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Cleo Whitcombe - Millimetre-wave spectroscopy of pyrrole: a model for astrophysical searches

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Pyrrole (c-C4H4NH) is a five-membered heterocyclic ring with C2v point group symmetry. The microwave and millimetre wave spectra of pyrrole and its isotopologues have been investigated since 1952, however, to improve the model's accuracy, we propose the laboratory search within the 60-78 GHz region in which no experimental data is available at present. The free-jet absorption millimetre wave spectrometer allowed us to measure 29 transition lines and a unique global fitting has been generated for the parent species in the ground state. From this, updated spectroscopic parameters have been obtained. Moreover, we measured new transition lines for the 13C isotopologues and the first excited state of the NH wagging motion. We aim to use the predictions to analyse radio astronomical surveys from the ALMA Archive. It is worth noting that other cyclic molecules have been identified since 2018 within the Taurus Molecular Cloud using single dish surveys. For example, a series of cyclic molecules have been detected such as benzonitrile (c-C6H5CN) [McGuire 2018], 1-cyanocyclopentadiene [McCarthy 2021] and 2-cyanocyclopentadiene [Lee 2021], which are possible due to the high electric dipole moment, μ>4 D, authorised by the cyano group. However, aromatic ring compounds with lower electric dipole moments, μ<1 D, have also been observed such as indene [Burkhardt 2021] and cyclopentadiene (c-C5H6) [Cernicharo 2021]. Unfortunately, recent searches of pyrrole in TMC1 were unsuccessful and fixed the column density upper limit to 13.43 cm-2 [Barnum 2022]. Barnum T.J. et al., ACS Earth Space Chem. 5 (2022) 2986. Burkhardt A.M. et al., Astrophys. J. Lett. 913 (2021) L18. Cernicharo J. et al., Astron. Astrophys. 649 (2021) L15. Lee K.L.K. et al., Astrophys. J. Lett. 910 (2021) L2. McCarthy M.C. et al., Nature Astronomy 5 (2021) 176. McGuire B.A. et al., Science 359 (2018) 202

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