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Pressure broadening coefficients of HO_2 for CO_2 and Ar at 625.66GHz for Martian atmosphere

Kota Kuribayashi (1,2), Asao Mizoguchi (1), Hideto Kanamori (1), Yasuko Kasai (1,2)

(1) Tokyo Institute of Technology, Ohkayama, Meguro-ku, Tokyo 152-8550, Japan, (2) National Institute of Information and Communications Technology (NICT), Nukui-kita, Koganei, Tokyo, 184-8795, Japan

Pressure broadening parameters are crucial to obtain the abundance of vertical profile of the atmospheric composition from spectroscopic remote sensing observations.

We determined the pressure broadening coefficients of the perhydroxyl (HO_2) radical for the carbon dioxide (CO_2) and the argon (Ar) respectively at the pure rotational transition at 625.66 GHz (N_{KaKc} = 10_{19} - 10_{010}, J = 10.5 - 10.5) in the vibronic ground state X^2A' by laboratory measurements. For the production of HO_2, the mercury-photosensitized reaction of the H_2 and O_2 precursors was used to provide an optimum condition for measurements of the pressure broadening coefficients. The measurements were carried out using a submillimeter-wave spectrometer that employs a backward wave oscillator (BWO) as the radiation source. Coefficients of pressure broadening for CO_2 and Ar at room temperature are determined by a convolution method. In this work, measurements were performed at room temperature as $\gamma(CO_2)$ = 7.457 $\pm$ 0.087 (3σ) and γ(Ar) = 2.193 $\pm$ 0.021 (3σ) MHz/Torr.

The Martian atmosphere pressure broadening coefficient, γ(Mars), can be estimated from $\gamma(CO_2)$, $\gamma(N_2)$, and γ(Ar) as γ(Mars) = $\gamma(CO_2)$ $\times$ 0.955 + $\gamma(N_2)$ $\times$ 0.027 + γ(Ar) $\times$ 0.016, where 0.955, 0.027, and 0.016 are the fractions of CO_2, N_2, and Ar in the Martian atmosphere. The Martian atmosphere broadening coefficient is estimated as γ(Mars) = 7.267 $\pm$ 0.085 (3σ) MHz/Torr at room temperature. The air-pressure broadening coefficient of the 625.66 GHz transition at room temperature was reported as γ(air) = 3.769 $\pm$ 0.067 (3σ) MHz/Torr (Mizoguchi et al, 2012). The ratio of γ(air) and γ(Mars) of HO_2 is 1.93, and this is larger than averaging one of γ(air) and $\gamma(CO_2)$ of HO_2 measured by Sagawa et al. (2009). The large ratio of HO_2 might cause the serious different of the abundance of the vertical profile in Martian atmosphere.

We plan to make a comparison of the spectrum simulated by the line-by-line radiative transfer calculations using our estimated pressure broadening coefficient of Martian atmosphere and the AMATERASU (Advanced Model for Atmospheric Terahertz Radiation Analysis and Simulation, Baron et al., 2008) forward model.