# Spectral Profiling & Imaging (*SPI*): Extending L.I.F.E. Technology for the Remote Exploration of Life in Ice Caves (R.E.L.I.C.) On Earth and Mars

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## ABSTRACT

On Earth, the ice of the lakes, glaciers, and caves of the cryosphere (from the ancient Greek word cryos, meaning "cold" or "ice") harbors rich, complex biotic communities. Ice cave habitats have been posited for the Mars cryosphere. Ice in such caves would protect microbes from UV, X-rays, and heavy particle radiation and might be accessible during robotic or astronaut missions. Detection of putative biota-rich ice will require *in situ* detection of biosignatures in cave walls, floor, and ceiling a few centimeters to tens of meters distant from the investigating rover or astronaut. We describe the development of a prototype for a non-destructive, non-contact device that rapidly generates reflectance and fluorescence images and a midline target profile of 960 reflectance and fluorescence spectra. Spectral Profiling and Imaging (***SPI***) requires no irreplaceable consumables and can be sufficiently miniaturized to be used by a single astronaut or a small robotic explorer. The current laboratory instrument is designated ***SPI$^2$*** since it generates data sets for two optical phenomena: reflectance and fluorescence. In final form ***SPI$^4$*** will be integrated with an autonomous rover and generate data for four optical phenomena: reflectance, fluorescence, Raman scattering, and circular polarization. ***SPI$^4$*** will be useful for the Remote Evaluation of Life in Ice Caves (**R.E.L.I.C.**) on planetary bodies whose distance from Earth prohibits real-time mission control.

**Keywords**: Epifluorescence Imaging, Epifluorescence spectroscopy, Raman Spectroscopy, Mars, Cryosphere, Robotics, Extremophiles, Biomedicine

**Citation**: Storrie-Lombardi, M.C., Hall, A.P., Hang, S., Lyzenga, G.A., Clark, C.M., Sattler, B.I., Bej, A.K. and Hoover, R.B. (2011) Spectral Profiling & Imaging (SPI): Extending L.I.F.E. technology for the remote exploration of life in ice Caves (R.E.L.I.C.) on Earth and Mars. *Instruments, Methods, and Missions for Astrobiology XIV* 8152 (17), 1-12.