High Resolution Spectroscopy of HCN Isotopomers: $H^{13}CN$, $HC^{15}N$, and $H^{13}C^{15}N$ in the Ground and First Excited Bending Vibrational State

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The eleven energetically lowest pure rotational transitions, $J \leftarrow J-1$ ($J = 1, 2, \ldots, 11$), of $H^{13}CN$, $H^{13}C^{15}N$, and $HC^{15}N$ in the ground and first excited bending state were measured. By operating the Cologne Tetrahertz Wave Spectrometer up to 1 THz in the sub-Doppler mode, a transition frequency accuracy of a few kHz is achieved. These measurements were carried out at frequencies between 80 – 950 GHz. In addition, some transitions of the three isotopomers with rotational quantum numbers $J = 20, 21, 22, 23$ have been measured in Doppler-limited resolution near 2 THz, using the frequency stabilized Cologne Sideband Spectrometer for Terahertz Applications (COSSTA). Furthermore, direct l-type transitions of $H^{13}CN$ in the first excited bending state with J up to 35 have been measured. These new data are of particular importance, since we discovered highly excited circumstellar $H^{12}CN$ recently. A global fit of the newly enlarged data set together with existing carefully screened ro-vibrational data yields molecular constants which are highly reliable and of great importance both for astrophysical observations and laboratory applications.

Key words: Molecular Spectroscopy; Sub-Doppler Spectroscopy; High Resolution Spectroscopy; HCN; Microwave Spectroscopy; THz Spectroscopy; Hyperfine Structure; Direct l-type Transition.