A POSSIBLE SOLUTION TO THE EARLY MARS PROBLEM: EXPERIMENTALLY VERIFIED COLLISION-INDUCED ABSORPTION CROSS-SECTIONS OF CO₂-H₂ AND CO₂-CH₄ COMPLEXES.

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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 (CO₂) and hydrogen gas (H₂), and by CO₂ and methane (CH₄) 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 CO₂-H₂ and CO₂-CH₄ 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 CO₂-H₂ and CO₂-CH₄ complexes performed using Fourier Transform Spectroscopy. We have obtained Beam-time 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: CO₂-CH₄ 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: CO₂-CH₄ CIA from this work (solid lines) along with comparisons to Wordsworth et al. (dotted lines) [1], which are increased by a factor of 100. CO₂-CO₂ CIA is assumed to be 0 in this spectral range.

Fig. 3: CO₂-H₂ CIA from this work (solid lines) along with comparison to Wordsworth et al. (dotted lines) [1] and Turbet et al. (X line) [2].

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