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NEW HORIZONS IN PLANETARY PROTECTION: CONTROLLING INTERPLANETARY BIOLOGICAL CONTAMINATION ON ROBOTIC AND HUMAN EXPLORATION MISSIONS

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Biological planetary protection in solar system exploration (referred to simply as planetary protection) is the name given to the policy aimed at preventing biological contamination of other worlds and the potential contamination of Earth by extraterrestrial life, if any. This policy has been applied to solar system exploration missions since their inception in the early 1960s, with the policy focus having been maintained by the ICSU Committee on Space Research (COSPAR). Planetary protection is intended not only to protect the Earth from harmful contamination, but to preserve the opportunity to learn about the existence of life or significant organic chemistry elsewhere—without erasing the very information that space exploration is intended to reveal. In protecting the Earth, the difficulties of shielding the entire populace of the Earth from a biological unknown is generally balanced against the benefit of learning about extraterrestrial worlds, and perhaps extraterrestrial life. Such a calculation involves careful analysis of the potential for extraterrestrial life to be returned to Earth within a space-borne sample, and a conservative approach to executing sample return missions.

Conversely, the potential contamination of other worlds is largely governed by the presence of Earth-like environments that may be colonized by microbes from Earth. Life exists here—and Earth microbes are proving to be much more robust survivors than once was believed. And thanks to a suite of recent NASA and ESA missions, there is increasing evidence that Earth-like environments on other planets can exist. The juxtaposition of these discoveries makes further astrobiological exploration of the solar system an enticing proposition, while calling for careful attention to biological

contamination issues when studying bodies like Mars and Europa. Evidence of potentially available liquid water, and other factors (e.g., energy, possible organics, etc.) may allow for the presence of life—including indigenous life—to exist there.

While there is general agreement about the importance of planetary protection measures, the implementation of planetary protection measures can be both expensive and difficult. When the implementation of stringent measures is necessary— for Mars or Europa, or for sample return missions from those or similar targets of interest—there is a need for increasing levels of technological readiness to enable missions to avoid biological contamination.

Translating planetary protection requirements into affordable and achievable engineering solutions requires a wide array of tools be accessible to mission designers, as well as an intimate understanding of potential sources of contamination and the accessibility of likely habitats on other worlds. While specific requirements for human missions have not been necessary since the last Apollo mission, recent developments at NASA and ESA suggest that such requirements will also have to be defined and validated within the next several years.