

Our Moral Obligation to Support Space Exploration

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The moral obligation to support space exploration follows from our obligations to protect the environment and to survive as a species. It can be justified through three related arguments: one supporting space exploration as necessary for acquiring resources, and two illustrating the need for space technology in order to combat extraterrestrial threats such as meteorite impacts. Three sorts of objections have been raised against this obligation. The first are objections alleging that supporting space exploration is impractical. The second is the widely held notion that space exploration and environmentalism are at odds with one another. Finally, there are two objections to using space resources that Robert Sparrow has raised on the topic of terraforming. The obligation to support space exploration can be defended in at least three ways: (1) the “argument from resources,” that space exploration is useful for amplifying our available resources; (2) the “argument from asteroids,” that space exploration is necessary for protecting the environment and its inhabitants from extraterrestrial threats such as meteorite impacts; and (3) the “argument from solar burnout,” that we are obligated to pursue interstellar colonization in order to ensure long-term human survival.

I. INTRODUCTION

The subject of space exploration has received a relatively small amount of attention in philosophical circles. Most of the discussion has been focused on practical issues: on what we may or may not do *if* we decide to explore the universe.¹ Rather little philosophical attention has been given to the ethical and environmental *foundations* of space exploration. That is, philosophers have seldom taken it upon themselves to subject our motivations for exploring space to philosophical analysis.² Although I

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¹ See Robert Ginsberg, “The Future of Interplanetary Ethics,” *Journal of Social Philosophy* 2 (1971): 5–7; William Hartmann, “Space Exploration and Environmental Issues,” *Environmental Ethics* 6 (1984): 227–40 (reprinted in the Hargrove anthology listed below, pp. 119–39); Robert Sparrow, “The Ethics of Terraforming,” *Environmental Ethics* 21 (1999): 227–45; Martyn Fogg, “The Ethical Dimensions of Space Settlement,” *Space Policy* 16 (2000): 205–11; and Dan MacArthur and Idil Boran, “Agent-Centered Restrictions and the Ethics of Space Exploration,” *Journal of Social Philosophy* 35 (2004): 148–63. See also the much-cited volume edited by Eugene Hargrove, *Beyond Spaceship Earth: Environmental Ethics and the Solar System* (San Francisco: Sierra Club Books, 1986), especially the “Philosophical and Environmental Perspectives” section.

² There are undertones of such an analysis in support of space exploration in Hartmann, “Space Exploration and Environmental Issues,” and Fogg, “The Ethical Dimensions of Space Settlement.” Bonnie Steinbock, “Progress and the Value of Space: Two Views,” *The Monist* 71, no. 1 (1988): 33–44, depicts

discuss practical issues as a matter of necessity, this paper is intended as a discussion of the ethical and environmental foundations of space exploration.

When broaching the topic of space exploration as an ethical issue the general response I receive is negative. The following is typical of the reasoning behind the response. "Just think about the immeasurable tons of rocket fuel we have burned up. How horribly wasteful, dangerous, and inefficient it all is, and for little to nothing in return. The threat to the environment by itself provides sufficient reason for curtailing manned spaceflight. Far from scaling up our space programs, we should reduce them to the bare minimum or dissolve them entirely." However, it would be a mistake to believe that the short-term environmental hazards of spaceflight exhaust both the environmental and ethical dimensions of space exploration. I argue that upon uncovering the additional ethical dimensions of space exploration, perhaps straightening out a common misconception or two along the way, it is clear that we in fact have a *moral obligation* to support space exploration.

There is a caveat: our obligation to support space exploration is conditioned on either our being obligated to ensure the survival of the human species or on our being obligated to protect the environment. Our solar system is a dangerous place. Our sun is predicted to expand into a red giant and afterwards burn out, rendering Earth uninhabitable. There are millions of asteroids zipping in and around our solar system. Statistics tell us that sooner or later a rock will strike our planet that is capable of destroying most life on Earth. If that is not enough, we also face problems of our own creation. The human population is expanding at an unsustainable rate. We only have access to a limited supply of the resources that keep us alive. These hazards are threatening to human beings, but they are also threatening to the environment. Stellar catastrophes can destroy entire planets. Asteroid strikes can cause mass extinctions. Of course, unchecked human expansion threatens the ecosystem in many ways. If we are obligated to preserve the species and to protect the environment, then it follows that we ought to take steps to mitigate and/or prevent these kinds of disasters from affecting ourselves and our environment.

I suggest in a series of three arguments that supporting space exploration is a necessary outlet for satisfying the obligations that we have to ourselves and to our environment. In the first argument, the "argument from resources," I explain that space exploration is useful for amplifying our available resources. In the second argument, the "argument from asteroids," I show that space exploration is necessary for protecting the environment and its inhabitants from extraterrestrial threats such as meteorite impacts. In the last argument, the "argument from solar burnout," I conclude that we are obligated to pursue interstellar colonization in order to ensure long-term human survival. After examining the arguments, I respond to a number

the motivations for space exploration in a negative light. There are innumerable non-philosophical articles on the subject in the journals *Acta Astronautica* and *Space Policy*. To name just one detailed non-philosophical analysis of our reasons for exploring space, see Charles Cockell, *Space on Earth: Saving our World by Seeking Others* (New York: Macmillan, 2007).

of objections that explicitly target space exploration. First, I respond to concerns about whether supporting space exploration is a practical human endeavor. Second, I dispel the myth that space exploration and environmentalism are at odds with one another. Finally, I consider the objections Robert Sparrow raises about the morality of using space resources.³ I close with a brief discussion of what it means to say we have an obligation to ensure the survival of the human race.

II. THE ARGUMENTS

In this section, I present and discuss three arguments in support of our having a moral obligation to support space exploration. The arguments themselves are not new. Arguments about resources, threats to the planet, and interstellar colonization have been around for some time.⁴ The novelty of the present approach consists in philosophically engaging the arguments and drawing out their ethical and environmental implications.

2.1. THE ARGUMENT FROM RESOURCES

Our planet contains a finite amount of basic resources; yet, humans require an ever increasing stock of basic goods in order to continue to flourish. If we want to allow the human species to continue to live comfortably and at the same time protect the environment, then we must begin to acquire resources from space. Here is the argument:

- (1) There are plentiful resources available in the wider solar system (and beyond).
- (2) We need basic resources to survive. The Earth has limited resources that we will one day exhaust.
- (3) Thus, acquiring resources from space is necessary for ensuring the long-term survival of the human race alongside protecting the ecosystem.
- (4) Investing in and developing space resource acquisition technologies is a necessary step in acquiring these resources.
- (5) Thus, investing in and developing space resource acquisition technologies

³ Sparrow, "The Ethics of Terraforming."

⁴ Resource-based arguments have been given by Peter Creola, "Space and the Fate of Humanity," *Space Policy* 12 (1996): 193–201; Marco Bernasconi and Cristina Bernasconi, "Why Implementing the Space Option is Necessary for Society," *Acta Astronautica* 54 (2004): 371–84; Cathy Swan and Peter Swan, "Why We Need a Space Elevator," *Space Policy* 22 (2006): 86–91; and Michael Rycroft, "Space Exploration and Goals for the Twenty-first Century," *Space Policy* 22 (2006): 158–61. Planetary-security-based arguments have been given by K. Sweet, "Planetary Preservation: The Need for Legal Provision," *Space Policy* 15 (1999): 223–31; and Jonathan Tate, "Avoiding Collisions: the Spaceguard Foundation," *Space Policy* 16 (2000): 261–65. All three sorts of arguments are canvassed in Seth Baum, "Cost-Benefit Analysis of Space Exploration: Some Ethical Considerations," *Space Policy* 25 (2009): 75–80.

is a necessary step in ensuring the long-term survival of the human race.

- (6) We have moral obligations both to ensure the long-term survival of the human race and to protect the environment. We are subsequently obligated to do what is necessary for meeting these obligations.
- (7) Therefore, we have a moral obligation to invest in and develop space resource acquisition technologies.

In this argument, (3) follows from (1) and (2), (5) follows from (3) and (4), and (7) follows from (5) and (6). I assume that (4) does not require justification. Resources from space do, on occasion, fall from the sky (meteorites have contributed and continue to contribute to Earth's chemical composition), but not controllably. Because I postpone discussing (6) until the end of the paper, there are only two assumptions left to examine.

2.1.1. ARE THERE PLENTIFUL RESOURCES IN SPACE?

The answer to this question is yes. The basic chemical resources necessary for human survival are indeed present throughout our solar system and the wider universe. Two of the most important resources for human survival are breathable air and water. We are not likely to find concentrated quantities of breathable air or liquid water elsewhere in our solar system. Oxygen and water can be extracted from lunar regolith, albeit inefficiently.⁵ Many of the millions of asteroids in and around our solar system contain significant amounts of crystallization water, i.e., water that can be extracted from minerals through the application of heat.⁶ Asteroids often contain large quantities of iron, nickel, and many other metals—enough to satisfy the needs of human industry for a long time to come.⁷ My point is that there is no shortage of resources available in space. It is important to ask whether human beings have a right to utilize these resources. Possibly, our obligation to utilize space resources is either mitigated or contravened by an obligation to respect the space environment. I explore this claim and related worries in section three.

2.1.2. WILL WE EXHAUST THE EARTH'S RESOURCES?

That the Earth has limited resources is indisputable. If there is a problem here, it is with the assertion that we *will* exhaust Earth's resources (e.g., clean water, breathable air, arable land, etc.). Since we cannot see into the future, we cannot claim with certainty that human beings *will* exhaust Earth's resources. But we can extrapolate. For instance, if population trends continue, the planet will become overpopulated. It should go without saying why this situation is undesirable.

⁵ John Lewis discusses the topic at length in *Mining the Sky: Untold Riches from the Asteroids, Comets, and Planets* (New York: Basic Books, 1997), chap. 4.

⁶ *Ibid.*, p. 108.

⁷ Charles Cockell writes, "Humanity's iron needs could be met for the next four hundred million years with all the asteroid material available to us in the Solar System" (*Space on Earth*, p. 59).

One way to alleviate the strain humans place on the planet is to undertake measures to control our population. This strategy is depressing. Child rearing is an activity in which many humans take great pleasure. If we have to deny responsible individuals the freedom to reproduce, it should only be because it is the best solution to the overcrowding problem. Perhaps some form of population control will become necessary. Nevertheless, utilizing space resources and establishing permanent extraterrestrial colonies, while beneficial activities themselves, would allow for less severe population control measures.⁸ Even if we are prepared to make such a sacrifice, the opponents of space exploration must still answer to the “argument from asteroids” and the “argument from solar burnout.”

I admit that the claim that we *will* exhaust Earth’s resources, (2) in the argument above, is rather strong. Consider a weaker claim:

(2a) It is *likely* that we will exhaust Earth’s resources.

Is (2a) true? That something in the ballpark of (2a) is true seems implicit in the conservationist’s position.⁹ If it is not likely that we are going to exhaust this planet’s ecological resources, then there is no strong reason why we ought to conserve Earth’s resources, at least from the point of view of a consequentialist. Perhaps the malfeasance implied by (2a) does not appeal to conservationist principles but instead to preservationist principles.¹⁰ Perhaps the worry is not that we will run out of basic resources, but that we will make the planet inhospitable to a large percentage of Earth’s current nonhuman population, in which case the threat is not to the survival of humanity but rather to the diversity of the ecosystem. In any event, I take it that most conservationists and preservationists are alike in having good reasons for believing that we are currently being irresponsible in our handling of Earth’s natural resources.

While we cannot be certain that (2) is true, we can at least be reasonably certain that (2a) is true. Does (2a) affect whether we are morally obligated to invest in space exploration? The truth of (2a) implies that it is *probable* that it will be necessary to utilize space resources for sustaining the human race alongside preserving the environment. If you do not think the moral obligation to support space exploration survives this revision, consider an analogous case. It is probable that in the future a hurricane similar in force to Hurricane Katrina will again strike Louisiana. We can prevent the recurrence of many of the misfortunes suffered in 2005 by dedicating

⁸ Even if we decide on an upper limit for the number of individuals the Earth can comfortably support, we still face future population problems. As Hartmann reminds us, our recycling technologies are not 100 percent efficient (“Space Exploration and Environmental Issues,” p. 233). This means that without bringing in new resources, the maximum number of human beings that the Earth can comfortably support will, over time, decline. If we want to sustain a *minimum* human population, it will inevitably be necessary to utilize space resources.

⁹ For more evidence that (2a) is true, see the papers listed as “resource-based arguments” in n. 4.

¹⁰ I thank an anonymous referee for suggesting this distinction.

resources to repair and improve the levee system in New Orleans. In general, we think society has some obligation to protect its citizens from the effects of natural disasters. It is reasonable then to conclude that as a society we have an obligation to effect repairs to the levee system in New Orleans. This obligation persists despite our being less than absolutely certain that such repairs will actually be necessary to save lives and to prevent damage to the city's infrastructure. Notice what is going on here: we are presented with a threat that has a high probability of maturing. We find that we have an obligation to protect individuals from the threat, despite the chance that it might not develop. The case of resource exhaustion is no different. There is a high probability that supporting space exploration will one day be necessary for sustaining Earthlings. *A fortiori*, our obligation to support space exploration persists, despite our being less than absolutely certain that we will use up Earth's resources. Therefore, (2a), if true, does not detract from our obligation to support space exploration.

It has been brought to my attention that I may be misrepresenting conservationism in claiming that the view requires believing that we will [likely] exhaust Earth's non-renewable resources. True, the worry that we will run out of resources may be a *part* of the conservationist's view, but it is *not* a requisite concern. Rather, the conservationist position is actually:

(2b) *If we conserve, then it is likely we will not exhaust Earth's resources.*¹¹

We should note that (2b) is not equivalent to the related belief that if we *do not* conserve, then we *will* (likely) exhaust Earth's resources. Perhaps the conservationist believes both of these things. If true, (2b) implies that space exploration is not necessary for either sustaining human beings or protecting the environment. A successful conservation program would result in continuously available resources, rendering our obligation to support space exploration unfounded. However, we may end up failing to conserve. (2b) may be false. Prudence informs us not to place all of our eggs in one basket. Other things being equal, it is better to have a more diverse body of resources to draw upon. How much are we willing to wager on the gamble that conservation will fulfill its promise? In any case, other things are not equal, as I show in the remaining two arguments.

2.2. THE ARGUMENT FROM ASTEROIDS

This argument draws out our obligation to develop technologies to protect the planet from extraterrestrial threats. Here is the argument:

¹¹ This characterization of conservationism was proposed by Bruce Russell (in conversation). I am not certain if it is his actual position on conservationism.

- (8) It is extremely likely that at sometime in the future a catastrophic event (e.g., a meteorite impact) will render Earth's biosphere uninhabitable.
- (6) We have moral obligations both to ensure the long-term survival of the human race and to protect the environment. We are subsequently obligated to do what is necessary for meeting these obligations.
- (9) So, we are obligated to take steps to prevent catastrophes that threaten Earth's ecosystem, such as meteorite impacts.
- (10) Developing technologies to defend the planet is the only way to meet this obligation.
- (11) Therefore, we are morally obligated to pursue planetary defense technologies.

I take it that (8) requires no defense. (9) follows from (6) and (8), and (11) follows from (9) and (10).¹² As indicated above, a discussion of (6) is postponed until later in the essay. Thus, only (10) remains to be examined.

2.2.1. IS THE DEVELOPMENT OF PLANETARY DEFENSE TECHNOLOGIES THE ONLY WAY TO PREVENT CATASTROPHES?

Were we obligated solely to ensure human survival, pursuing planetary defense technologies would not be necessary for preventing catastrophes from space. Human survival could be secured in another way, for instance, by establishing sustainable off-world colonies that do not depend on resources from Earth. But anthropocentric concerns do not exhaust our obligations. Catastrophes from space threaten nonhuman Earthlings as well. Does it similarly follow that it is not necessary to develop planetary defense technologies for preserving the environment? In order to answer this question, we must first distinguish between a strong and a weak notion of preservationism. I call these notions *weak preservationism* and *strong preservationism*. *Weak preservationism* holds that our minimal duty to the environment is to sustain the diversity of Earth's living organisms. Doing so requires us to take steps to maintain sustainable populations of as many of Earth's organisms as is possible. *Weak preservationism*, however, does not demand sustaining these organisms on Earth. *Strong preservationism* holds that our minimal duty to the environment is to sustain the diversity of Earth's living organisms in their natural habitats. Doing so requires us to not only preserve living organisms, but also the Earthly habitats of living organisms. If we embrace the position of the *weak preservationist*, then our obligation to the environment does not compel us to pursue planetary defense technologies because we can meet our obligation to the environment by sustaining a representative sample of Earth's biology elsewhere in the universe. Doing so would be a daunting task, to say the least, but it would imply that the development of planetary defense technologies is not necessary for fulfilling our duties to the

¹² That such an obligation persists despite the uncertain maturation of the threat should be clear from the previous section.

environment. If, however, we settle on the position of the *strong preservationist*, then it is unclear how it would be possible to preserve Earth's ecosystem in the face of threats from space except through the pursuit of planetary defense technologies. In either case, preservationism calls for our support of space exploration.

We should pause, nevertheless, to highlight a tacit assumption of this discussion, viz., that natural disasters ought to be averted if at all possible. This assumption has been called into question by Holmes Rolston, III.¹³ Consider the fact that approximately sixty-five million years ago a devastating meteorite impact caused the extinction of the dinosaurs. This tragedy was necessary for fashioning the world as we see it today. Just as the Cretaceous-Tertiary extinction event has been balanced by the rise of new life on Earth, so too might our extinction at the hands of an asteroid give rise to yet another "generation" of Earthlings. Should we therefore tolerate the possible obliteration of humankind, safe in the knowledge that once again the Earth will teem with life, just as a forest grows anew after a fire? According to Rolston, we have strong inductive evidence suggesting that disvalues in nature (e.g., death and disaster) inevitably transmute into values (e.g., life and new growth). Far from being unequivocally evil, natural disasters should be cherished for their contributions to value in the natural world.

But there is evidence that Rolston does not intend these remarks to cover the case of meteorite impacts. In an earlier work, he characterizes objects such as planets and asteroids as "formed integrities."¹⁴ A "formed integrity" is an object that is "formed in the wonderland of projective nature," or in other words, an object that is the product of a certain kind of natural process.¹⁵ "Projective nature" is the idea that nature engages in *creative* processes. For Rolston, both formed integrities and the natural processes capable of creating formed integrities are themselves loci of non-anthropocentric value, and subsequently ought to be preserved. He acknowledges that it is a part of projective nature that humans can and will explore space, but he adds that human activities in space should conform to several guidelines in order to ensure that we preserve natural value in the space environment.¹⁶ Rolston explains that meteorite impacts are not merely destructive, but are also responsible for jumpstarting new creative processes, just as the Cretaceous-Tertiary extinction event initiated the evolution of Earth's current ecosystem. *Prima facie*, it would be prohibited to prevent a future meteorite impact because doing so would degrade a formed integrity. Specifically, it would degrade a place of *potential* creativity. But if we were to allow a meteorite to destroy all life on Earth, we would default on our obligations in a different way by permitting the degradation of a place of great *active* creativity. Earth's ecosystem is numbered among the formed integrities, and

¹³ "Disvalues in Nature," *The Monist* 75, no. 2 (1992): 250–78. For pointing out this assumption, I thank an anonymous referee.

¹⁴ Holmes Rolston, III, "The Preservation of Natural Value in the Solar System," in Hargrove, *Beyond Spaceship Earth*, pp. 140–82.

¹⁵ *Ibid.*, p. 154.

¹⁶ *Ibid.*, pp. 170–78.

is clearly worthy of our protection. Unfortunately, Rolston does not tell us what we should do in situations where, in order to preserve a place of potential value, we must degrade (or permit the degradation of) a place of active value, or vice versa. But his other guidelines, for instance, those to protect places spontaneously worthy of a proper name, to protect places of historical value, and to protect places of aesthetic value, appear to favor protecting the active creativity of the current ecosystem over the potential creativity of a post-apocalyptic Earth. Further, there is no guarantee that all destructive episodes are precursors to future creation.¹⁷ Subsequently, on Rolston's own view there is room for permitting and encouraging the protection of Earth's ecosystem from meteorite impacts.¹⁸

2.3. THE ARGUMENT FROM SOLAR BURNOUT

I argue in this section that in the very long-term we have an obligation to pursue interstellar colonization. This obligation follows from the fact that Earth's sun will one day exhaust its fuel. In the process, it is predicted to expand into a red giant with a circumference that will outstrip Earth's orbit, potentially swallowing up our planet. This expansion will likely incinerate the surface of the Earth. As the red giant phase wanes, the sun will contract into a white dwarf, eventually burning out completely. If our planet survives, it will be a cold, dead rock, incapable of supporting life. The argument goes as follows:

¹⁷ As Rolston seems to appreciate (*ibid.*, p. 164).

¹⁸ To be sure, Rolston neither explicitly sanctions nor condemns diverting potentially threatening asteroids. A second criticism of this sort can be distilled from the ultra-strong preservationism advocated by Eric Katz in *Nature as Subject: Human Obligation and Natural Community* (Lanham, Md.: Rowman and Littlefield, 1997). On Katz's view the only truly *natural* environments are those that are *autonomous*, i.e., free from human intervention and generated without human assistance. Human intervention into nature is construed as domination and is morally impermissible because it fails to recognize and respect nature's autonomy. If protecting Earth's environment from space-related catastrophes such as meteorite impacts is simply another case of humans dominating nature, then we would be morally prohibited from protecting the planet. Doing so would violate our obligation to respect the autonomy of the universe, thereby devaluing the "preserved" (and no longer "natural") environments on Earth. Ned Hettinger criticizes Katz's general view in "The Problem of Finding a Positive Role for Humans in the Natural World," *Ethics and the Environment* 7, no. 1 (2002): 109–23, and in "Respecting Nature's Autonomy in Relationship with Humanity," in Thomas Heyd, ed., *Recognizing the Autonomy of Nature* (New York: Columbia University Press, 2005): 86–98, arguing that it is possible for humans to interact with the environment without threatening its autonomy. Hettinger writes, "When a natural system or entity plays an important role in what happens in human culture, that is, when it exerts significant influence over our lives, then substantial human influence over that natural entity is less likely to count as domination and more likely to be compatible with respect for nature's autonomy . . ." (*ibid.*, p. 92). I submit, accordingly, that since a meteorite impact would exert considerable influence over society (assuming that its potential effects were widely publicized), human efforts to divert an asteroid from striking the planet would demonstrate respect for nature's autonomy (but *c.f.* the paragraph beginning "One implication . . ." on *ibid.*, p. 93). Neither Hettinger nor Katz focus on space exploration, so treat these remarks with caution.

- (12) Living organisms from Earth require habitable environments in order to survive.
- (6) We have moral obligations both to ensure the long-term survival of the human race and to protect the environment. We are subsequently obligated to do what is necessary for meeting these obligations.
- (13) Thus, we have a moral obligation to ensure that humans, alongside other Earthlings, have access to permanent habitable environments.
- (14) The sun will one day burn out, in the process rendering Earth, along with the rest of the solar system, uninhabitable. Pursuing interstellar colonization is the only way of securing a permanent source of habitable environments.
- (15) Therefore, we are morally obligated to pursue interstellar colonization.

In this argument, (13) follows from (6) and (12), while (15) follows from (13) and (14). Since (12) is uncontroversial, we are left with (14), the assumption that pursuing interstellar colonization is necessary for ensuring the permanent survival of human beings and other organisms.

2.3.1. WILL COLONIZING SPACE ENSURE SURVIVAL?

I actually admit that (14) is false. Pursuing interstellar colonization will *not* ensure the permanent survival of *any* living organism. Why? Because scientists theorize that the universe is undergoing an unstoppable expansion that will eventually result in a heat death in which massive bodies fall into black holes and nuclei of the remaining atoms decay. Without nuclei there is no chemistry. Without chemistry there can be no life of the sort with which we are familiar. But this theoretical event is no reason for us to give up on interstellar colonization. To begin with, the universe will not reach an uninhabitable state for trillions and trillions of years. Just because I know that someday I will die does not mean I should stop eating today. Thus, while (14) is in fact false, it is nevertheless true on time scales extending (conservatively) to around 10^{20} years from now. The remaining habitable lifespan of the sun, around five billion years, makes up a small fraction (about five trillionths) of the remaining period in which the universe is habitable by humans. If we want to outlive the sun, then we must be prepared to find a place to live somewhere else in the universe.

One might say in response that we do not have a moral obligation to pursue interstellar travel because interstellar travel is a practical impossibility, and we are not obligated to do what is impossible. True, the hope for human travel to another solar system will not be realized anytime soon, if it is ever realized. Interstellar travel is orders of magnitude above anything we are capable of today. But does it follow from this fact that we are in no way obligated to pursue, or at the very least, keep an open mind about interstellar travel? If, as a society, we do not at least keep an open mind about interstellar travel, then we will for that reason be unlikely to explore possible avenues of traveling to other stars. Since the fate of the life on the

Earth depends on our one day being able to survive in other places in the universe, it follows that we ought to at least be open-minded about interstellar travel and tolerate judicious research on the subject.

III. OBJECTIONS

I have offered three arguments in favor of our moral obligation to support space exploration (in some form or other). However, there are a number of reasons for thinking that we are *not* obligated to support space exploration. Most criticisms of space exploration fall into one or more of three related categories. The first category is comprised of practical concerns, i.e., concerns about the feasibility of developing the various sorts of technologies that would be needed to satisfy our obligation to support space exploration. If pursuing space exploration is impracticable, then it would be unreasonable to demand the exploration of space as a moral duty. I dispel the myth that the arguments given in this essay rely mostly on false hopes about human beings and their technical capabilities. The second category contains practical environmental concerns. In general, these involve the criticism that our obligation to support space exploration undermines our obligation to protect the environment. We cannot extend our presence in space without furthering the depletion of Earth's resources. Since we ought to avoid furthering the depletion of Earth's resources, we ought not to expand our space programs. The bark of this criticism is much worse than its bite, as this sort of objection is rooted in common misconceptions about the extent to which space programs impact our society and the environment. The third category is comprised of non-practical environmental objections. These objections call into question our obligation to support space exploration on the grounds that human beings are not morally permitted to use space resources. I respond to two objections of this variety raised by Robert Sparrow.¹⁹ The objections considered here do not exhaust those that could be levied against an obligation to support space exploration, but for issues of space I have elected to examine only objections that explicitly involve space exploration.

3.1. FALSE HOPES

We have already encountered an instance of this kind of objection in subsection 2.3.1. It is possible to object to our obligation to support space exploration on the grounds that many of the technologies that we would have to develop are not practical possibilities. Might I be guilty of conflating science fiction with science fact?

Consider the objection that the above arguments depend on a false optimism about humanity. This objection holds that we have no obligation to support space exploration because it is delusional to think that humankind will sustain itself

¹⁹ Sparrow, "The Ethics of Terraforming."

or its environment long enough to encounter an asteroid strike or the death of the sun. What might cause the human race to die out? Several likely candidates include disease, depletion of life-sustaining resources, and nuclear holocaust. In the first case, if humans were to colonize the solar system, then any Earth-born disease could more easily be kept from spreading to the wider solar system, given proper warning. A global pandemic would only wipe out humanity provided that human beings were confined to the Earth. As for the second case, if we were to avail ourselves of space resources, then it is unlikely that humanity would die out due to the depletion of Earth's resources (unless the reason for our demise is that we had run out of asteroids to mine, but then we would have already supported space exploration!). In the last case, it is much less likely that humanity would extinguish itself through war if our numbers were more widely spread in space. Each examined condition under which humanity becomes extinct requires it to be the case that human beings *have not* colonized the solar system (and beyond). I conclude that the objection from false optimism begs the question against our obligation to support space exploration. The likely reasons why humanity would become extinct (rendering our obligation empty) all involve the assumption that human beings never adequately support space exploration.

If there is a real complaint about false hopes, then it must have something to do with the nature of the solutions to the dangers raised in the arguments. An important question is therefore whether it is reasonable to expect humankind to develop technologies that will (a) allow us to utilize the resources of the solar system, (b) protect the planet against threats such as meteorite impacts, and (c) transport populations from Earth to another solar system before the life cycle of the sun renders the planet uninhabitable.

As for (a), we have every reason to be optimistic. The technology needed to harvest resources from asteroids is not far beyond our current capabilities.²⁰ In fact, the reasons why we are not already doing so come largely as a result of political and economic considerations, and it would be out of place to object to a *moral* obligation to support space exploration because of politico-economic pressures. Indeed, political and economic disapprobation continues to besiege the environmental movement; yet, our moral duties to the environment persist. The reasons I have offered in support of space exploration parallel common reasons for protecting the environment. It follows by analogy that our obligation to support space exploration persists despite political and economic concerns.

Regarding (b), it is questionable whether we are capable of evading cosmic threats with current technology, but there are ideas on how we might do so. One solution uses a lens to focus a beam of sunlight on the surface of an asteroid in

²⁰ There is not enough space to discuss details here, but the interested reader may consult Lewis, *Mining the Sky*, for a wealth of information about how we might access space resources. See also Mark Sonter, "The Technical and Economic Feasibility of Mining the Near-Earth Asteroids," *Acta Astronautica* 41 (1997): 637–47.

order to vaporize surface asteroid material in a small area. Doing so would create a moderate amount of thrust that, over time, would deflect the asteroid's path off of a collision course with Earth. Another option is to use a gravity tractor, in which a controlled satellite "steers" the asteroid off of its original path via gravitational attraction. What such strategies have in common is that they depend upon identifying potentially threatening bodies months or years in advance of impact. We currently lack a reliable method for identifying threats, as well as a way of dealing with threats on short notice. It is impossible to say when we will be prepared to eliminate entirely the threat of asteroid collision, but at the same time it is absurd to say that the date will be hopelessly distant in time. Subsequently it is not a false hope to believe that we will one day acquire the ability to protect the planet from extraterrestrial threats such as meteorite impacts.

We are still left with the accusation that (c) we will never develop interstellar transportation capabilities. This is the most plausible technical objection. The current consensus is that faster-than-light travel is physically impossible, and so any interstellar voyage would take a remarkably long time even at remarkably high speeds. The nearest star to our sun, Proxima Centauri, is over four light years distant. That is nearly 40,000,000,000,000 kilometers! This distance means that a one-way trip would take much longer than four years, even with technology that is significantly more advanced than what we possess today. Whether it is technically feasible to design a ship to endure such a long journey and whether human physiology and sociology would ever allow individuals to survive such a trip are questions we must one day answer. The best response I can muster at this time is to remind the reader of my response to this concern at the end of subsection 2.3.1.

3.2. SUPPORTING SPACE EXPLORATION CONFLICTS WITH PROTECTING THE ENVIRONMENT²¹

One worry is a kind of moral hazard argument. If humanity realizes that there are ample resources available in the wider solar system, we may decide to deplete the resources of the planet at a significantly increased clip. This possibility comes as a consequence of our being insulated from the risks associated with the reckless consumption of Earth's limited resources. There is a second, related worry. Providing adequate support to space exploration would itself require society to dedicate significant resources to the development and construction of space vehicles. If we do so on a large enough scale, space-related industrial activity would on its own dramatically hasten the depletion of Earth's resources, casting doubt on our ability to adequately support space exploration in the first place. Consequently, if we act on our obligation to support space exploration, it will be at the cost of defaulting on our obligations to the environment.

Hartmann calls the hazards associated with using space resources the "disposable

²¹ I thank the two anonymous referees for clarifying the objections raised in this section.

planet mentality.” Will space exploration lead to a “disposable planet mentality”? It is impossible to predict. For the sake of argument, I grant that exploiting the resources of the wider solar system would have an effect on the hastened depletion of Earth’s resources. Supposing that this claim is true, does it then follow that supporting space exploration is immoral? Hartmann responds convincingly that the answer is *no*:

To argue against space survival insurance on the grounds that it fosters a disposable planet mentality is like a crazy man’s response to the fire chief’s warnings about fire hazards on a luxury liner. Instead of helping the passengers with lifeboat practice, he burns the lifeboats on the grounds that this will encourage the passengers to be more careful with matches.²²

A moral obligation to refrain from supporting space exploration on the grounds that it would lead to a “disposable planet mentality” would be like a moral obligation to burn lifeboats on the grounds that their existence makes passengers more likely to start shipboard fires. But fires may start for reasons we cannot control, just as geophysical and cosmological events may ruin the planet for reasons we cannot control. We need “space insurance” precisely because of the dangers that we *cannot* control. We should not be denied this safety net simply because we *might* take advantage of it as a result of our own irresponsibility.

What about the fear that increasing our support for space exploration would itself deplete Earth’s resources? The bark here is worse than the bite. I have witnessed a marked tendency for individuals to grossly overstate the impact the U.S. space program has on the environment and on the economy. Shuttle and rocket launches are very violent events, but launches themselves produce negligible long-term environmental consequences. At Cape Kennedy, short-term environmental consequences are minimal and include noise and air pollution. These effects typically subside shortly after launch and cause relatively minor harm to local biota. The recently scrubbed Constellation Program, which would have returned humans to the moon as a first step in a potential manned mission to Mars, was estimated by NASA to contribute 0.0012 percent of ozone depletion globally, and 0.004 percent of U.S. carbon emissions.²³ Economically, NASA’s budget accounted for \$17.8 billion out of the \$3,518 billion in outlays from the 2009 U.S. federal budget, or about 0.506 percent of federal spending.²⁴ It is true that advanced industry has a

²² Hartmann, “Space Exploration and Environmental Issues,” p. 237. The idea of space survival insurance is the idea of being able to depend on space resources in the event that Earth is unable to sustain us.

²³ National Aeronautics and Space Administration, “Final Constellation Programmatic Environmental Impact Statement” (http://www.nasa.gov/pdf/207909main_Cx_PEIS_final.pdf). See sec. 2.4.4.2.8.

²⁴ Office of Management and Budget, “Budget of the United States Government, Fiscal Year 2011” (<http://www.whitehouse.gov/sites/default/files/omb/budget/fy2011/assets/budget.pdf>). See p. 132 and p. 146.

tendency to contribute to environmental degradation. However, implementing a program such as Constellation, even scaled up by several orders of magnitude, would not significantly contribute to either carbon emissions or ozone depletion on a global scale. These are not the kinds of figures one would expect from a planet-endangering endeavor. Further, consider the fact that many of the heavy industrial tasks involved in acquiring space resources could eventually be performed in space. After the initial “down payment” of launching construction equipment into space, using processing and manufacturing plants in space would drastically reduce the strain space exploration places on the environment.²⁵ It is also worth noting that agencies such as NASA often benefit society in unforeseen ways. As Cockell points out, we have learned a great deal about how to efficiently manage resources from having to solve the problems posed by living in space, a place where the conservation of resources is a matter of life and death.²⁶ Trickle-down benefits, which have positively impacted the environment through advances in solar energy, petroleum remediation, and environmental monitoring technology, do not themselves justify the existence of the space program,²⁷ but they help to dispel the myth that supporting space exploration and protecting the environment are conflicting enterprises.

3.3 SPACE EXPLORATION AS AESTHETIC INSENSITIVITY AND HUBRIS

Sparrow has objected to terraforming, the process of geophysical engineering whereby an uninhabitable planet is rendered habitable by any number of means. Sparrow argues that terraforming is a kind of arrogant cosmic vandalism in that it exhibits two defective human qualities: aesthetic insensitivity and hubris.²⁸ This objection relies on the adoption of an agent-based virtue ethics. Sparrow characterizes virtue-ethics as “. . . our concern [with] the character of agents. It asks us to pay attention to the virtues and vices that we display through our actions.”²⁹ On this picture, it is neither their motives nor their consequences that make actions right or wrong, but instead whether their performances “demonstrate a virtuous (or vicious) character.”³⁰ Terraforming, a form of space resource utilization, is analogous to asteroid mining and asteroid diversion in an important way: both activities involve humans modifying and exploiting pristine space environments for human benefit. On the strength of this analogy, I roam freely between the topics of terraforming and asteroid diversion and mining. The reader should note, however, that Sparrow does not discuss asteroid mining in his article.

²⁵ And the economy. Earth’s gravity and thick atmosphere are the biggest contributors to high launch costs. The more work we can do in space, the better.

²⁶ Cockell, *Space on Earth*, pp. 89–91.

²⁷ As Cockell appreciates (*ibid.*, pp. 45–46).

²⁸ Sparrow, “The Ethics of Terraforming.”

²⁹ *Ibid.*, p. 230.

³⁰ *Ibid.*, pp. 230–31.

3.3.1. AESTHETIC CONSIDERATIONS

Sparrow makes two claims about terraforming and aesthetics. The first claim is that terraforming would itself result in the destruction of something beautiful, viz., the pristine environment of a planet, and since it is a vice to destroy beautiful objects, terraforming demonstrates a vicious character. The second claim is that terraforming is likely to be the product of our insensitivity to cosmic beauty, and since aesthetic insensitivity is a vice, terraforming again demonstrates a vicious character.

I have sympathy for Sparrow's position in the case of terraforming. Something would be lost were we to turn red Mars blue and green. On the other hand, it is more difficult to sympathize with this line of reasoning where asteroid mining is concerned. I do not personally believe that asteroid belts are particularly beautiful, but perhaps I am just aesthetically insensitive. Would it really be so great of a loss to the universe if we started mining asteroids?

A response Sparrow suggests is that we may have to drop our anthropocentric conceptions of beauty.³¹ Just because *human beings* do not find beauty in the main belt does not mean there is no beauty in the main belt. But there is a problem with this response. The problem is that this kind of reasoning can be used to classify just about *anything* as beautiful. If anthropocentric constraints need not apply, then given any object or arrangement of objects, it is possible to devise a theory according to which that object/arrangement is objectively beautiful. It does not matter whether any human is capable of appreciating the "beauty" prescribed by such a theory. I suppose I may no longer breathe when waking up because the precise arrangement of molecules in my bedroom is beautiful according to some (possible) theory, and my breathing would destroy something beautiful. Since I am unaware of the details of this theory (they surpass my ken, perhaps), I breathe in ignorance. More likely, since I presume that there is actually no such theory, I breathe in *arrogance*. But it is by no means clear that in breathing I have done something wrong, and I fail to see why this case is significantly different from the case of asteroid mining, or even terraforming for that matter.³² The difference between the cases is one of degree rather than one of kind.

Overall I am in agreement with Sparrow that there is a deep and valuable beauty in the solar system. But it should not escape recognition that the danger of disturbing cosmic beauty may not be as great as it seems. As Hartmann has suggested, just as we set up natural preserves here on Earth, we will likely set up wilderness

³¹ Ibid., pp. 234–35. C.f. Fogg's discussion of "cosmic preservationism" in Fogg, "The Ethical Dimensions of Space Settlement," pp. 208–09.

³² Let me be clear: I did say I was sympathetic with the idea that we would be "losing" something were we to terraform Mars. I did not say I agree that it would be wrong to terraform Mars. *Pace* Hume, having a sympathetic feeling does not commit anyone to an ethical theory.

areas in space.³³ In fact, many of the things we already find beautiful in space are well beyond our powers to manipulate. Nebulae and gas giants are both incredibly mesmerizing sights, and are both free from human intervention. We should recognize that it is rather easy to overstate the impact we will have on the universe, and we should not allow overblown worries to make us feel guilty about securing what is necessary for our survival. It would be pessimism of the least charitable sort to suppose that we would, in exploring space, forget entirely the lessons we have learned here on Earth about respecting the natural environment. What is more, in my experience those individuals who are interested in space and space technology are those who are most likely to appreciate beauty in the space environment. It is simply unlikely that the human use of space resources would involve either a gross aesthetic insensitivity or the wanton destruction of beauty.

A final consideration on aesthetics is in order. While motivating the viciousness of aesthetic insensitivity, Sparrow presents a case of a hiker who comes across an arrangement of icicles on the cutting point of a creek on a cold morning. The hiker, who walks these trails often, knows that the rise and fall of the sun melts the ice and freezes the water every day. The icicles of today will not be there tomorrow, and nor are they the same as the icicles of yesterday. Sparrow claims that it would still be wrong for the hiker to casually kick in the icicles because such an act would demonstrate “a significant defect of character” and would demonstrate a “gross and disturbing” insensitivity to beauty.³⁴ It is not unreasonable to extend the virtue of *sensitivity* to beauty to include the *appreciation* of beauty. Consider the following alteration of Sparrow’s hiker.³⁵ Suppose that one morning the hiker, call her Jones, decides to walk a different route, and in the process meets a second hiker, Noseworthy, who is unfamiliar with the area. Suppose Jones and Noseworthy get to talking, and it comes to pass that Noseworthy informs Jones of his unfamiliarity with the local sights. Jones, a lover of natural beauty, says to Noseworthy, “You know, if you take the next right in the trail and you’re prepared for something of a hike, you’ll eventually come across a fall in the creek where the evening freeze creates icicles that are absolutely stunning. Anyone who appreciates natural beauty ought to take a look if it’s not too much trouble—but I should add that it is worth the hike, even if it is a lot of trouble.” Having said this, Jones amicably departs the scene, leaving Noseworthy to decide on his route. Noseworthy walks down the trail toward the creek, but decides not to turn onto the path on the right leading to the fall, and concludes his hike without ever witnessing the icicles.

Noseworthy’s failure to go out of his way to witness a stunningly beautiful

³³ Hartmann, “Space Exploration and Environmental Issues,” pp. 234–35. See also, Don MacNiven, “Environmental Ethics and Planetary Engineering,” *Journal of the British Interplanetary Society* 48 (1995): 441–43.

³⁴ Sparrow, “The Ethics of Terraforming,” pp. 233–34.

³⁵ I am indebted to Daniel Blaser for suggesting this case to me.

sight clearly demonstrates a failure to appreciate beauty, especially since he has good evidence that the reward is more than worth the cost. If we have some kind of an obligation to appreciate beauty, then we must judge that Noseworthy had an obligation to visit the fall that he failed to meet. If there is in fact great beauty in the observable universe and if this beauty can be appreciated by human beings, then if at any time we are capable of doing so, the virtue of aesthetic appreciation demands space sightseeing as a *duty*. Just as tourists and schoolchildren visit natural preserves and art exhibits on vacations and field trips, perhaps tourists and schoolchildren will, in the distant future, visit exquisite sites in space. While this is not an objection to Sparrow's position on terraforming, it nonetheless highlights an interesting consequence of the moral status of space exploration on the assumption that aesthetic considerations are morally significant (as they are on Sparrow's agent-based conception of virtue ethics).

3.3.2. HUBRIS

Sparrow gives two accounts of hubris. His first account describes hubris as occurring when the possibility of an action's catastrophic failure would "reveal our ambitions as arrogant and futile" and indicate our act as "one which oversteps the limits of our wisdom and abilities."³⁶ Clearly, this notion of hubris does not apply to the position I have been advocating. I have not argued for the carefree exploitation of space resources. Rather, I have argued that we should expend a greater effort in expanding on our wisdom and on our abilities in the arena of space technology. Sparrow's second account of hubris goes a step further in alleging that human activities and capabilities are subject to certain natural boundaries. Our capabilities depend on what our "proper place" is in the universe. Actions that demonstrate the second variety of hubris are those that involve us treading outside of our proper place. What does it mean to say there is a "proper human place?"

To say that some location or area is our proper place is not an empty thought. It implies a certain relation of appropriateness in our presence there. A proper place is one in which one can flourish without too much of a struggle. It is one that we can live in and sustain. It is a place in which one fits and does not appear uncomfortable or out of place. . . . If we have to wear space suits to visit and to completely remodel it in order to stay, then it's simply not our place.³⁷

According to Sparrow we are not "in our place" when we need a significant amount of protective gear to go "outside," or when we are not in our "home." But this characterization of what it is for there to be a "proper place" is hopelessly vague and arbitrary. Are we demonstrating hubris when we set up permanent space stations in low earth orbit? Inhabitants of the International Space Station certainly do not

³⁶ Sparrow, "The Ethics of Terraforming," p. 238.

³⁷ Ibid.

“flourish without too much of a struggle.” Consider also how many places there are on our planet where life is a daily struggle due to hazardous living conditions. Are individuals living in polar climates demonstrating hubris because their lives are difficult? Their struggles are not unlike those that would be faced by dwellers of a terraformed planet. Perhaps this difficulty could be overcome, but it is not clear how. The requirements that a proper place must have a tolerable climate and a breathable atmosphere do not suffice, since they rule out intuitively unproblematic cases such as when humans inhabit polar regions or live in space stations. Sparrow suggests additional requirements, for instance, that our place should nurture us, allow us to reproduce, provide for us, and offer us security.³⁸ In modern society, the only reason the Earth provides these things for us is because we have developed a considerable industrial system. There is no reason to doubt that, given enough effort, a similar future awaits us in space. But then space habitats would nurture us, allow us to reproduce, provide for us, and afford us safety.

The sin of hubris is supposed to arise when we treat a location that is not our proper place as though it were our proper place. In believing that there is nothing wrong with terraforming Mars (or mining asteroids), we are saying it is perfectly acceptable to treat Mars (or the asteroid belt) as though it were one of our “proper places” even though it is not. Sparrow has not given a convincing argument that Earth is our only “proper place,” and since his moral injunction on terraforming requires this assumption, he is unable to draw the conclusion that we ought not to terraform other planets. He does, however, step back from a whole cloth restriction on terraforming. He writes,

Our proper place is at home until we have shown that we are mature enough to leave it. Whether or not people are ready to leave home depends on how well they live at home and how they look after that home. On this test, the human species does not look well qualified to start moving out to other planets. We must show that we are capable of looking after our current home before we could claim to have any place on another.³⁹

True, we as yet neither have the capability nor the incentive to terraform another planet. But in the end, I am not arguing for the immediate terraforming of other worlds, or even for the immediate mining of asteroids. I am simply arguing that we have an obligation to set ourselves on a course where we can develop such capabilities because there will come a day when we need them in order to survive. Moreover, it is not as if in exploring space we will suddenly forget what we have learned in recent decades about respecting the environment. It is by no means obvious that our moral and environmental principles will vanish just because we increase our presence outside of Earth’s atmosphere. Thus, I think the following criticism from Bonnie Steinbock is overly skeptical:

³⁸ Ibid.

³⁹ Ibid., pp. 238–39.

... people used to think that our own atmosphere could not be polluted, and that the oceans were too large to be contaminated. They were unfortunately wrong about that; might we be wrong about space? Do we really know that space is infinite (as opposed to very big) and that harmful waste shot into it will travel away from us (and all other life forms) forever? I am not suggesting that the bare possibility that it might not is a decisive reason against engaging in projects that are likely to have significant benefit. Rather, I am objecting to the *attitude* displayed by the space enthusiasts, which seems to me a complete lack of interest in even thinking about such questions. To a man, their preoccupation is with what *can* be done, rather than with what *ought* to be done.⁴⁰

I believe I have shown that the *attitude* with which we should promote space exploration is a laudable one, seeing as it is prompted by the consideration of what *ought* to be done, as opposed to what merely *can* be done. "Space enthusiasts," a class of individuals to which I certainly belong, are not beholden to the unreflective and purely technological vision of human space exploration (if this was ever true in the first place).⁴¹

IV. CONCLUSION: OBLIGATIONS AND HUMAN SURVIVAL

I have attempted to draw out our obligation to support space exploration from our obligations to the environment and from our obligations to ourselves. But it is undoubtedly the obligations we have to ourselves that play a stronger role in the arguments presented here. That is not to suggest that our obligations to ourselves are more important than our obligations to the environment. I hope to have made the case that supporting space exploration is an endeavor that contributes to protecting the environment. But I have not diagrammed in any detail the social costs involved. Just where among our vast array of social obligations does the obligation to support space exploration fall? What does it mean to say that we are obligated to ensure the survival of the human race? It would be impossible to grant these topics the attention that they deserve in the brief space available here; however, it is possible to speculate on them based on what has been said above.

The obligation to support space exploration is a fairly strong obligation, insofar as it is grounded in a number of society's pressing problems, such as resource allocation and security. I suspect that the reason for thinking that our obligation to support space exploration is not strong is rooted in the belief that supporting space exploration detracts significantly from our other obligations. As we have seen, this belief is unfounded.

⁴⁰ Steinbock, "Progress and the Value of Space," p. 40.

⁴¹ In the end, Sparrow acknowledges that utilizing space resources might demonstrate neither hubris nor aesthetic insensitivity if it were to be carried out "with genuine reluctance, in full knowledge of what was being destroyed, because no alternative existed for the survival of the human race" ("The Ethics of Terraforming," p. 240). I worry whether he is entitled to say these things, given that he claims the viciousness of an action is independent of its intentions and consequences (*ibid.*, p. 233), especially as Sparrow acknowledges that good intentions and good consequences are what ultimately recommend terraforming. In any case I hope I have shown that such dire circumstances do not need to apply in order to secure the moral permissibility of terraforming and other related endeavors.

Throughout this essay I have taken advantage of an alleged obligation to ensure the survival of the human race.⁴² The idea of ensuring the survival of the human race is decidedly vague. Insofar as everyone on the planet is threatened by meteors and diminishing resources, everyone on the planet is a beneficiary of our obligation to ensure human survival. Insofar as it will one day be vital for human beings to inhabit another solar system, it is impossible at this time to say who will be among the saved. It is likely that centuries will pass before we are capable of establishing colonies outside of our solar system, and countless millennia before it will actually be necessary.

The obligation to support space exploration is not an obligation born by any individual but rather by society as a whole. Space provides unique challenges that require the integration of a vast array of individuals and resources. While corporations are playing an increasing role in the space industry, for some time to come governments and multinational organizations such as the European Space Agency will be necessary for initiating and sustaining long-term projects such as asteroid mining and planetary defense. The future of human spaceflight is currently in a precarious position in the United States. We have already seen in the post-Apollo program how quickly knowledge about manufacturing space vehicles can be lost (in this case, the knowledge of how to build a rocket capable of landing human beings on the moon alive and returning them safely back to Earth). If there is not a constant drive to advance our current technologies, then there is a very real risk that we will in the future be unable to respond to planetary threats.

What we must do today is educate people about the very real dangers and promises that exist in our universe. Only after these dangers are more fully understood will space exploration stand a chance of proceeding with popular support. Compare this with the remarkable success of the “green” push in consumerism and social policy during the last decade or so. The increased public awareness of the environmental hazards involved in using certain household products, driving inefficient vehicles, not properly insulating homes, etc., has driven the public to embrace cleaner

⁴² I do not defend the existence of such an obligation. Much ink has been spilled on the issue of whether we are obligated to protect the rights of future individuals and future generations. For a foray into these issues, see Gregory Kavka, “The Paradox of Future Individuals,” *Philosophy and Public Affairs* 11, no. 2 (1982): 93–112; Derek Parfit “Future Generations: Further Problems,” *Philosophy and Public Affairs* 11, no. 2 (1982): 113–72, and *Reasons and Persons* (Oxford: Clarendon Press 1984)—especially, part four of the latter; and Robert Elliot, “The Rights of Future People,” *Journal of Applied Philosophy* 6, no. 2 (1989): 159–69. If we bear no obligation to protect the rights of future generations, then it might appear as though we are not obligated to ensure the survival of the human race. But it is not obvious that this conclusion follows. To oversimplify, the reason why we do not have an obligation to future persons is because it is epistemically indeterminate precisely who may come into existence and what sort of lives will be led by those who do. If it is impossible to identify to whom an obligation belongs, then there is little sense in maintaining that a genuine obligation exists. This is a difficult issue and it would be inappropriate to attempt to sort it out here. More importantly, it is not even clear how this objection applies to the obligation to ensure species survival. The literature on future persons focuses on the epistemology of the quality of life in the future, rather than the existence of life in the future. Since it is unclear what exactly the problem of future generations is for our moral obligation to continue the human race, I have no choice but to set this issue to the side.

technologies and less environmentally hazardous ways of living, the upshot being that economically friendly products are becoming more and more profitable. It is unreasonable to expect space-based hazards to deliver the same intensity of psychological motivation anytime soon (at least until the next planet-killing asteroid is spotted). But I nevertheless suspect that a tamer “space” movement could achieve moderate success, provided that increased focus is given to space-related issues at all levels of education in much the same way as the education of schoolchildren on the responsible treatment of the environment has benefited the environmental movement. In fact, it appears as though it is society’s ignorance of space-related matters that is largely responsible for our reluctance to grant space exploration its due social and ethical consideration.⁴³ There is little doubt in my mind that increased public education will generate renewed interest in the promises and perils of space.

It is difficult to say what path we are on at the moment—whether we are on our way to mining asteroids and exploring other solar systems, or whether we are on our way to hard-wiring into society the depressingly myopic construal of the aphorism “the sky is *the* limit.” I hope that I have provided a convincing argument that we should support space exploration. If I have failed, then I hope I have at least provided convincing evidence that the moral dimensions of space exploration warrant our careful reflection.

⁴³ Following a brief study of European undergraduate students in 2002, G. Ottaviani and M. Good (“Space Education: A Step Forward,” *Space Policy* 18 [2002]: 117–27) write, “. . . the data resulting from the survey, used for statistical purposes only, showed an overall poor awareness concerning the past, present, and future of space programmes and achievements, and more generally about the economic, political and social implications of space” (p. 125).