024; 2022). Although there is no space here to examine the argument in full detail, its core intuition can be briefly stated: given our deep uncertainty not only about our long-term prospects on Earth but also about whether humanity is the only—or merely a rare—form of reflective, self-aware intelligence in the cosmos, prudence requires that we act so as to delay extinction for as long as reasonably possible. This, in turn, appears to support investments in technologies that could extend humanity's temporal and spatial horizon by enabling long-term survival beyond Earth.

However, it is precisely on the basis of the cosmic bet argument that the positive cosmic redundancy principle is introduced as a necessary normative completion. Implicit in the cosmic bet is the recognition that long-term survival is conditional upon short- and

medium-term resilience. If humanity is to maximize its chances of persisting over cosmological timescales, it must first secure its continued existence in the near future. This entails focusing moral and political efforts on safeguarding the Earth as the primary and currently irreplaceable condition of human survival, rather than relying on illusory escape solutions such as rapid planetary abandonment.

Positive cosmic redundancy thus delineates a third normative path between two opposing extremes: on the one hand, the categorical rejection of extraterrestrial colonization as morally impermissible; on the other, the uncritical acceptance of large-scale space colonization and terraforming projects, often framed—*à la Musk*—as straightforward alternatives to planetary responsibility. By insisting that redundancy at the cosmic scale must complement, rather than substitute, robust terrestrial stewardship, the principle provides a more nuanced ethical framework for orienting humanity's future action under conditions of uncertainty.

5. A third path: dual responsibility and positive cosmic redundancy principle

The two perspectives examined in sections 1 and 2, while each capturing important ethical insights, remain partial when taken in isolation. The cosmic expansionist perspective rightly emphasizes the vulnerability of the human species to global catastrophes. As Nick Bostrom notes, “our future, and whether we will have a future at all, may well be determined by how we deal with these challenges” (Bostrom, 2002, p. 1). Similarly, Carl Sagan reminded us that if we do not venture into space, we will eventually go extinct (Sagan, 1997).

However, when taken as an absolute principle, this position risks legitimizing a dream of escape rather than a scientific project: the temptation to entrust our future to a remote promise while neglecting the immediate responsibilities we bear toward the only planet that is currently our home.

The terrestrial perspective—or earthism-by contrast, places these immediate responsibilities at the center of moral concern. As Hans Jonas recalled, the fundamental ethical imperative is to ensure the continuity of an authentic human life on Earth (Jonas, 1985). Other authors have voiced similar warnings about techno-escapism, arguing that if space colonization is conceived as an alternative to caring for our planet, it may undermine intergenerational responsibility.

Yet this position, while ethically grounded, risks short-sightedness if it rejects in principle any long-term vision of space colonization: however urgent our terrestrial commitments may be, they can never entirely eliminate the risks of human extinction.

It is at this juncture that a third way becomes conceivable. This position is not a mere compromise but rather a temporal articulation of moral responsibility:

In the short term, our highest priority must remain the preservation of planet Earth. It is here that the very possibility of transmitting dignified living conditions to future generations is decided, an imperative that echoes Jonas's principle of responsibility as well as the theories of intergenerational justice developed by John Rawls (1999) and the capabilities approach of Martha Nussbaum (2011).

In the long term, however, it may be both legitimate and perhaps morally required to consider space colonization as a form of positive cosmic redundancy, not a flight from reality but a supplementary option, one that increases the chances for the continuation of intelligent consciousness in the universe.

From this perspective, reference to John Rawls's just savings principle may be appropriate. Rawls introduced this principle as a foundational component of his theory of justice, explicitly aimed at extending its scope to issues of intergenerational justice. According to Rawls, each generation has a moral duty to preserve a sufficient stock of capital, understood broadly to include economic resources, natural assets, cultural

achievements, and institutional structures, so that future generations can sustain a well-ordered society governed by principles of justice and supported by just institutions.

Positive cosmic redundancy can be understood as an extension of this precautionary logic under conditions of heightened existential vulnerability. Insofar as the long-term preservation of just institutions and moral agency may depend on reducing species-level risks, investments in extraterrestrial capabilities, provided they do not undermine terrestrial sustainability, can be interpreted as a novel form of intergenerational saving. Unlike escapist “Plan B” narratives, positive cosmic redundancy does not substitute responsibility toward the Earth; rather, it supplements Rawlsian just savings by expanding the domain of what counts as prudential capital to include redundancy at the cosmic scale. On this view, the ethical permissibility of space colonization does not derive from its promise of transcendence, but from its conditional role in safeguarding the continuity of justice itself.

A complementary normative framework for grounding the positive cosmic redundancy principle can be found in Martha Nussbaum’s capabilities approach, too, particularly in its emphasis on securing the material and institutional conditions necessary for sustained human flourishing. Unlike Rawls’s focus on the basic structure of a well-ordered society, Nussbaum’s approach centers on the protection of a threshold level of core capabilities that must be made available to all individuals as a matter of justice (Nussbaum, 2011).

From this perspective, large-scale existential risks pose a distinctive moral threat: they do not merely redistribute disadvantages but, in a non-compensable way, undermine the very possibility of exercising central human capabilities. The value of positive cosmic redundancy can therefore be interpreted in capability-theoretic terms as a prudential strategy aimed at preserving the long-term background conditions under which fundamental capabilities—such as life, bodily health, practical reason, affiliation, and control over one’s environment—can continue to be realized.

Importantly, this interpretation does not frame space colonization as an enhancement of human excellence or as an aspirational expansion beyond Earth, but rather as a conditional safeguard against the collapse of the minimal capability threshold required for justice. In this sense, investments in extraterrestrial settlement, when constrained by strict sustainability requirements and by non-escapist narratives, function analogously to institutional guarantees within Nussbaum’s framework: they are justified not by the pursuit of superiority, but by their role in securing the preconditions of dignity and flourishing across generations.

Understood in this way, the positive cosmic redundancy principle extends the capabilities approach into the domain of intergenerational and planetary ethics, without abandoning its commitment to grounding justice in concrete, embodied, and universally shareable conditions of human life.

In this light, space colonization can be justified not as a “replacement” for Earth or a retreat to a “Planet B,” but as an additional opportunity—one that should be pursued without ever relinquishing the primary duty of planetary stewardship.

A similar prudential attitude is found in Adam Morton, who, after weighing the pros and cons of space colonization, concludes that our species “Think of humanity as a particular species that has evolved to fill a particular ecological niche in a tiny fraction of the time that there has been life on Earth. Our intelligence and our imagination are rooted in our history and limited by it. There is much that we do not understand, and many possibilities that we cannot fully grasp. Knowing this, we can at least resolve to make our plans slowly and carefully, giving ourselves enough time to resolve basic scientific problems about human possibilities beyond Earth” (Morton, 2018, p. 34).

This intermediate position thus offers a distinct dialectical advantage: For advocates of cosmic expansionism and techno-escapism, it imposes strict ethical constraints that preclude immediate disengagement from our terrestrial responsibilities.

In relation to the proponents of the terrestrial perspective (Earthlings), it broadens the temporal horizon, recognizing that our moral obligations do not end with the management of present crises but extend to the distant future of consciousness in the cosmos.

In other words, this is an ethics of dual responsibility: immediate care for the Earth, coupled with a long-term openness to a cosmic project—one pursued soberly, realistically, and without utopian excess. Only through this lens can space colonization be conceived not as an escape but as the prudent and responsible continuation of the human adventure.

We can summarize the above discussed views through Table 1

View	Core ideas	Consequences
Cosmic expansionism	Cosmic expansionism is a moral imperative for humankind	We ought to invest in the development of extraterrestrial settlement capacities in order to extend humanity's chances of long-term survival.
Earthism	The defense and protection of our planet is a moral imperative for humankind	Resources should be redirected away from outer space programs, especially those concerned with space colonization, and reallocated toward the defense and protection of the Earth.
Positive cosmic redundancy	We ought to defend and protect our planet in the short term, while also pursuing the long-term transformation of humanity into a multi-planetary species	We should prioritize investment in technologies for planetary protection while also, under appropriate conditions, supporting the development of technologies that could eventually enable humanity to become a multi-planetary species.

Table 1: cosmic expansionism, earthism, and positive cosmic redundancy

6. Cosmic bet argument, positive cosmic redundancy, and some practical criteria to apply

The cosmic bet argument is a prudential argument grounded in decision-making under conditions of deep uncertainty and asymmetric risk. It starts from the observation that, while the probability of existential catastrophes may be low or epistemically indeterminate, the magnitude of their potential harm is extreme and non-recoverable: the permanent loss of morally significant life, cultural achievements, and just institutions. Under such conditions, rational action cannot rely solely on standard expected-utility calculations; instead, it becomes reasonable to allocate resources toward strategies that reduce the risk of irreversible moral loss, even when their benefits are uncertain.

Within this framework, investments in space-related capabilities, such as long-term off-world habitation, are construed as a wager against existential fragility. The “bet” consists of accepting moderate and reversible costs in the present in order to hedge against

outcomes whose moral cost would be catastrophic. Importantly, the cosmic bet argument does not claim that such investments are morally obligatory, nor that they guarantee survival; it claims only that, given the asymmetry between potential costs and losses, refusing to hedge may itself be morally imprudent.

The positive cosmic redundancy principle can be understood as a normative refinement of this prudential wager. While the cosmic bet argument explains why it may be reasonable to invest in redundancy-enhancing strategies at the cosmic scale, the PCR specifies the moral conditions under which such a wager is ethically permissible. In particular, it constrains the bet by requiring that investments in extraterrestrial capabilities do not undermine existing obligations toward terrestrial sustainability, social justice, or intergenerational responsibility.

Seen in this light, positive cosmic redundancy transforms the cosmic bet into a morally disciplined form of precaution. Redundancy is pursued not as an escape from planetary responsibility, but as a conditional hedge aimed at preserving the long-term possibility of justice, agency, and human flourishing. The wager, therefore, is not placed on abandoning the Earth, but on ensuring that the moral achievements of humanity are not rendered cosmically fragile.

The positive cosmic redundancy principle does not claim that space colonization is morally obligatory, nor that it can serve as a form of compensation for ethical failure on Earth. Rather, it holds that it is morally permissible-and, under certain conditions, morally prudent to invest resources in the development of extraterrestrial settlement capacities, provided that such investments do not weaken primary obligations toward terrestrial sustainability, justice, and responsibility. The framework developed here, therefore, adopts a conditional and cumulative structure. Space colonization is not conceived as an escape clause from planetary duties, but as a form of positive moral redundancy, analogous to redundancy strategies employed in other high-risk domains such as nuclear safety, biodiversity conservation, or the long-term preservation of knowledge. Starting from the positive cosmic redundancy principle, it is possible to articulate a set of operational criteria aimed at specifying concrete and practical ways in which the principle can be applied within contexts of decision-making.

6.1 Criterion A - Terrestrial Sustainability Threshold, TST

The Terrestrial Sustainability Threshold (TST) is designed to exclude morally unacceptable trade-off scenarios in which investments in space exploration or colonization are made at the expense of fundamental human needs or in violation of binding climate commitments. Its primary function is to ensure that extraplanetary ambitions do not undermine the ethical priority of safeguarding the conditions of life and justice on Earth.

The criterion can be articulated as follows: a program aimed at extraterrestrial colonization is ethically eligible for funding only if the sponsoring state or funding consortium demonstrably meets a minimum, verifiable threshold of commitment to terrestrial sustainability. This requirement introduces a conditional logic into space policy: extraplanetary investments are permissible not as standalone initiatives, but only insofar as they are embedded within a broader framework of responsible planetary stewardship.

Compliance with the TST may be assessed through a range of indicators, including but not limited to the following:

1. Alignment with the United Nations Sustainable Development Goals, with particular emphasis on:
 - SDG 7 (Affordable and Clean Energy),
 - SDG 12 (Responsible Consumption and Production),
 - SDG 13 (Climate Action).

2. Substantive compatibility with the objectives of the Paris Agreement, understood not as mere symbolic endorsement but as concrete policy implementation.
3. Absence of intentional regression, meaning that funding allocated to space programs must not be used to justify the slowing down, dilution, or abandonment of existing environmental and climate policies.

From a philosophical standpoint, the TST plays a crucial role in preventing a moral hazard interpretation of the positive cosmic redundancy principle. Cosmic redundancy is ethically admissible only insofar as it does not function as a substitute for humanity's primary responsibility toward the Earth. Rather than legitimizing planetary neglect, the TST ensures that redundancy at the cosmic scale remains conditional upon sustained and demonstrable commitment to terrestrial justice and sustainability.

6.2 Criterion B - Verified Earth Co-Benefits, VECB

Within the framework of positive cosmic redundancy, space colonization cannot be justified solely as a form of cosmic insurance against existential risk. It must also be understood as a potential multiplier of terrestrial technological capacities, particularly in contexts characterized by scarcity, the need for resilience, and the management of ecological and material limits. From this perspective, extraplanetary projects acquire ethical relevance insofar as they contribute to enhancing humanity's ability to cope with constraints that are already pressing on Earth.

Accordingly, any program aimed at extraterrestrial colonization should include an explicit and credible roadmap for technology transfer, specifying how the knowledge, tools, and infrastructure developed for space applications will generate measurable benefits for terrestrial societies. This requirement ensures that investments in space are not normatively isolated but are systematically linked to the improvement of human capacities under terrestrial conditions.

Co-benefits should be sought in domains where space technologies have a clear potential to address pressing terrestrial challenges, including but not limited to the following areas:

1. Closed-loop life-support systems, with applications in:
 - water management in arid and resource-constrained environments,
 - regenerative and urban agriculture,
 - Energy and materials, particularly with respect to technological miniaturization, advanced recycling systems, and extreme energy efficiency.
2. Governance of extreme environments, including:
 - disaster response and emergency management,
 - infrastructural resilience in high-risk or degraded contexts.

To avoid purely rhetorical commitments, the realization of terrestrial co-benefits must be subject to robust mechanisms of verification. These may include:

1. the ex ante definition of clear indicators for terrestrial returns;
2. periodic and independent evaluations, in the form of ethical-technological audits;
3. revision or suspension clauses, allowing funding to be reconsidered in cases of systemic failure or persistent underperformance.

6.3 Criterion C - Anti-"Planet B" Communication Principle

The rhetoric of a “Planet B” undermines the positive cosmic redundancy principle from within. By framing space colonization as a substitute for planetary responsibility, it produces several ethically problematic effects. First, it weakens moral motivation to care for and preserve the Earth. Second, it introduces a narrative of premature disengagement, in which ecological failure is tacitly accepted as inevitable. Finally, it legitimizes forms of technological fatalism, suggesting that future innovations will compensate for present moral and political inaction.

In response to these risks, extraplanetary projects must be communicated not as alternative destinations for humanity, but as security-oriented forms of redundancy. Space colonization should be framed as a supplementary safeguard under conditions of uncertainty, rather than as a replacement for terrestrial stewardship.

This communicative principle can be translated into a set of concrete guidelines:

1. An explicit prohibition, in official and institutional communications, of:
 - “backup planet” framings,
 - eschatological narratives portraying terrestrial collapse and the Planet B solution as inevitable.
2. The use of appropriate analogies, such as:
 - biodiversity archives,
 - informational redundancy in computing,
 - fail-safe systems in high-risk engineering.
3. A sustained emphasis on epistemic dependence, highlighting that knowledge and technologies developed for space are primarily intended to improve life and resilience on Earth.

From an ethical standpoint, this criterion serves to protect the symbolic normativity of terrestrial responsibility. By regulating how space colonization is publicly framed and justified, it prevents the positive cosmic redundancy principle from being misconstrued as a moral license to disengage from the care and preservation of the Earth.

6.4 Criterion D - International Legal Compliance, ILC

The positive cosmic redundancy principle is fundamentally incompatible with extractivist or neo-colonial conceptions of outer space. Any ethical justification of extraplanetary expansion must therefore reject models that replicate patterns of appropriation, domination, or unilateral exploitation beyond Earth.

This normative stance is grounded in, and reinforced by, the existing framework of international space law, in particular:

1. The Outer Space Treaty (1967), which establishes:
 - the principle of non-appropriation,
 - the requirement of peaceful use,
 - the responsibility of states for space activities.
2. The Moon Agreement (1979), understood not only as a legally binding instrument for its signatories but also as a normative benchmark, insofar as it affirms:
 - the status of extraterrestrial resources as the common heritage of humankind,
 - principles of intergenerational equity.

On this basis, no project of space colonization can be regarded as morally admissible if its implementation depends on the suspension, circumvention, or opportunistic reinterpretation of the fundamental principles of international space law. Ethical permissibility requires legal integrity, not legal exceptionalism.

More broadly, the PCR implies a cosmopolitics of responsibility rather than a sovereign race for survival. It frames humanity's extraplanetary aspirations within a cooperative and normatively constrained horizon, in which long-term survival is pursued through shared obligations rather than competitive escape strategies.

Only when all these conditions are jointly satisfied can investments in space colonization be considered compatible with the positive cosmic redundancy principle.

This framework makes it possible to distinguish the positive cosmic redundancy principle both from forms of escapist techno-optimism and from strict earthism; to show that space colonization can be morally responsible without being morally necessary; and to integrate space ethics, theories of responsibility, and the philosophy of existential risk prevention into a coherent normative perspective.

7. Conclusions and practical landscape

Space colonization today stands as one of the most debated topics in the ethics of technology. The brief historical reconstruction presented above has shown how, after the heroic season of the Apollo missions and the subsequent "space winter," we are now experiencing a renewed phase of flourishing, marked by the increasing involvement of both state agencies and private actors. In this context, the ethical question no longer concerns merely the technical feasibility of exploring space, but rather the appropriateness of investing resources, time, and energy in a project that seeks to transform humanity into a multiplanetary species.

Two opposing visions dominate the current debate. On one side, the cosmic expansionism perspective regards space colonization as both a strategic and moral necessity—an effort to mitigate existential risks and to ensure the continuation of consciousness in the universe. On the other hand, the terrestrial perspective (Earthism) highlights the perils of techno-escapism and moral disengagement: envisioning new extraterrestrial homelands risks weakening our political and moral will to safeguard the Earth, the only inhabitable world we currently possess.

This analysis has suggested a third path, grounded in a temporal and axiological distinction: a form of dual responsibility. In the short term, the imperative remains to protect the Earth and to guarantee intergenerational justice, in line with the ethical frameworks proposed by Jonas, Rawls, and Nussbaum. In the long term, however, space colonization may be justified as a form of positive cosmic redundancy, not as an escape from present duties, but as a supplementary option designed to increase the chances for the continuation of the human adventure in the cosmos.

In this way, the space enterprise is neither absolutized nor demonized; rather, it is reinterpreted as an additional opportunity, one that should complement—but never replace—the primary task of stewarding our planetary home. Only under such conditions can space colonization evolve from an escapist myth into a responsible project, capable of reconciling prudence with foresight, care for the present with openness to the future. Within this framework, it becomes ethically permissible, albeit with the caveats discussed in the preceding paragraphs, to invest in research and technology related to space colonization, under a paradigm of operational prudence grounded in a moral precautionary principle specifically applied to the field of space sciences.

If the positive cosmic redundancy principle is not to remain a merely justificatory concept, but is instead to serve an orienting and evaluative function, it must be capable of being subjected to institutional assessment both *ex ante* and *ex post*. From this

perspective, space programs that are already underway or in advanced planning provide particularly promising experimental grounds for testing the principle in practice.

Initiatives such as Artemis can be interpreted not merely as technical-strategic programs, but as normative laboratories in which the positive cosmic redundancy principle can be operationalized through explicit ethical constraints. In particular, this would require:

1. the formal integration of PCR-based criteria into decision-making processes, alongside standard considerations of safety, feasibility, and cost;
2. mandatory terrestrial ethical impact assessments, analogous to environmental impact assessments, addressing:
 - compatibility with climate objectives,
 - documentable civilian and societal technological returns,
 - symbolic and communicative effects on public perceptions of the ecological crisis;
 - the inclusion of review clauses, whereby the continuation of successive program phases is made conditional upon sustained compliance with established thresholds of sustainability and co-benefit.

Understood in this way, Artemis-or comparable programs-would not be justified despite the ongoing terrestrial crisis, but rather in light of an extended conception of responsibility that complements, rather than substitutes for, planetary stewardship.

A second level of application concerns the deliberate design of experimental missions conceived from the outset according to an ethics-by-design approach, explicitly intended to test the positive cosmic redundancy principle in practice. Such missions would not merely pursue technical feasibility, but would function as controlled normative experiments. These missions could include, among other features:

- ethically earmarked budgets, in which a defined portion of funding is structurally allocated to terrestrial technology transfer;
- objectives of extreme ecological self-sufficiency, conceived as stress tests for models of sustainability that could later be applied under terrestrial conditions;
- an explicit prohibition of evasive or escapist communicative framings, monitored by independent oversight bodies;
- enhanced compliance not only with existing space treaties, but also with more demanding normative standards than those strictly required by law, for instance, strong interpretations of the non-appropriation principle.

Such missions would carry both epistemic and normative value. They would demonstrate not only what is technically feasible, but also the moral conditions under which extraplanetary endeavors can be regarded as ethically permissible.

Finally, the positive cosmic redundancy principle calls for a reconfiguration of space governance along multilevel and reflexive lines. Rather than being confined to technical or strategic coordination, governance structures should explicitly incorporate ethical oversight and long-term responsibility. In practical terms, this implies:

- the involvement of interdisciplinary ethics committees endowed with genuine consultative authority, rather than merely symbolic roles;
- robust mechanisms of public accountability, including transparency regarding the normative objectives and ethical rationales underpinning space programs;
- forms of international cooperation that go beyond security concerns and extend to shared commitments toward intergenerational responsibility.

By embedding space activities within such a governance framework, the PCR reinforces the idea that extraplanetary initiatives are not solely matters of technological ambition or geopolitical competition, but components of a broader ethical project oriented toward the long-term continuity of human agency and justice.

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References

1. Balbi, A. & Manasvi, L. (2023), Beyond mediocrity: how common is life?, ArXiv:2305.05395
2. Balistreri, M. & Umbrello, S. (2023), Modifying the environment or human nature? What is the right choice for space travel and Mars colonization?, *Nanoethics*, 17(5), pp. 1-13
3. Bostrom, N. (2002), Existential Risk. Analyzing human extinctions scenarios and related hazards, *Journal of evolution and technology*, 9,
4. Capova, K.A. (2016), The new space age in the making: emergence of exo-mining, exo-burials and exo-marketing, *International Journal of Astrobiology*, 15(4), pp. 307-310
5. Covone, G. (2023), *Altre terre. Viaggio alla scoperta di pianeti extrasolari*, HarperCollins Italia, Milano
6. Dick, S.J. & Launius, R.D. (2025), *Societal impact of spaceflight*, End Matter, Hutson Street Press
7. Deudney, D. (2020), *Dark Skies, Space expansionism, planetary geopolitics, & the end of humanity*, Oxford University Press, New York
8. Garasic, M. (2024), *Finché Marte non ci separi*, Fandango, Roma.
9. Green, P.B. (2022), *Space ethics*, Rowman and Littlefield, London
10. Jonas, H. (1985), *The imperative of responsibility. In search of an ethics for the technological age*, University of Chicago Press, Chicago
11. Lamb, D. (2005), *The search for extraterrestrial intelligence: a philosophical inquire*, Routledge
12. Le Gall, J-Y. (2016), Editorial in *Mars. La nouvelle frontier*, CNES MAG
13. Lo Sapio, L. (2024), The ethics of astrobiology and the cosmic bet argument, *International Journal of Technoethics*, 15(1), pp. 1-8
14. Lo Sapio, L. (2022), The Ethics of astrobiology: humanity's place in the cosmos and the extinction problem, *Frontiers in astronomy and space sciences*, 9.
15. Lunius, R.D. (2018), *The history of space exploration: discoveries from the ancient world to the extraterrestrial future*, Thames & Hudson, London
16. Mautner, N.M. (2009), Life-centered ethics, and the human future in space, *Bioethics*, 23(8), pp. 433-440
17. McAskill, W. (2022), *What we owe to the future*, Basic Books, New York
18. McCurdy, H.E. (2011), *Space and the American imagination*, John Hopkins University Press, Baltimore
19. Morton, A. (2018), *Should we colonize other planets?*, Polity, Cambridge.
20. Munevar, G. (2023), *The Dimming of starlight. The philosophy of space exploration*, Oxford University Press, New York
21. Musk, E. (2017), Making humans a multi-planetary species, *New Space*, 5(2), pp. 46-61
22. Nussbaum, M. (2011), *Creating capabilities. The human development approach*, Harvard University Press, Cambridge
23. Ord, T. (2020), *The precipice. Existential risk and the future of humanity*, Bloomsbury Publishing, London
24. Persson, E. (2012), The moral status of extraterrestrial life, *Astrobiology*, 12(10), pp. 976-984
25. Rawls, J. (1999), *A theory of justice*, Belknap Press, Cambridge
26. Sagan, C. (1997), *Pale blue dot. A vision of the human future in space*, Ballantine Books, New York
27. Schwartz, J.S.J., Billings, L., Nesvold, E. (2023), *Reclaiming space. Progressive and multicultural visions of space exploration*, Oxford University Press, New York
28. Shaw, R. & Soma, T. (2022), To the farm, Mars, and beyond: technologies for growing food in space, the future of long-duration space missions, and earth implications in English news media, *Frontiers in Communication*, 10.3389
29. Smith, K. (2019), Homo reductio. Eco-nihilism and human colonization of other worlds, *Futures*, 110, pp. 31-34.
30. Sparrow, R. (1999), The ethics of terraforming, *Environmental Ethics*, 21(3), pp. 227-245.
31. Szocik, K. (2023), *The Bioethics of space exploration. Human enhancement and gene editing in future space missions*, Oxford University Press, New York
32. Szocik, K. (2020), *Human enhancements for space missions. Lunar, Martian, and Future missions to the outer planets*, Springer
33. Torres, O.A.C. et al. (2024), Astrobiocentrism: reflections on challenges in the transition to a vision of life and humanity in space, *International Journal of astrobiology*, 23:e6
34. Vakoch, D.A., Punske, J. (2024), *Xenolinguistics. Towards a science of extraterrestrial language*, Routledge
35. Weinersmith, K & Wenersmith Z. (2023), *A City on Mars: Can We Settle Space, Should We Settle Space, and Have We Really Thought This Through?*, Particular Books