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STABLE CARBON ISOTOPE MEASUREMENTS USING LASER SPECTROSCOPY

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On Earth, autotrophic organisms incorporate carbon-12 into their bodies with greater efficiency than carbon-13. Carbon in organic earth sediments is enhanced in ^{12}C by about 2-3% and this enhancement constitutes a striking signature of the presence of life. The ability to measure $^{12}C/^{13}C$ ratios *in situ* would represent a powerful discriminatory tool for searching for now-extinct life on Mars which may have laid down isotopically enhanced carbon deposits. A Mars Rover and Sample Return mission could utilize a carbon isotopic ratio measurement to help select which rocks and soil samples to bring back to Earth and which to discard. Lead-salt tunable diode lasers (TDLs) emit coherent infra-red light with a very narrow linewidth of approximately 0.0003 cm^{-1}. It is possible to use a TDL to measure individual rotational lines within the vibrational absorption band and determine their intensities, which can be used to determine gas concentration and carbon isotopic ratios of CO_2 derived from Martian rock and soil samples.

The 2300 cm^{-1} spectral region is especially interesting because the $^{12}CO_2$ and $^{13}CO_2$ bands overlap in such a way that their rotational lines have approximately equal absorbance at the anticipated isotopic ratio (~90) of carbon on Earth and Mars. Pairs of rotational lines we have studied are separated by as little as 0.050 cm^{-1}, but are well resolved with a TDL. Using sophisticated sweep integration and signal averaging techniques, we have measured the stable isotope ratio in carbon dioxide to a precision of better than 1%.