Twelve Ethical Issues in Exploring Our Solar Ghetto

Ted Peters

Abstract. The field of *Astroethics* addresses moral and societal issues arising out of speculation regarding terrestrial contact with extraterrestrial life in both its intelligent and non-intelligent forms. This article tackles twelve issues associated with space exploration within the solar system, wherein it is expected that only microbial life, if any life, is likely to be discovered. The issues are these: (1) what does planetary protection mean? (2) does microbial life have intrinsic value? (3) should space explorers invoke the Precautionary Principle? (4) should we clean up our space junk? (5) What should we do about Satellite Surveillance? (6) should we weaponize space? (7) should scientific research take priority over commercial space ventures? (8) should we terraform Mars? (9) should we colonize Mars? (10) should we prepare for bombardment of Earth by asteroids? (11) should we rely upon a single planetary community of moral deliberation? (2) should we pursue the good of the *galactic commons*?

Key Terms. Ethics, Astroethics, Space Ethics, planetary protection, space debris, satellite surveillance, terraforming Mars, colonizing Mars, Precautionary Principle, galactic commons.

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Ted is co-editor of the forthcoming book with Cascade Books, *Astrotheology: Where Science and Theology Meet Extraterrestrial Life.* This article summarizes some material taken from the forthcoming book.

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"There is good warrant for extending the notion of neighbor beyond the human species to all other fellow creatures in the community of creation."
-- Elizabeth A. Johnson (Johnson, 2014, 281)

Science needs ethics. Astrobiological science needs *astroethics*. Astrobiologists, according to SETI's Margaret Race, must "acknowledge that science and technology are embedded inseparably in societal and cultural contexts" (Race, 2013, 154). In our culture we find that both science and science fiction dealing with space travel flood our public consciousness. What happens off-Earth cannot help but become a matter of grave concern for all of us who live on Earth. Without doubt terrestrial *Homo sapiens* are going to have an impact on extraterrestrial places and, quite likely, extraterrestrial realities will impact our life here at home. It's time for space ethics or astroethics to inform, guide, and direct terrestrial science, technology, and perhaps even commerce when we humans go to space.

Ethics is the "science of the moral," says theologian Paul Tillich (Tillich, 1963, 21). "The job of ethics is to evaluate issues of right and wrong, or good and bad, directing our focus to normative questions of value," contends space philosopher Carol Cleland (Cleland and Wilson, 29). To date, curiously, normative questions have seldom been raised to engage the flood of issues rising out of our increased capacity for becoming present in off-Earth locations. To date, the only concern to be given thorough ethical and public policy attention has been planetary protection, that is, protecting Earth from alien contamination while giving some consideration toward protecting off-Earth habitats from terrestrial contamination. Beyond planetary protection, the field of astroethics is fertile, but still waiting for plowing.

We might dub our method *responsibility ethics* or *quandary ethics,* because we begin with concrete quandaries and then consider alternative responses. "Quandary ethics deal with concrete, objective human situations. In addition, it is here that human reason, science, and human experience predominate," says Roman Catholic ethicist Charles Curran (Curran, 2011, 585).

We need to divide the array of quandaries addressed by astroethics into two sub-arrays, ethics responding to extraterrestrial intelligent life (ETIL) and ethics responding to extraterrestrial non-intelligent life (ETNL). ETNL is usually referred to as microbial life, occasionally even "stupid" life. If we make contact with the ETIL, it will most likely be associated with extrasolar planets in the habital zone. Intelligent life, if it exists, will be found on the 8.8 billion Earth-like planets in the larger Milky Way metropolis (Strom, 2015). If we make contact with the microbial life, it will most likely be within our own solar ghetto on Mars or a moon of Saturn or a similar location. In this article, we will restrict our attention to the search for microbial life within our solar ghetto. In other articles (Peters, 2011, 2013, 2014), I take up astroethics directed toward contact with ETIL elsewhere in the Milky Way.

Even though the concern over (1) planetary protection has already been addressed at NASA and the UN, we will review briefly what has been said ethically about it. Then, we will turn to a continuing list of potentially important issues to which only minimal attention has been given. Here is our list: (2) Does Extraterrestrial Life Have Intrinsic Value? (3) Should Space Explorers Invoke the Precautionary Principle? (4) Should We Clean Up Our Space Junk? (5) What Should We Do About Satellite Surveillance? (6) Should Nations Weaponize Space? (7) Who Gets Priority: Scientific Research or Making a Profit? (8) Should Earthlings Terraform Mars? (9) Should Earthlings Colonize Mars? (10) How Should We Protect Earth from Extraterrestrial Threats? (11) Does AstroEthics Require a Single Planetary Community of Moral Deliberation? (12) Should the Common Good Include the Galactic Commons? It might be too early to resolve each of these issues,

but simply formulating them for moral deliberation should provide a service for public policy makers.

To orient ourselves toward formulating and then addressing quandaries, let me allude to some preliminary contributions already offered by SETI exobiologist Margaret Race and Methodist bioethicist Richard Randolph. Race and Randolph have proposed four principles for developing an ethical scheme appropriate to the discovery of non-intelligent life in our solar system: (1) cause no harm to Earth, its life, or its diverse ecosystems; (2) respect the extraterrestrial ecosystem and do not substantively or irreparably alter it (or its evolutionary trajectory); (3) follow proper scientific procedures with honesty and integrity during all phases of exploration; and (4) ensure international participation by all interested parties (Race and Randolph, 2007, 495). This opening moral salvo makes a commitment to planetary protection; to treating off-Earth ecosystems has having intrinsic value; to demanding scientific integrity; and to emphasizing that all peoples on Earth belong to a single community of moral deliberation. In this spirit I will turn to a number of issues arising from the prospect that our space explorers will find the gold: non-intelligent yet beloved life elsewhere in our universe.

1. Planetary Protection: should we protect off-Earth sites as well as Earth?

The first on our list of ethical quandaries arising from the search for ETNL is *planetary protection* (PP). PP raises a concern to protect ecosystems from contamination by alien life forms that may be destructive. The risk of contamination goes in two directions, forward and backward. The possibility of *forward contamination* alerts us to the risk of disturbing an already existing ecosphere; the introduction of Earth's microbes carried by our spacecraft or equipment could be deleterious to an existing habitable environment. *Back contamination* would occur if a returning spacecraft brings home rocks or soil samples that contain life forms not easily

integrated into our terrestrial habitat. A quarantine program will be required to determine the safety of newly introduced ETNL.

Article IX of the 1967 UN Outer Space Treaty states that "...parties to the Treaty shall pursue studies of outer space including the Moon and other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose..." This PP principle has been guiding us since 1967.

In practice, prevention of backward contamination trumps protection against forward contamination. NASA scientists responsible for planetary protection, John Rummel and Catharine Conley, recommend that planetary protection be incorporated from the earliest stages of mission planning and development to ensure proper implementation. Although forward contamination is a matter of concern, some forward contamination is permissible. What is not permissible is backward contamination. Preventing harmful contamination of the Earth must be of the "highest priority" for all missions (Conley and Rummel, 2010).

Our terrestrial imagination is expanding in light of growing knowledge of space. Increasingly, we view our planet Earth within a cosmic horizon. With the cosmic horizon in mind, theological ethicist John Hart offers an augment to planetary protection by introducing the moral category: *cosmic commons.* If we understand our solar system or even our universe as a commons, we will think of a "shared space or place that provides both an abiotic (non-living) home and habitat for the biotic community (the community of all life), and the natural goods (resources) needed for biotic sustenance and well-being" (Hart, 2013, 15). Although planetary protectionists to date have not invoked the category of the cosmic commons, it may already be at work at the level of presupposition. Mars along with numerous off-Earth sites belong to this commons and deserve fitting protection just as Earth does. NASA's planetary protection officer, Catherine Conley, could not be more clear: "If you want to study

life elsewhere, you have to make sure not to bring Earth materials along" (Conley, 2014).

2. Does microbial life have intrinsic value?

Does life have intrinsic value? Or, does the value of living organisms depend on the usefulness they have for us? Is value inherent or instrumental? Do we terrestrial *Homo sapiens* have a responsibility toward extraterrestrial life based upon that life's intrinsic worth or based upon its usefulness to us? Almost no one to date has risen up to defend a brute instrumentalism, a crass exploitation of extraterrestrial life for terrestrial profit. What space explorers want to know is this: if we find life, must we respect and protect it?

Space philosopher Kelly Smith argues that any life, on Earth or elsewhere, must exhibit intelligence before it can claim intrinsic value. Smith is a ratio-centrist (Smith, 2016). This is not an unusual position. It feeds off our intact Enlightenment commitment to treat each rational person with dignity, that is, we treat a rational person as a moral end and never merely as an instrumental means. Our quandary is this: should off-Earth microbial life be treated as a moral end? Not if it lacks intelligence, says Smith.

Charles Cockell investigates the issue and identifies a question every ethicist must ask: is intrinsic value inherent in the entity itself or does it depend on the valuer? "Whether intrinsic value is something inherent in an object or something projected on to it, we definitely do need a valuer for that value to become of any ethical relevance" (Cockell, 2016, 169). This leads Cockell to aver, "the most likely type of life that we will find on other planetary bodies, if we find any at all, is microscopic life. Therefore, our treatment of microbial life on Earth and the ethics we apply to it is likely to be the strongest foundation for understanding how we should treat extraterrestrial life" (Cockell, 2016, 177).

Because of the obvious carry over to space ethics from terrestrial environmental ethics, we might remind ourselves of the concerns voiced early in the deep ecology movement. Norwegian eco-sophist Arne Næss gave us the term *deep ecology* in 1973, arguing for an exhaustively systemic view of nature and for treating both human and nonhuman life *alike* as having "intrinsic value" (Naess, 1973). This metaphysical commitment would imply ethically that we treat all of living nature as sacred. If we sacrilize the entire living world in nature, deep ecologists presume, then we human beings would treat our biosphere with reverence, respect, and responsibility. Might we borrow this principle for off-Earth biospheres, treating newly discovered life forms as having intrinsic rather than instrumental value?

Yes, would be the answer offered by environmental philosopher Holmes Rolston III, who argues against the instrumental approach on the grounds that non-human nature preceded human beings who value things. "Humans on Earth are latecomers, and it seems astronomically arrogant for such late products to say that the system is only of instrumental value, or that not until humans appear to do their valuing does value appear in the universe" (Rolston, 1990, 182). Valuing in general is grounded in nature, not in human preference, holds Rolston. This opens the door for treating off-Earth ecospheres as having intrinsic worth and integrity.

However, today's descendents of sixteenth century Reformation Protestants find it difficult to treat anything created as sacred in itself. God the Creator is sacred, to be sure; but the world of nature--whether living or non-living--belongs in the category of creature. Human dignity is called for, to be sure; and so is responsible stewardship called for. But not an intrinsic sacredness spread around to all living things. What is created cannot bear in itself an ontological sacredness. Nevertheless we might ask: could a creature be sacred if God deems it sacred? Might we appeal to intrinsic value if God imputes intrinsic value?

Richard Randolph, mentioned earlier, would answer in the affirmative. He affirms the intrinsic value of life by appeal to God. "From a

Christian point of view, God's preferential option for life means that all of life has intrinsic value. By this I mean that all living organisms, as well as their ecosystems, are entitled to a basic, underlying level of respect--and, even reverence--by humans. Every living organism is good in and of itself, regardless of the instrumental value it may have for humans" (Randolph, 2009, 287). We human beings on Earth should express this intrinsic worth of extraterrestrial life by behaving as servant/stewards, supporting both living organisms and their respective habitats wherever they may be found. "God's preferential option for life grounds the claim that all of life has intrinsic worth and that God intended for extraterrestrial life to flourish and be self-determinant" (Randolph, 2009, 287). In Næss and Rolston, the intrinsic value of the natural world derives from our treating nature as sacred. In Randolph, in contrast, the intrinsic value of the natural world derives from the respect God shows for it. The resulting sense of moral responsibility is the same in both cases.

Still we must ask: does intrinsic value apply to all life generally or only to selected living organisms? Might we discriminate between some life forms and other life forms, granting more worth in some cases and less in other cases? If so, what will be our criterion for selection?

A flat attribution of intrinsic value to all of nature or, within this all of life, is difficult to ground without appeal to God, who transcends nature. First, life does not treat itself with intrinsic value. Predation, for example, pervades the domain of living things. Life eats life. Some life dies so that other living things may live. Thus, if we human beings are going to protect life on the grounds of its intrinsic value, we do so for reasons other than imitating life itself. Second, we daily treat some living organisms instrumentally. Everything we eat we kill, except for salt. Plants and sometimes animals are sacrificed for our own survival or pleasure. We do this without thinking ethically. Therefore, if we are to impute intrinsic value to living entities in outer space, we may need to discriminate; and we may need to provide a reason for this discrimination.

Notre Dame University Bioethicist Celia Deane-Drummond contends that the concept of intrinsic value does not preclude discriminating between greater or lesser worth. "It is possible to hold to the notion of intrinsic value, while also being able to discriminate between different forms of life and non-life in terms of their worth" (Deane-Drummond, 2009, 104). Or, to say it another way, even if we impute intrinsic value to all living things, within this wide category we may identify some living things to be of greater value or worth. But, we ask: how do we decide? Without appealing to instrumental criteria for discriminating between greater or lesser worth, we should look for criteria within the scope of intrinsic value. One candidate might be sentience. Complex life forms are sentient in a way that we humans are sentient; whereas more simple life forms lack this attribute. Could sentience provide the criterion of discrimination?

Erik Persson, bioethicist at Lund University in Sweden, appeals to sentience within the larger category of life. "According to sentientism, one has to be sentient to have moral status whether terrestrial or extraterrestrial and whether biological or nonbiological [such as post-biological]....The most plausible theory for moral standing seems to be sentientism that connects directly to the basic idea behind modern ethics: that ethics is about dealing with situations where one's own actions affect others in a way that matters to them....If we accept sentientism, microbial life and plants do not have moral status, but there are reasons for protecting someone or something other than being a moral object" (Persson, 2012, 983). Complex or sentient life has greater moral worth than simple or primitive life, according to this scheme. Will this work? No.

Sentience will not work as a general ethical category, except for vegetarians. Here on Earth we have already committed ourselves to eating meat. Meat-eating requires the death of sentient creatures. We discriminate between pets, which we do not eat, from stock, which we do eat. Vegetarians object to this practice on moral grounds, on the grounds that we have a responsibility to all sentient creatures. If we are to export to extraterrestrial realms a categorical respect for all sentient organisms, then

for the sake of consistency we would need to adopt vegetarianism back at home. A consistent ethic based upon sentience would require vegetarianism on Earth as well as on all space expeditions.

Sentience will not help for another reason. To date, those contributing to this discussion have drawn on ethical precedents set by environmentalists and eco-ethicists. This ethical posture is oriented holistically toward entire ecosystems, toward protecting entire habitats with their resident living creatures regardless of level of sentience or intelligence. This holistic approach seems intuitively relevant to what we might discover on Mars or a moon orbiting Saturn. Once engaged, we would not discriminate between one species on behalf of another species. Rather, we would assume we are responsible for each entire biosphere with its already established life forms. Entailed in a holistic commitment to an entire ecosystem is an indispensible level of commitment to simple life forms and even to abiotic contributors to this ecosystem.

In sum, we may have to live for a period with a generic respect-for-life's-intrinsic-value principle until we have entered into actual engagement with ETNL or ETIL. At that point we will re-articulate the quandary and re-formulate our responsibility. By no means is this a form of kicking the ethical can down the road. Rather, we are simply marking specific areas where we will need to respond to actual rather than hypothetical situations.

3. Should space explorers invoke the Precautionary Principle?

In order to follow my moral advice in the previous section, we might find the Precautionary Principle worth adopting. Earth's ecologists are already used to debating and commending the *Precautionary Principle.* Might astroethicists borrow it?

The so-called *Wingspread Definition* of the *Precautionary Principle* was formulated at the 1992 United Nations Conference on Environment and Development: "When an activity raises threats of harm to human health or

the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically. In this context the proponent of the process or product, rather than the public, should bear the burden of proof" (Appell, 2001, 18). When space scientists and ethicists met at Princeton for a COSPAR workshop in 2010, they embraced a variant formulation: "we define the *precautionary principle* as an axiom which calls for further investigation in cases of uncertainty before interference that is likely to be harmful to Earth and other extraterrestrial bodies, including life, ecosystems, and biotic and abiotic environments" (COSPAR, 2010). For the time being, space explorers from Earth may wish to treat newly discovered life forms as if they possess intrinsic value, at least until further ethical deliberation takes place.

Employment of the Precautionary Principle for space exploration provides the kind of middle axiom that connects the larger value of life with practical policies that facilitate off Earth activities.

4. Should we clean up our Space Junk?

"Debris from nearly 60 years of activity in space poses an increasing hazard to both human and remote operations in Earth orbit" (Schwarz, 2016, 2). Currently, about 22,000 large pieces of space junk in the form of dead satellite parts are orbiting Earth. We have turned our upper atmosphere into a trash dump. Do we want to pollute extraterrestrial space just as we have befouled our terrestrial nest?

Over the last six decades we earthlings have shot up into space approximately 20,000 metric tons of material. 4500 metric tons remain in orbit, broken into countless chunks of junk. Of the 4800 satellites placed in orbit, half of these, 2400, are still present. But, of these 2400 satellites, only 600 or so are still active. The inactive satellites and other rocket debris sail silently like a never-ceasing stream of unaimed bullets just waiting for a target to get into their way (Marks, 2011).

The problem with our orbiting landfill is not merely that it is ugly. It is also dangerous. It risks danger to future space flights and future satellites. Jacques Arnould, astroethicist for the French Centre Nationale d'Etudes Spatiales (CNES), warns us: "there are now 22,000 human-made objects larger than 10 centimeters across in orbit and half a million larger than 1 centimetre—and all pose a grave risk to space missions....Even if space agencies never launched another rocket, the cloud of debris will continue to grow as a pieces of space junk crash into one another" (Arnould, 2011, 92). As space junk crashes, each piece fragments and multiplies the number of dangerous micrometeorite material that risks damage to future space vehicles we send up. Some space scientists fear a runaway chain reaction--called the Kessler syndrome--that pulverizes everything in orbit, including functioning satellites. This would establish a band of untraversable danger, a no-man's land in space. Here is the warning: for safety's sake, stay out of the space dump.

To date, no one has been held responsible for space junk. Those who make profits or who otherwise gain from sending this material into space are not required to recycle or dispose of their waste. Space waste accumulates, but nobody is required to pay for cleaning it up. Nations or corporations treat the Greater Earth or cosmic commons as their ashtray, as a public trash dump. Follow the money.

If we define Greater Earth as a part of the galactic commons, then we find ourselves already beset with a classic moral problem: those with power and influence utilize common space for their own profit while the population as a whole absorbs the cost of deterioration or degradation of what is publically shared. If and when our planetary society consolidates its diversity into a single community of moral deliberation, then responsibility will need to be parsed and parceled according to a renewed principle of justice.

The European Space Agency has set up a Space Debris Office to coordinate research activities in all major debris disciplines, including measurements, modeling, protection, and mitigation, and coordinates such

activities with the national research efforts of space agencies in Italy, the United Kingdom, France and Germany. Together with ESA, these national agencies form the European Network of Competences on Space Debris.

The Japan Aerospace Exploration Agency (JAXA) is testing to see if a tethering technique might begin the process of debris-gathering. The tether consists of a long conductive wire attached to a junk chunk which, by implementing an electrodynamic drag, would pull the debris into the atmosphere where it would burn up. The Space Thethered Autonomous Robotic Satellite-2 (STARS-2) is testing the idea and, if it works, then it could be attached to future missions aimed at capturing existing debris (News Report, 2014).

5. What should we do about Satellite Surveillance?

Reconnaissance satellites or spy satellites have been deployed over sixty years for purposes of military or intelligence applications. The telescopes on board are pointed toward Earth, not toward the stars. Mission tasks include high resolution photography; measurement and signature intelligence; communications eavesdropping; covert communications; monitoring of nuclear test ban compliance; and detection of missile launches. With the improvements in technology, today's spy satellites have a resolution capacity down to objects as small as ten centimeters. Surveillance satellites also provide us with efficient communications, weather reporting, Google maps, and many more public services.

Spying is international, not just national. The Echelon spy network coordinates satellite snooping by the governments of the United Kingdom, the United States, Canada, Australia, and New Zealand. The Echelon network spies, sorts, decrypts, archives, and processes three million telephone calls transmitted by satellite every minute.

Remote sensing and communication technologies were developed before any legal structure was put in place to govern their developments.

The United States government sells pictures taken by satellites; but it keeps certain subjects from public review. Sensitive facilities such as military installations are restricted, as are remote pictures taken over Israel. Similarly, private companies use satellites for remote sensing and sell their pictures.

"Can a State gather information about the natural riches and resources of another sovereign State without having obtained the latter's prior agreement?" asks Arnould. "Is it not up to the remote sensing State to ask for the prior permission of the State whose territory is being observed?" (Arnould, 2011, 75). This sounds like a reasonable ethical question. Yet, it presupposes the present situation of sovereign nation states, a political system that may have made sense prior to the current thrust toward economic and technological globalization. Satellite surveillance and communication services, right along with other space activities, are playing into an emerging planetary consciousness.

Protecting national boundaries from foreign intelligence or even public transparency may soon be an artifact of history, an era we remember but no longer live in. Perhaps the way forward is to support an ethic of maximal *information without discrimination*. Rather than attempt to police information gathered from remote sensing, it would be healthier and easier to prevent such information from deleterious usage.

6. Should we weaponize space?

"Star Wars" became the nickname for U.S. President Ronald Reagan's 1983 proposal for the Strategic Defense Initiative (SDI). Reagan had inherited the cold war strategy of "Mutual Assured Destruction" (MAD), the policy of detente that had kept the peace between the United States and the Soviet Union since World War Two. Reagan asked his scientists to help him create SDI, which would include among other things space-based weapons. Specifically, these space-based weapons would rely upon lasers aimed at shooting down Soviet Intercontinental Ballistic Missiles (ICBMs).

Reagan's Strategic Defense Initiative Organization (SDIO) worked with an earlier idea developed by physicist Edward Teller for an X-Ray laser. Then, SDIO funded newer ideas. Beginning in 1985, designs and tests were planned for innovative forms of laser technology. The U.S. Air Force tested a deuterium fluoride laser, also known as the Mid-Infrared Advanced Chemical Laser. Later the Air Force tried shooting an old satellite with a Tactical High Energy Laser; and the U.S. Navy shot at drones with similar laser designs. The best these experiments could report was "mixed" success, just enough success to keep funding flowing.

Today, eyes on militarizing space are looking up. "For modern warfare, space has become the ultimate high ground, with the U.S. as the undisputed king of the hill," writes Lee Billings (Billings, 2015, 15). "China and Russia are both developing capabilities to sabotage crucial U.S. military satellites" (Billings, 2015, 18). Laser technology has advanced, so that satellites will begin to use lasers to disable other satellites. One can only imagine a skirmish that could lead to Star Wars or, more precisely, Satellite Wars.

This scenario is important, because the 1967 United Nations Outer Space Treaty emphasizes that celestial locations could be used "exclusively for peaceful purposes." The treaty explicitly prohibited the "placing in orbit around the Earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction." Light saber battles between satellites was not explicitly prohibited. Any regulation of military equipment in space is today the responsibility of bilateral and multilateral agreements, not the United Nations. No global community of moral deliberation exists, at least not yet.

7. Who Gets Priority: Scientific Research or Making a Profit?

Economic and political motivations for gaining dominance in space may increase over the next decades. The telecommunications industry is already accustomed to the cost effective use of satellites. We are on the brink of an

era of space tourism, with the first trips to suborbit and low orbit vacations in the planning stages. Visits to the moon will most likely follow. Establishing research laboratories on the moon and Mars are being envisioned. Might it be prudent to ready ourselves for an El Dorado type of gold rush to the new extraterrestrial world? If so, should we try to put policies and policing mechanisms in place in advance?

Up until this point we have thought of outer space as a sandbox for Earth's scientists to play in. Governments have found the money to fund modest exploratory adventures; and scientists have organized to conduct experiments which have yielded an abundant harvest of new knowledge about our cosmos. Frequently, scientific goals have been mixed with military goals, because leaders in the military have been willing to share their budgets for scientific purposes. Scientific experiments do very little damage, if any. Somewhere on the Moon is a golf ball left by visiting astronauts. Landing on Mars or on Titan has not infected or contaminated anybody's ecosystem, as far as we know. NASA decontaminated its first Mars lander, but more recently NASA has saved the money spent for decontamination under the assumption that a little contamination of Mars doesn't matter. The impact on our solar system by scientific activity is benign.

This situation is about to change. The private sector is now ogling space for profit. What about space tourism? Simply flying a few wealthy passengers high enough to experience weightlessness is not likely to provoke anyone's moral ire. But, what about tour busses roaming the surface of the Moon? Busses will leave tire tracks. Perhaps trash. No doubt tourists will want to visit that golf ball as well as historical sites where astronauts first landed. Will the crowds of visitors damage those sites? Are those sites sacred? Protectable? Who will decide and what will be the criteria by which they decide?

The market does not always react the way the marketers predict. Low cost and frequent flights to suborbit heights might actually encourage increased participation by scientists. These scientists will want to do

research on the *ignorosphere*. The ignorosphere is a level just above balloon traffic but too low for satellites. Scientific researchers might buy tickets with the tourists and then look out the windows (Stern, 2015).

8. Should Earthlings terraform Mars?

Should we terraform Mars? Or, any other planet or moon, for that matter? Will we Earthlings rest content until we see the golden arches of McDonalds on the red planet?

One person who would resist McDonalds' golden arches on Mars is T. Sullivan Woodruff. "I will argue for an extension and adaptation of a rigorous environmental ethics stance that has been proposed for Earth. On this scheme, planets have intrinsic value....Such a planetocentric ethics treats all planets somewhat as we treat designated wilderness areas on Earth--that is, with a 'hands off' approach unless other treatment is strictly justified for scientific or other needs" (Woodruff, 2013, 167). Note that Woodruff argues for 'hands off' regardless of whether there is or is not life on Mars.

Our Mars Man is Christopher McKay, a space scientist at NASA's Ames Research Center. According to McKay, we work with the assumption that Mars is lifeless. At least it is lifeless today. The red planet may have been home to life in the past; but Mars must have lost its atmosphere and its ability to sustain life for reasons yet unknown. Its thin atmosphere is replete with carbon dioxide, but not oxygen. Let us speculate: suppose we would transplant living organisms from Earth that take in carbon dioxide and expel oxygen into the atmosphere? Then, when enough oxygen suffuses the atmosphere, we could introduce oxygen inhaling organisms that expel greenhouse gases. These greenhouse gases would warm up Mars, and life would thrive. A self-regenerating ecosystem could run on its own. In less than a century, estimates McKay, we could establish a biosphere that would last ten to a hundred million years.

McKay calls this terraforming project "planetary ecosynthesis." This proposal for planetary ecosynthesis raises a number of ethical concerns.

Immediately, one might ask: should we do it? To what do we appeal ethically to answer this question?

In response to this quandary, McKay proffers a simple axiom: life is better than non-life. "I suggest that the long-term goal for astrobiology and society is to enhance the richness and diversity of life in the Universe" (McKay, 2013) 159). Virtually no one who mulls over the question of life's intrinsic value would challenge McKay's starting point. But, we ask: what comes next?

On Earth the principle that life is better than non-life has influenced our decisions and policies to preserve life. We preserve species from distinction. We preserve habitats to encourage certain species to proliferate. In short, we attempt to prevent certain forms of life from dying out.

This would not apply to Mars, however. If we assume that Mars is currently lifeless, then we would not find ourselves preserving existing life. Rather, the question is: should we seed life on Mars? If life is better than non-life, says McKay, then the moral answer should be in the affirmative. Transferring terrestrial life forms to Mars would be better than leaving Mars lifeless.

Curiously, McKay appeals to both intrinsic value and instrumental or utilitiarian value when justifying planetary ecosynthesis. First, the intrinsic argument. Because life has intrinsic value, Mars with life would be ethically of greater worth than a lifeless Mars, even if it is transplanted life. Second, the instrumental argument. Because we on Earth would learn so much from the Mars project about sustaining a biosphere, we could apply what we learn on Mars to sustaining Earth's biosphere in the face of our imminent ecological challenges. "Both utilitarian and intrinsic worth arguments support the notion of planetary ecosynthesis" (Mckay, 2011, 259).

How might such an argument sit with a theologian? With a Buddhist theologian? Frencisca Cho, Associate Professor of Buddhist Studies at Georgetwon University, offers a Buddhist interpretation. “A Buddhist would apply neither an intrinsic nor instrumental value of life or nature to

the question of terraforming Mars. The idea of an intrinsic value would go against the principle of emptiness. Instrumental value, on the other hand, would be problematic because one could not ensure that the instrumental objectives had the proper motivations....There is no intrinsic worth to nature but neither is there intrinsic worth to human beings....There is no option between them, so you have to transcend that framework all together" (Cho, 2007, 212). From a Buddhist perspective, neither an appeal to the intrinsic value of life nor an appeal to life's utilitarian value to human beings provides ethical guidance for the terraforming question.

Another issue appears on our moral radar screen, namely, the risk that we terrestrials will make a mess out of Mars. We have already spoiled one planet. Will we spoil others? Theologian Cynthia Crysdale recommends that we incorporate this risk into our ethical vision. "We need to think of ourselves as living within an ethic of risk, not an ethic of control. I say this in direct reference to the actions we take in terraforming or colonizing or exploring other planets. My caution is to point out that the conditions of possibility that we establish in the hopes of one outcome may at the same time establish conditions under which totally unforeseen schemes of recurrence become established" (Crysdale, 2011, 240). Dr. Crysdale has wisely asked us to consider human nature--that is, human sinfulness--when making plans. No ethical justification could suffice without acknowledgement of who we are as humans. Nevertheless, anticipating the unforeseen damage we humans are capable of is a principle one must incorporate into any such project, regardless of whether it is justified by appeal to an intrinsic or utilitarian ground.

Should we terraform Mars or any other celestial body within our solar ghetto? On the one hand, McKay's argument that life is better than non-life provides a sound point of departure. On the other hand, transplanting terrestrial life to an extraterrestrial location looks a great deal like colonizing. As we bring the history of terrestrial colonization to mind, we cannot avoid recalling the imperialism and greed that motivated colonization and the devastating impact of exploitation and genocide on

the lands colonized. The Crysdale incorporation of risk based upon what we know from history about human nature gives one pause.

Our pause cannot last too long. The Mars Society is already making plans to colonize the red planet.

9. Should Earthlings Colonize Mars?

Should we go beyond terraforming and actually colonize the red planet?

Yes, and more places in the solar system as well. "Humans-to-mars" is the direction Robert Zubrin is leading his followers in the Mars Society. His "Mars Direct" colonization plan "advocates a minimalist, live-off-the-land approach to exploring the planet Mars, allowing for maximum results with minimum investment. Using existing launch technology and making use of the Martian atmosphere to generate rocket fuel, extracting water from the Martian soil and eventually using the abundant mineral resources of the Red Planet for construction purposes, the plan drastically lowers the amount of material which must be launched from Earth to Mars, thus sidestepping the primary stumbling block to space exploration and rapidly accelerating the timetable for human exploration of the solar system" (Mars Direct, 2013). Money raised from the private sector will support this effort. Mars Society adherents see themselves as rivals to NASA. They are in a space race and plan to beat NASA to the fourth planet.

The Mars Society plans to initiate Mars Direct by sending an "Earth Return Vehicle" or ERV, arriving on the red planet six months following launch from Earth. While on the Mars surface, the ERV will set up and operate nuclear reactors, which will generate the fuel needed for the return trip, 13 months later.

The second Earth-to-Mars launch will take place 26 months after the first, sending two more craft, a second ERV and a habitat module for the astronauts to live in. After a year and a half on the Martian surface, the first crew returns to Earth, leaving behind the habitat, the rovers associated with it and any ongoing experiments conducted there. When they land on

Earth six months later, they are greeted to a hero's welcome. From this point on the cycle is repeated, with more and more of Mars opening up to human exploration and habitation. This will be the beginning of a permanent human settlement on the planet Mars.

The Mars One project based in the Netherlands and headed by Bas Lansdorp is making similar plans. As of the summer of 2013 the project planners began their selection of the first crew headed for the Red Planet in 2023. The crew would be given seven years of training in engineering, medicine, agriculture, and astrophysics. This would be a one way trip. Once the astronauts have landed, they would become Martians.

The mood of the Mars Society and the Mars One project is one of promethean expectation. The human race is being called by destiny to go, go, go. To spread our race throughout the solar system fulfills our inherited evolutionary mandate, to fill every niche with life.

Some Muslims find the prospect of Mars colonization objectionable, especially the risk of self-sacrifice on the part of the first explorers. Because the first wave of travelers from Earth to Mars will know in advance that they will not be returning, the one way trip idea looks like a plan for suicide. To this, Muslim theologians object. In early 2014 the fatwa committee of the General Authority of Islamic Affairs and Endowment in the United Arab Emirates issued the fatwa after determining that "such a one-way journey poses a real risk to life, and that can never be justified in Islam." They continued, "There is a possibility that an individual who travels to planet Mars may not be able to remain alive there, and is more vulnerable to death." Qu'ran 4/29: "Do not kill yourselves or one another. Indeed, Allah is to you ever merciful." In sum, suicide is immoral, even on Mars (Rojas, 2014).

It would seem to me that we need not think of one way trippers to Mars as necessarily committing suicide. There is a risk of death, to be sure; but there is also the prospect that earthlings might live a normal life span in the atmospheric bubble on Mars' surface. To die of natural causes off-Earth does not necessarily count as suicide, in my judgment.

When the Spanish crown commissioned Christopher Columbus in 1492 to sail west across the Atlantic ocean, it was hoped he would return with gold and mineral wealth. Europe's race to the new world had begun, a race to maximize national power and wealth through exploiting foreign land. Might we see a repeat here? Not exactly. Even if the Mars Society or Mars One are successful at establishing a permanent habitat for earthlings on Mars, it is not clear that this would lead to profits for those back on the third planet who funded their expedition. If profit is to be made, it would not likely occur within the lifetime of those planning the mission. This gargantuan mission will have to rely on the promethean spirit, at least for the near future.

10. Death from the Sky?

Back on the third planet, the vast majority of earthlings will still be living here. The very thought that Mars might provide a safe refuge for *Homo sapiens* once we have polluted our home planet is utterly preposterous, according to anyone who has considered the matter. We had better make our peace with one another and with our own biosphere, because Earth will continue to be our home for the foreseeable future. If we *Homo sapiens* do not get our act together and end up so fouling our habitat that we go extinct, the non-intelligent (might we say "stupid") life in our solar system will not be limited to Titan microbes.

Nevertheless, even with sober ecological policies, Earth will continue to be a dangerous home. The heavens hold plenty of threats. The Sun occasionally launches solar flares, which fry electricity grids by generating intense currents in wires. A solar megastorm in 1859 sparked fires in telegraph offices. If such a flare would reach Earth today, it would knock out satellites and shut down power grids for months or longer. Such an event would incur trillions of dollars in economic damage. Although we rely upon the sun for our daily life, some day it just might kill us.

In addition to solar threats, we need to anticipate the possibility of a large comet or asteroid strike. On February 15, 2013, more than 400 Russian people were injured when an asteroid exploded just above the city of Chelyabinsk. NASA referred to it as a "tiny asteroid" that measured roughly 45 feet across, weighed about 10,000 tons, traveling about 40,000 mph. The object vaporized roughly 15 miles above the surface of the Earth, causing a shock wave that triggered the global network of listening devices that was established to detect nuclear test explosions. The force of the explosion measured between 300 and 500 kilotons, equivalent to a modern nuclear bomb (Morin, 2013).

Within hours of the Russian disaster, another asteroid, 2012 DA14 passed between Earth and our geosynchronous satellites. Once or twice every two million years our planet gets smacked by rocks two kilometers or more in diameter, leading to extinctions. It is widely believed among scientists that sixty-five million years ago an asteroid ten kilometers in diameter hit Earth and triggered the mass extinction of dinosaurs. Can we protect Earth from future asteroid catastrophes? The UN's Science and Technical Subcommittee's Near-Earth Object Working Group and its internal panel, Action Team 14, have been working on the details of an international approach since 2001 to anticipate and thwart such Near Earth Objects (NEOs).

> The Action Team identified three primary components of threat mitigation: (a) discovering hazardous asteroids or comets and identifying those objects requiring action; (b) planning a mitigation campaign that includes deflection and/or disruption actions and civil defense activities; and (c) implementing a mitigation campaign, if the threat warrants. The Action Team emphasized the value of finding hazardous NEOs as soon as possible in order to avoid unnecessary delays in NEO threat mitigation missions. Recommendations of the Action Team are meant to: (a) ensure that all nations are aware of potential threats and (b) ensure the design and coordination of

mitigation activities among nations that could be affected by an impact and those that might play an active role in any eventual deflection or disruption campaign (Haubold and Nadis, 2014).

Solar flares and asteroid strikes. That's not all. More rare but equally potent would be the blast of radiation from a nearby γ-ray (gamma ray) burst. A short-hard γ-ray burst, caused by the violent merger of two black holes or two neutron stars or a combination, provides the most frightening scenario. If one such blast would be directed at Earth from within 200 parsecs away (less than 1% of the distance across the Milky Way), it would zap Earth with enough high-energy photons to wipe out 30% of the atmosphere's protective ozone layer for nearly a decade. Such an event — expected once every 300 million years or so — would double the amount of ultraviolet light reaching the ground and scorch phytoplankton, which make up the base of the ocean's food web. Astronomers are unable to predict such bursts, so we have no way of knowing whether such a rare event is imminent.

What about long-soft bursts? From a distance of about 2,000 parsecs, 'long-soft' γ-ray bursts — which result from the collapse of massive stars — could also damage our planet and cause extinctions. Long-soft bursts are rarer than short-hard bursts. In addition, they are easier to spot in advance because they come from larger, brighter stars (*Nature*, 2013).

How does knowledge of these potential threats from the heavens provoke ethical concerns? Because these damage scenarios lead us to think ahead. We need to plan for our planet's future, and we need to incorporate such possibilities into our planning. With regard to solar flares, fortunately, there are ways to mitigate the damage should it occur: engineers can protect the grid with fail-safes or by turning off the power in the face of an incoming blast. With regard to a comet or asteroid strike, we will be given advanced notice. A diversion strategy could be effective, perhaps by hitting the object while it is yet far away with a nuclear bomb. We have no way to prevent gamma ray bursts from striking our Earth, but we could provide

protective shields in sanctuaries for life forms we wish to restart following the event. These matters belong to our ethical quandary. Just how will we respond?

11. A Single Planetary Community of Moral Deliberation?

We have been suggesting that the community most appropriate for deliberating over such quandaries would consist of all the peoples of Earth working together. Margaret Race has been making this point based on the principle of inclusivity. "It is important to recognize that current deliberations and decision making are almost exclusively in the realm of scientific and spacefaring elites," observes Race. This suggests that ethicists must be "proactive in expanding the dialogue" so that it becomes planetary in scope. Space ethics must rely on the equivalent of "informed societal consent" (Race, 2013, 154). Perhaps the matter of establishing a single planetary community of moral deliberation is even more urgent than Race's push for inclusivity. When confronting scenarios that have a planet-wide impact such as a threatening asteroid, the planet as a whole should become the community of moral deliberation and provide the network to shoulder the responsibility.

Planetary plans to meet such threats should, at least in principle, be international or supranational. The principle of distributive justice may require that each nation contribute to a coordinated effort in proportion to its capability by providing either technological expertise or funding for such expertise. Planetization is a corollary to the notion of a galactic commons. Eco-images such as "green globalization" or "spaceship Earth" connote the circumstances that lead to the concept of a single planetary society.

Former US Vice President Al Gore is optimistic. "Fortunately, the awakening of the Global Mind is disrupting established patterns--creating exciting new opportunities for emergent centers of influence not controlled by elites...[elites who have set incentives] that reward unsustainable

exploitation of limited resources, the destruction of ecosystems crucial to the survival of civilization, unlimited flows of pollution, and the disregard of human and social values" (Gore, 2013, 364). A long-term global ecoethic or accompanying galactic astroethic should be the product of a single planetary society that rises above the self-destructive greed of competing subsidiary economic forces.

12. Should the Common Good Include the Galactic Commons?

I recommend that the astroethicist invest moral energy in promoting the common good. Pope Paul VI defined the common good as "the sum of those conditions of social life which allow social groups and their individual members relatively thorough and ready access to their own fulfillment" (Pope Paul VI, 1965). This leads to the next question: just how big is the commons for our common good? One's entire nation? Our entire planet? Our solar system? Our galaxy? The universe?

Is it reasonable to hold that all things in the cosmos are sufficiently connected that we can realistically consider a commons? According to Mark Lupisella at NASA's Goddard Space Flight Center, the answer is affirmative. Everything in the entire universe is connected if for no other reason than to say it all evolved from one source, the Big Bang. Predicated on this past evolutionary connectedness, Lupisella proposes an ethic based upon a connection-action principle. "The connection-action principle...suggests that the universe's fundamental property of *connectedness* is manifested as relations and action, and hence ultimately as creativity--potentially in ever increasing degrees" (Lupisella, 2016, 89).

John Hart proceeds to treat the cosmic commons as sacred, grounding cosmic ethics in sacredness of the commons. "The sacred cosmic commons is a communion of commonses cosmically interrelated and integrated. It is stardust become spirit; it is atoms become life and thought, all in the presence of a transcendent-immanent, Being-Becoming creating Spirit" (Hart, 2013, 15).

Although I like the heartfelt spirit of Lupisella and Hart, I hesitate to assert that the entire cosmos can become a field of ethical care. This is because the galaxies are moving away from one another at such a speed that no substantive interaction could take place. The diminishing of interaction between galaxies is due to the light year problem: the speed of expansion is such that communication even at the speed of light cannot catch up.

What I do believe is reasonable is this: the Milky Way can and perhaps should be the domain of ethical care. Even though communication and, hence, interaction will be difficult between distant solar systems, at least it is conceivable that reciprocity within the Milky Way Galaxy might occur. With this parameter in mind, I recommend we think ethically about our *galactic commons.* Beyond our relationship to microbial life within our solar system, astroethics should place our moral deliberation within the horizon of the galactic commons.

Conclusion

Despite the fact that the field of astroethics is the new kid in school, already a considerable list of issues appear on its report card. Within our solar ghetto, we must provide ethical deliberation prompted by the prospect that we will be traveling in outer space and that we may discover primal or microbial life, what we affectionately call stupid life, within our solar neighborhood. These prospects elicit an ethical quandary regarding matters such as: planetary protection (including protection of Earth and protection of off-Earth ecospheres); the intrinsic value of extraterrestrial life and of off-Earth ecosystems; what to do about space junk; satellite spying; weaponization of space; the competition between scientific research and economic interests, including space tourism; terraforming Mars; Mars colonization; mitigating the damage done by solar flares, asteroid collisions, and gamma bursts; and such.

These quandaries prompt in us a sense of responsibility. The very knowledge that such challenges may be approaching us in the future is sufficient to prompt in us the question: what should we do? The matter

becomes more complex when we ask: just who makes up the community of moral deliberation here? It appears obvious that challenges to the future of all life on Earth--actually, all life in the galactic commons--lead to the prospect of planetization. All peoples of Earth in cooperation need to deliberate over what is best for our planet as a whole, and our cosmic commons as a whole. Can the peoples of Earth think of themselves as a single planetary society shouldering responsibility for all biota and even abiotic factors in our solar ghetto and Milky Way metropolis?

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