TORSIONALLY EXCITED DIMETHYL ETHER IN THE LABORATORY AND IN SPACE

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Dimethyl ether (DME) is highly abundant in hot cores and numerous transitions within the vibrational ground state have been detected in various interstellar line surveys of sources such as Orion KL[a,b]. As a nearly prolate asymmetric top with two internal rotors, it shows a complex spectrum with low lying torsional modes. The energy levels of the two lowest torsional states (v_{11}, and v_{15}) lie only 200 and 240 cm^{-1} above the ground state (barrier height $\approx 915\,\mathrm{cm}^{-1}$), and are thus sufficiently populated in these interstellar sources to exhibit transitions in line surveys due to high excitation temperatures in hot cores. So far, the lack of sufficiently accurate predictions for the two lowest excited torsional states prevented their identification in astronomical spectra. Therefore, we analyzed spectra, which have been recorded within the context of the investigations of the ground state[c,d]. In total, more than 9500 transitions have been assigned covering the frequency range from 38 up to 1670 GHz. The enlarged splitting of each rotational level into four substates (AA, EE, AE, EA) compared to its size in the ground state and a large number of perturbed transitions hampered not only the line assignment but also the astrophysical modelling. However, the inclusion of interaction terms between both excited states in the model of an effective Hamiltonian for a symmetric two-top rotor, allowed us to model both excited states within a global fit, and also to accurately determine the energy difference between both states. Frequency predictions have been calculated based on this analysis and have been used to unambiguously assign numerous rotational transitions within these excited states in the astronomical line survey of the hot core region G327.3-0.6.

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