A POSSIBLE SOLUTION TO THE EARLY MARS PROBLEM: EXPERIMENTALLY VERIFIED COLLISION-INDUCED ABSORPTION CROSS-SECTIONS OF CO_2-H_2 AND CO_2-CH_4 COMPLEXES.

Paul J. Godin[1], C. Campbell[1], T. G. Nguyen[1], T. Wizenberg[2], K. Strong[2], and J. E. Moores[1], [1]Department of Earth and Space Science and Engineering, York University, 4700 Keele Street, Toronto, ON, M3J 1P3, Canada, pgodin@yorku.ca, [2]Department of Physics, University of Toronto, 60 Saint George Street, Toronto, ON, M5S 1A7, Canada

An unanswered question in planetary science is how could the early Martian atmosphere have maintained a greenhouse effect sufficient to allow for liquid water on the surface? A recent study by Wordsworth et al. [1] suggested that previously unaccounted-for collision-induced absorption (CIA) by carbon dioxide (CO_2) and hydrogen gas (H_2), and by CO_2 and methane (CH_4) could provide the additional atmospheric absorption needed to trap enough radiation to raise the Martian surface temperature above freezing. To date the only CIA cross-sections for CO_2-H_2 and CO_2-CH_4 complexes in the literature are only at room temperature and cover a spectral range of 60 to 535 cm^{-1} [2].

Preliminary results will be presented from experimental measurements of the CIA cross-sections for CO_2-H_2 and CO_2-CH_4 complexes performed using Fourier Transform Spectroscopy. We have obtained Beamtime at the Canadian Light Source Far-IR beamline which will allow us to derive Cross-sections over a spectral range of 0-3000 cm^{-1} and a temperature range of 200-350 K. In addition to allowing us to experimentally validate the hypothesis of Wordsworth [1] and the measurements of Tubert et al. [2], the cross-sections so obtained can also be applied to other planetary systems with CO2-rich atmospheres, such as Venus, and will be useful to terrestrial spectroscopists.

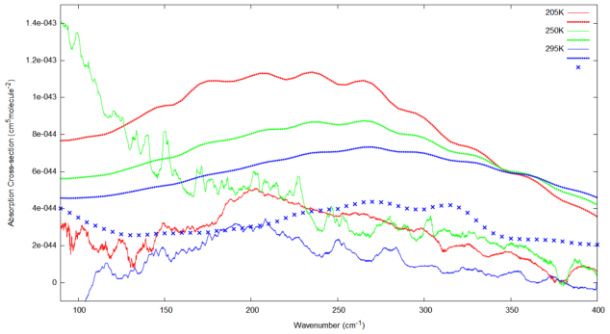

Fig. 1: CO_2-CH_4 CIA from this work (solid lines) along with comparisons to Wordsworth et al. (dotted lines) [1] and Turbet et al. (X line) [2].

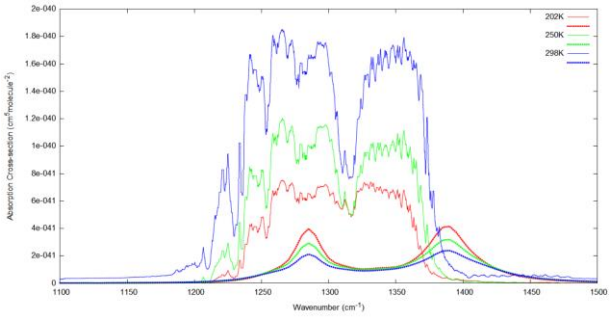

Fig. 2: CO_2-CH_4 CIA from with work (solid lines) along with comparisons to Wordsworth et al. (dotted lines) [1], which are increased by a factor of 100. CO_2-CO_2 CIA is assumed to be 0 in this spectral range.

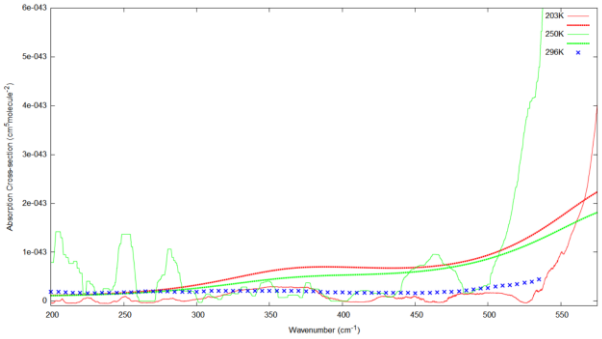

Fig. 3: CO_2-H_2 CIA from this work (solid lines) along with comparison to Wordsworth et al. (dotted lines) [1] and Turbet et al. (X line) [2].

References:

[1] Wordsworth, R., *et al.* (2017), Geophys. Res. Lett., 44, 665–671, doi:10.1002/2016GL071766.

[2] Turbet M., *et al.* (2019), Icarus, 321, 189-199, doi: 10.1016/j.icarus.2018.11.021.