Stability of diatomic carbon anion C_2^- in interstellar clouds: a time-resolved laboratory spectroscopy in a cryogenic ion storage ring

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The diatomic carbon C_2 is one of the most studied molecules as the simplest system having a C-C bond, and so are their ionic species C_2^+ and C_2^-. In astronomical observation, the A-X absorption line of neutral C_2 has been detected in the near-infrared spectrum of a luminous blue hypergiant Cyg OB2 No. 12. [1,2] On the other hand, C_2^+ and C_2^- are yet undetected so far, and their relevance to the C_2 abundance and chemical reaction network is not fully elucidated.

In this work, we carried out high-resolution rovibrational spectroscopy of C_2^- in a cryogenic ion storage ring RICE. [3] The photo-detachment spectrum in the 537.63 – 568.18 nm wavelength region (17600 – 18600 cm^{-1}) exhibited a lot of unassigned absorption lines, which were not ascribed to the known A-X and B-X transitions. Interestingly, these lines may or may not appear depending on how these C_2^- ions are produced in ion sources. Taking the unique advantage of the storage ring experiment, we analyzed the temporal evolution of the photo-detachment spectrum and identified a millisecond-order autodetachment process of C_2^-. [4]. The possible origins of these lines and their effect on the stability and reactivity of C_2^- in interstellar clouds will be discussed.

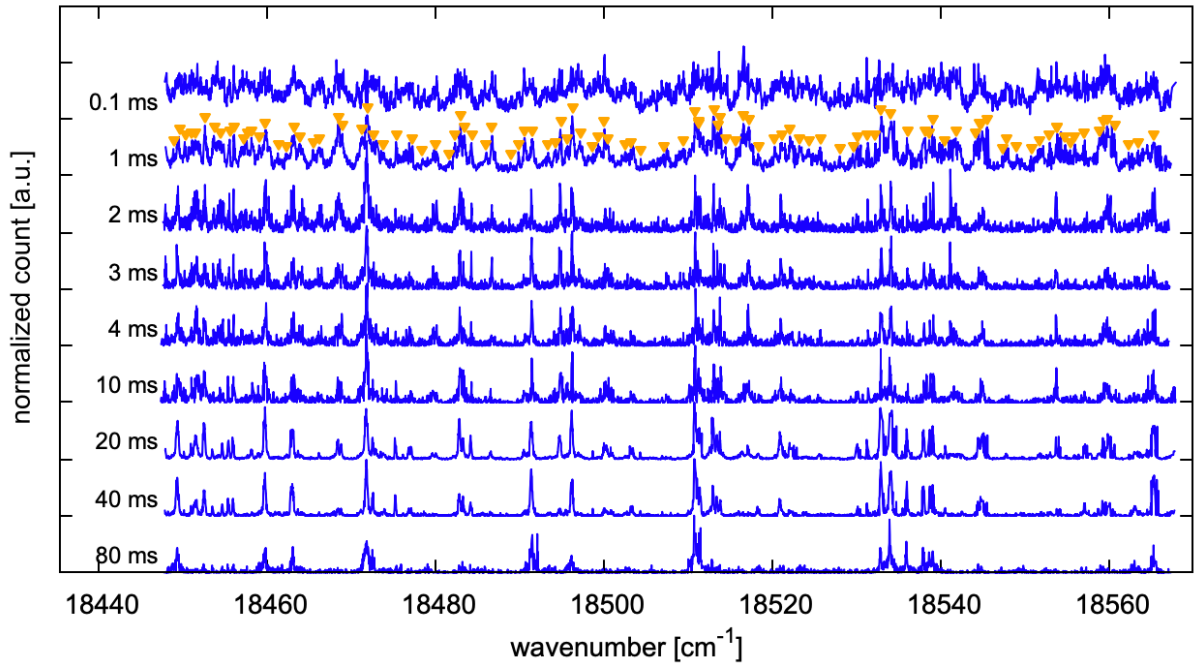

Fig1. A part of the C_2^- photo-detachment spectra recorded at different storage times.

[1] S.P. Souza and B.L. Lutz, *ApJL* 216, L49 (1977).
[2] S. Hamano *et al*., *ApJ* 881, 143 (2019) .
[3] Y. Nakano *et al*., *Rev. Sci. Instr.* 88, 033110 (2017).
[4] M. Iizawa *et al*., *J. Phys. Soc. Jpn* 91, 084302 (2022).