SUBMILLIMETER-WAVE SPECTROSCOPY OF $HCOOCH_3$ AND $H^{13}COOCH_3$ IN THE TORSIONAL EXCITED STATES

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Methyl formate exists abundantly in interstellar hot cores and corinos and is known as an interstellar weed. Recently, normal methyl formate in its first excited torsional state ($v_t = 1$) was identified from U-lines towards Orion KL[a] based on laboratory measurements of methyl formate in $v_t = 1$ through 200 GHz[bc]. In our previous study of $HCOOCH_3$ and $H^{13}COOCH_3$ in the ground torsional state[d], the rotational-torsional spectrum was measured throughout the 100-380 GHz region with our FASSST apparatus. Among the rotational lines in the ground torsional state, satellite lines were also detected for both isotopic species. In this study, we have made new rotational-torsional assignments to $v_t = 1$ and 2 for both isotopic species based on previous microwave and millimeter-wave data on normal methyl formate in $v_t = 1$ and with the aid of reduced Fortrat diagrams. The rotational-torsional analysis of the A and E substates in a torsional state was performed with the ErHam program, which was developed for molecules with one or two internal rotors. Approximately 1000 transitions assigned to $v_t = 1$ were analyzed to a unitless standard deviation of 1 for the normal and $^{13}C_1$ species of methyl formate. A majority of transitions with high $J >\sim 20$ and high $K_a \geq 9$ in $v_t = 1$ showed large and systematic deviations in preliminary fits and were omitted in the final fit. The torsional assignments to $v_t = 1$ and 2 are supported with relative energies calculated from intensity ratios and molecular constants. The latest results of our internal rotation analysis of $HCOOCH_3$ and $H^{13}COOCH_3$ in thier torsional excited states will be discussed.

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