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## Search of H<sub>2</sub>O<sub>2</sub> in the Martian atmosphere by MEX/PFS

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Recently, a small amount of CH<sub>4</sub> was discovered in the Martian atmosphere. This discovery is remarkable because its sources are potentially biological or geological actives. However, its source, circulation and sink are still open questions. Recent observations showed the temporal and spatial variation of CH<sub>4</sub>, which requires fast loss, which might indicate strong oxidants. H<sub>2</sub>O<sub>2</sub> would be the best tracer for the amount of possible oxidants in the Martian atmosphere. However, past ground-based and space-born observations were very limited. Thus, the temporal and spatial variations of H<sub>2</sub>O<sub>2</sub> have not been understood yet.

H<sub>2</sub>O<sub>2</sub> has not detected from a Martian orbiter because it required high-spectral resolution in order to distinguish between weak absorption lines of H<sub>2</sub>O<sub>2</sub> (~0.1% of the background radiance) and stronger absorptions by H<sub>2</sub>O. At the moment, the Planetary Fourier Spectrometer (PFS) onboard Mars Express (MEX) is the best instrument for this objective, which has been successfully operated for seven years. It possesses the highest spectral resolution in the mid-IR range (~1.3 cm<sup>-1</sup>) in previous orbiters. However, even this resolution could not completely separate H<sub>2</sub>O<sub>2</sub> from H<sub>2</sub>O. We need careful treatment in the analysis.

In our study, we select the wavelength range from 360 to 385 cm<sup>-1</sup> where the contamination of H<sub>2</sub>O<sub>2</sub> by H<sub>2</sub>O is minimum. And, the sensitive calibration was performed: (1) FFT with the Hamming apodization, (2) characterization of a weak instrumental noise, and (3) careful averaging several thousands of measurements. In order to retrieve the mixing ratio of H<sub>2</sub>O<sub>2</sub>, the radiative transfer model for the Martian atmosphere has also been developed. By the comparison of the observed spectra with the model, we succeeded to determine the mixing ratio of Martian H<sub>2</sub>O<sub>2</sub> with the accuracy of several tens ppb. By this method, (1) total average, (2) annual variation, and (3) seasonal variation of the H<sub>2</sub>O<sub>2</sub> mixing ratio was obtained with the data observed 3 Martian years (Jan. 2004 - Dec. 2009). The main results are summarized as follows.

(1) Total average: Total averaged H<sub>2</sub>O<sub>2</sub> mixing ratios have been successfully determined to be 45 +- 21 ppb in the forward pendulum direction, and 25 +- 18 ppb in the reverse pendulum direction, respectively.

(2) Annual variation: The annual mean amount of H<sub>2</sub>O<sub>2</sub> in the three Martian years (MY 27, 28, and 29) was investigated. The mixing ratios of H<sub>2</sub>O<sub>2</sub> were 50 +- 27 ppb and 43 +- 26 ppb at the MY 27, 0 - 89 ppb and 0 - 74 ppb at the MY 28 (upper limits), and 46 +- 21 ppb and 28 +- 20 ppb at the MY 29, respectively

(3) Seasonal variation: It shows the variation from 0 to 120 ppb during the observational period, with an average of 39 +- 16 ppb in total data set.

In all results of (1)-(3), derived amount of H<sub>2</sub>O<sub>2</sub> is slightly larger than that predicted by the photochemical models and past observations. This discrepancy would be due to (1) the bias of data selection; the high Martian temperature (only 250-270K) and the local time (only 10-16), and/or (2) the contribution of large but short enhancement in long-term average. In addition, it was noticed that the observational variations of CH<sub>4</sub> reported by previous works would not be explained by the process of photochemical loss even with our results.

Keywords: Mars, Atmosphere, Infrared spectroscopy, Methane, Oxidation, Hydrogen peroxide