ASTRONOMICAL DETECTION OF THE INTERSTELLAR ANION $C_{10}H^-$ TOWARDS TMC-1 FROM THE GOTHAM LARGE PROGRAM ON THE GBT

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Using data from the GOTHAM (GBT Observations of TMC-1: Hunting for Aromatic Molecules) survey, we report the first astronomical detection of the $C_{10}H^-$ anion. The astronomical observations also provided the necessary data to refine the spectroscopic parameters of $C_{10}H^-$. From the velocity stacked data and the matched filter response, $C_{10}H^-$ is detected at $>9\sigma$ confidence level at a column density of $4.04^{+10.67}_{-2.23} \times 10^{11}$ cm^{-2}. A dedicated search for the $C_{10}H$ radical was also conducted towards TMC-1. In this case, the stacked molecular emission of $C_{10}H$ was detected at a $\sim$3.2σ confidence interval at a column density of $2.02^{+2.68}_{-0.82} \times 10^{11}$ cm^{-2}. However, since the determined confidence level is currently $<5\sigma$, we consider the identification of $C_{10}H$ as tentative. The full GOTHAM dataset was also used to better characterize the physical parameters including column density, excitation temperature, linewidth, and source size for the C_4H, C_6H and C_8H radicals and their respective anions, and the measured column densities were compared to the predictions from a gas/grain chemical formation model and from a machine learning analysis. Given the measured values, the $C_{10}H^-$/$C_{10}H$ column density ratio is $\sim 2.0^{+5.9}_{-1.6}$ - the highest value measured between an anion and neutral species to date. Such a high ratio is at odds with current theories for interstellar anion chemistry. For the radical species, both models can reproduce the measured abundances found from the survey; however, the machine learning analysis matches the detected anion abundances much better than the gas/grain chemical model, suggesting that the current understanding of the formation chemistry of molecular anions is still highly uncertain.

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[a]Presenting on behalf of the entire GOTHAM collaboration