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SUBARU/IRCS 観測による火星メタン分布および生成領域の探索
Spatial distribution and source region of Martian CH4 searched by the observation with SUBARU/IRCS

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We observed Mars for the search of CH4 in January and April 2012 using SUBARU/IRCS. It aims to clarify the spatial distributions and the production region of Martian CH4, which has only reported by the limited groups. The analysis is now on going. This paper will show the preliminary results.

In 2004, a small amount of CH4 was discovered in the Martian atmosphere (e.g., Formisano et al., 2004). This discovery is remarkable because its sources are potentially geological or biological activities (Atreya et al., 2007). However, it is still an open question what the CH4 producing mechanism is and where the source of CH4 is. The identification of the source of CH4 is important not only for scientific progress but also for future life exploring missions on Mars. That is because recently a CH4 oxidizing microorganism was discovered on the Earth (Beal et al., 2009), and such kind of life is potentially alive around the source of CH4 on Mars.

The Martian CH4 was detected by CSHELL (R=40,000) on NASA Infrared Telescope Facility (IRTF) (Mumma et al., 2009) and by Planetary Fourier Spectrometer (PFS) onboard Mars Express (MEX) (Geminale et al., 2011). However, the obtained spatial and temporal variations disagreed. At the moment, there are no other observational results. Zahnle et al. (2011) showed that the previous ground-based observations by IRTF/CSHELL had large uncertainties. It suggested that the contaminations from telluric 13CH4 lines would be fatal, which were 10-50 times stronger than the Martian CH4 lines. In order to characterize and eliminate such contaminations, we performed simultaneous observations of six independent Martian CH4 lines (3038, 3028, 3010, 3000, 2990 and 2979 cm-1) with and without contamination from telluric 13CH4 lines using IRCS echelle spectrograph (R=40,000) for SUBARU telescope. We attempted to investigate the spatial distribution and possible source areas of CH4, i.e. (1) the areas, where the extend plumes of CH4 were detected by IRTF/CSHELL and MEX/PFS, and (2) the mud volcanism areas. On Earth, mud volcanism vents major quantities of CH4 (10 x 106 tons/year), which have been estimated to be about 25 % of the CH4 released to the atmosphere each year by geological sources (Etiope and Klusman, 2002). On Mars, the potential for mud volcanism in the Northern Plains of Mars has been recognized. In particular, the mounds in Acidalia Planitia and the Utopia/Isidis pitted cones (UIPC) are suggested as mud volcanism areas (Dorothy and Carlton, 2010; McFowan, 2011). It is remarkable that the areas, where the extend plumes of CH4 were detected by IRTF/CSHELL, are located on the same outer ring of the Isidis basin that intersects UIPC, which suggests that the mud volcanism area might be the source of CH4. On 4-5 January 2012 using SUBARU/IRCS, we observed the UIPC and the areas observed before as being CH4 rich. The other mud volcanism area will be observed on 12, April 2012. The latter will be simultaneous observations with MEX/PFS in order to validate the results.

In addition to the observations with SUBARU/IRCS, we also investigate the vertical profile of CH4 using MEX/PFS. PFS is currently the best space-born instrument for the detection of CH4 although due to the limitation of its spectral resolution the observed absorption depth of CH4 is reduced by a factor of 100 compared to the high resolution one. The vertical profile of CH4 is of interest because Formisano et al (2009) suggested that the maximum abundance of CH4 was not observed close to the soil, but in the middle of the atmosphere at 25-35 km. In order to derive the quantitative profile, we adapt the SARTre model, a radiative transfer code with multiple scattering for limb geometry observations developed for the terrestrial atmosphere (Mendrok, 2006), to be applied for the Martian atmosphere together with PFS team. In the presentation, the current status of the model development will also be reported.

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