

Life Detection Microscope (LDM): *In situ* imaging of living cells on surface of Mars

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Today's Mars is a cold and dry planet, but the Mars of years past would have had a large amount of liquid water on the surface. Several billion years ago, Mars could have been similar to the early Earth from which life arose, and life may have also originated on Mars during this period. Although the Viking mission in 1976, which explored life on Mars, did not find evidence for life [1], many findings associated with the possibility of life have been discovered since the Viking mission: past and present aqueous environments, organic compounds, methane, reduced compounds for microorganism energy sources, and so on [2] [3]. These findings suggest that microorganisms might exist on Mars surface.

For searching extant microorganisms, a microscopic instrument would be a powerful tool, which directly images life forms and identify their shapes, sizes, and other morphological structures, but it has not been used in space missions yet. For *in situ* detection of microbial cells, we have proposed the Life Detection Microscope (LDM) which visualizes organic compounds by staining the samples with fluorescent pigments [4]. The LDM scans a volume of 1 mm³ and detects organic compounds including cells and other biological materials in high sensitivity (<10⁴ cells per gram clay). The fluorescent pigments have been selected to identify the fundamental features of cells by differentiating among organic compounds surrounded by membranes or enzyme activity. The LDM is also equipped with a high resolution imaging system (1 μm/pixel) which visualizes detailed life forms as well as regolith and dust particles. The search for living microorganisms is important not only for scientific interest but for planetary protection. Before future human missions begin, surveys investigating the presence of living microorganisms should be conducted to mitigate the risk of human contact with Martian microorganisms, which may be harmful to human health. The LDM would be effective tool for this purpose.

References

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