Perspectives in high-sensitivity detection of isotopologues with laser spectroscopy

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Isotopologues have been measured using gas-source isotope ratio mass spectroscopy. However, with the advent of infrared quantum cascade laser technology, high precision measurements of the isotopologues have been available for the last decade [e.g., 1]. Most notably, high-sensitivity detection of isotopologues of CO_2, CH_4, H_2O and N_2O by this kind of laser technology has been applied to the atmospheric measurement of the earth and Mars [2], and additionally to detect the doubly substituted CO_2 and CH_4 isotopologues for understanding the earth's climate [3, 4].

Sakai et al. (2014) reported a high-precision measurement of doubly substituted CO_2 isotopologue ($^{13}C^{18}O^{16}O$: 45ppm in abundance) derived from carbonates by a mid-infrared (4.3μm) quantum cascade laser spectroscopy. The ratio of the absorption curve areas yields <0.03‰ for $^{13}C^{18}O^{16}O/^{12}C^{16}O^{16}O$ with <1/10th sample volume compared with mass spectrometry. This result shows a brief glimpse of the promise of laser spectroscopy as a new measurement technology for high-sensitivity detection of isotopologues.

In this presentation, I will discuss a possibility that a mid-infrared laser spectroscopy, designed to measure the trace species and the isotopologues, could be applicable to the gas measurement in re-entry capsule of Hayabusa2.

[1] Tuzson, B. et al. 2008. *Infrared Physics & Technology*, 51, 198-206. [2] Webster, C.R. et al. 2013. *Science*, 341: 260-263. [3] Ono, S. et al. 2014. *Anal. Chem.*, 86: 6487-6494. [4] Sakai, S. et al. 2014. Abstract of 7th International Symposium on isotopomers, 76.