HIGH-RESOLUTION ROTATIONAL SPECTROSCOPY OF THE CARBON CHAIN ANIONS C$_3$N$^-$, C$_4$H$^-$, AND C$_4$D$^-$

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The rotational spectra of C$_3$N$^-$, C$_4$H$^-$, and C$_4$D$^-$ have been observed at high spectral resolution by Fourier transform microwave spectroscopy. For both C$_3$N$^-$ and C$_4$D$^-$, frequencies of the hyperfine components in the lowest-$J$ transitions have been determined to better than 0.1 ppm. The derived quadrupole coupling constants $\epsilon Q q$ for both anions are in good agreement with theoretical predictions. A number of other properties of these anions, including linewidths and rotational temperatures, have been systematically studied with respect to similar-sized neutral molecules. The production of C$_4$H$^-$ using different hydrocarbon precursor and buffer gases has also been investigated.