CO_2 absorption in the far wings of rovibrational bands: implications for Venus nightside observations.

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High atmospheric pressure poses a serious challenge to spectroscopic studies of Venus, in particular, because in the lower atmosphere, the shape of spectral lines becomes significantly different from the classical Voigt profile. As near the line center, the shape is nearly unchanged, in the far wings the actual absorption is by several orders of magnitude lower than predicted by Lorentzian formfactor. On the other hand, it is transparency windows in between strong CO_2 rovibrational bands, where lower atmosphere of Venus is available for observations and where most of radiative flux from the deep atmospheric layers takes place. To date, a few empirical line shape profiles have been used to explain the observed radiances in the transparency windows, based on specified sub-Lorentzian exponential cutoff. We have explored available theoretical approaches to construct the model profile reproducing CO_2 absorption in the high range of pressure and temperatures. We concluded that a simple model of line mixing in the strong collision approximation, which results in fourth-power decay of the band wings, provides more accurate fitting to both Venus observation and laboratory data than the empirical profile in the mid-IR range. However, this model lacks accuracy in the shortwave range, in particular in the 1.2 μm transparency window. Employing a tuneable factor controlling coupling between rotational branches substantially improves the fitting. Further improvement of the model includes taking into account the effect of intermolecular potential leading to the exponential decay of very far wings overlaying the conventional line-mixing band shape.