TEMPERATURE BEHAVIOR OF THE 3_{13}-2_{20} WATER VAPOR SPECTRAL LINE SELF-BROADENING

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This paper presents some results of an experimental study of the temperature behavior of the collisional self–roadening of the 3_{13}–2_{20} water vapor absorption line in the ground state in the temperature range 266–376 K. It is shown that temperature dependence of a self–roadening parameter can be approximated, accurately to the measurement error, by a power law with the power factor $N = 0.66$ (6). A comparision of experimental results with data of other experiments and theoretical predictions is carried out.

Investigations of temperature dependence of selfbroadening of the 3_{13}–2_{20} absorption line of a water vapor molecule in its ground state have been conducted using a RAD spectrometer[1] and an SSCh synthesizer of submillimeter waves.[2] A technique of measuring a spectral line half–width using the RAD+SSCh complex and frequency modulation was described previously in Ref 3. Thermostatic control of the RAD cell made of copper was perfomed with liquid nitrogen. During experiments the pressure inside the cell was controlled with two vacuum gauges providing the accuracy of pressure measurements better than 5%. Temperature of the cell walls was measured using two platinum thermoresistor V12, a standard TSPN–3 providing 0.01 K accuracy of temperature measurements and a TSP–5071 thermoresistor. Temperature gradient along the cell did not exceed 0.2 K during the frequency measurement and maximum temperature change was below 0.3 K.

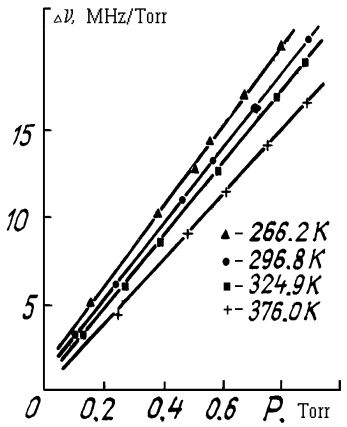

FIG. 1. The pressure dependence of the 3_{13}–2_{20} water vapor absorption line half–width at different temperatures.

Measurements of the 3_{13}–2_{20} line half–width were perfomed at pressures 0.15–0.9 Torr and at temperatures 266–376K. Pressure behaviours of the 3_{13}–2_{20} absorption line half–width of the water vapor molecule observed at different temperatures are shown in the figure and the parameters of self–broadening determined at the same temperatures are presented in Table.

TABLE I. The values of the 3_{13}–2_{20} water vapor absorption line selfbroadening parameter at different temperatures.

T, K	266.2 (3)	296.8 (3)	324.9 (3)	376.0 (3)
$\Delta\nu_{br}$ MHz/Torr	23.83 (35)	21.69 (45)	20.81 (50)	18.90 (30)

The temperature dependence of self–broadening was approximated by the power law

$$\Delta\nu_{br}(T) = \Delta\nu_{br}(296)\left(\frac{296}{T}\right)^{N}. \quad (1)$$

The fitting of the experimental data made on a computer using the least–squares method has shown that within the experimental error the data presented in the table are well approximated by formula (1) with $N = 0.66$ (6). This value of the power factor essentially differs from the N values measured by French groups ($N = 1.17$ (6)[4] and $N = 0.85$ (5)[5]).

The value of N obtained in this study well agrees with the theoretical predictions $N = 0.649$ and $N = 0.659$ obtained in Refs. 6 and 7 based on the ATS method and $N = 0.664$ and $N = 0.673$ obtained in Ref. 7 using the QFT technique. The theoretical prediction of $N = 0.79$ in Ref. 5 also differs from the value we have obtained in this study.

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