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Title	High-resolution Fourier Transform Infrared (FTIR) Spectroscopy of acetylene molecules ( $^{12}\text{C}_2\text{H}_2$ , $^{12}\text{C}_2\text{HD}$ and $^{12}\text{C}_2\text{D}_2$ )
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## ABSTRACT

The high resolution Fourier transform infrared (FTIR) spectrum of acetylene and deuterated acetylene were recorded and analyzed.  $\nu_1$ ,  $\nu_3$ ,  $\nu_4$ ,  $\nu_5$  and  $\nu_4 + \nu_5$  bands of  $^{12}\text{C}_2\text{HD}$ ,  $\nu_3$  and  $\nu_5$  bands of  $^{12}\text{C}_2\text{H}_2$  and  $\nu_3$  and  $\nu_5$  bands of  $^{12}\text{C}_2\text{D}_2$  were recorded from wavenumber  $400\text{ cm}^{-1}$  to  $750\text{ cm}^{-1}$  at a resolution of  $0.00096\text{ cm}^{-1}$  and  $1000\text{ cm}^{-1}$  to  $3400\text{ cm}^{-1}$  at a resolution of  $0.0063\text{ cm}^{-1}$ . In total, 671 rovibrational transitions were assigned using a least-square fit analysis. The vibration-rotation energy expression and effective rotational constants of linear tetra-atomic molecules of acetylene and its deuterated forms were derived. The root-mean square (rms) deviation of the fit for  $\nu_1$ ,  $\nu_3$ ,  $\nu_4 + \nu_5$  bands of  $^{12}\text{C}_2\text{HD}$  was found to be  $0.000264\text{ cm}^{-1}$  and  $0.000117\text{ cm}^{-1}$  for  $\nu_4$  and  $\nu_5$  bands. The rms deviation of the fit of the  $\nu_3$  band of  $^{12}\text{C}_2\text{H}_2$  was  $0.000619\text{ cm}^{-1}$  and  $0.000180\text{ cm}^{-1}$  for the  $\nu_5$  band. The rms deviation of the fit analysis of the  $\nu_3$  and  $\nu_5$  band of  $^{12}\text{C}_2\text{D}_2$  was found to be  $0.000241\text{ cm}^{-1}$  and  $0.000617\text{ cm}^{-1}$  respectively. The band centres of the  $\nu_1$ ,  $\nu_3$ ,  $\nu_4$ ,  $\nu_5$  and  $\nu_4 + \nu_5$  bands of  $^{12}\text{C}_2\text{HD}$  were found to be  $3335.605605 \pm 0.000060870\text{ cm}^{-1}$ ,  $2583.607411 \pm 0.000063415\text{ cm}^{-1}$ ,  $519.3755803 \pm 0.000025091\text{ cm}^{-1}$ ,  $678.8008460 \pm 0.000023019\text{ cm}^{-1}$  and  $1200.498665 \pm 0.000097742\text{ cm}^{-1}$  respectively. The band centres of the  $\nu_3$  and  $\nu_5$  bands  $^{12}\text{C}_2\text{H}_2$  were calculated to be  $3294.840883 \pm 0.00020264\text{ cm}^{-1}$  and  $538.6370708 \pm 0.00010955\text{ cm}^{-1}$  respectively. Finally, the band centres of  $\nu_3$  and  $\nu_5$  bands of  $^{12}\text{C}_2\text{D}_2$  were determined to be  $2439.247248 \pm 0.000053475\text{ cm}^{-1}$  and  $538.6370708 \pm 0.00010955\text{ cm}^{-1}$  respectively.