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Microbots for Large-Scale Planetary Surface and Subsurface Exploration

This proposal presents a new mission concept for planetary exploration, based on the deployment of a large number of small (meso-scale) spherical mobile robots (“microbots”) over vast areas of a planet’s surface and subsurface, including structures such as caves and near-surface crevasses. This would allow extremely large-scale in situ analysis of terrain composition and history. This approach represents an alternative to rover and lander-based planetary exploration, which is limited to studying small areas of a planet’s surface at a small number of sites. The proposed approach is also distinct from balloon or aerial vehicle-based missions, in that it would allow direct in situ measurement.

In the proposed mission, a large number (i.e. hundreds or thousands) of cm/mm-scale, sub-kilogram microbots would be distributed over a planet’s surface by an orbital craft and would employ hopping and bouncing as a locomotion mode to reach scientifically interesting artifacts. They would be powered by high energy-density polymer “muscle” actuators, and equipped with a suite of miniaturized imagers, spectrometers, sampling devices, and chemical detection sensors to conduct in situ measurements of terrain and rock composition, structure, etc. Multiple microbots would coordinate to share information and cooperatively analyze large portions of a planet’s surface or subsurface.

In this Phase I study, the microbot mission scenario would be developed and its potential science return would be compared to traditional rover-based missions. Enabling technologies for actuation, power, sensing and communication would be surveyed, and preliminary microbot physical design concepts would be proposed. The mission scenario would be based on design concepts to be operational in 10 to 40 years, and would be justified by technical feasibility studies. This work would be carried out by a multi-university team of engineers and astrobiologists.

