Planetary Protection
An Ethical and Philosophical Introduction

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Outline of the talk:

- Describe the historical motivation for, and present composition of, planetary protection policies.
- Raise a series of philosophical and ethical problems related to the search for extraterrestrial microbial life.
- Suggest a novel ethical framework from which to assess the rationale and scope of planetary protection.
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Shortly after the establishment of NASA, the ICSU established the Committee on Space Research (COSPAR), and subsequently CETEX’s activities were subsumed by COSPAR.
COSPAR’s work on planetary protection eventually informed Article IX of the 1967 Outer Space Treaty:

\[\ldots \text{States Parties to the Treaty shall pursue studies of outer space, including the Moon and other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose.}\ldots\]
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No legal clarification has ever been given for the term ‘harmful contamination.’ Thus, COSPAR’s protection policies, though widely implemented, do not carry the force of law.
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Category I

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**Category II** missions “comprise all types of missions to those target bodies where there is significant interest relative to the process of chemical evolution and the origin of life, but where there is only a remote chance that contamination carried by a spacecraft could compromise future investigations. The requirements are for simple documentation only... primarily to outline intended or potential impact targets.” (COSPAR 2011)
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Category III missions “comprise certain types of missions (mostly flyby and orbiter) to a target body of chemical evolution and/or origin of life interest and for which scientific opinion provides a significant chance of contamination which could compromise future investigations. Requirements will consist of documentation... and some implementing procedures, including trajectory biasing, the use of cleanrooms during spacecraft assembly and testing, and possibly bioburden reduction. Although no impact is intended for Category III missions, an inventory of bulk constituent organics is required if the probability of impact is significant.” (COSPAR 2011)
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Category III missions: flyer and orbiter missions to Mars, Europa, and Enceladus.
**Category IV** missions “comprise certain types of missions (mostly probe and lander) to a target body of chemical evolution and/or origin of life interest and for which scientific opinion provides a significant chance of contamination which could compromise future investigations. Requirements imposed include rather detailed documentation... including a bioassay to enumerate the bioburden, a probability of contamination analysis, an inventory of the bulk constituent organics and an increased number of implementing procedures. The implementing procedures required may include trajectory biasing, clean-rooms, bioburden reduction, possible partial sterilization of the direct contact hardware and a bioshield for that hardware. Generally, the requirements and compliance are similar to Viking, with the exception of complete lander/probe sterilization.” (COSPAR 2011)
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Category IV missions: lander Missions to Mars, Europa, and Enceladus. Currently Mars has its own subcategory.
Category V missions “comprise all Earth-return missions. The concern for these missions is the protection of the terrestrial system, the Earth and the Moon. (The Moon must be protected from back contamination to retain freedom from planetary protection requirements on Earth-Moon travel.) For solar system bodies deemed by scientific opinion to have no indigenous life forms, a subcategory “unrestricted Earth return” is defined. Missions in this subcategory have planetary protection requirements on the outbound phase only... For all other Category V missions, in a subcategory defined as “restricted Earth return,” the highest degree of concern is expressed by the absolute prohibition of destructive impact upon return, the need for containment throughout the return phase of all returned hardware which directly contacted the target body or unsterilized material from the body, and the need for containment of any unsterilized sample collected and returned to Earth.” (COSPAR 2011)
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Category V missions: restricted return from Mars and Europa; unrestricted return from Venus and the Moon.
Methods

- Dry heat sterilization (e.g., Viking, 30 hours at 111.7 C)
- Wet heat sterilization (steam; much shorter than dry heat)
- Alcohol wipes
- Ethylene dioxide and methyl bromide gas
- Beta/gamma/ultraviolet exposure
Two “Philosophical” Questions

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Is there anything at stake here besides protection of opportunities for scientific discovery?
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Discovering extraterrestrial life would enable the kind of comparative study that is needed for constructing a (more) general theory of living organisms.
However, both the ability to discover extraterrestrial life and the ability to protect such life from our interference presuppose that we will be able to recognize it in the first place.
“Life as we know it on Earth today is based upon a complex cooperative arrangement between proteins and nucleic acids. Proteins supply the bulk of the structural material for building bodies, as well as the catalytic material for powering and maintaining them. Nucleic acids store the hereditary information required for reproduction and for synthesizing the enormous quantity and variety of proteins required by an organism during its life span. . . Admittedly, we don’t know how different life could be from life as we know it, because we don’t know all the ways in which a physical system could realize the functions attributed to life. Moreover, we can’t rule out the possibility that the most important characteristics of life have yet to be discovered. The functions traditionally attributed to life may be little more than symptoms of more fundamental but as yet unknown properties.” (Cleland 2006)
“What we really need to focus on is coming up with an adequately general theory of living systems. . . But in order to formulate a general theory of living systems, one needs more than a single example of life. As revealed by its remarkable biochemical and microbiological similarities, life on Earth has a common origin. Despite its amazing morphological diversity, terrestrial life represents only a single case. The key to formulating a general theory of living systems is to explore alternative possibilities for life.” (Cleland 2002)
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There is an obvious ethical consideration nearby: “...the perceived need to conduct good scientific investigations is indeed an ethical position, and a strongly held one, given the amount of money and effort that NASA has spent on planetary protection.” (Meltzer 2011)
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Rather, astrobiologists and space policy researchers seemed to converge on the notion that planetary protection policies were only genuinely ethically motivated when they were implemented for the purpose of protecting extraterrestrial life for its own sake.
“If there is life on Mars, I believe we should do nothing with Mars. Mars then belongs to the Martians, even if the Martians are only microbes. The existence of an independent biology on a nearby planet is a treasure beyond assessing, and the preservation of that life form must, I think, supersede any other possible use of Mars.” (Sagan 2013)
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“Would we have any respect for these organisms, i.e. any sense that we should not arbitrarily destroy them? It seems certain that we would... we recognise them as having a telos, or a ‘purpose’... it is their direction of development, their responses to their environment, and their exhibiting the properties of having a ‘good of their own’ that we respect.” (Cockell 2011)
The idea that direct moral consideration needs to be given to microbial life is novel and is difficult to square with much of the existing work in ethics, which has tended to focus on actions affecting humans, and to a lesser extent, on actions affecting individuals that are capable of experiencing pleasure and pain. (E.g., Kant’s deontology, Mill’s utilitarianism, Aristotle’s virtue ethics.)
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There has consequently been a concerted effort among astrobiologists (and interested philosophers) to devise some conception of intrinsic or inherent value that microbial life can be said to possess.
Step Back

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The ‘Life Bias’:

Life-bearing $\leftrightarrow$ Worthy of protection   Lifeless $\leftrightarrow$ Unworthy of protection
In order to ethically motivate protection of sites of scientific interest more generally (e.g., to astrochemists, planetary scientists, astronomers, etc.), we need to conceive of an ethical framework that entails obligations to protect environments other than those potentially harboring ET life.
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Thus, in addition to attempting to justify ethical obligations regarding ET life, we might also consider justifying ethical obligations regarding the conduct of scientific research and exploration.
So what happens when we assume that we have an ethical obligation to carry out scientific research and exploration—in particular, in space?
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Short and sweet: we can no longer rely strongly on the life-bearing/lifeless distinction when deciding what space environments are worth protecting from contamination.
“...the sense of disillusionment and disappointment of poets who would prefer to have the moon be unstructured, a kind of Rorschach test in the sky. As long as we don’t know what it is, we can project whatever feelings we have on it. And when we find out what it really is, how disappointing. Oh, lifeless, airless rock. But if we look closer, we can find poetry there. The magnificent wasteland, as Buzz Aldrin called it, is in fact a record of how worlds are formed. We see the birthing of worlds in the desolation of the lunar landscape, and it applies to every world in the solar system.” (Sagan 1994)
“To a geologist, the landscapes recall the Canadian High Arctic or the rocky deserts of Libya. The sky, however, is a strange inversion of the Earth’s: brown, orange, lilac, yellow or olive green during the day but electric blue in the glow of the setting sun. Sometimes the blue returns before sunrise in high, feathery wisps on the brightening sky—noctilucent clouds in the upper atmosphere. The little moon Phobos rises and sets twice daily, passing in front of its smaller, slower twin, Deimos. In the warmer seasons, low-latitude hillsides and crater-flanks are painted in fine, dark, parallel strokes by trickles of saltwater. On the floors of craters, black and red sand and dust pile into ripples and dunes, the largest in the solar system. Dust devils are ubiquitous, scrawling dark curlicues on the desert floor like the tracks in a cloud chamber. Compared to Earth, Mars is stark and simple. Undisturbed by the messy influence of biology, Martian features have a mathematical regularity; the same patterns recur at many different scales, like those of a fractal: frost polygons, craters, ripples and dunes, fractures, veins and valley networks.” (McMahon 2016)
“...it is a familiar human trait, but also a failing, to encounter what is in terms of what it is not... It does not seem unfair to suggest that it is this sense of lack, this sense of what isn’t there, which shapes and to some extent distorts perceptions and feeds a dismissal of calls for planetary protection... And yet what is there is also remarkable in its own right.” (Milligan 2014)
“Humans are now in a poor position to say what the formed integrities elsewhere in the solar system are. Speculating over what places, planets, moons should be designated as nature preserves would be more foolish than for Columbus to have worried over what areas of the New World should be set aside as national parks and wildernesses. All the same, in retrospect, our forefathers would have left us a better New World had they been concerned sooner about preserving what they found there...” (Rolston 1986)
Both the previous and recently adopted (Ref. 10) NASA planetary protection policies place requirements only on spacecraft which may encounter celestial objects in the solar system. Both Voyager 1 and 2 will encounter nothing further in the solar system because they will escape it. Thus there are no requirements on the Voyager Interstellar Mission (VIM).

The specific final disposition of the two Voyager spacecraft is as follows: Voyager 1 has a heliocentric speed (relative to the sun) of 3.50 AU/year on a trajectory inclined 35° to the plane of the ecliptic (celestially northward) with an azimuth relative to the vernal equinox (positive in sense of the planets’ revolution) of 260°. The spacecraft will reach the middle of the Oort cloud in about the year 2,000. It will next approach the star AC+79°3888 (within 1.6 light years) about the year 40,200. The values for Voyager 2 are 3.13 AU/year, 48° (southward), and 305°. It will also reach the middle of the Oort cloud about the year 2,000 and will reach Ross 248 (within 1.2 light years) about the year 39,600.
Thank You!

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- COSPAR 2011 Planetar Protection Policy.