Lifetime measurements of chain hydrocarbon anions and electron detachment

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Since the discoveries of hydrocarbon anions, such as C_4H^-, C_6H^-, and C_8H^-, in the carbon-rich circumstellar clouds, various chemical models have been proposed to understand the formation dynamics of anions in space. Especially, electron attachment/detachment processes play an important role to derive anion-to-neutral ratios in the clouds. However, the discrepancy still exists between models and observations. In order to comprehend the detachment processes, we measured lifetimes of metastables of the chain hydrocarbon anions, C_4H^- and C_6H^-, in the time range between milliseconds and seconds by using an electrostatic ion storage ring at Tokyo Metropolitan University (TMU E-ring) [1].

The anions, extracted from a cesium sputter ion source at energy of 20 keV, were stored in the ring. Then, neutral particles due to electron detachment during the anion storage were detected by micro-channel plates located at an extension of a straight section of the ring. The vacuum in the ring was kept about 5×10^{-9} Pa in operation.

The decay plots of the C_4H^- and C_6H^- anions are shown in figures 1 (a) and (b), respectively. Very slow decays were observed, which were in the time range of seconds, due to electron detachment collision-induced by residual gas in the ring. On the other hands, rapid decays appeared shorter than 20 ms, due to electron detachment for metastable anions. Each decay curve can be applied neither single exponential nor $1/t$ functions, but a multiple exponential function. The decay of C_6H^- is faster than that of C_4H^-. We will discuss the decay rates comparing the ones from a theoretical model [2].

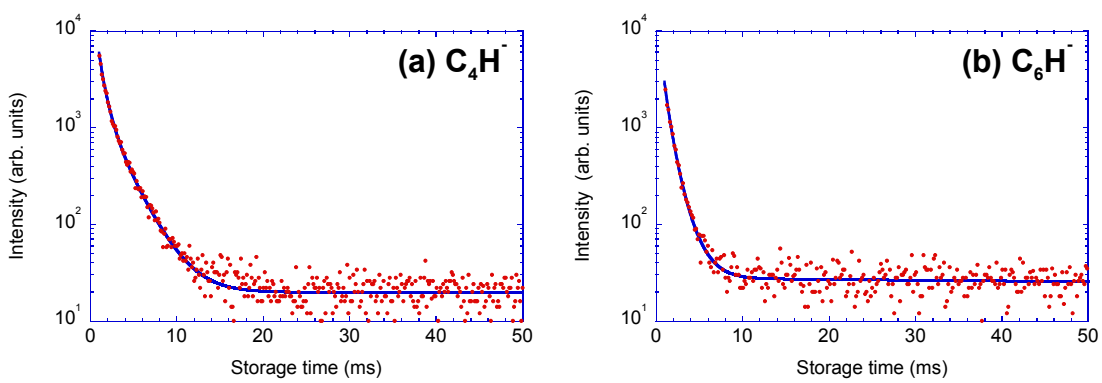

Figure 1. Decay plots of (a) C_4H^- and (b) C_6H^- anions stored in the ring. Each plot shows the data acquired at the first 50 ms. Solid line: the curve in each plot was fitted with multiple exponential components.

References

[1] Jinno S *et al.* 2007 *Nucl. Instrum. Meth. A* **572** 568.
[2] Herbst E and Osamura Y 2008 *ApJ* **679** 1670.

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