SUB-DOPPLER SATURATION SPECTROSCOPY WITH THE COLOGNE THZ SPECTROMETER

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With the Cologne terahertz spectrometer (1) we have performed Lamp-dip measurements in the submillimeter wave region. The large output power of the frequency and phase stabilized backward wave oscillators (typically between 10 mW and 1 mW in the frequency range 300 GHz to 1000 GHz) was sufficient to saturate various molecular transitions. Together with the power reflected from the bolometer it has been possible to observe saturation dips in a free space absorption cell, whereby no further means have been required. Different molecules such as NH_3, HCl, and some of their isotopomers have been measured with sub-Doppler resolution at 570 GHz and 625 GHz. In the case of ammonia the ^{14}N hyperfine structure of the lowest ro-inversion transitions $J = 1 \leftarrow 0$ in the ground and $J = 0 \leftarrow 1$ in the $v_2 = 1$ vibrational state has been fully resolved. The absolute frequencies have been measured with an accuracy of about 1 kHz. For the $v_2 = 1$ state the quadrupole coupling constant eqQ and the nuclear spin-rotation coupling constant C_N determined from this saturation dip measurements are $eqQ(v_2, J, K, s) = eqQ(1, 1, 0, s) = -4433.8(20)$ kHz and $C_N = 6.38(60)$ kHz.
The value of C_N for the vibrational ground state has been determined to be 6.7(3) kHz, whereby the eqQ value has been fixed to the number given by Hougen (2). This value is in very good agreement with the value $C_N = 6.80734$ kHz determined by Kukolich from two cavity maser measurements of the pure inversion transitions (3).
The present data confirm new possibilities for high resolution molecular spectroscopy in the submillimeter wave region. The parameters of the spectrometer and some recent results of sub-Doppler saturation measurements will be discussed.

(1) G. Winnewisser, Vib. Spectrosc. 8, 241 (1995).
(2) J.T. Hougen, J. Chem. Phys. 57, 4207 (1972).
(3) S.G. Kukolich, Phys. Rev. 156, 83 (1967).