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すばる望遠鏡によって得られた火星 CO2 同位体分布
Global mapping of the CO2 isotopologues in the Martian atmosphere as observed Subaru/IRCS

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We investigated Martian CO2 isotopic ratios at 2-4 micron spectra observed by Subaru IRCS.

The determination of the isotopic ratios on Mars is important to study atmospheric evolution. The relative abundance of isotopes of CO2 provides insight into the loss of Mars primordial atmosphere. In addition, the distributions and variations of C and O isotopes can constrain the information about the magnitude and distribution of sources and sinks of CO2, i.e. the global coupling between surface, aerosols, and atmosphere. Photochemical reaction, condensation into the polar caps and aerosols, soil and subsurface reservoir respiration impart C and O isotope signals to the atmosphere that can be used as a tracer at various temporal and spatial scales.

High-resolution global imaging spectroscopy of Martian CO2 isotoplogues has been achieved at 2-4 micron (2970-3050 cm-1) by IRCS with Subaru telescope on 30 November 2011 (Ls=37), 4-5 January 2012(Ls=52), and 12 April 2012 (Ls=96). Owing to its wide wavelength coverage, our measurements obtained a comprehensive dataset of CO2 isotopes (626, 627, 628, and 636) & water vapor isotopes (H2O and HDO) simultaneously, providing a global perspective on their near-surface distributions.

Spectra were collected in the northern hemisphere at a spectral resolution of R=20,000. The diameter in these periods of Mars was more or less 9 arcsec. The seeing was 0.5-0.8 arcsec (pixel scale: 0.06 arcsec). We used two slit positions. The slit along the N-S direction on Mars covered the region between the northern polar cap and the equator, in order to investigate the sublimation of the polar cap and condensation into the CO2 ice clouds at mid-latitude. The W-E direction of the slit position was also selected in order to clarify the local-time dependence surrounding of sub-solar area. The mud volcanic regions, Utopia/Isidid Nilli Forssae, Sytris Major, were also covered by these observing runs.

Terrestrial absorptions were reduced using standard-star calibrations in order to retrieve the Martian isotope lines. After that, we could successfully obtained clear CO2 isotopes (626, 627, 628) absorptions in the range of 3330-3380 cm-1 for 626, 2620-2640 cm-1 for 627, and 2630-2660 cm-1 for 628, respectively. The 3400 cm-1 range shows lines of 636. Finally, the chosen spectral range involves plenty good enough lines of the Martian CO2 isotopes.

In this paper, we will present these isotopologues, their distributions, and seasonal variations. Their S/N will be quantitatively discussed.

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