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Retrieving the ratios of soft to hard velocity-changing collision's frequencies from H_2O line profiles near 0.8 μm

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It was shown in Refs. [1–3] that soft velocity-changing collisions with scattering on small angles ~0.1…0.3 rad flatten a line profile due to reducing the Dicke's line narrowing caused by hard collisions with large-angle scattering. In the limit of negligible hard collisions the line profile tends to the Voigt one. The theory [1–3] contains the parameters additional to the parameters inherent in the conventional hard collision model profiles, i.e. the frequency and mean angle of scattering for soft collisions. Thus, there is an opportunity to retrieve the ratio (R) of soft to hard collision's frequencies from processing experimental line profiles with the theory simultaneously taking into account both soft and hard collisions. As a result of such processing it was ascertained that in the case of dipole-dipole interaction between water vapor molecules soft collisions dominate hard ones ($R > 0.95$) and for dipole-quadrupole interaction of H_2O and N_2 molecules this ratio is lesser ($0.8 > R > 0.5$) that agrees with the theoretical estimations [3] made with the aid of calculated collision integral kernel.

Water vapor line self-broadening and broadening by nitrogen pressure was studied in 12411–12421 cm^{-1} spectral range using optoacoustic spectrometer with Ti-Sapphire laser having 50 kHz linewidth of generation [4].

References

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